Equa. No.	Description	Equation	Page No.
1.1	Peak Runoff (Rational Method)	$Q = CiA$	1-13
1.2	Time of Concentration (Kirpich Equation)	$T_c = 0.0078\ L^{0.77}\ S^{-0.385}\ C_F$	1-21
1.3	Critical Depth in Open Channel Flow	$A^3/T = Q^2/g$	1-31
1.4	Froude Number	$Fr = V/(gD)^{0.5}$	1-32
1.5	Manning's Equation for evaluating uniform flow in open channels	$V = \frac{1.486}{n} R^{2/3} S^{1/2}$	1-33
1.6	Compound Bend Angle	$\gamma = 180° - Cos^{-1}(-\cos(\alpha) \times \cos(\beta))$	1-54
1.7a	Modified Manning's Equation for evaluating gutter flow hydraulics (depth known)	$Q = 0.56(z/n)\ S^{1/2} d^{8/3}$	1-66
1.7b	Modified Manning's Equation for evaluating gutter flow hydraulics (spread known)	$Q = (0.56/n)\ S_x^{5/3} S^{1/2} T^{8/3}$	1-66
1.8	Determine pavement cross slope for a V-shaped gutter	$S_X = S_{X1} S_{X2} / (S_{X1} + S_{X2})$	1-66
1.9	Length of inlet required to intercept 100% of gutter flow	$L_a = Q_a/(Q_a/L_a)$	1-72
1.10	Ratio of frontal flow to total gutter flow for grate inlets	$E_o = Q_w/Q = 1 - (1 - W/T)^{2.7}$	1-74
1.11	Ratio of side flow to total gutter flow for grate inlets	$Q_s/Q = 1 - Q_w/Q = 1 - E_o$	1-74
1.12	Ratio of frontal flow intercepted to total frontal flow for grate inlets	$R_f = 1 - 0.09\ (V - V_o)$	1-74
1.13	Ratio of side flow intercepted to total side flow for grate inlets	$R_s = 1 / [1 + (0.15 V^{1.8} / S_x L^{2.3})]$	1-74
1.14	Efficiency of a grate	$E = R_f E_o + R_s(1-E_o)$	1-75
1.15	Interception capacity of a grate on grade	$Q_i = EQ = Q[R_f E_o + R_s(1-E_o)]$	1-75
1.16	Capacity for a grate inlet in a low point or sump, inlet acting as a weir	$Q_i = CPd^{1.5}$	1-76
1.17	Capacity for a grate inlet in a low point or sump, inlet operating as an orifice	$Q_i = CA(2gd)^{0.5}$	1-76
1.18	Length of slotted pipe inlet required to intercept 100% of gutter flow on continuous grade	$L_T = 0.6 Q^{0.42} S^{0.3} (1/nS_x)^{0.6}$	1-77
1.19	Interception efficiency of a slotted pipe inlet shorter than the length required for total interception of gutter flow on continuous grade	$E = 1 - (1 - L/L_T)^{1.8}$	1-77
1.20	Actual gutter flow intercepted by a slotted pipe inlet on a continuous grade	$Q_i = EQ$	1-77
1.21	Capacity for a slotted pipe inlet in a low point or sump, inlet operating as an orifice	$Q_i = 0.8LW(2gd)^{0.5}$	1-78
1.22	Capacity for a slotted pipe inlet (with a slot width of 1.75 in) in a low point or sump, inlet operating as an orifice	$Q_i = 0.94Ld^{0.5}$	1-78
1.23	Capacity of a slotted vane drain	$Q = Kd^{5/3}$	1-78

Equa. No.	Description	Equation	Page No.
