

## 4.5 Grassed Channel BMP Summary Fact Sheets



**Description:** Grassed channels provide nominal water quality treatment of runoff. These channels can provide good pre-treatment for other BMPs. They can reduce impervious cover, accent the natural landscape, provide aesthetic benefits and reduce flow velocity as compared to other channel linings. Channels remove pollutants from storm water by filtration through grasses and other vegetation, settling, and infiltration through soil. Grass channels are typically used in residential and commercial developments.

### IMPORTANT CONSIDERATIONS

**DESIGN REQUIREMENTS:**

- Must have dense grass coverage or vegetation with permanent reinforcement designed to withstand erosion potential.
- Maximum depth of flow for the 1-inch, 6-hour storm event is 4 inches.
- A trapezoidal cross-sectional shape with side slopes flatter than 3:1 (h:v) and a minimum bottom width of 2 feet is required.
- Must be designed to pass the 10-yr, 25-yr, and 100-yr storm event without causing erosion or flood damage problems.
- The slope of the channel must be 2% or less. Check dams may be used to produce an effective slope of 2% or less for channels with slopes greater than 2%.
- Drainage area must be a maximum of 20 acres with no dry weather flow.
- The minimum length in the direction of flow must be 100 feet.

**ADVANTAGES/BENEFITS:**

- Channels can be designed to provide pretreatment for other BMP systems.
- Can be used as part of the runoff conveyance system.
- Can act to partially infiltrate runoff from small storm events if underlying soils are pervious.
- Can be designed to reduce runoff velocity and erosion problems.
- Can reduce impervious cover, accent the natural landscape, and provide aesthetic benefits.

**DISADVANTAGES/LIMITATIONS:**

- Higher maintenance than curb and gutter systems.
- Cannot be used on steep slopes greater than 5%; slopes less than 2% are recommended.
- Potential for bottom erosion and re-suspension.
- Cannot achieve the required TSS removal target as a stand-alone BMP.

**MAINTENANCE CONSIDERATIONS:**

- Maintain grass heights of 3 to 6 inches.
- Remove sediment from forebay and channel.

### STORMWATER MANAGEMENT SUITABILITY

L = Low    M = Moderate    H = High

- 1-inch, 6-hr Water Quality Protection**
- 1-yr 24-hr Channel Protection Volume**
- Peak Attenuation Control for 10-yr, 6-hr Storm**
- Peak Attenuation Control for 25-yr, 6-hr storm**

Grass channels can provide some water quality benefit for the 1-inch, 6-hour storm event, but provide minimal benefit for control of larger storm events such as the 1-year, 24-hour storm or other flood control storm events.

### IMPLEMENTATION CONSIDERATIONS

- Land Requirements**
- Capital Cost**
- Maintenance Cost**
- Maintenance Considerations**

### PRIMARY POLLUTANT REMOVAL PROCESSES

- Filtration

### POLLUTANT REMOVAL RATES

Effective.	Length	Depth	Slope	Pollutant Removal Rates
Optimal	100 feet	4 inches	2%	20% TSS 0% TP

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## 4.5 Grass Channels

### 4.5.1 General Description

Grassed channels are typically designed to provide nominal treatment of runoff. These channels can provide good pre-treatment for other BMPs. They can reduce impervious cover, accent the natural landscape, provide aesthetic benefits and reduce velocity as compared to other channels. Grass channels remove pollutants from storm water by filtration through grasses and other vegetation, settling, and infiltration through soil. Grass channels can be used in residential and commercial developments.

Grass channel design differs from the enhanced grass swale design in that they do not have an engineered filter media to enhance pollutant removal capabilities and, therefore, have a lower pollutant removal rate than enhanced grass swales. Grass channels can partially infiltrate runoff from small storm events in areas with previous soils.

When designing a grass channels, the two primary considerations are channel capacity and minimization of erosion. To enhance water quality treatment, grass channels must have broader bottoms, lower slopes, and denser vegetation than most drainage channels. Additional treatment can be provided by placing check-dams across the channel below pipe inflows, and at various other points along the channel in order to produce an effective slope of 1% or less.

Figure 4.5.1 shows typical grass channels and Figure 4.5.2 shows a schematic of a grass channel.

Grass channels should not be confused with a filter-strip/wooded buffer strip or an enhanced grass swale. Grass channels are not engineered to provide the same treatment capability as an enhanced grass swale with filter media or the limited treatment. Filter strips are designed to accommodate overland flow rather than channelized flow. All of these practices may be used for pretreatment or included in a treatment train approach.

