K & E

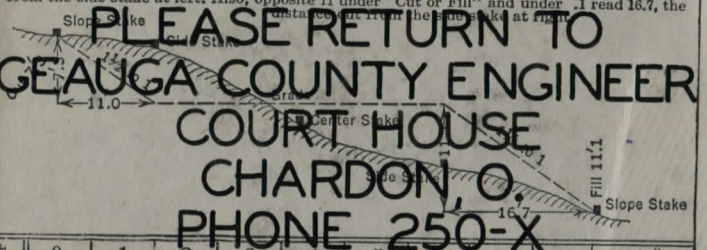
FIELD BOOK

1360

DISTANCES FROM SIDE STAKES FOR CROSS-SECTIONING

Roadway of any Width. Side Slopes 1½ to 1.

In the figure below: opposite 7 under "Cut or Fill" and under .3 read 11.0, the distance out from the side stake at left. Also, opposite 11 under "Cut or Fill" and under .1 read 16.7, the distance out from the side stake at right.



Cut or Fill	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	Cut or Fill
	Distance out from Side or Shoulder Stake										
0	0.0	0.2	0.3	0.5	0.6	0.8	0.9	1.1	1.2	1.4	0
1	1.5	1.7	1.8	2.0	2.1	2.3	2.4	2.6	2.7	2.9	1
2	3.0	3.2	3.3	3.5	3.6	3.8	3.9	4.1	4.2	4.4	2
3	4.5	4.7	4.8	5.0	5.1	5.3	5.4	5.6	5.7	5.9	3
4	6.0	6.2	6.3	6.5	6.6	6.8	6.9	7.1	7.2	7.4	4
5	7.5	7.7	7.8	8.0	8.1	8.3	8.4	8.6	8.7	8.9	5
6	9.0	9.2	9.3	9.5	9.6	9.8	9.9	10.1	10.2	10.4	6
7	10.5	10.7	10.8	11.0	11.1	11.3	11.4	11.6	11.7	11.9	7
8	12.0	12.2	12.3	12.5	12.6	12.8	12.9	13.1	13.2	13.4	8
9	13.5	13.7	13.8	14.0	14.1	14.3	14.4	14.6	14.7	14.9	9
10	15.0	15.2	15.3	15.5	15.6	15.8	15.9	16.1	16.2	16.4	10
11	16.5	16.7	16.8	17.0	17.1	17.3	17.4	17.6	17.7	17.9	11
12	18.0	18.2	18.3	18.5	18.6	18.8	18.9	19.1	19.2	19.4	12
13	19.5	19.7	19.8	20.0	20.1	20.3	20.4	20.6	20.7	20.9	13
14	21.0	21.2	21.3	21.5	21.6	21.8	21.9	22.1	22.2	22.4	14
15	22.5	22.7	22.8	23.0	23.1	23.3	23.4	23.6	23.7	23.9	15
16	24.0	24.2	24.3	24.5	24.6	24.8	24.9	25.1	25.2	25.4	16
17	25.5	25.7	25.8	26.0	26.1	26.3	26.4	26.6	26.7	26.9	17
18	27.0	27.2	27.3	27.5	27.6	27.8	27.9	28.1	28.2	28.4	18
19	28.5	28.7	28.8	29.0	29.1	29.3	29.4	29.6	29.7	29.9	19
20	30.0	30.2	30.3	30.5	30.6	30.8	30.9	31.1	31.2	31.4	20
21	31.5	31.7	31.8	32.0	32.1	32.3	32.4	32.6	32.7	32.9	21
22	33.0	33.2	33.3	33.5	33.6	33.8	33.9	34.1	34.2	34.4	22
23	34.5	34.7	34.8	35.0	35.1	35.3	35.4	35.6	35.7	35.9	23
24	36.0	36.2	36.3	36.5	36.6	36.8	36.9	37.1	37.2	37.4	24
25	37.5	37.7	37.8	38.0	38.1	38.3	38.4	38.6	38.7	38.9	25
26	39.0	39.2	39.3	39.5	39.6	39.8	39.9	40.1	40.2	40.4	26
27	40.5	40.7	40.8	41.0	41.1	41.3	41.4	41.6	41.7	41.9	27
28	42.0	42.2	42.3	42.5	42.6	42.8	42.9	43.1	43.2	43.4	28
29	43.5	43.7	43.8	44.0	44.1	44.3	44.4	44.6	44.7	44.9	29
30	45.0	45.2	45.3	45.5	45.6	45.8	45.9	46.1	46.2	46.4	30
31	46.5	46.7	46.8	47.0	47.1	47.3	47.4	47.6	47.7	47.9	31
32	48.0	48.2	48.3	48.5	48.6	48.8	48.9	49.1	49.2	49.4	32
33	49.5	49.7	49.8	50.0	50.1	50.3	50.4	50.6	50.7	50.9	33
34	51.0	51.2	51.3	51.5	51.6	51.8	51.9	52.1	52.2	52.4	34
35	52.5	52.7	52.8	53.0	53.1	53.3	53.4	53.6	53.7	53.9	35
36	54.0	54.2	54.3	54.5	54.6	54.8	54.9	55.1	55.2	55.4	36
37	55.5	55.7	55.8	56.0	56.1	56.3	56.4	56.6	56.7	56.9	37
38	57.0	57.2	57.3	57.5	57.6	57.8	57.9	58.1	58.2	58.4	38
39	58.5	58.7	58.8	59.0	59.1	59.3	59.4	59.6	59.7	59.9	39
40	60.0	60.2	60.3	60.5	60.6	60.8	60.9	61.1	61.2	61.4	40

KEUFFEL & ESSER CO., N. Y.

