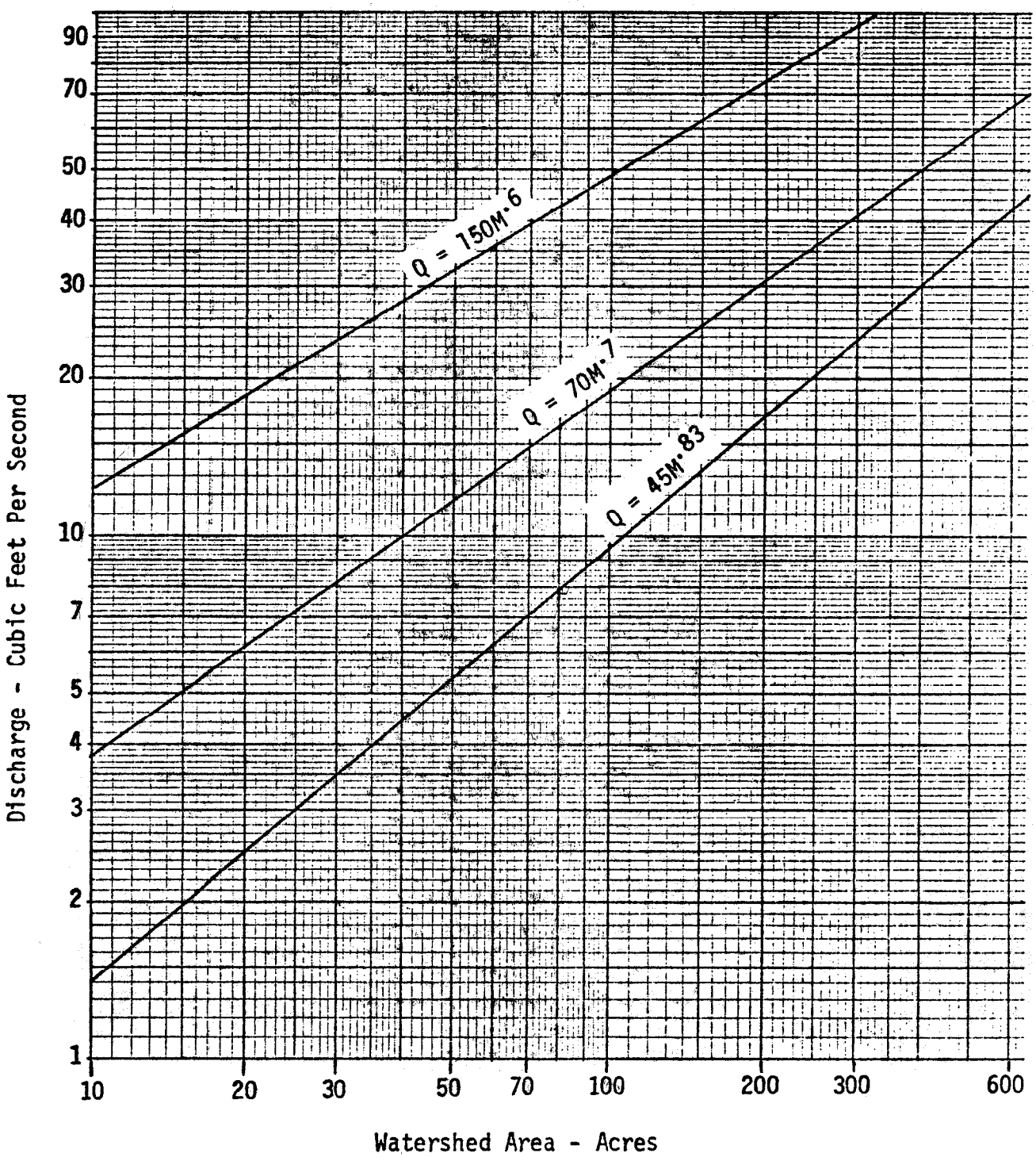
DRAINAGE RUNOFF CURVES



$Q = 150M^{.6}$ - good protection from overflow (not maximum flood runoff)
$Q = 70M^{.7}$ - excellent drainage
$Q = 45M^{.83}$ - good agricultural drainage; basic drainage for grain crops
Q = Discharge in cfs M = Drainage area in square miles.

MINIMUM BERM WIDTH WHEN SPOIL IS NOT SPREAD

Ditch Depth - Ft	Berm Width - Ft
2-6	8.0
6-8	10.0
Over 8	15.0

MAXIMUM FIELD DITCH SPACING

Field Slope Percent	Graded Field Feet	Non-Graded Field Feet
0 - 0.3	1320	1320
0.4 - 0.6	880	660
0.7 - 0.9	660	440

CROSSABLE FIELD DITCH

Field Slope Percent	Acres Drainage Area					
0 - 0.3	5	13	25	38	50	62
0.4 - 0.6	4	10	20	30	40	50
0.7 - 0.9	3	7	15	22	30	37
Channel Grade Percent	"V" Shape Channel 10.1 Side Slopes					
	Constructed Depth - Ft.					
0.2	1.0	1.2	1.4	1.6	1.7	1.8
0.3	0.9	1.1	1.3	1.4	1.5	1.6
0.4	0.8	1.0	1.2	1.3	1.4	1.5
0.5	0.8	0.9	1.1	1.2	1.3	1.4
0.6	0.7	0.8	1.0	1.1	1.2	1.3
Channel Grade Percent	Trapezoidal Channel 8' Bottom 8:1 Side Slopes					
	Constructed Depth - Ft.					
0.2	0.9	1.1	1.2	1.4	1.5	1.6
0.3	0.8	1.0	1.1	1.3	1.4	1.5
0.4	0.7	0.9	1.0	1.2	1.3	1.4
0.5	0.6	0.8	1.0	1.1	1.2	1.3
0.6	0.6	0.7	0.9	1.0	1.1	1.2

The constructed channel depth is the required channel with freeboard.

