APPENDIX 4 – TABLES
Metric Conversion Tables

Base Units

Quantity	Unit	Symbol
length	meter	m
mass*	kilogram	kg
time	second	s
electric current	ampere	A
temperature	kelvin	K
luminous intensity	candela	cd

* “Weight” in common practice often is used to mean “mass”.

Decimal Prefixes

Prefix	Symbol	Order of Magnitude	Expression
nano	n	10^{-9}	0,000,000,001 (1 billionth)
micro	μ	10^{-6}	0.000001 (one millionth)
milli	m	10^{-3}	0.001 (one thousandth)
kilo	k	10^{3}	1000 (one thousand)
Mega	M	10^{6}	1,000,000 (1 million)
Giga	G	10^{9}	1,000,000,0000 (1 billion)

Derived Units

Quantity	Name	Symbol	Expression
frequency	hertz	Hz	$Hz = s^{-1}$
force	newton	N	$N = kg \cdot m/s^2$
pressure, stress	pascal	Pa	$Pa = N/m^2$
energy, work, quantity of heat	joule	J	$J = N \cdot m$
power, radiant flux	watt	W	$W = J/s$
electric charge, quantity	coulomb	C	$C = A \cdot s$
electric potential	volt	V	V = W/A or J/C
capacitance	farad	F	F = C/V
electric resistance	ohm	Ω	$\Omega = V/A$
electric conductance	siemens	S	S = A/V or Ω^{-1}
magnetic flux	weber	Wb	$Wb = V \cdot s$
magnetic flux density	tesia	T	$T = Wb/m^2$
inductance	henry	H	H = Wb/A
luminous flux	lumen	lm	$lm = cd \cdot sr$
illuminance	lux	lx	$lx = lm/m^2$

Project Definition

	Quantity	Metric Unit	Symbol	English Unit
Surveying	Length	kilometer, meter	km, m	mile, foot
	area	square kilometer hectare square meter	km^2 ha m^2	square mile acre square foot
	plane angle	degree minute second	° ‘ “	° ‘ “
Excavating	length	meter, millimeter	m, mm	foot, inch
	volume	cubic meter	m^3	cubic yard
Haul	distance	kilometer	km	mile
	volume	cubic meter	m^3	cubic yard
	mass	metric ton	t	English ton
Paving	length	meter, millimeter	m, mm	foot, inch
	area	square meter	m^2	square yard
Concrete	length	meter, millimeter	m, mm	foot
	area	square meter	m^2	square foot
	volume	cubic meter	m^3	cubic yard
	temperature	degree Celsius	°C	°F
	water capacity	liter	L	gallon, MG
	mass (weight)	kilogram, gram	kg, g	pound
	x-sectional area	square millimeter	mm^2	square inch
Drainage	length	meter, millimeter	m, mm	foot
	area	hectare	ha	acre
		square meter	m^2	square foot
		square kilometer	km^2	square mile
	volume	cubic meter	m^3	square foot
	discharge	cubic meter/second	m^3/s	cubic foot/s
	velocity	meter/second	m/s	foot/second
	slope	millimeter/meter	mm/m	feet/foot

Area, Length, and Volume Conversion Factors

Quantity	From Inch-Pound Units	To Metric Units	Multiply By
Length	* mile (U.S. Statute) mile (international) yard foot * foot (U.S. Survey) inch	m km m m m mm mm	1609.347 1.609344 0.9144 0.3048 0.30480061 304.8 25.4
Area	* square mile (U.S. Statute) * acre square yard square foot square inch	km^2 m^2 ha (10,000 m^2) m^2 m^2 mm^2	2.589998 4046.873 0.4046873 0.83612736 0.09290304 645.16
Volume	acre foot cubic yard cubic foot cubic foot cubic foot 100 board feet gallon 1000 gallons cubic inch	m^3 m^3 cm^3 L (1000 cm^3) m^3 L (1000 cm^3) kL (1000 L) cm^3 mm^3	1233.4894 0.7645549 28316.85 28,31685 0.02831685 0.235974 3.785412×10^{-3} 3785412. 16387.064

@

Note: Underline denotes exact number.

* Any data, in feet, derived from and published as a result of geodetic surveys will remain with the U.S. Survey foot including all stationing, land measure, and coordinate conversions.

The U.S. Survey foot, as established in the U.S. Metric Law of 1886, is based on the relationship of 1 m = 39.37 inches or 1 foot = 1200/3937 m. All conversion factors for units of land measure in this table referenced to this footnote (*) are based on the U.S. Survey foot.

Civil and Structural Engineering
Conversion Factors

Quantity	From Inch-Pound Units	To Metric Units	Multiply By
Mass	lb kip (1000 lb) ton	kg **megagram** (1000 kg) **MG**	0.4535924 0.435924 0.9071847
Mass/unit length	plf	kg/m	1.488164
Mass/unit area	psf	kg/m^2	4.882428
Mass density	pcf	kg/m^3	16l01846
Force	lb kip	N kN	4.448222 4.448222
Force/unit length	plf klf	N/m Kn/m	14.59390 14.59390
Pressure, stress modulus of elasticity	psf ksf psi psi	Pa kPa kPa Mpa	47.88026 47.88026 6.894757 0.006894757
Bending moment, torque, moment of force	ft-lb ft-kip in-lb	N• m kN• m N• m	1.355818 1.355818 0.1129848
Moment of mass	lb-ft	kg• m	0.138255
Moment of inertia	$lb\text{-}ft^2$	kg• m^2	0.0421401
Second moment of area	in^4 ft^4	mm^4 m^4	416,231.4 0.008630975
Section modulus	in^3	mm^3	16,387.064

Note: Underline denotes exact number.

Metric/English Area Conversion

Quantity	To Convert		Multiply By
	From	To	
Length	Meter (m) Foot	Foot Meter (m)	3937/1200=3.280833 ft/m 0.30480061 m/ft
Acre	Acre Acre	Hectare (ha) Square Meter (m^2)	0.40468726 ha/Acre 4046.87260988 m^2/Acre
	Hectare (ha) Square Meter (m^2) Hectare (ha)	Acre Square Foot Square Meter (m^2)	2.47104393 Acre/ha 10.76386736 ft^2/m^2 10,000 m^2/ha

Drawing Sizes

ISO Designation	Metric Sheet Size	Replaces
A0	841 x 1189 mm	34 x 44 inches
A1	594 x 841 mm	22x34 inches
A2	420 x 594 mm	17 x 22 inches
A3	297 x 420 mm	11 x 17 inches
A4	210 x 297 mm	8 1/2 x 11 inches

Units for Structural Steel Design

Fraction (in.)	Exact Conversion (mm)	Rounded to: (mm)
1/16	1.5875	2
1/8	3.175	3
3/16	4.7625	5
1/4	6.35	6
5/16	7.9375	8
3/8	9.525	10
7/16	11.1125	11
1/2	12.7	13
5/8	15.875	16
3/4	19.05	19
7/8	22.225	22
1	25.4	25

Metric Bolt Designation

Designation	Diameter (mm)	Diameter (in.)
M16	16	0.63
M20	20	0.79
M22	22	0.87
M24	24	0.94
M27	27	1.06
M30	30	1.18
M36	36	1.42

Structural Steel for Bridges

Grade S.I.	Grade U.S.	Yield Strength (MPa)
205	30	205
250	35	240
250	36	250
275	40	275
310	45	310
345	50	345
345W	50W	345
415	60	415
450	65	450
485W	70W	485
620	90	620
655	95	655
690	100	690
690W	100W	690
725	105	725
795	115	795
860	125	860
895	130	895
1000	145	1000
1035	150	1035
1105	160	1105
1140	165	1140
1240	180	1240
1450	210	1450
1795	260	1795

Reinforcing Steel

Metric Bar Designation	U.S. Customary Designation	Diameter (in.)	Area ($in.^2$)	Diameter (mm)	Area ($mm^{2)}$
	#3	0.375	0.11	9.5	71
10				11.3	100
	#4	0.500	0.20	12.7	127
	#5	0.625	0.31	15.9	198
15				16.0	200
	#6	0.750	0.44	19.1	285
20				19.5	300
	#7	0.875	0.60	22.2	388
25				25.2	500
	#8	1.000	0.79	25.4	507
	#9	1.125	1.00	28.6	641
30				29.9	700
	#10	1.270	1.27	32.3	817
35				35.7	1000
	#11	1.410	1.56	35.8	1007
	#14	1.693	2.25	43.0	1452
45				43.7	1500
55				56.4	2500
	#18	2.257	4.00	57.3	2581

Hard Conversions for Construction Materials

Reinforcing Bars, M31M				
Grade		Tensile and Yield Strengths		
Metric Value	English Value	Tensile Strength (Mpa)	Minimum Yield Strength (Mpa)	Minimum Yield Strength (ksi)
300	40	500	300	40
400	60	600	400	60

Coefficient of Thermal Expansion		
	Metric Value	English Value
Steel	0.0000117/°C	0.0000065/°F
Concrete	0.0000108/°C	0.000006/°F

Unit Weights		
	Metric Value	English Value
Steel	7848.3 kg/m^3	490 pcf
Concrete	2402.5 kg/m^3	150 pcf

