

LEVELS  
CENTERVILLE ROAD  
ROAD  $\frac{9}{16}$  NO. 2  
FILE NO 4

FIELD BOOK

360

Office of Ramsey Co. Engineer  
ST. PAUL, MINN.

Date Filed .....

File No. ....

# KEUFFEL & ESSER CO.

## DRAWING MATERIALS AND SURVEYING INSTRUMENTS. NEW YORK.

CHICAGO. ST. LOUIS. SAN FRANCISCO. MONTREAL.

### TABLES FOR EXCAVATIONS AND EMBANKMENTS.

DISTANCES FROM CENTER OF ROADWAY FOR CROSS-SECTIONING.

ROADWAY 18 FEET WIDE. SIDE SLOPES 1 TO 1.

FOR SINGLE TRACK EXCAVATION.

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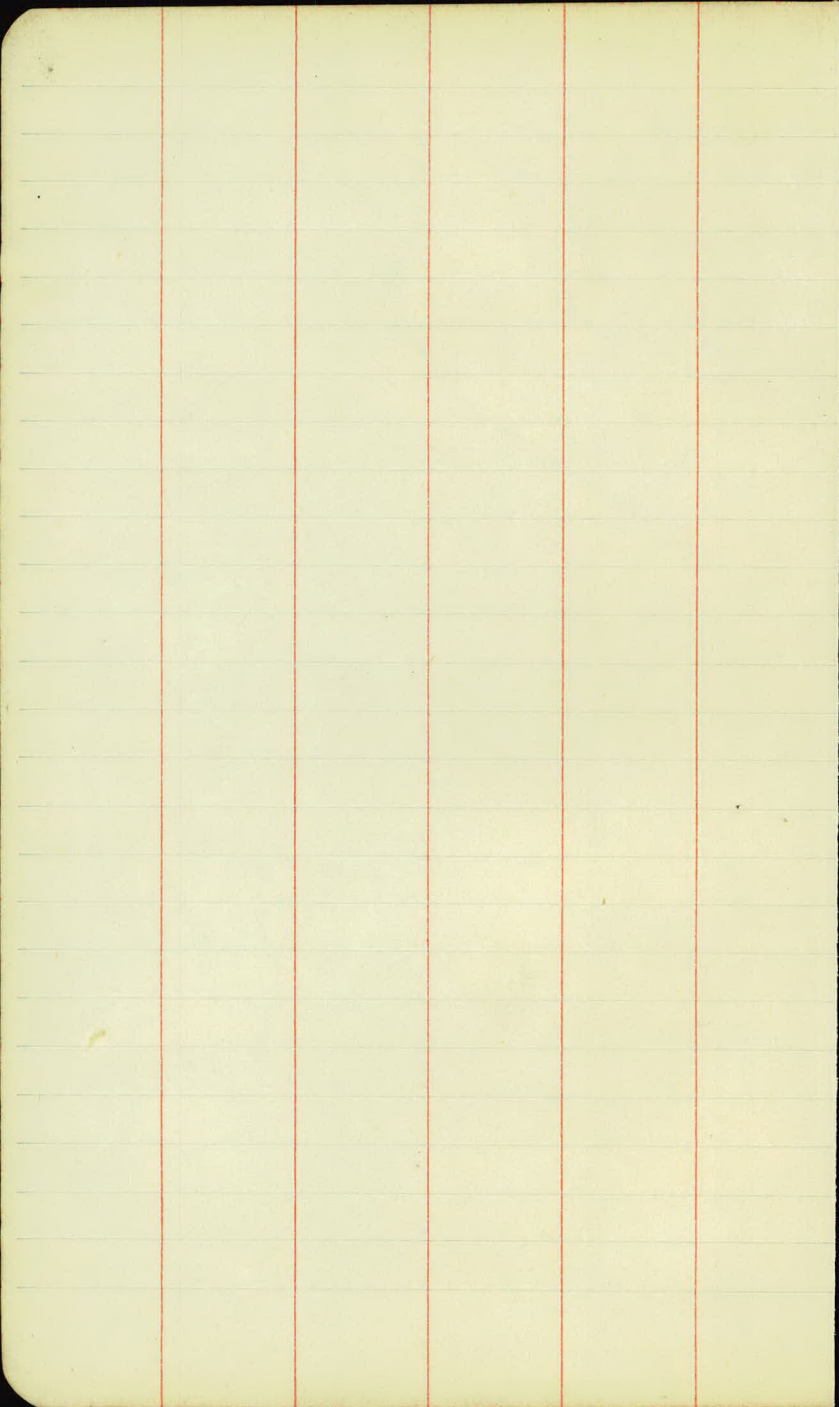
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0	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	0
1	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	1
2	11.0	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8	11.9	2
3	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	3
4	13.0	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8	13.9	4
5	14.0	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.9	5
6	15.0	15.1	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9	6
7	16.0	16.1	16.2	16.3	16.4	16.5	16.6	16.7	16.8	16.9	7
8	17.0	17.1	17.2	17.3	17.4	17.5	17.6	17.7	17.8	17.9	8
9	18.0	18.1	18.2	18.3	18.4	18.5	18.6	18.7	18.8	18.9	9
10	19.0	19.1	19.2	19.3	19.4	19.5	19.6	19.7	19.8	19.9	10
11	20.0	20.1	20.2	20.3	20.4	20.5	20.6	20.7	20.8	20.9	11
12	21.0	21.1	21.2	21.3	21.4	21.5	21.6	21.7	21.8	21.9	12
13	22.0	22.1	22.2	22.3	22.4	22.5	22.6	22.7	22.8	22.9	13
14	23.0	23.1	23.2	23.3	23.4	23.5	23.6	23.7	23.8	23.9	14
15	24.0	24.1	24.2	24.3	24.4	24.5	24.6	24.7	24.8	24.9	15
16	25.0	25.1	25.2	25.3	25.4	25.5	25.6	25.7	25.8	25.9	16
17	26.0	26.1	26.2	26.3	26.4	26.5	26.6	26.7	26.8	26.9	17
18	27.0	27.1	27.2	27.3	27.4	27.5	27.6	27.7	27.8	27.9	18
19	28.0	28.1	28.2	28.3	28.4	28.5	28.6	28.7	28.8	28.9	19
20	29.0	29.1	29.2	29.3	29.4	29.5	29.6	29.7	29.8	29.9	20
21	30.0	30.1	30.2	30.3	30.4	30.5	30.6	30.7	30.8	30.9	21
22	31.0	31.1	31.2	31.3	31.4	31.5	31.6	31.7	31.8	31.9	22
23	32.0	32.1	32.2	32.3	32.4	32.5	32.6	32.7	32.8	32.9	23
24	33.0	33.1	33.2	33.3	33.4	33.5	33.6	33.7	33.8	33.9	24
25	34.0	34.1	34.2	34.3	34.4	34.5	34.6	34.7	34.8	34.9	25
26	35.0	35.1	35.2	35.3	35.4	35.5	35.6	35.7	35.8	35.9	26
27	36.0	36.1	36.2	36.3	36.4	36.5	36.6	36.7	36.8	36.9	27
28	37.0	37.1	37.2	37.3	37.4	37.5	37.6	37.7	37.8	37.9	28
29	38.0	38.1	38.2	38.3	38.4	38.5	38.6	38.7	38.8	38.9	29
30	39.0	39.1	39.2	39.3	39.4	39.5	39.6	39.7	39.8	39.9	30
31	40.0	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	31
32	41.0	41.1	41.2	41.3	41.4	41.5	41.6	41.7	41.8	41.9	32
33	42.0	42.1	42.2	42.3	42.4	42.5	42.6	42.7	42.8	42.9	33
34	43.0	43.1	43.2	43.3	43.4	43.5	43.6	43.7	43.8	43.9	34
35	44.0	44.1	44.2	44.3	44.4	44.5	44.6	44.7	44.8	44.9	35
36	45.0	45.1	45.2	45.3	45.4	45.5	45.6	45.7	45.8	45.9	36

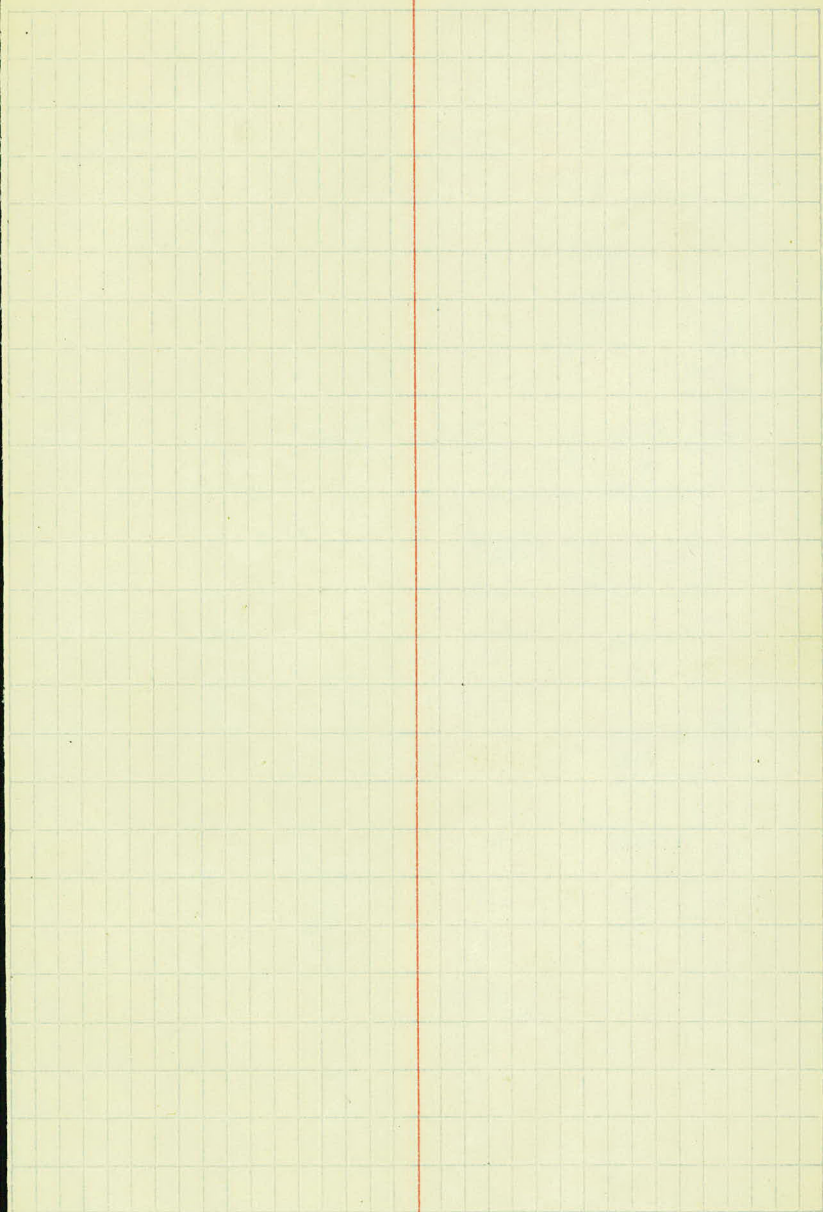
Calculated by Julien A. Hall, M. Am. Soc. C. E.

For Keith's Railroad Curve Tables see end of book.

