

DR. #11 Blackhawk Co.

No 2

Shed line - Levels Bremer



Co.

ENGINEERS'
FIELD BOOK
No. 404

1093

EUGENE DIETZGEN CO.

DRAWING MATERIALS, MATHEMATICAL and
SURVEYING INSTRUMENTS

Chicago New York San Francisco New Orleans Pittsburg Toronto

Distances from Center of Roadway for Cross-Sectioning

Roadway 16 feet wide. Side Slopes 1 on 1.

For Single Track Embankment.

II	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	H
0	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	0
1	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	1
2	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	2
3	11.0	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8	11.9	3
4	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	4
5	13.0	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8	13.9	5
6	14.0	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.9	6
7	15.0	15.1	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9	7
8	16.0	16.1	16.2	16.3	16.4	16.5	16.6	16.7	16.8	16.9	8
9	17.0	17.1	17.2	17.3	17.4	17.5	17.6	17.7	17.8	17.9	9
10	18.0	18.1	18.2	18.3	18.4	18.5	18.6	18.7	18.8	18.9	10
11	19.0	19.1	19.2	19.3	19.4	19.5	19.6	19.7	19.8	19.9	11
12	20.0	20.1	20.2	20.3	20.4	20.5	20.6	20.7	20.8	20.9	12
13	21.0	21.1	21.2	21.3	21.4	21.5	21.6	21.7	21.8	21.9	13
14	22.0	22.1	22.2	22.3	22.4	22.5	22.6	22.7	22.8	22.9	14
15	23.0	23.1	23.2	23.3	23.4	23.5	23.6	23.7	23.8	23.9	15
16	24.0	24.1	24.2	24.3	24.4	24.5	24.6	24.7	24.8	24.9	16
17	25.0	25.1	25.2	25.3	25.4	25.5	25.6	25.7	25.8	25.9	17
18	26.0	26.1	26.2	26.3	26.4	26.5	26.6	26.7	26.8	26.9	18
19	27.0	27.1	27.2	27.3	27.4	27.5	27.6	27.7	27.8	27.9	19
20	28.0	28.1	28.2	28.3	28.4	28.5	28.6	28.7	28.8	28.9	20
21	29.0	29.1	29.2	29.3	29.4	29.5	29.6	29.7	29.8	29.9	21
22	30.0	30.1	30.2	30.3	30.4	30.5	30.6	30.7	30.8	30.9	22
23	31.0	31.1	31.2	31.3	31.4	31.5	31.6	31.7	31.8	31.9	23
24	32.0	32.1	32.2	32.3	32.4	32.5	32.6	32.7	32.8	32.9	24
25	33.0	33.1	33.2	33.3	33.4	33.5	33.6	33.7	33.8	33.9	25
26	34.0	34.1	34.2	34.3	34.4	34.5	34.6	34.7	34.8	34.9	26
27	35.0	35.1	35.2	35.3	35.4	35.5	35.6	35.7	35.8	35.9	27
28	36.0	36.1	36.2	36.3	36.4	36.5	36.6	36.7	36.8	36.9	28
29	37.0	37.1	37.2	37.3	37.4	37.5	37.6	37.7	37.8	37.9	29
30	38.0	38.1	38.2	38.3	38.4	38.5	38.6	38.7	38.8	38.9	30
31	39.0	39.1	39.2	39.3	39.4	39.5	39.6	39.7	39.8	39.9	31
32	40.0	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	32
33	41.0	41.1	41.2	41.3	41.4	41.5	41.6	41.7	41.8	41.9	33
34	42.0	42.1	42.2	42.3	42.4	42.5	42.6	42.7	42.8	42.9	34
35	43.0	43.1	43.2	43.3	43.4	43.5	43.6	43.7	43.8	43.9	35
36	44.0	44.1	44.2	44.3	44.4	44.5	44.6	44.7	44.8	44.9	36
37	45.0	45.1	45.2	45.3	45.4	45.5	45.6	45.7	45.8	45.9	37
38	46.0	46.1	46.2	46.3	46.4	46.5	46.6	46.7	46.8	46.9	38
39	47.0	47.1	47.2	47.3	47.4	47.5	47.6	47.7	47.8	47.9	39
40	48.0	48.1	48.2	48.3	48.4	48.5	48.6	48.7	48.8	48.9	40

Example—If point is 22.6 ft. above grade, how far should it be from center line to be a slope stake point? Ans. from Table 30.6. For same slopes but other widths of roadbed, correct above figures by one-half difference in width of roadbed; thus in example above, for 20 ft. roadbed distance will be $30.6 + (20 - 16) \div 2$ or 2 ft. added to 30.6 = 32.6. For slopes of 1 on 1 $\frac{1}{2}$ see inside of back cover.

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R. P. BRIGGS,
CIVIL ENGINEER
WATERLOO, - IOWA

W. B. Baker
COUNTY AUDITOR

AUG - 8 '21

FILLED

Shed Line — 10-10-

Borings — " 78-80

Bench Marks — " 82

Levels Main Brewer Co. " 84-92

" BR 24 " " " 92

" 25 " " 94-96

" BR 25-A+25-B 98

" BR 26 100

" " 27 102

" 27-A 104

" " 27-B 106

" " 28 106

" " 29 108-110

" " 30 — — 116

" " 31 112-114

" " 31-A 114

Check B Ms BR 7 118

Extras — 2-10

Levels BR X 60-62

" BR Y 64-66

Extras.

Line	Approx Sta	Item	Amt.	Size	Dist. from D Line
Main CD.	12	F.H. Inlet	1		N side
" "	37	"	1		W side Hwy.
" "	55	"	1		S side
" "	65	"	1		W side
" "	83	"	1		S side
" "	98	"	2		W side Hwy.
" "	125	Inlet	2 (Sage S Main + Broad bent)		
" "	151	F.H. Inlet	2		W side Hwy.

BR 1	0+50	Inlet	1	12"	
" 2	3	"	1	24"	
" 2	26	"	2	12"	
" 2	28	"	2	12"	
" 2	92	"	2	12"	
" 2A	5	"	2	12"	
" 2-B	0+50	"	1	15"	
" 2-F	End	"	2	12"	
" 3	0+50	"	1	15"	
" 3	End	"	2	12"	
" 3-A	"	"	1	12"	
" 3-B	End	"	2	12"	
" 4	End	"	2	12"	
" 4	"	S.P. #2	150'		
" 4-A	"	Inlets	2	12"	
" 4-A	End	#2 S.P.	150'		

Line	Sta	Item	Amt	Size	
BR 5	0+50	Inlet	1	12"	
" 5	End	"	2	12"	
" 6	1	"	1	15"	
" 7	0+50	"	1	15"	
" 7	14	"	2	15"	30' from D Line
" 7	75	"	2	12"	
" 7	90	"	2	12"	
" 7-A	23	"	2	12"	
" 7-A-1	11	"	2	12"	
" 7-A-1	End	"	2	12"	
" 7-A-2	10	"	2	12"	
" 7-B	End	"	2	12"	
" 7-C	End	"	1	12"	
" 7-E	0+50	"	1	12"	
" 7-E	End	"	2	12"	
" 8	2	"	1	24" (800' #2 S.P.)	
" 9	0+50	"	1	15"	
" 9	End	"	2	12"	
" 9A	End	"	2	12"	
" 9-A	1	Trees	4		
" 10	1	Inlet	1	12"	
" 10	End	"	2	12"	
" 11	0+50	"	1	12"	
" 12	0+50	"	1	12"	
" 13	1	"	1	12"	
" 13	End	"	2	12"	

Line	Sta	Item	Am't	Size
BR 14	1	Inlet	1	12"

Maid 19/50 Bulkhead

"	210-50	Inlet	2	15" 40'
"	260	"	2	15" 40'
"	320	"	2	12"
"	End	"	2	12"

BR 15	14	Inlet	2	15" 20'
	38	"	2	12 (200 SP)
	72	"	2	12

BR 15-A	Hwy	"	3	12"
" 15-B	"	"	2	12" (150' S.P.)
" 15-C	End	"	1	12" (15 trees)
" 15-C-1	"	"	1	12"
" 15-C-2	"	"	1	12"
" 15-D	7/4 End	"	3	12"
" 18	End	"	2	12"
" 18	End	3 P.	100'	
" 18-A	End	Inlets	2	12"
" 18-A-1	"	"	2	12 100'-S.P.
" 18-A-1	all	S.P.		
" 20	Hwy	Inlet	2	12"
" 22	"	"	2	12

Line	Sta	Item	Am't	Size
BR 23	End	Inlet	2	12
BR 23	"	S.P.	100'	
BR 23-A	"	Inlet	2	12
" 23-A	"	Trees	3	
" 25	22	Inlet	2	12"
" 27	End	"	2	12"
" 27-B	"	"	2	12"
" 29	"	"	2	12"
" 30	13	"	2	12"
" 30	End	"	1	12"
30-17	"	"	1	12"

Note: Inlet tile left out until sizes designed.

8/10/20 π At $\Delta-1$

B.S. $258^{\circ}-35'$ 1365 $\Delta-0$
 $\Delta-1-S-0$ $264^{\circ}-02'$ 1355 To S-0

S-0 Not on SL

 π At $\Delta-3$

B.S. $186^{\circ}-10'$ 1920
 $252\frac{1}{2}$ 700
 $196\frac{3}{4}$ 900
 $\Delta-3-S-1$ $190^{\circ}-23'$ 850

To S-1

Close on Top. (H. last from $\Delta-2$) at this point

S-1 Not on SL E-W Hwy.

 π At S-1

B.S. $190^{\circ}-23'$ 845 To $\Delta-3$
 Tie 75 S-3
 $170\frac{1}{2}$ 475
 162 630

Schmidt's Silo W.

S-1-S-2 $156^{\circ}-08'$ 825 To S-2

 π At S-2

B.S. $156^{\circ}-08'$ 836 To S-1
 Tie $83^{\circ}-32'$
 131° 310'
 $128\frac{1}{4}$ 710

Same Silo

S-2-S-3 $127^{\circ}-42'$ 740 To S-3

N45, Hwy.

π H+ 5-3

B.S. 127°-42' 730 TOS-2

Tie 50°-04

92° 415'

92 750

91 1040

S-3-S-4 87° 14' 1350 TOS-4

 π H+ 5-4

B.S. 87°-14 1340 TOS-3

Tie 24°-51'

Tie 92-33

130° 390'

 126³/₄ 640

S-4-S-5 127°-35' 930 TOS-5

 π H+ 5-5

B.S. 127°-35' 930 TOS-4

1° 47

83-10

261 90'

~~330~~

 175¹/₂ 620

S-5-S-6 119-36' 1005 TOS-6

Same Silo

Same Silo

Grey Silo N.W.

S-5 Not on SL.

At edge of Corn field on E-W & Sec 9

π At $\Delta-6$ B.S. $119^{\circ}36'$ $1005'$ To $\Delta-5$ Tie $343^{\circ}55'$ Tie $69^{\circ}20'$ $124-18$ π At. $\Delta 6$ (Not on SL.)BS $343^{\circ}55'$ $248^{\circ}15'$ $650'$ $233^{\circ}45'$ $860'$ 220° $940'$ 210° $1200'$? 200° $1400'$? E + W. P.L. $192 \frac{3}{4}$ 1600 56-57 $144^{\circ}30'$ $1250'$ π At $\Delta-7$ Not on SL.BS. $144^{\circ}30'$ $1250'$ 57-58 $174^{\circ}0'$ $1600'$ π At $\Delta-8$ Not on SL.BS. 174° $1600'$ $303 \frac{3}{4}$ $1560'$ to pt. taken $312 \frac{3}{4}$ $1070'$ 75° $303 \frac{3}{4}$ 1560
 156° S-6 is $7\frac{1}{2}$ posts West + 9' S of center
Sec-9.

To Schmidts Silo Now S.

Grey silo S.W. by W.

W mill NW.

To Schmidts Silo S.

S-6

N. side E + W. Hwy.

S-7.

From S-6.

N + S PL.

$209\frac{1}{4}$ 730'
 $266\frac{1}{4}$ 110'
 157° 230'
 $135\frac{1}{4}$ 430'

Tie 342-35

Tie 22-34

$120\frac{1}{2}$ 860'

58-59 $261^{\circ}-53'$ 655'

π At 59 Not on SL.

BS. $261^{\circ}-53'$ 655'

5-9-510 $172^{\circ}-04'$ 1055'

π At 5-10 Not on SL.

BS. $172^{\circ}-04'$ 1060'

$60\frac{1}{4}^{\circ}$ 1400'

70° 1320

$90\frac{1}{4}^{\circ}$ 1000'

$102\frac{1}{4}$ 960'

$112\frac{1}{2}$ 1140'

130° 1140'

$141\frac{1}{2}$ 1400'

5-10-5-11 $126^{\circ}-15'$ 1470'

Tie $79^{\circ}-26'$

E E+W HWY.

Schmidt Silo S.

Grey Silo SW

58

510

59

5-11

Pt. Red Barn West

π S-11 Not on SL.

BS	126°-15'	1460
	231°	385'
	177°	400'
	152 $\frac{3}{4}$	660
	142 $\frac{1}{2}$	960
	133 $\frac{3}{4}$	1240
	132 $\frac{1}{2}$	1640
	131 $\frac{1}{2}$	1740

Tie 151-30

S11- S12 103°-33' 1660

π S-12 E edge N+S Hwy.

