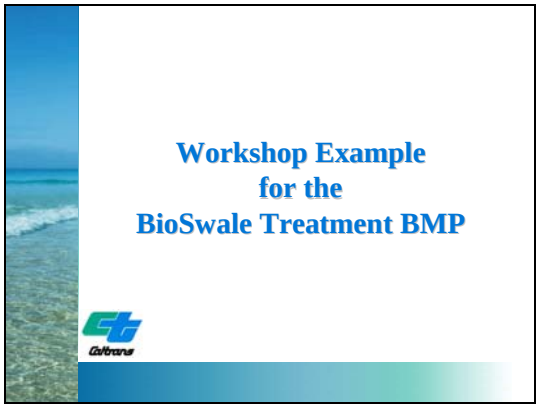
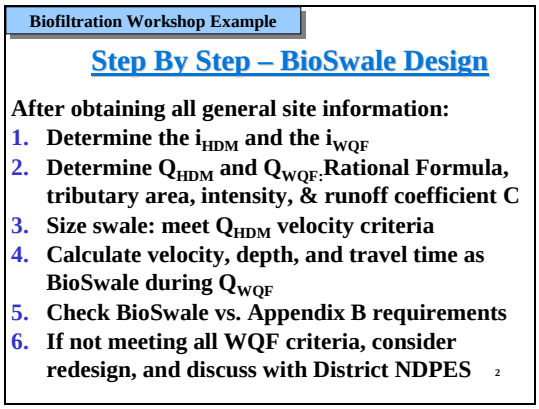


Slide 1: This module will present the Workshop Example for the Caltrans-approved Treatment BMP Biofiltration Swales. Refer to the Workshop Handout for a description of the problem, and to find the equations that will be used.

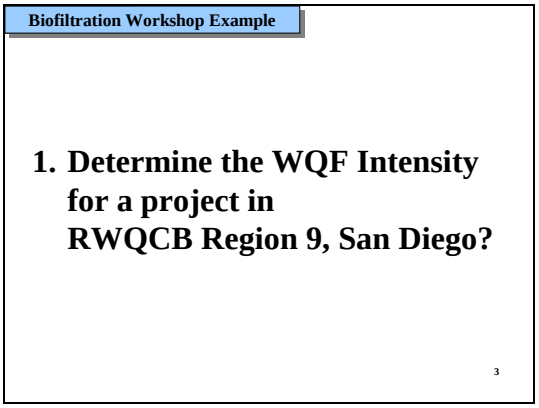


Slide 2: After obtaining all general site information:

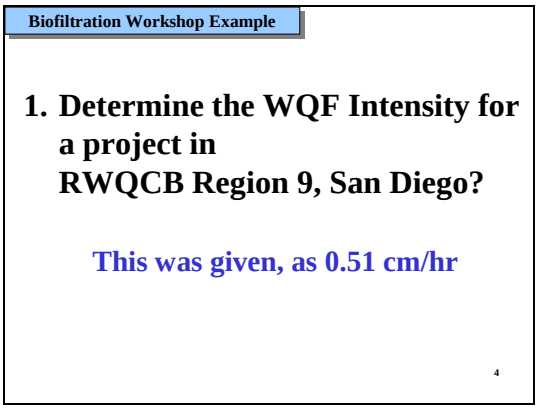
1. Determine the i_{HDM} and the i_{WQF}
2. Determine Q_{HDM} and Q_{WQF}: Rational Formula, tributary area, intensity, & runoff coefficient C
3. Size swale: meet Q_{HDM} velocity criteria
4. Calculate velocity, depth, and travel time as BioSwale during Q_{WQF}
5. Check BioSwale vs. Appendix B requirements
6. If not meeting all WQF criteria, consider redesign, and discuss with District NDPES

Remember that the catchment area may include both impermeable surfaces and permeable surfaces, so the runoff coefficient C must be proportioned between the areas.

- Remember to use the appropriate design events in Step 2.
- Remember that the time of concentration does not apply to the WQF calculation: the intensity used is not determined from an IDF curve (intensity, duration, frequency), instead, use the I_{wqf} presented in the PPDG Section 2.



Slide 3: The WQF intensity is given in the Workshop Handout problem statement, but it should be checked against PPDG Section 2, page 2-20



Slide 4: Note again that we would go to an IDF curve to determine the intensity for the HDM event. The Biofiltration Swale uses the WQF event intensity.

Biofiltration Workshop Example

2. Calculate the Q_{WQF} for the project using the Rational Formula?

5

Slide 5: Follow the steps in the Workshop Handout, page 3.