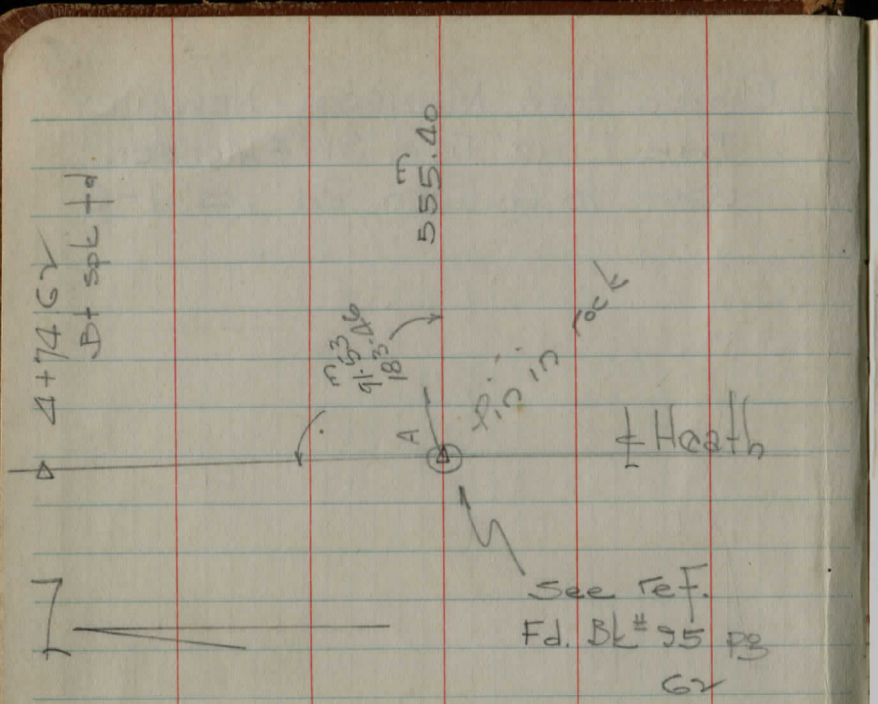
For Curve Tables see end of book.

F98 Munson-Newbury Twp Line & Cedar Rd E&F pg 1 — # 13
Levels Claridon-Troy Rd (B10 south to
F109 - Hall Rd pgs 1 6 et seqs 7
CHAGRIN RIVER BRIDGE #16 Sec C 22
CHAGRIN River BRIDGE (Sperry Rd) #12 25
F144 Pekin Rd - Sperry to Auburn 30
Pekin Rd. - East of Auburn to Bass Lake Road. 29
F98 Cedar Rd Structure 700' E. Rockhaven 34
F114 Forest Rd (Claridon) Yellow sheets 35

175

The paper in this book No. F360 is made of 100% high grade rag stock with a WATER RESISTING surface sizing.

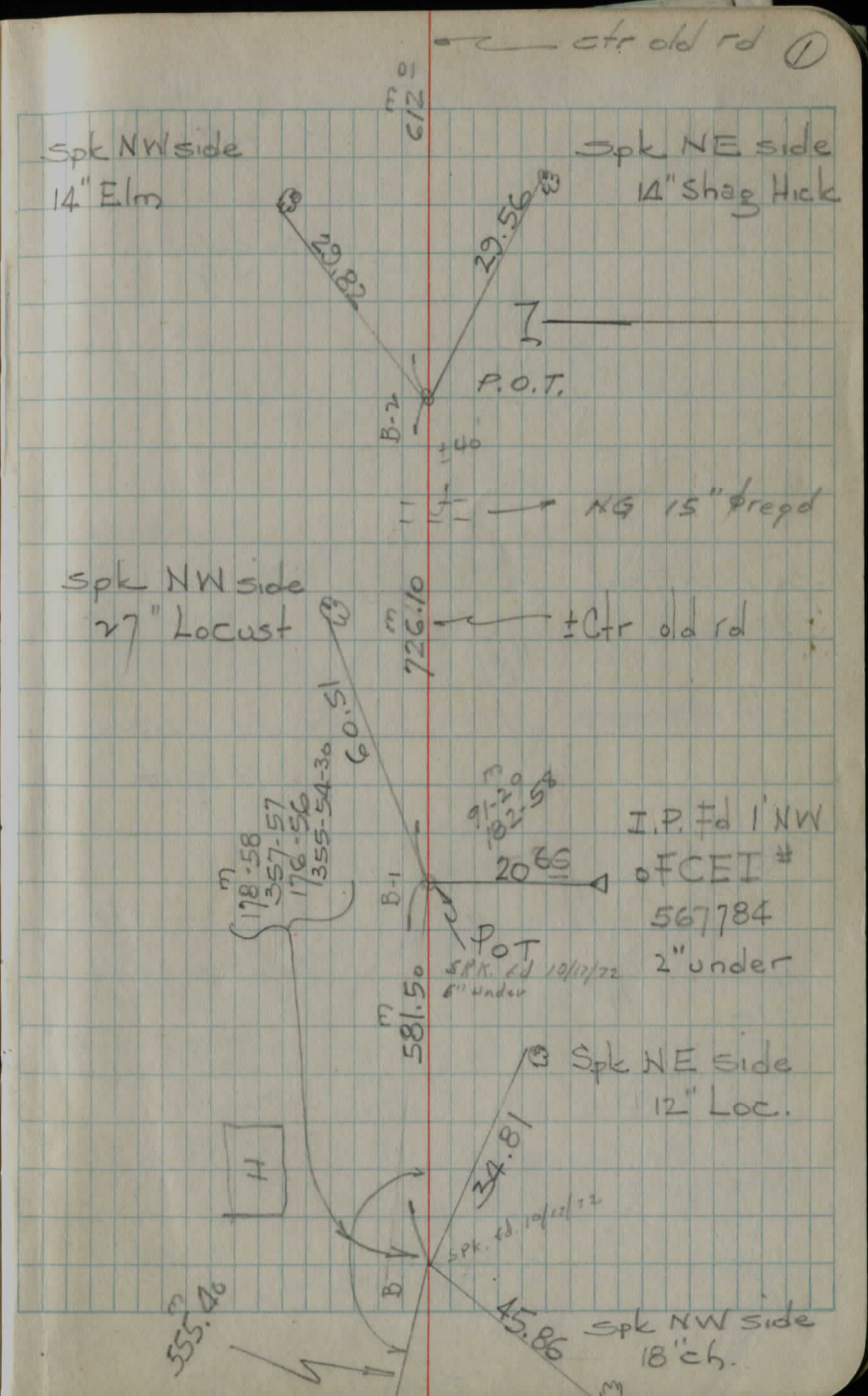
Randon trav. MUNSON - NEWBURY
TWP. LINE from SW ✱ Munson
east to Auburn Rd pgs. 1-6