BS. 103°-33' 1680'

S12-13 173°-15' 1140

Tie 157°-25'

π S-13 in N+S Hwy Not on SL.

BS. 173°-15' 1160

262 $\frac{3}{4}$ 620

13-14 172°-24' 1180

π S-14 15' SW Sec. Corr

B.S. 172°-24' 1190'

14-15 261°-43' 820'

S10

~~Windmill NW~~
Silo 11- with white
band ground.

Not on SL. (S12 also on E+W. P.L.)
S-11

S13

Red Silo 700' NW.

S12

S14

Not on S.L.

S-15

π At S-15 N. side

BS	261°-43'	820'	ETW Hwy. Nat on SL.
	1 $\frac{3}{4}$ °	560'	S-14
	+107 $\frac{3}{4}$	90'	pt. $\frac{1}{2}$ ETW Hwy.
	213 $\frac{1}{2}$	260'	
	195 $\frac{3}{4}$	550'	
	206°	1120'	
	201 $\frac{1}{4}$ °	1600'	
15-16	193°-28'	1700	516.

π At S 16 Not on SL.

BS.	193°-28	1720	515
	172°	130	
	137 $\frac{1}{2}$	550	
	140 $\frac{1}{4}$	820	
	145 $\frac{1}{4}$	1100	
	148 $\frac{1}{4}$	1340	
	138	1740	
16-17	116°-20'	1640	

π At S-17 Not on SL

BS.	1660	5-16
	173 $\frac{1}{4}$	670
17-18	127°-58'	875

on E side N+S Hwy

E N+S Hwy
To S-18

At 5-18 Not on SL

B.S. $127^{\circ}38'$ 870
 $190\frac{1}{4}$ 740
 $151\frac{1}{2}$ 1000
 Tie $48^{\circ}14'$ 1380
 $135\frac{1}{2}$ 1950
 $125\frac{1}{2}$ 2000
 18-19 $118^{\circ}28'$ 19
 19

At 5-19 Not on SL

B.S. $118^{\circ}28'$ 1980
 Tie $10^{\circ}39'$ by Newbl
 Tie $214^{\circ}45'$ W.M. II Water Tank NE

Discontinued Azimuth readings from 5-19

5-20 575' S of E.W. Hwy N Line sec 32 on N+5 E sec 32
 Used N+5 E sec 180°

SL from 520 runs 113°

5-21 E.W. Hwy 1140' W from N end N+5 E sec 32

To 5-17

$190\frac{1}{4}$

Will at new Blgs in sec 32
 N+5 E

To 5-19

To 5-18

Note: S.L. runs

Next S point $141^{\circ}30'$ from
 5-19

At 5-21 - on S.L.

263°-39'

83°-18'

121 1/2

390'

83 1/2

1550

119 3/4

650

116 3/4

1060

21-22

94°-50'

1550

At 5-22 on N45 Hwy

B.S.

94°-50'

1560

195°

510

170 3/4

530

357 1/2

320

139 1/2

1000

120

990

108

900

99 1/4

1080

95 1/4

1240

83

1280

22-23

84°-08'

1340

At 5-23

B.S.

84°-08'

1330

99 3/4

410

115

950

Hwy E

Hwy W.

X Roads Not SL

To 5-22

Not on SL

To 5-21

N45 Hwy

Some X Roads Not SL

To 5-23

To 5-22

At 5-21 - on S.L.

263°-39'

83°-18'

121 1/2

390'

83 1/2

1550

119 3/4

650

116 3/4

1060

21-22

94°-50'

1550

At 5-22 on N45 Hwy

B.S.

94°-50'

1560

195°

510

170 3/4

530

357 1/2

320

139 1/2

1000

120

990

108

900

97 1/4

1080

95 1/4

1240

83

1280

22-23

84°-08'

1340

At 5-23

B.S.

84°-08'

1330

99 3/4

410

115

950

Hwy E

Hwy W.

X Roads Not SL

To 5-22

Not on SL

To 5-21

ENTIRE Hwy

SOME X Roads Not SL

To 5-23

To 5-22

346°	560'
321 $\frac{1}{2}$	830'
321	1200'
316°	1440
315 $\frac{1}{2}$	1800
321	2080
325	2000
334 $\frac{3}{4}$	1900
345 $\frac{1}{2}$	1760
359°	1780
25-26 11°-10'	1680

π At S-26 on SL.

B5.	11°-10'	1680
45		100
3 $\frac{3}{4}$ °		450
359°		670
9°		800
$\frac{1}{2}$ °		1400
0°		1520

26-27	322°-14'	1920
Tie	135°-28'	

B. 1995
HOFF
Alexander.

E+IN. P.L.

S-26

S-25

10/28/20

S-27

Ch. Steadie by water tank NW.

S- Side Shed line

 π At $\Delta \# 2$ (S-O) Not on SL.

BS. 286°-06

352 170'

352 800'

O-1 338-25 1460

 π S-1 on SL.

BS. 338-25 1480

358° 140

25° 640 E+M P.L.

1-2 41°-18' 1120

 π S-2 Not on SL.

BS. 41°-18' 1155

260 $\frac{1}{2}$ 240

326° 270

2-3 83°-16' 970

 π At S-2 Not on SL

BS 83°-16' 970

303° 880

315 $\frac{1}{4}$ 1050323 $\frac{1}{4}$ 1300

Briggs

HOFF 10/29/20

Alex

to $\Delta \# 1$

S-O

S-1.

	$238\frac{1}{4}$	1680
	349°	1740
	$359\frac{1}{2}$	1700
	$12\frac{1}{4}$	1720
3-4	28-38	2060

π At S-4 (Not on SL)

B.S.	$28^{\circ}38'$	2050
4-5	$356^{\circ}14'$	520'
COR.	$172\frac{1}{2}$	1640'

π At S-5 Not on SL.

B.S.	$356^{\circ}14'$	520'
	181	155
	$91\frac{1}{4}$	225
	$19\frac{3}{4}$	580 E+W. P.L.
5-6	$55^{\circ}08'$	1140

π At S-6 Not on SL.

B.S.	$55^{\circ}08'$	1160
	$278\frac{1}{4}$	720
6-7	$17^{\circ}12'$	1140'

75.00
1900
2000

1025
205

Levels

to S-4

in N+S Hwy E.S. side

SW. CoR. Sec. 15

SE

6.0

5.8

5.7

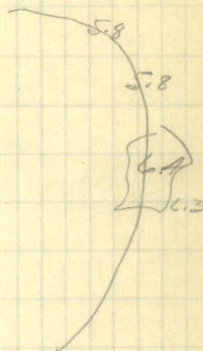
5.3

5.3

5.3

5.6

5.6



π At 2-7 (Nat on SL)

 B.S. $17^{\circ}-12'$ 1150 to 56.

 238° 250

 $94\frac{1}{4}$ 75'

 7-8 $89^{\circ}-14'$ 1200' to 5-8

 π At 5-8 on SL

 B.S. $89^{\circ}-14'$ — 1190

 $285\frac{1}{2}$ 300

 $245\frac{1}{2}$ 35'

 Center 30C 175° 940'

 Tie $234^{\circ}-0'$
 $86\frac{1}{4}$ 230

40 620

 $14\frac{1}{2}$ 730

 $67\frac{1}{2}$ 910

 5-8- Δ -29 $84^{\circ}-24'$ 550

 π At Δ -29 = 5-9

 B.S. $84^{\circ}-24'$ 550

 Tie $177^{\circ}-50'$

37 340

 $46\frac{1}{2}$ 950

 5-9 510 $40^{\circ}-12'$ 1810

Levels

5.8

5.7 Ridge

5.8

5.2

 5.7

5.6

5.5

5.5

 5.6

5.6

6.5

 5.3

6.2

Center Sec. 21

5-6

5.40 5.70 5.70

4.95 5.40 5.60

6.50 5.70

5.90

5.95

6.10

B. Silo N.

To 5-10

π At 5-10 Not on JL.

B.S.	40°-12'	1820'
	207°	720'
	264 $\frac{1}{2}$	590'
	288 $\frac{1}{4}$	500' Buildings
	324°	530'
	358°	595' E+IV. HWY
	16 $\frac{1}{4}$	910'
	21°	1160'

To 5-9 = 4.29.

Tie	17°-15'	
10-11	40°-15'	- 1420'

Pl. vent on Brick barn SW.

π At 5-11 (not on JL)

B5	40°-15'	1440'
	328 $\frac{1}{4}$	640
	255	780
	4 $\frac{1}{2}$	1160
	21°	1200
	28°	1400
	27 $\frac{1}{2}$	1660
Sec. C.R.	207°-37'	470
	43 $\frac{1}{2}$	1610
	59°	1360
	74 $\frac{1}{4}$	1240
	87	1240

5-10

Sac. Car.

11-12	119°-25'	1280'
-------	----------	-------

At S-12 (Not on SL)

BS	40° 12'	1820'
BS	119° 25'	1280
	42 $\frac{3}{4}$	610
	68	775
	85 $\frac{1}{2}$	1020

12-13 165° 55' 1480'

At S-13 (Not on SL)

BS	165° 55'	1480'
	45 $\frac{1}{4}$	1560
	51	1320
	61 $\frac{1}{2}$	1260
	78 $\frac{1}{4}$	940
	105 $\frac{1}{2}$	950
	117 $\frac{3}{4}$	940

13-14 155° 37' 1340'

At S-14 Not on SL.

BS.	155° 37'	1340'
	50 $\frac{1}{2}$	820'
	62	800'
	66 $\frac{3}{4}$	890'
	78	1080
	86 $\frac{3}{4}$	1220
	104 $\frac{1}{2}$	1400

~~To S-9~~

To 11

E+W. HWY.

To S13

To S-12

To S14

E+W. PL.

N+S. PL. ?

Tie 245°-20'
14-15 133°-15' 1360

At S-15 (Not on SL)
BS. 133°-15' 1360
66 $\frac{1}{2}$ 610'

15-16 171°-39' 800'

At S-16 (Not on SL)
BS. 171°-39' 800'
16-17 84°-15' 1060'

At S-17 (Not on SL)
BS. 84°-15' 1055'
17-18 85°-20' 780'

At S-18 (Not on SL)
B.S. 85°-20' 785'
321 $\frac{1}{2}$ 1950
327 $\frac{1}{2}$ 1920
335 $\frac{1}{2}$ 1800
344 $\frac{1}{4}$ 1620
352 1520
357 $\frac{3}{4}$ 1280
9 $\frac{1}{2}$ 1075
20 $\frac{1}{4}$ 750

ball former School-house N.E.

517 in barnyard

22 $\frac{1}{2}$ ° 740'

33° 515'

66° 375'

112° 675'

125° 1160

18-19 139°-04' 1500'

. π At S-19 (Not on SL)

B.S. 139°-04' 1520'

82 $\frac{1}{4}$ ° 285'137 $\frac{3}{4}$ ° 510'

171° 790 N+S. HWY

19-20 170°-35' 1620'

 π At S-20

B.S. 170°-35' 1620

344 $\frac{1}{2}$ ° 260'173 $\frac{1}{2}$ ° 780' E HWY.

20-21 173°-55' 1030'

 π At S. 21

B.S. 173°-55' 1050

150 $\frac{3}{4}$ ° 530155 $\frac{1}{4}$ ° 800142 $\frac{1}{4}$ ° 1060145 $\frac{1}{2}$ ° 1520

E+W. Hwy. School house Cor.

S-19 on E. side N+S. Hwy.

20 on W. side N+S. Hwy.

S-20 on shed line

Use $\angle$ Road as shed line

S-21 E side Road.

21-22 170°-00' 1800'

 π At 22 (Not on SL)

B.S. 170°-00' 1785'

42 $\frac{3}{4}$ 760'82 $\frac{3}{4}$ 780'

Sec. Cor. 253°-10' 55'

98 $\frac{1}{2}$ 765'

145° 700'

159° 940'

171 $\frac{1}{4}$ 1360169 $\frac{1}{2}$ 1560

22-23 167°-39' 1780'

 π At 5-23 on SL.

B.S. 167°-39' 1765'

157° 380

146 $\frac{1}{4}$ 680144 $\frac{3}{4}$ 1070141 $\frac{1}{2}$ 1300

23-24 181°-38' 1320'

Fte

 π At 5-23

B.S. 167°-39' 1780

Cor 184 $\frac{1}{2}$ 980

23-24 181°-45' 1320

Briggs

Hoff 11/5/20

Alex

in E+W Hwy.

745°
153°
884
1760

To 5-24

~~Windmill Run~~

π At S-24 Not on SL.

BS

181°-45'

92 $\frac{1}{4}$

500'

24-25

168°-51'

740'

π At S-25 Not on SL

BS.

168°-51'

73 $\frac{3}{4}$

460'

97 $\frac{1}{2}$

800'

131°

900'

139

1100'

135 $\frac{1}{2}$

1220

Buildings

25-26

149°-18'

1520

π At S-26 Not on SL.

BS.

149°-18'

125 $\frac{1}{2}$

300'

Hwy Reading

128°

590'

127°

840'

26-27

158°-22'

1080'

π At S-27 Not on SL.

BS.

