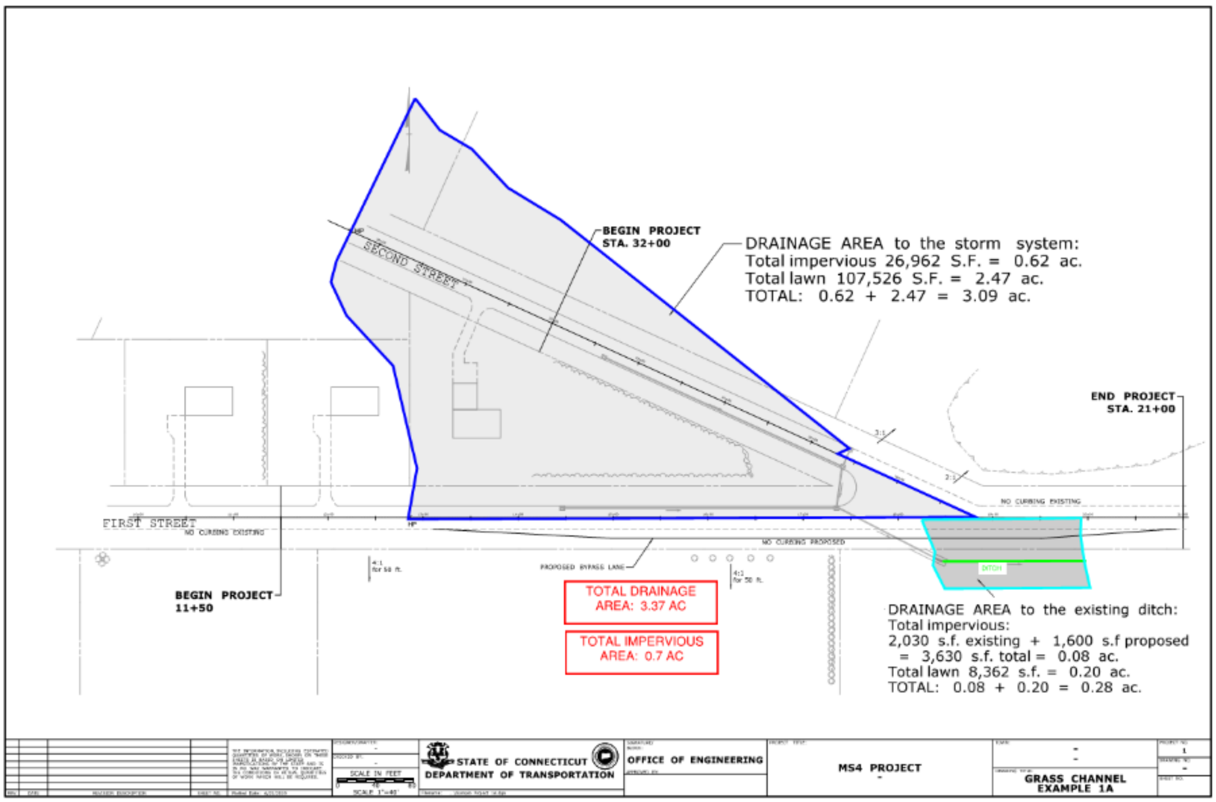
Example 1A: Grass Drainage Channel BMP Rev. 9-19-19

Adding onto Example 1, and examining possible water quality measures:

Examining the benefit of utilizing the existing ditch (Sta. 19+0 RT) as a grass drainage channel Best Management Practice (BMP.) For this BMP we need to calculate the Water Quality Flow (WQF.)

Following the Grass Channel "One-Pager", the first 150' of the existing ditch has a slope of about 2%, afterward it becomes steeper, exceeding the 6% maximum criteria. It was decided to utilize trapezoidal grass channel with a 4' bottom, 3:1 side slopes and a 2% slope. Assuming that channel will have to first be designed (using Stormcad, Flowmaster, or the FHWA Hydraulic Toolbox) to meet the required design storm, freeboard and shear stress requirements, we now need to determine if it meets Water Quality Flow criteria.



Using information about the drainage area to the BMP, the depth and velocity of the Water Quality Flow will be determined. This will be found after a few steps.

Using the WQV/WQF Worksheet found at:

..\MS4 Water_Quality_Volume__Water_Quality_Flow_Worksheet.xlsx

Skip the **WQV** tab that you used to determine the Water Quality Volume for the "Site" in Example 1.

Choose the **BMP WQV WQF** tab.

- Enter the Drainage Area to the BMP.
- Enter the impervious area (C≥0.7)

The Water Quality Volume for the BMP will be calculated.

