IOWA STORMWATER MANAGEMENT MANUAL

5.03 VEGETATED FILTER STRIPS

IOWA Department of Natural Resources

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Refer to the glossary for words in **bold black text.**
Some items of emphasis are in **bold blue text.**

5.03-1 LAYOUT AND DESIGN

A. SUMMARY

Vegetated filter strips are areas of land that are graded uniformly to maintain sheet flow and reduce the potential for water to concentrate into specific flow paths. These filter strips may be used as **pretreatment** practice, placed upstream of other water quality or quantity **best management practices** (BMPs). These types of practices may be used to reduce the potential for sediments and nutrients from being washed to downstream BMPs. When dense permanent vegetation is established at ground level (such as dense turf grasses and native grasses and forbs) water is filtered and infiltration is promoted.

DESIGN PROCESS OVERVIEW

1. Complete Site Evaluation and Planning
2. Develop Site Into Watershed Subareas and Identify Locations for BMPs
3. Locate Pretreatment Practices
4. Develop Maintenance Plan
5. Integrate into Stormwater Plan

MAINTENANCE REQUIREMENTS

1. Designate Responsible Parties for Maintenance
2. Complete Construction Sequencing
3. Remove Accumulated Sediment and Debris Frequently from Pretreatment Area
4. Perform Regularly Occurring Maintenance on Inlets and Plant Materials

Vegetated Filter Strip along a creek in Davenport, Iowa.

NOTE

See Section 5.03-1-C for more information on limitations on tributary area.

NOTE

See additional information in Section 5.03-2 on integration of SQR in design calculations.

B. APPLICATIONS

MOST SUITABLE LOCATIONS

Filter strips should be located "on contour", meaning they should be level when traveling along a line perpendicular to the direction of flow. ESSENTIAL They may be located adjacent to the perimeters of ponds and wetlands to reduce nutrients and fertilizers applied to turf lawn areas. They also may be placed adjacent to impervious surfaces, although filter strips can only provide pretreatment for small areas of **impervious** cover. Water must be spread evenly as it enters the filter strip from an impervious area. This is critical to understand, as the treatment the strip provides will be much more limited once flow begins to concentrate. Once within the strip, sheet flow can only be maintained for short distances, which is why the impervious area each strip can treat is limited.

Filter strips should be constructed features when they receive runoff from impervious surfaces. **Undisturbed areas with natural vegetation should not be used for pretreatment of paved surfaces.** These areas may have variances in slope that allow flow to concentrate, reducing the effects of the buffer or potentially leading to rill or gully erosion. Areas with natural vegetation may be preserved or enhanced to act as buffers around ponds and wetlands, when the tributary area will be primarily open space.

KEY POLLUTANTS OF CONCERN

When filter strips are used as a pretreatment practice, they typically reduce suspended sediments. When established near ponds and wetlands, they may also be used to reduce the amount of fertilizers and nutrients from adjacent turf lawn areas.

UNIFIED SIZING CRITERIA

Vegetated filter strips as described in this section are primarily intended for use as pretreatment measures. However, they can be designed to include **Soil Quality Restoration** (SQR) to provide water quality benefits by allowing runoff from small areas of impervious cover to be evenly spread across an area where SQR is applied.

C. DESIGN ELEMENTS AND CRITERIA

TRIBUTARY AREA

When placed against paved surfaces (such as a parking lot or roadway without a curb edge), **the filter strip should not receive runoff from more than a 60 feet length of paved area measured from the parking edge.** ESSENTIAL

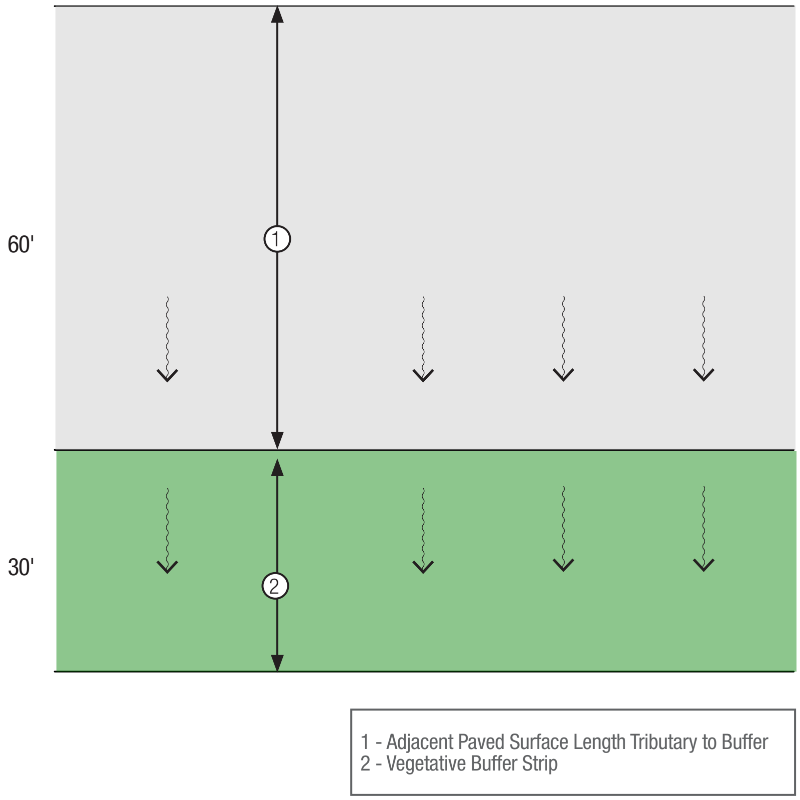
TYPICAL ENTRY POINTS FROM IMPERVIOUS SURFACES

When runoff enters the filter strip from the edge of a paved surface, **flow must not be funneled into concentrated flow paths.** ESSENTIAL Along parking areas, the edge of the paving should generally be level (when measured along a line perpendicular to flow). For roadways without a curb, the roadway edge can be sloped, as long as the roadway surface doesn't funnel flow into a concentrated path (such as at the low point in a roadway).

A maintenance strip is recommended along paved edges of parking lots or paved storage areas. The purpose of this maintenance strip is to provide a place where heavier sediments can be trapped and removed more easily than from within the vegetated strip. This maintenance strip should be three (3) to five (5) feet wide. The surface should be stabilized with one of the following: TARGET

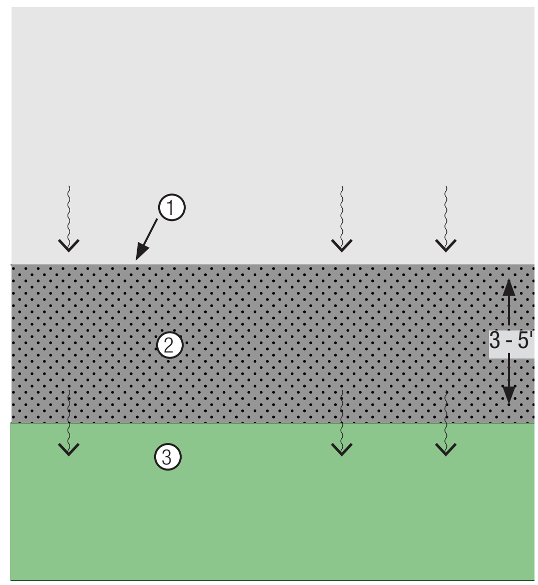
- Aggregate materials (free of fine materials) that are one (1) to four (4) inch in diameter
- Paver blocks
- Articulated concrete blocks
- Vegetated concrete mats