158°-22'

83 $\frac{1}{4}$

610'

107 $\frac{1}{2}$

850'

126 $\frac{1}{2}$

990'

Briggs

Hoff alone

138 $\frac{1}{2}$

1140'

140 $\frac{1}{2}$

1400'

27-28

132° - ~~54~~ ²⁸'

176°'

T At 5-28 on SL.

BS.

~~142° - 54'~~
132° - 28'

135°

350

162°

580

167 $\frac{3}{4}$

830'

166°

1140'

160°

1400'

28-29

156° - 15'

1700'

T At 5-29 on SL.

BS.

156° - 15'

1700'

178 $\frac{1}{2}$

200'

160 $\frac{1}{2}$

480'

160 $\frac{1}{2}$

830'

166 $\frac{1}{2}$

770'

161 $\frac{1}{2}$

1240'

HWY. Reading

159°

1390'

166 $\frac{1}{4}$

1600'

169 $\frac{1}{2}$

1940

Tie this to SL from H-

12/4/20

5-29 20' S. PL.

BX

Sta # BS H.I. - S Elev
 B.M. 10 7.18 33.37 26.19

9.30 24.07

0 23.96

1 12.25 21.12

2 9.20 24.17

3 8.60 24.77

4 8.05 25.32

5 7.20 26.17

6 6.00 27.37

7 5.40 27.97

8 5.10 28.27

+88 4.10 29.27

9 3.80 29.57

10 3.40 29.97

L. +10 11.68 42.07 3.28 30.17
 T.P. 11 2.98 30.139

12

13

14

15

16

17

18

19 5.00 31.07

= Sta 127 Main
 Ditch Xing

100' W of Cor
 S Line NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec 17

E Line NW $\frac{1}{4}$ NE $\frac{1}{4}$ Sec 17
 100' N of Cor

Sta	135	H1	-S	Elev
20		92.07		
20	9.05	47.95	3.17	38.90
21			8.50	39.45
22			7.40	40.55
23			5.15	42.20
24			3.80	44.15
+79			2.20	45.95
+90			3.25	44.70
25			1.10	46.85
+15			0.80	47.45
+25			2.75	45.20
+42			0.85	47.10

S Hwy E

S Hwy D

E Hwy

N " D

N " E End

450' W of X Road

BRY

Sta	BS	HI	-5	Elev
BM	7.28	36.32		29.04
			11.85	24.77
0				24.86
1			11.00	25.32
2			10.50	25.82
3			9.65	26.67
4			9.35	26.97
5			9.20	27.12
6			9.25	27.17
7			9.30	27.02
+40			9.15	27.17
8			9.00	27.32
9			8.90	27.42
10			8.50	27.82
11			8.30	28.02
12	6.10	34.41	7.95	28.37
13			5.90	28.57
14			5.75	28.72
15			6.25	28.22
16			5.30	29.17
17			4.55	30.12
18			4.10	30.37
19	7.20	38.92	3.75	30.72
20			6.20	31.72

= Sta 144 Main

Sta	BS	H.I.	- 5 Elev
21	57.92	5.55	32.37
+53		5.80	32.12
+90		6.10	31.82
+85		4.00	33.92
L 22		5.40	32.52
23		5.00	32.92
24		4.55	33.37
L 25		3.80	34.12
+65		3.95	33.97
+85		1.80	36.12
26		3.20	34.72
+13		2.00	35.92

EMwy E

E Hwy D

E Hwy

12' W E Hwy

Hwy D

E E W Hwy

N Hwy D

End at S.E. Cor Sec ~~3~~ ¹

LIDE	Sta	
Main	32	3' - Black Soil
BR2	3	1' - Gravel
		1' - sand
		1' - Blue Sandy clay
Main	56+50	3' - B/K Soil
BR4	0	2' - Clay (yellow) Slightly Gravelly
Main	86+35	3 1/2' - B/K Soil
BR7	0	1' - yellow clay (Gravel) 1' Blue " "
Main	135	4' - B/K Soil 1' - Yel. Clay 1' - Gravelly Clay (Slight)
Main	191+50	3' - B/K Soil 3' - Slightly gravelly Yel. clay.

Line Sta

Main 258

3' B/K soil

2' yel clay

1' Gravely yel clay

Main 312

3' B/K soil

3' yel clay.

Bench Marks

B.M.	Elev	
# 16	42.67	Spike in field Ecap Bridge on Blk hawk - Bremer Go line - Sta 260+50 Main
# 17	53.01	Spike in Willow Stump = Center post Sec 32
# 18	70.09	Top NE Cor E wall Conc Culvert W Line Sec 32 Sta 323 Main
# 19	71.29	Top NE Cor E wall Conc Culvert in pasture of Bldgs NE $\frac{1}{4}$ Sec 31 opp Sta 333+50 Main
# 41	56.11	NE Cor End Conc Culvert E line Sec 32 Sta 22+40 BR 25

Sta	BS	H.I.	- S	Elev
B.M. 16	5.90	48.59		42.67
260+84		9.10		39.47
260+96		7.50		41.07
261		7.60		40.97
262		7.10		41.47
263		6.55		42.02
264-T.P.	5.74	48.21 6.10		42.47
"	5.42	48.22 5.76		+ 2.81
264-Ditch		7.60		40.97
265		4.85		43.37
266		4.85		43.37
267		4.40		43.82
268		3.90		44.32
269		3.70		44.52
270-T.P.	5.87	50.63	3.46	44.76
"	5.63	50.62	3.23	44.99
271		5.05		45.58
272		5.00		45.63
Hub				
4273		5.64		44.99
274		5.25		45.38
275		4.75		45.88
276-T.P.	5.02	51.28	4.37	46.26
"	4.77	51.28	4.12	46.51
277		5.20		46.28
Hub				
278		4.45		46.83
cont.				

Spike 105 end Ecap Bridge on Golias
= Sta 0 BR 24
N Hwy F

= Sta 0 BR 25.

= Sta 0 BR 26

549	B5	H.I.	-5	ERV
279		51.28	4.65	46.63
280			4.90	46.38
281			4.95	46.33
282-T.A	6.10	52.58	4.80	46.48
"	5.86	52.57	4.57	46.71
283			6.10	46.47
284			5.70	46.87
285			6.00	46.57
286			5.45	47.12
287			5.00	47.57
288-T.12	6.32	54.39	4.50	48.07
"	5.99	54.40	4.16	48.41
289			5.85	48.55
290			5.75	48.65
L. 291			5.30	49.10
292			5.05	49.35
292+36			4.50	49.90
^{Feb.} 293			4.43	49.97
B.M. #17			1.39	53.01
294-T.A	5.82	56.09	4.13	50.27
"	5.50	56.08	3.82	50.58
295			5.45	50.63
296			5.20	50.88
297			4.70	51.38
		CRP 300.		2100

= Sta 0 BR 28 (27)

E-W E Sec 32 - Approx 600' W of Sec Cen.
= Sta 0 BR 28

Spike in willow stump = center post Sec 32

Sta	B.S.	H.I.	-S	Elev.
298		56.08	4.50	51.58
299			7.15	51.93
300 - T.P.	7.57	60.25	3.40	52.68
" "	7.32	60.26 60.24	3.13	52.95
301			6.70	53.56
302			5.60	54.66
303			4.80	55.46
L 304			4.05	56.11
305			3.80	56.46
306 - T.P.	5.95	62.05	3.16	57.10
" "	5.72	63.05	2.93	57.33
307			6.15	56.90
308			5.65	57.40
308+24				
309			5.15	57.90
310			4.60	58.45
311			3.70	59.35
312 T.P.	6.97	67.46	2.86	60.19
" "	6.72	67.17	2.60	60.45
313			6.20	60.97
314			5.00	62.17
315			3.95	63.22
L 315+62			3.35	63.92
316			3.55	63.62

C.R.H.
M.R.

= Sta 0 BR 29

N45E NW $\frac{1}{4}$ sec 32

= Sta 0 BR 30

N45E W $\frac{1}{2}$ NW $\frac{1}{4}$ sec 31 (R)

M.R.

Sta	B.S.	H.I.	-S.	Elev
317		67.17	2.80	64.37
318 T.P.	5.62	70.84	1.95	65.22
"	5.37	70.84	1.70	65.47
319			5.20	65.64
320			4.75	66.09
321			4.60	66.24
322			4.25	66.59
322+65			3.45	67.39
+80			4.50	66.34
+95			0.65	70.19
323			0.95	69.89
323+15			3.30	67.54
323+35			2.80	68.04
BM #18	3.88	73.97	0.75	70.09
324			6.25	67.72
325			6.00	67.97
326			5.50	68.47
327			5.80	68.17
328			5.00	68.97
329			5.05	68.92
330 T.P.	6.95	76.77	4.21	68.76
"	6.70	76.72	3.95	69.02
331			7.15	69.57
332			6.50	70.22
		CRK		W.R.D.

E Hwy F

" " D

E "

W " D

W " F

NE Cor E Wall N Conc Culvert

W LINE SC 632

Sta	B.S.	H.I.	-S	Elev
333		76.72	6.45	70.27
334			5.80	70.92
335			5.75	70.97
336			5.70	71.02
337			5.15	71.57
338			4.15	72.57
338+58			2.65	74.07
+68			3.15	73.57
+85			0.50	76.22
339			1.80	74.92
339+14			0.35	76.37
BM #19			4.43	71.29

S Hwy F

E Hwy N Line Sec 31,

N " D

N Hwy F - End Main - W. Gatepost ^{N side Hwy}NE cor E wing Cone Culvert in pasture
by Sta 333+50BR 24

BM	5.57	48.24	42.67
0		8.75	39.49
0+40		9.50	38.74
1		8.70	39.54
2		8.20	40.04
3		7.15	41.09
4		6.35	41.89
4+28		5.15	43.09

open
area.

W.R.D.

= Sta 260+84 Main
At end Bridge in Ditch

Note - Elevs. taken in N Hwy Ditch.

End of S.W. cor SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec 32

Sta	B.S.	H.I.	-S	Elev.
0	6.44	51.43		44.99
1			6.75	44.68
2			6.70	44.73
3			6.35	45.08
4			6.05	46.38
5			5.80	45.63
6 - T.P.	6.62	52.90	5.15	46.28
"	6.35	52.91	4.87	46.56
7			6.30	46.61
8			5.95	46.96
8+46			6.00	46.91
9			5.55	47.36
10			5.00	47.91
11			4.65	48.26
12 T.P.	7.38	55.40	4.39	48.52
"	7.15	55.91	4.15	48.76
13			6.80	49.11
14			6.25	49.66
15			5.65	50.26
16			4.90	51.01
17			4.25	51.66
18 - T.P.	6.88	58.84	3.95	51.96
"	6.53	58.85	3.59	52.32
18+15			6.90	51.94
19		CRD.	6.85	51.99
		94A.		90A.

= Sta 273 Main.
= Sta 0 BR 25-A.

N+5E SE 1/4 Sec 32

Sta	B.S.	H.I.	-S	Elev.
20		58.57	6.40	52.44
21			6.30	52.54
22			5.35	53.49
22+09			5.20	53.64
22+15			6.30	52.59
22+30			3.40	55.44
22+45			4.14	54.70
Hwy D ch by 22+45			5.95	52.89
B.M. #4			2.73	56.11
23			3.70	55.14
24 T.P.	7.33	63.04	3.16	55.68
" "	6.99	63.00	2.83	56.01
25			6.40	56.60
26			5.95	57.05
27			5.25	57.75
28			4.50	58.58
29			3.50	59.50
30 - T.P.	6.28	66.41	2.87	60.13
" "	6.00	66.40	2.60	60.40
31			5.20	61.20
32			4.35	62.05
33			3.35	63.05
33+10			4.50	61.60
33+32			2.30	64.10
adj. M.A.			:	M.A.

Br 25-B

(1	135	4.60
1205		5.85 Hwy D
1217		4.15

W Hwy F

" " D

E "

= Sta 0 Br 25-B

NE Cor E wall Conc Culvert E Line ^{Sec 32}Note: Hwy Ditch Arc 150' below
elevations taken.

D. 5.55

E Hwy D

End E Hwy F W Line Sec 33

Sta	B.S.	H.I.	-S	Elev
0	6.75	51.43		44.68
1			6.80	44.63
2			5.75	45.68
3			4.80	46.63
4			3.65	47.78
5			2.80	48.63
5+30			2.30	49.13

End N45 E SE $\frac{1}{4}$ Sec 32

BR 25-B

0	7.14	58.84		
1			4.60	54.24
1+05			5.85	52.99
1+14			4.15	54.69
				WRA.

C.P. #
M.A.

= Sta 22+45 BR 25

E Hwy D

End E Hwy F NW Cor SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec 33

Sta	B.S.	H.I.	-S	Elev
H ² B 0	5.48	52.31		46.83
1			5.25	47.06
2			5.20	47.11
3			4.25	47.96
4			4.10	48.21
5			3.30	49.01
6 - T.P.	6.27	55.63	2.95	49.36
"	6.05	55.63	2.73	49.58
7			6.45	49.18
8			5.10	50.53
9			4.70	50.93
10			4.55	51.08
10+75			4.15	51.48
11			4.05	51.58
12 - T.P.	7.13	59.56	3.20	52.43
"	6.94	59.57	3.00	52.63
13			6.95	52.62
13+30			5.70	53.87
14			5.45	54.12
15			4.85	54.72
16			3.95	55.62
17			2.70	56.87
18			1.80	57.77
18+50			1.20	58.37

CH²N
9442

9442

= Sta 278 Main

(Elevs in wide open ditch gravel)
depth Sta 4 - Sta 7.