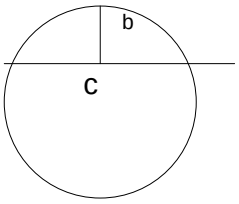
Sieves

Sieve Designation, (W)	
SI Standard[B]	**English Alternative**
125 mm	5 in.
106 mm	4.24 in.
100 mm	4 in.
90 mm	3 1/2 in.
75 mm	3 in.
63 mm	2 1/2 in.
53 mm	2.12 in.
50 mm	2 in.
45 mm	1 3/4 in.
37.5 mm	11/2 in.
31.5 mm	1 1/4 in.
26.5 mm	1.06 in.
25.0 mm	1 in.
22.4 mm	7/8 in.
19.0 mm	3/4 in.
16.0 mm	5/8 in.
13.2 mm	0.530 in.
12.5 mm	1/2 in.
11.2 mm	7/16 in.
9.50 mm	3/8 in.
8.00 mm	5/16 in.
6.70 mm	0.265 in.
6.30 mm	1/4 in.
5.60 mm	No. 3 1/2
4.75 mm	No. 4
4.00 mm	No. 5
3.35 mm	No. 6
2.80 mm	No. 7
2.36 mm	No. 8
2.00 mm	No. 10
1.70 mm	No. 12
1.40 mm	No. 14
1.18 mm	No. 16
1.00 mm	No. 18
850 µm	No. 20
710 µm	No. 25
600 µm	No. 30
500 µm	No. 35
425 µm	No. 40
355 µm	No. 45

Sieves (*Continued*)

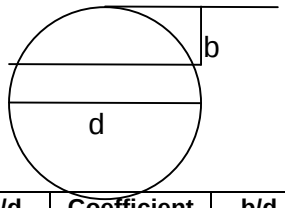
Sieve Designation, (W)	
SI Standard[B]	**English Alternative**
300 µm	No. 50
250 µm	No. 60
212 µm	No. 70
180 µm	No. 80
150 µm	No. 100
125 µm	No. 120
106 µm	No. 140
90 µm	No. 170
75 µm	No. 200
63 µm	No. 230
53 µm	No. 270
45 µm	No. 325
38 µm	No. 400
32 µm	No. 450
25 µm	No. 500
20 µm	No. 635

Areas of Circular Segments



Given: rise, b x chord, c x coefficient for b/c
Example. Given: rise = 2.10 and chord = 5.65.
b/c = 2.10/5.65 =0.3717
Coefficient by interpolation = 0.7354
Area = b x c x coeffi. = 2.10 x 5.65 x 0.7354 = 8.7255

A•	Coefficient	b/c	A•	Coefficient	b/c	A•	Coefficient	b/c	A•	Coefficient	b/c
1	.6667	.0022	46	.6722	.1017	91	.6895	.2097	136	.7230	.3373
2	.6867	.0044	47	.6724	.1040	92	.6901	.2122	137	.7249	.3404
3	.6667	.0066	48	.6727	.1063	93	.6906	.2148	138	.7290	.3436
4	.6667	.0067	49	.6729	.1086	94	.6912	.2174	139	.7270	.3489
5	.6667	.0109	50	.6732	.1109	95	.6918	.2200	140	.7281	.3501
6	.6667	.0131	51	.6734	.1131	96	.6924	.2226	141	.7292	.3634
7	.6668	.0153	52	.6737	.1154	97	.6930	.2282	142	.7303	.3867
8	.6668	.0175	53	.6740	.1177	98	.6936	.2279	143	.7314	.3600
9	.6669	.0197	54	.6743	.1200	99	.6942	.2305	144	.7325	.3633
10	.6670	.0218	55	.6746	.1224	100	.6948	.2332	146	.7326	.3806
11	.6670	.0240	56	.6749	.1247	101	.6954	.2388	148	.7248	.3700
12	.6671	.0282	57	.6752	.1270	102	.6961	.2386	147	.7380	.3794
13	.6672	.0284	58	.6755	.1293	103	.6967	.2412	148	.7372	.3786
14	.6672	.0306	59	.6758	.1316	104	.6974	.2439	149	.7384	.3802
15	.6673	.0328	60	.6761	.1340	105	.6980	.2466	150	.7396	.3837
16	.6674	.0350	61	.6784	.1363	106	.6987	.2493	151	.7408	.3871
17	.6874	.0372	62	.6788	.1387	107	.6994	.2520	152	.7421	.3908
18	.6675	.0394	63	.6771	.1410	106	.7001	.2548	153	.7434	.3942
19	.6678	.0416	64	.6775	.1434	109	.7008	.2575	154	.7447	.3977
20	.6677	.0437	65	.6779	.1457	110	.701`5	.2603	155	.7480	.4013
21	.6678	.0459	66	.6782	.1481	111	.7022	.2631	156	.7473	.4049
22	.6679	.0481	67	.6788	.1505	112	.7030	.2659	157	.7488	.4085
23	.6880	.0504	68	.6790	.1529	113	.7037	.2887	158	.7500	.4122
24	.6681	.0582	69	.6794	.1553	114	.7045	.2715	159	.7514	.4159
25	.6682	.0548	70	.6797	.1577	115	.7052	.2743	160	.7528	.4196
26	.6684	.0570	71	.6801	.1901	116	.7080	.2772	161	.7542	.4233
27	.6685	.0592	72	.6805	.1625	117	.7088	.2800	162	.7567	.4270
28	.6687	.0614	73	.6809	.1649	118	.7076	.2829	163	.7571	.4308
29	.6688	.0636	74	.6814	.1673	119	.7084	.2858	164	.7596	.4346
30	.6890	.0658	75	.6818	.1697	120	.7092	.2887	165	.7801	.4385
31	.6691	.0681	76	.6822	.1722	121	.7100	.2916	168	.7818	.4424
32	.6693	.0703	77	.8826	.1748	122	.7109	.2945	167	.7832	.4463
33	.6894	.0725	78	.8831	.1771	123	.7117	.2975	167	.7948	.4502
34	.6696	.0747	79	.6835	.1795	124	.7128	.3004	169	.7864	.4542
35	.6698	.0770	80	.6840	.1820	125	.7134	.3034	170	.7680	.4582
36	.6700	.0792	81	.6844	.1845	126	.7143	.3064	171	.7896	.4822
37	.6702	.0814	82	.6849	.1869	127	.7152	.3094	172	.7712	.4663
38	.6704	.0637	83	.6854	.1894	1`28	.7161	.3124	173	.7729	.4704
39	.6706	.0859	84	.6859	.1919	129	.7170	.3155	174	.7746	.4745
40	.6708	.0882	85	.6864	.1944	130	.7180	.3185	175	.7763	.4787
41	.6710	.0904	86	.6869	.1970	131	.7189	.3216	178	.7781	.4828
42	.6712	.0927	87	.6874	.1996	132	.7199	.3247	177	.7799	.4871
43	.6714	.0449	88	.6879	.2020	133	.7209	.3278	178	.7817	.4914
44	.6717	.0972	89	.6884	.2046	134	.7219	.3309	179	.7835	.4967
45	.6719	.0995	90	.6890	.2071	135	.7229	.3341	180	.7854	.5000



