DESIGN COEFFICIENT TABLES

Hazen-Williams Friction Factor (C)

Pipe Material	Values for C		
	Range	Average Value	Typical Design Value
	High/Low		
Plastic, PVC, Polyethylene	160/150	150-155	150
pipe or tubing			
Cement or mastic lined iron	160/130	148	140
or steel pipe			
Copper, brass, lead, tin or	150/120	140	130
glass pipe or tubing			
Wood Stave	145/110	120	110
Welded or Seamless Steel	150/80	130	100
Cast and ductile iron	150/80	130	100
Concrete	152/85	120	100
Corrugated steel	-	60	60

Manning's Equation roughness coefficient (n)

Material	Values for n			
	Range	Typical Design Value		
Polyethylene pipe	0.008-0.011	0.009		
Uncoated cast or ductile iron pipe	0.012-0.015	0.013		
Corrugated steel pipe	0.021-0.030	0.024		
Concrete pipe	0.012-0.016	0.015		
Vitrified clay pipe	0.011-0.017	0.013		
Brick and cement mortar sewers	0.012-0.017	0.015		
Wood stave	0.010-0.013	0.011		
Rubble masonry	0.017-0.030	0.021		
Concrete Culvert Pipe (Smooth)	0.010-0.011	0.011		
Concrete Boxes (Smooth)	0.012-0.015	0.013		
Spiral Rib Metal Pipe (Smooth)	0.012-0.013	0.013		
Corrugated Metal Pipe, Pipe-Arch and Box. (2 -2/3 in by ½ in Annular corrugation)	0.022-0.027	0.024		
Corrugated Metal Pipe, Pipe-Arch and Box. (2 -2/3 in by ½ in Helical corrugation)	0.011-0.023	0.020		
Corrugated Metal Pipe, Pipe-Arch and Box. (6 in by 1 in Helical corrugation)	0.022-0.025	0.024		
Corrugated Metal Pipe, Pipe-Arch and Box. (5 in by 1 in)	0.025-0.026	0.026		
Corrugated Metal Pipe, Pipe-Arch and Box. (3 in by 1 in)	0.027-0.028	0.028		
Corrugated Metal Pipe, Pipe-Arch and Box. (6 in by 2 in Structural Plate)	0.033-0.035	0.034		

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pavement and concrete gutter			
gutter	-	0.015	0.015
Concrete pavement 0.014-0.016 0.015	-		
	Concrete pavement	0.014-0.016	0.015

Culvert Design - Outlet Control, Full or Partly Full Entrance Head Loss Coefficient (Ke)

Type of Structure and Design of Entrance	Ке
Pipe, Concrete	Re
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls, Socket end	0.2
Headwall or headwall and wingwalls, Square-edge	0.5
Rounded, radius D/12	0.2
Mitered to conform to fill slope	0.7
End-Section conforming to fill slope	0.5
Beveled edges, 33.7 deg. or 45 deg. bevels	0.2
Side- or slope-tapered inlet	0.2
Pipe or Pipe-Arch Corrugated Metal	0.2
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
End-Section conforming to fill slope	0.5
Beveled edges, 33.7 deg. or 45 deg. bevels	0.2
Side- or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls), Square-edge on 3	0.5
edges	
Headwall parallel to embankment (no wingwalls), Rounded on 3	0.2
edges to radius of D/12 or B/12 or beveled edges on 3 sides	
Wingwalls at 30 deg to 75 deg to barrel, Square-edged at crown	0.4
Wingwalls at 30 deg to 75 deg to barrel, Crown edge rounded to	0.2
radius of D/12 or beveled top edge	
Wingwalls at 10 deg to 25 deg to barrel, Square-edged at crown	0.5
Wingwalls parallel (extension of sides), Square-edged at crown	0.7
Wingwalls parallel (extension of sides), Side- or slope-tapered inlet	0.2