E-W & Sec 32

End N+SE NE 1/4 Sec 32 280' N of ^{1/4} E-W

Sta	BS	H.I.	-S	Elev
0 ^{Hvb}	8.11	56.18		48.07
"	7.78	56.19		48.41
1			7.30	48.89
2			5.80	50.39
3			4.95	51.24
^{Hvb}			4.70	51.49
4+50			4.25	51.94
5			4.10	52.09
6 T.P.	7.30	60.61	2.88	53.31
"	7.12	60.62	2.67	53.50
7			6.40	54.22
8			5.65	54.97
9			5.25	55.37
10			5.40	55.22
11			5.25	55.37
V 11+05			5.60	55.02
12 T.P.	7.17	62.65	2.14	55.48
"	6.85	62.66	4.81	55.81
13			6.80	55.85
14			6.25	56.40
15			5.20	57.45
16			4.50	58.15
17			3.55	59.10
18 T.P.	9.78	69.89	2.57	60.11
"	9.52	69.89	2.28	60.37
		^{cap} MRA.		MRA.

= 5+9288 Main

= Sta 0 BR 27-H.

N45 E SW 1/4 Sec 32 100' S of E & W 1/4 E

Sta	B.S.	H.I.	-S.	Elev.
19	69.89	8.65		61.24
19+25		8.70		61.19
20		7.80		62.09
21		8.00		61.89
22		7.70		62.49
23		6.50		63.09
24		5.50		64.39
24+24		4.80		65.09
24+36		5.10		64.79
24+48		3.20		66.69
24+60		6.70		63.49
24+72		5.15		64.74

BIP 27-17

0	12.40	64.34		51.94
1			11.15	53.19
2			10.10	54.24
3			9.30	55.04
3+75			7.90	56.44
4			7.65	56.69
5			6.05	58.29
6			5.50	58.84
7			4.55	59.79
8			3.90	60.44
9			3.50	60.84
10			2.85	61.49
10+64			2.60	61.74

MRA.
MRA.

MRA.

= Sta 0 BIP 27 13

Sta 17- Sta 22 in Ditch Ave 1' Depth

E Hwy F

E " D

E Hwy W Line Sec 32

W Hwy D

" " F End 100' N of E & W Sec

= Sta 4+50 BIP 27

End 1/4 Sec SW 1/4 Sec

Sta	BS	HI	-5	Elev.
0	8.70	69.89		61.19
1			7.00	62.89
2			6.90	62.99
3			6.50	63.39
4			6.90	62.99
5			6.50	63.09
6			6.70	63.19
6+24			6.15	63.74
6+32			6.60	63.29
6+45			4.70	65.19
6+60			6.60	63.29
6+71			6.30	63.59

exp.

BR 28

0	5.95	55.92		49.97
1			5.90	50.02
2			5.60	50.32
3			5.45	50.47
4			4.76	51.16
5			3.75	52.17
Sta 35			2.90	53.02
				98 RA.

98 RA.

= Sta 19+25 BR 27
Sta 0 - Sta 2 in Ditch are Depth 1'

E. Hwy F.

E " D

E Hwy

W " D

W 40e Sec 32
End " " F 250' S of E+W 4 sec

= Sta 293 Moio

End N45 4 Sec 32 75' N sec Gen.

Sta	BS	HI	-S	Elev
0	6.50	59.18		52.68
"	6.23	59.18		52.95
1			6.20	52.98
2			5.65	53.53
3			5.03	54.18
4			4.75	54.43
5			4.40	54.78
5738			3.60	55.58
6 T.P.	5.58	61.44	3.32	55.86
"	5.30	61.43	3.05	56.18
7			5.05	56.38
8			4.80	56.63
9			4.45	56.98
10			4.10	57.33
11			3.80	57.63
12-T.P.	7.13	65.32	3.24	58.19
T.P.	6.80	65.33	2.90	58.53
13			6.80	58.53
14			6.50	58.83
15			5.95	59.38
16			5.45	59.88
17			4.40	60.93
18			3.90	61.43

CRP.
90RA.

= Sta 300 Main

N+5 & NW 1/4 sec 32

Sta	B.S.	H.I.	-S	Elev.
18 +65	65.33	3.20		62.13
+80		3.75		61.68
+95		1.40		63.93
19		2.00		63.33
19 +13		4.30		61.03
19 +23		3.45		61.88
				9112A

E Hwy F

" " D

E Hwy W Line Sec 32

W Hwy D

" " F - End

Sta	BS	HI	-S	Elev
0 ^{Hub}	10.75	70.94		60.19
"	10.50	70.95		60.45
1			9.70	61.25
2			7.70	63.25
3			6.25	64.70
4			4.05	66.90
4.5			3.00	67.95
6 - T.P.	7.26	78.90	1.31	69.64
"	8.10	78.91	0.94	70.01
7			8.00	70.91
7+73			7.30	71.61
8			7.25	71.66
9			6.10	72.81
10			5.45	73.46
11			4.35	74.56
12 - T.P.	7.23	82.45	3.69	75.22
"	6.92	82.45	3.38	75.53
13			6.90	75.55
13+84			5.80	76.65
13+90			6.35	76.10
13+95			5.45	77.00
14			4.75	77.70
14+10			4.40	78.05
14+24			5.45	77.00
Ditch			6.70	75.75
	ORN			9RA.

= 5+9312 Main

N + S E NW $\frac{1}{4}$ NW $\frac{1}{4}$ Sec 32

S Hwy F

S " D

= Sta 0 BR ^{31.} 30. A

By 5+914+24

Sta	B.S.	H.I.	-S	Elev
15		82.45	5.05	77.40
16			4.45	78.00
16+60			2.65	79.80
16+85			3.80	78.65
17			3.45	79.00

BR 30 H.

0	5.45	82.45		77.00
1			5.40	77.05
2			4.20	78.25
2+65			2.45	80.00
2+80			4.40	78.05
2+85			3.35	79.10

C.R.A.
M.A.

M.A.

± N+5 Hwy
N+W Hwy D
End at SE Cor. post sec 30.

= Sta 13+95 13R 30

± N+5 Hwy
S+W Hwy D
End at NE Cor post sec 31

B&I

	B.S.	H.I.	-S	Elev	{ 17.57 22.61
B.M.	4.64	26.74		22.10	
T.P.	4.43	23.93	7.24	19.50	
" "	4.23	23.93	7.04	19.70	
B.M.		6.35(?)		19.58	
T.P.	2.31	24.02	2.22	21.71	
" "	2.11	24.02	2.02	21.91	
T.P.	6.40	26.44	3.98	20.04	
" "	6.19	26.44	3.77	20.25	
B.M.			3.73	22.71	
T.P.	8.87	33.13	2.18	24.24	
" "	8.67	33.12			
" "		33.11	2.00	24.44	
T.P.	5.10	33.18	5.04	28.08	
" "	4.93	33.19			
" "		33.20	4.85	28.29	
T.P.	7.38	38.77	3.80	29.39	
" "	9.18	38.76			
" "		38.75	3.62	29.57	
T.P.	5.02	39.25	4.53	34.23	
" "	4.80	39.26	4.30	34.46	
T.P.	7.52	42.44	4.34	34.92	
" "		42.45			
" "	7.37	42.46	4.17	35.09	
B.M.			4.96	34.30	
T.P.	5.69	46.99	1.15	41.30	
" "	5.58	46.98	1.05	41.40	
T.P.	4.87	44.92	6.93	40.05	
" "	4.69	44.92	6.75	40.23	
B.M.			5.68	39.24	
				39.24	

Spike in E end of cap Bridge W Line Sec 16

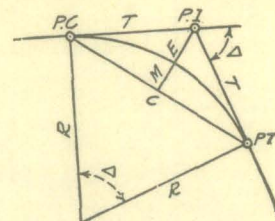
Spike in NE Cor post SW $\frac{1}{4}$ SW $\frac{1}{4}$ Sec 16
BY STA 0 13 R 7NE Cor. N. wall culvert S Line sec 16
S 1/4 14 50 BR 7

Top of boulder in pasture BR 7-A

Spike in NE Cor post SE $\frac{1}{4}$ SE $\frac{1}{4}$ Sec 20

DIETZGEN'S RAILROAD CURVE AND REDUCTION TABLES

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CURVE FORMULAS

$$\text{Radius} = R = \frac{50}{\sin. D/2} \quad (1) \text{ Degree of Curve} = D \text{ and } \sin. \frac{D}{2} = \frac{50}{R} \quad (2)$$

$$\text{Tangent} = T = R \tan \frac{\Delta}{2} \quad (3) \text{ Length of Curve} = L = 100 \frac{\Delta}{D} \quad (4)$$

$$\text{Middle ordinate} = M = R(1 - \cos. \frac{\Delta}{2}) \quad (5) = R \text{vers} \frac{\Delta}{2} \quad (6)$$

$$\text{External} = E = T \tan \frac{\Delta}{4} \quad (7) = R \div \cos. \frac{\Delta}{2} - R \quad (8) = R \text{exsec} \frac{\Delta}{2} \quad (9)$$

$$\text{Long Chord} = C = 2 R \sin. \frac{\Delta}{2} \quad (10) \Delta = \text{Central Angle}$$

EXPLANATION AND USE OF TABLES

Stations.—Given P. I.—Sta. 161 + 60.35 to find Sta. of P. C. and P. T. $\Delta = 62^\circ 10'$ $D = 8^\circ 20'$. From Table IV for 1° curve $T = 3454.1$ and $\div 8\frac{1}{4} = 414.49$ ft. From Table V correction = .36 or $T = 414.85$ ft. P. C. = Sta. P. I. — $T = 157 + 45.50$. Also from (4) $L = 746.00$ and P. T. = Sta. P. C. + $L = 164 + 91.50$.

Offsets.—Tangent offsets vary (approximately) directly with D and with square of the distance. Thus tangent offset for Sta. 158 on above curve is 2.16 ft. found as follows. From Table III tangent offset for 100 ft. = 7.27 ft. Distance = $158 - \text{Sta. P. C.} = 54.50$, hence offset = $7.27 (54.50 \div 100)^2 = 2.16$ ft. Also square of any distance divided by twice the radius equals (approximately) the distance from tangent to curve. Thus $(54.50)^2 \div (2 \times 688.26) = 2.16$ ft.

Deflections.—Deflection angle = $\frac{1}{2} D$ for 100 ft., $\frac{1}{4} D$ for 50 ft., etc. For c ft. = (in minutes) $.3 \times C \times D^\circ$ or = defl. for 1 ft. from Table III $\times C$. For Sta. 158 of above curve = $.3 \times 54.5 \times 8\frac{1}{4} = 136.2'$ or $2^\circ 16.2'$, or = $2.50 \times 54.5 = 136.2'$ from Table III. For Sta. 159 deflection angle = $2^\circ 16.2' + 8^\circ 20' \div 2 = 6^\circ 26.2'$, etc.

Externals.—May be found in similar manner to tangents. Thus E for curve above is 115.37. For from Table IV for 1° curve $E = 960.6$ for $8^\circ 20' = 960.6 \div 8\frac{1}{4} = 115.27$ and from Table V correction = .10 or $E = 115.37$. Or suppose $\Delta = 32^\circ$ and E is measured and found to be 42 ft. What is D ? From Table IV $E = 230.9$ and $\div 42 = 5.5$ or $D = 5^\circ 30'$.

TABLE I.—MINUTES IN DECIMALS OF A DEGREE.

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

TABLE II.—INCHES IN DECIMALS OF A FOOT.

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

TABLE III.—RADI, ORDINATES AND DEFLECTIONS.

