Stormwater Management - Chapter 9 Nathanson

General

Both a quantity and quality problem
Since 1994 regulated by EPA under NPDES
(NPDES - National Pollution Discharge Elimination System)
Point sources controlled by NPDES
Storm discharge permit required.

Estimating Storm Runoff

Rational Method

$Q = CIA$ peak runoff in m^3/h or ft^3/s

C ~ dimensionless Coef (See Table 9.1)
I ~ rainfall intensity m./h or mm/h
A ~ area acres or ha

USA units require no conversion
SI units convert to m ($1\ ha = 10^4 m^2$; $1\ \frac{mm}{h} = 10^{-3}\ \frac{m}{h}$)
To obtain composite C use Eqn 9.2)

Rainfall Intensity

Select recurrence interval
Select storm duration based on Time of Concentration

Time of Concentration

Overland flow time plus channel flow time
See Figs 9.3 and 9.4

SCS Graphical Method (now National Resources Conservation Service - NRCS)

Uses USA units

Identify soil group and determine CN value (Table 9.2)

Use Fig. 9.5 with rainfall and CN value to determine runoff R. in. This is volume under hydrograph

Compute runoff $\frac{ft^3}{mi^2 \cdot sec \cdot in.}$

$$Q \frac{ft^3}{s} = q \left(\frac{CSM}{in}\right) \cdot A\,(mi^2) \cdot R\,(in.) \quad \text{at } T_c$$

