

Friction Loss for Water in Feet Head per 100 Feet of Pipe Length

Table 1				Table 2			
3/4– inch Nominal	Steel Schedule – 40 Pipe ID: 0.824 Inches \varnothing /D: 0.00218			1 – inch Nominal	Steel Schedule – 40 Pipe ID: 1.049 Inches \varnothing /D: 0.00172		
Flow Rate (gpm)	V(ft/sec)	V ² /2g (ft)	Friction Loss Head per 100 ft of Pipe	Flow Rate (gpm)	V(ft/sec)	V ² /2g (ft)	Friction Loss Head per 100 ft of Pipe
2.0	1.20	0.02	1.21	3	1.11	0.02	0.77
2.5	1.50	0.04	1.80	4	1.48	0.03	1.30
3.0	1.81	0.05	2.50	5	1.86	0.05	1.93
3.5	2.11	0.07	3.30	6	2.23	0.08	2.68
4.0	2.41	0.09	4.21	7	2.60	0.10	3.56
4.5	2.71	0.11	5.21	8	2.97	0.14	4.54
5.0	3.01	0.14	6.32	9	3.34	0.17	5.65
6.0	3.61	0.20	8.87	10	3.71	0.21	6.86
7.0	4.21	0.28	11.8	12	4.45	0.31	9.62
8.0	4.81	0.36	15.0	14	5.20	0.42	12.8
9.0	5.42	0.46	18.8	16	5.94	0.55	16.5
10	6.02	0.56	23.0	18	6.68	0.70	20.6
11	6.62	0.68	27.6	20	7.42	0.86	25.1
12	7.22	0.81	32.6	22	8.17	1.04	30.2
13	7.82	0.95	37.8	24	8.91	1.23	35.6
14	8.42	1.10	43.5	26	9.65	1.45	41.6
15	9.03	1.27	49.7	28	10.39	1.68	47.9
16	9.63	1.44	56.3	30	11.1	1.93	54.6
17	10.23	1.63	63.1	32	11.9	2.19	61.8
18	10.8	1.82	70.3	34	12.6	2.48	69.4
19	11.4	2.03	78.0	36	13.4	2.78	77.4
20	12.0	2.25	86.1	38	14.1	3.09	86.0
22	13.2`	2.72	104	40	14.8	3.43	95.0
24	14.4	3.24	122	42	15.6	3.78	104.5
26	15.6	3.80	143	44	16.3	4.15	114
28	16.8	4.41	164	46	17.1	4.53	124
30	18.1	5.06	187	48	17.8	4.93	135
NULL				50	18.6	5.35	146
				55	20.4	6.48	176

Friction Loss for Water in Feet Head per 100 Feet of Pipe Length

Table 3				Table 4			
1 ³ / ₄ inch	Steel Schedule – 40 Pipe ID: 1.380 Inches \varnothing /D: 0.00130			1 ¹ / ₂ inch	Steel Schedule – 40 Pipe ID: 1.610 Inches \varnothing /D: 0.00112		
Flow Rate (gpm)	V(ft /sec)	V ² / 2g (ft)	Friction Loss Head per 100 ft of Pipe	Flow Rate (gpm)	V(ft/s ec)	V ² / 2g (ft)	Friction Loss Head per 100 ft of Pipe
6	1.29	0.03	0.70	6	0.95	0.01	0.33
7	1.50	0.04	0.93	7	1.10	0.02	0.44
8	1.72	0.05	1.18	8	1.26	0.02	0.56
9	1.93	0.06	1.46	9	1.42	0.03	0.69
10	2.15	0.07	1.77	10	1.58	0.04	0.83
12	2.57	0.10	2.48	12	1.89	0.06	1.16
14	3.00	0.14	3.28	14	2.21	0.08	1.53
16	3.43	0.18	4.20	16	2.52	0.10	1.96
18	3.86	0.23	5.22	18	2.84	0.13	2.42
20	4.29	0.29	6.34	20	3.15	0.15	2.94
22	4.72	0.35	7.58	22	3.47	0.19	3.52
24	5.15	0.41	8.92	24	3.78	0.22	4.14
26	5.58	0.48	10.37	26	4.10	0.26	4.81
28	6.01	0.56	11.9	28	4.41	0.30	5.51
30	6.44	0.64	13.6	30	4.73	0.35	6.26
32	6.86	0.73	15.3	32	5.04	0.40	7.07
34	7.29	0.83	17.2	34	5.36	0.45	7.92
36	7.72	0.93	19.2	36	5.67	0.50	8.82