## Index

- N.C. Line Levels P. 4 - 6
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N.C. Line - Levels

Sta	+	H.I	-	Rod	Elev.
BM.	2.46	222.46 ✓			220.00 ✓
0+00				3.46	219.00 ✓
0+05				3.3	219.2 ✓
0+75				3.2	219.3 ✓
1+00				3.3	219.2 ✓
1+21				3.6	218.9 ✓
2+00				6.5	216.0 ✓
3+00				9.9	212.6 ✓
T.P.	0.32	213.28 ✓	9.50		212.96 ✓
	<u>2.78</u>				
4+00				3.3	210.00 ✓
4+49				3.75	209.53 ✓
+54				3.68	209.6 ✓
+62				3.7	209.6 ✓
5+00				6.5	206.8 ✓
+65.7				10.5	202.8 ✓
+80				12.6	200.7 ✓
+83				10.4	202.9 ✓
6+00				9.9	203.4 ✓
+03				9.8	203.5 ✓
+04				10.7	202.6 ✓
+15				10.0	203.3 ✓
+24				11.2	202.1 ✓
+30				10.2	203.1 ✓
+40				12.6	200.7 ✓
T.P.	5.46	208.01 ✓	10.73		202.55 ✓

220.00  
202.55  
17.45

20.33  
2.78  
17.45

Cherry Tree Mt. Corner Cent Rd & Edgerton St  
End of paving Edgerton Rd. Top of pave

22246  
950  

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21296

Top of south rail N.P. Track  
" " North 1/2 " " "

Sta	+	H.I	-	Rod	Elev
	5.46	208.01 ✓			
7+00				6.4	201.6 ✓
+50				6.4	201.6 ✓
8+00				6.6	201.4 ✓
9+00				7.7	200.3 ✓
+33				7.7	200.3 ✓
10+00				4.8	203.2 ✓
+18				3.2	204.8 ✓
+30				3.9	204.1 ✓
+55				3.1	204.9 ✓
+70				4.2	203.8 ✓
+88				12.5	195.5 ✓
11+00				12.9	195.1 ✓
T.P.	13.33	219.16 ✓	2.18		205.83 ✓
	<u>18.79</u>				
+08				17.0	202.2 ✓
+12				14.1	205.1 ✓
+22				13.3	205.9 ✓
+35				10.8	208.4 ✓
+44				8.2	211.0 ✓
12+00				4.1	215.1 ✓
+24				4.6	217.6 ✓
T.P.	7.55	225.82 ✓	0.89		218.27 ✓
			<u>3.07</u>		
+50				7.4	218.4 ✓
+51				7.7	218.1 ✓
+53				8.4	217.4 ✓
	18.79	218.27			
	<u>3.07</u>	<u>202.55</u>			
	15.72	15.72			



N.C. Line - Levels.

Sta	+	H.I.	-	Rod	Elev.
	7.55	225.82			
12+65				6.6	219.2
13+00				5.9	219.9
+95				5.7	220.1
14+00				6.2	219.6
+10				7.9	217.9
+80				6.6	219.2
B.M.			6.18		219.64

7.55	219.64
<u>6.18</u>	<u>218.27</u>
1.37	1.37

Nail in tele pole R of sta 14+36 (13+45 S.C. Line)

## So. C. Line - Levels

Sta	B.S.	H.I.	F.S.	Rod	Elev
B.M.	4.53	224.53 ✓			220.00 ✓
0+00				5.52	219.01 ✓
0+05				5.4	219.11 ✓
0+75				5.2	219.31 ✓
1+00				5.3	219.2 ✓
2+00				4.6	219.9 ✓
3+00				4.6	219.9 ✓
4+00				4.4	220.1 ✓
5+00				4.3	220.2 ✓
T.P.	3.49	224.41 ✓	3.61		220.92 ✓
6+00	<u>8.02</u>			4.0	220.4 ✓
7+00				4.1	220.3 ✓
8+00				4.5	219.9 ✓
9+00				5.1	219.3 ✓
10+00				7.1	217.3 ✓
+60				8.3	216.1 ✓
11+00				8.4	216.0 ✓
+12				8.47	215.9 ✓
+20 T.P.	8.68	224.77 ✓	8.32		216.09 ✓
+86.7			<u>11.93</u>	7.9	216.9 ✓
12+00				7.8	217.0 ✓
13+00				6.6	218.2 ✓
B.M.				5.11	219.6 ✓
14+00				5.3	219.5 ✓
15+00	11.93	220.00		4.4	220.4 ✓
	<u>8.02</u>	216.09			
	3.91	<u>3.91</u>			

Nail in cherry tree N.E. Cor Cent. Rd. <sup>End paving</sup> Edgerton Rd.

Top of 50. rail N.P. Track  
" " N. " " "

Nail in tele pole R of sta 13+45 <sup>219.64 or</sup> the N.C. line

Sta	+	H.I.	-	Rod	Elev
	8.68	224.77 ✓			
16+00				3.8	221.0 ✓
17+00				3.5	221.3 ✓
18+00				3.1	221.7 ✓
T.P.	6.50	228.18 ✓	3.09		221.68 ✓
19+00				5.7	222.5
20+00				5.3	222.9
21+00				4.9	223.3
22+00				4.4	223.8
23+00				4.2	224.0
24+00				4.1	224.1
25+00				3.9	224.3
T.P.	6.30	230.56 ✓	3.92		224.26
26+00	<u>31.48</u>			5.7	224.9
27+00				5.3	225.3
28+00				5.1	225.8
29+00				4.7	226.9
30+00				4.1	226.5
B.M.				3.28	227.28
31+00				3.6	227.0
32+00				3.4	227.2
T.P.	6.07	233.26 ✓	3.37		227.19 ✓
33+00			<u>10.38</u>	5.8	227.5
34+00				5.7	227.6
35+00				5.1	228.2
	21.48	227.19			
	<u>10.38</u>	216.09			
	11.10	<u>11.10</u>			

Nail in tele pole Ref sta 30+25

Sta	+	H.I	-	Red	Elev.
	6.07	233.26			
36+00				4.2	229.1
37+00				2.6	230.7
38+00				1.1	232.2
39+00				0.3	233.0
T.P.	5.15	237.54	0.67		232.59
+8480.				4.3	233.4
40+00				4.3	233.4
41+00				4.1	233.6
42+00				4.4	233.3
43+00				4.9	232.8
44+00				5.9	231.8
45+00				6.1	231.6
B.M.	4.36	236.29	6.81	6.81	230.93
	<u>15.58</u>				
46+00				4.3	231.0
47+00				4.8	230.5
48+00				4.9	230.4
49+00				4.6	230.7
50+00				5.6	229.7
51+00				5.9	229.4
52+00				5.6	229.7
T.P.	1.35	232.13	4.51		230.78
			<u>11.99</u>		
53+00				2.4	229.7
54+00				3.5	228.6
+21				4.4	227.7

15.58      230.78  
11.99      227.19  
 3.59      3.59

Nail in tele pole R. of sta 45+60

Top of stake 52+00

Sta	+	H.I	-	Rod	Elev,
	1.35	2321.3			
55+00				10.5	221.6
+30				13.1	219.0
T.P.	1.48	220.91	12.70		219.43
+36	<u>2.83</u>			2.0	218.29
+60				6.2	214.7
56+00				7.3	213.6
57+00				8.1	212.8
58+00				8.4	212.5
+65				7.3	213.6
+70				10.5	210.4
+80				7.7	213.2
+90				8.4	212.5
59+00				8.4	212.5
T.P.	9.91	223.26	7.56		213.35
+65			<u>20.26</u>	10.3	213.0
+75				9.4	213.9
+90				7.5	215.8
60+00				8.0	215.3
+46				8.2	215.1
+62				5.3	218.0
+80				5.1	218.2
61+00				5.1	218.2
62+00				4.6	218.7
63+00				4.7	218.6
	<u>20.26</u>	230.78			
	<u>2.83</u>	213.35			
	17.43	17.43			

Ditch-bottom,

Edge of road,

Sta	+ H.I.	-	Rod Elev.
	9.91	223.26	
B.M.			5.00 218.21
64+00			4.6 218.7
65+00			4.5 218.8
T.P.	4.54	223.44	4.36 218.90
+525 B.C.			4.7 218.7
66+00			4.5 218.9
67+00			4.3 219.1
68+00			4.7 218.7
69+00			4.5 218.9
70+00			4.5 218.9
71+00			4.5 218.9
T.P.	5.16	225.24	3.36 220.08
72+00	19.61		5.6 219.6
73+00			5.3 219.9
74+00			4.8 220.4
75+00			4.5 220.7
76+00			4.7 220.5
77+00			5.2 220.0
T.P.	4.28	224.62	4.90 220.34
B.M.	4.63	224.89	12.62 220.26
78+00			5.5 219.4
79+00			5.1 219.8
80+00			4.5 220.4
81+00			3.8 221.1

19.61  
12.62  
 6.99

220.34  
213.35  
 6.99

Nail in tele pole R of sta 63+04

Spike in 10" oak R. of sta 77+75

2/13/23

Sta	+	M.I	-	Rod	Elev.
	4.63	224.89			
82+00				3.0	221.93
T.P.	4.37	227.19	2.07		222.52
83+00				4.8	222.4
84+00				4.9	222.3
85+00				4.9	222.3
86+00				4.5	222.7
86+96.1 B.C.				4.1	223.1
87+00				4.0	223.2
88+00				3.4	223.8
T.P.	4.62	229.14	2.67		224.52
88+42.2 P.I.				5.5	223.6
89+00				5.1	224.0
+87.9 B.C.				4.9	224.2
90+00				4.8	224.3
B.M.			6.03	6.03	223.11
91+00				5.1	224.0
92+00				5.7	223.4
93+00				6.1	223.1 D
B.M.	5.73	228.84			223.17
T.P.	19.35	2.932	6.35	222.19	
94+00			17.12	3.5	221.9
94+80.7 B.C.				4.6	220.8
95+00				4.9	220.5
96+00				6.9	218.5
	19.35	222.49			
	17.12	220.26			
	2.23	223			

M.W. Carley - Level  
W. Steiner - Road

Nail in 10" tree 25' L of Sta 90+45

2/15/23

Sta	+	H.I	-	Rod	Elev
97+00	2.93	225.42			
97+00				8.1	217.3
98+00				8.9	216.76
T.P.	3.48	220.24	8.66		216.76
B.M.	3.84	218.76	5.32	5.32	214.92
99+00				3.1	215.7
99+01.1 B.C.				3.1	215.7
100+00				4.8	214.0
101+00				5.0	213.8
101+20				4.9	213.9
102+00				1.8	217.0
102+43.1 B.C.				0.1	218.7
T.P.	9.92	227.98	0.70	218.06	
103+00				7.3	220.7
104+00				4.4	223.6
104+54 B.C.				3.4	224.6
B.M.				2.98	225.00
105+00				1.7	226.3
T.P.	11.66	238.61	1.03		226.95
106+00	31.83			9.4	229.2
107+00				6.5	232.1
108+00				5.2	233.4
109+00				4.2	234.4
110+00				3.0	235.6
T.P.	6.01	243.90	0.72		237.89
	31.83				
	16.43	237.89		16.43	
	15.40	222.49			
		15.40			