Deg.	Radius	Mid. Ord.	Tan. Offset	Def. for 1 Foot	Deg.	Radius	Mid. Ord.	Tan. Offset	Def. for 1 Foot
0° 10'	34377.5	.036	.145	0.05'	7°	819.02	1.528	6.105	2.10'
20	17188.8	.073	.291	0.10	20'	781.84	1.600	6.395	2.25
30	11459.2	.109	.436	0.15	30	764.49	1.637	6.540	2.25
40	8594.42	.145	.582	0.20	40	747.89	1.673	6.685	2.30
50	6875.55	.182	.727	0.25					
1	5729.65	.218	.873	0.30	8	716.78	1.746	6.976	2.40
10	4911.15	.255	1.018	0.35	20	688.16	1.819	7.266	2.50
20	4297.28	.291	1.164	0.40	30	674.69	1.855	7.411	2.55
30	3819.83	.327	1.309	0.45	40	661.74	1.892	7.556	2.60
40	3437.87	.364	1.454	0.50					
50	3125.36	.400	1.600	0.55	9	637.28	1.965	7.846	2.70
2	2864.93	.436	1.745	0.60	20	614.56	2.037	8.136	2.80
10	2644.58	.473	1.891	0.65	30	603.80	2.074	8.281	2.85
20	2455.70	.509	2.036	0.70	40	593.42	2.110	8.426	2.90
30	2292.01	.545	2.181	0.75					
40	2148.79	.582	2.327	0.80	10	573.69	2.183	8.716	3.00
50	2022.41	.618	2.472	0.85	30	546.44	2.292	9.150	3.15
3	1910.08	.655	2.618	0.90	40	521.67	2.402	9.585	3.30
10	1809.57	.691	2.763	0.95	50	499.06	2.511	10.02	3.45
20	1719.12	.727	2.908	1.00	12	478.34	2.620	10.45	3.60
30	1637.28	.764	3.054	1.05	30	459.28	2.730	10.89	3.75
40	1562.88	.800	3.199	1.10	40	441.68	2.839	11.32	3.90
50	1494.95	.836	3.345	1.15	50	425.40	2.949	11.75	4.05
4	1432.69	.873	3.490	1.20	14	410.28	3.058	12.18	4.20
10	1375.40	.909	3.635	1.25	30	396.20	3.168	12.62	4.35
20	1322.53	.945	3.718	1.30	15	383.07	3.277	13.05	4.50
30	1273.57	.982	3.826	1.35	30	370.78	3.387	13.49	4.65
40	1228.11	1.018	4.071	1.40	40	359.27	3.496	13.92	4.80
50	1185.78	1.055	4.217	1.45	50	348.45	3.606	14.35	4.95
5	1146.28	1.091	4.362	1.50	17	338.27	3.716	14.78	5.10
10	1109.33	1.127	4.507	1.55	30	319.62	3.935	15.64	5.40
20	1074.68	1.164	4.653	1.60	40	302.94	4.155	16.51	5.70
30	1042.14	1.200	4.798	1.65	20	287.94	4.374	17.37	6.00
40	1011.51	1.237	4.943	1.70	21	274.37	4.594	18.22	6.30
50	982.64	1.273	5.088	1.75	22	262.04	4.814	19.08	6.60
6	955.37	1.309	5.234	1.80	23	250.79	5.035	19.94	6.90
10	929.57	1.346	5.379	1.85	40	240.49	5.255	20.79	7.20
20	905.13	1.382	5.524	1.90	25	231.01	5.476	21.64	7.50
30	881.95	1.418	5.669	1.95	26	222.27	5.697	22.50	7.80
40	859.92	1.455	5.814	2.00	27	214.18	5.918	23.35	8.10
					28	206.68	6.139	24.19	8.40
					29	199.70	6.360	25.04	8.70
					30	193.18	6.583	25.88	9.00

TABLE IV.—TANGENTS AND EXTERNALS TO A 1° CURVE.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
1°	50.00	.22	11°	551.70	26.50	21°	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
2	100.01	.87	12	602.21	31.56	22	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
3	150.04	1.96	13	652.81	37.07	23	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
4	200.08	3.49	14	703.51	43.03	24	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
5	250.16	5.46	15	754.32	49.44	25	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
6	300.28	7.86	16	805.25	56.31	26	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
7	350.44	10.71	17	856.30	63.63	27	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
8	400.66	13.99	18	907.49	71.42	28	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
9	450.93	17.72	19	958.81	79.67	29	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
10	501.28	21.89	20	1010.3	88.39	30	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

Note. Chord Deflection=2 times tangent deflection.

TABLE IV.—TANGENTS AND EXTERNALS TO A 1° CURVE.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
31°	1589.0	216.3	41°	2142.2	387.4	51°	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	627.2
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
32°	1643.0	230.9	42°	2199.4	407.6	52°	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
33°	1697.2	246.1	43°	2257.0	428.5	53°	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
34°	1751.7	261.8	44°	2314.9	450.0	54°	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
35°	1806.6	278.1	45°	2373.3	472.1	55°	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	483.3	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
36°	1861.7	294.9	46°	2432.1	494.8	56°	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
37°	1917.1	312.2	47°	2491.3	518.2	57°	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
38°	1972.9	330.2	48°	2551.0	542.2	58°	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
39°	2029.0	348.6	49°	2611.2	566.9	59°	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
40°	2085.4	367.7	50°	2671.8	592.3	60°	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.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
61°	3375.0	920.2	71°	4086.9	1308.2	81°	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
62°	3442.7	954.8	72°	4162.8	1352.6	82°	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
63°	3511.1	990.2	73°	4239.7	1398.0	83°	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
64°	3580.3	1026.6	74°	4317.6	1444.6	84°	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
65°	3650.2	1063.9	75°	4396.5	1492.4	85°	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
66°	3720.9	1102.2	76°	4476.5	1541.4	86°	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
67°	3792.4	1141.4	77°	4557.6	1591.6	87°	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
68°	3864.7	1181.6	78°	4639.8	1643.0	88°	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
69°	3937.9	1222.7	79°	4723.2	1695.8	89°	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
70°	4011.9	1265.0	80°	4807.7	1749.9	90°	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.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
91°	5830.5	2444.9	101°	6950.6	3278.1	111°	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
92	5933.2	2518.5	102	7075.5	3374.9	112	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
93	6037.8	2594.0	103	7203.2	3474.4	113	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
94	6144.3	2671.6	104	7333.6	3576.8	114	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
95	6252.8	2751.3	105	7467.0	3682.3	115	8993.8	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
96	6363.4	2833.2	106	7603.5	3791.0	116	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
97	6476.2	2917.3	107	7743.2	3902.9	117	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
98	6591.2	3003.8	108	7886.2	4018.2	118	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
99	6708.6	3092.7	109	8032.7	4137.1	119	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
100	6828.3	3184.1	110	8182.8	4259.7	120	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 TANGENTS AND EXTERNALS.

These corrections are to be added to the approximate values, found by dividing the tangent, or external, for a 1° curve (Table IV) by the degree of curve, in order to obtain the true tangents, or externals. Intermediate values may be obtained by interpolation.

FOR TANGENTS ADD

Central Angle	DEGREE OF 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	.79	.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
110°	.51	1.03	1.56	2.08	2.61	3.14	3.67	4.21	4.76	5.31	5.86	6.43	7.01	7.60
120°	.62	1.25	1.93	2.52	3.16	3.81	4.45	5.11	5.77	6.44	7.12	7.80	8.50	9.22

FOR EXTERNALS ADD

Central Angle	DEGREE OF 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	.217	.230	.247	.264
40°	.023	.046	.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	.331	.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	.268	.353	.438	.523	.608	.693	.777	.877	.977	1.07	1.18	1.29
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
110°	.268	.536	.806	1.08	1.35	1.63	1.91	2.20	2.48	2.76	3.05	3.35	3.66	3.96
120°	.360	.721	1.08	1.45	1.82	2.19	2.57	2.95	3.33	3.72	4.11	4.50	4.91	5.32

TABLE VI.—CORRECTIONS FOR SUB-CHORDS AND LONG CHORDS.

FOR SUB-CHORDS ADD										Excess of arc per 100 ft.	LONG CHORDS				
D	10	20	30	40	50	60	70	80	90		D	200	300	400	500
4°	.00	.00	.01	.01	.01	.01	.01	.01	.00	.02	1	199.99	299.97	399.92	499.85
6	.00	.01	.01	.02	.02	.02	.02	.01	.01	.05	2	199.97	299.88	399.70	499.39
8	.01	.02	.02	.03	.03	.03	.03	.02	.01	.08	3	199.93	299.73	399.32	498.63
10	.01	.02	.03	.04	.05	.05	.05	.04	.02	.13	4	199.88	299.51	398.78	497.57
12	.02	.04	.05	.06	.07	.07	.07	.05	.03	.18	5	199.81	299.24	398.10	496.20
14	.02	.05	.07	.08	.09	.10	.09	.07	.04	.25	6	199.73	298.90	397.26	494.53
16	.03	.06	.09	.11	.12	.12	.12	.09	.05	.33	7	199.63	298.51	396.28	492.57
18	.04	.08	.11	.14	.15	.16	.15	.12	.07	.41	8	199.51	298.05	395.14	490.31
20	.05	.10	.14	.17	.19	.20	.18	.15	.09	.51	9	199.38	297.54	393.86	487.75
22	.06	.12	.17	.21	.23	.24	.22	.18	.10	.62	10	199.24	296.96	392.42	484.90
24	.07	.14	.20	.25	.28	.28	.26	.21	.12	.74	12	198.90	295.63	389.12	478.34
26	.09	.17	.24	.29	.32	.33	.31	.25	.15	.86	14	198.51	294.06	385.22	470.65
28	.10	.19	.27	.34	.37	.38	.36	.29	.17	1.00	16	198.05	292.25	380.76	461.86
30	.11	.22	.31	.39	.43	.44	.41	.33	.19	1.15	18	197.54	290.21	375.74	452.02
32	.13	.25	.36	.44	.49	.50	.47	.38	.22	1.31	20	196.96	287.94	370.17	441.15
34	.15	.28	.40	.50	.55	.57	.53	.43	.25	1.48	22	196.32	285.44	364.06	429.30
36	.17	.32	.45	.56	.62	.64	.59	.48	.28	1.66	24	195.63	282.71	357.43	416.53
38	.18	.36	.51	.62	.70	.71	.66	.53	.31	1.86	26	194.87	279.76	350.30	402.89
40	.21	.40	.56	.69	.77	.79	.73	.59	.35	2.06	28	194.06	276.59	342.69	388.43
42	.23	.44	.62	.76	.85	.87	.81	.65	.38	2.28	30	193.18	273.20	334.61	373.20
44	.25	.48	.68	.84	.94	.96	.89	.72	.42	2.50	32	192.25	269.61	326.08	357.23
46	.27	.52	.75	.92	1.02	1.05	.98	.78	.46	2.74	34	191.26	265.81	317.12	340.73
48	.30	.57	.81	1.00	1.12	1.14	1.06	.86	.50	2.99	36	190.21	261.80	307.77	323.61
50	.32	.62	.89	1.09	1.21	1.24	1.15	.93	.55	3.24	38	189.10	257.60	298.03	305.99
52	.35	.67	.96	1.18	1.31	1.35	1.25	1.01	.59	3.52	40	187.94	253.21	287.94	287.94
54	.38	.73	1.04	1.28	1.42	1.46	1.35	1.09	.64	3.80	42	186.72	248.63	277.51	269.54
56	.41	.78	1.12	1.38	1.53	1.57	1.46	1.17	.69	4.09	44	185.44	243.87	266.78	250.85
58	.44	.84	1.20	1.48	1.65	1.69	1.57	1.26	.74	4.40	46	184.10	239.93	255.78	231.95
60	.47	.91	1.29	1.59	1.76	1.81	1.68	1.35	.80	4.72	48	182.71	233.83	244.51	212.92

NOTE.—When a chord of less than 100 ft. is used the corrections given in the above table should be added to the nominal length of chord to get the length which should be used in order that the 100 ft. points will check with those obtained by using the standard 100 ft. chord. Thus in locating a 14° curve by 25 ft. chords measure 25'.06 for each chord. Long chords are useful in passing obstacles.

TABLE VII.—MIDDLE ORDINATES FOR RAILS IN FEET.

Deg. of Curve	LENGTH OF RAILS							Deg. of Curve	LENGTH OF RAILS.						
	32	30	28	26	24	22	20		32	30	28	26	24	22	20
1°	.022	.020	.016	.013	.011	.009	.008	16°	.356	.313	.273	.236	.200	.170	.139
2	.045	.038	.034	.029	.025	.021	.017	17	.378	.333	.290	.252	.213	.180	.148
3	.037	.058	.051	.044	.037	.031	.026	18	.400	.351	.306	.265	.225	.190	.156
4	.089	.079	.069	.060	.050	.042	.035	19	.423	.371	.324	.280	.238	.201	.165
5	.112	.099	.086	.074	.063	.053	.044	20	.445	.392	.341	.296	.250	.212	.174
6	.134	.117	.102	.088	.076	.064	.052	21	.466	.410	.357	.309	.262	.222	.182
7	.156	.137	.120	.104	.088	.074	.061	22	.487	.430	.375	.325	.275	.233	.191
8	.179	.158	.137	.119	.100	.085	.070	23	.509	.450	.390	.338	.287	.243	.199
9	.201	.175	.153	.133	.112	.095	.078	24	.531	.469	.408	.354	.299	.253	.208
10	.223	.196	.171	.148	.125	.106	.087	25	.552	.486	.424	.367	.311	.263	.216
11	.245	.216	.188	.163	.139	.117	.096	26	.573	.506	.441	.382	.323	.274	.225
12	.268	.236	.206	.179	.151	.128	.105	27	.594	.524	.457	.396	.335	.284	.233
13	.290	.254	.222	.192	.163	.138	.113	28	.618	.545	.475	.411	.348	.294	.242
14	.312	.275	.239	.207	.175	.148	.122	29	.638	.564	.491	.424	.361	.303	.250
15	.334	.295	.257	.223	.188	.159	.131	30	.660	.583	.508	.438	.374	.313	.259

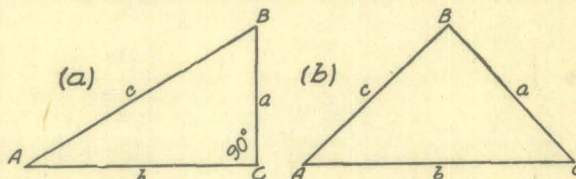
SLOPE REDUCTIONS.