Tributary Area

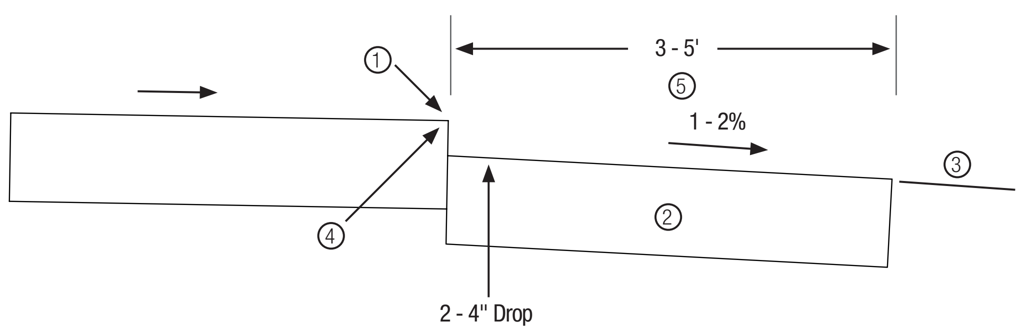


- The edge of the maintenance strip against the paved edge should be set two (2) to four (4) inches below the edge of a paved parking area. This drop is to prevent accumulating sediment from building up and causing water to pond up on the pavement. TARGET
- The slope across the maintenance edges should be one (1) to two (2) percent. This flatter slope enhances the potential for sediment to be intercepted. TARGET
- The downslope side of the maintenance strip should have some type of edger that separates it from the adjacent vegetation and promotes uniform flow into the filter strip. Along roadway shoulders the maintenance edge may be omitted. TARGET

Maintenance Strip



1 - Edge of Pavement
2 - Maintenance Strip
3 - Buffer Strip
4 - 2-4" Drop at Pavement Edge
5 - 1-2% Slope Across Maintenance Edge



LEVEL SPREADERS

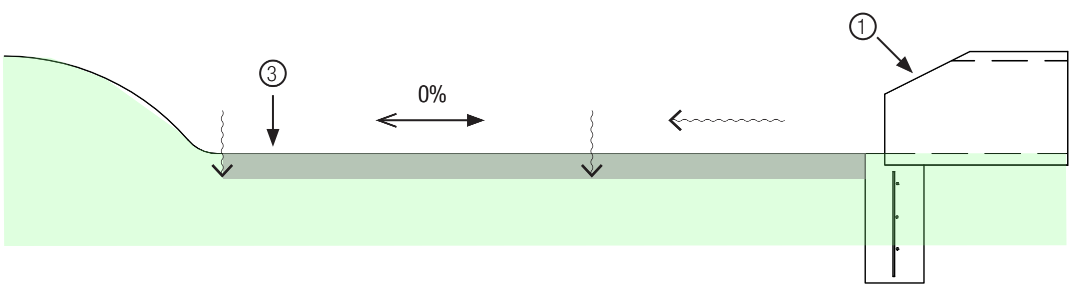
Runoff can also be routed into a vegetated buffer from a concentrated source, such as a roof downspout. However, the flow must be spread evenly across the filter strip at the upper edge. ESSENTIAL This can be accomplished by using a level spreader to spread concentrated flow out across a maintenance edge. Level spreaders can consist of pavers or blocks that are set level (when measured along a line perpendicular to how flow will pass through the filter strip), but slightly elevated from the maintenance strip, causing water to spread out and pond within the maintenance edge. Perforated pipes or trench drains set level (as measured perpendicular to flow through the strip) can also be used to spread flow across the strip.

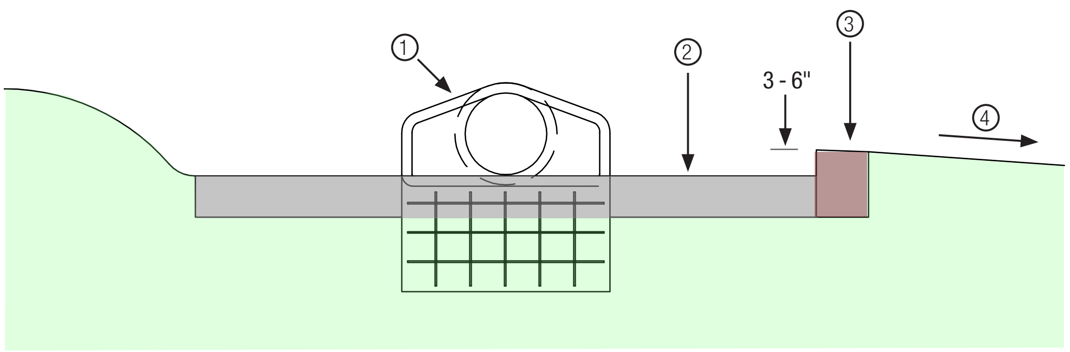
- The level spreader should be long enough to spread flow from the WQv event evenly across the buffer strip, at a rate of no more than 0.003 cfs per foot of buffer width (measured perpendicular to flow through the strip). ESSENTIAL
- When using a level spreader, the length of flow through the filter strip below the level spreader should be at least 30 feet from the level spreader. ESSENTIAL

NOTE

See additional information in Section 5.03-2 on the design of level spreaders.

Level Spreader - Option 1





1 - Pipe Outlet
2 - Stilling Area (3-6" Depth)
3 - Level Spreader (any type of durable material that can be laid flat)
4 - Buffer Strip

NOTE

These illustrations show concepts of how level spreaders can be constructed. Many different variations of this design are possible.

In this example, a level edge constructed from concrete, composite or other materials is used to spread flows over a determined width.

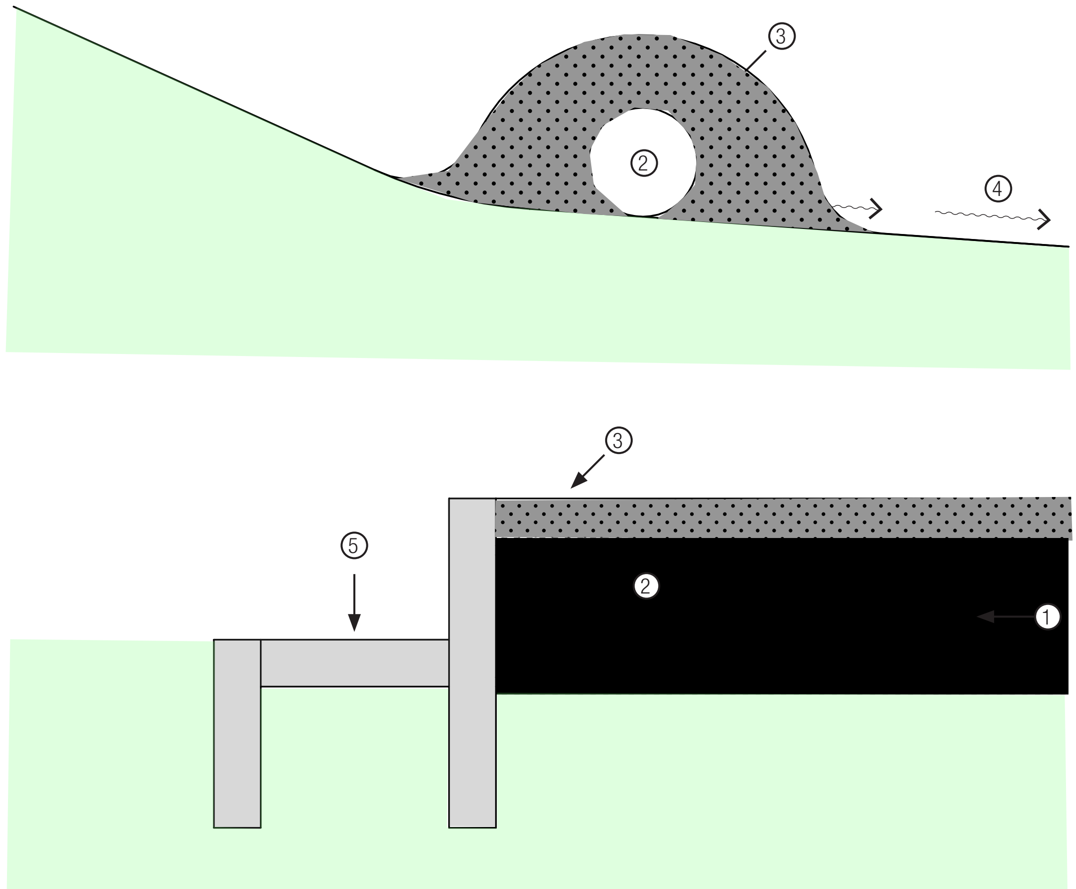
NOTE

These illustrations show concepts of how level spreaders can be constructed. Many different variations of this design are possible.