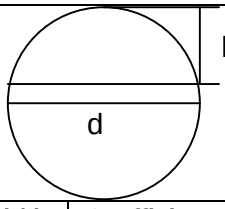
Areas of Circular Segments

for Ratios of Rise and Diameter

b = Rise; d = Diameter

Area = d^2 x Coefficient

b/d	Coefficient	b/d	Coefficient	b/c	Coefficient	b/c	Coefficient	b/d	Coefficient
.001	.000042	.051	.015119	.101	.041477	.151	.074590	.201	.112625
.002	.000119	.052	.015561	.102	.042081	.152	.075307	.202	.113427
.003	.000219	.053	.016008	.103	.042687	.153	.076028	.203	.114231
.004	.000337	.054	.016458	.104	.043296	.154	.076747	.204	.115036
.005	.000471	.055	.016912	.105	.043908	.155	.077470	.205	.115842
.006	.000619	.056	.017369	.106	.044523	.156	.078194	.206	.116651
.007	.000779	.057	.017831	.107	.045140	.157	.078921	.207	.117460
.008	.000952	.058	.018297	.108	.045759	.158	.079650	.208	.118271
.009	.001135	.059	.018766	.109	.046381	.159	.080380	.209	.119084
.010	.001329	.060	.019239	.110	.047006	.160	.081112	.210	.119898
.011	.001533	.061	.019716	.111	.047633	.161	.081847	.211	.120713
.012	.001746	.062	.020197	.112	.048262	.162	.082582	.212	.121530
.013	.001969	.063	.020681	.113	.048894	.163	.083320	.213	.122348
.014	.002199	.064	.021168	.114	.049529	.164	.084060	.214	.123167
.015	.002438	.065	.021660	.115	.050165	.165	.084801	.215	.123938
.016	.002685	.066	.022155	.116	.050805	.166	.085545	.216	.124811
.017	.002940	.067	.022653	.117	.051446	.167	.086290	.217	.125634
.018	.003202	.068	.023155	.118	.052090	.168	.087037	.218	.126459
.019	.003472	.069	.023660	.119	.052737	.169	.087785	.219	.127286
.020	.003749	.070	.024168	.120	.053385	.170	.088536	.220	.128114
.021	.004032	.071	.024680	.121	.054037	.171	.089288	.221	.128943
.022	.004322	.072	.025196	.122	.054690	.172	.090042	.222	.129773
.023	.004619	.073	.025714	.123	.055346	.173	.090797	.223	.130606
.024	.004922	.074	.026236	.124	.056004	.174	.091555	.224	.131438
.025	.005231	.075	.026761	.125	.066684	.175	.092314	.225	.132273
.026	.005546	.076	.027290	.126	.057327	.176	.093074	.226	.133109
.027	.005867	.077	.027821	.127	.057991	.177	.093837	.227	.133948
.028	.006194	.078	.028356	.128	.058658	.178	.094601	.228	.134784
.029	.006527	.079	.028894	.129	.059328	.179	.095367	.229	.135624
.030	.006866	.080	.029435	.130	.059999	.180	.096135	.230	.136465
.031	.007209	.081	.029979	.131	.060673	.181	.096904	.231	.137307
.032	.007559	.082	.030526	.132	.061349	.182	.097675	.232	.138151
.033	.007913	.083	.031077	.133	.062027	.183	.098447	.233	.138996
.034	.008273	.084	.031630	.134	.062707	.184	.099221	.234	.139842
.035	.008638	.085	.032186	.135	.063389	.185	.099997	.235	.140689
.036	.009008	.086	.032746	.136	.064074	.186	.100774	.236	.141538
.037	.009383	.087	.033308	.137	.064761	.187	.101553	.237	`.152388
.038	.009764	.088	.033873	.138	.065449	.188	.102334	.238	.143239
.039	.010148	.089	.034441	.139	.066140	.189	.103116	.239	.144091
.040	.010538	.090	.035012	.140	.066833	.190	.103900	.240	.144945
.041	.010932	.091	.035588	.141	.067528	.191	.104686	.241	.145800
.042	.011331	.092	.036162	.142	.068225	.192	.105472	.242	.146658
.043	.011734	.093	.036742	.143	.068924	.193	.106262	.243	.147513
.044	.012142	.094	.037324	.144	.069626	.194	.107051	.244	.148371
.045	.012555	.095	.037909	.145	.070329	.195	.107843	.245	.149321
.046	.012971	.096	.038497	.148	.071034	.196	.108636	.246	.150091
.047	.013393	.097	.039087	.147	.071741	.197	.109431	.247	.150953
.048	.013818	.098	.039681	.148	.072450	.198	.110227	.248	.151816
.049	.0145248	.099	.040277	.149	.073162	.199	.111025	.249	.152681
.050	.014681	.100	.040875	.150	.073875	.200	.111824	.250	.153548



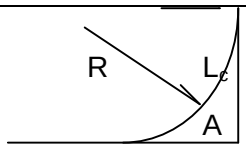
Areas of Circular Segments (cont.)

for Ratios of Rise and Diameter

b = Rise; d = Diameter

Area = d^2 x Coefficient

b/d	Coefficient	b/d	Coefficient	b/c	Coefficient	b/c	Coefficient	b/d	Coefficient
.251	.154413	.301	.199085	.351	.245935	.401	.294350	.451	.343778
.252	.155281	.302	.200003	.352	.246890	.402	.295330	.452	.344773
.253	.156149	.303	.200922	.353	.247845	.403	.296311	.453	.345768
.254	.157019	.304	.201841	.354	.248801	.404	.297292	.454	.346764
.255	.157891	.305	.202782	.355	.249758	.405	.298274	.455	.347760
.256	.158763	.306	.203683	.356	.250715	.406	.299256	.456	.348756
.257	.159636	.307	.204605	.357	.251673	.407	.300238	.457	.349752
.258	.160511	.308	.205528	.358	.252632	.408	.301221	.458	.350749
.259	.161386	.309	.206452	.359	.253591	.409	.302204	.459	.351745
.260	.162263	.310	.207376	.360	.254551	.410	.303187	.460	.352742
.261	.163141	.311	.208302	.361	.255511	.411	.304171	.461	.353739
.262	.164020	.312	.209228	.362	.256472	.412	.305156	.462	.354736
.263	.164900	.313	.210155	.363	.257433	.413	.306140	.463	.355733
.264	.165781	.314	.211083	.364	.258395	.414	.307125	.464	.356730
.265	.166663	.315	.212011	.365	.259358	.415	.308110	.485	.357728
.266	.167546	.316	.212941	.366	.260321	.416	.309096	.466	.358725
.267	.168431	.317	.213871	.367	.261285	.417	.310082	.467	.359723
.268	.169316	.318	.214802	.368	.262249	.418	.311068	.468	.360721
.269	.170202	.319	.215734	.369	.263214	.419	.312055	.469	.361719
.270	.171090	.320	.216666	.370	.264179	.420	.313042	.470	.36271`7
.271	.171978	.321	.217600	.371	.265145	.421	.314029	.471	.363715
.272	.172868	.322	.218534	.372	.266111	.422	.315017	.472	.364714
.273	.173758	.323	.219469	.373	.267078	.423	.316005	.473	.365712
.274	.174650	.324	.2204040	.374	.268046	.424	.316993	.474	.366711
.275	.175542	.325	.221341	.375	.269014	.425	.317981	.475	.367710
.276	.176436	.326	.222278	.376	.269982	.426	.318970	.476	.368706
.277	.177330	.327	.223216	.377	.270951	.427	.319959	.477	.369707
.278	.178226	.328	.224154	.378	.271921	.428	.320949	.478	.370706
.279	.179122	.329	.225094	.379	.272891	.429	.321938	.479	.371706
.280	.180020	.330	.226034	.380	.273861	.430	.322928	.480	.372704
.281	.180918	.331	.226974	.381	.274832	.431	.323919	.481	.373704
.282	.181818	.332	.227916	.382	.275804	.432	.324909	.482	.374703
.283	.182718	.333	.228858	.383	.276776	.433	.325900	.483	.375702
.284	.183619	.334	.229801	.384	.277748	.434	.326891	.484	.376702
.285	.184522	.335	.230745	.385	.278721	.435	.327883	.485	.377701
.296	.185425	.336	.231689	.386	.279695	.438	.328874	.486	.378701
.287	.186329	.337	.232634	.387	.280669	.437	.329866	.487	.370701
.288	.18725	.338	.233580	.388	.281643	.438	.330858	.488	.380700
.289	.188141	.339	.234526	.389	.282618	.439	.331851	.489	381700
.290	.189048	.340	.235473	.390	.283593	.440	.332843	.490	.382706
.291	.189956	.341	.236421	.391	.284569	.441	.333836	.491	.383700
.292	.190865	.342	.237369	.392	.285545	.442	.334829	.492	.384690
.293	.191774	.343	.238319	.393	.286521	.443	.335823	.493	385699
.294	.192685	.344	.239268	.394	.287499	.444	.336816	.494	.386890
.295	.193597	.345	.240219	.395	.288476	.445	.337810	.495	.387699
.296	.194509	.384	.241170	.396	.289454	.446	.338804	.496	.388690
.297	.195423	.347	.242122	.397	.290432	.447	.339796	.498	.389698
.298	.196337	.348	.243074	.398	.291411	.448	.340793	.498	.390699
.299	.197252	.349	.244027	.399	.292393	.449	.341788	.499	.391698
.300	.198168	.350	.244980	.400	.293370	.450	.342783	.500	.392699



Areas of 90° Fillets

R = Radius
L_c = Length of Curve

Area = R^2 x .214602

L_C = .0174533 R90°
= 1.570796 x 12

R	L_c	Area	R	L_c	Area
1	1.57	0.22	13.5	21.21	39.11
1.5	2.36	0.48	14	21.99	42.06
2	3.14	0.86	14.5	22.78	45.12
2.5	3.93	1.34	15	23.56	48.29
3	4.71	1.93	15.5	24.35	51.56
3.5	5.50	2.63	16	25.13	54.94
4	6.28	3.43	16.5	25.92	58.43
4.5	7.07	4.35	17	26.70	62.02
5	7.85	5.37	17.5	27.49	65.72
5.5	8.64	6.49	18	28.27	69.53
6	9.42	7.73	18.5	29.06	73.45
6.5	10.21	9.07	19	29.84	77.47
7	11.00	10.52	19.5	30.63	81.60
7.5	11.78	12.07	230	31.42	85.84
8	12.57	13.73	20.5	32.20	90.19
8.5	13.35	15.50	21	32.99	94.64
9	14.14	17.38	21.5	33.77	99.20
9.5	14.92	19.37	22	34.56	103.87
10	15.71	21.46	22.5	35.34	108.64
10.5	16.49	23.66	23	36.13	113.52
11	17.28	25.97	23.5	36.91	118.51
11.5	18.06	28.38	24	37.70	123.61
12	18.85	30.90	24.5	38.48	128.81
12.5	19.63	33.53	25	39.27	134.13
13	20.42	36.27	25.5	40.05	139.54