Culvert Design - Constants for Inlet Control Design Equation

Shape and Material	Inlet Edge Description	К	М	С	Y
Circular Concrete	ete Square edge w/headwall .		2.0	.0398	.67
	Groove end w/headwall	.0018	2.0	.0292	.74
	Groove end projecting	.0045	2.0	.0317	.69
Circular CMP	Headwall	.0078	2.0	.0379	.69
	Mitered to slope	.0210	1.33	.0463	.75
	Projecting	.0340	1.50	.0553	.54
Circular	Beveled ring, 45 deg. bevels	.0018	2.50	.0300	.74
	Beveled ring, 33.7 deg. bevels	.0018	2.50	.0243	.83
Rectangular Box	30 to 75 deg wingwall flares	.026	1.0	.0347	.81
	90 and 15 deg wingwall flares	.061	75	.0400	.80
	0 deg wingwall flares	.061	.75	.0423	.82
	45 deg wingwall flare d=.043D	.510	.667	.0309	.80
	18 to 33.7 deg wingwall flare d = .083D	.486	.667	.0249	.83
	90 deg headwall w/ 3/4" chamfers	.515	.667	.0375	.79
	90 deg headwall w/ 45 deg bevels	.495	.667	.0314	.82
	90 deg headwall w/ 33.7 deg bevels	.486	.667	.0252	.865
	¾" chamfers, 45 deg skewed headwall	.545	.667	.04505	.73
	¾" chamfers, 30 deg skewed headwall	.533	.667	.0425	.705
	¾" chamfers, 15 deg skewed headwall	.522	.667	.0402	.68
	45 deg bevels; 10 to 45 deg skewed headwall	.498	.667	.0327	.75
Rectangular Box ¾″ chamfers	45 deg non-offset wingwall flares	.497	.667	.0339	.803
	18.4 deg non-offset wingwall flares	.493	.667	.0361	.806
	18.4 non-offset wingwall flares, 30 deg skewed barrel	.495	.667	.0386	.71

Rectangular Box	45 deg wingwall flares - offset	.497	.667	.0302	.835
Top Bevels					
	33.7 deg wingwall flares - offset	.495	.667	.0252	.881
	18.4 deg wingwall flares - offset	.493	.667	.0227	.887
C M Boxes	90 deg headwall	.0083	2.0	.0379	.69
	Thick wall projecting	.0145	1.75	.0419	.64
	Thin wall projecting	.0340	1.5	.0496	.57
Horizontal Ellipse –	Square edge w/headwall	.0100	2.0	.0398	.67
Concrete					
	Groove end w/headwall	.0018	2.5	.0292	.74
	Groove end projecting	.0045	2.0	.0317	.69
Vertical Ellipse –	Square edge w/headwall	.0100	2.0	.0398	.67
Concrete					
	Groove end w/headwall	.0018	2.5	.0292	.74
	Groove end projecting	.0095	2.0	.0317	.69
Pipe Arch,	90 deg headwall	.0083	2.0	.0379	.69
18" Corner Radius - CM					
	Mitered to slope	.0300	1.0	.0463	.75
	Projecting	.0340	1.5	.0496	.57
	Projecting	.0300	1.5	.0496	.57
	No Bevels	.0088	2.0	.0368	.68
	33.7 deg Bevels	.0030	2.0	.0269	.77
Pipe Arch,	Projecting	.0300	1.5	.0496	.57
31" Corner Radius - CM	, ,				
	No Bevels	.0088	2.0	.0368	.68
	33.7 deg Bevels	.0030	2.0	.0269	.77
Arch CM	90 deg headwall	.0083	2.0	.0379	.69
	Mitered to slope	.0300	1.0	.0463	.75
	Thin wall projecting	.0340	1.5	.0496	.57
Circular	Smooth tapered inlet throat	.534	.555	.0196	.90
	Rough tapered inlet throat	.519	.64	.0210	.90
Elliptical Inlet Face	Tapered inlet - beveled edges	.536	.622	.0368	.83
	Tapered inlet - square edges	.5035	.719	.0478	.80
	Tapered inlet - thin edge projecting	.547	.80	.0598	.75
Rectangular	Tapered inlet throat	.475	.667	.0179	.97
Rectangular - Concrete	Side tapered - less favorable edges	.56	.667	.0446	.85
Rectangular concrete	· · · · · · · · · · · · · · · · · · ·	56	667	0378	87
	Side tapered - more favorable edges Slope tapered - less favorable edges	.56 .50	.667 .667	.0378 .0446	.87 .65

