2.18 Water Quality Flow

Use the water quality flow (WQf) to design a post-construction stormwater management practice that operates under steady inflow-outflow conditions. These are typically pretreatment practices (for example, a grass swale or manufactured treatment device) where undetained stormwater passes through a filter media, vortex, or other physical pollutant removal process.

Calculate the WQf using the standard rational method for predicting peak discharge as required in the Ohio EPA NPDES general permit for construction activities

$$WQf = C \times i \times A \qquad \text{(Equation 2.18.1)}$$

where WQf = water quality flow in cubic feet per second (cfs),

C = rational method coefficient of runoff (dimensionless),

i = rainfall intensity in inches per hour (in/hr), and

A = area draining through the practice (acres).

Consult civil engineering texts for comprehensive instruction and best practices in modelling urban hydrology with the rational method.

The WQf approach does not substitute for a WQv-based extended detention or infiltrating practice. The WQf is similar to the water quality volume (WQv) in that it optimizes runoff capture for treatment, but a WQf-based practice does not mitigate downstream channel impacts and might not provide comparable long-term, low-maintenance pollutant removal.

Coefficient of Runoff (C)

Coefficient of runoff (C) values for land conditions and uses (commercial, industrial, etc.) are available in most civil engineering texts. Engineering judgment based on experience and understanding is necessary to properly select C from the range of values reported in them.

Runoff coefficients for basic urban landcovers are suggested in Table 2.18.1. Area-weight these values to develop a composite coefficient. This may prove more accurate for typical small urban developments than a value chosen by land-use category.

Table 2.18.1 Suggested Rational Method Coefficients of Runoff (adapted from North Carolina, 2017)

Description of Surface		Runoff Coefficient, C
Pavement		0.95
Pitched roofs		1.00
Flat roofs		0.90
Lawn	<2% grade	0.15
	2-7% grade	0.20
	>7% grade	0.30
Wooded areas		0.15
Unimproved areas		0.35

Rainfall intensity (i)

Rainfall intensity (i) in Equation 2.18.1 is the average or constant rain intensity (inches per hour) lasting a duration equal or longer than the time of concentration (Tc) of the drainage area (Cleveland, 2011). The intensity-duration curve for the WQf is given in Table 2.18.2. Select the intensity reported for the event duration equaling the Tc estimated for the area draining to the practice.

Estimating Time of Concentration (Tc)

The rational method assumes that the peak runoff rate occurs when the entire area is contributing flow. Therefore, the time of concentration (Tc) is the time required for runoff to travel from the most hydraulically distant point in the drainage area (the longest travel time) to the outlet. In some cases, runoff from a highly impervious portion of the drainage area with a shorter time of concentration produces a greater peak discharge than would occur from the entire drainage area with a longer time of concentration (MHFD, 2018). Disregard areas (often right-of-way or boundary setbacks) where flow time is too slow to add to the peak discharge. This is demonstrated in the first calculation step of Example Problem 2.3.1 (Grass Swale).

Segment the flow length by flow type (sheet flow, shallow concentrated flow, pipe flow and open channel flow). Apply the limitations and the hydraulic relationships described in Chapter 3 of TR-55 (USDA, 1986) for each segment to estimate a total Tc. Do not include the flow path through a grass swale itself as part of the time of concentration.

Table 2.18.2 Tabular Values of Intensity-Duration Curve for WQf

Duration (Minutes)	Intensity (in/hr)	Duration Continued	Intensity Continued	Duration Continued	Intensity Continued
0 - 5	2.37	24	1.16	43	0.78
6	2.26	25	1.13	44	0.77
7	2.15	26	1.10	45	0.76
8	2.04	27	1.07	46	0.75
9	1.94	28	1.05	47	0.74
10	1.85	29	1.03	48	0.73
11	1.76	30	1.01	49	0.72
12	1.68	31	0.99	50	0.71
13	1.62	32	0.97	51	0.69
14	1.56	33	0.95	52	0.68
15	1.51	34	0.93	53	0.67
16	1.46	35	0.92	54	0.66
17	1.41	36	0.90	55	0.66
18	1.37	37	0.88	56	0.65
19	1.33	38	0.86	57	0.64
20	1.29	39	0.85	58	0.64
21	1.26	40	0.83	59	0.63
22	1.22	41	0.82	60+	0.62
23	1.19	42	0.80		

Area Draining into the Stormwater Management Practice

The WQf is a product of the actual area that contributes stormwater runoff to or drains through a stormwater management practice. The drainage area does not necessarily equal the project area. The drainage area can include area beyond the defined project boundary that drains into a practice or, where multiple practices serve a development, include only the sub-section of the project site that drains to that practice.

References

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