M. W. Corley-Levby<sup>3</sup>  
W. Sterk-Rod

Spike in fence-post 25' L of sta 99+85

Mon on ~~4~~ 104+63.9

2/16/23

Sta	+	H.I.	-	Red	Elev.
	6.01	243.90			
111+00				6.3	237.6
112+00				5.4	238.5
113+00				4.9	239.0
114+00				4.7	239.2
115+00				4.4	239.5
B.M.				3.23	240.67
116+00				4.3	239.6
117+00				3.9	240.0
T.P.	8.43	248.81	3.52		240.38
118+00				8.4	240.4
119+00				7.2	241.6
120+00				5.9	242.9
121+00				4.7	244.1
122+00				3.6	245.2
123+00				3.0	245.8
124+00				3.2	245.6
B.M.	<u>8.63</u>	254.81	2.63		246.18
	23.07				
125+00				7.8	247.0
126+00				7.0	247.8
127+00				5.6	249.2
128+00				4.6	250.2
129+00				2.7	252.1
130+00				1.7	253.1
B.M.	6.63	260.75	<u>0.99</u>		253.82
	23.07	253.82	7.14		
	<u>7.14</u>	237.89			
	15.93	15.93			

M. W. Carley - Level 14  
Wister K-Rod

spike in tele pole L of sta 15+05

spike in tele pole L of sta 124+38

Monument ~~e~~ sta 130+93

2/16/23 ✓

Sta	+	H.I. ✓	-	Rod	Elev
	6.63	250.45			
131+00				6.5	251.0
132+00				6.0	254.5
133+00				5.9	254.6
134+00				5.3	255.2
135+00				4.4	256.1
136+00				3.7	256.8
137+00				3.7	256.8
138+00				3.3	257.2
I.P.	10.07	257.12 ✓	3.40		257.05 ✓
139+00	<u>16.70</u>			8.6	258.5
140+00				7.0	260.1
B.M.				5.80	261.32 ✓
141+00				5.9	261.7
142+00				4.0	263.1
143+00				3.1	264.0
144+00				3.0	264.1
I.P.	7.24	271.86 ✓	<u>215.0</u>		264.62 ✓
145+00			5.90	8.0	263.9
146+00				8.0	263.9
147+00				5.7	266.2
148+00				3.9	268.0
148+60				2.0	269.9
149+00				1.7	270.2
150+00				1.4	270.5
B.M.	16.70	264.62			
	<u>5.90</u>	253.82			
	10.80	<u>10.80</u>			

M. W. Corley 15  
W. Stark

Spike in tele pole L of sta 140+67

2/16/23

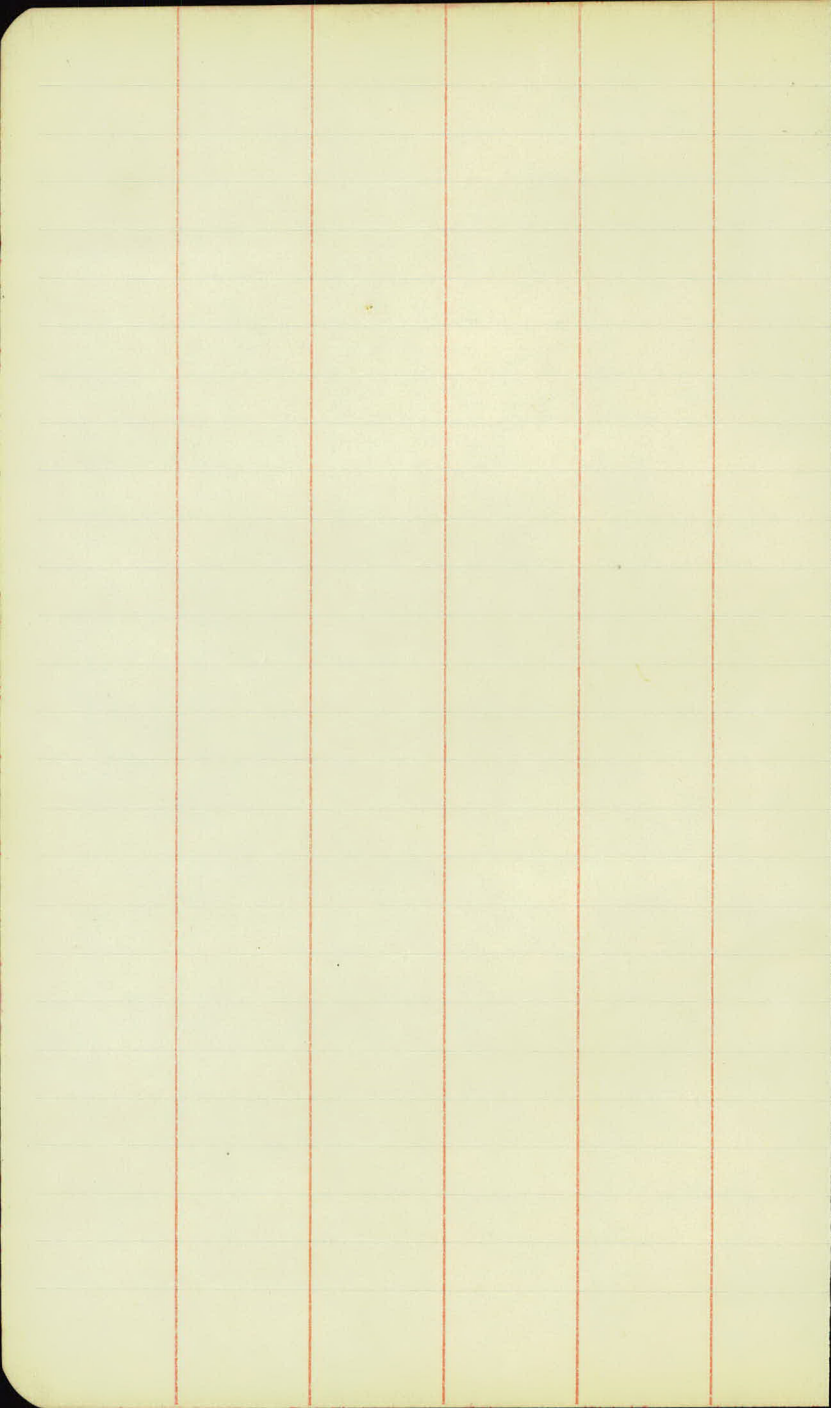
Sta	+	H.I. ✓	-	Rod	Elev
	7.24	271.86			
151+00				15	270.4
B.M.	<u>9.11</u>	276.83 ✓	4.14		267.72
152+00	16.35			6.1	270.7
153+00				5.3	271.3
154+00				5.0	271.8
155+00				6.0	270.8
156+00				8.1	268.7
157+00				9.6	267.2
B.M.			<u>10.05</u>	10.05	266.78
			14.19		
	<u>16.35</u>	266.78			
	14.19	<u>264.62</u>			
	2.16	2.16			
158+00	266.2				
159+00	266.2				
160+00	267.5				
160+133	267.6				

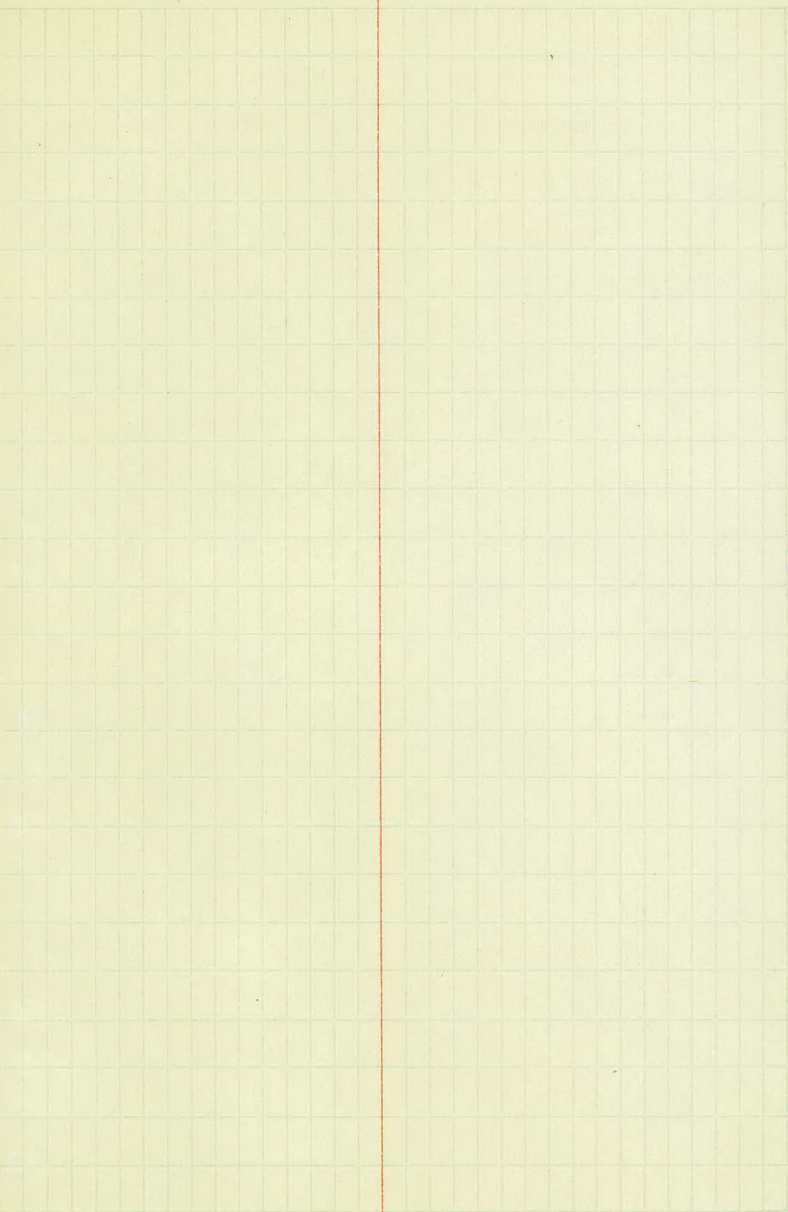
M. W. Carley - Level<sup>61</sup>  
W. S. Terki - Rod.

Top of monument on  $\# 157 + 23.5$

This ties in with El-267.34 RC Levels.

account small diff. & doubt as to orig. datum  
used. check levels will not be run unless  
considered necessary - PRB 2/25/23





N. McC. Line

2/17/23

Sta	+	H.I.	-	Red.	Elev.
B.M.	0.68	210.28	✓		209.60
05+65.7				7.5	202.8
06+00				9.9	200.4
T.P.			✓		
06+80	1.20	198.55	12.93		197.35
06+80				3.6	195.0
07+00				4.4	194.2
08+00				5.5	193.0
09+00				5.8	192.8
09+40				5.8	192.8
T.P.	6.39	199.60	5.34		193.21
09+52				7.5	192.1
09+60				10.1	189.5
10+00				9.5	190.1
11+00				9.8	189.8
11+55				9.4	190.2
12+00				5.5	199.1
T.P.	12.23	211.02	0.81		198.79
13+00				9.0	202.0
13+30				7.4	203.6
14+00				2.0	209.6
T.P.	11.15	221.21	0.96		210.06
14+85	31.65			2.4	218.8
15+00				1.5	219.7
T.P.	7.18	227.91	0.48		220.73
16+00				20.52	221.1
	31.65	220.73			
	20.52	209.60			
	11.13	11.13			

M. W. Carley - Level<sup>65</sup>  
Wister - Rod

Top of rail on R.R. crossing,

Nail in top 30' ~~R~~ of sta 06+47

Top of fence post R of 09+40

Nail in top L of sta 12+30.