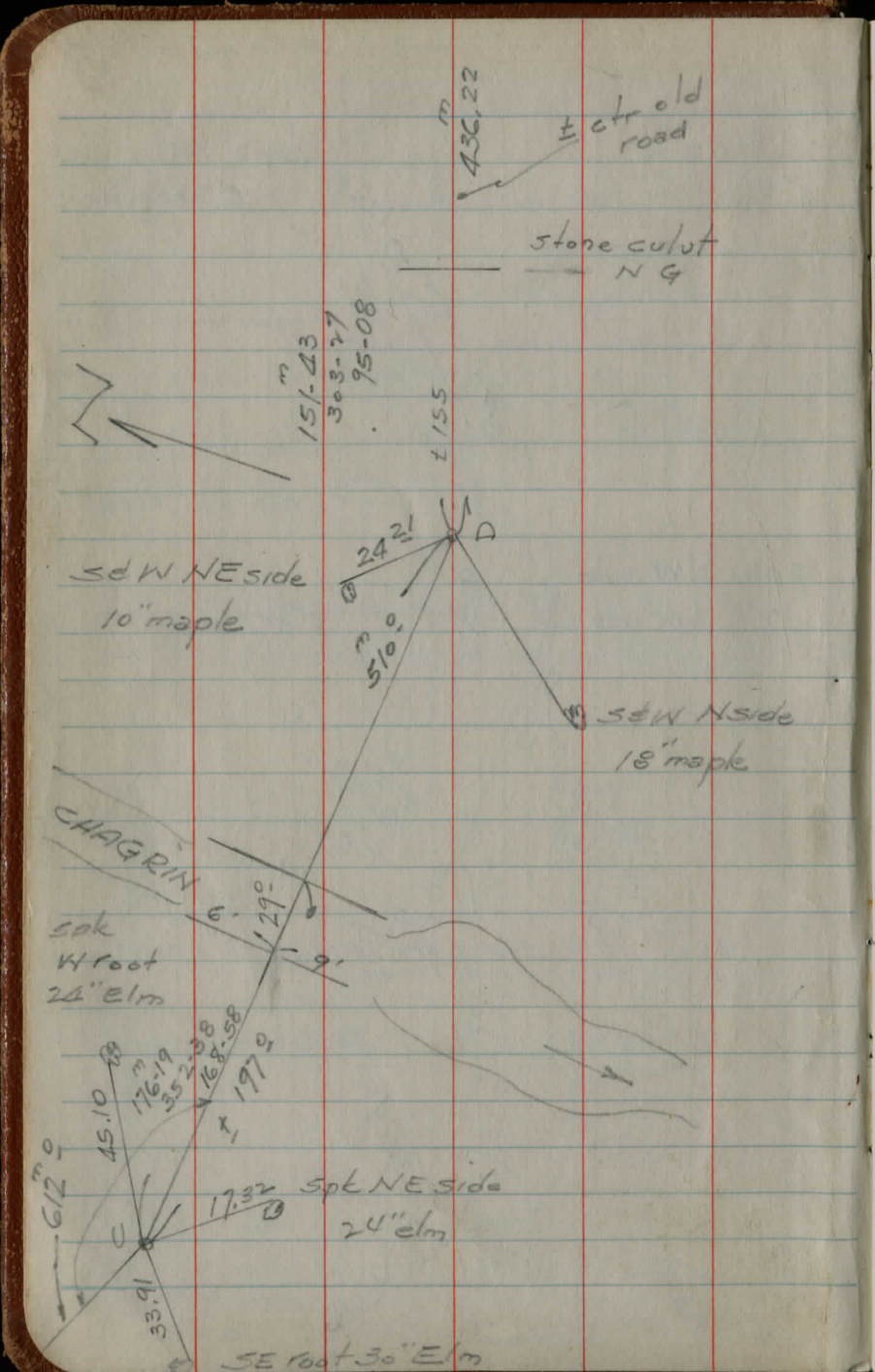


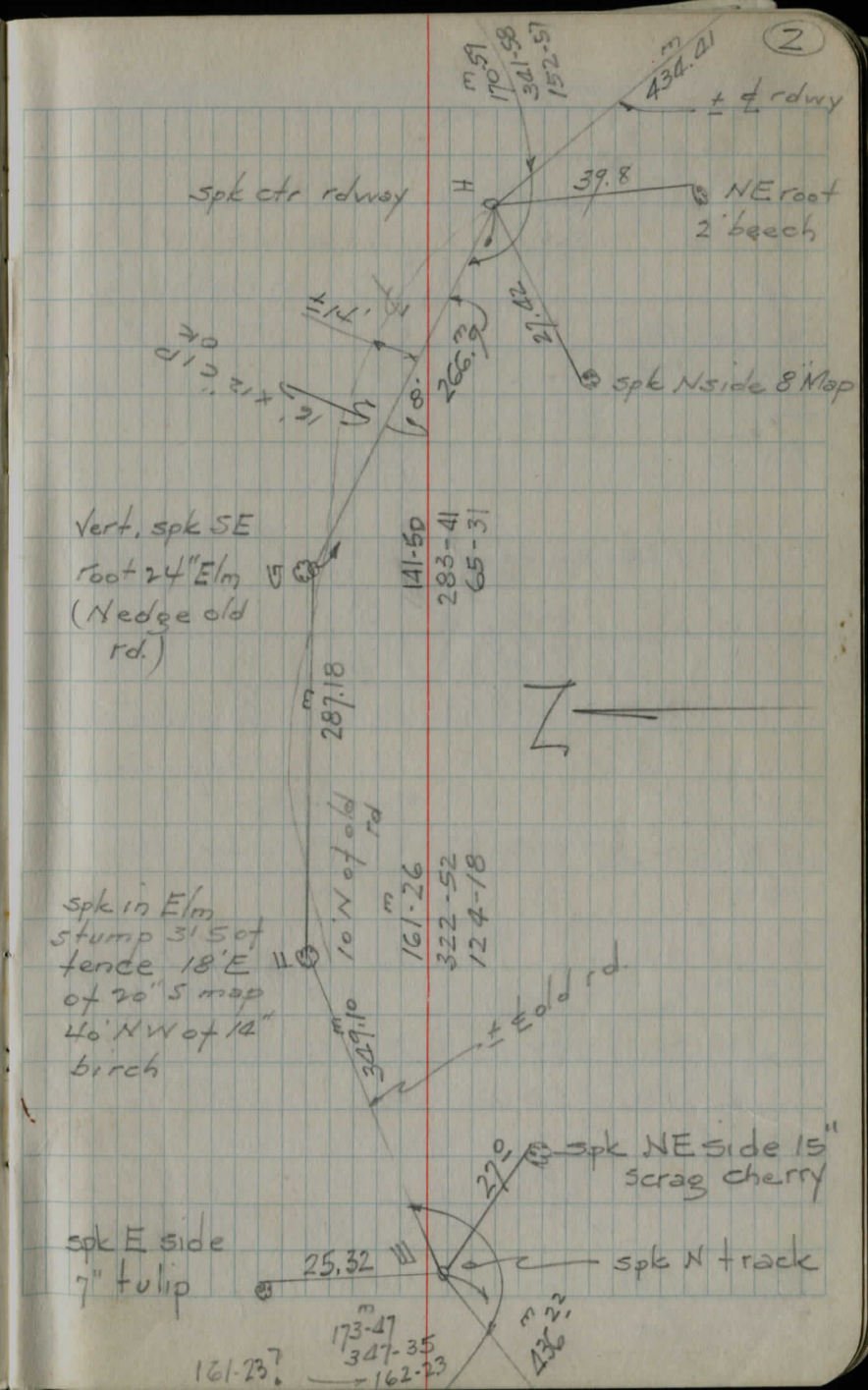