VALUES OF V AND Q FOR DRAINAGE DITCHES

1½:1 Side Slopes n = 0.040

Ditch Size		% Slope																			
Bottom Width Feet	Depth Flow Feet	0.02		0.04		0.06		0.08		0.10		0.15		0.20		0.30		0.40		0.50	
		V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q
4	1.0	0.4	2	0.6	3	0.7	4	0.8	5	0.9	5	1.2	6	1.3	7	1.6	9	1.9	10	2.1	12
6		.4	3	.6	5	.8	6	.9	7	1.0	7	1.2	9	1.4	11	1.7	13	2.0	15	2.2	17
8		.5	4	.7	6	.8	8	.9	8	1.0	10	1.3	12	1.5	15	1.8	17	2.1	20	2.3	22
10		.5	5	.7	8	.8	9	.9	11	1.1	12	1.3	15	1.5	17	1.8	21	2.1	24	2.3	27
4	1.5	0.5	5	0.7	7	0.9	9	1.0	10	1.2	11	1.4	13	1.7	15	2.0	19	2.3	22	2.6	25
6		.6	7	.8	10	1.0	12	1.1	14	1.2	15	1.5	19	1.8	22	2.1	27	2.5	31	2.8	34
8		.6	9	.8	13	1.0	15	1.2	18	1.3	20	1.6	24	1.8	28	2.2	34	2.6	40	2.9	44
10		.6	11	.8	15	1.0	19	1.2	22	1.3	24	1.6	30	1.9	34	2.3	42	2.6	49	3.0	54
4	2.0	0.6	8	0.9	12	1.1	15	1.2	17	1.4	19	1.7	23	1.9	27	2.4	33	2.7	38	3.0	43
6		.6	12	.9	16	1.1	20	1.3	23	1.4	26	1.8	32	2.0	37	2.5	45	2.9	52	3.2	58
8		.7	15	1.0	21	1.2	26	1.3	30	1.5	33	1.8	40	2.1	47	2.6	57	3.0	66	3.4	74
10		.7	18	1.0	25	1.2	31	1.4	36	1.5	40	1.9	49	2.2	57	2.7	70	3.1	80	3.5	90
4	2.5	0.7	13	1.0	19	1.2	23	1.4	26	1.5	30	1.9	36	2.2	42	2.6	51	3.1	59	3.4	66
6		.7	18	1.0	25	1.3	31	1.5	35	1.6	40	2.0	48	2.3	56	2.8	68	3.2	79	3.6	88
8		.8	22	1.1	31	1.3	38	1.5	44	1.7	50	2.1	61	2.4	70	2.9	86	3.4	99	3.8	111
10		.8	27	1.1	38	1.4	46	1.6	54	1.7	60	2.1	73	2.5	85	3.0	104	3.5	120	3.9	134
4	3.0	0.8	19	1.1	27	1.3	33	1.5	38	1.7	43	2.1	53	2.4	61	2.9	75	3.4	86	3.8	96
6		.8	25	1.1	36	1.4	44	1.6	50	1.8	56	2.2	69	2.5	80	3.1	97	3.6	112	4.0	126
8		.8	31	1.2	44	1.4	54	1.7	62	1.9	70	2.3	85	2.6	99	3.2	121	3.7	140	4.2	156
10		.9	37	1.2	53	1.5	65	1.7	75	1.9	84	2.4	102	2.7	118	3.3	145	3.8	167	4.3	187
4	3.5	0.8	27	1.2	38	1.4	46	1.6	53	1.8	59	2.2	73	2.6	84	3.2	103	3.7	119	4.1	133
6		.9	34	1.2	48	1.5	59	1.7	68	1.9	76	2.4	93	2.7	108	3.4	132	3.9	152	4.3	170
8		.9	42	1.3	59	1.6	72	1.8	84	2.0	94	2.5	115	2.9	132	3.5	162	4.0	187	4.5	209
10		.9	50	1.3	70	1.6	86	1.9	99	2.1	111	2.6	136	2.9	157	3.6	192	4.2	222	4.7	248

V = Velocity (fps) Q = Discharge (cfs)

If V or Q is desired for some other value of "n", multiply table value by $\frac{0.040}{\text{rev. n}}$

VALUES OF V AND Q FOR DRAINAGE DITCHES

2:1 Side Slopes n = 0.040

Ditch Size		% Slope																			
Bottom Width Feet	Depth Flow Feet	0.02		0.04		0.06		0.08		0.10		0.15		0.20		0.30		0.40		0.50	
		V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q
4	1.0	0.4	2	0.6	3	0.7	4	0.8	5	0.9	6	1.1	7	1.3	8	1.6	10	1.9	11	2.1	12
6		.4	3	.6	5	.8	6	.9	7	1.0	8	1.2	10	1.4	11	1.7	14	2.0	16	2.2	17
8		.5	4	.6	6	.8	8	.9	9	1.0	10	1.2	12	1.4	14	1.8	17	2.0	20	2.3	23
10		.5	5	.7	8	.8	10	.9	11	1.0	12	1.3	15	1.5	18	1.8	22	2.1	25	2.3	28
4	1.5	0.5	5	0.7	8	0.9	9	1.0	11	1.2	12	1.4	15	1.6	17	2.0	21	2.3	24	2.6	27
6		.6	7	.8	10	1.0	13	1.1	15	1.2	16	1.5	20	1.7	23	2.1	29	2.4	33	2.7	37
8		.6	9	.8	13	1.0	16	1.1	19	1.3	21	1.6	26	1.8	30	2.2	36	2.5	42	2.8	47
10		.6	11	.8	16	1.0	20	1.2	23	1.3	25	1.6	31	1.8	36	2.2	44	2.6	50	2.9	57
4	2.0	0.6	10	0.9	14	1.1	17	1.2	19	1.4	22	1.7	26	1.9	31	2.4	38	2.7	43	3.0	49
6		.6	13	.9	18	1.1	22	1.3	26	1.4	28	1.7	35	2.0	40	2.5	49	2.9	57	3.2	64
8		.7	16	.9	23	1.2	28	1.3	32	1.5	36	1.8	44	2.1	50	2.6	62	3.0	71	3.3	80
10		.7	19	1.0	27	1.2	33	1.4	38	1.5	43	1.9	52	2.2	61	2.6	74	3.0	85	3.4	95
4	2.5	0.7	15	1.0	22	1.2	27	1.4	31	1.5	34	1.9	42	2.2	49	2.6	59	3.0	68	3.4	77
6		.7	20	1.0	28	1.2	34	1.4	40	1.6	44	2.0	54	2.3	62	2.8	76	3.2	88	3.6	99
8		.8	24	1.1	34	1.3	42	1.5	49	1.7	55	2.1	66	2.4	77	2.9	94	3.3	109	3.7	122
10		.8	29	1.1	41	1.3	50	1.5	57	1.7	65	2.1	79	2.4	91	3.0	111	3.4	129	3.8	144
4	3.0	0.8	23	1.1	32	1.3	39	1.5	45	1.7	51	2.1	62	2.4	71	2.9	88	3.4	101	3.8	113
6		.8	29	1.1	40	1.4	50	1.6	57	1.8	64	2.2	78	2.5	90	3.1	110	3.5	127	4.0	143
8		.8	34	1.2	49	1.4	60	1.6	69	1.8	77	2.3	95	2.6	109	3.2	134	3.7	155	4.1	173
10		.9	41	1.2	57	1.5	71	1.7	81	1.9	91	2.3	111	2.7	129	3.3	158	3.8	182	4.2	204
4	3.5	0.8	32	1.2	45	1.4	55	1.6	63	1.8	71	2.3	87	2.6	100	3.2	128	3.4	132	4.1	158
6		.9	39	1.2	56	1.5	68	1.7	79	1.9	88	2.4	107	2.7	124	3.3	152	3.9	175	4.3	196
8		.9	47	1.3	67	1.6	81	1.8	94	2.0	105	2.5	129	2.8	148	3.5	182	4.0	210	4.5	235
10		.9	55	1.3	77	1.6	95	1.8	110	2.1	123	2.5	150	2.9	173	3.6	213	4.1	245	4.6	274