2/17/23

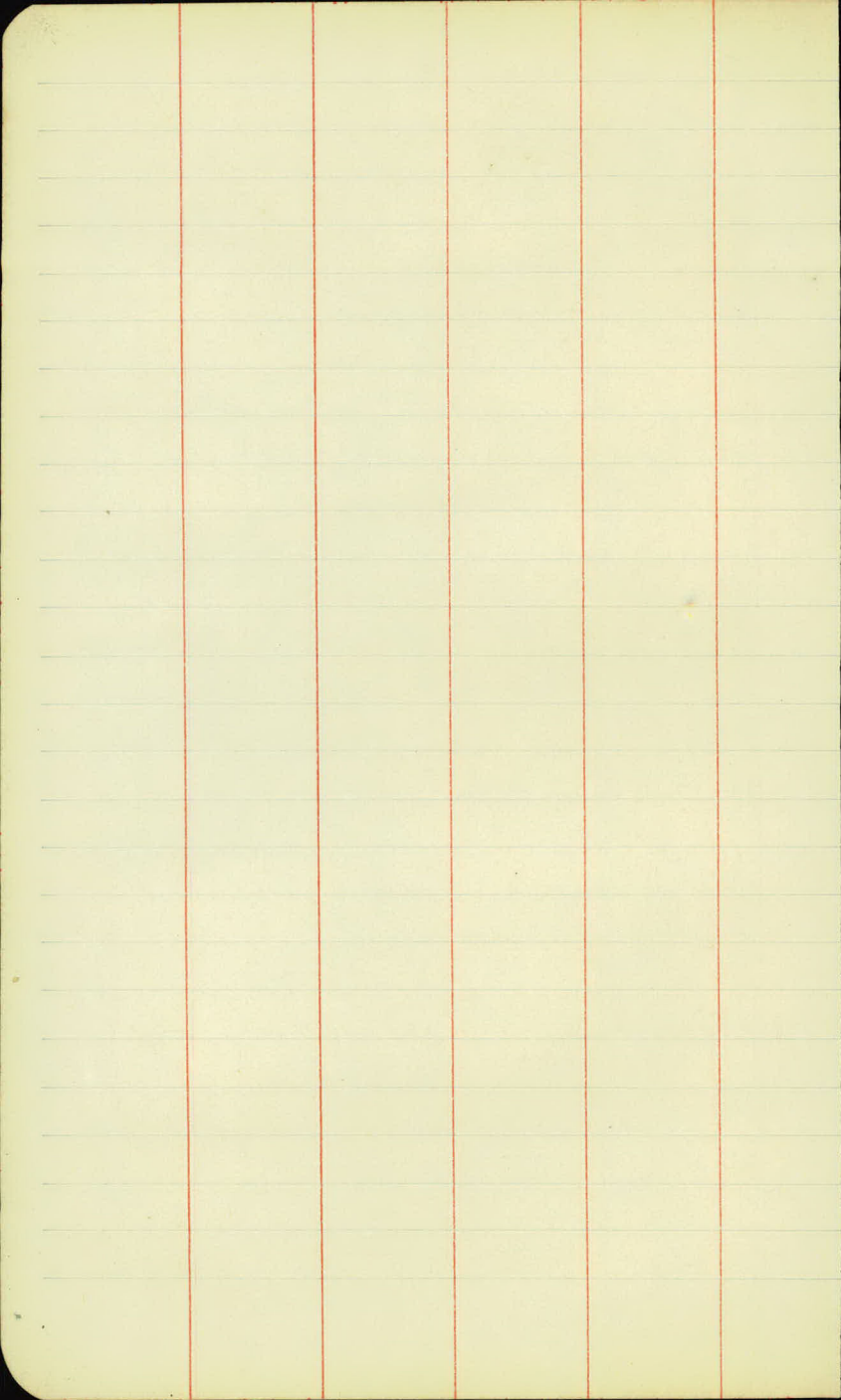
Sta	f	M.I	Rod	Elev
	7.18	227.91		
17+00			5.2	222.7
18+00			5.2	222.7
19+00			5.5	222.4
19+95			5.5	222.4
20+00			6.3	221.6
20+42			6.0	221.9
B.M.			5.58	221.33
B.M.			8.14	219.77

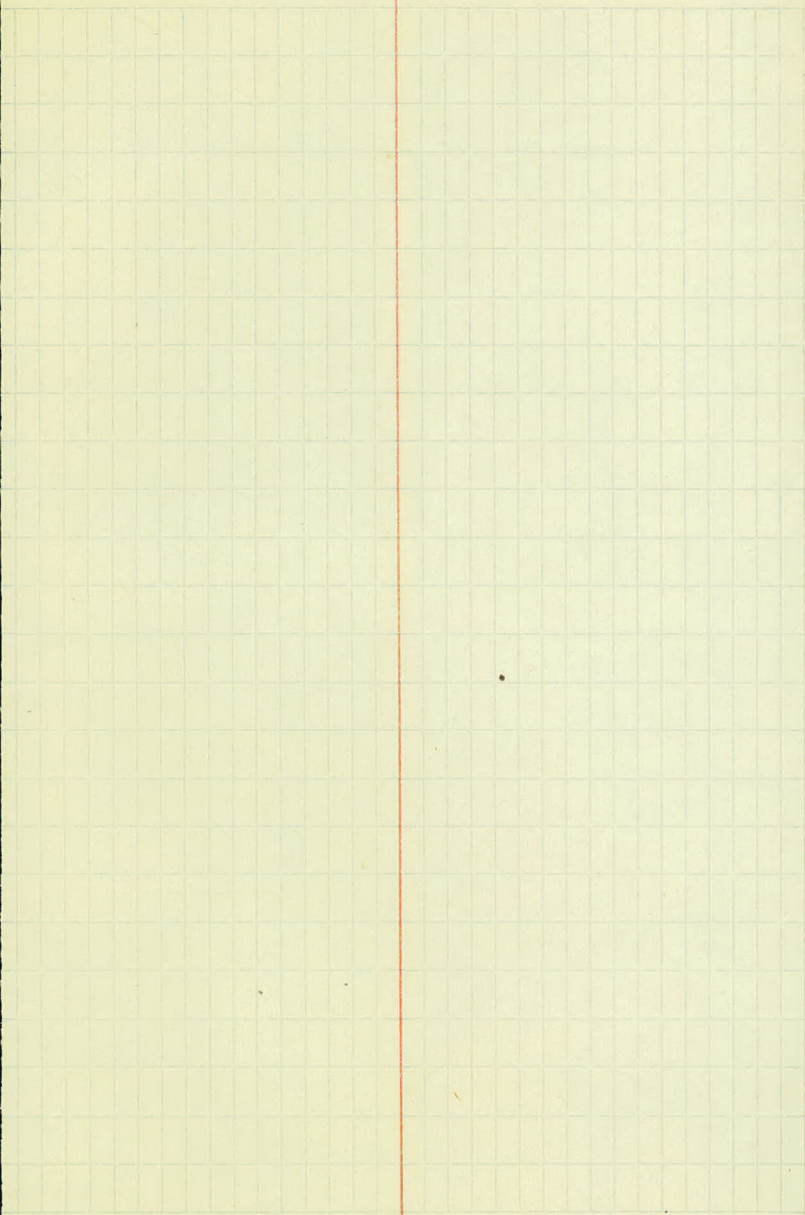
☒ of old road

Spike in tele. pole on R of sta 20+70

1966 Old B.M. Eighth tele pole from int.

Sta 13+45 on S.C.L.

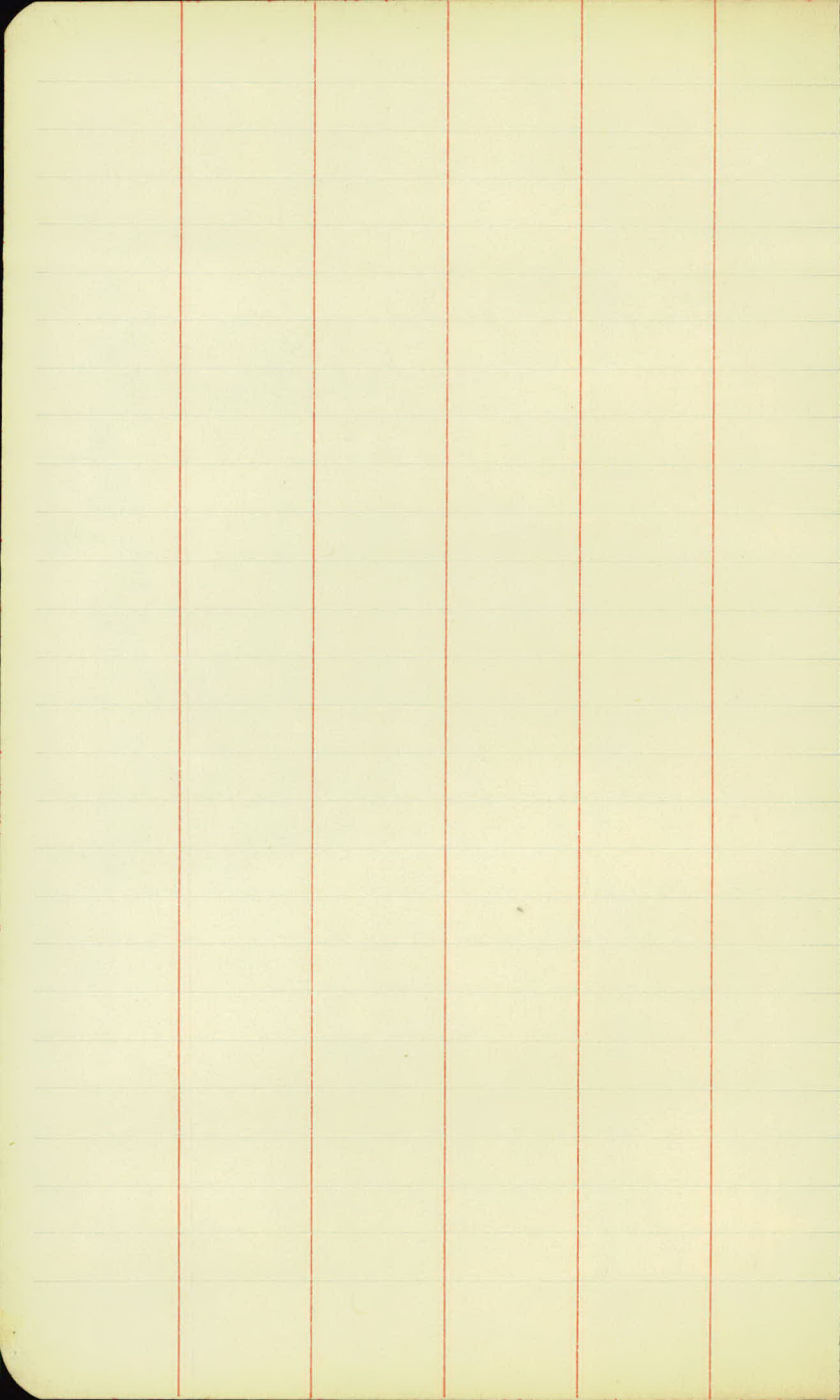




Sta	Present culv.	Recommended Culv.
101+79	38" + 35'	
	Ext 15' R 20' L	

Inv. -3.5 Drains L.