> ***Drainage Area****-(catchment area) means the land from which stormwater runoff is collected and discharges through a single outfall.*

- Enter Time of Concentration (Tc). For this example: Assumed 10 minutes (this is the minimum Tc that should be used.)

(Inputs are shown in BLUE.)

WATER QUALITY VOLUME (WQV) CALCULATION

Drainage Area to BMP (A) =	3.37	acres
=	0.00527	square miles

BMP DRAINAGE AREA

Drainage Area	Impervious Area
Subcatchment-1	0.62
Subcatchment-2	0.08
Subcatchment-3	0.00
Total Impervious	0.70

Design Precipitation (P) =	1	inch
% Impervious Cover (I) =	21	
Volumetric Runoff Coefficient (R) =	0.237	
WQV =	**0.067**	**ac-ft**
	2899	**cu-ft**
1/2 WQV=	**0.033**	**ac-ft**
=	**1449**	**cu-ft**

WATER QUALITY FLOW (WQF) CALCULATION

RUNOFF CURVE NUMBER (CN)

Runoff Depth (Q) =	0.237	inches
CN =	87	Figure 2-1 (SWQM)

TIME OF CONCENTRATION (Tc), 10 minute minimum

Tc =	10	min
Tc =	0.17	hours
Initial Abstraction (I_a) =	0.299	Table 4-1 (SWQM)
I_a/P Calculation =	0.299	
Unit Peak Discharge (q_u) =	520	Exhibit 4-111 (SWQM)
WQF =	**0.65**	**cfs**
1/2 WQF =	**0.32**	**cfs**

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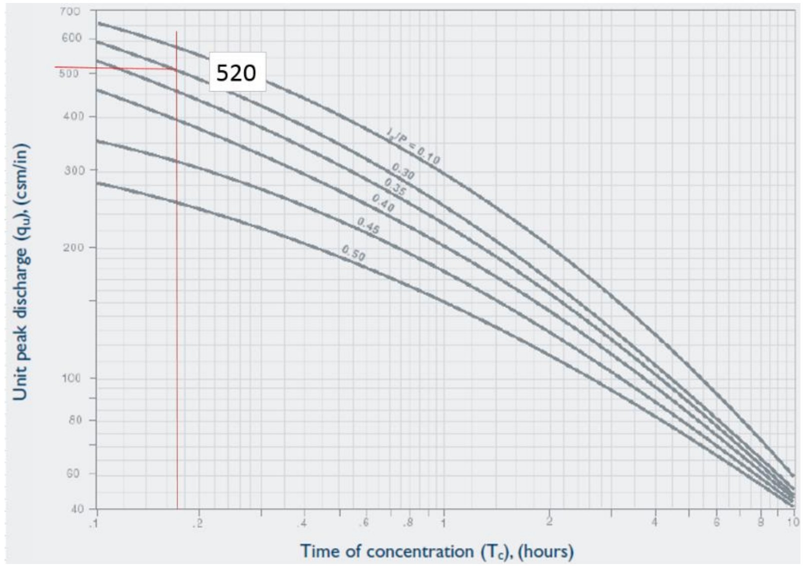
Everything will be calculated except for Unit Peak Discharge (qu), which will have to be looked up using Exhibit 4-111 using the calculated Initial Abstraction (Ia).



WQF has been calculated and is now used to determine if Grass Channel BMP criteria are met for depth and velocity.

Use the **Trapezoidal Channel Calculator** tab (or any of the previously mentioned Hydraulic programs to determine these parameters for your calculated WQF.

Note: For determining the 10 or 25-year flow capacity of a grass channel, typically a Manning's "n" of 0.03 will be used. The depth of the water quality flow is shallow (in the order of an inch.) A good stand of natural grass in a channel may present a Manning's "n" of 0.05 - 0.08 to a shallow water flow (HEC-15.)

Trapezoidal Channel Flow

Trapezoidal Channel Features:

Bottom Width (ft)	4
Slope (ft/ft)	0.02
Side slopes (Z:1)	3
Manning's n	0.06
WQF (cfs)	**0.65** cfs

(compare with table to determine approx. depth and velocity)