V = Velocity (fps) Q = Discharge (cfs)

If V or Q is desired for some other value of "n" multiply table value by $\frac{0.040}{\text{rev. n}}$

VALUES OF V AND Q FOR DRAINAGE DITCHES

3:1 Side Slopes n = 0.040

Ditch Size		% Slope																			
Bottom Width Feet	Depth Flow Feet	0.02		0.04		0.06		0.08		0.10		0.15		0.20		0.30		0.40		0.50	
		V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q
4	1.0	0.4	3	0.6	4	0.7	5	0.8	6	0.9	7	1.1	8	1.3	9	1.6	11	1.8	13	2.0	14
6		.4	4	.6	5	.7	7	.9	8	1.0	9	1.2	11	1.3	12	1.7	15	1.9	17	2.1	19
8		.4	5	.6	7	.8	8	.9	10	1.0	11	1.2	13	1.4	15	1.7	19	2.0	22	2.2	24
10		.5	6	.6	8	.8	10	.9	12	1.0	13	1.2	16	1.4	19	1.7	23	2.0	26	2.3	29
4	1.5	0.5	6	0.7	9	0.9	11	1.0	13	1.1	14	1.4	18	1.6	20	2.0	25	2.3	29	2.5	32
6		.5	8	.8	12	.9	14	1.1	17	1.2	19	1.5	23	1.7	26	2.1	32	2.4	37	2.7	42
8		.6	10	.8	15	1.0	18	1.1	21	1.2	23	1.5	28	1.7	33	2.1	40	2.5	46	2.8	52
10		.6	12	.8	17	1.0	21	1.1	25	1.3	27	1.5	34	1.8	39	2.2	48	2.5	55	2.8	61
4	2.0	0.6	12	0.8	17	1.0	21	1.2	24	1.3	27	1.6	33	1.9	38	2.3	46	2.7	53	3.0	59
6		.6	15	.9	21	1.1	26	1.2	30	1.4	33	1.7	41	2.0	47	2.4	58	2.8	67	3.1	75
8		.6	18	.9	25	1.1	31	1.3	36	1.4	40	1.7	49	2.0	57	2.5	70	2.9	81	3.2	90
10		.7	21	.9	30	1.1	37	1.3	42	1.5	47	1.8	58	2.1	67	2.6	82	3.0	95	3.3	106
4	2.5	0.7	19	1.0	27	1.2	34	1.3	39	1.5	43	1.8	53	2.1	61	2.6	75	3.0	87	3.4	97
6		.7	24	1.0	34	1.2	41	1.4	47	1.6	53	1.9	65	2.2	75	2.7	92	3.1	106	3.5	119
8		.7	28	1.0	40	1.3	49	1.5	56	1.6	63	2.0	77	2.3	89	2.8	109	3.2	126	3.6	141
10		.7	33	1.1	46	1.3	57	1.5	65	1.7	73	2.0	89	2.4	103	2.9	127	3.3	146	3.7	163
4	3.0	0.7	29	1.1	41	1.3	50	1.5	58	1.7	65	2.0	80	2.4	92	2.9	113	3.3	130	3.7	146
6		.8	35	1.1	50	1.3	61	1.6	70	1.7	78	2.1	96	2.5	111	3.0	136	3.5	157	3.9	175
8		.8	41	1.1	58	1.4	71	1.6	82	1.8	92	2.2	112	2.5	130	3.1	159	3.6	183	4.0	205
10		.8	47	1.2	66	1.4	81	1.7	94	1.8	105	2.3	129	2.6	149	3.2	182	3.7	210	4.1	235
4	3.5	0.8	41	1.2	59	1.4	72	1.6	83	1.8	93	2.2	114	2.6	131	3.2	161	3.7	186	4.1	208
6		.8	49	1.2	69	1.5	85	1.7	98	1.9	110	2.3	134	2.7	155	3.3	190	3.8	219	4.2	245
8		.9	57	1.2	80	1.5	98	1.8	113	2.0	127	2.4	155	2.8	179	3.4	219	3.9	253	4.4	283
10		.9	64	1.3	91	1.6	112	1.8	129	2.0	144	2.5	176	2.8	204	3.5	249	4.0	288	4.5	322

V = Velocity (fps) Q = Discharge (cfs)

If V or Q is desired for some other value of "n", multiply table value by $\frac{0.040}{\text{rev. n}}$

VALUES OF V AND Q FOR DRAINAGE DITCHES

4:1 Side Slopes n = 0.040

Ditch Size		% Slope																			
Bottom Width Feet	Depth Flow Feet	0.02		0.04		0.06		0.08		0.10		0.15		0.20		0.30		0.40		0.50	
		V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q
4	1.0	0.4	3	0.6	4	0.7	5	0.8	6	0.9	7	1.1	9	1.2	10	1.6	13	1.8	14	2.0	16
6		.4	4	.6	6	.7	7	.8	8	.9	9	1.1	11	1.3	13	1.6	16	1.8	16	2.1	21
8		.4	5	.6	7	.7	9	.9	10	1.0	12	1.2	14	1.4	16	1.7	20	1.9	23	2.2	26
10		.4	6	.6	9	.8	11	.9	12	1.0	14	1.2	17	1.4	20	1.7	24	2.0	28	2.2	31
4	1.5	0.5	8	0.7	11	0.9	13	1.0	15	1.1	17	1.4	21	1.6	23	1.9	29	2.2	33	2.5	37
6		.5	9	.7	13	.9	16	1.0	19	1.2	21	1.4	26	1.6	30	2.0	36	2.3	42	2.6	47
8		.5	11	.8	16	.9	20	1.1	23	1.2	25	1.5	31	1.7	36	2.1	44	2.4	50	2.7	56
10		.6	13	.8	19	1.0	23	1.1	26	1.2	29	1.5	36	1.7	42	2.1	51	2.5	59	2.8	66
4	2.0	0.6	14	0.8	20	1.0	25	1.2	28	1.3	31	1.6	38	1.8	44	2.3	54	2.6	62	2.9	70
6		.6	17	.9	24	1.0	29	1.2	34	1.4	38	1.6	46	1.9	54	2.4	66	2.7	76	3.0	85
8		.6	20	.9	28	1.1	35	1.2	40	1.4	45	1.7	55	2.0	64	2.4	78	2.8	90	3.2	101
10		.6	23	.9	33	1.1	40	1.3	46	1.4	52	1.8	63	2.0	73	2.5	90	2.9	104	3.2	116
4	2.5	0.7	23	0.9	33	1.2	40	1.3	46	1.5	52	1.8	64	2.1	74	2.6	90	3.0	104	3.3	116
6		.7	27	1.0	39	1.2	48	1.4	55	1.5	62	1.9	75	2.2	87	2.7	107	3.1	123	3.4	138
8		.7	32	1.0	45	1.2	55	1.4	64	1.6	72	2.0	88	2.2	101	2.7	123	3.2	142	3.5	159
10		.7	36	1.0	51	1.3	63	1.5	73	1.6	81	2.0	99	2.3	115	2.8	140	3.3	162	3.6	181
4	3.0	0.7	36	1.0	50	1.3	61	1.5	71	1.7	80	2.0	97	2.3	112	2.9	137	3.3	158	3.7	177
6		.8	42	1.1	58	1.3	72	1.5	83	1.7	93	2.1	113	2.4	131	3.0	160	3.4	185	3.8	207
8		.8	47	1.1	67	1.4	82	1.6	94	1.8	106	2.2	129	2.5	150	3.0	183	3.5	211	3.9	236
10		.8	53	1.1	75	1.4	92	1.6	106	1.8	119	2.2	145	2.6	168	3.1	206	3.6	238	4.0	266
4	3.5	0.8	51	1.1	73	1.4	89	1.6	102	1.8	114	2.2	134	2.6	162	3.1	198	3.6	228	4.1	256
6		.8	59	1.2	83	1.5	102	1.7	118	1.9	131	2.3	160	2.7	186	3.2	227	3.7	262	4.2	293
8		.9	66	1.2	94	1.5	115	1.7	133	1.9	148	2.4	181	2.7	210	3.3	257	3.8	296	4.3	330
10		.9	74	1.2	104	1.5	128	1.8	147	2.0	165	2.4	202	2.8	234	3.4	286	3.9	329	4.4	368