MUNSON - NEWBURY TWP. LINE

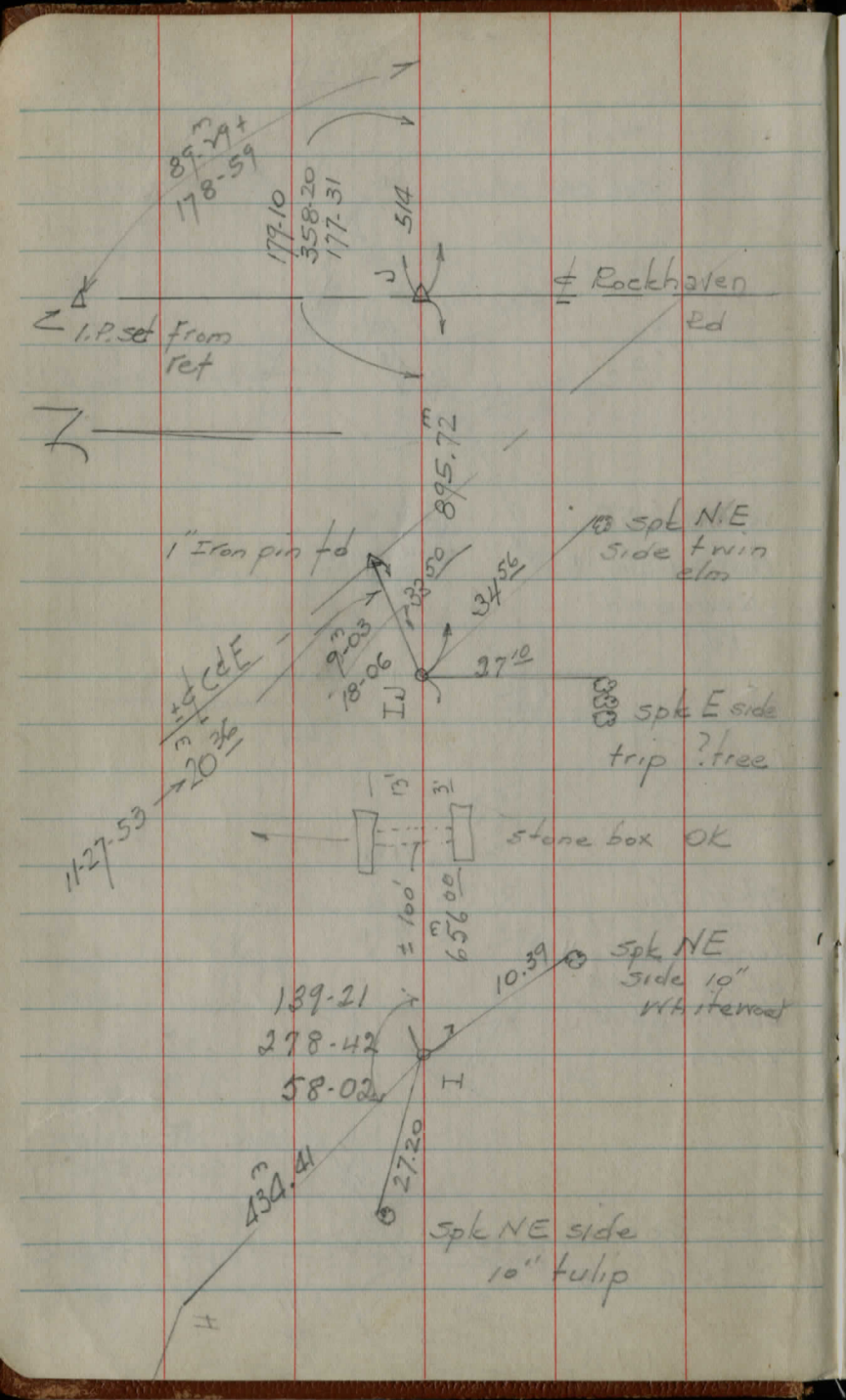