# KEITH'S RAILROAD CURVE TABLES.

Published by KEUFFEL & ESSER CO., New York.

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## HOW TO USE KEITH'S TABLES.

### EXAMPLE.

Wanted a Curve with an Ext. of about 12 ft. Angle  
of Intersection or I. P.= $23^{\circ} 20'$  to the R. at Station  
 $542+72$ .

Ext. in Tab. IV opposite  $23^{\circ} 20'$ =120.87  
 $120.87+12=132.87$ . Say a  $10^{\circ}$  Curve.

Tan. in Tab. IV opp.  $23^{\circ} 20'$ =1183.1  
 $1183.1+10=1183.1$ .

Tab. V. correction for A.  $23^{\circ} 20'$  for a  $10^{\circ}$  Cur.=0.16  
 $1183.1+0.16=1183.26$ =corrected Tangent.

(If corrected Ext. is required find in same way)  
Ang.  $23^{\circ} 20'$ = $23.33^{\circ}+10$ = $2.3333$ =L. C.

$2^{\circ} 19\frac{1}{2}'$ =def. for sta.	542	I. P.=sta.	542+72
$4^{\circ} 49\frac{1}{2}'$ = " " "	+50	Tan.=	1.18.47
$7^{\circ} 19\frac{1}{2}'$ = " " "	543	B. C.=sta.	541+53.53
$9^{\circ} 49\frac{1}{2}'$ = " " "	+50	L. C.=	2.33.33
$11^{\circ} 40'$ = " " "	543+	E. C.=sta.	543+86.86
	86.86		

$100-53.53=46.47 \times 3'$ (def. for 1 ft. of  $10^{\circ}$  Cur.)= $139.41'$ =  
 $2^{\circ} 19\frac{1}{2}'$ =def. for sta. 542.

Def. for 50 ft.= $2^{\circ} 30'$  for a  $10^{\circ}$  Curve.

Def. for 36.86 ft.= $1^{\circ} 50\frac{1}{2}'$  for a  $10^{\circ}$  Curve

(These tables are published in Field Books of  
KEUFFEL & ESSER Co., New York, N. Y.)

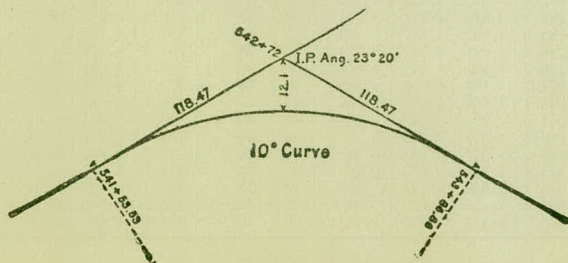


TABLE I. — Minutes in Decimals of a Degree.

<b>1'</b>	.0167	<b>11'</b>	.1833	<b>21'</b>	.3500	<b>31'</b>	.5167	<b>41'</b>	.6833	<b>51'</b>	.8500
<b>2</b>	.0333	<b>12</b>	.2000	<b>22</b>	.3667	<b>32</b>	.5333	<b>42</b>	.7000	<b>52</b>	.8667
<b>3</b>	.0500	<b>13</b>	.2167	<b>23</b>	.3833	<b>33</b>	.5500	<b>43</b>	.7167	<b>53</b>	.8833
<b>4</b>	.0667	<b>14</b>	.2333	<b>24</b>	.4000	<b>34</b>	.5667	<b>44</b>	.7333	<b>54</b>	.9000
<b>5</b>	.0833	<b>15</b>	.2500	<b>25</b>	.4167	<b>35</b>	.5833	<b>45</b>	.7500	<b>55</b>	.9167
<b>6</b>	.1000	<b>16</b>	.2667	<b>26</b>	.4333	<b>36</b>	.6000	<b>46</b>	.7667	<b>56</b>	.9333
<b>7</b>	.1167	<b>17</b>	.2833	<b>27</b>	.4500	<b>37</b>	.6167	<b>47</b>	.7833	<b>57</b>	.9500
<b>8</b>	.1333	<b>18</b>	.3000	<b>28</b>	.4667	<b>38</b>	.6333	<b>48</b>	.8000	<b>58</b>	.9667
<b>9</b>	.1500	<b>19</b>	.3167	<b>29</b>	.4833	<b>39</b>	.6500	<b>49</b>	.8167	<b>59</b>	.9833
<b>10</b>	.1667	<b>20</b>	.3333	<b>30</b>	.5000	<b>40</b>	.6667	<b>50</b>	.8333	<b>60</b>	1.0000

TABLE II. — Inches in Decimals of a Foot.

1-16	3-32	$\frac{1}{8}$	3-16	$\frac{1}{4}$	5-16	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729
1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

TABLE III. — Radii, Ordinates and Deflections.

Deg.	Radius	Mid. Ord.	Tan. Def.	Chd. Def.	Def. for 1 Foot	Deg.	Radius	Mid. Ord.	Tan. Def.	Chd. Def.	Def. for 1 Foot
<b>0° 10'</b>	34377.	.036	.145	.291	0.05'	<b>7°</b>	819.0	1.528	6.105	12.21	2.10
20	17189.	.073	.291	.582	0.10	20'	781.8	1.600	6.395	12.79	2.20
30	11459.	.109	.436	.873	0.15	30	764.5	1.637	6.540	13.08	2.25
40	8594.4	.145	.582	1.164	0.20	40	747.9	1.673	6.685	13.37	2.30
50	6875.5	.182	.727	1.454	0.25	<b>8</b>	716.8	1.746	6.976	13.95	2.40
<b>1</b>	5729.6	.218	.873	1.745	0.30	20	688.2	1.819	7.266	14.53	2.50
10	4911.2	.255	1.018	2.036	0.35	30	674.7	1.855	7.411	14.82	2.55
20	4297.3	.291	1.164	2.327	0.40	40	661.7	1.892	7.556	15.11	2.60
30	3819.8	.327	1.309	2.618	0.45	<b>9</b>	637.3	1.965	7.846	15.69	2.70
40	3437.9	.364	1.454	2.909	0.50	20	614.6	2.037	8.136	16.27	2.80
50	3125.4	.400	1.600	3.200	0.55	30	603.8	2.074	8.281	16.56	2.85
<b>2</b>	2864.9	.436	1.745	3.490	0.60	40	593.4	2.110	8.426	16.85	2.90
10	2644.6	.473	1.891	3.781	0.65	<b>10</b>	573.7	2.183	8.716	17.43	3.00
20	2455.7	.509	2.036	4.072	0.70	30	546.4	2.292	9.150	18.30	3.15
30	2292.0	.545	2.181	4.363	0.75	<b>11</b>	521.7	2.402	9.585	19.18	3.30
40	2148.8	.582	2.327	4.654	0.80	30	499.1	2.511	10.02	20.04	3.45
50	2022.4	.618	2.472	4.945	0.85	<b>12</b>	478.3	2.620	10.45	20.91	3.60
<b>3</b>	1910.1	.655	2.618	5.235	0.90	30	459.3	2.730	10.89	21.77	3.75
10	1809.6	.691	2.763	5.526	0.95	<b>13</b>	441.7	2.839	11.32	22.64	3.90
20	1719.1	.727	2.908	5.817	1.00	30	425.4	2.949	11.75	23.51	4.05
30	1637.3	.764	3.054	6.108	1.05	<b>14</b>	410.3	3.058	12.18	24.37	4.20
40	1562.9	.800	3.199	6.398	1.10	30	396.2	3.168	12.62	25.24	4.35
50	1495.0	.836	3.345	6.689	1.15	<b>15</b>	383.1	3.277	13.05	26.11	4.50
<b>4</b>	1432.7	.873	3.490	6.980	1.20	30	370.8	3.387	13.49	26.97	4.65
10	1375.4	.909	3.635	7.271	1.25	<b>16</b>	359.3	3.496	13.92	27.84	4.80
20	1322.5	.945	3.718	7.561	1.30	30	348.5	3.606	14.35	28.70	4.95
30	1273.6	.982	3.926	7.852	1.35	<b>17</b>	338.3	3.716	14.78	29.56	5.10
40	1228.1	1.018	4.071	8.143	1.40	<b>18</b>	319.6	3.935	15.64	31.29	5.40
50	1185.8	1.055	4.217	8.433	1.45	<b>19</b>	302.9	4.155	16.51	33.01	5.70
<b>5</b>	1146.3	1.091	4.362	8.724	1.50	<b>20</b>	287.9	4.374	17.37	34.73	6.00
10	1109.3	1.127	4.507	9.014	1.55	<b>21</b>	274.4	4.594	18.22	36.44	6.30
20	1074.7	1.164	4.653	9.305	1.60	<b>22</b>	262.0	4.814	19.08	38.16	6.60
30	1042.1	1.200	4.798	9.596	1.65	<b>23</b>	250.8	5.035	19.94	39.87	6.90
40	1011.5	1.237	4.943	9.886	1.70	<b>24</b>	240.5	5.255	20.79	41.58	7.20
50	982.6	1.273	5.088	10.18	1.75	<b>25</b>	231.0	5.476	21.64	43.28	7.50
<b>6</b>	955.4	1.309	5.234	10.47	1.80	<b>26</b>	222.3	5.697	22.50	44.99	7.80
10	929.6	1.346	5.379	10.76	1.85	<b>27</b>	214.2	5.918	23.35	46.69	8.10
20	905.1	1.382	5.524	11.05	1.90	<b>28</b>	206.7	6.139	24.19	48.38	8.40
30	881.9	1.418	5.669	11.34	1.95	<b>29</b>	199.7	6.360	25.04	50.07	8.70
40	859.9	1.455	5.814	11.63	2.00	<b>30</b>	193.2	6.583	25.88	51.76	9.00

TABLE IV. — Tangents and External to a 1° Curve.