When distances are measured on a slope they may be reduced to the equivalent horizontal distance by the following approximate rule:—subtract from the slope distance the square of the rise divided by twice the slope distance. Thus for a slope distance of 250.3 ft. and a rise of 15 ft. correction= $15^2 \div 2 \times 250.3 = .45$ (by slide rule) or horizontal distance= $250.3 - .45 = 249.85$. When vertical angle= $V. A.$ is measured horizontal distance= $\text{slope distance} \times \cos V. A.$ Thus for slope distance of 248.7 ft. and $V. A.$ of $4^\circ 20'$ from Table VIII $\cos = .99714$ and correction= $1 - .99714 = .00286$ per foot or total of $.286 \times 2\frac{1}{2}$ (near enough) = .57 and horizontal distance= $248.7 - .57 = 248.13$ ft.

See fig. (a).

TRIGONOMETRICAL FORMULAS.

$$\begin{aligned}\sin. & A = \frac{a}{c} \\ \cos. & A = \frac{b}{c} \\ \tan. & A = \frac{a}{b} \\ \cot. & A = \frac{b}{a} \\ \sec. & A = \frac{c}{b} \\ \text{cosec.} & A = \frac{c}{a}\end{aligned}$$



FORMULA FOR SOLVING TRIANGLES.

Given		Sought.		Right triangles. See fig. (a).	
a, c	A, B, b	$\sin. A = \frac{a}{c}, \cos. B = \frac{b}{c}, b = \sqrt{(c+a)(c-a)}$			
a, b	A, B, c	$\tan. A = \frac{a}{b}, \cot. B = \frac{b}{a}, c = \sqrt{a^2 + b^2}$			
A, a	B, b, c	$B = 90^\circ - A, b = a \cot. A, c = \frac{a}{\sin. A}$			
A, b	B, a, c	$B = 90^\circ - A, a = b \tan. A, c = \frac{b}{\cos. A}$			
A, c	B, a, b	$B = 90^\circ - A, a = c \sin. A, c = c \cos. A$			
Given		Sought.		Oblique triangles. See fig. (b).	
A, B, a	b	$b = \frac{a \sin. B}{\sin. A}$			
A, a, b	B	$\sin. B = \frac{b \sin. A}{a}$			
a, b, C	$A - B$	$\tan. \frac{1}{2}(A - B) = \frac{(a - b) \tan. \frac{1}{2}(A + B)}{a + b}$			
a, b, c	A	$\left\{ \begin{aligned} \text{If } s = \frac{1}{2}(a + b + c), \sin. \frac{1}{2} A &= \sqrt{\frac{(s - b)(s - c)}{bc}} \\ \cos. \frac{1}{2} A &= \sqrt{\frac{s(s - a)}{bc}}, \tan. \frac{1}{2} A = \sqrt{\frac{(s - b)(s - c)}{s(s - a)}} \\ \sin. A &= \frac{2V(s - a)(s - b)(s - c)}{abc} \end{aligned} \right.$			
A, B, C, a	area	$\text{area} = \frac{a^2 \sin. B \sin. C}{2 \sin. A}$			
A, b, c	area	$\text{area} = \frac{1}{2} bc \sin. A$			
a, b, c	area	$s = \frac{1}{2}(a + b + c), \text{area} = \sqrt{s(s - a)(s - b)(s - c)}$			

TABLE VIII.—NATURAL TRIGONOMETRICAL FUNCTIONS.

Angle	Sine.	Tan.	Cotg.	Cosin.		Angle	Sine.	Tan.	Cotg.	Cosin.	
0°	0	0	00	1	90	0°	1	0	00	0	90
10	.0029	.0029	343.8	.99998	50	10	.1392	.1405	7.115	.99027	82
20	.0058	.0058	171.9	.99998	40	20	.1421	.1435	6.968	.98986	50
30	.0087	.0087	114.6	.99996	30	30	.1449	.1465	6.827	.98944	40
40	.0116	.0116	85.94	.99993	20	40	.1478	.1495	6.691	.98902	30
50	.0145	.0145	68.75	.99989	10	50	.1507	.1524	6.561	.98858	20
							.1536	.1554	6.435	.98814	10
1	.0175	.0175	57.29	.99985	89	9	.1564	.1584	6.314	.98769	81
10	.0204	.0204	49.10	.99979	50	10	.1593	.1614	6.197	.98723	50
20	.0233	.0233	42.96	.99973	40	20	.1622	.1644	6.084	.98676	40
30	.0262	.0262	38.19	.99966	30	30	.1650	.1673	5.976	.98629	30
40	.0291	.0291	34.37	.99958	20	40	.1679	.1703	5.871	.98580	20
50	.0320	.0320	31.24	.99949	10	50	.1708	.1733	5.769	.98531	10
2	.0349	.0349	28.64	.99939	88	10	.1736	.1763	5.671	.98481	80
10	.0378	.0378	26.43	.99929	50	10	.1765	.1793	5.576	.98430	50
20	.0407	.0407	24.54	.99917	40	20	.1794	.1823	5.485	.98378	40
30	.0436	.0437	22.90	.99905	30	30	.1822	.1853	5.396	.98325	30
40	.0465	.0466	21.47	.99892	20	40	.1851	.1883	5.309	.98272	20
50	.0494	.0495	20.21	.99878	10	50	.1880	.1914	5.226	.98218	10
3	.0523	.0524	19.08	.99863	87	11	.1908	.1944	5.145	.98163	79
10	.0552	.0553	18.07	.99847	50	10	.1937	.1974	5.066	.98107	50
20	.0581	.0582	17.17	.99831	40	20	.1965	.2004	4.989	.98050	40
30	.0610	.0612	16.35	.99813	30	30	.1994	.2035	4.915	.97992	30
40	.0640	.0641	15.60	.99795	20	40	.2022	.2065	4.843	.97934	20
50	.0669	.0670	14.92	.99776	10	50	.2051	.2095	4.773	.97875	10
4	.0698	.0699	14.30	.99756	86	12	.2079	.2126	4.705	.97815	78
10	.0727	.0729	13.73	.99736	50	10	.2108	.2156	4.638	.97754	50
20	.0756	.0758	13.20	.99714	40	20	.2136	.2186	4.574	.97692	40
30	.0785	.0787	12.71	.99692	30	30	.2164	.2217	4.511	.97630	30
40	.0814	.0816	12.25	.99668	20	40	.2193	.2247	4.449	.97566	20
50	.0843	.0846	11.83	.99644	10	50	.2221	.2278	4.390	.97502	10
5	.0872	.0875	11.43	.99619	85	13	.2250	.2309	4.331	.97437	77
10	.0901	.0904	11.06	.99594	50	10	.2278	.2339	4.275	.97371	50
20	.0929	.0934	10.71	.99567	40	20	.2306	.2370	4.219	.97304	40
30	.0958	.0963	10.39	.99540	30	30	.2334	.2401	4.165	.97237	30
40	.0987	.0992	10.08	.99511	20	40	.2363	.2432	4.113	.97169	20
50	.1016	.1022	9.788	.99482	10	50	.2391	.2462	4.061	.97100	10
6	.1045	.1051	9.514	.99452	84	14	.2419	.2493	4.011	.97030	76
10	.1074	.1080	9.255	.99421	50	10	.2447	.2524	3.962	.96959	50
20	.1103	.1110	9.010	.99390	40	20	.2476	.2555	3.914	.96887	40
30	.1132	.1139	8.777	.99357	30	30	.2504	.2586	3.867	.96815	30
40	.1161	.1169	8.556	.99324	20	40	.2532	.2617	3.821	.96742	20
50	.1190	.1198	8.345	.99290	10	50	.2560	.2648	3.776	.96667	10
7	.1219	.1228	8.144	.99255	83	15	.2588	.2679	3.732	.96593	75
10	.1248	.1257	7.953	.99219	50	10	.2616	.2711	3.689	.96517	50
20	.1276	.1287	7.770	.99182	40	20	.2644	.2742	3.647	.96440	40
30	.1305	.1317	7.596	.99144	30	30	.2672	.2773	3.606	.96363	30
40	.1334	.1346	7.429	.99106	20	40	.2700	.2805	3.566	.96285	20
50	.1363	.1376	7.269	.99067	10	50	.2728	.2836	3.526	.96206	10
											74
Cosin.	Cotg.	Tan.	Sine.	Angle.		Cosin.	Cotg.	Tan.	Sine.	Angle.	

TABLE VIII.—NATURAL TRIGONOMETRICAL FUNCTIONS.

Angle	Sine.	Tan.	Cotg.	Cosin.		Angle	Sine.	Tan.	Cotg.	Cosin.	
16	.2756	.2867	3.487	.96126	74	24	.4067	.4452	2.246	.91355	66
10	.2784	.2899	3.450	.96046	50	10	.4094	.4487	2.229	.91236	50
20	.2812	.2931	3.412	.95964	40	20	.4120	.4522	2.211	.91116	40
30	.2840	.2962	3.376	.95882	30	30	.4147	.4557	2.194	.90996	30
40	.2868	.2994	3.340	.95799	20	40	.4173	.4592	2.177	.90875	20
50	.2896	.3026	3.305	.95715	10	50	.4200	.4628	2.161	.90753	10
17	.2924	.3057	3.271	.95615	73	25	.4226	.4663	2.145	.90631	65
10	.2952	.3089	3.237	.95545	50	10	.4253	.4699	2.128	.90507	50
20	.2979	.3121	3.204	.95459	40	20	.4279	.4734	2.112	.90383	40
30	.3007	.3153	3.172	.95372	30	30	.4305	.4770	2.097	.90259	30
40	.3035	.3185	3.140	.95284	20	40	.4331	.4806	2.081	.90133	20
50	.3062	.3217	3.108	.95195	10	50	.4358	.4841	2.066	.90007	10
18	.3090	.3249	3.078	.95106	72	26	.4384	.4877	2.050	.89879	64
10	.3118	.3281	3.048	.95015	50	10	.4410	.4913	2.035	.89752	50
20	.3145	.3314	3.018	.94924	40	20	.4436	.4950	2.020	.89623	40
30	.3173	.3346	2.989	.94832	30	30	.4462	.4986	2.006	.89493	30
40	.3201	.3378	2.960	.94740	20	40	.4488	.5022	1.991	.89363	20
50	.3228	.3411	2.932	.94646	10	50	.4514	.5059	1.977	.89232	10
19	.3256	.3443	2.904	.94552	71	27	.4540	.5095	1.963	.89101	63
10	.3283	.3476	2.877	.94457	50	10	.4566	.5132	1.949	.88968	50
20	.3311	.3508	2.850	.94361	40	20	.4592	.5169	1.935	.88835	40
30	.3338	.3541	2.824	.94264	30	30	.4617	.5206	1.921	.88701	30
40	.3365	.3574	2.798	.94167	20	40	.4643	.5243	1.907	.88566	20
50	.3393	.3607	2.773	.94068	10	50	.4669	.5280	1.894	.88431	10
20	.3420	.3640	2.747	.93969	70	28	.4695	.5317	1.881	.88295	62
10	.3448	.3673	2.723	.93869	50	10	.4720	.5354	1.868	.88158	50
20	.3475	.3706	2.699	.93769	40	20	.4746	.5392	1.855	.88020	40
30	.3502	.3739	2.675	.93667	30	30	.4772	.5430	1.842	.87882	30
40	.3529	.3772	2.651	.93565	20	40	.4797	.5467	1.829	.87743	20
50	.3557	.3805	2.628	.93462	10	50	.4823	.5505	1.816	.87603	10
21	.3584	.3839	2.605	.93358	69	29	.4848	.5543	1.804	.87462	61
10	.3611	.3872	2.583	.93253	50	10	.4874	.5581	1.792	.87321	50
20	.3638	.3906	2.560	.93148	40	20	.4899	.5619	1.780	.87178	40
30	.3665	.3939	2.539	.93042	30	30	.4924	.5658	1.767	.87036	30
40	.3692	.3973	2.517	.92935	20	40	.4950	.5696	1.756	.86892	20
50	.3719	.4006	2.496	.92827	10	50	.4975	.5735	1.744	.86748	10
22	.3746	.4040	2.475	.92718	68	30	.5000	.5774	1.732	.86603	60
10	.3773	.4074	2.455	.92609	50	10	.5025	.5812	1.720	.86457	50
20	.3800	.4108	2.434	.92499	40	20	.5050	.5851	1.709	.86310	40
30	.3827	.4142	2.414	.92388	30	30	.5075	.5890	1.698	.86163	30
40	.3854	.4176	2.394	.92276	20	40	.5100	.5930	1.686	.86015	20
50	.3881	.4210	2.375	.92164	10	50	.5125	.5969	1.675	.85866	10
23	.3907	.4245	2.356	.92050	67	31	.5150	.6009	1.664	.85717	59
10	.3934	.4279	2.337	.91936	50	10	.5175	.6049	1.653	.85567	50
20	.3961	.4314	2.318	.91822	40	20	.5200	.6088	1.643	.85416	40
30	.3987	.4348	2.300	.91706	30	30	.5225	.6128	1.632	.85264	30
40	.4014	.4383	2.282	.91590	20	40	.5250	.6168	1.621	.85112	20
50	.4041	.4417	2.264	.91472	10	50	.5275	.6208	1.611	.84959	10
											58
Cosin.	Cotg.	Tan.	Sine.	Angle.		Cosin.	Cotg.	Tan.	Sine.	Angle.	

TABLE VIII.—NATURAL TRIGONOMETRICAL FUNCTIONS.