10 - 12, 13 1953

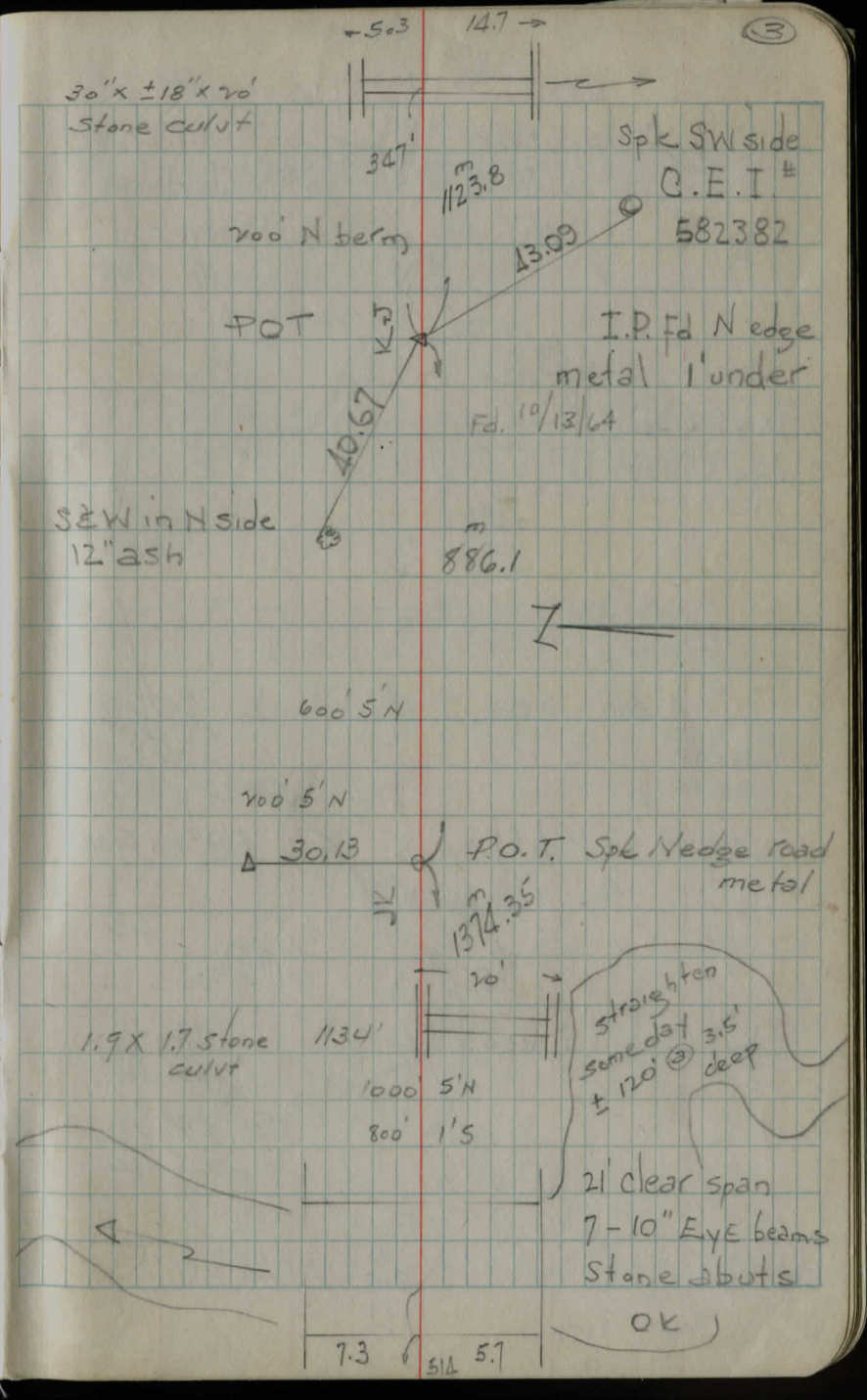
J. M.
E. S.
M. D.
C. P.