In this example, a perforated pipe surrounded by clean aggregate materials are shown. Slotted drain pipe materials could also be used for this purpose.

Level Spreader - Option 2

1 - Inlet Pipe (upstream)
2 - Perforated Pipe Laid Flat (or slotted drain laid sideways)
3 - 1" Clean Aggregate (IDOT Gradation No. 3)
4 - Buffer Strip
5 - Optional Large Storm Overflow (headwall or outfall structure with overflow set above head required to push WQv flow through pipe perforations)



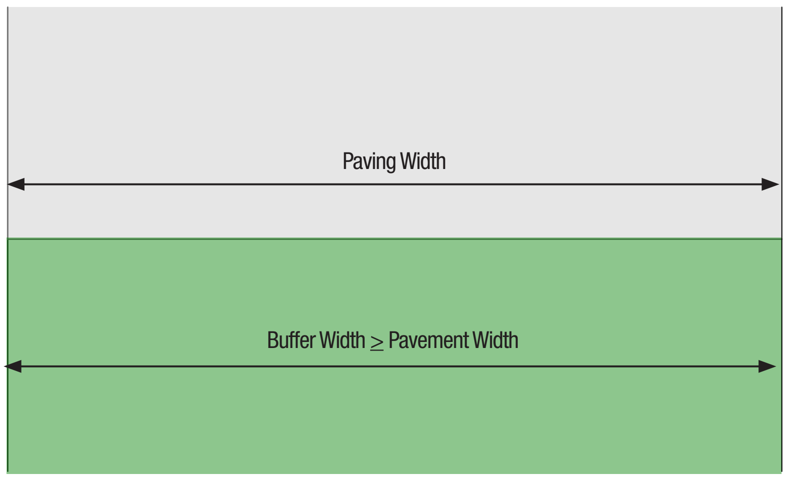
CROSS-SECTIONAL GEOMETRY

As noted previously, vegetated filter strips should be level when measured perpendicular to flow. Sufficient topsoil and/or soil quality restoration should be used to sustain desired vegetation. ESSENTIAL

- When receiving runoff from impervious surfaces, the filter strip should be at least as wide as the edge of the adjacent paved surface or level spreader. ESSENTIAL
- When used as a buffer for lawn areas along ponds and wetlands, the buffer should be wide enough that the peak flow from the 2-year storm event is spread evenly across the width of the filter strip at a rate of no more than 0.0075 cfs (cubic foot per second) per foot of buffer strip (measured perpendicular to flow through the strip). In these areas, the length of flow through the filter strip should be no less than 30 feet. ESSENTIAL

NOTE

See the Appendix of this section for information on how this guidance was derived.



LONGITUDINAL GEOMETRY

- The slope within the vegetated filter strip should be between one and four percent (1 – 4%). TARGET
- The filter strip should be graded to be "on contour", where the strip stays at the same elevation as you would travel across it parallel to flow. ESSENTIAL
- The filter strip should not be less than ten (10) feet in length (measured parallel to the direction of flow through the strip) and should be at least one-half (1/2) a foot in length for every foot of paved surface upstream of the buffer. The length of the buffer is measured from the downstream end of the maintenance edge. ESSENTIAL

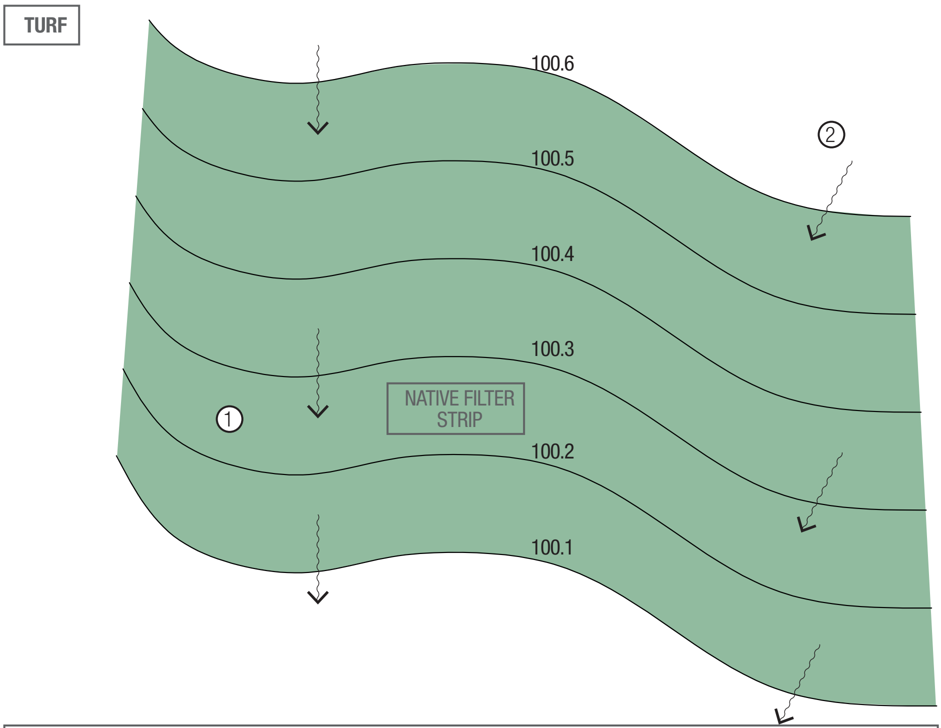
NOTE

See the Appendix of this section for information on how this guidance was derived.

This guidance was based on using Manning's equation to calculate flow velocity to provide an approximate travel time of 5 minutes through the buffer strip during the WQv storm event.

Table 5.03-1-1: Recommended length of flow through the filter strip.

For Paved Areas	For Other Areas		
Length of Pavement Approaching	WQv Peak Flow Into Buffer	2-Year Peak Flow Into Buffer	Length of Flow Through Buffer
(in feet)	(in cfs/foot of buffer)	(in cfs/foot of buffer)	(in feet)
10	0.0005	0.0012	10
20	0.0011	0.0025	10
30	0.0016	0.0038	15
40	0.0021	0.0050	20
50	0.0027	0.0063	25
60	0.0032	0.0075	30



1 - Shape Buffer to be on the Contour
2 - Buffer Width so that 2-Year Peak Flow Spread over Buffer width is Equal or Less than 0.0075 cfs/foot

VEGETATION

Permanent vegetation within the vegetated buffer strip may be sod, turf seeding, cool season grasses (similar to Type 2 seed mix, SUDAS Section 9010) or native seeding / plants. When used as a buffer along ponds and wetlands, native vegetation should be used. **The designer should consider the expected moisture conditions and expected maintenance routine when selecting permanent vegetation.** Native vegetation offers the benefit of deeper and more dense root structures which can absorb water more quickly and keeps the soil profile loose and more porous.