Areas of Fillets Other Than 90° =
R^2 [tan 4/2 - (.008727 x 4)]

Length of return other than 90° =
.0174533 x 4R

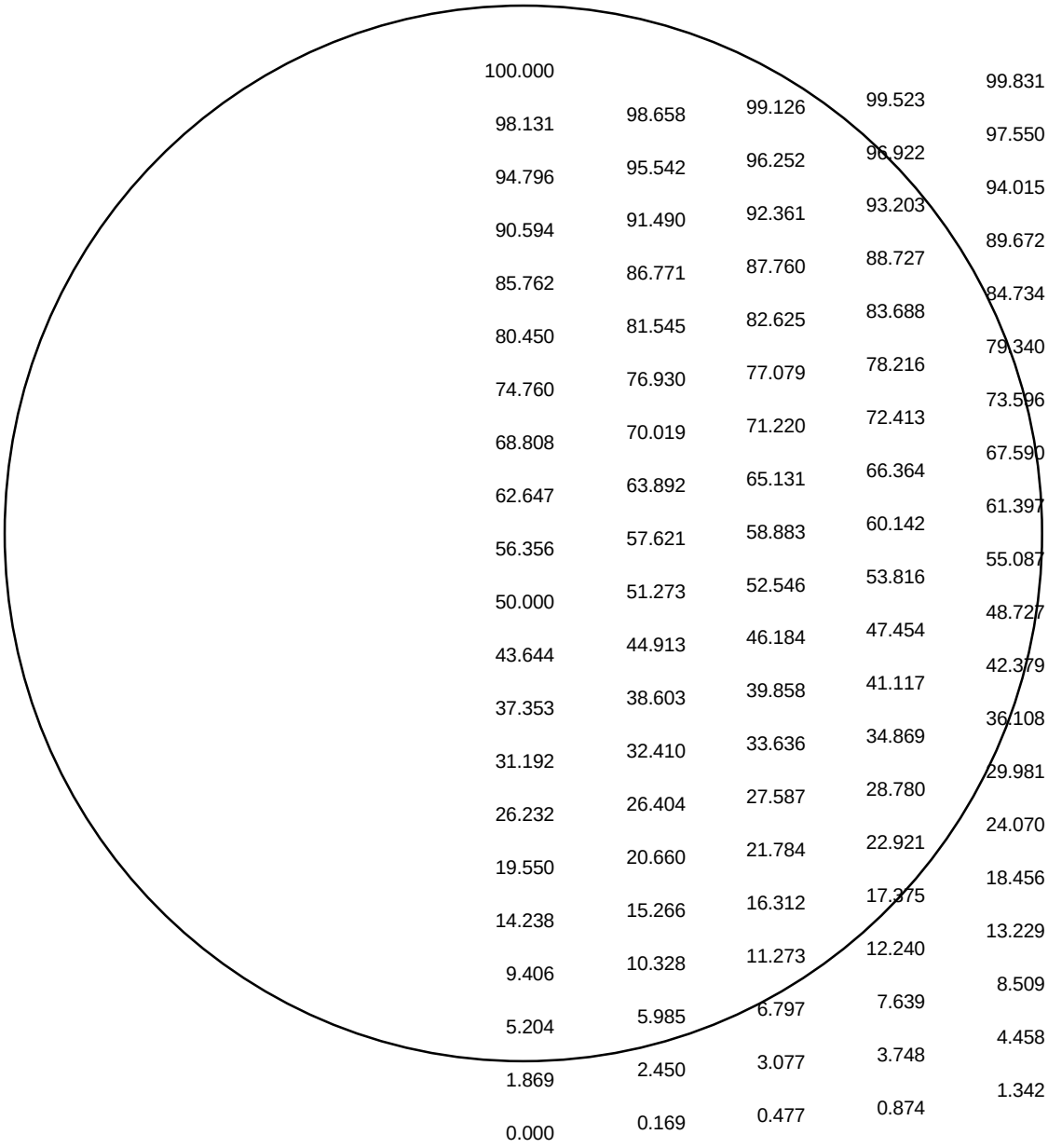
R	L_c	Area	R	L_c	Area
26	40.84	145.07	38.5	60.47	318.09
26.5	41.63	150.70	39	61.26	326.41
27	42.41	156.44	39.5	62.05	334.83
27.5	43.20	162.29	40	62.83	343.36
28	43.98	168.25	40.5	63.62	352.00
28.5	44.77	174.31	41	64.40	360.75
29	45.55	180.48	41.5	65.19	369.60
29.5	46.34	186.76	42	65.97	378.56
30	47.12	193.14	42.5	6.76	387.62
30.5	47.91	199.63	43	67.54	396.80
31.0	48.69	206.23	43.5	68.33	406.08
31.5	49.48	212.94	44	69.11	415.47
32	50.26	219.75	44.5	69.90	424.97
32.5	51.05	226.67	45	70.68	434.57
33	51.84	233.70	45.5	71.47	444.28
33.5	52.62	240.84	46	72.26	454.10
34	53.40	248.08	46.5	73.04	464.02
34.5	54.19	255.43	47	73.83	474.06
35	54.98	262.89	47.5	74.61	484.20
35.5	55.76	270.45	48	75.40	494.44
36	56.55	278.12	48.5	76.18	504.80
36.5	57.33	285.90	49	76.97	515.26
37	58.12	293.79	49.5	77.75	525.83
37.5	58.90	301.78	50	78.54	536.50
38	59.69	309.89			

Volume of Cylinder Tank

Sketch showing the relation between the depth and the volume of a liquid in a right cylinder tank when the axis of the tank is level. Percent of volume is set opposite percent of depth.

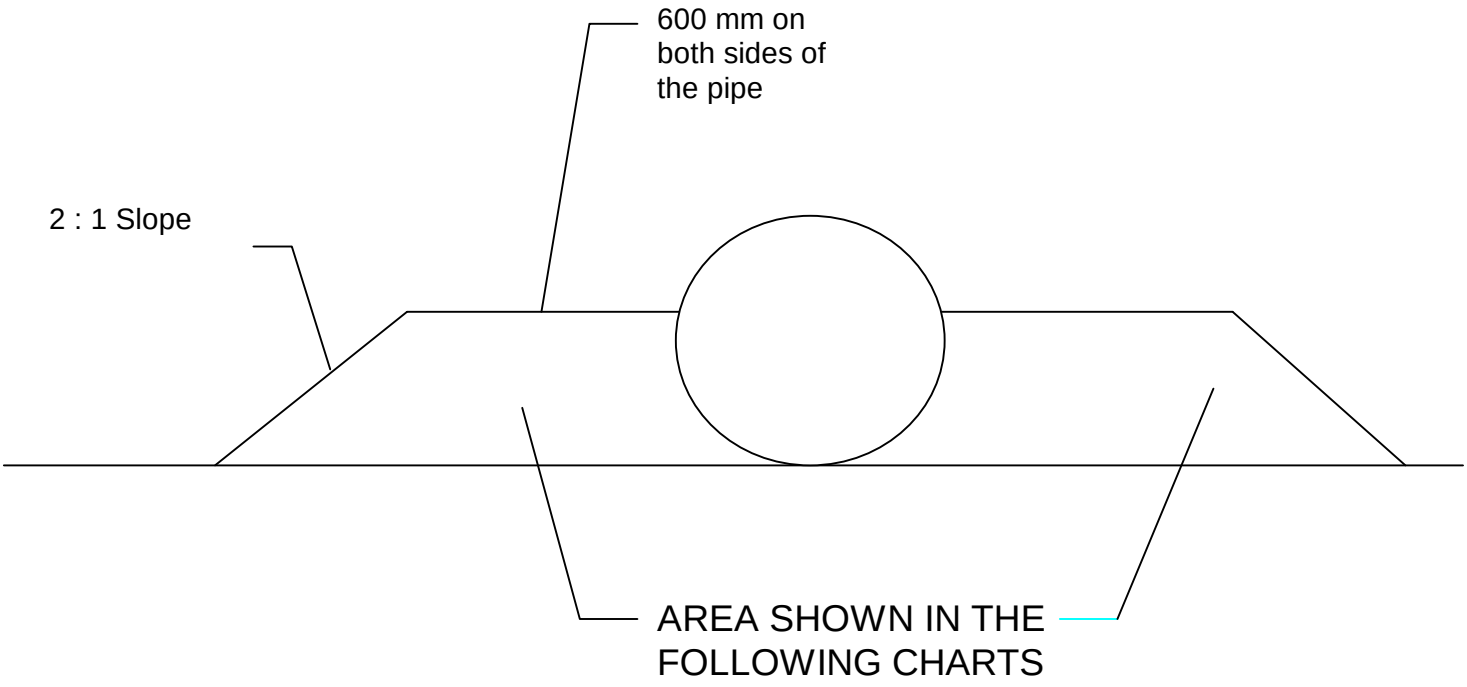
Exact Only for Right Cylinder tank

Percent of Total Volume of Tank



For Tanks with Crowned Ends, add to Volume of Right Cylinder Part of the Tank, the Volume of the **Two Crowned Ends** and use table **As Is** for results which will be considerably less than **One Percent In Error** when **Height (h)** of crown does not exceed **Twelve Percent** of the **Diameter** of the **Tank** and also when **Length (L)** of the right cylinder part of the tank is not less than the **Diameter (D)** of the tank. Percent of **Error** decreases as **L/D** increases.