Angle	Tangent	External	Angle	Tangent	External	Angle	Tangent	External
<b>1°</b>	50.00	.22	<b>11°</b>	551.70	26.50	<b>21°</b>	1061.9	97.57
10'	58.34	.30	10'	560.11	27.31	10'	1070.6	99.16
20	66.67	.39	20	568.53	28.14	20	1079.2	100.75
30	75.01	.49	30	576.95	28.97	30	1087.8	102.35
40	83.34	.61	40	585.36	29.82	40	1096.4	103.97
50	91.68	.73	50	593.79	30.68	50	1105.1	105.60
<b>2</b>	100.01	.87	<b>12°</b>	602.21	31.56	<b>22°</b>	1113.7	107.24
10	108.35	1.02	10	610.64	32.45	10	1122.4	108.90
20	116.68	1.19	20	619.07	33.35	20	1131.0	110.57
30	125.02	1.36	30	627.50	34.26	30	1139.7	112.25
40	133.36	1.55	40	635.93	35.18	40	1148.4	113.95
50	141.70	1.75	50	644.37	36.12	50	1157.0	115.66
<b>3</b>	150.04	1.96	<b>13°</b>	652.81	37.07	<b>23°</b>	1165.7	117.38
10	158.38	2.19	10	661.25	38.03	10	1174.4	119.12
20	166.72	2.43	20	669.70	39.01	20	1183.1	120.87
30	175.06	2.67	30	678.15	39.99	30	1191.8	122.63
40	183.40	2.93	40	686.60	40.99	40	1200.5	124.41
50	191.74	3.21	50	695.06	42.00	50	1209.2	126.20
<b>4</b>	200.08	3.49	<b>14°</b>	703.51	43.03	<b>24°</b>	1217.9	128.00
10	208.43	3.79	10	711.97	44.07	10	1226.6	129.82
20	216.77	4.10	20	720.44	45.12	20	1235.3	131.65
30	225.12	4.42	30	728.90	46.18	30	1244.0	133.50
40	233.47	4.76	40	737.37	47.25	40	1252.8	135.35
50	241.81	5.10	50	745.85	48.34	50	1261.5	137.23
<b>5</b>	250.16	5.46	<b>15°</b>	754.32	49.44	<b>25°</b>	1270.2	139.11
10	258.51	5.83	10	762.80	50.55	10	1279.0	141.01
20	266.86	6.21	20	771.29	51.68	20	1287.7	142.93
30	275.21	6.61	30	779.77	52.89	30	1296.5	144.85
40	283.57	7.01	40	788.26	53.97	40	1305.3	146.79
50	291.92	7.43	50	796.75	55.13	50	1314.0	148.75
<b>6</b>	300.28	7.86	<b>16°</b>	805.25	56.31	<b>26°</b>	1322.8	150.71
10	308.64	8.31	10	813.75	57.50	10	1331.6	152.69
20	316.99	8.76	20	822.25	58.70	20	1340.4	154.69
30	325.35	9.23	30	830.76	59.91	30	1349.2	156.70
40	333.71	9.71	40	839.27	61.14	40	1358.0	158.72
50	342.08	10.20	50	847.78	62.38	50	1366.8	160.76
<b>7</b>	350.44	10.71	<b>17°</b>	856.30	63.63	<b>27°</b>	1375.6	162.81
10	358.81	11.22	10	864.82	64.90	10	1384.4	164.86
20	367.17	11.75	20	873.35	66.18	20	1393.2	166.95
30	375.54	12.29	30	881.88	67.47	30	1402.0	169.04
40	383.91	12.85	40	890.41	68.77	40	1410.9	171.15
50	392.28	13.41	50	898.95	70.09	50	1419.7	173.27
<b>8</b>	400.66	13.99	<b>18°</b>	907.49	71.42	<b>28°</b>	1428.6	175.41
10	409.03	14.58	10	916.03	72.76	10	1437.4	177.55
20	417.41	15.18	20	924.58	74.12	20	1446.3	179.72
30	425.79	15.80	30	933.13	75.49	30	1455.1	181.89
40	434.17	16.43	40	941.69	76.86	40	1464.0	184.08
50	442.55	17.07	50	950.25	78.26	50	1472.9	186.29
<b>9</b>	450.93	17.72	<b>19°</b>	958.81	79.67	<b>29°</b>	1481.8	188.51
10	459.32	18.38	10	967.38	81.09	10	1490.7	190.74
20	467.71	19.06	20	975.96	82.53	20	1499.6	192.99
30	476.10	19.75	30	984.53	83.97	30	1508.5	195.25
40	484.49	20.45	40	993.12	85.43	40	1517.4	197.53
50	492.88	21.16	50	1001.7	86.90	50	1526.3	199.82
<b>10</b>	501.28	21.89	<b>20°</b>	1010.3	88.39	<b>30°</b>	1535.3	202.12
10	509.68	22.62	10	1018.9	89.89	10	1544.2	204.44
20	518.08	23.38	20	1027.5	91.40	20	1553.1	206.77
30	526.48	24.14	30	1036.1	92.92	30	1562.1	209.12
40	534.89	24.91	40	1044.7	94.46	40	1571.0	211.48
50	543.29	25.70	50	1053.3	96.01	50	1580.0	213.86

## IV

TABLE IV. — Tangents and Externals to a 1° Curve.

Angle	Tangent	External	Angle	Tangent	External	Angle	Tangent	External
<b>31°</b>	1589.0	216.3	<b>41°</b>	2142.2	387.4	<b>51°</b>	2732.9	618.4
10'	1598.0	218.7	10'	2151.7	390.7	10'	2743.1	622.8
20	1606.9	221.1	20	2161.2	394.1	20	2753.4	627.5
30	1615.9	223.5	30	2170.8	397.4	30	2763.7	631.7
40	1624.9	226.0	40	2180.3	400.8	40	2773.9	636.2
50	1633.9	228.4	50	2189.9	404.2	50	2784.2	640.7
<b>32</b>	1643.0	230.9	<b>42</b>	2199.4	407.6	<b>52</b>	2794.5	645.2
10	1652.0	233.4	10	2209.0	411.1	10	2804.9	649.7
20	1661.0	235.9	20	2218.6	414.5	20	2815.2	654.3
30	1670.0	238.4	30	2228.1	418.0	30	2825.6	658.8
40	1679.1	241.0	40	2237.7	421.4	40	2835.9	663.4
50	1688.1	243.5	50	2247.3	425.0	50	2846.3	668.0
<b>33</b>	1697.2	246.1	<b>43</b>	2257.0	428.5	<b>53</b>	2856.7	672.7
10	1706.3	248.7	10	2266.6	432.0	10	2867.1	677.3
20	1715.3	251.3	20	2276.2	435.6	20	2877.5	682.0
30	1724.4	253.9	30	2285.9	439.2	30	2888.0	686.7
40	1733.5	256.5	40	2295.6	442.8	40	2898.4	691.4
50	1742.6	259.1	50	2305.2	446.4	50	2908.9	696.1
<b>34</b>	1751.7	261.8	<b>44</b>	2314.9	450.0	<b>54</b>	2919.4	700.9
10	1760.8	264.5	10	2324.6	453.6	10	2929.9	705.7
20	1770.0	267.2	20	2334.3	457.3	20	2940.4	710.5
30	1779.1	269.9	30	2344.1	461.0	30	2951.0	715.3
40	1788.2	272.6	40	2353.8	464.6	40	2961.5	720.1
50	1797.4	275.3	50	2363.5	468.4	50	2972.1	725.0
<b>35</b>	1806.6	278.1	<b>45</b>	2373.3	472.1	<b>55</b>	2982.7	729.9
10	1815.7	280.8	10	2383.1	475.8	10	2993.3	734.8
20	1824.9	283.6	20	2392.8	479.6	20	3003.9	739.7
30	1834.1	286.4	30	2402.6	483.8	30	3014.5	744.6
40	1843.3	289.2	40	2412.4	487.2	40	3025.2	749.6
50	1852.5	292.0	50	2422.3	491.0	50	3035.8	754.6
<b>36</b>	1861.7	294.9	<b>46</b>	2432.1	494.8	<b>56</b>	3046.5	759.6
10	1870.9	297.7	10	2441.9	498.7	10	3057.2	764.6
20	1880.1	300.6	20	2451.8	502.5	20	3067.9	769.7
30	1889.4	303.5	30	2461.7	506.4	30	3078.7	774.7
40	1898.6	306.4	40	2471.5	510.3	40	3089.4	779.8
50	1907.9	309.3	50	2481.4	514.3	50	3100.2	784.9
<b>37</b>	1917.1	312.2	<b>47</b>	2491.3	518.2	<b>57</b>	3110.9	790.1
10	1926.4	315.2	10	2501.2	522.2	10	3121.7	795.2
20	1935.7	318.1	20	2511.2	526.1	20	3132.6	800.4
30	1945.0	321.1	30	2521.1	530.1	30	3143.4	805.6
40	1954.3	324.1	40	2531.1	534.2	40	3154.2	810.9
50	1963.6	327.1	50	2541.0	538.2	50	3165.1	816.1
<b>38</b>	1972.9	330.2	<b>48</b>	2551.0	542.2	<b>58</b>	3176.0	821.4
10	1982.2	333.2	10	2561.0	546.3	10	3186.9	826.7
20	1991.5	336.3	20	2571.0	550.4	20	3197.8	832.0
30	2000.9	339.3	30	2581.0	554.5	30	3208.8	837.3
40	2010.2	342.4	40	2591.0	558.6	40	3219.7	842.7
50	2019.6	345.5	50	2601.1	562.8	50	3230.7	848.1
<b>39</b>	2029.0	348.6	<b>49</b>	2611.2	566.9	<b>59</b>	3241.7	853.5
10	2038.4	351.8	10	2621.2	571.1	10	3252.7	858.9
20	2047.8	354.9	20	2631.3	575.3	20	3263.7	864.3
30	2057.2	358.1	30	2641.4	579.5	30	3274.8	869.8
40	2066.6	361.3	40	2651.5	583.8	40	3285.8	875.3
50	2076.0	364.5	50	2661.6	588.0	50	3296.9	880.8
<b>40</b>	2085.4	367.7	<b>50</b>	2671.8	592.3	<b>60</b>	3308.0	886.4
10	2094.9	371.0	10	2681.9	596.6	10	3319.1	892.0
20	2104.3	374.2	20	2692.1	600.9	20	3330.3	897.5
30	2113.8	377.5	30	2702.3	605.3	30	3341.4	903.2
40	2123.3	380.8	40	2712.5	609.6	40	3352.6	908.8
50	2132.7	384.1	50	2722.7	614.0	50	3363.8	914.5

TABLE IV. — Tangents and Externals to a 1° Curve.