UNDERDRAINS

Underdrains may be used to allow the surface of the filter strip to dry out between rainfall events. This may be most beneficial when the filter strip is to be maintained as turf grass, where mowing will be frequently occurring. When used, underdrains should be perforated PVC or HDPE materials, at least four (4) inches in diameter. TARGET

When used, they should be spaced so that at least 10% of the surface area of the filter strip is within one (1) foot of the centerline of a subdrain. In essence, a buffer less than 20 feet in length should have at least one subdrain running perpendicular to flow. Buffers greater than 20 feet in width should have an additional subdrain, placed in the upper half of the buffer. The underdrain should be connected to a downstream storm sewer system or surface outlet point. TARGET

The subdrains should be installed similar to SUDAS Figure 4040.231 (Case A, Type 1). TARGET

GROUNDWATER

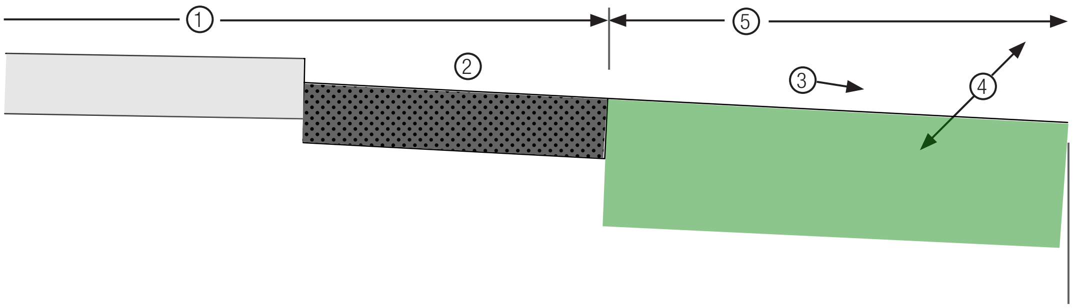
Underdrains should be considered essential in locations where the depth to the seasonal high water table is shallow or where groundwater seeps are observed on the surface. Without underdrains, such areas may have a very wet surface and be difficult to mow or maintain. ESSENTIAL

NOTE

Refer to Section 11 for native seed and plant material alternatives. Refer to Section 5.03-3 for information about temporary seeding and pollution prevention measures during construction.

Longitudinal Geometry

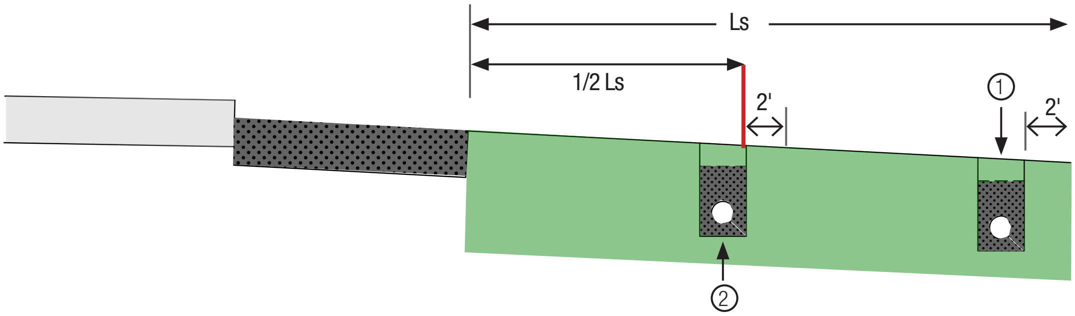
1 - Paved Surface Length - Lp
2 - Maintenance Strip
3 - Filter Strip Slope: 1-4%
4 - Place "On Contour"
5 - Length: 10 feet or 1/2 x Lp (whichever is greater)

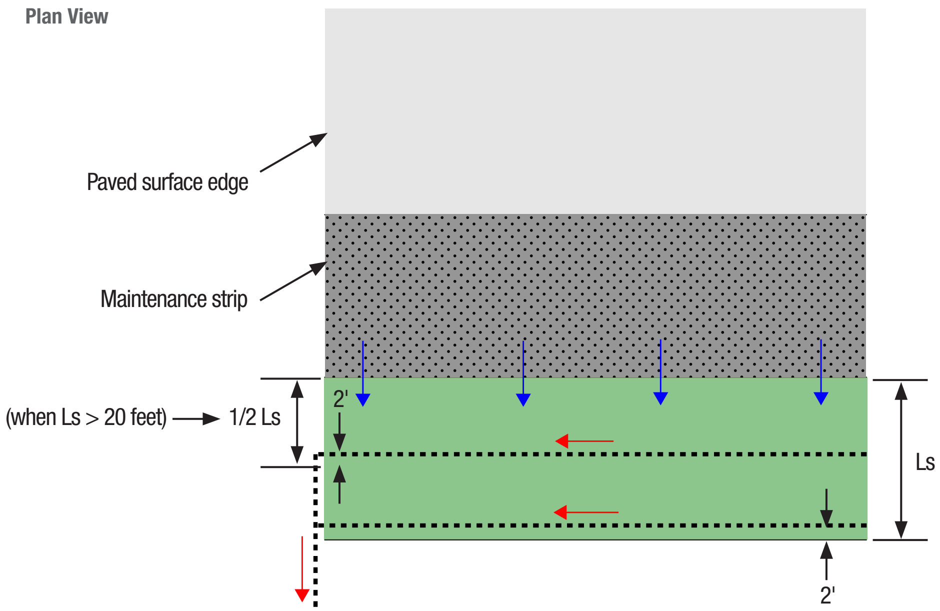


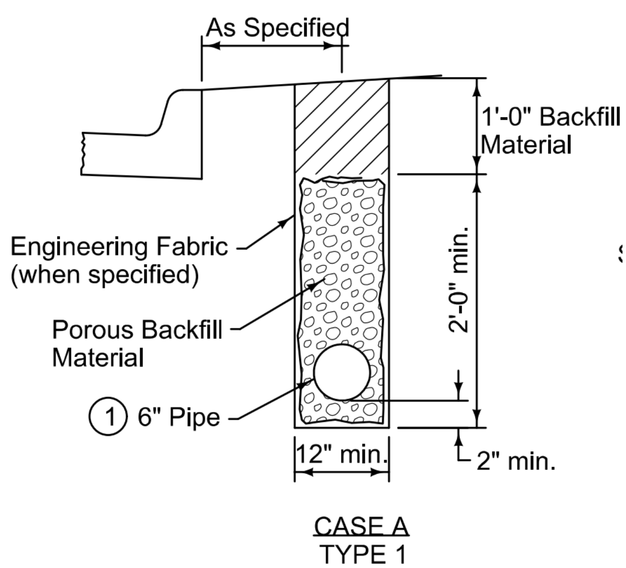
Subdrain Location

1 - When 1 Subdrain is Required, Locate at End of Filter Strip as Shown.
2 - When 2 Subdrains are Required, Locate Second Just Above Half-way Distance Through Strip as Shown.

Ls = Length of filter strip







Example of Underdrain Detail from SUDAS Figure 4040.231.

NOTE

See Section 7.03 (Currently Chater 5, Section 6) and Section 5.03-3 for more information about SQR.

WATER QUALITY MANAGEMENT USING SOIL QUALITY RESTORATION

Soil quality restoration can be used to meet **Water Quality volume** (WQv) treatment goals, where runoff from adjacent impervious surfaces is spread out evenly across an area where SQR is applied with the proper depth and organic matter content.

5.03-2 SIZING CALCULATIONS

A. CALCULATION PROCEDURES

1. **For a vegetated filter strip length adjacent to paved areas:**
   - The length of flow draining to the filter strip should not be greater than 60 feet.
   - The length of flow through filter strip should not be less than ten (10) feet in length and should be at least one-half (1/2) a foot in length for every foot of paved surface upstream of the buffer.
   - The length of flow through the filter strip does not include the length of flow through the maintenance edge.
2. **Sizing a level spreader.**
   - When applied, a level spreader should be sized so that the peak flow from the WQv storm event is spread evenly across the width of the filter strip at a rate of 0.003 cfs (cubic foot per second) per foot of strip (measured perpendicular to flow through the strip).
3. **Vegetated filter strip width for ponds and wetlands.**
   - When used as a buffer for lawn areas along ponds and wetlands, the buffer should be wide enough that the peak flow from the 2-year storm event is spread evenly across the width of the filter strip at a rate of 0.0075 cfs (cubic foot per second) per foot of strip (measured perpendicular to flow through the strip).
4. **Proper spacing of underdrains.**
   - When used, underdrains should be spaced so that at least 10% of the surface area of the filter strip is within one (1) foot of the centerline of a subdrain.
5. **Using soil quality restoration to meet WQv goals.**
   - When attempting to use SQR to meet WQv goals, the following conditions listed in ISWMM Section 7.03 (Soil Quality Management and Restoration) need to be met. Some of those requirements are as follows: ESSENTIAL
     - To act as a BMP for managing runoff from adjacent areas, runoff needs to be distributed evenly as sheet flow across the area to be counted as a BMP so it can infiltrate into the soil profile.
     - The finished surface of the BMP area should be graded as such that flow to be treated will spread out across it. Flow should remain as sheet flow and not concentrate into low points or swales.
     - Only those areas where sheet flow will pass over the finished surface should be counted as a BMP towards treating the WQv for adjacent areas.
     - The BMP area will need to be verified to have healthy topsoil to the desired depth and organic matter content needed to manage the WQv. Refer to Part I, "Construction Observation and Verification Requirements" within the Soil Quality Management and Restoration section of ISWMM.
   - Any available water storage in the SQR profile that exceeds the WQv rainfall that falls directly on the SQR area (1.25 inches), would be available to count toward the WQv treatment goals of the adjacent impervious surface. See the following exhibit (Reference Table C5-S6-6, ISWMM Soil Quality Management and Restoration Section).