q obtained from Fig 9.6 using T_c

Effects of Land Development

Development generally causes volume and peak to increase

Storm Sewer Systems

Layout and design

See Figs 9.9 and 9.12

On-Site Stormwater Detension

Normally utilizes temporary detention

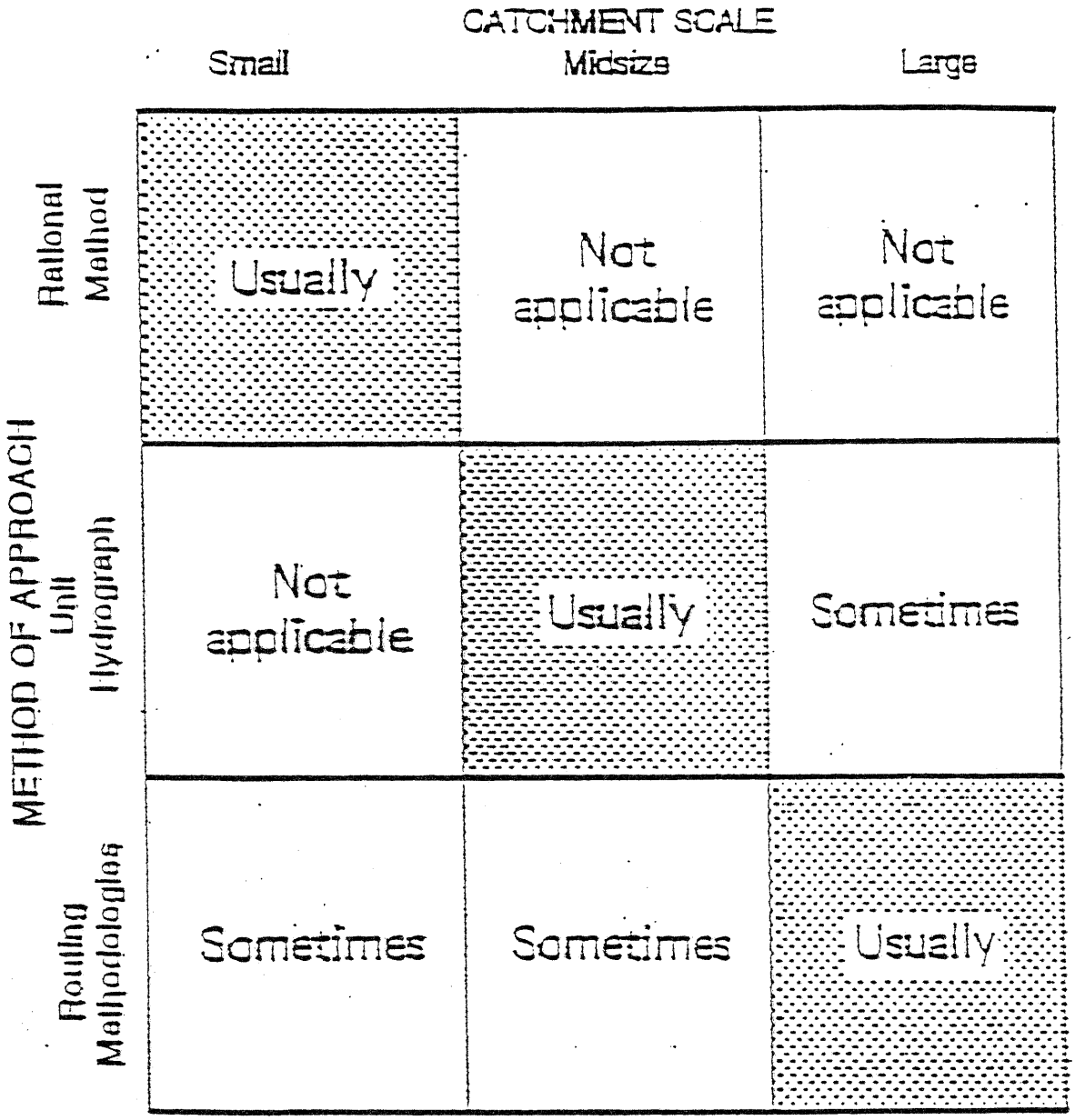
Three basin types

Retention, detention, recharge

See Fig 9.13 & 9.14

Design computations for detention
Utilizes storage equation
$\Delta S = I \cdot \Delta t - O \cdot \Delta t$
see Fig 9.15
Triangular hydrograph
see Fig 9.17

FLOOD PLAINS
Flood hazard area
Usually use 100 year flood
Flood insurance program
Operated by FEMA
(FEMA - Federal Emergency Management Agency)
Flood plain maps available for most cities



RELATIONSHIP BETWEEN CATCHMENT SCALE AND THREE COMMONLY USED APPROACHES TO FLOOD HYDROLOGY

Small ~ less than 10 km^2 (4 mi^2) - rational method less than 2.5 km^2 (1 mi^2) - T_c < 1 hr.

midsize ~ less than 5000 km^2 (2000 mi^2) - $\overline{T_c}$ ~ 1 to 24 hr Unit Hydrograph 1 to 6 hr

large ~ greater than 5000 km^2 (2000 mi^2) - $\overline{T_c}$ > 24 hr.

1. *Infiltration.* Ability of the soil to infiltrate water depends upon many characteristics of the soil as noted in Chapter 2. The following range of values are typical of various bare soils after 1 hr of continuous rainfall.[9]

Soil group	Infiltration, in./hr
High (sandy, open-structured)	0.50 to 1.00
Intermediate (loam)	0.10 to 0.50
Low (clay, close-structured)	0.01 to 0.10

TABLE 8-11 Typical *C* Values for 5-yr to 10-yr Frequency Design

Description of area	Runoff coefficients
Business	
Downtown areas	0.70–0.95
Neighborhood areas	0.50–0.70
Residential	
Single-family areas	0.30–0.50
Multiunits, detached	0.40–0.60
Multiunits, attached	0.60–0.75
Residential (suburban)	0.25–0.40
Apartment dwelling areas	0.50–0.70
Industrial	
Light areas	0.50–0.80
Heavy areas	0.60–0.90
Parks, cemeteries	0.10–0.25
Playgrounds	0.20–0.35
Railroad yard areas	0.20–0.40
Unimproved areas	0.10–0.30
Streets	
Asphaltic	0.70–0.95
Concrete	0.80–0.95
Brick	0.70–0.85
Drives and walks	0.75–0.85
Roofs	0.75–0.95
Lawns; Sandy Soil:	
Flat, 2%	0.05–0.10
Average, 2 to 7%	0.10–0.15
Steep, 7%	0.15–0.20
Lawns; Heavy Soil:	
Flat, 2%	0.13–0.17
Average, 2 to 7%	0.18–0.22
Steep, 7%	0.25–0.35

$Q = CIA$

Q = cfs

I = Rain Intensity IN./HR

A = Acres

Soil Group	Description
A	High infiltration rate/low runoff potential
B	Moderate infiltration rate
C	Slow infiltration rate
D	Very slow infiltration/high runoff potential

TABLE 9.2 TYPICAL SCS RUNOFF CURVE NUMBERS

Land-use Description	CN Value for Hydrologic Soil Group			
	A	B	C	D
Meadow	30	58	71	78
Forest	25	55	70	77
Grass lawns	39	61	74	80
Commercial–business	89	92	94	95
Residential	54	70	80	85
Pavement–roofs	98	98	98	98