V = Velocity (fps) Q = Discharge (cfs)

If V or Q is desired for some other value of "n", multiply table value by $\frac{0.040}{\text{rev. n}}$

VALUES OF V AND Q FOR DRAINAGE DITCHES

8:1 Side Slopes n = 0.040

Ditch Size		% Slope																			
Bottom Width Feet	Depth Flow Feet	0.02		0.04		0.06		0.08		0.10		0.15		0.20		0.30		0.40		0.50	
		V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q
0	0.5							0.4	0.8	0.5	0.9	0.6	1	0.7	1	0.8	2	0.9	2	1.0	2
4		0.2	1	0.4	1	0.4	2	.5	2	.6	2	.7	3	.8	3	.9	4	1.1	4	1.2	5
6		.3	1	.4	2	.5	2	.5	3	.6	3	.7	4	.8	4	1.0	5	1.2	6	1.3	7
8		.3	2	.4	2	.5	3	.5	3	.6	4	.7	4	.9	5	1.0	6	1.2	7	1.4	8
0	1.0	0.3	3	0.5	4	0.6	5	0.7	5	0.7	6	0.9	7	1.0	8	1.3	10	1.5	12	1.6	13
4		.4	4	.5	6	.7	8	.8	9	.8	10	1.0	12	1.2	14	1.5	17	1.7	20	1.9	22
6		.4	5	.6	8	.7	9	.8	11	.9	12	1.1	15	1.2	17	1.5	21	1.7	24	1.9	27
8		.4	6	.6	9	.7	11	.8	13	.9	14	1.1	17	1.3	20	1.6	25	1.8	28	2.0	32
0	1.5	0.4	8	0.6	11	0.7	13	0.9	16	1.0	17	1.2	21	1.4	25	1.7	30	1.9	35	2.2	39
4		.5	11	.7	16	.8	19	.9	23	1.1	25	1.3	31	1.5	36	1.8	44	2.1	50	2.4	56
6		.5	13	.7	19	.8	23	1.0	26	1.1	29	1.4	37	1.6	42	1.9	51	2.2	59	2.5	66
8		.5	15	.7	21	.9	26	1.0	30	1.1	34	1.4	42	1.6	48	1.9	58	2.3	68	2.5	75
0	2.0	0.5	17	0.7	24	0.9	30	1.0	33	1.2	37	1.4	46	1.7	53	2.0	65	2.3	75	2.6	84
4		.6	23	.8	32	1.0	39	1.1	45	1.2	50	1.5	61	1.8	71	2.2	86	2.5	100	2.8	112
6		.6	26	.8	36	1.0	44	1.2	51	1.3	57	1.6	69	1.8	81	2.2	98	2.6	114	2.9	127
8		.6	29	.8	40	1.0	49	1.2	57	1.3	63	1.6	77	1.9	90	2.3	110	2.6	127	3.0	142
0	2.5	0.6	30	0.9	43	1.1	53	1.2	61	1.4	68	1.7	83	1.9	96	2.3	117	2.7	136	3.0	152
4		.7	39	.9	55	1.1	67	1.3	77	1.4	86	1.8	106	2.0	122	2.5	150	2.9	173	3.2	194
6		.7	43	.9	60	1.1	74	1.3	85	1.5	96	1.8	117	2.1	135	2.6	166	2.9	199	3.3	214
8		.7	48	1.0	67	1.2	82	1.3	94	1.5	105	1.8	129	2.1	149	2.6	182	3.0	210	3.4	236
0	3.0	0.7	49	1.0	70	1.2	85	1.4	99	1.5	110	1.9	135	2.2	156	2.7	191	3.1	221	3.4	247
4		.7	60	1.0	86	1.2	104	1.4	121	1.6	135	2.0	165	2.3	191	2.8	234	3.2	270	3.6	302
6		.7	67	1.1	95	1.3	114	1.5	132	1.7	149	2.0	181	2.3	209	2.9	257	3.3	296	3.7	330
8		.8	72	1.1	102	1.3	125	1.5	144	1.7	161	2.0	196	2.4	227	2.9	278	3.3	320	3.7	359

V = Velocity (fps) Q=Discharge (cfs)

If V or Q is desired for some other value of "n", multiply table value by $\frac{0.040}{\text{rev. n}}$