CULVERT PIPE FILL



English Culvert Pipe-Arch Embankment Areas As Ft²

(Y=Height to Widest Section of Pipe as Feet)

Equivalent Round Size

Y	24”	30”	36”	42”	48”	54”	60”	66”	72”
0.1	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.2	1.3
0.2	1.1	1.1	1.1	1.2	1.3	1.4	1.5	1.7	1.8
0.3	1.6	1.6	1.6	1.7	1.8	1.9	2.1	2.2	2.4
0.4	2.0	2.2	2.2	2.2	2.4	2.5	2.6	2.8	2.9
0.5	2.8	2.7	2.7	2.7	2.9	3.1	3.2	3.4	3.5
0.6	3.7	3.6	3.5	3.4	3.4	3.7	3.8	4.0	4.2
0.7	4.6	4.6	4.5	4.4	4.2	4.1	4.5	4.7	4.9
0.8	5.5	5.6	5.6	5.5	5.3	5.0	4.9	5.4	5.6
0.9	6.5	6.6	6.7	6.7	6.5	6.2	5.9	5.8	5.7
1.0	7.5	7.7	7.8	7.9	7.8	7.5	7.1	6.8	6.7
1.1	8.6	8.8	9.0	9.1	9.1	8.9	8.6	8.1	7.8
1.2	9.7	10.0	10.2	10.4	10.4	10.3	10.0	9.6	9.2
1.3	10.8	11.2	11.5	11.7	11.8	11.7	11.5	11.2	10.8
1.4	12.0	12.4	12.8	13.1	13.2	13.2	13.1	12.8	12.4
1.5	13.2	13.7	14.1	14.5	14.7	14.7	14.6	14.4	14.1
1.6	14.5	15.0	15.5	15.9	16.2	16.3	16.3	16.1	15.8
1.7	15.8	16.4	16.9	17.4	17.7	17.9	17.9	17.8	17.6
1.8	17.1	17.8	18.4	18.;9	19.3	19.5	19.6	19.6	19.4
1.9	18.5	19.2	19.9	20.4	20.9	21.2	21.4	21.4	21.3
2.0	19.9	20.7	21.4	22.0	22.6	22.9	23.1	23.2	23.2
2.1	21.4	22.2	23.0	23.7	24.3	24.7	25.0	25.1	25.1
2.2	22.9	23.8	24.6	25.4	26.0	26.5	26.8	27.0	27.0
2.3	24.4	25.4	26.3	27.1	27.8	28.3	28.7	29.0	29.1
2.4	26.0	27.0	28.0	28.8	29.6	30.2	30.7	31.0	31.1
2.5	27.6	28.7	29.7	30.6	31.5	32.1	32.6	33.0	33.2
2.6	29.3	30.4	31.5	32.5	33.4	34.1	34.7	35.1	35.3
2.7	31.0	32.2	33.3	34.3	35.3	36.1	36.7	37.2	37.5
2.8	32.7	34.0	35.2	36.3	37.3	38.1	38.8	39.3	39.7
2.9	34.5	35.8	37.1	38.2	39.4	40.2	41.0	41.5	41.9
3.0	36.3	37.7	39.0	40.2	41.4	42.3	43.1	43.8	44.2
3.1	38.2	39.6	41.0	42.2	43.5	44.5	45.4	46.1	46.6
3.2	40.1	41.6	43.0	44.3	45.7	46.7	47.6	48.4	48.9
3.3	42.0	43.6	45.1	46.4	47.8	48.9	49.9	50.7	51.3
3.4	44.0	45.6	47.2	48.6	50.1	51.2	52.3	53.1	53.8
3.5	46.0	47.7	49.3	50.8	52.3	53.5	54.6	55.6	56.3
3.6	48.1	49.8	51.5	53.0	54.6	55.9	57.1	58.1	58.8
3.7	50.2	52.0	53.7	55.3	57.0	58.3	59.5	60.6	61.4
3.8	52.3	54.2	56.0	57.6	59.4	60.7	62.0	63.1	64.0
3.9	54.5	56.4	58.3	60.0	61.8	63.2	64.6	65.7	66.6
4.0	56.8	58.7	60.6	62.4	64.3	65.7	67.1	68.4	69.3
4.1	59.0	61.0	63.0	64.8	66.8	68.3	69.8	71.0	72.0
4.2	61.3	63.4	65.4	67.3	69.3	70.9	72.4	73.8	74.8
4.3	63.7	65.8	67.8	69.8	71.9	73.6	75.1	76.5	77.6
4.4	66.0	68.2	70.3	72.4	74.5	76.2	77.9	79.3	80.5
4.5	68.5	70.7	72.9	75.0	77.2	79.0	80.6	82.2	83.4
4.6	70.9	73.2	75.5	77.6	79.9	81.7	83.5	85.0	86.3
4.7	73.4	75.8	78.1	80.3	82.6	84.5	86.3	88.0	89.3
4.8	76.0	78.4	80.7	83.0	85.4	87.4	89.2	90.9	92.3
4.9	78.5	81.0	83.4	85.7	88.2	90.2	92.2	93.9	95.3
5.0	81.2	83.7	86.2	88.5	91.1	93.2	95.1	97.0	98.4

English Elliptical Culvert Pipe-Arch Embankment Areas as Ft²

(Y=Height to Widest Section of Pipe as Feet)

Equivalent Round Size

Y	24”	30”	36”	42”	48”	54”	60”	66”	72”
0.1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
0.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
0.4	2.0	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9
0.5	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5
0.6	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
0.7	4.0	4.0	3.9	3.9	3.9	3.9	3.9	3.9	3.9
0.8	4.9	4.8	4.7	4.7	4.7	4.6	4.6	4.6	4.6
0.9	5.9	5.7	5.6	5.5	5.5	5.4	5.4	5.4	5.4
1.0	6.9	6.7	6.5	6.4	6.4	6.3	6.3	6.2	6.2
1.1	8.0	7.8	7.5	7.4	7.3	7.2	7.2	7.1	7.1
1.2	9.1	9.0	8.6	8.4	8.3	8.2	8.2	8.1	8.1
1.3	10.3	10.2	9.9	9.5	9.4	9.3	9.2	9.1	9.1
1.4	11.5	11.5	11.2	10.8	10.6	10.4	10.3	10.2	10.1
1.5	12.7	12.8	12.6	12.2	11.9	11.6	11.5	11.4	11.3
1.6	14.0	14.1	14.0	13.7	13.3	12.9	12.7	12.6	12.5
1.7	15.3	15.5	15.4	15.2	14.9	14.3	14.1	13.9	13.7
1.8	16.6	16.9	16.9	16.7	16.5	15.9	15.5	15.2	15.1
1.9	18.0	18.3	18.4	18.3	18.1	17.6	17.0	16.7	16.5
2.0	19.4	19.8	19.9	19.9	19.8	19.4	18.7	18.2	18.0
2.1	20.9	21.4	21.5	21.6	21.5	21.1	20.6	19.9	19.6
2.2	22.4	23.0	23.2	23.3	23.3	23.0	22.5	21.7	21.2
2.3	24.0	24.6	24.8	25.0	25.1	24.8	24.4	23.7	23.0
2.4	25.6	26.2	26.6	26.8	26.9	26.7	26.4	25.7	24.9
2.5	27.2	27.9	28.3	28.6	28.8	28.7	28.4	27.9	27.1
2.6	28.9	29.7	30.1	30.5	30.7	30.7	30.4	29.9	29.2
2.7	30.6	31.4	31.9	32.4	32.7	32.7	32.5	32.1	31.5
2.8	32.3	33.3	33.8	34.3	34.7	34.8	34.7	34.8	33.7
2.9	34.1	35.1	35.7	36.3	36.7	36.9	36.8	36.5	38.0
3.0	35.9	37.0	37.7	38.3	38.8	39.0	39.1	38.8	38.4
3.1	37.8	38.9	39.7	40.4	40.9	41.2	41.3	41.1	40.7
3.2	39.7	40.9	41.7	42.5	43.1	43.4	43.6	43.4	43.2
3.3	41.7	42.9	43.8	44.6	45.3	45.7	45.9	45.8	45.6
3.4	43.7	45.0	45.9	46.8	47.5	48.0	48.3	48.2	48.1
3.5	45.7	47.1	48.1	49.0	49.8	50.4	50.7	50.7	50.6
3.6	47.8	49.2	50.3	51.3	52.1	52.7	53.2	53.2	53.2
3.7	49.9	51.4	52.5	53.6	54.5	55.2	55.7	55.8	55.8
3.8	52.0	53.6	54.8	55.9	56.9	57.6	58.2	58.4	58.5
3.9	54.2	55.9	57.1	58.3	59.3	60.1	60.8	61.0	61.2
4.0	56.4	58.2	59.4	60.8	61.8	62.7	63.4	63.7	63.9
4.1	58.7	60.5	61.8	63.2	64.3	65.3	66.0	66.4	66.7
4.2	61.0	62.9	64.3	65.7	66.9	67.9	68.7	69.1	69.5
4.3	63.4	65.3	66.7	68.3	69.5	70.6	71.5	71.9	72.4
4.4	65.8	67.8	69.3	70.8	72.1	73.3	74.2	74.8	75.3
4.5	68.2	70.3	71.8	73.5	74.8	76.0	77.1	77.6	78.2
4.6	70.7	72.8	74.4	76.1	77.5	78.8	79.9	80.5	81.2
4.7	73.2	75.4	77.0	78.8	80.3	81.6	82.9	83.5	84.2
4.8	75.7	78.0	79.7	81.6	83.1	84.5	85.7	86.5	87.3
4.9	78.3	80.6	82.4	84.3	85.9	87.4	88.7	89.5	90.4
5.0	80.9	83.3	85.2	87.2	88.8	90.4	91.7	92.6	93.5