TABLE 9–1 TYPICAL RUNOFF COEFFICIENTS

Type of Surface or Land Use	Runoff Coefficient C
Woodland areas	0.01 to 0.20
Grassland or lawns	0.10 to 0.25
Pavements and roofs	0.70 to 0.95
Suburban residential areas	0.25 to 0.40
Apartment housing areas	0.50 to 0.70
Industrial areas	0.60 to 0.90
Business areas	0.70 to 0.95

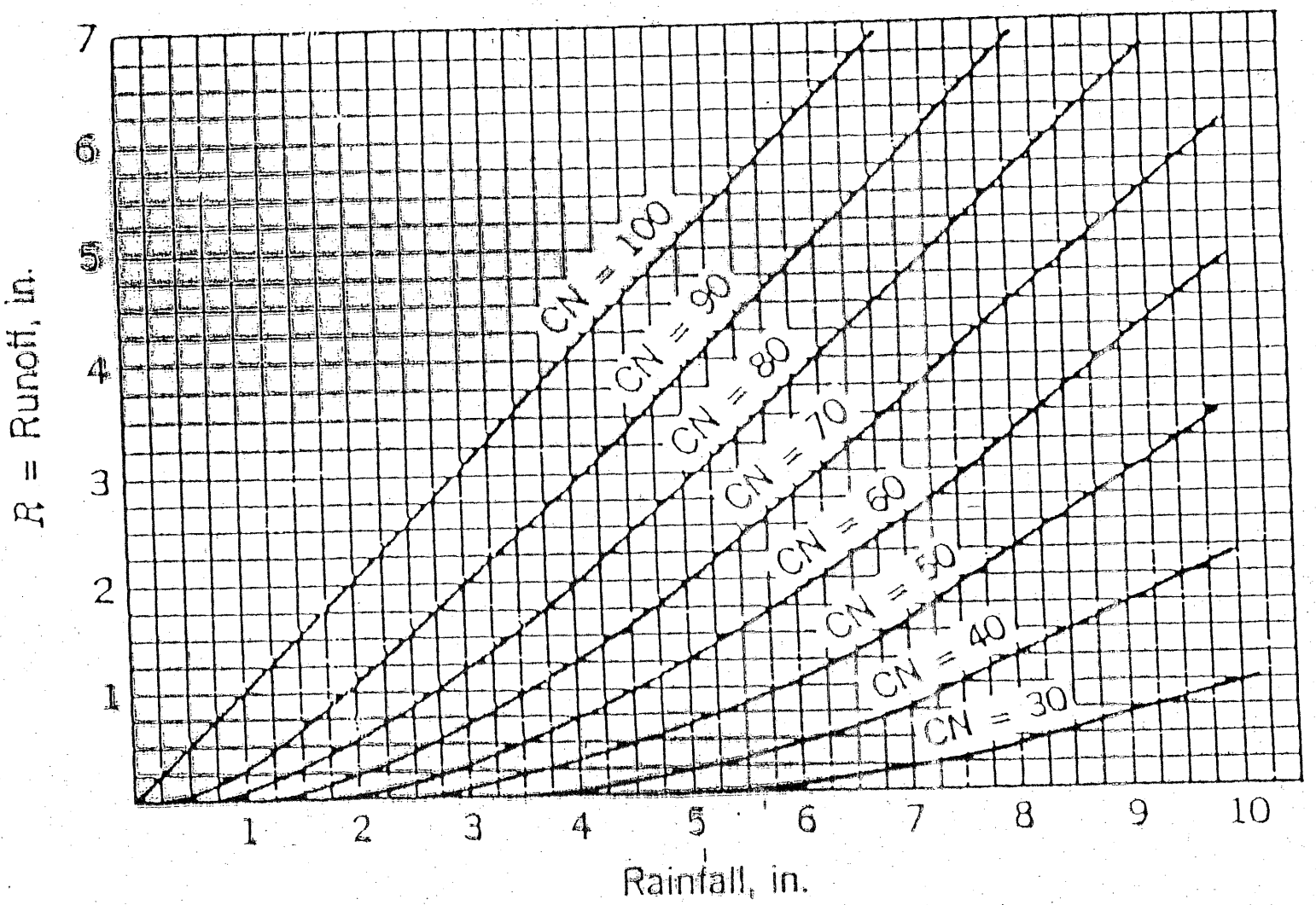


FIGURE 9.5 A selection of SCS rainfall–runoff relationships for several CN values. (Adapted from "A Method for Estimating Volume and Rate of Runoff in Small Watersheds," with permission of the Soil Conservation Service/USDA.)

SCS now NRCS