END AREA TABLES FOR OPEN DITCHES

END AREAS IN SQUARE FEET

4.0' BOTTOM WIDTH

Depth	SIDE SLOPES					
in Feet	1½:1	2:1	3:1	4:1	6:1	8:1
0.1	0.4	0.4	0.4	0.4	0.5	0.5
0.2	0.9	0.9	0.9	1.0	1.0	1.1
0.3	1.3	1.4	1.5	1.6	1.7	1.9
0.4	1.8	1.9	2.1	2.2	2.6	2.9
0.5	2.4	2.5	2.8	3.0	3.5	4.0
0.6	2.9	3.1	3.5	3.8	4.6	5.3
0.7	3.5	3.8	4.3	4.8	5.7	6.7
0.8	4.2	4.5	5.1	5.8	7.0	8.3
0.9	4.8	5.2	6.0	6.8	8.5	10.1
1.0	5.5	6.0	7.0	8.0	10.0	12.0
1.1	6.2	6.8	8.0	9.2	11.7	14.1
1.2	7.0	7.7	9.1	10.6	13.4	16.3
1.3	7.7	8.6	10.3	12.0	15.3	18.7
1.4	8.5	9.5	11.5	13.4	17.4	21.3
1.5	9.4	10.5	12.8	15.0	19.5	24.0
1.6	10.2	11.5	14.1	16.6	21.8	26.9
1.7	11.1	12.6	15.5	18.4	24.1	29.9
1.8	12.1	13.7	16.9	20.2	26.6	33.1
1.9	13.0	14.8	18.4	22.0	29.3	36.5
2.0	14.0	16.0	20.0	24.0	32.0	40.0
2.1	15.0	17.2	21.6	26.0	34.9	43.7
2.2	16.1	18.5	23.3	28.2	37.8	47.5
2.3	17.1	19.8	25.1	30.4	40.9	51.5
2.4	18.2	21.1	26.9	32.6	44.2	55.7
2.5	19.4	22.5	28.8	35.0	47.5	60.0
2.6	20.5	23.9	30.7	37.4	51.0	64.5
2.7	21.7	25.4	32.7	40.0	54.5	69.1
2.8	23.0	26.9	34.7	42.6	58.2	73.7
2.9	24.2	28.4	36.8	45.2	62.1	78.9
3.0	25.5	30.0	39.0	48.0	66.0	84.0
3.1	26.8	31.6	41.2	50.8	70.1	89.3
3.2	28.2	33.3	43.5	53.8	74.2	94.7
3.3	29.5	35.0	45.9	56.8	78.5	100.3
3.4	30.9	36.7	48.3	59.8	83.0	106.1
3.5	32.4	38.5	50.8	63.0	87.5	112.0
3.6	33.8	40.3	53.3	66.2	92.2	118.1
3.7	35.3	42.2	55.9	69.6	96.9	124.3
3.8	36.9	44.1	58.5	73.0	101.8	130.7
3.9	38.4	46.0	61.2	76.4	106.9	137.3
4.0	40.0	48.0	64.0	80.0	112.0	144.0
4.1	41.6	50.0	67.0	83.6	117.3	150.9
4.2	43.3	52.1	69.7	87.4	122.6	157.9
4.3	44.9	54.2	72.7	91.2	128.1	165.1
4.4	46.6	56.3	75.7	95.0	133.8	172.5
4.5	48.4	58.5	78.8	99.0	139.5	180.0
4.6	50.1	60.7	81.9	103.0	145.4	188.7
4.7	51.9	63.0	85.1	107.2	151.3	195.5
4.8	53.8	65.3	88.3	111.4	157.4	203.5
4.9	55.6	67.6	91.6	115.6	163.7	211.7
5.0	57.5	70.0	95.0	120.0	170.0	220.0
5.1	59.4	72.4	98.4	124.4	176.5	228.5
5.2	61.4	74.9	101.9	129.0	183.0	237.1
5.3	63.3	77.4	105.5	133.6	189.7	245.9
5.4	65.3	79.9	109.1	138.2	196.6	254.9
5.5	67.4	82.5	112.8	143.0	202.5	264.0
5.6	69.4	85.1	116.5	147.8	210.6	273.3
5.7	71.5	87.8	120.2	152.8	217.7	282.7
5.8	73.7	90.5	124.1	157.8	225.0	292.3
5.9	75.8	93.2	131.4	162.4	232.9	302.1
6.0	78.0	96.0	132.0	168.0	240.0	312.0
6.1	80.2	98.5	136.0	173.2	247.7	322.1
6.2	82.5	101.7	140.1	178.6	255.4	332.3
6.3	84.7	104.6	144.3	184.0	263.3	342.7
6.4	87.0	107.5	148.5	189.4	271.4	353.3
6.5	89.4	110.5	152.8	195.0	279.5	364.0
6.6	91.7	113.5	157.1	200.6	287.8	374.9
6.7	94.1	116.6	161.5	206.4	296.1	385.9
6.8	96.6	119.7	165.9	212.2	304.6	397.1
6.9	99.0	122.8	170.4	218.0	313.3	408.5
7.0	101.5	126.0	175.0	224.0	322.0	420.0
7.1	104.0	129.2	179.6	230.0	330.9	431.7
7.2	106.6	132.6	184.3	236.2	339.8	443.5
7.3	109.1	135.8	189.1	242.4	348.9	455.5
7.4	111.7	139.1	193.9	248.6	358.2	467.7
7.5	114.4	142.5	198.8	255.0	367.5	480.0

6.0' BOTTOM WIDTH

Depth	SIDE SLOPES					
in Feet	1½:1	2:1	3:1	4:1	6:1	8:1
0.1	0.6	0.6	0.6	0.6	0.7	0.7
0.2	1.3	1.3	1.3	1.4	1.4	1.5
0.3	1.9	2.0	2.1	2.2	2.3	2.5
0.4	2.6	2.7	2.9	3.0	3.4	3.7
0.5	3.4	3.5	3.8	4.0	4.5	5.0
0.6	4.1	4.3	4.7	5.0	5.8	6.5
0.7	4.9	5.2	5.7	6.2	7.1	8.1
0.8	5.8	6.1	6.7	7.4	8.6	9.9
0.9	6.6	7.0	7.8	8.6	10.3	11.9
1.0	7.5	8.0	9.0	10.0	12.0	14.0
1.1	8.4	9.0	9.9	11.4	13.7	16.3
1.2	9.4	10.1	11.5	13.0	15.8	18.7
1.3	10.3	11.2	12.9	14.6	17.9	21.3
1.4	11.3	12.3	14.3	16.2	20.2	24.1
1.5	12.4	13.5	15.8	18.0	22.5	27.0
1.6	13.4	14.7	17.3	19.8	25.0	30.1
1.7	14.5	16.0	18.9	21.8	27.5	33.3
1.8	15.7	17.3	20.5	23.8	30.2	36.7
1.9	16.8	18.6	22.2	25.8	33.1	40.3
2.0	18.0	20.0	24.0	28.0	36.0	44.0
2.1	19.2	21.4	25.8	30.2	43.1	47.9
2.2	20.5	22.9	27.7	32.6	44.2	51.9
2.3	21.7	24.4	29.7	35.0	45.5	56.1
2.4	23.0	25.9	31.7	37.4	48.6	60.5
2.5	24.4	27.5	33.8	40.0	52.5	65.0
2.6	25.7	29.1	35.9	42.6	56.2	69.7
2.7	27.1	30.8	38.1	45.4	59.9	74.5
2.8	28.6	32.5	40.3	48.2	63.8	79.5
2.9	30.0	34.2	42.6	51.0	67.9	84.7
3.0	31.5	36.0	45.0	54.0	72.0	90.0
3.1	33.0	37.8	47.4	57.0	76.3	95.5
3.2	34.6	39.7	49.9	60.2	80.6	101.1
3.3	36.1	41.6	52.5	63.4	85.1	106.9
3.4	37.7	43.5	55.1	66.6	89.8	112.9
3.5	39.4	45.5	57.8	70.0	94.5	119.0
3.6	41.0	47.5	60.5	73.4	99.4	125.3
3.7	42.7	49.6	63.3	77.0	104.3	131.7
3.8	44.5	51.7	66.1	80.6	109.4	138.3
3.9	46.2	53.8	69.0	84.2	114.7	145.1
4.0	48.0	56.0	72.0	88.0	120.0	152.0
4.1	49.8	58.2	75.0	91.8	125.5	159.1
4.2	51.7	60.5	78.1	95.8	131.0	166.3
4.3	53.5	62.8	81.3	99.8	136.7	173.7
4.4	55.4	65.1	84.5	103.8	142.6	181.3
4.5	57.4	67.5	87.8	108.0	148.5	189.0
4.6	59.3	69.9	91.1	112.2	154.6	196.9
4.7	61.3	72.4	94.5	116.6	160.7	204.9
4.8	63.4	74.9	97.9	121.0	167.0	213.1
4.9	65.4	77.4	101.4	125.4	173.5	221.5
5.0	67.5	80.0	105.0	130.0	180.0	230.0
5.1	69.6	82.6	108.6	134.6	186.7	238.7
5.2	71.8	85.3	112.3	139.4	193.4	247.5
5.3	73.9	88.0	116.1	144.2	200.3	256.5
5.4	76.1	90.7	119.9	149.0	207.4	265.7
5.5	78.4	93.5	123.8	154.0	214.5	275.0
5.6	80.6	96.3	127.7	159.0	221.8	284.5
5.7	82.9	99.2	131.7	164.2	229.1	294.1
5.8	85.3	102.1	135.7	169.4	236.6	303.9
5.9	87.6	105.0	139.8	174.6	244.3	312.9
6.0	90.0	108.0	144.0	180.0	252.0	324.0
6.1	92.4	111.0	148.2	185.4	259.9	334.3
6.2	94.9	114.1	152.5	191.0	267.8	344.7
6.3	97.3	117.2	156.9	196.6	275.9	355.3
6.4	99.8	120.3	161.3	202.2	284.2	366.1
6.5	102.4	123.5	165.8	208.0	292.5	377.0
6.6	104.9	126.7	170.3	213.8	301.0	388.1
6.7	107.5	130.0	174.9	219.8	309.5	399.3
6.8	110.2	133.3	179.5	225.8	318.2	410.7
6.9	112.8	136.6	184.2	231.8	327.1	422.3
7.0	115.5	140.0	189.0	238.0	336.0	434.0
7.1	118.2	143.4	193.8	244.2	345.1	445.9
7.2	121.0	146.9	198.7	250.6	354.2	457.9
7.3	123.7	150.4	203.7	257.0	363.5	470.1
7.4	126.5	153.9	208.7	263.4	373.0	482.5
7.5	129.4	157.5	213.8	270.0	382.5	495.0