Rational Method/Modified Rational Method Runoff Coefficients (C)

Categorized by surface	С
forested	0.059-0.2
asphalt	0.7-0.95
brick	0.7-0.85
concrete	0.8-0.95
shingle roof	0.75-0.95
lawns, well drained (sandy soil), up to 2% slope	0.05-0.1
lawns, well drained (sandy soil), 2% to 78% slope	0.10-0.15
lawns, well drained (sandy soil), over 7% slope	0.15-0.2
lawns, poor drainage (clay soil), up to 2% slope	0.13-0.17
lawns, poor drainage (clay soil), 2% to 7% slope	0.18-0.22
lawns, poor drainage (clay soil), over 7% slope	0.25-0.35
driveways, walkways	0.75-0.85
Categorized by use	
farmland	0.05-0.3
pasture	0.05-0.3
unimproved	0.1-0.3
parks	0.1-0.25
cemeteries	0.1-0.25

railroad yard	0.2-0.40
playgrounds (except asphalt or concrete)	0.2-0.35
business districts, neighborhood	0.5-0.7
business districts, city (downtown)	0.7-0.95
residential, single family	0.3-0.5
residential, multi-plexes, detached	0.4-0.6
residential, multi-plexes, attached	0.6-0.75
residential, suburban	0.25-0.4
residential, apartments, condominiums	0.5-0.7
industrial, light	0.5-0.8
industrial, heavy	0.6-0.9

Modified Rational Method, Typical Values of Infiltration Rates, (F), inches/hour

Description	Soil group symbol	Infiltration, F, in/hr
Sand and gravel mixture	GW, GP, SW, SP	0.8-1.0
Silty gravels and silty sands to inorganic silt, and well- developed loams	GM, SM, ML, MH, OL	0.3-0.6
Silty clay sand to sandy clay	SC, CL	0.2-0.3
Clays, inorganic and organic	СН, ОН	0.1-0.2
Bare rock, not highly fractured		0.0-0.1

Soil Cohesion and Friction Factors (For use in Thrust Block Design)

Soil Material	Friction Angle	Soil Cohesion and Friction Factors		
	(degrees)	Cs	fp	fs
Sand, dry well graded	44.5	0	0.76	0
Sand, saturated, well graded	39	0	0.80	0
Silt, dry, passing 200 sieve	40	0	0.95	0
Silt, saturated, passing 200 sieve	32	0	0.75	0
Cohesive granular soil wet to moist	13 - 22	385 - 920	0.65	0.35
Clay, wet to moist	11.5 - 16.5	460 - 1,175	0.50	0.50
Clay, wet to moist at maximum compaction	11.5 – 16.5	460 - 1,175	0.50	0.80

Kerby's Roughness Coefficient

Categorized by surface	Kerby n
Smooth, impervious surface	0.02
Smooth, packed bare soil	0.10
Poor grass, cultivated row crops of moderately rough bare soil	0.20
Pasture or average grass	0.40
Deciduous timberland	0.60
Timberland with deep forest litter or dense grass	0.80

Slope Intercept Coefficient k

Categorized by surface	k
Forest with heavy ground litter; hay meadow (overland flow)	0.076
Trash fallow or minimum tillage cultivation; contour or strip cropped; woodland (overland flow)	0.152
Short grass pasture (overland flow)	0.213
Cultivated straight row (overland flow)	0.274
Nearly bare and untilled (overland flow); alluvial fans in western mountain regions	0.305
Grassed waterway (shallow concentrated flow)	0.457
Unpaved (shallow concentrated flow)	0.491
Paved area (shallow concentrated flow); small upland gullies	0.619