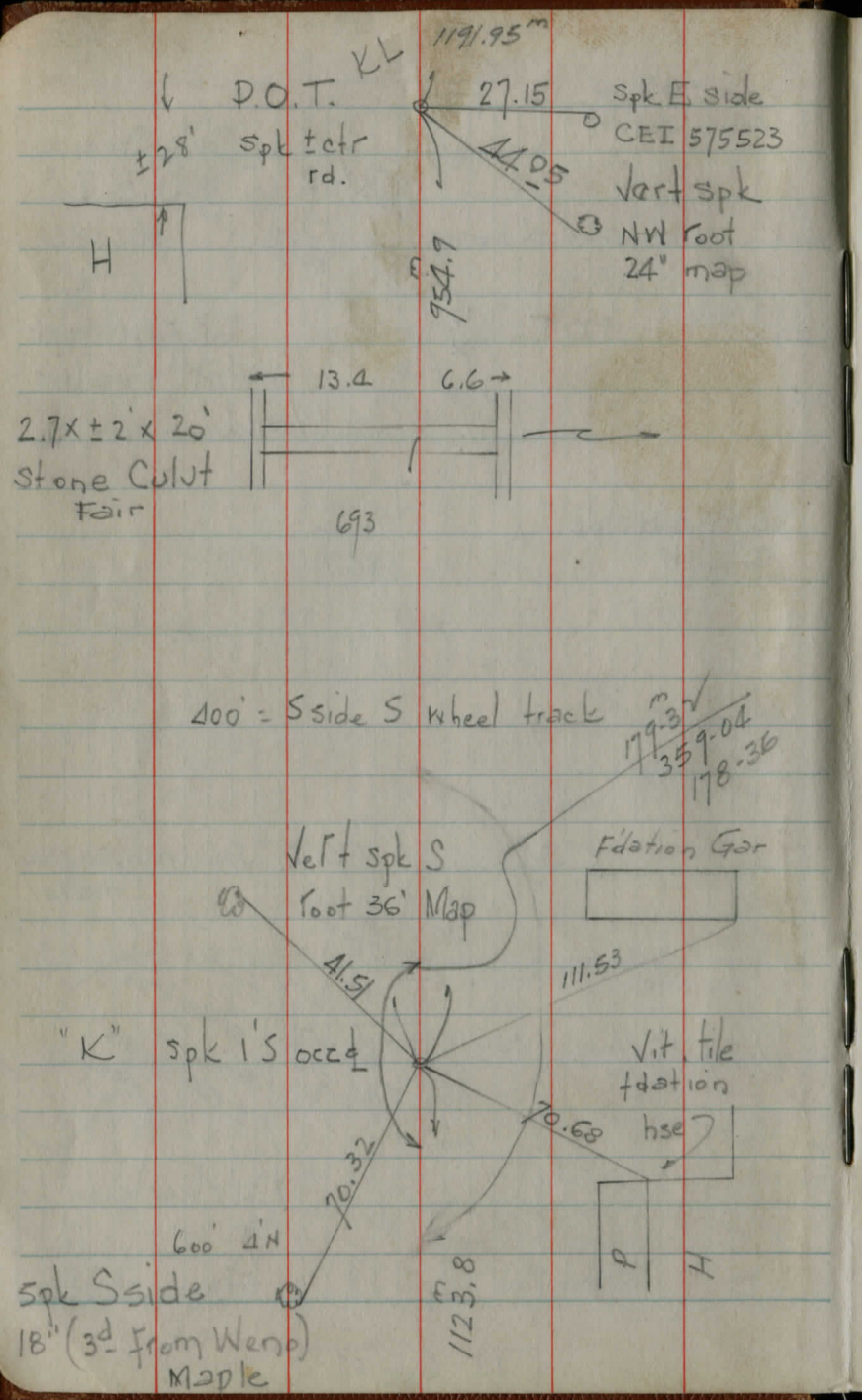


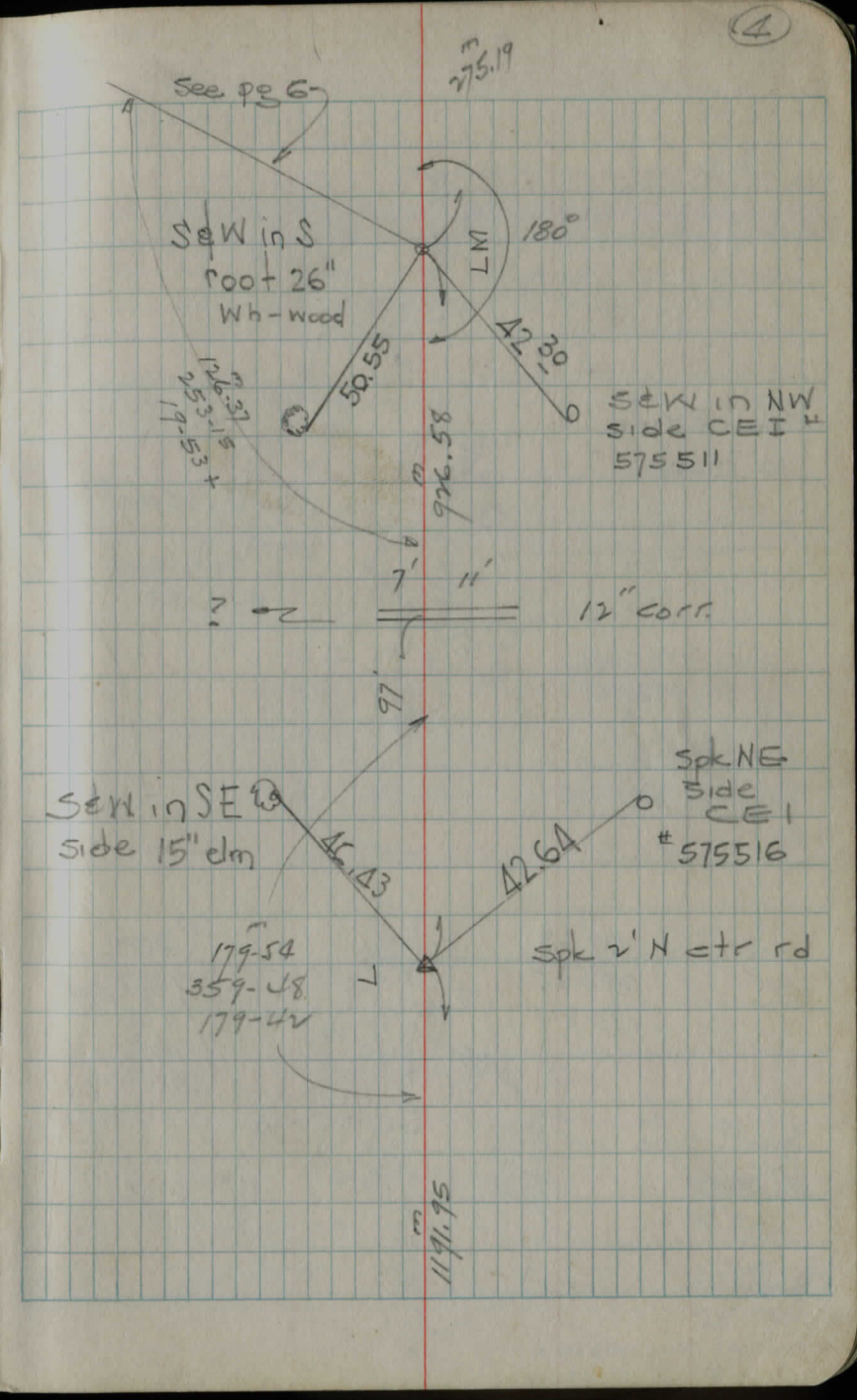

m 436.22
± ctr old road
stone culvt N G
m 151.43
303-27
95-08
± 155
24 21
D
sdW NEside 10" maple
m 510°
sdW Nside 18" maple
CHAGRIN
6.
129°
9.
spk W root 24" elm
45.10
m 176-19
352-38
168-58
197°
x1
6/2
17.32
spk NE side 24" elm
33.91
SE root 30" Elm