English Circular Culvert Pipe Embankment End Areas as Ft²

(Y=Height to Center of Pipe as Feet)

Pipe Diameter

Y	12”	15”	18”	24”	30”	36”	42”	48”	54”	60”	72”
0.1	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.2	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
0.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
0.4	2.0	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
0.5	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
0.6	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.1	3.1
0.7	4.1	4.0	4.0	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8
0.8	4.9	4.9	4.8	4.7	4.6	4.6	4.6	4.6	4.6	4.5	4.5
0.9	5.7	5.7	5.7	5.5	5.4	5.4	5.4	5.3	5.3	5.3	5.3
1.0	6.6	6.6	6.6	6.4	6.3	6.2	6.2	6.2	6.2	6.1	6.1
1.1	7.5	7.6	7.6	7.4	7.2	7.1	7.1	7.1	7.0	7.0	7.0
1.2	8.5	8.6	8.6	8.5	8.2	8.1	8.0	8.0	7.9	7.9	7.9
1.3	9.5	9.6	9.6	9.6	9.4	9.1	9.0	9.0	8.9	8.9	8.8
1.4	10.5	10.7	10.7	10.7	10.6	10.3	10.1	10.0	10.0	9.9	9.8
1.5	11.6	11.8	11.9	11.9	11.8	11.5	11.2	11.1	11.0	11.0	10.9
1.6	12.7	12.9	13.0	13.1	13.1	12.8	12.5	12.3	12.2	12.1	12.0
1.7	13.9	14.1	14.2	14.4	14.4	14.1	13.7	13.5	13.4	13.3	13.2
1.8	15.1	15.3	15.5	15.7	15.7	15.5	15.2	14.8	14.7	14.5	14.4
1.9	16.3	16.6	16.8	17.0	17.1	17.0	16.7	16.2	16.0	15.8	15.6
2.0	17.6	17.9	18.1	18.4	18.5	18.5	18.2	17.7	17.4	17.2	17.3
2.1	18.9	19.2	19.5	19.8	20.0	20.0	19.8	19.3	18.9	18.6	18.3
2.2	20.3	20.6	20.9	21.3	21.5	21.5	21.4	21.0	20.5	20.1	19.8
2.3	21.7	22.0	22.3	22.8	23.1	23.1	23.0	22.7	22.2	21.7	21.3
2.4	23.1	23.5	23.8	24.3	24.7	24.8	24.7	24.4	24.0	23.4	22.9
2.5	24.6	25.0	25.4	25.9	26.3	26.5	26.4	26.2	25.8	25.2	24.5
2.6	26.1	26.6	26.9	27.5	28.0	28.2	28.2	28.0	27.7	27.1	26.2
2.7	27.7	28.1	28.5	29.2	29.7	29.9	30.0	29.9	29.6	29.1	28.0
2.8	29.3	29.8	30.2	30.9	31.4	31.7	31.9	31.8	31.5	31.1	29.8
2.9	30.9	31.4	31.9	32.6	33.2	33.6	33.8	33.7	33.5	33.1	31.8
3.0	32.6	33.1	33.6	34.4	35.0	35.5	35.7	35.7	35.5	35.2	33.9
3.1	34.3	34.9	35.4	36.2	36.9	37.4	37.7	37.7	37.6	37.3	36.1
3.2	36.1	37.6	37.2	38.1	38.8	39.3	39.7	39.8	39.7	39.5	38.3
3.3	37.9	38.5	39.0	40.0	40.8	41.3	41.7	41.9	41.9	41.7	40.6
3.4	39.7	40.4	40.9	41.9	42.8	43.4	43.8	44.0	44.1	43.9	43.0
3.5	41.6	42.3	42.9	43.9	44.8	45.5	45.9	46.2	46.3	46.2	45.4
3.6	43.5	44.2	44.8	45.9	46.9	47.6	48.1	48.4	48.6	48.5	47.8
3.7	45.5	46.2	46.8	48.0	49.0	49.7	50.3	50.7	50.9	50.9	50.2
3.8	47.5	48.2	48.9	50.1	51.1	51.9	52.6	53.0	53.2	53.3	52.7
3.9	49.5	50.3	51.0	52.2	53.3	54.2	54.9	55.3	55.6	55.7	55.3
4.0	51.6	52.4	53.1	54.4	55.5	56.5	57.2	57.7	58.0	58.2	57.9
4.1	53.7	54.5	55.3	56.6	57.8	58.8	59.6	60.1	60.5	60.7	60.5
4.2	55.9	56.7	57.5	58.9	60.1	61.1	62.0	62.5	63.0	63.3	63.1
4.3	58.1	58.9	59.7	51.2	62.5	63.5	64.4	65.1	65.6	65.9	65.8
4.4	60.3	61.2	62.0	63.5	64.9	66.0	66.9	67.6	68.2	68.5	68.6
4.5	62.6	63.5	64.4	65.9	67.3	68.5	69.4	70.2	70.8	71.2	71.4
4.6	64.9	65.9	66.7	68.3	69.8	71.0	72.0	72.8	73.5	73.9	74.2
4.7	67.3	68.2	69.1	70.8	72.3	73.5	74.6	75.5	76.2	76.7	77.0
4.8	69.7	70.7	71.6	73.3	74.8	76.1	77.3	78.2	78.9	79.5	79.9
4.9	72.1	73.1	74.1	75.8	77.4	78.8	80.0	80.9	81.7	82.3	82.9
5.0	74.6	75.6	76.6	78.4	80.0	81.5	82.7	83.7	84.5	85.2	85.9

Metric Circular Culvert Pipe Embankment End Areas as m²

(Y=Height to Center of Pipe as mm)