Stage / Discharge Table

Q (cfs)	Depth (in)	Depth (ft)	Area (sf)	Velocity (fps)
0.00	**0.0**	0	0.00	
0.01	0.1	0.01	0.06	0.21
0.04	0.2	0.02	0.12	0.33
0.07	0.3	0.03	0.18	0.42
0.12	0.4	0.03	0.23	0.51
0.17	0.5	0.04	0.29	0.59
0.23	0.6	0.05	0.35	0.66
0.30	0.7	0.06	0.41	0.72
0.37	0.8	0.07	0.47	0.78
0.44	0.9	0.08	0.53	0.84
0.52	**1.0**	0.08	0.58	0.90
0.70	1.2	0.10	0.70	1.00
0.89	1.4	0.12	0.82	1.09
1.09	1.6	0.13	0.93	1.17
1.31	1.8	0.15	1.05	1.25
1.54	**2.0**	0.17	1.17	1.32
1.78	2.2	0.18	1.28	1.39
2.03	2.4	0.20	1.40	1.45
2.29	2.6	0.22	1.52	1.51
2.56	2.8	0.23	1.63	1.57
2.84	**3.0**	0.25	1.75	1.62
3.12	3.2	0.27	1.87	1.67
3.41	3.4	0.28	1.98	1.72
3.71	3.6	0.30	2.10	1.76
4.01	3.8	0.32	2.22	1.81
4.31	**4.0**	0.33	2.33	1.85
5.92	5.0	0.42	2.92	2.03

From the Stage/Discharge Table, Grass Channel criteria is met:

- depth will be less than_4"
- velocity less than 1 fps

Editing the Example 1 Worksheet to add the Grass Channel:

It has been determined by the above work that all Design Considerations/Criteria in the Grass Channel one-pager are met. Therefore treatment and disconnection credits apply:

Full WQV: 15% treatment and 15% Disconnection Credit

(This example has a Full WQV Goal since the “Total Site” was <40% impervious cover.)

The WQV for the drainage area to the Grass Channel was previously calculated to be 0.067

WQV x 15% = 0.067 x .15 = 0.01 ac-ft

Entering this value into Section 4 of the Example 1 Worksheet:

Section 4: Stormwater BMP Selection Summary			
Design Phase ☐30% ☐60% ☐90% ☐FDP	WQV Retained (ac-ft)	WQV Treated (ac-ft)	Site Constraints
Disconnection			
No curb / natural dispersion	0.012	0.012	Insufficient Right-of-Way
Vegetative filter strip			Choose an Item.
Other			Choose an Item.
Conveyance & Disconnection			
Grass channel		0.01	Choose an Item.
Water quality swale (dry)			Choose an Item.
Other			Choose an Item.
Infiltration / Retention			
Infiltration basin			Choose an Item.
Infiltration trench			Choose an Item.
Underground infiltration system			Choose an Item.
Dry well			Choose an Item.
Other			Choose an Item.
Treatment			
Wet basin / wetland system			Choose an Item.
Extended dry detention basin			Choose an Item.
Hydrodynamic-oil/grit sys.			Choose an Item.
Bioretention with underdrain			Choose an Item.
Other			Choose an Item.
TOTAL	0.012	0.022	
Notes:			

The total WQV treated will be entered into DC3 on the front page.

Finally determining the value for DC5 Post-construction DCIA:

This value will be the disconnection credit = 15% of the amount of the impervious area contained in the drainage area to the Grass Channel BMP:

Impervious Area to BMP x 15% = 0.70 ac x .15 = 0.11 ac

This calculated value will be subtracted from the Post-construction Directly Connected Impervious Area entered in DC5. For Example 1, DC5 was 0.66 ac, which yielded a slight increase of 0.04 ac for DCIA. Adding the Grass Channel, it will now be 0.66-0.11 = 0.55 ac. Therefore, there is now a slight decrease in DC7 shown below. This is more in the direction of what the Department needs to do for MS4!

Water Quality Calculations			30% Design		60% Design	90% Design	FDP
DC1	WQV retention design goal	☑ Full ☐ 1/2"-WQV	ac-ft	☑ TBD	0.079 ac-ft	ac-ft	ac-ft
DC2	WQV goal ***retained*** (refer to page 2)		ac-ft		0.012 ac-ft	ac-ft	ac-ft
DC3	WQV goal ***treated*** (refer to page 2)		ac-ft		0.022 ac-ft	ac-ft	ac-ft
DC4	Total WQV *retained and treated*		0 ac-ft		0.034 ac-ft	0 ac-ft	0 ac-ft
DC5	Post-construction DCIA(acres)		ac.	☑ TBD	0.55 ac.	ac.	ac.
DC6	Pre-construction DCIA (refer to EC2 above)		ac.		0.62 ac.	ac.	ac.
DC7	Change in DCIA from pre- to post-construction *Can be positive (DCIA gained) or negative (DCIA lost)*		0 ac.	☑ TBD	-0.07 ac.	0 ac.	0 ac.

Note: Grass Channels are better than culverts or paved channels for treating water quality, but as can be seen from this example, they provide very little treatment of WQV and no retention (since channels are designed for conveyance. But they can be used to build upon. (ie: stone check dams, infiltration swale…)