     See table provided on the next page.
6. Locate the vegetated filter strip on the proposed site plan or construction drawings.

Table 5.03-1-2: Amount of available water storage in healthy soil profiles based on percent organic matter content. Data is based on research conducted by Hudson (1994).

Assumes bulk density of 1.25 gm/cm^3 and silt loam texture.

Available Water Content (AWC = Field Capacity - Permanent Wilting Point); AWC = Theta * 100; Theta = Volumetric Water Content

% SOM by weight	Bulk Density (gm/cm^3)	Available Water Storage (in/in soil)	Available Water Storage (in/4 in soil)	Available Water Storage (in/6 in soil)	Available Water Storage (in/8 in soil)
1	1.25	0.13	0.52	0.77	1.03
2	1.25	0.17	0.66	1.00	1.33
3	1.25	0.20	0.81	1.22	1.62
4	1.25	0.24	0.96	1.44	1.92
5	1.25	0.28	1.11	1.66	2.22
6	1.25	0.31	1.26	1.88	2.51
7	1.25	0.35	1.40	2.11	2.81
8	1.25	0.39	1.55	2.33	3.10

B. DESIGN EXAMPLES

1. Vegetated filter strip length near paved areas.

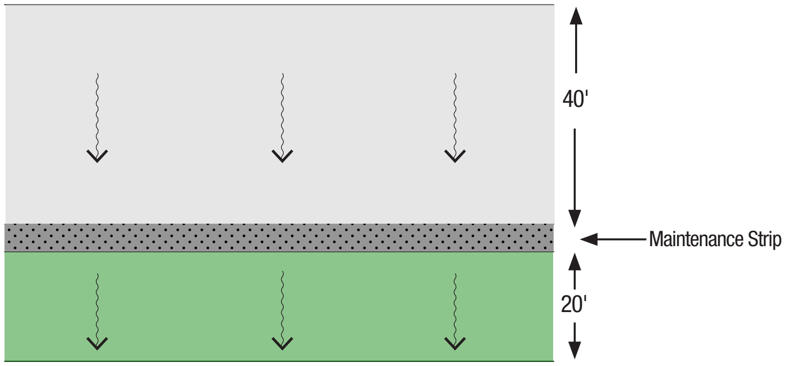
- The length of flow draining to the filter strip should not be greater than 60 feet.
- The length of flow through filter strip should not be less than ten (10) feet in length and should be at least one-half (1/2) a foot in length for every foot of paved surface upstream of the buffer.
- The length of flow through the filter strip does not include the length of flow through the maintenance edge.

EXAMPLE 1A

A filter strip is proposed to receive runoff from part of a parking area draining uniformly toward the edge of paving. The length of flow measured from the upper edge of the tributary area to the pavement edge is 40 feet.

Length of filter strip = Length of paved surface flow (feet) x 0.5 (feet / foot)

= 40 feet x 0.5 (feet / foot) = 20 feet

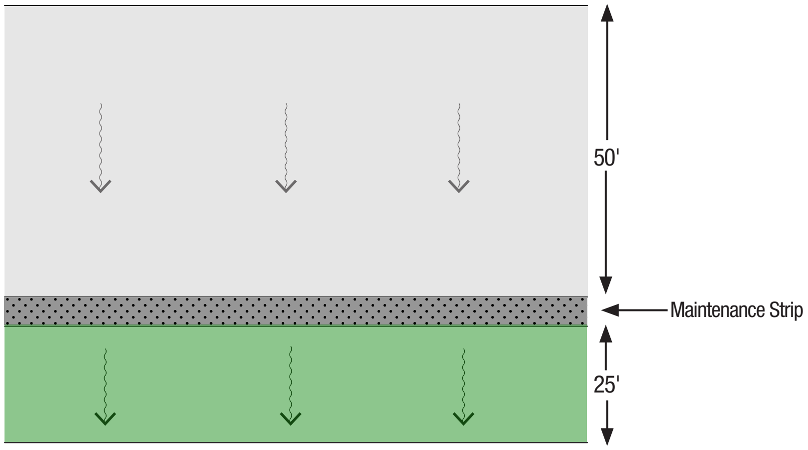


EXAMPLE 1B

Same example as Example 1A, but in this example the length of flow measured from the upper edge of the tributary area to the pavement edge is 50 feet.

Length of filter strip = Length of paved surface flow (feet) x 0.5 (feet / foot)

= 50 feet x 0.5 (feet / foot) = 25 feet



2. Sizing a level spreader.

- When applied, a level spreader should be sized so that the peak flow from the WQv storm event is spread evenly across the width of the filter strip at a rate of 0.0030 cfs (cubic foot per second) per foot of strip (measured perpendicular to flow through the strip).

EXAMPLE 2A

Runoff from a 8,000 square foot (0.184 acres) roof is to be directed to a filter strip. A level spreader is to be used to convert the concentrated flow into sheet flow.

- Using Hydraflow Hydrographs to perform the NRCS TR-55 calculations, with a **Curve Number** (CN) of 99, a **Time of Concentration** (Tc) of 5 minutes and a time interval of 1 minute:
  - Peak flow (Q) = 0.46 cfs (cubic foot per second)
- Length of level spreader = Peak flow (cfs) / [0.0003 (cfs / foot)]
  = 0.46 cfs / [0.003 (cfs / foot)] = 153 feet

EXAMPLE 2B

Runoff from the same building in Example 2A is going to be routed through a perforated pipe used as a level spreader. The length of pipe required to convey that flow can be found as follows:

Equation 5.03-2-1

$$L = Q/(B * \ Cd * \ Ao * \ \sqrt{2gh})$$

Where:

L = Length of perforated pipe required (feet)

Q = Design flow rate (cfs)

B = Clogging factor (portion of openings blocked by soil materials = 0.5)

Cd = Orifice coefficient (0.6)

Ao = Perforation open area per unit length of pipe (square feet per foot)

g = gravitational constant (32.2 ft/s^2)

H = head (use 3/4 of pipe diameter to represent the elevation difference at the top of the pipe to the centroid of perforations) (in feet)

Adapted from source: Flow through perforated pipe - LID SWM Planning and Design Guide (sustainabletechnologies.ca)

Pipe manufacturer data sheets can be used to identify the open area per unit length of pipe which will vary based on pipe material and diameter. For this example, assume the following:

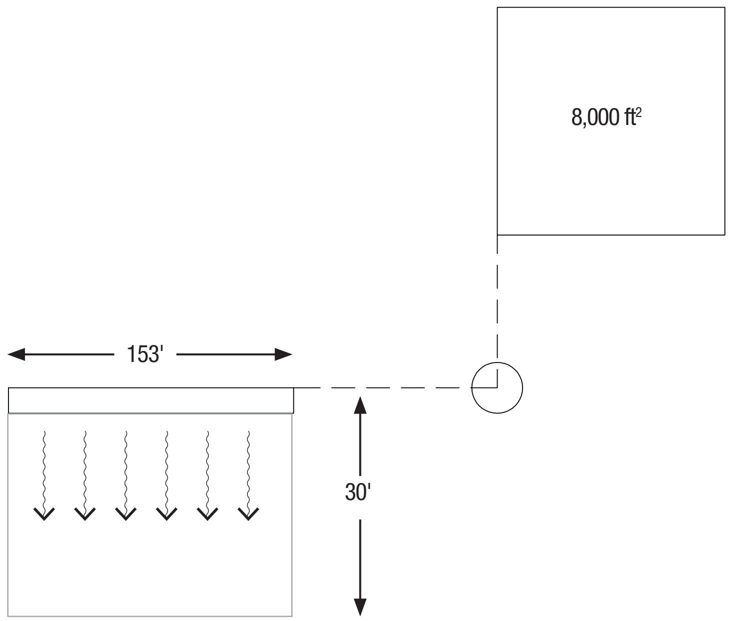
- A 12 inch diameter A2000 PVC HDPE pipe material is to be used, which has an open area of 2.0 square inches (2/144) per linear foot.