Grass channels can be used in a variety of development types; however, they are primarily applicable to areas of low to moderate density where the impervious cover in the contributing drainage area is relatively small. Thus, grass channels are mainly used in moderate to large lot residential developments, small impervious areas (parking lots and rooftops), along roads and highways, and in commercial developments as part of a landscaped area. Because of their relatively large land requirement, grassed channels are generally not used in higher density areas. The topography and soils of a site will determine the applicability of the use of grass channel designs. Overall, the topography should allow for the design of a channel with relatively flat slopes and sufficient cross-sectional area to maintain non-erosive velocities.



**Figure 4.5.1 Example of Grassed Channel BMP**

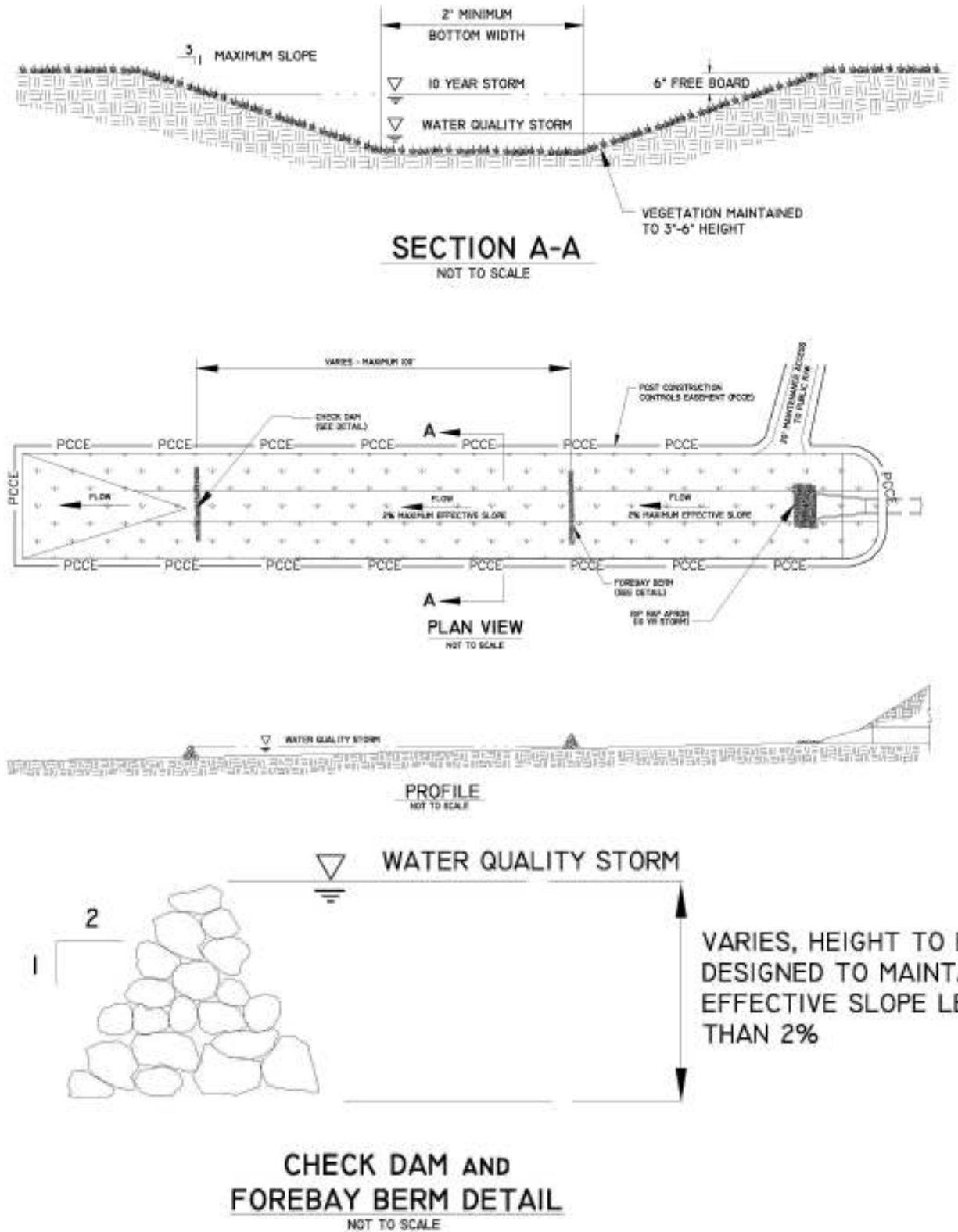


Figure 4.5.2 Schematic of Typical Grassed Channel

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## 4.5.2 Storm Water Management Suitability