Friction Loss for Water in Feet Head per 100 Feet of Pipe Length

38	8.1 5	1.03	21.3	38	5.99	0.58	9.78
40	8.5 8	1.14	23.5	40	6.30	0.62	10.79
42	9.0 1	1.26	25.8	42	6.62	0.68	11.8
44	9.4 4	1.38	28.2	44	6.93	0.75	12.9
46	9.8 7	1.51	30.7	46	7.25	0.82	14.0
48	10. 30	1.65	33.3	48	7.56	0.89	15.2
50	10. 7	1.79	36.0	50	7.88	0.97	16.4
55	11. 8	2.16	43.2	55	8.67	1.17	19.7
60	12. 9	2.57	51.0	60	9.46	1.39	23.2
65	13. 9	3.02	59.6	65	10.24	1.63	27.1
70	15. 0	3.50	68.8	70	11.03	1.89	31.3
75	16. 1	4.02	78.7	75	11.8	2.17	35.8
80	17. 2	4.58	89.2	80	12.6	2.47	40.5
85	18. 2	5.17	100.2	85	13.4	2.79	45.6
90	19. 3	5.79	112	90	14.2	3.13	51.0
95	20. 4	6.45	124	95	15.0	3.48	56.5
100	21. 5	7.15	138	100	15.8	3.86	62.2
				110	17.3	4.67	74.5
				120	18.9	5.56	88.3
				130	20.5	6.52	103



Friction Loss for Water in Feet Head per 100 Feet of Pipe Length

Table 5				Table 6			
2 Inches		Steel Schedule 40 Pipe ID:2.067 Inches ϕ /D: 0.00087		2 1/2 Inches		Steel Schedule 40 Pipe ID:2.469 Inches ϕ /D: 0.000729	
Flow Rate (GPM)	V (ft/sec)	V ² /g (ft)	Friction Loss Head per 100 ft of Pipe	Flow Rate (GPM)	V (ft/sec)	V ² /g (ft)	Friction Loss Head per 100 ft of Pipe
10	0.96	0.01	0.25	16	1.07	0.02	0.24
12	1.15	0.02	0.34	18	1.21	0.02	0.30
14	1.34	0.03	0.45	20	1.34	0.03	0.36
16	1.53	0.04	0.58	22	1.47	0.03	0.43
18	1.72	0.05	0.72	24	1.61	0.04	0.50
20	1.91	0.06	0.87	26	1.74	0.05	0.58
22	2.10	0.07	1.03	28	1.88	0.05	0.66
24	2.29	0.08	1.20	30	2.01	0.06	0.75
26	2.49	0.10	1.39	35	2.35	0.09	1.00
28	2.68	0.11	1.60	40	2.68	0.11	1.28
30	2.87	0.13	1.82	45	3.02	0.14	1.60
35	3.35	0.17	2.42	50	3.35	0.17	1.94
40	3.82	0.23	3.10	55	3.69	0.21	2.32
45	4.30	0.29	3.85	60	4.02	0.25	2.72
50	4.78	0.36	4.67	65	4.36	0.30	3.16
55	5.26	0.43	5.59	70	4.69	0.34	3.63
60	5.74	0.51	6.59	75	5.03	0.39	4.13
65	6.21	0.60	7.69	80	5.36	0.45	4.66
70	6.69	0.70	8.86	85	5.70	0.50	5.22
75	7.17	0.80	10.1	90	6.03	0.57	5.82
80	7.65	0.91	11.4	95	6.37	0.63	6.45
85	8.13	1.03	12.8	100	6.70	0.70	7.11
90	8.60	1.15	14.2	110	7.37	0.84	8.51
95	9.08	1.28	15.8	120	8.04	1.00	10.0
100	9.56	1.42	17.4	130	8.71	1.18	11.7
110	10.52	1.72	20.9	140	9.38	1.37	13.5
120	11.5	2.05	24.7	150	10.05	1.57	15.4
130	12.4	2.40	28.8	160	10.7	1.79	17.4
140	13.4	2.78	33.2	170	11.4	2.02	19.6
150	14.3	3.20	38.0	180	12.1	2.26	21.9
160	15.3	3.64	43.0	190	12.7	2.52	24.2
170	16.3	4.11	48.4	200	13.4	2.79	26.7
180	17.2	4.60	54.1	220	14.7	3.38	32.2
190	18.2	5.13	60.1	240	16.1	4.02	38.1
200	19.1	5.68	66.3	260	17.4	4.72	44.5