$$L = 0.46\, cfs/(0.5 * \ 0.6 * (\frac{2\ inch}{144\ (sq.inches — square\ feet)} SF) * \sqrt{2(32.2 \frac{ft}{s^2})(0.75 * 12\ inches * \frac{1\ foot}{12\ inches})}$$

L = 16 feet

In this case, the required length of pipe needed for the level spreader (16 feet, from example 2B) is less than the required width of the vegetated filter strip (153 feet, from example 2A). So the level spreader pipe would need to extend the full length of the strip and be 153 feet long. If the required pipe length was found to be longer, the width of the strip would need to be increased to match the length of the level spreader.

In this scenario, flow that isn't able to leave through the perforations should be allowed to continue down the pipe to a point where it can outlet to the surface or a downstream pipe network. The pipe diameter should be selected to convey the peak flow for the design event for the pipe. For example, for a roof drain, the designer may choose to design the pipe to convey the 10- or 100-year



NOTE

See information about level spreaders on page 5. Also related to information in the table on page 7, where flow rate of 0.003 cfs per LF of buffer will need 30 feet of filter strip length.

storm event.

3. Vegetated filter strip width for ponds and wetlands.

- When used as a buffer for lawn areas along ponds and wetlands, the buffer should be wide enough that the peak flow from the 2-year storm event is spread evenly across the width of the filter strip at a rate of 0.0075 cfs (cubic foot per second) per foot of strip (measured perpendicular to flow through the strip).

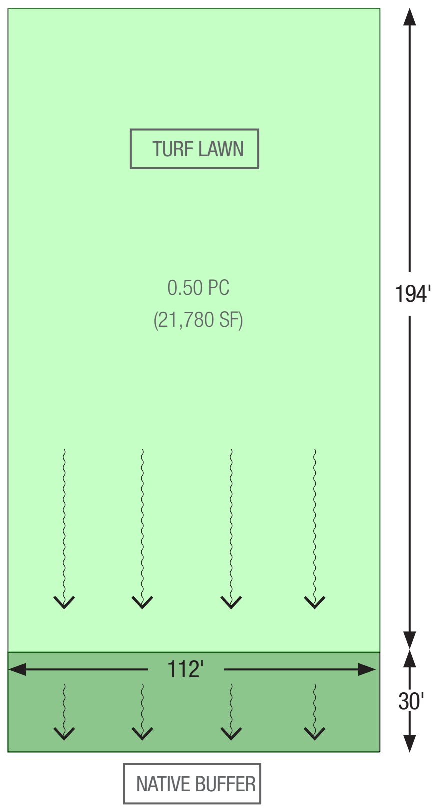
EXAMPLE 3

Runoff from a 0.50-acre area of turf lawn in good condition (**HSG** C, CN=74) is to be directed to a 30' long filter strip near the edge of a proposed pond. The project is located in East Central Iowa (Region 6) where the 2-year, 24-hour storm event is 3.01 inches of rainfall.

- Using Hydraflow Hydrographs to perform the NRCS TR-55 calculations, with a Time of Concentration (Tc) of 5 minutes and a time interval of 1 minute:
  - Peak flow (Q) = 0.84 cfs (cubic foot per second)
- Width of vegetated buffer = Peak flow (cfs) / [0.0075 (cfs / foot)]

NOTE

See table 5.03-1-1 on page 7.



= 0.84 cfs / [0.0075 (cfs / foot)] = 112 feet

4. Proper spacing of underdrains.

- When used, underdrains should be spaced so that at least 10% of the surface area of the filter strip is within one (1) foot of the centerline of a subdrain.

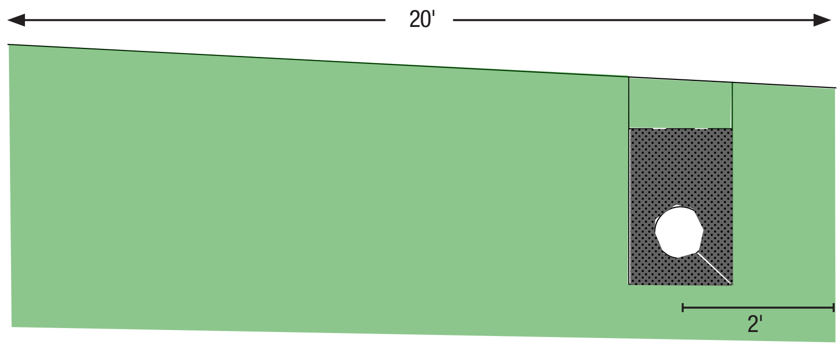
EXAMPLE 4A

For a Vegetated buffer strip that is 20 feet long, the required underdrain coverage area would be:

- Required coverage within two feet of a subdrain = Length of filter strip (feet) x 10%
  = 20 feet x 10% = 2 feet

Therefore, the area within one foot of the centerline of a single subdrain would be sufficient:

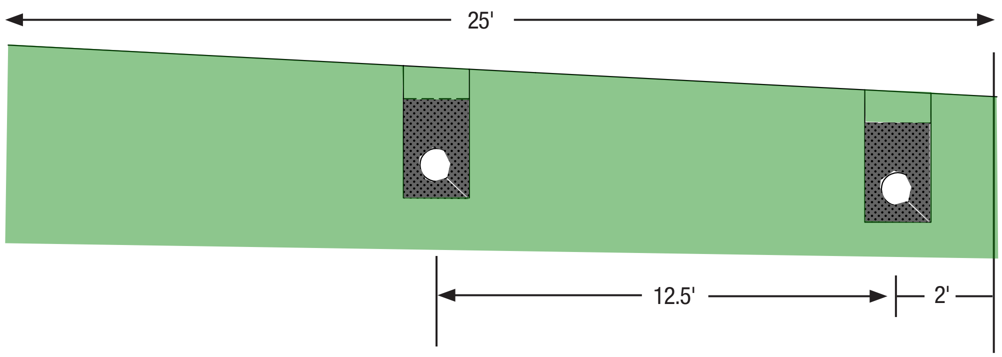
- 1 underdrains x 1 (foot either side / underdrain) x 2 sides = 2 feet



EXAMPLE 4B

For a Vegetated buffer strip that is 25 feet long, the required underdrain coverage area would be:

- Required coverage within two feet of a subdrain = Length of filter strip (feet) x 10%
  = 25 feet x 10% = 2.5 feet



Therefore, if two underdrains were provided, the area within one foot of the centerline of each subdrain would be sufficient:

- 2 underdrains x 1 (foot either side / underdrain) x 2 sides = 4 feet

5. Using soil quality restoration to meet WQv goals.

- Using Example 1B, where the length of flow measured from the upper edge of the tributary area to the pavement edge is 50 feet. The width of the parking edge is 90 feet.
  - Total area = 4,500 SF (square feet), 0.10 acres, 100% impervious
- Calculate required Water Quality volume (WQv):
  - Calculate Runoff Coefficient (Rv) = 0.05 + 0.009 (I)
    - I = Impervious Cover (%)
  - Rv = 0.05 + 0.009 (I) = 0.05 + 0.009 (100) = 0.95
  - WQv = Rv x P = 0.95 x 1.25 inches = 1.1875 watershed-inches

    WQv = 1.1875 watershed-inches x 4,500 SF / (12 inches / foot) = 445 CF (cubic feet)
- Calculate available capacity of SQR in vegetated filter strip:
  - In Example 1B, the length of the filter strip was found to be 25 feet. The filter strip would be the same width as the adjacent paved area (90 feet).
    - Total SQR area = 2,250 SF (square feet)
  - Assume that the SQR area in the filter strip has 8 inches of depth with 5% organic matter. From the table below, the available water storage capacity would be 2.22 inches.
    - The first 1.25 inches of storage capacity would be occupied by the rainfall from the WQv event, leaving 0.97 inches of excess storage capacity.
    - Storage capacity (CF) = SQR area (SF) x storage capacity (inches) / (12 in. / ft.)