Grass channels are designed primarily to partially treat the water quality volume ( $WQ_v$ ) and will typically need to be used in conjunction with other structural controls to meet pollutant removal goals. Grass channels have a small amount of benefit in controlling the channel protection volume ( $CP_v$ ) and larger flood control events through exfiltration to the underlying soils. However, ensuring that the exfiltration benefit is provided for the entire design life is challenging, therefore, these exfiltration benefits are considered negligible for application in the Mecklenburg County area. They can be used to convey higher flows to other BMP controls.

### Water Quality Control ( $WQ_v$ )

Grass channels rely on filtration by creating sheet flow conditions through the vegetation to provide removal of storm water contaminants. A small amount water quality benefit occurs through exfiltration to the underlying soils.

### Channel Protection Control ( $CP_v$ )

Generally, only the  $WQ_v$  is treated by a grass channel, and another structural control must be used to control the channel protection volume ( $CP_v$ ). However, for some smaller sites, a grass channel may be designed to capture and detain some or all of the  $CP_v$  through the design and construction of check dams or other structural devices that provide controlled outflow.

### Peak Attenuation Control ( $Q_p$ )

The design of grass channels may include flow diversion and/or be designed to safely pass flood flows. Another structural control may be required in conjunction with a channel system to reduce the post-development peak flows to pre-developed conditions. The channel lining must be designed to withstand erosion for the 10-year, 6-hour storm event.

## 4.5.3 Pollutant Removal Capabilities

One grass channel design has been developed for application in the Mecklenburg County area. The *optimal efficiency design* has the capability to remove 20% of the total suspended solids and 0% of the total phosphorus load. The design assumes urban post-development runoff conditions that has been observed in the Mecklenburg County area and that the facilities are sized, designed, constructed, and maintained in accordance with the recommended specifications contained in this manual. The design pollutant removal rate is derived from sampling data and computations completed for the developed of this manual. In a situation where a removal rate is not deemed sufficient additional controls may be put in place at a given site in a series or “treatment train” approach. See Section 4.5.4 for a discussion of design values and appropriate pollution removal rates.

## 4.5.4 Planning and Design Criteria

The following criteria are to be considered minimum standards for the design of a grass channel. Items listed in Section 4.1.4.A through 4.1.4.H. are requirements and must be addressed in the design. Items listed in Section 4.1.4.I. are recommendations and are optional.

### A. Design Requirements

Following is a list of design requirements that must be followed in the design of grassed channel BMPs:

- Following are the design values that are required for the grass channel design that is available for application in Mecklenburg County. The appropriate minimum design values and associated pollutant removal rates for the design is given in Table 4.5.1.

**Table 4.5.1 Design Values and Pollution Removal Rates**

Effective.	Length	Depth	Slope	Pollutant Removal Rates
Optimal	100 feet	4 inches	2%	20% TSS 0% TP

- Grass channel must have dense grass coverage or vegetation with permanent reinforcement to reduce erosion potential. Three different plant types must be included in the design.
- Maximum depth of flow for water quality purposes must be 4.0 inches.
- Grass channels must have a minimum bottom width of 2 feet to ensure adequate filtration. The maximum channel bottom width is 8 feet. Wider channels can be designed, but must contain berms, walls, or a multi-level cross section to prevent channel braiding or uncontrolled sub-channel formation. If a larger channel is needed, the use of a compound cross section is recommended.
- Grass channels must have a trapezoidal cross-sectional shape and must be designed with moderate side slopes no greater than 3:1 (h:v) for ease of maintenance and side inflow by sheet flow (4:1 or flatter is required).
- The channel must be designed to pass the 10-year, 25-year, and 100-year storm events without causing erosion problems or damages from large floods.
- Grass channels that will serve as drainage facilities for the development must be designed to convey the storm events and must be integrated into surrounding topography.
- The slope of the channel must be 2% or less.
- Drainage area must be a maximum 20 acres with no dry weather flow.
- The minimum length in the direction of flow must be 100 feet.