END AREA TABLES FOR OPEN DITCHES

END AREAS IN SQUARE FEET

8.0' BOTTOM WIDTH

Depth	SIDE SLOPES					
in Feet	1½:1	2:1	3:1	4:1	6:1	8:1
0.1	0.8	0.8	0.8	0.8	0.9	0.9
0.2	1.7	1.7	1.7	1.8	1.8	1.9
0.3	2.5	2.6	2.7	2.8	2.9	3.1
0.4	3.4	3.5	3.7	3.8	4.2	4.5
0.5	4.4	4.5	4.8	5.0	5.5	6.0
0.6	5.3	5.5	5.9	6.2	7.0	7.7
0.7	6.3	6.6	7.1	7.6	8.5	9.5
0.8	7.4	7.7	8.3	9.0	10.2	11.5
0.9	8.5	8.8	9.7	10.5	12.1	13.7
1.0	9.5	10.0	11.0	12.0	14.0	16.0
1.1	10.6	11.2	12.5	13.7	16.6	18.5
1.2	11.8	12.5	13.9	15.4	18.2	21.1
1.3	12.9	13.8	15.5	17.2	20.5	23.9
1.4	14.1	15.1	17.1	19.0	23.0	26.9
1.5	15.4	16.5	18.8	21.0	25.5	30.0
1.6	16.6	17.9	20.5	23.0	24.2	33.3
1.7	17.9	19.4	22.3	25.2	30.9	36.7
1.8	19.3	20.9	24.1	27.4	33.8	40.3
1.9	20.6	22.4	26.0	29.7	36.9	44.1
2.0	22.0	24.0	28.0	32.0	40.0	48.0
2.1	23.4	25.6	30.0	34.5	43.3	52.1
2.2	24.9	27.3	32.1	37.0	46.6	56.3
2.3	26.4	29.0	34.3	39.6	50.1	60.7
2.4	27.8	30.7	36.5	42.2	53.8	65.3
2.5	29.4	32.5	38.8	45.0	57.5	70.0
2.6	30.9	34.3	41.1	47.8	61.4	74.9
2.7	32.5	36.2	43.5	50.8	65.3	79.9
2.8	34.2	38.1	45.9	53.8	69.4	85.1
2.9	35.8	40.0	48.5	56.9	73.7	90.5
3.0	37.5	42.0	51.0	60.0	78.0	96.0
3.1	39.2	44.0	53.7	63.3	82.5	101.7
3.2	41.0	46.1	56.3	66.6	87.0	107.5
3.3	42.7	48.2	59.1	70.0	91.7	113.5
3.4	44.5	50.3	61.9	73.4	96.6	119.7
3.5	46.4	52.5	64.8	77.0	101.5	126.0
3.6	48.2	54.7	67.7	80.6	106.6	132.5
3.7	50.1	57.0	70.7	84.4	111.7	139.1
3.8	52.1	59.3	73.7	88.2	117.0	145.9
3.9	54.0	61.6	76.9	92.1	122.5	152.9
4.0	56.0	64.0	80.0	96.0	128.0	160.0
4.1	58.0	66.4	83.3	100.1	133.7	167.3
4.2	60.1	68.9	86.5	104.2	139.4	174.7
4.3	62.1	71.4	89.9	108.4	145.3	182.3
4.4	64.2	73.9	93.3	112.6	151.4	190.1
4.5	66.4	76.5	96.8	117.0	157.5	198.0
4.6	68.5	79.1	100.3	121.4	163.8	206.1
4.7	70.7	81.8	103.9	126.0	170.1	214.3
4.8	73.0	84.5	107.5	130.6	176.6	222.7
4.9	75.2	87.2	111.2	135.3	183.3	231.3
5.0	77.5	90.0	115.0	140.0	190.0	240.0
5.1	79.8	92.8	118.9	144.9	196.9	248.9
5.2	82.2	95.7	122.7	149.8	203.8	257.9
5.3	84.5	98.6	126.7	154.8	210.9	267.1
5.4	86.9	101.5	130.7	159.8	218.2	275.5
5.5	89.4	104.5	134.8	165.0	225.5	286.0
5.6	91.8	107.5	138.9	170.2	233.0	295.7
5.7	94.3	110.6	143.1	175.6	240.5	305.5
5.8	96.9	113.7	147.3	181.0	248.2	315.5
5.9	99.4	116.8	151.7	186.5	256.1	325.7
6.0	102.0	120.0	156.0	192.0	265.0	336.0
6.1	104.7	123.2	160.4	197.7	272.1	346.5
6.2	107.3	126.5	164.9	203.4	280.2	357.1
6.3	109.9	129.8	169.5	209.2	288.5	367.5
6.4	112.6	133.1	174.1	215.0	297.0	378.9
6.5	115.4	136.5	178.8	221.0	305.5	390.0
6.6	118.1	139.9	183.5	227.0	314.2	401.3
6.7	120.9	143.4	188.3	233.2	322.9	412.7
6.8	123.8	146.9	193.1	239.4	331.8	424.3
6.9	126.6	150.4	198.0	245.7	340.9	436.1
7.0	129.5	154.0	203.0	252.0	350.0	448.0
7.1	132.5	157.7	208.2	258.6	359.3	460.1
7.2	135.4	161.4	213.3	265.2	368.6	472.3
7.3	138.4	165.1	218.5	271.8	378.1	484.7
7.4	141.4	168.8	223.6	278.4	387.8	497.3
7.5	144.4	172.5	228.8	285.0	397.5	510.0