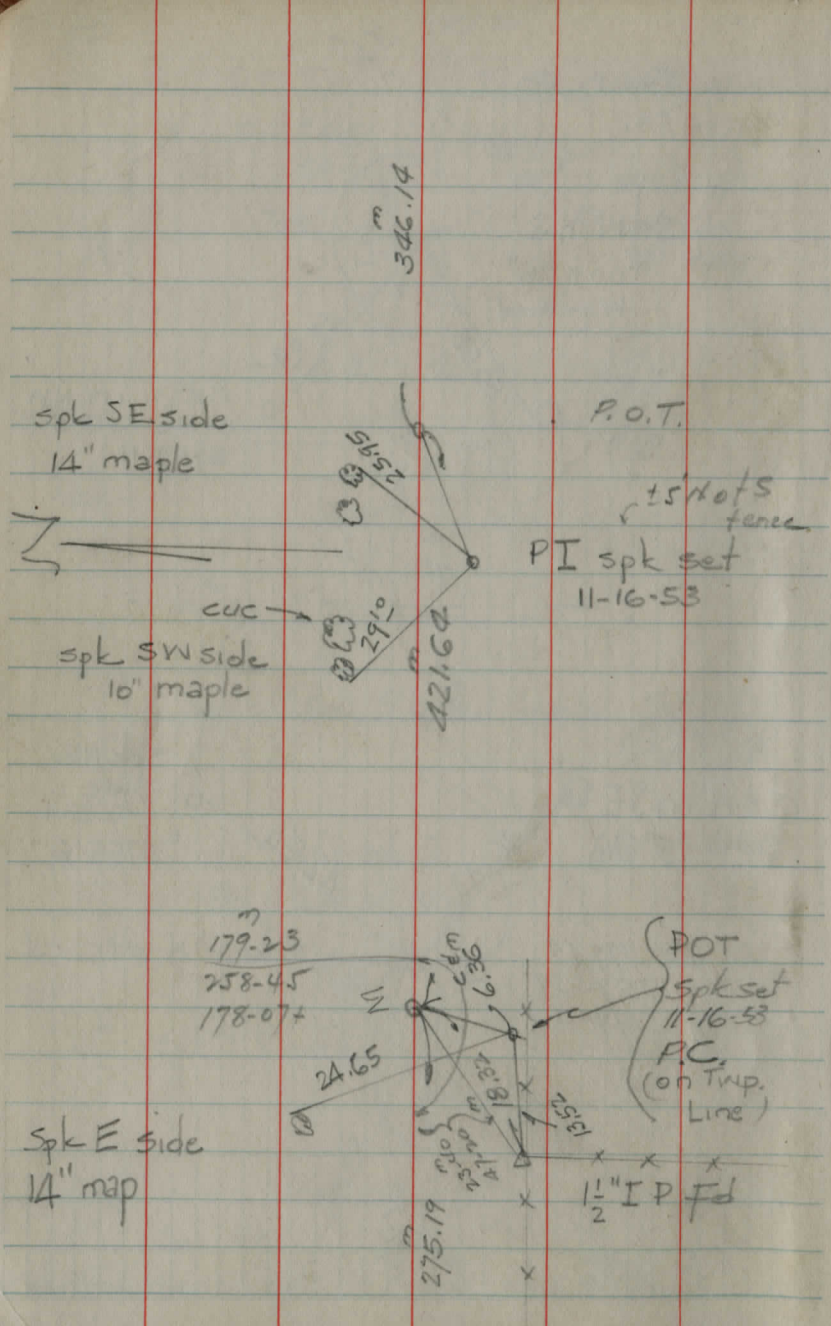

2
m 434.41
± ℄ rdwy
m 59
170-58
341-58
152-57
spk ctr rdway
H
39.8
NE root 2' beech
11x14'
21x21'
266.3
27.42
spk Nside 8" Map
Vert. spk SE root 24" Elm (Nedge old rd.)
141-50
283-41
65-31
m 287.18
161.26
322-52
124-18
spk in Elm stump 31 S of fence 18 E of 20" S map 40 NW of 14" birch
10' N of old rd
m 349.10
± E old rd.
270°
spk NE side 15" scrag cherry
spk E side 7" tulip