Pipe Diameter

Y	12”	15”	18”	24”	30”	36”	42”	48”	54”	60”	72”
30	0.037161	0.037161	0.037161	0.037161	0.037161	0.037161	0.037161	0.037161	0.037161	0.037161	0.037161
60	0.083613	0.083613	0.083613	0.083613	0.083613	0.083613	0.083613	0.083613	0.083613	0.083613	0.083613
90	0.130064	0.130064	0.130064	0.130064	0.130064	0.130064	0.130064	0.130064	0.130064	0.130064	0.130064
122	0.185806	0.185806	0.176516	0.176516	0.176516	0.176516	0.176516	0.176516	0.176516	0.176516	0.176516
152	0.241548	0.241548	0.241548	0.232258	0.232258	0.232258	0.232258	0.232258	0.232258	0.232258	0.232258
183	0.30658	0.30658	0.29729	0.29729	0.29729	0.29729	0.29729	0.29729	0.29729	0.287999	0.287999
213	0.380902	0.371612	0.371612	0.362322	0.362322	0.362322	0.353032	0.353032	0.353032	0.353032	0.353032
244	0.455225	0.455225	0.445935	0.436644	0.427354	0.427354	0.427354	0.427354	0.427354	0.418064	0.418064
274	0.529547	0.529547	0.529547	0.510967	0.501676	0.501676	0.501676	0.492386	0.492386	0.492386	0.492386
305	0.61316	0.61316	0.61316	0.594579	0.585289	0.575999	0.575999	0.575999	0.575999	0.566709	0.566709
335	0.696773	0.706063	0.706063	0.687482	0.668902	0.659612	0.659612	0.659612	0.650321	0.650321	0.650321
365	0.789676	0.798966	0.798966	0.789676	0.761805	0.752515	0.743224	0.743224	0.733934	0.733934	0.733934
396	0.882579	0.891869	0.891869	0.891869	0.873289	0.845418	0.836127	0.836127	0.826837	0.826837	0.817547
427	0.975482	0.994063	0.994063	0.994063	0.984772	0.956901	0.938321	0.92903	0.92903	0.91974	0.91045
457	1.077675	1.096256	1.105546	1.105546	1.096256	1.068385	1.040514	1.031224	1.021933	1.021933	1.012643
488	1.179869	1.198449	1.20774	1.21703	1.21703	1.189159	1.161288	1.142707	1.133417	1.124127	1.114836
518	1.291352	1.309933	1.319223	1.337804	1.337804	1.309933	1.272772	1.254191	1.244901	1.23561	1.22632
550	1.402836	1.421417	1.439997	1.458578	1.458578	1.439997	1.412126	1.374965	1.365675	1.347094	1.337804
580	1.51432	1.54219	1.560771	1.579352	1.588642	1.579352	1.551481	1.505029	1.486449	1.467868	1.449287
610	1.635094	1.662964	1.681545	1.709416	1.718706	1.718706	1.690835	1.644384	1.616513	1.597932	1.607223
640	1.755867	1.783738	1.811609	1.83948	1.858061	1.858061	1.83948	1.793029	1.755867	1.727997	1.700126
670	1.885932	1.913803	1.941674	1.978835	1.997415	1.997415	1.988125	1.950964	1.904512	1.867351	1.83948
700	2.015996	2.043867	2.071738	2.118189	2.14606	2.14606	2.13677	2.108899	2.062447	2.015996	1.978835
732	2.14606	2.183221	2.211092	2.257544	2.294705	2.303995	2.294705	2.266834	2.229673	2.173931	2.12748
762	2.285415	2.322576	2.359737	2.406189	2.44335	2.461931	2.45264	2.43406	2.396898	2.341157	2.276124
793	2.424769	2.471221	2.499092	2.554834	2.601285	2.619866	2.619866	2.601285	2.573414	2.517672	2.43406
823	2.573414	2.610575	2.647737	2.712769	2.75922	2.777801	2.787091	2.777801	2.74993	2.703478	2.601285
854	2.722059	2.768511	2.805672	2.870704	2.917155	2.945026	2.963607	2.954317	2.926446	2.889285	2.768511
884	2.870704	2.917155	2.963607	3.028639	3.084381	3.121542	3.140123	3.130832	3.112252	3.075091	2.954317
914	3.028639	3.075091	31.21542	3.195865	3.251606	3.298058	3.316639	3.316639	3.298058	3.270187	3.149413
944	3.186574	3.242316	3.288768	3.36309	3.428122	3.474574	3.502445	3.502445	3.493154	3.465283	3.3538
974	3.3538	3.409542	3.455993	3.539606	3.604638	3.651089	3.688251	3.697541	3.688251	3.66967	3.558186
1005	3.521025	3.576767	3.623219	3.716122	3.790444	3.836896	3.874057	3.892637	3.892637	3.874057	3.771863
1036	3.688251	3.753283	3.799734	3.892637	3.97625	4.031992	4.069153	4.087734	4.097024	4.078443	3.994831
1066	3.864766	3.929799	3.98554	4.078443	4.162056	4.227088	4.26425	4.29212	4.301411	4.29212	4.217798
1097	4.041282	4.106314	4.162056	4.26425	4.357153	4.422185	4.468636	4.496507	4.515088	4.505797	4.440765
1127	4.227088	4.29212	4.347862	4.459346	4.552249	4.617281	4.673023	4.710184	4.728765	4.728765	4.663733
1158	4.412894	4.477927	4.542959	4.654442	4.747345	4.821668	4.8867	4.923861	4.942442	4.951732	4.89599
1188	4.5987	4.673023	4.738055	4.849539	4.951732	5.035345	5.100377	5.137538	5.165409	5.174699	5.137538
1219	4.793797	4.868119	4.933151	5.053925	5.156119	5.249022	5.314054	5.360505	5.388376	5.406957	5.379086
1250	4.988893	5.063216	5.137538	5.258312	5.369796	5.462699	5.537021	5.583473	5.620634	5.639215	5.620634
1280	5.19328	5.267602	5.341925	5.471989	5.583473	5.676376	5.759988	5.80644	5.852892	5.880762	5.862182
1311	5.397667	5.471989	5.546311	5.685666	5.80644	5.899343	5.982956	6.047988	6.094439	6.12231	6.11302
1341	5.602053	5.685666	5.759988	5.899343	6.029407	6.131601	6.215213	6.280246	6.335987	6.363858	6.373149
1372	5.81573	5.899343	5.982956	6.12231	6.252375	6.363858	6.447471	6.521793	6.577535	66.14696	6.633277
1402	6.029407	6.12231	6.196633	6.345278	6.484632	6.596116	6.689019	6.763341	6.828373	6.865535	6.893406
1433	6.252375	6.335987	6.4196	6.577535	6.71689	6.828373	6.930567	7.01418	7.079212	7.125663	7.153534
1463	6.475342	6.568245	6.651858	6.809793	6.949147	7.069921	7.181405	7.265018	7.33005	7.385792	7.422953
1494	6.698309	6.791212	6.884115	7.04205	7.190695	7.32076	7.432243	7.515856	7.590178	7.64592	7.701662
1524	6.930567	7.02347	7.116373	7.283598	7.432243	7.571598	7.683081	7.775984	7.850307	7.915339	7.980371

Metric Culvert Pipe-Arch Embankment Areas as m²

(Y=Height to Widest Section of Pipe as mm)

Equivalent Round Size

Y	24”	30”	36”	42”	48”	54”	60”	66”	72”
30	0.055742	0.055742	0.065032	0.065032	0.074322	0.083613	0.092903	0.111484	0.120774
60	0.102193	0.102193	0.102193	0.111484	0.120774	0.130064	0.139355	0.157935	0.167225
90	0.148645	0.148645	0.148645	0.157935	0.167225	0.176516	0.195096	0.204387	0.222967
122	0.185806	0.204387	0.204387	0.204387	0.222967	0.232258	0.241548	0.260129	0.269419
152	0.260129	0.250838	0.250838	0.250838	0.269419	0.287999	0.29729	0.31587	0.325161
183	0.343741	0.334451	0.325161	0.31587	0.31587	0.343741	0.353032	0.371612	0.390193
213	0.427354	0.427354	0.418064	0.408773	0.390193	0.380902	0.418064	0.436644	0.455225
244	0.510967	0.520257	0.520257	0.510967	0.492386	0.464515	0.455225	0.501676	0.520257
274	0.60387	0.61316	0.62245	0.62245	0.60387	0.575999	0.548128	0.538838	0.529547
305	0.696773	0.715353	0.724644	0.733934	0.724644	0.696773	0.659612	0.631741	0.62245
335	0.798966	0.817547	0.836127	0.845418	0.845418	0.826837	0.798966	0.752515	0.724644
365	0.901159	0.92903	0.947611	0.966192	0.966192	0.956901	0.92903	0.891869	0.854708
396	1.003353	1.040514	1.068385	1.086966	1.096256	1.086966	1.068385	1.040514	1.003353
427	1.114836	1.151998	1.189159	1.21703	1.22632	1.22632	1.21703	1.189159	1.151998
457	1.22632	1.272772	1.309933	1.347094	1.365675	1.365675	1.356384	1.337804	1.309933
488	1.347094	1.393546	1.439997	1.477158	1.505029	1.51432	1.51432	1.495739	1.467868
518	1.467868	1.52361	1.570061	1.616513	1.644384	1.662964	1.662964	1.653674	1.635094
550	1.588642	1.653674	1.709416	1.755867	1.793029	1.811609	1.8209	1.8209	1.802319
580	1.718706	1.783738	1.84877	1.895222	1.941674	1.969544	1.988125	1.988125	1.978835
610	1.84877	1.923093	1.988125	2.043867	2.099609	2.12748	2.14606	2.155351	2.155351
640	1.988125	2.062447	2.13677	2.201802	2.257544	2.294705	2.322576	2.331866	2.331866
670	2.12748	2.211092	2.285415	2.359737	2.415479	2.461931	2.489801	2.508382	2.508382
700	2.266834	2.359737	2.44335	2.517672	2.582705	2.629156	2.666317	2.694188	2.703478
732	2.415479	2.508382	2.601285	2.675608	2.74993	2.805672	2.852123	2.879994	2.889285
762	2.564124	2.666317	2.75922	2.842833	2.926446	2.982188	3.028639	3.0658	3.084381
793	2.722059	2.824252	2.926446	3.019349	3.102962	3.167994	3.223735	3.260897	3.279477
823	2.879994	2.991478	3.093671	3.186574	3.279477	3.3538	3.409542	3.455993	3.483864
854	3.037929	3.158703	3.270187	3.37238	3.465283	3.539606	3.604638	3.651089	3.688251
884	3.205155	3.325929	3.446703	3.548896	3.66038	3.734702	3.809025	3.855476	3.892637
914	3.37238	3.502445	3.623219	3.734702	3.846186	3.929799	4.004121	4.069153	4.106314
944	3.548896	3.67896	3.809025	3.920508	4.041282	4.134185	4.217798	4.28283	4.329282
974	3.725412	3.864766	3.994831	4.115605	4.245669	4.338572	4.422185	4.496507	4.542959
1005	3.901928	4.050573	4.189927	4.310701	4.440765	4.542959	4.635862	4.710184	4.765926
1036	4.087734	4.236379	4.385023	4.515088	4.654442	4.756636	4.858829	4.933151	4.998184
1066	4.27354	4.431475	4.58012	4.719474	4.858829	4.970313	5.072506	5.165409	5.230441
1097	4.468636	4.626571	4.784507	4.923861	5.072506	5.19328	5.304764	5.397667	5.462699
1127	4.663733	4.830958	4.988893	5.137538	5.295473	5.416247	5.527731	5.629924	5.704247
1158	4.858829	5.035345	5.20257	5.351215	5.518441	5.639215	5.759988	5.862182	5.945795
1188	5.063216	5.239731	5.416247	5.574182	5.741408	5.871472	6.001536	6.10373	6.187342
1219	5.276893	5.453408	5.629924	5.79715	5.973665	6.10373	6.233794	6.354568	6.438181
1250	5.481279	5.667085	5.852892	6.020117	6.205923	6.345278	6.484632	6.596116	6.689019
1280	5.694956	5.890053	6.075859	6.252375	6.438181	6.586826	6.72618	6.856244	6.949147
1311	5.917924	6.11302	6.298826	6.484632	6.679729	6.837664	6.977018	7.107083	7.209276
1341	6.131601	6.335987	6.531084	6.72618	6.921276	7.079212	7.237147	7.367211	7.478695
1372	6.363858	6.568245	6.772632	6.967728	7.172115	7.33934	7.487985	7.63663	7.748114
1402	6.586826	6.800503	7.01418	7.209276	7.422953	7.590178	7.757404	7.896758	8.017532
1433	6.819083	7.04205	7.255727	7.460114	7.673791	7.850307	8.017532	8.175468	8.296241
1463	7.060631	7.283598	7.497275	7.710952	7.93392	8.119726	8.286951	8.444886	8.574951
1494	7.292889	7.525146	7.748114	7.961791	8.194048	8.379854	8.56566	8.723595	8.85366
1524	7.543727	7.775984	8.008242	8.221919	8.463467	8.658563	8.835079	9.011595	9.141659