**B. Physical Specifications/Geometry**

Channel slopes of 2% or less are recommended unless topography necessitates a steeper slope with a maximum of 5%, in which case drop structures can be placed to limit the energy slope to within the recommended 2% range. Energy dissipation may be required below the drops. Spacing between the drops must not be closer than 50 feet and greater than 100 feet. Depth of the  $WQ_v$  must not exceed 4 inches during the 1-inch, 6-hour storm event.

The 2% hydraulic gradeline slope requirement is met by ensuring that the slope is less than 2% using the critical depth elevation at each drop structure or by setting the top elevation of the lower drop structure equal or higher than the toe elevation of the higher drop structure.

Check dams or other devices can be provided in lieu of drop structures. The  $WQ_v$  must be designed to flow through the check dam within 24-hours.

The peak velocity for the 10-year storm must be non-erosive for the soil and vegetative cover provided. Channels must be sized to convey runoff from a flood event safely with a minimum of 6 inches of freeboard and without damage to adjacent property.

The channel must be limited to the width and depth specified in the design. The bottom must not be loaded in a way that causes soil compaction and scarified prior to placement of gravel and permeable soil. The sides of the channel must be trimmed of all large roots. The sidewalls must be uniform with no voids and scarified prior to backfilling.



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### **C. Pretreatment/Inlets**

Pretreatment considerations are summarized below:

- Inlets to grass channels must be provided with energy dissipators such as riprap.
- Pretreatment of runoff to a grass channel system is typically provided by a sediment forebay located at the inlet. The pretreatment volume should be equal to 0.2 inches for impervious acre. This storage is usually obtained by providing check dams at pipe inlets and/or driveway crossings.
- Grass channel systems that receive direct concentrated runoff may have a 6-inch drop to a pea gravel diaphragm flow spreader at the upstream end of the control.
- A pea gravel diaphragm and gentle side slope must be provided along the top of channels to provide pretreatment for lateral sheet flows.

### **D. Outlet Structures**

The channel system must discharge to the storm drainage infrastructure or a stable outfall.

### **E. Emergency Spillway**

Grass channels must be adequately designed to safely pass flows that exceed the design storm flows.

### **F. Maintenance Access**

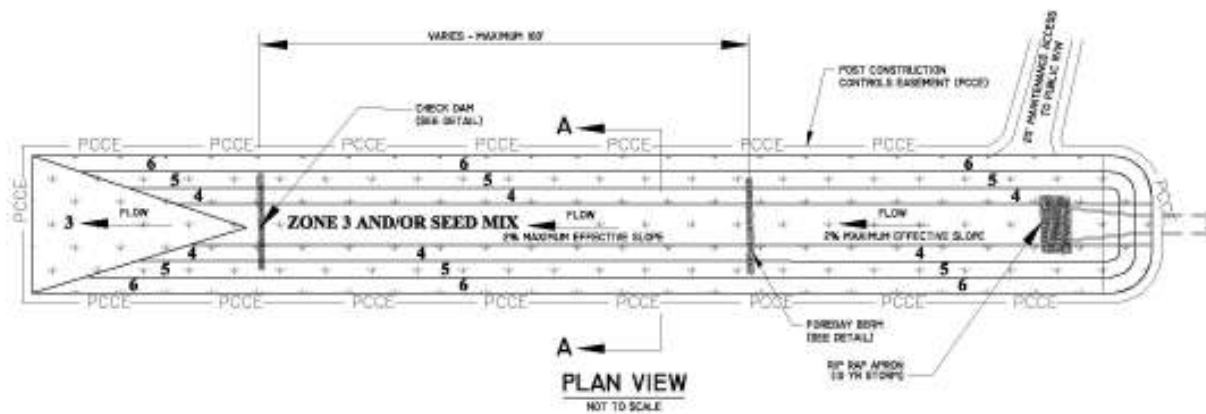
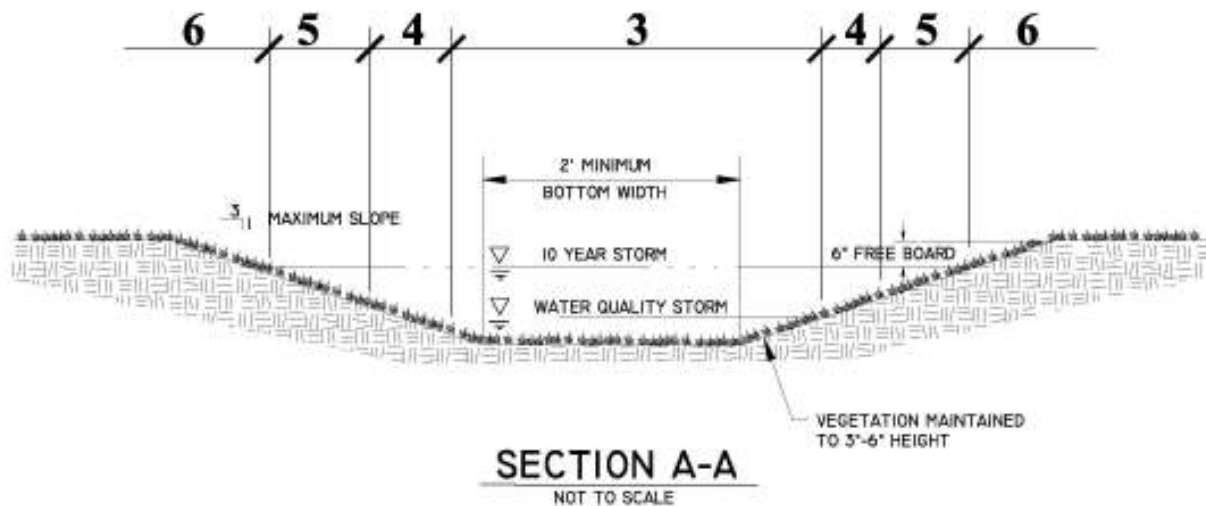
Adequate access must be provided for all grass channels for inspection and maintenance.