      = 2,250 SF x 0.97 inches / (12 in. / ft.) = 182 CF
- The SQR area as designed has about 40% (182 CF / 445 CF) of the required capacity to meet the WQv needs for the paved area draining to the filter strip. The remaining WQv volume (263 CF) would need to be addressed by another

NOTE

This information is taken from Table 5.03-1-2 on page 12.

Table 5.03-2-1: Amount of available water storage in healthy soil profiles based on percent organic matter content. Data is based on research conducted by Hudson (1994).

Assumes bulk density of 1.25 gm/cm^3 and silt loam texture.

Available Water Content (AWC = Field Capacity - Permanent Wilting Point); AWC = Theta * 100; Theta = Volumetric Water Content

% SOM by weight	Bulk Density (gm/cm^3)	Available Water Storage (in/in soil)	Available Water Storage (in/4 in soil)	Available Water Storage (in/6 in soil)	Available Water Storage (in/8 in soil)
5	1.25	0.28	1.11	1.66	2.22

5.03-3 CONSTRUCTION

A. POLLUTION PREVENTION

If the vegetated filter strip is part of a project whose total disturbed area exceeds one acre (including all parts of a common plan of development) a stormwater pollution prevention plan (SWPPP) is required by state and federal law to be prepared.

Prior to construction, coverage under the State of Iowa's NPDES General Permit No. 2 shall be obtained (or, if required, coverage through an individual permit).

The SWPPP document will meet state and local regulatory requirements and will detail the structural and non-structural pollution prevention best management practices (BMPs) that are to be employed at the site.

EXTERIOR PROTECTION

All perimeter and site exit controls should be installed prior to any land-disturbing activities. Such controls may include (but are not limited to) site construction exits, perimeter sediment controls, construction limit fencing, waste collection, sanitary facilities and concrete washout containment systems.

INTERIOR PROTECTION

As construction activities begin, internal controls will be added to prevent erosion and sediment loss from the site area.

Erosion controls (mulches, rolled erosion control products, turf reinforcement mats, etc.) prevent detachment of soil particles from the surface. Sediment controls (wattles, filter socks, silt fences, sediment basins, etc.) capture sediments after they have become suspended in runoff. Installation of controls may need to be staged to be implemented immediately after construction operations have ceased or are paused in a certain area.

If the vegetated filter strip is associated with a project with other stormwater best management practices, refer to the relevant section of ISWMM for more pollution prevention information.

B. CONSTRUCTION SEQUENCING

Vegetated filter strips are often constructed as a small part of a larger project. Because they usually serve a stormwater conveyance function, they typically will be created during rough site grading. Underdrains will usually be installed as part of installation of site storm sewer systems. During later construction phases, fine grading will be needed prior to placement of topsoil materials.

Establish permanent vegetation within the filter strip before construction of any infiltration based BMPs that are immediately downstream of the filter strip. This is necessary to prevent sediment materials from being washed into those types of BMPs, which can reduce their infiltration potential, leading to failures. Tempoary seeding and/or mulching may be necessary to protect the surface of the filter strip from erosion until the permanent vegetation can be established.

C. CONSTRUCTION OBSERVATION

A designated representative of the owner should observe construction operations on a frequent basis to confirm the following:

- Topsoil stripping, stockpiling and respread activities is completed as specified.
- Rough grading generally conforms to plan elevations and test results are provided that demonstrate that compaction requirements have been met.
- Level spreaders or adjacent paved surfaced leading to the filter strips are installed to the dimension, location and elevations specified on the plans and proper installation techniques and trench compaction techniques have been followed.
- The maintenance edge is installed to the dimension, location and elevations specified on the plans.
- The correct surface protection material is installed within the maintenance edge.
- Verify that the underdrain is the specified material, perforation type and is installed properly.
- Verify that the filter strip is graded to the dimension, location and elevations specified on the plans.
- Verify that the required methods of soil quality restoration are completed and that surface roughening and seedbed preparation are completed prior to seeding.
- Confirm that seed, plug and other landscape materials (trees, shrubs, etc.) delivered to the site are in accordance with the contract documents.
- Observe that the rate of temporary and permanent seed and mulch materials are in compliance with the contract documents, and that activities are completed within the specified seeding dates.
- Complete a walk-through with the designer and contractor to identify any items which are not in compliance with project requirements. Document issues in a punch list and confirm when all items are installed or repaired.
- As needed by the local jurisdiction, author a letter of acceptance noting either conformance with construction documents, or any allowed deviation thereof.
- Be present during vegetation establishment and maintenance operations to verify that required duties are completed.

D. AS-BUILT REQUIREMENTS

During construction, records should be kept by the contractor (and site observer) that will allow record drawings of as-built improvements to be provided to the owner. To demonstrate that the project has complied with contract documents, these records should include, but not be limited to, the following:

- The width, length and slope of the filter strip.
- The location and flowline elevations of any storm pipes or structures leading into the filter strip area.
- The elevation of any level spreaders.
- The elevation of the pavement edge and maintenance strip.
- The location and flow elevation of any underdrains, cleanouts and pipe outlets.
- Confirmation that required trees and shrubs have been installed.
- The location and elevation of any underdrains (if used).

A vegetated buffer strip along a creek in Davenport.

5.03-4 MAINTENANCE

During the design process, the entity responsible for routine and long-term maintenance should be identified and engaged. ESSENTIAL These tasks are necessary to maintain the function of the filter strip. Invasive growth, storage loss, surface erosion and pollution of downstream stormwater BMPs may occur if these tasks are not completed.

Activity	Schedule
Look for signs of sediment accumulation, flow channelization and erosion damage. Check surface water entry points for signs of surface erosion.	At least annually AND after rain events of 1.25" or larger.
Inspect the maintenance edge.	After rain events of 1.25" or larger for the first year. At least three times annual after that, but more frequently as needed if sediment buildup is often observed.
Remove sediment from the maintenance area.	When observed, at least once annually.
Clean and remove debris as necessary.	When observed.
Repair undercut or eroded areas within the filter strip.	When observed.
Mow the filter strip.	As needed if turf grass is used. Mow the strip high enough to prevent scalping. Refer to Section 11 when native landscaping is used.
Inspect for weeds, undesirable plants and brush.	At least twice annually.
Remove dead or dying vegetation.	Annually.
Inspect the condition of the level spreader (if used).	Annually.

- Sediments excavated from filter strips that do not receive runoff from designated **hotspots** are not considered toxic or hazardous material and can be safely disposed of by either land application or at a permitted landfill.
- Sediment testing may be required prior to sediment disposal when a hotspot land use is present.
- Sediment removed from filter strips during construction should be disposed of according to an approved SWPPP.

5.03-5 SIGNAGE RECOMMENDATIONS

Signage for pretreatment areas is not commonly used at pretreatment practices compared to at stormwater quality BMPs. However, signage could be provided as an educational tool to detail the purpose and function of the filter strip to the general public. Signage can also be used to advise maintenance staff on maintenance requirements.

Illustration of an educational sign.