Angle	Sine.	Tan.	Cotg.	Cosin.		Angle	Sine.	Tan.	Cotg.	Cosin.	
or						or					
32	.5299	.6249	1.600	.84805	58	30	.6225	.7954	1.257	.78261	30
10	.5324	.6289	1.590	.84650	50	40	.6248	.8002	1.250	.78079	20
20	.5348	.6330	1.580	.84495	40	50	.6271	.8050	1.242	.77897	10
30	.5373	.6371	1.570	.84339	30	39	.6293	.8098	1.235	.77715	51
40	.5398	.6412	1.560	.84182	20	10	.6316	.8146	1.228	.77531	50
50	.5422	.6453	1.550	.84025	10	20	.6338	.8195	1.220	.77347	40
33	.5446	.6494	1.540	.83867	57	30	.6361	.8243	1.213	.77162	30
10	.5471	.6536	1.530	.83708	50	40	.6383	.8292	1.206	.76977	20
20	.5495	.6577	1.520	.83549	40	50	.6406	.8342	1.199	.76791	10
30	.5519	.6619	1.511	.83389	30	40	.6428	.8391	1.192	.76604	50
40	.5544	.6661	1.501	.83228	20	10	.6450	.8441	1.185	.76417	50
50	.5568	.6703	1.492	.83066	10	20	.6472	.8491	1.178	.76229	40
34	.5592	.6745	1.483	.82904	56	30	.6494	.8541	1.171	.76041	30
10	.5616	.6787	1.473	.82741	50	40	.6517	.8591	1.164	.75851	20
20	.5640	.6830	1.464	.82577	40	50	.6539	.8642	1.157	.75661	10
30	.5664	.6873	1.455	.82413	30	41	.6561	.8693	1.150	.75471	49
40	.5688	.6916	1.446	.82248	20	10	.6583	.8744	1.144	.75280	50
50	.5712	.6959	1.437	.82082	10	20	.6604	.8796	1.137	.75088	40
35	.5736	.7002	1.428	.81915	55	30	.6626	.8847	1.130	.74896	30
10	.5760	.7046	1.419	.81748	50	40	.6648	.8899	1.124	.74703	20
20	.5783	.7089	1.411	.81580	40	50	.6670	.8952	1.117	.74509	10
30	.5807	.7133	1.402	.81412	30	42	.6691	.9004	1.111	.74314	48
40	.5831	.7177	1.393	.81242	20	10	.6713	.9057	1.104	.74120	50
50	.5854	.7221	1.385	.81072	10	20	.6734	.9110	1.098	.73924	40
36	.5878	.7265	1.376	.80902	54	30	.6756	.9163	1.091	.73728	30
10	.5901	.7310	1.368	.80730	50	40	.6777	.9217	1.085	.73531	20
20	.5925	.7355	1.360	.80558	40	50	.6799	.9271	1.079	.73333	10
30	.5948	.7400	1.351	.80386	30	43	.6820	.9325	1.072	.73135	47
40	.5972	.7445	1.343	.80212	20	10	.6841	.9380	1.066	.72937	50
50	.5995	.7490	1.335	.80038	10	20	.6862	.9435	1.060	.72737	40
37	.6018	.7536	1.327	.79864	53	30	.6884	.9490	1.054	.72537	30
10	.6041	.7581	1.319	.79688	50	40	.6905	.9545	1.048	.72337	20
20	.6065	.7627	1.311	.79512	40	50	.6926	.9601	1.042	.72136	10
30	.6088	.7673	1.303	.79335	30	44	.6947	.9657	1.036	.71934	46
40	.6111	.7720	1.295	.79158	20	10	.6967	.9713	1.030	.71732	50
50	.6134	.7766	1.288	.78980	10	20	.6988	.9770	1.024	.71529	40
38	.6157	.7813	1.280	.78801	52	30	.7009	.9827	1.018	.71325	30
10	.6180	.7860	1.272	.78622	50	40	.7030	.9884	1.012	.71121	20
20	.6202	.7907	1.265	.78442	40	50	.7050	.9942	1.006	.70916	10
							.7071	1.	1.	.70711	45
	Cosin.	Cotg.	Tan.	Sine.	Angle.		Cosin.	Cotg.	Tan.	Sine.	Angle.

TABLE IX.—CALCULATION OF EARTHWORK.

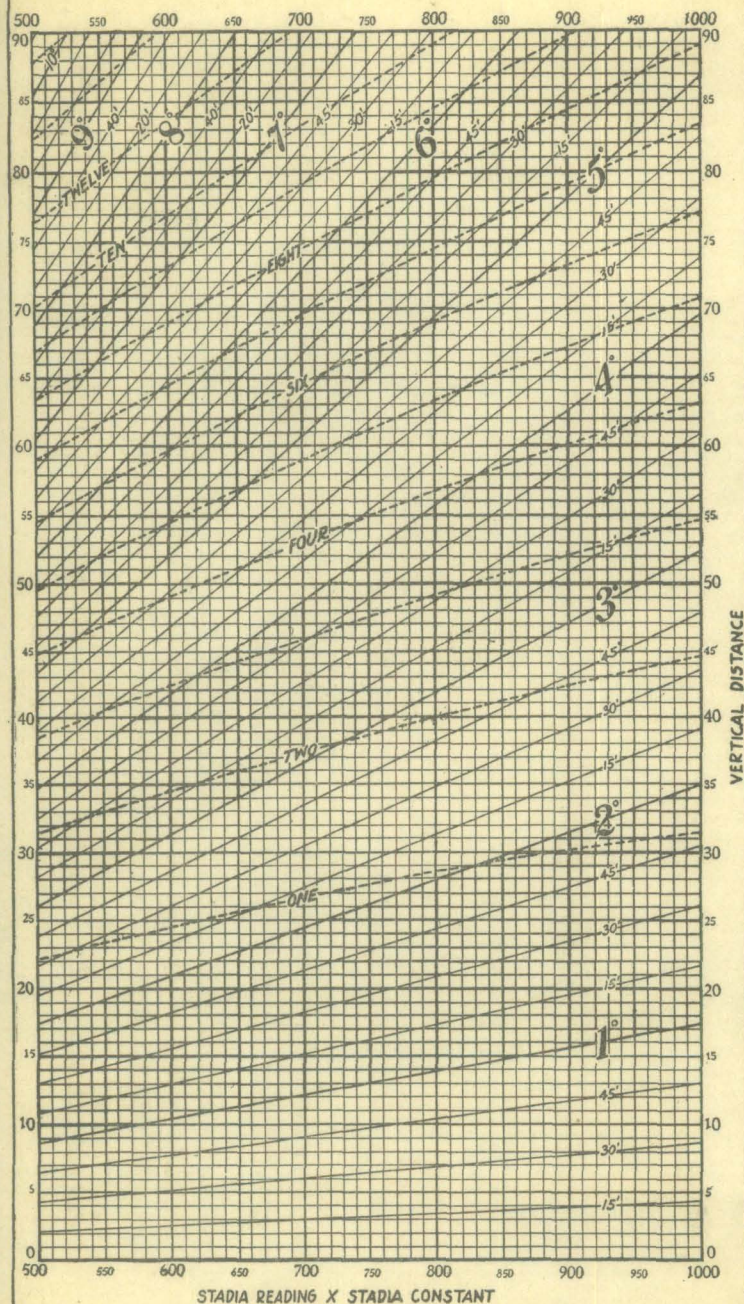
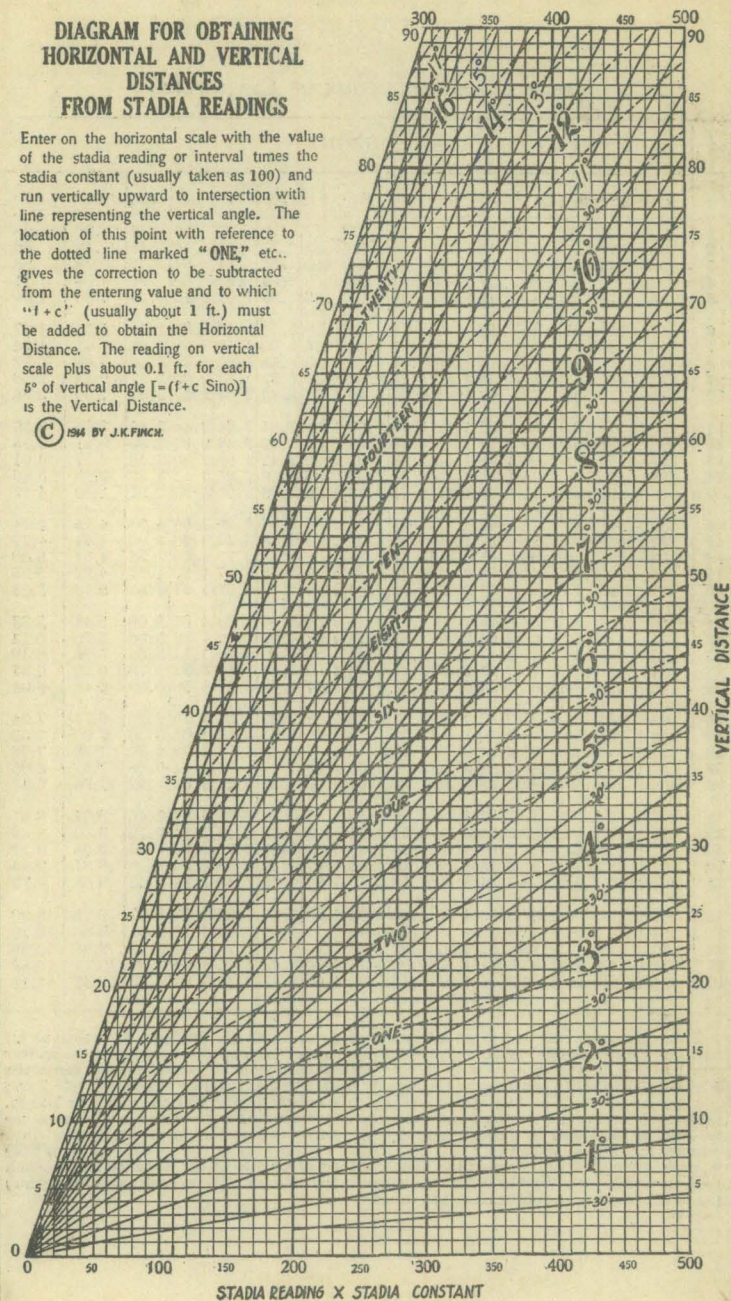
Width	HEIGHT														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	.02	.04	.06	.07	.09	.11	.13	.15	.17	.18	.20	.22	.24	.26	.28
2	.04	.07	.11	.15	.18	.22	.26	.30	.33	.37	.41	.44	.48	.52	.56
3	.06	.11	.17	.22	.28	.33	.39	.44	.50	.56	.61	.67	.72	.78	.83
4	.07	.15	.22	.30	.37	.44	.52	.59	.67	.74	.81	.89	.96	1.04	1.11
5	.09	.19	.28	.37	.46	.56	.65	.74	.83	.93	1.02	1.11	1.20	1.30	1.39
6	.11	.22	.33	.44	.56	.67	.78	.89	1.00	1.11	1.22	1.33	1.44	1.55	1.67
7	.13	.26	.39	.52	.65	.78	.91	1.04	1.16	1.30	1.42	1.55	1.68	1.81	1.94
8	.15	.30	.44	.59	.74	.89	1.04	1.19	1.33	1.48	1.63	1.78	1.92	2.08	2.22
9	.17	.33	.50	.67	.83	1.00	1.17	1.33	1.50	1.67	1.83	2.00	2.17	2.33	2.50
10	.18	.37	.56	.74	.93	1.11	1.30	1.48	1.67	1.85	2.04	2.22	2.41	2.59	2.78
11	.20	.41	.61	.82	1.02	1.22	1.43	1.63	1.83	2.04	2.24	2.44	2.65	2.85	3.06
12	.22	.44	.67	.89	1.11	1.33	1.56	1.78	2.00	2.22	2.44	2.67	2.89	3.11	3.33
13	.24	.48	.72	.96	1.20	1.44	1.68	1.92	2.16	2.41	2.65	2.89	3.13	3.37	3.61
14	.26	.52	.78	1.04	1.30	1.55	1.81	2.08	2.33	2.59	2.85	3.11	3.37	3.63	3.89
15	.28	.56	.83	1.11	1.39	1.67	1.94	2.22	2.50	2.78	3.06	3.33	3.61	3.89	4.17
16	.30	.59	.89	1.18	1.48	1.78	2.07	2.37	2.67	2.96	3.26	3.56	3.85	4.15	4.44
17	.31	.63	.94	1.26	1.57	1.89	2.20	2.52	2.83	3.15	3.46	3.78	4.09	4.41	4.72
18	.33	.67	1.00	1.33	1.67	2.00	2.33	2.67	3.00	3.33	3.67	4.00	4.33	4.67	5.00
19	.35	.70	1.06	1.41	1.76	2.11	2.46	2.82	3.17	3.52	3.87	4.22	4.57	4.92	5.28
20	.37	.74	1.11	1.48	1.85	2.22	2.59	2.96	3.33	3.70	4.07	4.44	4.81	5.18	5.56
21	.39	.78	1.17	1.55	1.94	2.33	2.72	3.11	3.50	3.89	4.28	4.67	5.06	5.44	5.83
22	.41	.81	1.22	1.63	2.04	2.44	2.85	3.26	3.67	4.07	4.48	4.89	5.30	5.70	6.11
23	.43	.85	1.28	1.70	2.13	2.56	2.98	3.41	3.83	4.26	4.68	5.11	5.54	5.96	6.39
24	.44	.89	1.33	1.78	2.22	2.67	3.11	3.56	4.00	4.44	4.89	5.33	5.78	6.22	6.67
25	.46	.92	1.39	1.85	2.31	2.78	3.24	3.70	4.17	4.63	5.09	5.56	6.02	6.48	6.94
26	.48	.96	1.44	1.92	2.41	2.89	3.37	3.85	4.33	4.82	5.30	5.78	6.26	6.74	7.24
27	.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50
28	.52	1.04	1.55	2.07	2.59	3.11	3.63	4.15	4.67	5.18	5.70	6.22	6.74	7.26	7.78
29	.54	1.07	1.61	2.15	2.68	3.22	3.76	4.30	4.83	5.37	5.91	6.44	6.98	7.52	8.06
30	.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00	5.55	6.11	6.67	7.22	7.78	8.33
31	.57	1.15	1.72	2.30	2.87	3.44	4.02	4.59	5.17	5.74	6.32	6.89	7.46	8.04	8.61
32	.59	1.18	1.78	2.37	2.96	3.56	4.15	4.74	5.33	5.92	6.52	7.11	7.70	8.30	8.89
33	.61	1.22	1.83	2.44	3.05	3.67	4.28	4.89	5.50	6.11	6.72	7.33	7.94	8.55	9.17
34	.63	1.26	1.89	2.52	3.15	3.78	4.40	5.04	5.67	6.29	6.93	7.56	8.18	8.81	9.44
35	.65	1.30	1.94	2.59	3.24	3.89	4.53	5.18	5.83	6.48	7.13	7.78	8.42	9.08	9.72
36	.67	1.33	2.00	2.67	3.33	4.00	4.66	5.33	6.00	6.67	7.33	8.00	8.67	9.33	10.00
37	.68	1.37	2.06	2.74	3.42	4.11	4.79	5.48	6.17	6.85	7.54	8.22	8.91	9.59	10.28
38	.70	1.41	2.11	2.82	3.52	4.22	4.92	5.63	6.33	7.03	7.74	8.44	9.15	9.85	10.56
39	.72	1.44	2.17	2.89	3.61	4.33	5.05	5.78	6.50	7.22	7.95	8.67	9.39	10.11	10.83
40	.74	1.48	2.22	2.96	3.70	4.44	5.18	5.92	6.67	7.41	8.15	8.89	9.63	10.37	11.11