Angle	Tangent	External	Angle	Tangent	External	Angle	Tangent	External
<b>61°</b>	3375.0	920.2	<b>71°</b>	4086.9	1308.2	<b>81°</b>	4893.6	1805.3
10'	3386.3	925.9	10'	4099.5	1315.6	10'	4908.0	1814.7
20	3397.5	931.6	20	4112.1	1322.9	20	4922.5	1824.1
30	3408.8	937.3	30	4124.8	1330.3	30	4937.0	1833.6
40	3420.1	943.1	40	4137.4	1337.7	40	4951.5	1843.1
50	3431.4	948.9	50	4150.1	1345.1	50	4966.1	1852.6
<b>62</b>	3442.7	954.8	<b>72</b>	4162.8	1352.6	<b>82</b>	4980.7	1862.2
10	3454.1	960.6	10	4175.6	1360.1	10	4995.4	1871.8
20	3465.4	966.5	20	4188.5	1367.6	20	5010.0	1881.5
30	3476.8	972.4	30	4201.2	1375.2	30	5024.8	1891.2
40	3488.3	978.3	40	4214.0	1382.8	40	5039.5	1900.9
50	3499.7	984.3	50	4226.8	1390.4	50	5054.3	1910.7
<b>63</b>	3511.1	990.2	<b>73</b>	4239.7	1398.0	<b>83</b>	5069.2	1920.5
10	3522.6	996.2	10	4252.6	1405.7	10	5084.0	1930.4
20	3534.1	1002.3	20	4265.6	1413.5	20	5099.0	1940.3
30	3545.6	1008.3	30	4278.5	1421.2	30	5113.9	1950.3
40	3557.2	1014.4	40	4291.5	1429.0	40	5128.9	1960.2
50	3568.7	1020.5	50	4304.6	1436.8	50	5143.9	1970.3
<b>64</b>	3580.3	1026.6	<b>74</b>	4317.6	1444.6	<b>84</b>	5159.0	1980.4
10	3591.9	1032.8	10	4330.7	1452.5	10	5174.1	1990.5
20	3603.5	1039.0	20	4343.8	1460.4	20	5189.3	2000.6
30	3615.1	1045.2	30	4356.9	1468.4	30	5204.4	2010.8
40	3626.8	1051.4	40	4370.1	1476.4	40	5219.7	2021.1
50	3638.5	1057.7	50	4383.3	1484.4	50	5234.9	2031.4
<b>65</b>	3650.2	1063.9	<b>75</b>	4396.5	1492.4	<b>85</b>	5250.3	2041.7
10	3661.9	1070.2	10	4409.8	1500.5	10	5265.6	2052.1
20	3673.7	1076.6	20	4423.1	1508.6	20	5281.0	2062.5
30	3685.4	1082.9	30	4436.4	1516.7	30	5296.4	2073.0
40	3697.2	1089.3	40	4449.7	1524.9	40	5311.9	2083.5
50	3709.0	1095.7	50	4463.1	1533.1	50	5327.4	2094.1
<b>66</b>	3720.9	1102.2	<b>76</b>	4476.5	1541.4	<b>86</b>	5343.0	2104.7
10	3732.7	1108.6	10	4489.9	1549.7	10	5358.6	2115.3
20	3744.6	1115.1	20	4503.4	1558.0	20	5374.2	2126.0
30	3756.5	1121.7	30	4516.9	1566.3	30	5389.9	2136.7
40	3768.5	1128.2	40	4530.4	1574.7	40	5405.6	2147.5
50	3780.4	1134.8	50	4544.0	1583.1	50	5421.4	2158.4
<b>67</b>	3792.4	1141.4	<b>77</b>	4557.6	1591.6	<b>87</b>	5437.2	2169.2
10	3804.4	1148.0	10	4571.2	1600.1	10	5453.1	2180.2
20	3816.4	1154.7	20	4584.8	1608.6	20	5469.0	2191.1
30	3828.4	1161.3	30	4598.5	1617.1	30	5484.9	2202.2
40	3840.5	1168.1	40	4612.2	1625.7	40	5500.9	2213.2
50	3852.6	1174.8	50	4626.0	1634.4	50	5517.0	2224.3
<b>68</b>	3864.7	1181.6	<b>78</b>	4639.8	1643.0	<b>88</b>	5533.1	2235.5
10	3876.8	1188.4	10	4653.6	1651.7	10	5549.2	2246.7
20	3889.0	1195.2	20	4667.4	1660.5	20	5565.4	2258.0
30	3901.2	1202.0	30	4681.3	1669.2	30	5581.6	2269.3
40	3913.4	1208.9	40	4695.2	1678.1	40	5597.8	2280.6
50	3925.6	1215.8	50	4709.2	1686.9	50	5614.2	2292.0
<b>69</b>	3937.9	1222.7	<b>79</b>	4723.2	1695.8	<b>89</b>	5630.5	2303.5
10	3950.2	1229.7	10	4737.2	1704.7	10	5646.9	2315.0
20	3962.5	1236.7	20	4751.2	1713.7	20	5663.4	2326.6
30	3974.8	1243.7	30	4765.3	1722.7	30	5679.9	2338.2
40	3987.2	1250.8	40	4779.4	1731.7	40	5696.4	2349.8
50	3999.5	1257.9	50	4793.6	1740.8	50	5713.0	2361.5
<b>70</b>	4011.9	1265.0	<b>80</b>	4807.7	1749.9	<b>90</b>	5729.7	2373.3
10	4024.4	1272.1	10	4822.0	1759.0	10	5746.3	2385.1
20	4036.8	1279.3	20	4836.2	1768.2	20	5763.1	2397.0
30	4049.3	1286.5	30	4850.5	1777.4	30	5779.9	2408.9
40	4061.8	1293.6	40	4864.8	1786.7	40	5796.7	2420.9
50	4074.4	1300.9	50	4879.2	1796.0	50	5813.6	2432.9

TABLE IV. — Tangents and Externals to a 1° Curve.

Angle	Tangent	External	Angle	Tangent	External	Angle	Tangent	External
<b>91°</b>	5830.5	2444.9	<b>101°</b>	6950.6	3278.1	<b>111°</b>	8336.7	4386.1
10'	5847.5	2457.1	10'	6971.3	3294.1	10'	8362.7	4407.6
20	5864.6	2469.3	20	6992.0	3310.1	20	8388.9	4429.2
30	5881.7	2481.5	30	7012.7	3326.1	30	8415.1	4450.9
40	5898.8	2493.8	40	7033.6	3342.3	40	8441.5	4472.7
50	5916.0	2506.1	50	7054.5	3358.5	50	8468.0	4494.6
<b>92</b>	5933.2	2518.5	<b>102</b>	7075.5	3374.9	<b>112</b>	8494.6	4516.6
10	5950.5	2531.0	10	7096.6	3391.2	10	8521.3	4538.8
20	5967.9	2543.5	20	7117.8	3407.7	20	8548.1	4561.1
30	5985.3	2556.0	30	7139.0	3424.3	30	8575.0	4583.4
40	6002.7	2568.6	40	7160.3	3440.9	40	8602.1	4606.0
50	6020.2	2581.3	50	7181.7	3457.6	50	8629.3	4628.6
<b>93</b>	6037.8	2594.0	<b>103</b>	7203.2	3474.4	<b>113</b>	8656.6	4651.3
10	6055.4	2606.8	10	7224.7	3491.3	10	8684.0	4674.2
20	6073.1	2619.7	20	7246.3	3508.2	20	8711.5	4697.2
30	6090.8	2632.6	30	7268.0	3525.2	30	8739.2	4720.3
40	6108.6	2645.5	40	7289.8	3542.4	40	8767.0	4743.6
50	6126.4	2658.5	50	7311.7	3559.6	50	8794.9	4766.9
<b>94</b>	6144.3	2671.6	<b>104</b>	7333.6	3576.8	<b>114</b>	8822.9	4790.4
10	6162.6	2684.7	10	7355.6	3594.2	10	8851.0	4814.1
20	6180.2	2697.9	20	7377.8	3611.7	20	8879.3	4837.8
30	6198.3	2711.2	30	7399.9	3629.2	30	8907.7	4861.7
40	6216.4	2724.5	40	7422.2	3646.8	40	8936.3	4885.7
50	6234.6	2737.9	50	7444.6	3664.5	50	8965.0	4909.9
<b>95</b>	6252.8	2751.3	<b>105</b>	7467.0	3682.3	<b>115</b>	8992.8	4934.1
10	6271.1	2764.8	10	7489.6	3700.2	10	9022.7	4958.6
20	6289.4	2778.3	20	7512.2	3718.2	20	9051.7	4983.1
30	6307.9	2792.0	30	7534.9	3736.2	30	9080.9	5007.8
40	6326.3	2805.6	40	7557.7	3754.4	40	9110.3	5032.6
50	6344.8	2819.4	50	7580.5	3772.6	50	9139.8	5057.6
<b>96</b>	6363.4	2833.2	<b>106</b>	7603.5	3791.0	<b>116</b>	9169.4	5082.7
10	6382.1	2847.0	10	7626.6	3809.4	10	9199.1	5107.9
20	6400.8	2861.0	20	7649.7	3827.9	20	9229.0	5133.3
30	6419.5	2875.0	30	7672.9	3846.5	30	9259.0	5158.8
40	6438.4	2889.0	40	7696.3	3865.2	40	9289.2	5184.5
50	6457.3	2903.1	50	7719.7	3884.0	50	9319.5	5210.3
<b>97</b>	6476.2	2917.3	<b>107</b>	7743.2	3902.9	<b>117</b>	9349.9	5236.2
10	6495.2	2931.6	10	7766.8	3921.9	10	9380.5	5262.3
20	6514.3	2945.9	20	7790.5	3940.9	20	9411.3	5288.6
30	6533.4	2960.3	30	7814.3	3960.1	30	9442.2	5315.0
40	6552.6	2974.7	40	7838.1	3979.4	40	9473.2	5341.5
50	6571.9	2989.2	50	7862.1	3998.7	50	9504.4	5368.2
<b>98</b>	6591.2	3003.8	<b>108</b>	7886.2	4018.2	<b>118</b>	9535.7	5395.1
10	6610.6	3018.4	10	7910.4	4037.8	10	9567.2	5422.1
20	6630.1	3033.1	20	7934.6	4057.4	20	9598.9	5449.2
30	6649.6	3047.9	30	7959.0	4077.2	30	9630.7	5476.5
40	6669.2	3062.8	40	7983.5	4097.1	40	9662.6	5504.0
50	6688.8	3077.7	50	8008.0	4117.0	50	9694.7	5531.7
<b>99</b>	6708.6	3092.7	<b>109</b>	8032.7	4137.1	<b>119</b>	9727.0	5559.4
10	6728.4	3107.7	10	8057.4	4157.3	10	9759.4	5587.4
20	6748.2	3122.9	20	8082.3	4177.5	20	9792.0	5615.5
30	6768.1	3138.1	30	8107.3	4197.9	30	9824.8	5643.8
40	6788.1	3153.3	40	8132.3	4218.4	40	9857.7	5672.3
50	6808.2	3168.7	50	8157.5	4239.0	50	9890.8	5700.9
<b>100</b>	6828.3	3184.1	<b>110</b>	8182.8	4259.7	<b>120</b>	9924.0	5729.7
10	6848.5	3199.6	10	8208.2	4280.5	10	9957.5	5758.6
20	6868.8	3215.1	20	8233.7	4301.4	20	9991.0	5787.7
30	6889.2	3230.8	30	8259.3	4322.4	30	10025.0	5817.0
40	6909.6	3246.5	40	8285.0	4343.6	40	10059.0	5846.5
50	6930.1	3262.3	50	8310.8	4364.8	50	10093.0	5876.1

Table V. Corrections for use with table IV,

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		For Tangents Add													
ANGLE	CURVE	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
10°		.03	.06	.09	.13	.16	.19	.22	.25	.28	.31	.34	.38	.42	.46
15°		.04	.10	.14	.19	.24	.29	.34	.39	.45	.51	.53	.58	.63	.68
20°		.06	.13	.19	.26	.32	.39	.45	.51	.58	.65	.72	.79	.84	.90
25°		.08	.16	.24	.33	.40	.49	.58	.67	.75	.83	.90	.99	1.06	1.14
30°		.10	.19	.29	.39	.49	.59	.69	.79	.89	.99	1.09	1.20	1.29	1.39
35°		.11	.22	.34	.47	.58	.69	.70	.81	.92	1.04	1.29	1.42	1.54	1.66
40°		.13	.26	.40	.53	.67	.80	.93	1.06	1.20	1.34	1.49	1.64	1.79	1.94
45°		.15	.30	.44	.60	.76	.91	1.06	1.21	1.37	1.52	1.70	1.87	2.04	2.21
50°		.17	.34	.51	.68	.85	1.02	1.19	1.36	1.54	1.72	1.91	2.10	2.29	2.48
55°		.19	.38	.57	.76	.95	1.14	1.32	1.52	1.72	1.92	2.14	2.35	2.56	2.77
60°		.21	.42	.63	.84	1.05	1.27	1.49	1.71	1.94	2.17	2.38	2.60	2.83	3.07
65°		.23	.46	.69	.93	1.16	1.40	1.64	1.88	2.13	2.38	2.63	2.88	3.13	3.39
70°		.25	.51	.76	1.02	1.28	1.54	1.80	2.06	2.33	2.60	2.88	3.16	3.44	3.72
75°		.27	.56	.83	1.12	1.40	1.69	1.98	2.27	2.57	2.87	3.16	3.47	3.78	4.09
80°		.30	.61	.91	1.22	1.53	1.84	2.15	2.46	2.78	3.10	3.44	3.78	4.12	4.46
85°		.33	.66	1.00	1.33	1.68	2.02	2.36	2.70	3.05	3.40	3.77	4.14	4.55	4.89
90°		.36	.72	1.09	1.45	1.83	2.20	2.57	2.94	3.32	3.70	4.10	4.50	4.91	5.32
95°		.39	.79	1.19	1.55	2.00	2.40	2.80	3.20	3.61	4.02	4.40	4.98	5.38	5.83
100°		.43	.86	1.30	1.74	2.18	2.62	3.06	3.50	3.95	4.40	4.88	5.37	5.85	6.34