Friction Loss for Water in Feet Head per 100 Feet of Pipe Length

220	21.0	6.88	80.0	280	18.8	5.47	51.3
240	22.9	8.18	95.0	300	20.1	6.28	58.5

Table 7				Table 8			
3 Inches		Steel Schedule 40 Pipe ID:3.068 Inches ϕ /D: 0.000587		3 1/2 Inches		Steel Schedule 40 Pipe ID:3.548 Inches ϕ /D: 0.000507	
Flow Rate (GPM)	V (ft/sec)	V ² /g (ft)	Friction Loss Head per 100 ft of Pipe	Flow Rate (GPM)	V (ft/sec)	V ² /g (ft)	Friction Loss Head per 100 ft of Pipe
25	1.09	0.02	0.19	35	1.14	0.02	0.17
30	1.30	0.03	0.26	40	1.30	0.03	0.22
35	1.52	0.04	0.35	45	1.46	0.03	0.27
40	1.74	0.05	0.44	50	1.62	0.04	0.33
45	1.95	0.06	0.55	60	1.95	0.06	0.46
50	2.17	0.07	0.66	70	2.27	0.08	0.60
55	2.39	0.09	0.79	80	2.60	0.11	0.77
60	2.60	0.11	0.92	90	2.92	0.13	0.96
65	2.82	0.12	1.07	100	3.25	0.16	1.17
70	3.04	0.14	1.22	110	3.57	0.20	1.39
75	3.25	0.17	1.39	120	3.89	0.24	1.64
80	3.47	0.19	1.57	130	4.22	0.28	1.90
85	3.69	0.21	1.76	140	4.54	0.32	2.18
90	3.91	0.24	1.96	150	4.87	0.37	2.48
100	4.34	0.29	2.39	170	5.52	0.47	3.15
110	4.77	0.35	2.86	180	5.84	0.53	3.50
120	5.21	0.42	3.37	190	6.17	0.59	3.87
130	5.64	0.50	3.92	200	6.49	0.66	4.27
140	6.08	0.57	4.51	220	7.14	0.79	5.12
150	6.51	0.66	5.14	240	7.79	0.94	6.04
160	6.94	0.75	5.81	260	8.44	1.11	7.04
170	7.38	0.85	6.53	280	9.09	1.28	8.11
180	7.81	0.95	7.28	300	9.74	1.47	9.26
190	8.25	1.06	8.07	320	10.4	1.68	10.48
200	8.68	1.17	8.90	340	11.0	1.89	11.8
220	9.55	1.42	10.7	360	11.7	2.12	13.2
240	10.4	1.69	12.6	380	12.3	2.36	14.6
260	11.3	1.98	14.7	400	13.0	2.62	16.2
280	12.2	2.29	16.9	420	13.6	2.89	17.8
300	13.0	2.62	19.2	440	14.3	3.17	19.4
320	13.9	3.00	22.0	460	14.9	3.46	21.2

Friction Loss for Water in Feet Head per 100 Feet of Pipe Length

340	14.8	3.38	24.8	480	15.6	3.77	23.0
360	15.6	3.79	27.7	500	16.2	4.09	25.0
380	16.5	4.23	30.7	550	17.8	4.95	30.1
400	17.4	4.68	33.9	600	19.5	5.89	35.6
420	18.2	5.16	37.3	650	21.1	6.91	41.6
440	19.1	5.67	40.9				
460	20.0	6.19	44.6				

Table 9				Table 10			
4 Inches		Steel Schedule 40 Pipe ID:4.026 Inches ϕ /D: 0.000447		5 Inches		Steel Schedule 40 Pipe ID:5.047 Inches ϕ /D: 0.000357	
Flow Rate (GPM)	V (ft/sec)	V ² /g (ft)	Friction Loss Head per 100 ft of Pipe	Flow Rate (GPM)	V (ft/sec)	V ² /g (ft)	Friction Loss Head per 100 ft of Pipe
40	1.01	0.02	0.12	70	1.12	0.02	0.11
50	1.26	0.02	0.18	80	1.28	0.03	0.14
60	1.51	0.04	0.25	90	1.44	0.03	0.17
70	1.76	0.05	0.33	100	1.60	0.04	0.20
80	2.02	0.06	0.42	120	1.92	0.06	0.29
90	2.27	0.08	0.52	140	2.25	0.08	0.38
100	2.52	0.10	0.62	160	2.57	0.10	0.49
110	2.77	0.12	0.74	180	2.89	0.13	0.61
120	3.02	0.14	0.88	200	3.21	0.16	0.74
130	3.28	0.17	1.02	220	3.53	0.19	0.88
140	3.53	0.19	1.17	240	3.85	0.23	1.04
150	3.78	0.22	1.32	260	4.17	0.27	1.20
160	4.03	0.25	1.49	280	4.49	0.31	1.38
170	4.28	0.29	1.67	300	4.81	0.36	1.58
180	4.54	0.32	1.86	320	5.13	0.41	1.78
190	4.79	0.36	2.06	340	5.45	0.46	2.00
200	5.04	0.40	2.27	360	5.77	0.52	2.22
220	5.54	0.48	2.72	380	6.09	0.58	2.46
240	6.05	0.57	3.21	400	6.41	0.64	2.72
260	6.55	0.67	3.74	420	6.74	0.71	2.98
280	7.06	0.77	4.30	440	7.06	0.77	3.26
300	7.56	0.89	4.89	460	7.38	0.85	3.55
320	8.06	1.01	5.51	480	7.70	0.92	3.85
340	8.57	1.14	6.19	500	8.02	1.00	4.16
360	9.07	1.28	6.92	550	8.82	1.21	4.98
380	9.58	1.43	7.68	600	9.62	1.44	5.88
400	10.10	1.58	8.47	650	10.4	1.69	6.87