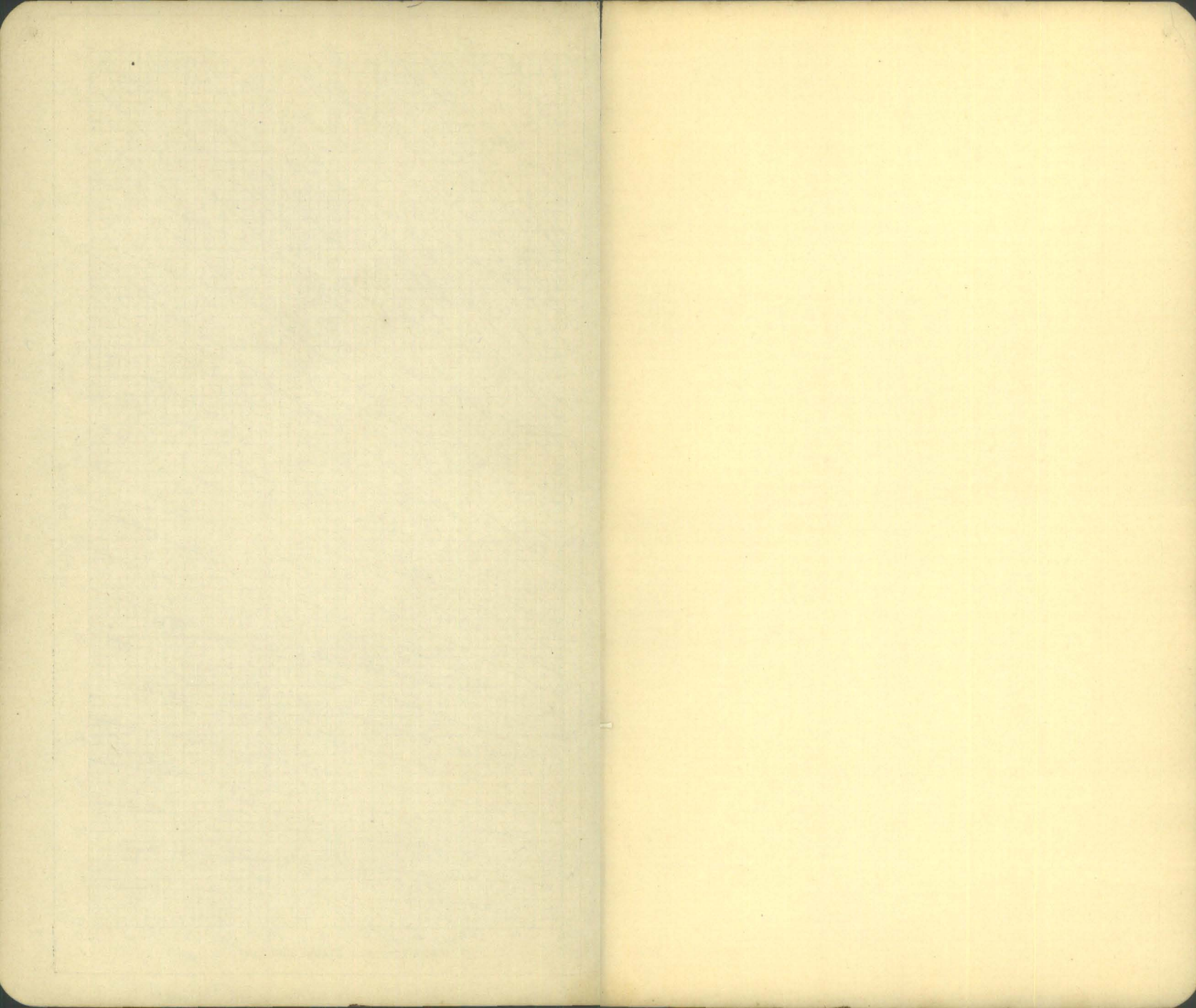
Table gives cu. yds. in 1 ft. of a triangle of given width and height. Corrections for tenths of width are one tenth the values found under each height considering the widths from 1 to 9 as tenths and similarly the corrections for tenths of height are one tenth the figures opposite width considering the heights from 1 to 9 as tenths. Thus if $w = 16.2$ and $h = 5.3$, cu. yds. $= 1.48 + .028 + .089 = 1.597$ cu. yds. or practically 160 cu. yds. per 100 ft. If w exceeds 40 ft., use one half and multiply result by 2, if both w and h are large use one half of each and multiply result by 4. Any cross-section may be divided into triangles by the following rule. To the triangle of the sum of the outside cuts (or fills) $= h$, and $\frac{1}{2}$ the roadbed $= w$, add the triangles formed by taking the distance out to each break in turn ($= w$'s) by the difference between the cuts (or fills) on each side of it ($= h$'s) always subtracting the outer from the inner.

DIAGRAM FOR OBTAINING HORIZONTAL AND VERTICAL DISTANCES FROM STADIA READINGS

Enter on the horizontal scale with the value of the stadia reading or interval times the stadia constant (usually taken as 100) and run vertically upward to intersection with line representing the vertical angle. The location of this point with reference to the dotted line marked "ONE," etc., gives the correction to be subtracted from the entering value and to which "+c" (usually about 1 ft.) must be added to obtain the Horizontal Distance. The reading on vertical scale plus about 0.1 ft. for each 5° of vertical angle $[(f+c) \sin \alpha]$ is the Vertical Distance.

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BR 28

Sta 35 H1 - 3 Elev

5.95 592

49.97

= 54.293 Mann

1 5.90

2 5.160

3 5.45

4 4.90

5 3.75

5+35 2.90

End of 1st sec 32

75' Not sec 20

DISTANCES FROM CENTER OF ROADWAY FOR
CROSS-SECTIONING.

Roadway 16 feet wide. Side Slopes 1 on 1½.

For Single Track Embankment.

H	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	H
0	8.0	8.2	8.3	8.5	8.6	8.8	8.9	9.1	9.2	9.4	0
1	9.5	9.7	9.8	10.0	10.1	10.3	10.4	10.6	10.7	10.9	1
2	11.0	11.2	11.3	11.5	11.6	11.8	11.9	12.1	12.2	12.4	2
3	12.5	12.7	12.8	13.0	13.1	13.3	13.4	13.6	13.7	13.9	3
4	14.0	14.2	14.3	14.5	14.6	14.8	14.9	15.1	15.2	15.4	4
5	15.5	15.7	15.8	16.0	16.1	16.3	16.4	16.6	16.7	16.9	5
6	17.0	17.2	17.3	17.5	17.6	17.8	17.9	18.1	18.2	18.4	6
7	18.5	18.7	18.8	19.0	19.1	19.3	19.4	19.6	19.7	19.9	7
8	20.0	20.2	20.3	20.5	20.6	20.8	20.9	21.1	21.2	21.4	8
9	21.5	21.7	21.8	22.0	22.1	22.3	22.4	22.6	22.7	22.9	9
10	23.0	23.2	23.3	23.5	23.6	23.8	23.9	24.1	24.2	24.4	10
11	24.5	24.7	24.8	25.0	25.1	25.3	25.4	25.6	25.7	25.9	11
12	26.0	26.2	26.3	26.5	26.6	26.8	26.9	27.1	27.2	27.4	12
13	27.5	27.7	27.8	28.0	28.1	28.3	28.4	28.6	28.7	28.9	13
14	29.0	29.2	29.3	29.5	29.6	29.8	29.9	30.1	30.2	30.4	14
15	30.5	30.7	30.8	31.0	31.1	31.3	31.4	31.6	31.7	31.9	15
16	32.0	32.2	32.3	32.5	32.6	32.8	32.9	33.1	33.2	33.4	16
17	33.5	33.7	33.8	34.0	34.1	34.3	34.4	34.6	34.7	34.9	17
18	35.0	35.2	35.3	35.5	35.6	35.8	35.9	36.1	36.2	36.4	18
19	36.5	36.7	36.8	37.0	37.1	37.3	37.4	37.6	37.7	37.9	19
20	38.0	38.2	38.3	38.5	38.6	38.8	38.9	39.1	39.2	39.4	20
21	39.5	39.7	39.8	40.0	40.1	40.3	40.4	40.6	40.7	40.9	21
22	41.0	41.2	41.3	41.5	41.6	41.8	41.9	42.1	42.2	42.4	22
23	42.5	42.7	42.8	43.0	43.1	43.3	43.4	43.6	43.7	43.9	23
24	44.0	44.2	44.3	44.5	44.6	44.8	44.9	45.1	45.2	45.4	24
25	45.5	45.7	45.8	46.0	46.1	46.3	46.4	46.6	46.7	46.9	25
26	47.0	47.2	47.3	47.5	47.6	47.8	47.9	48.1	48.2	48.4	26
27	48.5	48.7	48.8	49.0	49.1	49.3	49.4	49.6	49.7	49.9	27
28	50.0	50.2	50.3	50.5	50.6	50.8	50.9	51.1	51.2	51.4	28
29	51.5	51.7	51.8	52.0	52.1	52.3	52.4	52.6	52.7	52.9	29
30	53.0	53.2	53.3	53.5	53.6	53.8	53.9	54.1	54.2	54.4	30
31	54.5	54.7	54.8	55.0	55.1	55.3	55.4	55.6	55.7	55.9	31
32	56.0	56.2	56.2	56.5	56.6	56.8	56.9	57.1	57.2	57.4	32
33	57.5	57.7	57.8	58.0	58.1	58.3	58.4	58.6	58.7	58.9	33
34	59.0	59.2	59.3	59.5	59.6	59.8	59.9	60.1	60.2	60.4	34
35	60.5	60.7	60.8	61.0	61.1	61.3	61.4	61.6	61.7	61.9	35
36	62.0	62.2	62.3	62.5	62.6	62.8	62.9	63.1	63.2	63.4	36
37	63.5	63.7	63.8	64.0	64.1	64.3	64.4	64.6	64.7	64.9	37
38	65.0	65.2	65.3	65.5	65.6	65.8	65.9	66.1	66.2	66.4	38
39	66.5	66.7	66.8	67.0	67.1	67.3	67.4	67.6	67.7	67.9	39
40	68.0	68.2	68.3	68.5	68.6	68.8	68.9	69.1	69.2	69.4	40

Example—If point is 22.6 ft. above grade, how far should it be from center line to be a slope stake point? Ans. from Table 41.9. For same slopes but other widths of roadbed correct above figures by one-half difference in width of roadbed; thus in example above for 20 ft. roadbed distance will be $41.9 + (20 - 16) \div 2$ or 2 ft. added to 41.9 = 43.9. For slopes of 1 on 1 see inside of front cover.