10.0' BOTTOM WIDTH

Depth	SIDE SLOPES					
in Feet	1½:1	2:1	3:1	4:1	6:1	8:1
0.1	1.0	1.0	1.0	1.0	1.1	1.1
0.2	2.1	2.1	2.1	2.2	2.2	2.3
0.3	3.1	3.2	3.3	3.4	3.5	3.7
0.4	4.2	4.3	4.5	4.6	5.0	5.3
0.5	5.4	5.5	5.8	6.0	6.5	7.0
0.6	6.5	6.7	7.1	7.4	8.2	8.9
0.7	7.7	8.0	8.5	9.0	9.9	10.9
0.8	9.0	9.3	9.9	10.6	11.8	13.1
0.9	10.2	10.6	11.4	12.2	13.9	15.5
1.0	11.5	12.0	13.0	14.0	16.0	18.0
1.1	12.8	13.4	14.6	15.8	18.3	20.7
1.2	14.2	14.9	16.3	17.8	20.6	23.5
1.3	15.5	16.4	18.1	19.8	23.1	26.5
1.4	16.9	17.9	19.9	21.8	25.8	29.7
1.5	18.4	19.5	21.8	24.0	28.5	33.0
1.6	19.8	21.1	23.7	26.2	31.4	36.5
1.7	21.3	22.8	25.7	28.6	34.3	40.1
1.8	22.9	24.5	27.7	31.0	37.4	43.9
1.9	24.4	26.2	29.8	33.4	40.7	47.9
2.0	26.0	28.0	32.0	36.0	44.0	52.0
2.1	27.6	29.8	34.2	38.6	47.5	56.3
2.2	29.3	31.7	36.5	41.4	51.0	60.7
2.3	30.9	33.6	38.9	44.2	54.7	65.3
2.4	32.6	35.5	41.3	47.0	58.6	70.1
2.5	34.4	37.5	43.8	50.0	62.5	75.0
2.6	36.1	39.5	46.3	53.0	66.6	80.1
2.7	37.9	41.6	48.9	56.2	70.7	85.3
2.8	39.8	43.7	51.5	59.4	75.0	90.7
2.9	41.6	45.8	54.2	62.6	79.5	96.3
3.0	43.5	48.0	57.0	66.0	84.0	102.0
3.1	45.4	50.2	59.8	69.4	88.7	107.9
3.2	47.4	52.5	62.7	73.0	93.4	113.9
3.3	49.3	54.8	65.7	76.6	98.3	120.1
3.4	51.3	57.1	68.7	80.2	103.4	126.5
3.5	53.4	59.5	71.8	84.0	108.5	133.0
3.6	55.4	61.9	74.9	87.8	113.8	139.7
3.7	57.5	64.4	78.1	91.8	119.1	146.5
3.8	59.7	66.9	81.3	95.8	124.6	153.5
3.9	61.8	69.4	84.6	99.8	130.3	160.7
4.0	64.0	72.0	88.0	104.0	136.0	168.0
4.1	66.2	74.6	91.4	108.2	141.9	175.5
4.2	68.5	77.3	94.9	112.6	147.8	183.1
4.3	70.7	80.0	98.5	117.0	153.9	190.9
4.4	73.0	82.7	102.1	121.4	160.2	198.9
4.5	75.4	85.5	105.8	126.0	166.5	207.0
4.6	77.7	88.3	109.5	130.6	173.0	215.3
4.7	80.1	91.2	113.3	135.4	179.5	223.7
4.8	82.6	94.1	117.1	140.2	186.2	232.3
4.9	85.0	97.0	121.0	144.0	193.1	241.1
5.0	87.5	100.0	125.0	150.0	200.0	250.0
5.1	90.0	103.0	129.0	155.0	207.1	259.1
5.2	92.6	106.1	133.1	160.2	214.2	268.3
5.3	95.1	109.2	137.3	165.4	221.5	277.7
5.4	97.7	112.3	141.5	170.6	229.0	287.3
5.5	100.4	115.5	145.8	176.0	236.5	297.0
5.6	103.0	118.7	150.1	181.4	244.2	306.9
5.7	105.7	122.0	154.5	187.0	251.9	316.9
5.8	108.5	125.3	158.9	192.6	259.8	327.1
5.9	111.2	128.6	163.4	198.2	267.9	337.5
6.0	114.0	132.0	168.0	204.0	276.0	348.0
6.1	116.8	135.4	172.6	209.8	284.3	358.7
6.2	119.7	138.9	177.3	215.8	292.6	369.5
6.3	122.5	142.4	182.1	221.8	301.1	380.5
6.4	125.4	145.9	186.9	227.8	309.8	391.7
6.5	128.4	149.5	191.8	234.0	318.5	403.0
6.6	131.3	153.1	196.7	240.2	327.4	414.5
6.7	134.3	156.8	201.7	246.6	336.3	426.1
6.8	137.4	160.5	206.7	253.0	345.4	437.9
6.9	140.4	164.2	211.8	259.4	354.7	449.9
7.0	143.5	168.0	217.0	266.0	364.0	462.0
7.1	146.6	171.8	222.2	272.6	373.5	474.3
7.2	149.8	180.7	227.5	279.4	383.0	486.7
7.3	152.9	181.6	232.9	286.2	392.7	499.3
7.4	156.1	183.5	238.3	293.0	402.6	512.1
7.5	159.4	187.5	243.8	300.0	412.5	525.0

DRAINAGE RECOMMENDATIONS FOR MISSOURI SOILS

Introduction

There have been approximately 350 different soil series mapped in Missouri. About one-half of these have problems with excess water. There are also nearly 4 million acres of prime farmland in Missouri classed 2W, which means wetness is a factor limiting productivity. In addition, there are large areas of wet pastureland, marginal cropland, and woodland throughout the state. This guide gives recommendations for surface and subsurface drainage practices for most Missouri cropland soils.