Friction Loss for Water in Feet Head per 100 Feet of Pipe Length

420	10.6	1.74	9.30	700	11.2	1.96	7.93
440	11.1	1.91	10.2	750	12.0	2.25	9.05
460	11.6	2.09	11.1	800	12.8	2.56	10.22
480	12.1	2.27	12.0	850	13.6	2.89	11.5
500	12.6	2.47	13.0	900	14.4	32.4	12.9
550	13.9	2.99	15.7	950	15.2	3.61	14.3
600	15.1	3.55	18.6	1000	16.0	4.00	15.8
700	17.6	4.84	25.0	1200	19.2	5.76	22.5
750	18.9	5.55	28.6	1300	20.8	6.75	26.3
800	20.2	6.32	32.4				

Table 11				Table 12			
6 Inches		Steel Schedule 40 Pipe ID:6.065 Inches ϕ /D: 0.000293		8 Inches		Steel Schedule 40 Pipe ID:7.981 Inches ϕ /D: 0.000226	
Flow Rate (GPM)	V (ft/sec)	V ₂ /g (ft)	Friction Loss Head per 100 ft of Pipe	Flow Rate (GPM)	V (ft/sec)	V ₂ /g (ft)	Friction Loss Head per 100 ft of Pipe
100	1.11	0.02	0.08	60	1.03	0.02	0.05
120	1.33	0.03	0.12	180	1.15	0.02	0.06
140	1.55	0.04	0.16	200	1.28	0.03	0.08
160	1.78	0.05	0.20	220	1.41	0.03	0.09
180	2.00	0.06	0.25	240	1.54	0.04	0.11
200	2.22	0.08	0.30	260	1.67	0.04	0.13
220	2.44	0.09	0.36	280	1.80	0.05	0.14
240	2.66	0.11	0.42	300	1.92	0.06	0.16
260	2.89	0.13	0.49	320	2.05	0.07	0.18
280	3.11	0.15	0.56	340	2.18	0.07	0.21
300	3.33	0.17	0.64	360	2.31	0.08	0.23
320	3.55	0.20	0.72	380	2.44	0.09	0.25
340	3.78	0.22	0.81	400	2.57	0.10	0.28
360	4.00	0.24	0.90	450	2.89	0.13	0.35
380	4.22	0.28	1.00	500	3.21	0.16	0.42
400	4.44	0.31	1.10	550	3.53	0.19	0.51
420	4.66	0.34	1.20	600	3.85	0.23	0.60
440	4.89	0.37	1.31	650	4.17	0.27	0.70
460	5.11	0.41	1.42	700	4.49	0.31	0.80
480	5.33	0.44	1.54	750	4.81	0.36	0.91
500	5.55	0.48	1.66	800	5.13	0.41	1.02
550	6.11	0.58	1.99	850	5.45	0.46	1.15
600	6.66	0.69	2.34	900	5.77	0.52	1.27

