# Pavement Drainage

This section was extracted from the Urban Drainage Design Manual, **Hydraulic Engineering Circular Number 22 (HEC-22)**, Pavement Drainage; published by the Federal Highway Administration in November 1996. All charts referred to in this section are provided in HEC 22 Charts.

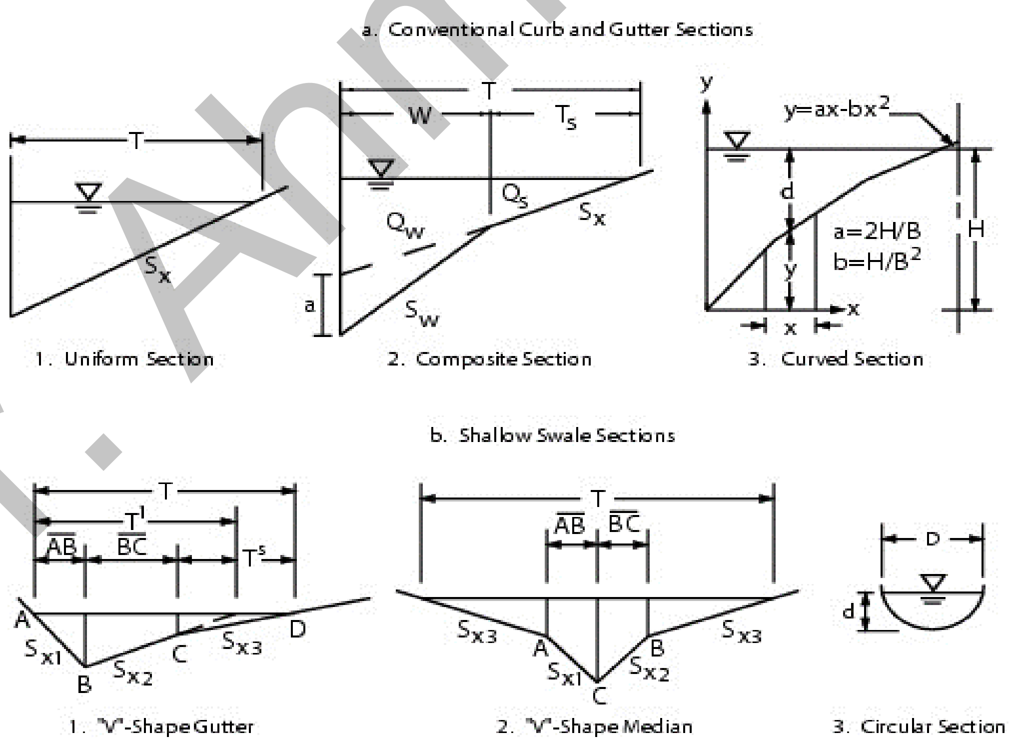
## 1.1 Selection of Check Storm and Spread

**Table 6-1: Suggested Minimum Design Frequency and Spread**

| Road Classification | | Design Frequency | Design Spread |
|---|---|---|---|
| High Volume, Divided, or Bi-Directional | <70 km/hr (45 mph) | 10-year | Shoulder +1m |
| | >70 km/hr (45 mph) | 10-year | Shoulder |
| | Sag Point | 5-year | Shoulder +1m |
| Collector | <70 km/hr (45 mph) | 10-year | 1/2 driving lane |
| | >70 km/hr (45 mph) | 10-year | Shoulder |
| | Sag Point | 10-year | 1/2 driving lane |
| Local Streets | Low ADT | 5-year | 1/2 driving lane |
| | High ADT | 10-year | 1/2 driving lane |
| | Sag Point | 10-year | 1/2 driving lane |

Grate Inlets on Grade

## 1.2 Roadside and Median Channels



## 1.3 Flow in Gutters

$$Q = \frac{k_c}{n} S_x^{1.67} S_L^{0.50} T^{2.67}$$

Where:

Kc = 0.376
n = Manning's coefficient
Q = Gutter Flow rate ($m^3/s$)
T = Width of flow—spread (m)
$S_X$ = Cross slope (m/m)
$S_L$ = Longitudinal slope (m/m)

$$d = TS_x$$

Where:

d = Depth of flow (m)
T = Width of flow—spread (m)
$S_X$ = Cross slope (m/m)

| Table 6-3: Manning's n for Street and Pavement Gutters | |
|---|---|
| Type of Gutter or Pavement | Manning's n |
| Concrete gutter, trowled finish | 0.012 |
| Asphalt pavement, smooth texture | 0.013 |
| Asphalt pavement, rough texture | 0.016 |
| Concrete gutter-asphalt pavement, smooth | 0.013 |
| Concrete gutter-asphalt pavement, rough | 0.015 |
| Concrete pavement, float finish | 0.014 |
| Concrete pavement, broom finish | 0.016 |
| For gutters with small slope, where sediment may accumulate, increase the above values of "n" by 0.02 | |
| Reference: USDOT, FHWA, HDS-3 | |

## 1.4 Gutter Flow Velocity

$$V = \frac{k_c}{n} S_x^{0.67} S_L^{0.50} T^{0.67}$$

Where:

V = Velocity in the triangular channel (m/sec.)
Kc = 0.752
n = Manning's coefficient
$S_X$ = Cross slope (m/m)
$S_L$ = Longitudinal slope (m/m)
T = Width of flow—spread (m)

**Step 1. Compute the interception capacity of the curb-opening upstream of the grate**

**Curb Opening Length Required to intercept 100% of Gutter Flow (m)**

$$L_T = k_c\, Q^{0.42}\, S_L^{0.30} \left(\frac{1}{n\, S_X}\right)^{0.60}$$

Where:

| | | |
|---|---|---|
| $L_T$ | = | Curb Opening Length Required to intercept 100% of Gutter Flow (m) |
| Kc | = | 0.817 |
| n | = | Manning's coefficient |
| $S_X$ | = | Cross slope (m/m) |
| $S_L$ | = | Longitudinal slope (m/m) |
| Q | = | Gutter Flow rate ($m^3$/s) |

**The efficiency of Curb Opening inlets shorter than the length required for total interception**

$$E_c = 1 - \left[1 - \frac{L}{L_T}\right]^{1.80}$$

Where:

| | | |
|---|---|---|
| $L_T$ | = | Curb Opening Length Required to intercept 100% of Gutter Flow (m) |
| L | = | Curb Opening Length (m) |
| $E_C$ | = | The efficiency of Curb Opening inlets |

**Interception capacity of the curb-opening upstream of the grate**

$$Q_{ic} = E\, Q$$

Where:

| | | |
|---|---|---|
| $Q_{ic}$ | = | interception capacity of the curb-opening upstream of grate ($m^3$/s) |
| E | = | The efficiency of Curb Opening inlets |
| Q | = | Gutter Flow rate ($m^3$/s) |