## For Externals Add

ANGLE	CURVE	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
10°		.001	.003	.004	.006	.007	.008	.009	.011	.012	.014	.015	.017	.018	.020
15°		.003	.007	.010	.014	.018	.023	.027	.029	.032	.035	.039	.043	.047	.051
20°		.006	.011	.017	.022	.028	.034	.038	.045	.051	.057	.063	.070	.076	.083
25°		.009	.018	.027	.036	.046	.056	.065	.074	.083	.093	.106	.120	.127	.135
30°		.013	.025	.038	.051	.065	.078	.090	.103	.116	.129	.149	.170	.179	.188
35°		.018	.035	.054	.072	.086	.109	.131	.153	.175	.197	.213	.230	.247	.264
40°		.023	.045	.070	.093	.117	.141	.172	.203	.234	.265	.277	.290	.315	.341
45°		.030	.060	.093	.119	.153	.184	.216	.254	.289	.325	.351	.378	.411	.445
50°		.037	.075	.116	.151	.189	.227	.266	.305	.345	.384	.425	.467	.508	.550
55°		.046	.093	.142	.188	.236	.283	.332	.381	.420	.479	.530	.582	.641	.700
60°		.056	.112	.168	.225	.283	.340	.398	.457	.516	.575	.636	.697	.774	.851
65°		.067	.135	.204	.273	.343	.412	.483	.554	.625	.697	.771	.845	.922	1.01
70°		.080	.159	.240	.321	.403	.485	.568	.652	.735	.819	.906	.994	1.08	1.17
75°		.095	.182	.266	.353	.440	.528	.617	.707	.797	.897	1.07	1.18	1.29	1.39
80°		.110	.220	.332	.445	.558	.671	.787	.903	1.02	1.13	1.25	1.38	1.50	1.62
85°		.128	.259	.391	.524	.657	.790	.926	1.06	1.20	1.34	1.47	1.62	1.76	1.91
90°		.149	.299	.450	.603	.756	.910	1.07	1.22	1.38	1.54	1.70	1.87	2.03	2.20
95°		.174	.350	.522	.706	.885	1.06	1.25	1.43	1.62	1.80	1.99	2.18	2.38	2.58
100°		.200	.401	.604	.809	1.01	1.22	1.43	1.64	1.85	2.06	2.28	2.50	2.73	2.96

Table VI. Deflections for Sub Chords for Short Radius Curves.

Degree of Curve	Radius 50 sin. def. ang.	$\frac{1}{2}$ sub chord R = sin of def. angle				Length of arc for 100 ft.
		12.5 Ft.	15 Ft.	20 Ft.	25 Ft.	
30°	193.18	1° 51'	2° 17'	2° 58'	3° 43'	101.15
32°	181.39	1° 59'	2° 25'	3° 10'	3° 58'	101.33
34°	171.01	2° 06'	2° 33'	3° 21'	4° 12'	101.48
36°	161.80	2° 13'	2° 41'	3° 33'	4° 26'	101.66
38°	153.58	2° 20'	2° 49'	3° 44'	4° 40'	101.85
40°	146.19	2° 27'	2° 57'	3° 55'	4° 54'	102.06
42°	139.52	2° 34'	3° 05'	4° 07'	5° 08'	102.29
44°	133.47	2° 41'	3° 13'	4° 18'	5° 22'	102.53
46°	127.97	2° 48'	3° 21'	4° 29'	5° 36'	102.76
48°	122.92	2° 55'	3° 29'	4° 40'	5° 50'	103.00
50°	118.31	3° 02'	3° 38'	4° 51'	6° 04'	103.24
52°	114.06	3° 09'	3° 46'	5° 02'	6° 17'	103.54
54°	110.11	3° 16'	3° 54'	5° 13'	6° 31'	103.84
56°	106.50	3° 22'	4° 02'	5° 23'	6° 44'	104.14
58°	103.14	3° 29'	4° 10'	5° 34'	6° 57'	104.43
60°	100.00	3° 35'	4° 18'	5° 44'	7° 11'	104.72

## CURVE FORMULAS.

$$T = R \tan \frac{1}{2} I$$

$$T = \frac{50 \tan \frac{1}{2} I}{\text{Sin. D}}$$

$$\text{Sin. D} = \frac{50}{R}$$

$$\text{Sin. D} = \frac{50 \tan \frac{1}{2} I}{T}$$

$$R = T \cot. \frac{1}{2} I$$

$$R = \frac{50}{\text{Sin. D}}$$

$$E = R \text{ ex. sec. } \frac{1}{2} I$$

$$E = T \tan \frac{1}{2} I$$

$$\text{Chord def.} = \frac{\text{chord}^2}{R}$$

$$\text{No. chords} = \frac{1}{2} \frac{I}{D}$$

$$\text{Tan. def.} = \frac{1}{2} \text{ chord def.}$$

The square of any distance, divided by twice the radius, will equal the distance from tangent to curve, very nearly.

Table IV. contains Tangents and Externals to a 1° curve. Tan. and Ext. to any other radius may be found nearly enough, by dividing the Tan. or Ext. opposite the given Central Angle by the given degree of curve.

To find Deg. of Curve, having the Central Angle and Tangent: Divide Tan. opposite the given Central Angle by the given Tangent.

To find Deg. of Curve, having the Central Angle and Tangent: Divide Ext. opposite the given Central Angle by the given External.

To find Nat. Tan. and Nat. Ex. Sec. for any angle by Table IV.: Tan. or Ext. of twice the given angle divided by the radius of a 1° curve will be the Nat. Tan. or Nat. Ex. Sec.

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft.), and divide given deflection by the product.

Rule 2. Multiply given deflection by 57.3, and divide the product by the given distance.

To find deflection for a given angle and distance. Multiply the angle by .01745, and the product by the distance.

RIGHT ANGLE TRIANGLES. - Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

Given Base 100, Alt 10  $10^2 \div 200 = .5$ .  $100 + .5 = 100.5$  hyp.

Given Hyp. 100, Alt. 25.  $25^2 \div 200 = 3.125$ .  $100 - 3.125 = 96.875 =$  Base.

Error in first example, .002; in last, .045.

To find Tons of Rail in one mile of track: multiply weight per yard by 11, and divide by 7.

DISTANCES FROM CENTER OF ROADWAY FOR CROSS-SECTIONING.

ROADWAY 14 FEET WIDE. SIDE SLOPES 1 1/2 TO 1.

FOR SINGLE TRACK EMBANKMENT.

	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	
0	7.0	7.2	7.3	7.5	7.6	7.8	7.9	8.1	8.2	8.4	0
1	8.5	8.7	8.8	9.0	9.1	9.3	9.4	9.6	9.7	9.9	1
2	10.0	10.2	10.3	10.5	10.6	10.8	10.9	11.1	11.2	11.4	2
3	11.5	11.7	11.8	12.0	12.1	12.3	12.4	12.6	12.7	12.9	3
4	13.0	13.2	13.3	13.5	13.6	13.8	13.9	14.1	14.2	14.4	4
5	14.5	14.7	14.8	15.0	15.1	15.3	15.4	15.6	15.7	15.9	5
6	16.0	16.2	16.3	16.5	16.6	16.8	16.9	17.1	17.2	17.4	6
7	17.5	17.7	17.8	18.0	18.1	18.3	18.4	18.6	18.7	18.9	7
8	19.0	19.2	19.3	19.5	19.6	19.8	19.9	20.1	20.2	20.4	8
9	20.5	20.7	20.8	21.0	21.1	21.3	21.4	21.6	21.7	21.9	9
10	22.0	22.2	22.3	22.5	22.6	22.8	22.9	23.1	23.2	23.4	10
11	23.5	23.7	23.8	24.0	24.1	24.3	24.4	24.6	24.7	24.9	11
12	25.0	25.2	25.3	25.5	25.6	25.8	25.9	26.1	26.2	26.4	12
13	26.5	26.7	26.8	27.0	27.1	27.3	27.4	27.6	27.7	27.9	13
14	28.0	28.2	28.3	28.5	28.6	28.8	28.9	29.1	29.2	29.4	14
15	29.5	29.7	29.8	30.0	30.1	30.3	30.4	30.6	30.7	30.9	15
16	31.0	31.2	31.3	31.5	31.6	31.8	31.9	32.1	32.2	32.4	16
17	32.5	32.7	32.8	33.0	33.1	33.3	33.4	33.6	33.7	33.9	17
18	34.0	34.2	34.3	34.5	34.6	34.8	34.9	35.1	35.2	35.4	18
19	35.5	35.7	35.8	36.0	36.1	36.3	36.4	36.6	36.7	36.9	19
20	37.0	37.2	37.3	37.5	37.6	37.8	37.9	38.1	38.2	38.4	20
21	38.5	38.7	38.8	39.0	39.1	39.3	39.4	39.6	39.7	39.9	21
22	40.0	40.2	40.3	40.5	40.6	40.8	40.9	41.1	41.2	41.4	22
23	41.5	41.7	41.8	42.0	42.1	42.3	42.4	42.6	42.7	42.9	23
24	43.0	43.2	43.3	43.5	43.6	43.8	43.9	44.1	44.2	44.4	24
25	44.5	44.7	44.8	45.0	45.1	45.3	45.4	45.6	45.7	45.9	25
26	46.0	46.2	46.3	46.5	46.6	46.8	46.9	47.1	47.2	47.4	26
27	47.5	47.7	47.8	48.0	48.1	48.3	48.4	48.6	48.7	48.9	27
28	49.0	49.2	49.3	49.5	49.6	49.8	49.9	50.1	50.2	50.4	28
29	50.5	50.7	50.8	51.0	51.1	51.3	51.4	51.6	51.7	51.9	29
30	52.0	52.2	52.3	52.5	52.6	52.8	52.9	53.1	53.2	53.4	30
31	53.5	53.7	53.8	54.0	54.1	54.3	54.4	54.6	54.7	54.9	31
32	55.0	55.2	55.3	55.5	55.6	55.8	55.9	56.1	56.2	56.4	32
33	56.5	56.7	56.8	57.0	57.1	57.3	57.4	57.6	57.7	57.9	33
34	58.0	58.2	58.3	58.5	58.6	58.8	58.9	59.1	59.2	59.4	34
35	59.5	59.7	59.8	60.0	60.1	60.3	60.4	60.6	60.7	60.9	35
36	61.0	61.2	61.3	61.5	61.6	61.8	61.9	62.1	62.2	62.4	36

Calculated by Julien A. Hall, M. Am. Soc. C. E.

MADE IN GERMANY.

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