### **G. Safety Features**

Ponding depths for durations longer than 6 hours for all storm events must be limited to a maximum of 18 inches.

### **H. Landscaping**

Landscape design must specify proper grass species and other plants based on specific site, soils, and hydric conditions present along the channel. A minimum of three different vegetation species is required. Plan must also include an invasive species prevention plan. Vegetation and landscaping plan must include plans for the first year of operation and full maturity (i.e. 3-year duration). See Chapter 6 – Vegetation and Landscaping. Figure 4.5.3 illustrates the planting zones for a grass channel.



**Figure 4.5.3 Planting Zones for Grassed Channel**

**I. Design Recommendations**

In addition to the design requirements, following are some design recommendations that should be considered for grass channel design:

- Grass channel siting should take into account the location and use of other site features, such as buffers and undisturbed natural areas, and should attempt to aesthetically “fit” the facility into the landscape.
- Grass channels are designed to treat the WQ<sub>v</sub> and to safely pass larger storm flows. Flows can enter the channel through a pretreatment forebay. Runoff can also enter along the sides of the channel as sheet flow through the use of a pea gravel flow spreader trench along the top of the bank.
- Grass channels can be used on most soils as long as the grass and vegetation cover can grow.
- Designers must choose a grass that can withstand relatively high velocity flows at the entrances for both wet and dry periods.

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#### 4.5.5 Design Procedure

Step 1 - Using the BMP Selection Matrix presented at the beginning of Chapter 4 determine if the development site and conditions are appropriate for the use of a grass channel system.

Step 2 - Consider any special site-specific design conditions.

Step 3 – Compute site hydrologic parameters using the SCS procedures and/or computer models that use the SCS procedure.

Step 4 - Calculate the Water Quality Volume ( $WQ_v$ ), Channel Protection Volume ( $CP_v$ ), and Flood Protection  $Q_{10}$ ,  $Q_{25}$ , and  $Q_{100}$  flood hydrographs.

Step 5 - Determine pretreatment volume if included in the design. The forebay should be sized to contain 0.2 inches per impervious acre of contributing drainage.

Step 6 - Determine channel dimensions.

Size bottom width, depth, length, and slope necessary to store  $WQ_v$  with a design depth of 4.0 inches or less.

- Slope cannot exceed 2% (check dams required for steeper slopes).
- Bottom width must range from 2 to 8 feet.
- Ensure that side slopes are no greater than 3:1 (4:1 recommended).

Step 7 - Compute number of check dams (or similar structures) required to produce a hydraulic grade line slope of 1% or less and to detain the  $WQ_v$ .

Step 8 - Check low flow and design event velocity, erosion potential, and freeboard. Provide 6 inches of freeboard.