Biofiltration Workshop Example

Calculate Q_{WQF}

Q = C i A

C – runoff coefficient

'i' – intensity, inches/hr

A – acres

6

Slide 6: Note that some use the metric version of the Rational Formula, with the conversions built included, as given in HDM page 810-15. Note the units required!
A factor must be considered for the HDM events, the C(f) factor; this is given on HDM page 810-16 and on the Workshop Handout on the bottom of page 1. Since the C(f) factor is 1.0 for the relatively frequent event rainfall events (meaning less than 25 years recurrence interval), and since the Water Quality event has a recurrence interval on the order of 1 to 2 years, the factor has been omitted on this slide. When using the factor for the HDM events: the product of C(f) x C must be less than or equal to 1.0!

Biofiltration Workshop Example

Calculate Q_{WQF}

Q_{WQF} = 0.28 C I A,

C – runoff coefficient = 0.9

'I' – intensity, mm/hr = 5.1 mm/hr

A – 0.016 sq km (1.6 ha)

Q_{WQF} = (0.28)(0.9)(5.1 mm/hr)(0.016 km^2)

= 0.021 m^3/s metric

Q_{WQF} = (0.9)(0.20 inches/hr)(3.954 acres)

= 0.72 cfs US Customary units

7

Slide 7: Note that some use the metric version of the Rational Formula, with the conversions built included, as given in HDM page 810-15. Note the units are required as shown. 0.28 is a constant.
Confer the previous slide for a discussion of the C(f) factor for infrequent events.
This is the Q at the WQF event. We will later use it in a swale that has already been sized based for an HDM event.
Note that the HDM Q_{25} event can often be 6 to 10 times the intensity!

Biofiltration Workshop Example

Water Depth and Velocity in the channel

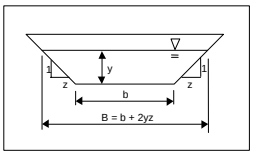
$$Q = \frac{1}{n} A R^{2/3} S^{1/2}$$

Where:

n = Manning's Number;

n = 0.05, for HDM Peak Flow.

n = 0.24, for Water Quality Flow.



Cross Sectional Area (A) = (b + zy)y

Wetted Perimeter (P) = b + 2(y^2+y^{2}z^2)$^{0.5}$

Hydraulic Radius (R) = A/P

8

Slide 8: For our example we will consider trapezoidal channel for the Bioswales. This slide shows Manning's Formula for the conveyance, with all terms identified.
Due to time constraints, the Workshop Handout has calculated depth of flows and velocities for several Qs using the

Manning's Equation and the problem givens, on page 3. Enter the table using the Q calculated on the previous slide, and copy off the depth and velocity.

Biofiltration Workshop Example

3. Calculate the Depth and Velocity of Flow?

Use the handout page 3, table for Manning's Equation; enter using Q = 0.021 m^3/sec

9

Slide 9: Enter the table on page 3. Using the Q calculated on the previous slide, and copy off the depth and velocity.
In US Customary units:
Q = 0.9 x 0.20 in/hr x 3.954 ac
= 0.72 fps

Biofiltration Workshop Example

3. Determine the Depth of Flow

Q_{WQF} = 0.021 solved in Step 2
Depth, Y = 110 mm, from Table
Velocity = 0.11 m/s , from Table

10

Slide 10: For the parameters given on the Workshop Example page 3, this is the information that you should have determined. This information can be found on the handout table.
The US Customary units would be: 0.36 ft depth; 0.26 fps velocity.

Biofiltration Workshop Example

4a. Calculate travel time, HRT

Recall: Length = 100 m V = 0.11 m/s
Since travel time (HRT) = L/V

HRT = 909 seconds = 15.2 minutes

11

Slide 11: For the parameters given on the Workshop Example sheet, this is the information that you should have determined. This information can be found on the handout table.
In US Customary units:
HRT = 328 ft / 0.36 fps = 906 seconds
= 15.1 minutes

Biofiltration Workshop Example

4b. Calculate interrelationship among HRT, velocity, and depth

HRT [minutes]/(depth [mm] x velocity [m/s])
15.2/ (110 x 0.11) = 1.26 > 0.22 (metric) OK

12

Slide 12: For the parameters given on the Workshop Example sheet, this is the information that you should have determined. This information can be found on the handout table.
US Customary units for interrelationship formula:
HRT [minutes]/(depth [ft] x velocity [ft]) =
15.2/ (0.36 x 0.36) = 116.5 > 20 OK

Biofiltration Workshop Example

5. Compare the calculated values to the allowable values, using the table?

13

Slide 13: Please turn to PPDG Section 2, page 2-20 (also copied to page 1 of the Workshop Handout).

Biofiltration Workshop Example

Compare to allowable velocity and depth

Depth = 110 mm	Up to 150 mm OK
Velocity = 0.11 m/s	Up to 0.3 m/s OK
HRT = 15.2 minutes	> 5 minutes OK
HRT/(depth x velocity) = 1.26	> 0.22 OK

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Slide 14: The proposed BioSwale meets all criteria. Verify placement with District Maintenance.

BioSwale Workshop Example

Questions?

Slide 15: End of the presentation.