Metric Elliptical Culvert Pipe-Arch Embankment Areas as m²

(Y=Height to Widest Section of Pipe as mm)

Equivalent Round Size

Y	24”	30”	36”	42”	48”	54”	60”	66”	72”
30	0.037161	0.037161	0.037161	0.037161	0.037161	0.037161	0.037161	0.037161	0.037161
60	0.083613	0.083613	0.083613	0.083613	0.083613	0.083613	0.083613	0.083613	0.083613
90	0.130064	0.130064	0.130064	0.130064	0.130064	0.130064	0.130064	0.130064	0.130064
122	0.185806	0.185806	0.176516	0.176516	0.176516	0.176516	0.176516	0.176516	0.176516
152	0.241548	0.241548	0.241548	0.232258	0.232258	0.232258	0.232258	0.232258	0.232258
183	0.30658	0.29729	0.29729	0.29729	0.29729	0.29729	0.29729	0.29729	0.29729
213	0.371612	0.371612	0.362322	0.362322	0.362322	0.362322	0.362322	0.362322	0.362322
244	0.455225	0.445935	0.436644	0.436644	0.436644	0.427354	0.427354	0.427354	0.427354
274	0.548128	0.529547	0.520257	0.510967	0.510967	0.501676	0.501676	0.501676	0.501676
305	0.641031	0.62245	0.60387	0.594579	0.594579	0.585289	0.585289	0.575999	0.575999
335	0.743224	0.724644	0.696773	0.687482	0.678192	0.668902	0.668902	0.659612	0.659612
365	0.845418	0.836127	0.798966	0.780386	0.771095	0.761805	0.761805	0.752515	0.752515
396	0.956901	0.947611	0.91974	0.882579	0.873289	0.863998	0.854708	0.845418	0.845418
427	1.068385	1.068385	1.040514	1.003353	0.984772	0.966192	0.956901	0.947611	0.938321
457	1.179869	1.189159	1.170578	1.133417	1.105546	1.077675	1.068385	1.059095	1.049804
488	1.300643	1.309933	1.300643	1.272772	1.23561	1.198449	1.179869	1.170578	1.161288
518	1.421417	1.439997	1.430707	1.412126	1.384255	1.328513	1.309933	1.291352	1.272772
550	1.54219	1.570061	1.570061	1.551481	1.5329	1.477158	1.439997	1.412126	1.402836
580	1.672255	1.700126	1.709416	1.700126	1.681545	1.635094	1.579352	1.551481	1.5329
610	1.802319	1.83948	1.84877	1.84877	1.83948	1.802319	1.737287	1.690835	1.672255
640	1.941674	1.988125	1.997415	2.006706	1.997415	1.960254	1.913803	1.84877	1.8209
670	2.081028	2.13677	2.155351	2.164641	2.164641	2.13677	2.090318	2.015996	1.969544
700	2.229673	2.285415	2.303995	2.322576	2.331866	2.303995	2.266834	2.201802	2.13677
732	2.378318	2.43406	2.471221	2.489801	2.499092	2.480511	2.45264	2.387608	2.313286
762	2.526963	2.591995	2.629156	2.657027	2.675608	2.666317	2.638446	2.591995	2.517672
793	2.684898	2.75922	2.796382	2.833543	2.852123	2.852123	2.824252	2.777801	2.712769
823	2.842833	2.917155	2.963607	3.010058	3.037929	3.037929	3.019349	2.982188	2.926446
854	3.000768	3.093671	3.140123	3.186574	3.223735	3.233026	3.223735	3.186574	3.130832
884	3.167994	3.260897	3.316639	3.37238	3.409542	3.428122	3.418832	3.390961	3.344509
914	3.335219	3.437412	3.502445	3.558186	3.604638	3.623219	3.632509	3.604638	3.567477
944	3.511735	3.613928	3.688251	3.753283	3.799734	3.827605	3.836896	3.818315	3.781154
974	3.688251	3.799734	3.874057	3.948379	4.004121	4.031992	4.050573	4.031992	4.013411
1005	3.874057	3.98554	4.069153	4.143476	4.208508	4.245669	4.26425	4.254959	4.236379
1036	4.059863	4.180637	4.26425	4.347862	4.412894	4.459346	4.487217	4.477927	4.468636
1066	4.245669	4.375733	4.468636	4.552249	4.626571	4.682313	4.654442	4.710184	4.700894
1097	4.440765	4.57083	4.673023	4.765926	4.840248	4.89599	4.942442	4.942442	4.942442
1127	4.635862	4.775216	4.87741	4.979603	5.063216	5.128248	5.174699	5.18399	5.18399
1158	4.830958	4.979603	5.091087	5.19328	5.286183	5.351215	5.406957	5.425538	5.434828
1188	5.035345	5.19328	5.304764	5.416247	5.50915	5.583473	5.648505	5.667085	5.685666
1219	5.239731	5.406957	5.518441	5.648505	5.741408	5.825021	5.890053	5.917924	5.936504
1250	5.453408	5.620634	5.741408	5.871472	5.973665	6.066569	6.131601	5.239731	6.196633
1280	5.667085	5.843601	5.973665	6.10373	6.215213	6.308116	6.382439	6.4196	6.456761
1311	5.890053	6.066569	6.196633	6.345278	6.456761	6.558955	6.642567	6.679729	6.72618
1341	6.11302	6.298826	6.438181	6.577535	6.698309	6.809793	6.893406	6.949147	6.995599
1372	6.335987	6.531084	6.670438	6.828373	6.949147	7.060631	7.162824	7.209276	7.079212
1402	6.568245	6.763341	6.911986	7.069921	7.199986	7.302179	7.422953	7.478695	7.543727
1433	6.800503	7.004889	7.153534	7.32076	7.460114	7.580888	7.701662	7.757404	7.822436
1463	7.03276	7.246437	7.404372	7.580888	7.720243	7.850307	7.961791	8.036113	8.110435
1494	7.274308	7.487985	7.65521	7.831726	7.980371	8.119726	8.2405	8.314822	8.398435
1524	7.515856	7.738823	7.915339	8.101145	8.24979	8.398435	8.519209	8.602822	8.686434

Weights of Prestressed Concrete Bearing Pile

For computing bearing capacity required on Form RD-209

Pile Type	Constant Section Wt. Per Lin. Ft. (Pounds)	Tapered Section Total Weight (Pounds)
I	148	None
II	200	None
III	173	None
IV	212	None
V	124	1740
VI	169	2500
VII	221	2950

This table is based on and is for use only with Standard Plan 1720-C-R2.

Steel Pipe Pile Data

	ARMCO		Union Metal
Size O.D. (ins)	12	12¾	12 (Nominal)
Wall T. (ins)	.188	.188	7 Ga.
Wt. per Lin. Ft. (lbs.)	23.72	25.16	25.3
Conc. per Lin. Ft. (C.Y.)	.0273	.0309	.0255

Union Metal 30’ tapered Se. Type F. Total Wt. 589 Lbs. Conc. 0.55 Cu.Yd.

Size O.E. (ins.)	14	14 (Nominal)
Wall T. (ins.)	.188	7 Ga.
Wt. per Lin. Ft. (Lbs.)	27.66	29.5
Conc. per Lin. Ft. (C.Y.)	.0375	.0350

Union Metal 40’ tapered Sec. Type F. Total Wt. 895 Lbs. Conc. 0.95 Cu.Yd.

For Raymond step tapered pile contact your District Construction Engineer.