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650	7.22	0.81	2.73	950	6.09	0.58	1.41
700	7.77	0.94	3.13	1000	6.41	0.64	1.56
750	8.33	1.08	3.57	1100	7.05	0.77	1.87
800	8.88	1.23	4.03	1200	7.70	0.92	2.20
850	9.44	1.38	4.53	1300	8.34	1.08	2.56
900	9.99	1.55	5.05	1400	8.98	1.25	2.95
950	10.5	1.73	5.60	1500	9.62	1.44	3.37
1000	11.1	1.92	6.17	1600	10.3	1.64	3.82
1100	12.2	2.31	7.41	1700	10.9	1.85	4.29
1200	13.3	2.76	8.76	1800	11.5	2.07	4.79
1300	14.4	3.24	10.2	1900	12.2	2.31	5.31
1400	15.5	3.76	11.8	2000	12.8	2.56	5.86
1500	16.7	4.31	12.5	2200	14.1	3.09	7.02
1600	17.8	4.91	15.4	2400	15.4	3.68	8.31
1700	18.9	5.54	17.3	2600	16.7	4.32	9.70
1800	20.0	6.21	19.4	2800	18.0	5.01	11.20
1900	21.1	6.92	21.6	3000	19.2	5.75	12.8
2000	22.2	7.67	23.8	3200	20.5	6.55	14.5

Table 13				Table 14			
10 Inches	Steel Schedule 40 Pipe ID:4.026 Inches ϕ /D: 0.000447			12 Inches	Steel Schedule 40 Pipe ID:5.047 Inches ϕ /D: 0.000357		
Flow Rate (GPM)	V (ft/sec)	V ² /g (ft)	Friction Loss Head per 100 ft of Pipe	Flow Rate (GPM)	V (ft/sec)	V ² /g (ft)	Friction Loss Head per 100 ft of Pipe
240	0.98	0.01	0.04	350	1.00	0.02	0.03
260	1.06	0.02	0.04	400	1.15	0.02	0.04
280	1.14	0.02	0.05	450	1.29	0.03	0.05
300	1.22	0.02	0.05	500	1.43	0.03	0.06
350	1.42	0.03	0.07	550	1.58	0.04	0.07
400	1.63	0.04	0.09	600	1.72	0.05	0.08
450	1.83	0.05	0.11	650	1.86	0.05	0.10
500	2.03	0.06	0.14	700	2.01	0.06	0.11
550	2.24	0.08	0.16	750	2.15	0.07	0.12
600	2.44	0.09	0.19	800	2.29	0.08	0.14
650	2.64	0.11	0.22	850	2.44	0.09	0.16
700	2.85	0.13	0.26	900	2.58	0.10	0.17
750	3.05	0.15	0.20	950	2.72	0.12	0.19
800	3.25	0.17	0.33	1000	2.87	0.13	0.21
850	3.46	0.19	0.37	1100	3.15	0.15	0.25

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900	3.66	0.21	0.41	1200	3.44	0.18	0.30
950	3.87	0.23	0.46	1300	3.73	0.22	0.34
1000	4.07	0.26	0.50	1400	4.01	0.25	0.40
1100	4.48	0.31	0.60	1500	4.30	0.29	0.45
1200	4.88	0.37	0.70	1600	4.59	0.33	0.51
1300	5.29	0.44	0.82	1700	4.87	0.37	0.57
1400	5.70	0.50	0.94	1800	5.16	0.41	0.64
1500	6.10	0.58	1.07	1900	5.45	0.46	0.70
1600	6.51	0.66	1.21	2000	5.73	0.51	0.78
1700	6.92	0.74	1.36	2200	6.31	0.62	0.93
1800	7.32	0.83	1.52	2400	6.88	0.74	1.10
1900	7.73	0.93	1.68	2600	7.45	0.86	1.28
2000	8.14	1.03	1.86	2800	8.03	1.00	1.47
2200	8.95	1.25	2.23	3000	8.60	1.15	1.68
2400	9.76	1.48	2.64	3200	9.17	1.31	1.90
2600	10.6	1.74	3.08	3400	9.75	1.48	2.13
2800	11.4	2.02	3.56	3600	10.3	1.65	2.37
3000	12.2	2.32	4.06	3800	10.9	1.84	2.63
3200	13.0	2.63	4.59	4000	11.5	2.04	2.92
3400	13.8	2.97	5.16	4500	12.9	2.59	3.65
3600	14.6	3.33	5.76	5000	14.3	3.19	4.47
3800	15.5	3.71	6.40	5500	15.8	3.86	5.38
4000	16.3	4.12	7.07	6000	17.2	4.60	6.39
4500	18.3	5.21	8.88	6500	18.6	5.39	7.47
5000	20.3	6.43	10.9	7000	20.1	6.26	8.63

No allowance has been made for age, differences in diameter, or any abnormal condition of interior surface. Any factor of safety must be estimated from the local conditions and the requirements of each particular installation. Recommended flow rates (boldface) for suction and discharge pipes are to avoid sanding at lower flow rates and to avoid too much friction at higher flow rates.