5.03-6 GLOSSARY

Best Management Practice (BMP)	A feature designed to meet stormwater water quality or quantity management goals.
Curve Number	A parameter used in NRCS Technical Release 20 or 55 (TR-20 or TR-55) that is used to estimate the rate and volume of stormwater runoff that will be created from rainfall, based on the soil types and land uses at a given location. Values range from around 30 to 100, with higher values resulting in more runoff being predicted from the equations used by TR-20 and TR-55 methods. See the NRCS TR-55 Methodology section of ISWMM for more information.
Hotspot	Land uses or activities that have the potential to generate higher pollutant loads than typical urban land uses. Gas stations and some industrial sites are examples of hotspots.
Hydrologic Soil Group (HSG)	Categories shown on County Soils Maps that describe the runoff potential of common soil groups. HSG categories range from A to D, with HSG A soils generating the least amount of runoff from rainfall events and HSG D soils generating the most.
Impervious cover	Surfaces on the landscape that do not allow water to pass through, such as roofs and paved surfaces.
Pretreatment	Use of practices or features to capture the heaviest sediment particles, trash or debris out of stormwater flows before it can enter a downstream BMP.
Time of concentration	The length of time it takes stormwater runoff to pass from the farthest upstream point in a drainage area to the outlet after runoff from rainfall has started.
Soil Quality Restoration (SQR)	Creating a healthy soil profile through methods of respreading topsoil materials or using blends of compost and sand to improve soil properties. (See the Soil Quality Management and Restoration Section of ISWMM.)
Underdrain	A perforated pipe installed below the surface intended to collect water that has infiltrated into the ground.
Unified Sizing Criteria (USC)	The set of stormwater management quality and quantity goals recommended by ISWMM.
Water Quality Volume (WQv)	One of ISWMM's USC, defined as the runoff generated by a 1.25-inch rainfall event. Over 90% of all rainfall events in Iowa are at or less than this amount of rain.

5.03-7 RESOURCES

5.03-8 APPENDIX

KEY DESIGN PARAMETER CHECKLIST

There are important aspects of this manual to consider when jurisdictions seek to create stormwater ordinances or policies that reference or adopt this manual. The Iowa Department of Natural Resources (IDNR) is responsible for the creation and maintenance of this manual, working with a technical committee of local volunteers. However, regulation and enforcement of post-construction stormwater management is primarily left to local jurisdictions.

Therefore, the IDNR does not enforce as requirements, the sizing and design criteria set for this document. For this reason, the language used within this manual has purposefully been written as a guideline, rather than a standard. This means certain language that conveys something is required (i.e. shall, must, etc.) is generally avoided. This has the potential to leave "gray areas" as to what may be interpreted to be required and what is recommended or optional, if this manual is adopted and referenced by local jurisdictions as a standard.

Throughout this section, different design parameters or considerations have been grouped into key categories:

ESSENTIAL

An element of the design of a BMP seen as critical to its proper performance, operation or aesthetics. **These aspects should be most important for inclusion and compliance and should rarely be deviated from.**

TARGET

An element of the design of a BMP seen as important to its proper performance, operation or aesthetics. **These aspects should be included in designs, if at all possible.** However, there is more flexibility to allow deviations if it can be demonstrated that it is infeasible to meet the requirement at a given location, or if a certain requirement is in conflict with other requirements. **Designers should explain any reason for deviation from targets, for the consideration of the jurisdiction as part of their review.**

IDEAL

An element of the design of a BMP seen as the recommended approach for its proper performance, operation or aesthetics. Designers are encouraged to include these in designs as best practice. However, these items are seen as less critical as those noted as essentials or targets.

CAUTION

These are notes or design guidance to highlight items for the designers' careful consideration.

ADVISORY

These are practices, techniques or potential deviations from the design ethic that should be avoided in most circumstances.

ESSENTIAL

1. Filter strips should be located “on contour”, meaning they should be level when traveling along a line perpendicular to the direction of flow. (page 2)
2. When placed against paved surfaces (such as a parking lot or roadway without a curb edge), the filter strip should not receive runoff from more than a 60 feet length of paved area measured from the parking edge. (page 2)
3. When runoff enters the filter strip from the edge of a paved surface, flow must not be funneled into concentrated flow paths. (page 2)
4. Runoff can also be routed into a vegetated buffer from a concentrated source, such as a roof downspout. However, a level spreader should be used to spread the flow evenly across the filter strip at the upper edge. (page 5)
    a. The level spreader should be long enough to spread flow from the WQv event evenly across the buffer strip, at a rate of no more than 0.003 cfs per foot of buffer width (measured perpendicular to flow through the strip). (page 5)
    b. When using a level spreader, the length of flow through the filter strip should be at least 30 feet from the level spreader. (page 5)
5. Sufficient topsoil and/or soil quality restoration (SQR) should be used to sustain desired vegetation. (page 7)
6. When receiving runoff from impervious surfaces, the filter strip should be at least as wide as the edge of the adjacent paved surface or level spreader. (page 7)
7. When used as a buffer for lawn areas along ponds and wetlands, the buffer should be wide enough that the peak flow from the 2-year storm event is spread evenly across the width of the filter strip at a rate of no more than 0.0075 cfs (cubic foot per second) per foot of buffer strip (measured perpendicular to flow through the strip). (page 7)
    a. In these areas, the length of flow through the filter strip should be no less than 30 feet. (page 7)
8. The filter strip should be graded to be “on contour”, where the strip stays at the same elevation as you would travel across it parallel to flow. (page 7)
9. The filter strip should not be less than ten (10) feet in length (measured parallel to the direction of flow through the strip) and should be at least one-half (1/2) a foot in length for every foot of paved surface upstream of the buffer. The length of the buffer is measured from the downstream end of the maintenance edge. (page 7)
10. When attempting to use SQR to meet WQv goals, the conditions listed in ISWMM Section 7.03 (Soil Quality Management and Restoration) need to be met. Some of those requirements are listed in Section 5.03-3, Part A, Item 5. (page 11)
11. During the design process, the entity responsible for routine and long-term maintenance should be identified and engaged. (page 22)

TARGET

1. A maintenance strip is recommended along paved edges of parking lots or paved storage areas. (page 2)
    a. The maintenance strip should be three (3) to five (5) feet wide. (page 2)
    b. It should be stabilized with one of the materials as listed in Section 5.03-1, Part C. (page 2)
    c. The edge of the maintenance strip against the paved edge should be set two (2) to four (4) inches below the paved edge. (page 4)
    d. The slope across the maintenance edge should be one to two percent (1-2%). (page 4)
    e. The downslope side of the maintenance strip should have an edger than separates it from the adjacent vegetation and promotes uniform flow into the filter strip. (page 4)
2. When a level spreader is used (see Essential Item #4), the length of flow through the filter strip should be at least 30 feet from the level spreader. (page 5)
3. The slope within the vegetated filter strip should be between one and four percent (1-4%). (page 7)
4. Underdrains may be used to allow the surface of the filter strip to dry out between rainfall events. This may be most beneficial when the filter strip is to be maintained as turf grass, where mowing will be frequently occurring. (page 8)
    a. When used, underdrains should be perforated PVC or HDPE materials, at least four (4) inches in diameter. (page 8)
    b. When used, underdrains should be spaced so that at least 10% of the surface area of the filter strip is within one (1) foot of the centerline of a subdrain.
        - Buffers less than 20 feet in width should have at least one subdrain running perpendicular to flow.
        - Buffers greater than 20 feet in width should have an additional subdrain, placed in the upper half of the buffer.

BACKGROUND INFORMATION ON VEGETATED BUFFER CALCULATIONS

Runoff from open space areas during a WQv event is difficult to model using TR-55. See appendix for more information on how this sizing method was determined.

To create an equivalent sizing method, a comparison was made with paved surfaces.

For example, a 0.172 acre paved surface with a Tc of 5 minutes and a CN of 99 for the WQv would have a peak flow rate of 0.3 cfs. Using a level spreader to spread that flow over 100 feet of buffer width results in a peak flow of 0.003 cfs / linear foot.

That same paved surface would have a peak flow rate of about 0.75 cfs for the 2-year event (about 3 inches across Iowa, with a Tc of 5 minutes and CN of 98). Spreading that flow over the same 100 feet of buffer width results in a peak flow of about 0.0075 cfs.

Therefore, for lawn areas, using a rate of 0.0075 cfs per linear foot of buffer for the 2-year event should result in a comparable buffer width as if the buffer was sized for 0.03 cfs per linear foot for the WQv event.

See table on page 7, for other equivalent flow rates and recommended buffer lengths.