Step 9 - Design low flow orifice at downstream headwalls and check dams. Design check dam outlet conditions to pass  $WQ_v$  in 24 hours.

Step 10 - Prepare Vegetation and Landscaping Plan.

A landscaping plan for the grass channels must be prepared to indicate how the channel system will be stabilized and established with vegetation. A minimum of three different types of vegetation types is required. Plan must also include an invasive species prevention plan. Vegetation and landscaping plan must include plans for the first year of operation and full maturity (i.e. 3-year duration).

#### 4.5.6 Inspection and Maintenance Requirements

Specific maintenance inspections and requirements are contained in Chapter 7 of the Administrative Manual.



## 4.5.7 Design Form

### Design Procedure Form: Grassed Channels

#### GRASS CHANNEL FEASIBILITY

1. Is the use of grass channel appropriate?
2. Confirm design criteria and applicability.

#### PRELIMINARY HYDROLOGIC CALCULATIONS

3. Compute,  $WQ_v$  volume requirements  
 Compute Runoff Coefficient,  $R_v$   
 Compute  $WQ_v$  volume requirements
4. Compute site hydrologic input parameters  
 Development Conditions  
 Area  
 CN  
 Adjusted CN  
 Time of concentration  
  
 Compute  $CP_v$   
 Compute  $Q_{10}$   
 Compute  $Q_{25}$   
 Compute  $Q_{100}$

#### GRASS CHANNEL DESIGN

5. Pretreatment volume (if included in design)  
 $Vol_{pre} = \text{Acres of Impervious Area}(0.2''(1'/12''))$
6. Determine channel dimensions  
 Assume trapezoidal channel with max depth of 4.0 inches
7. Compute number of check dams (or similar structures) required to maintain 1% hydraulic gradeline slope
8. Check low flow and design storm velocity erosion potential and freeboard  
  
 Overflow weir (use weir equation)  
 Use weir equation for slot length ( $Q = CLH^{3/2}$ )
9. Design low flow orifice or other drawdown condition for each checkdam  
 Area of orifice from orifice equation  
 $Q = CA(2gh)^{0.5}$
10. Attached vegetation and landscaping plan including an invasive species prevention plan.

#### NOTES:

$$R_v = \underline{\hspace{2cm}}$$

$$WQ_v = \underline{\hspace{2cm}} \text{ acre-ft}$$

Pre-developed	Post-developed
$\underline{\hspace{2cm}}$ acres	$\underline{\hspace{2cm}}$ acres
$\underline{\hspace{2cm}}$	$\underline{\hspace{2cm}}$ s
$\underline{\hspace{2cm}}$	$\underline{\hspace{2cm}}$ s
$\underline{\hspace{2cm}}$ hours	$\underline{\hspace{2cm}}$ hours

$$CP_v = \underline{\hspace{2cm}} \text{ cfs}$$

$$Q_{p10} = \underline{\hspace{2cm}} \text{ cfs}$$

$$Q_{p25} = \underline{\hspace{2cm}} \text{ cfs}$$

$$Q_{100} = \underline{\hspace{2cm}} \text{ cfs}$$

$$WQ_{pre} = \underline{\hspace{2cm}} \text{ acre-ft}$$

$$\text{Length} = \underline{\hspace{2cm}} \text{ ft}$$

$$\text{Width} = \underline{\hspace{2cm}} \text{ ft}$$

$$\text{Side Slopes} = \underline{\hspace{2cm}}$$

$$\text{Area} = \underline{\hspace{2cm}} \text{ ft}^2$$

$$\text{Slope} = \underline{\hspace{2cm}} \text{ ft/ft}$$

$$\text{Depth} = \underline{\hspace{2cm}} \text{ ft}$$

$$\text{Distance} = \underline{\hspace{2cm}} \text{ ft}$$

$$\text{Number} = \underline{\hspace{2cm}} \text{ each}$$

$$V_{min} = \underline{\hspace{2cm}} \text{ fps}$$

$$\text{Weir Length} = \underline{\hspace{2cm}} \text{ ft}$$

$$\text{Area} = \underline{\hspace{2cm}} \text{ ft}^2$$

$$\text{Diam.} = \underline{\hspace{2cm}} \text{ inch}$$

Notes: \_\_\_\_\_

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#### **4.5.8 Design Example**

The design example prepared for the enhanced grassed swale and presented in Section 4.4.8 serves as the grass channel design example.