1.24	Discharge rate of flow of a storm sewer	$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$	1-81
1.25	Velocity of flow in a storm sewer flowing full	$V_{full} = \frac{0.590}{N} D^{2/3} S^{1/2}$	1-81
1.26	Discharge rate of flow in a storm sewer flowing full	$Q_{full} = \frac{0.463}{n} D^{8/3} S^{1/2}$	1-81
1.27	Energy losses from pipe friction in storm sewers	$S_f = [Qn/1.486\ AR^{2/3}]^2$	1-82
1.28	Head losses due to friction in storm sewers	$H_f = S_f L$	1-82
1.29	Velocity head losses in storm sewers	$H = K(V^2)/2g$	1-83
1.30	Terminal losses in storm sewers	$H_{tm} = (V^2)/2g$	1-83
1.31	Entrance losses in storm sewers	$H_e = K(V^2)/2g$	1-83
1.32	Head loss at a storm sewer junction	$H_{j1} = (V^2)\ (outflow)/2g$	1-83
1.33	Energy loss in a storm sewer junction due to a change in direction of flow	$H_b = K(V^2)\ (outlet)/2g$	1-84
1.34	Energy loss in a storm sewer junction with several entering flows	$H_{j2} = [(Q_4V_4^2)-(Q_1V_1^2)-(Q_2V_2^2)+(KQ_1V_1^2)]/(2gQ_4)$	1-85
2.1	Shear stress on a channel	$\tau = \gamma RS$	2-27
2.2	Permissible shear stress for non-cohesive soils	$\tau_p = (4.0\ lbs/cu\ ft) \times (D_{50} \div SF)$	2-28
2.3	Channel bend shear stress	$\tau_b = (K_b) \times (\tau_{max})$	2-30
2.4	Distance increased shear stress travels down a channel from a bend	$L_p = (0.604) \times (R^{7/6} \div n_b)$	2-30
2.5	Brink depth at a pipe culvert outlet	$Y_e = (A \div 2)^{0.5}$	2-55
2.6	Froude Number	$V_0 \div (g\ Y_e)^{0.5}$	2-55
2.7a – 2.7f	Variable used in calculating riprap basin depression	$F \div Y_e = (variable \times Fr) – variable$	2-55
2.8	Riprap basin depression	$F = (F \div Y_e) \times Y_e$	2-55
I.1	Earth loads on trench conduits	$W_c = C_d\ w\ B_d^2$	I-3
I.2	Earth loads on positive projecting embankment conduits	$W_c = C_c\ w\ B_c^2$	I-3
I.3	Earth loads on negative projecting embankment conduits	$W_c = C_n\ w\ B_d\ B'_d$	I-4
I.4	Earth loads on induced trench embankment conduits	$W_c = C_n\ w\ B_c^2$	I-5
I.5	Live loads on buried conduits	$W_L = \pi W\ L\ (2P_1 + P_2)/\ L + 24$	I-6
I.6	Pipe strength	D-Load = TEB / D	I-10
I.7	Pipe design strength	$\frac{(D\text{-}Load \times D) \times L_f}{FS}$	I-10
I.8	Pipe stiffness	$PS = F/\Delta Y \geq EI / 0.149r^3 = 0.559\ E\ (t/r)^3$	I-11
I.9	Theoretical pipe stiffness	$PS = 4.47\ [E/(DR-1)^3]$	I-12
I.10	Earth loads on flexible culverts (lbs/lin ft)	$W_c = HwB_c$	I-14

Equa. No.	Description	Equation	Page No.
I.11	Earth loads on flexible culverts (psi)	$P = wH / 144$	I-14
I.12	Deflection of buried flexible conduits	$\Delta X = D_L \dfrac{Kw_c r^3}{EI + 0.061 E'r^3}$	I-15
I.13	Relationship between the horizontal and vertical deflection of buried flexible conduits	$\Delta X = 0.913\ \Delta Y$	I-15
I.14	Percent of deflection of buried flexible conduits, ($\Delta X = \Delta Y$)	$\% \dfrac{\Delta Y}{D} = \dfrac{D_L KP\ (100)}{0.149 \dfrac{F}{\Delta Y} + 0.061E'}$	I-15
I.15	Percent of deflection of buried flexible conduits, ($\Delta X = \Delta Y$)	$\% \dfrac{\Delta Y}{D} = \dfrac{D_L KP\ (100)}{[2E/3(DR-1)^3] + 0.061E'}$	I-15
I.16	Percent of deflection of buried flexible conduits with live loads considered, ($\Delta X = \Delta Y$)	$\% \dfrac{\Delta Y}{D} = \dfrac{(D_L KP + K\ W')\ (100)}{[2E/3(DR-1)^3]+0.061E'}$	I-16