Recommendations for drainage are normally based on field tests and on experience with drainage practices on different soils. Mathematical equations have also been developed to help make recommendations for depth and spacing of subsurface drains. Several surface drainage practices have been installed in Missouri, so recommendations for surface drainage can be supplemented by past experience. But, very few subsurface drainage practices have been installed in Missouri. Therefore, little data on increased yields or improved farmability due to subsurface drainage is available.

The recommendations contained in this guide are based on soils information and mathematical equations supplemented by local experience when available, and the experience and recommedations of adjoining states with similar soils.

Benefits of Drainage

Well drained soil allows more infiltration and less runoff, especially from lower intensity rains. This results in less soil erosion and reduced loss of chemicals and fertilizers. This not only improves water quality in streams and lakes, but also keeps the valuable topsoil, chemicals, and fertilizers on the land.

The removal of free water by drainage allows the soil to warm up more quickly because more heat is required to raise the temperature of wet soil. Soils which warm up quicker in the spring can be planted earlier and better germination conditions for seed are provided. Good drainage is important for minimum tillage and no-till.

By allowing air to enter the soil, removal of free water promotes the soil bacterial action needed for the manufacture of plant food. The roots of plants, as well as soil bacteria, must have oxygen. Drainage accomplishes this by providing air space in the soil. Rainfall water passing downward in the soil carries out carbon dioxide and permits fresh air to be drawn in. Thus, drainage provides needed soil aeration.

The removal of ground water also improves conditions for plant root growth. For example, if free water is removed only from the top foot of soil, crop roots will feed in this confined area; but if free water is removed from the top three feet, this entire depth of soil is available as a root zone from which plants can obtain nutrients and moisture.

Factors Affecting Drainage

The method and intensity of drainage depends largely on the soil types and their characteristics. Topography and geology can also affect drainage.

Missouri has a wide variety of soils with a broad range of characteristics. The two main soil characteristics considered in this guide are: 1) the rate of water movement through the soil called "permeability", and 2) the degree of natural wetness before any drainage practices have been applied. Other characteristics considered are soil depth and topographic position. Some soils are shallow to bedrock or sand. Some occur on bottom lands and have occasional flooding problems. Other lack sufficient land slope to cause water to flow to an outlet or have no natural outlet.

The soil permeability (denoted by numbers 1 through 4) is the permeability of the most restrictive soil layer in the upper 36 inches of the soil profile. Permeability is the rate that water moves down through the soil profile (expressed in inches per hour) when the soil is saturated. The values do not consider lateral seepage or soil features such as plowpans or surface crusts.

The soil drainage class (denoted by capital letters) indicates the natural drainage of the soil. This classification can serve as an indicator of the relative yield increase that can be expected from applying drainage practices. Yield increases will probably be greater on soils with the poorest natural drainage. The following is a description of the drainage classes:

A - Poorly drained or very poorly drained soils - soils commonly saturated with free water at or near the surface long enough during the growing season to reduce the yields of most farm crops unless the soil is artificially drained.

B - Somewhat poorly drained soils - without artificial drainage, the water table would be near the surface only during the very wettest periods. Soils would be saturated with free water in the subsoil for significant periods during the growing season so the growth of most farm crops is restricted unless artificially drained.

C - Moderately well or well drained soils - soils where the growth of most common farm crops is not restricted by excess water during the growing season.

D - Excessively drained or somewhat excessively drained soils -soils that are droughty during dry periods of the year. The growth of most common farm crops may be restricted by a shortage of water during the growing season.

Use of This Guide

The following tables are an alphabetical listing of the Missouri soils which have been identified as benefitting from drainage. The individual soils are listed along with their permeability and natural drainage class. Soil limitations which may affect the use or design of some drainage practices are also shown for some soils. Recommendations for surface and subsurface drainage are provided for most soils. Reference numbers and letters used in the tables are explained on the page opposite each table.

More than one drainage practice is shown for many soils. Each land user must determine the method or combination of methods that would give the best results for his situation. A combination of surface and subsurface drainage practices generally gives the best results on most soils needing drainage.

The recommendations for subsurface drainage systems include a range of depths and spacings for the drains. Generally, the narrowest spacing shown should be used if the drains are installed at the shallowest depth shown. Wider spacing should be used for the deeper depths.

The drainage recommendations for each soil are for field crops. A more intensive drainage system is usually required for truck crops. An adequate soil conservation program should also be installed on the drained land. Sound management techniques and good agronomic practices improve the efficiency of any drainage system.

Identification of the soil type for any given tract of land can be determined from soil survey reports, from conservation farm plans, or from unpublished soil maps. These soil maps must be made at a relatively small scale, so some smaller areas of wet soils may not be drawn on the map. Therefore, these recommendations may need to be used in conjunction with an onsite review and detailed investigations.

DEFINITIONS

(See Introduction for further explanation)

Soil Permeability:

1 - Rapid or moderately rapid
2 - Moderate
3 - Moderately slow
4 - Slow or very slow

Natural Soil Drainage:

A - Poor or very poor
B - Somewhat poor
C - Well or moderately well
D - Excessive or somewhat excessive

Drainage Recommendations

1. Land leveling or suface field ditches may be needed to improve surface drainage on nearly level slopes and on areas with small depressions.

2. Wetness is usually due to sidehill seepage. Use interceptor drains near the contact of the less permeable layer.

3. Adequate gravity outlets for subsurface drainage systems are rarely available. A pump station may be needed for an outlet.

4. Areas may be subject to occasional-to-frequent overflow. An onsite evaluation is needed to determine severity and frequency of overflow. Use diversions to intercept runoff from adjacent uplands. Dikes or levees may be needed along adjacent streams if flooding is severe.

5. Subsurface drainage systems are not practical because a slowly permeable layer is in the top 24 inches of the soil profile. Drain spacings less than 20 feet are required.

6. Subsurface drainage systems may be effective but drain spacings less than 60 feet are required.

7. Subsurface drainage is usually effective at depths and spacings indicated.

8. Surface and subsurface drainage is not normally beneficial.

9. Subsurface drainage may be beneficial to lower the seasonal high water table. Wide subsurface drain spacings are effective with adequate surface drainage.

10. Subsurface drainage is generally not practical to lower the seasonal high water table because of difficulty in installation into dense fragipan within top 36 inches of soil profile.

Soil Limitations

a. A clayey subsoil layer with slow or very slow permeability restricts the downward movement of water within the root zone of most plants.

b. Highly aklaline subsoil, which will greatly reduce crop production if exposed, may limit depth of cut during landgrading.

c. Bedrock within the top 48 inches of the soil profile may interfere with grade and alignment of subsurface drains or conduits.

d. Subsoil may contain sand. Unstable trenches may occur during installation of conduits. Perforated drains may need filters. If sand is shallow in soil profile, it may limit depth of cut during landgrading.

e. Fragipan in top 30 inches of profile will limit root development of most crops.