25.32
spk N track
m 173-47
347-35
162-23
161.23
m 436.22

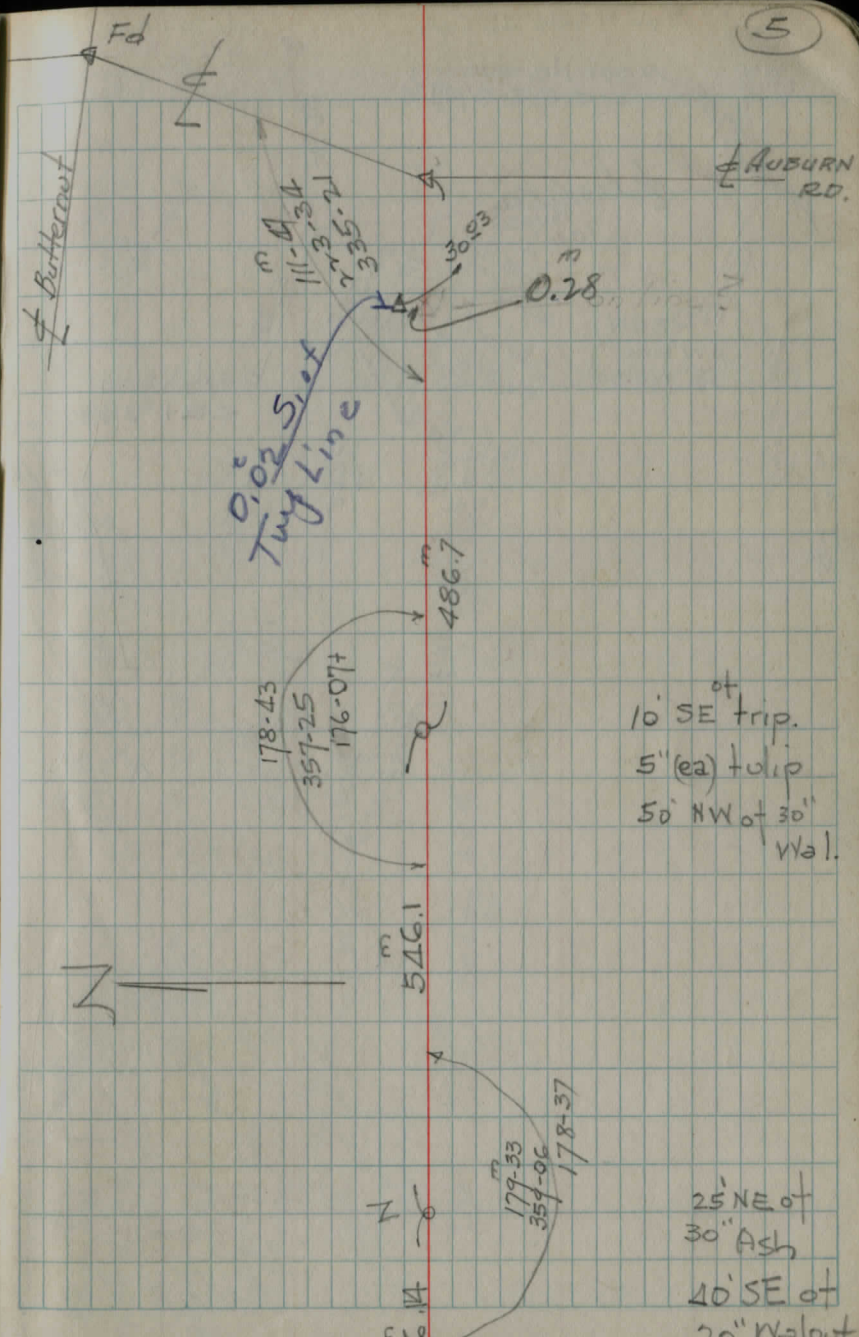

89.29
178-59
177-10
358-20
177-31
514
J
℄ Rockhaven Rd
I.P. set from ref
895.72
1" Iron pin fd
Spk NE side twin elm
33 50
34 56
9.03
18.06
IJ
27 10
℄ CdE
20 36
11.27.53
Spk E side trip ? tree
stone box OK
100'
656.00
139.21
278-42
58-02
I
10.39
Spk NE side 10" WH iteroot
27.20
434.41
Spk NE side 10" tulip

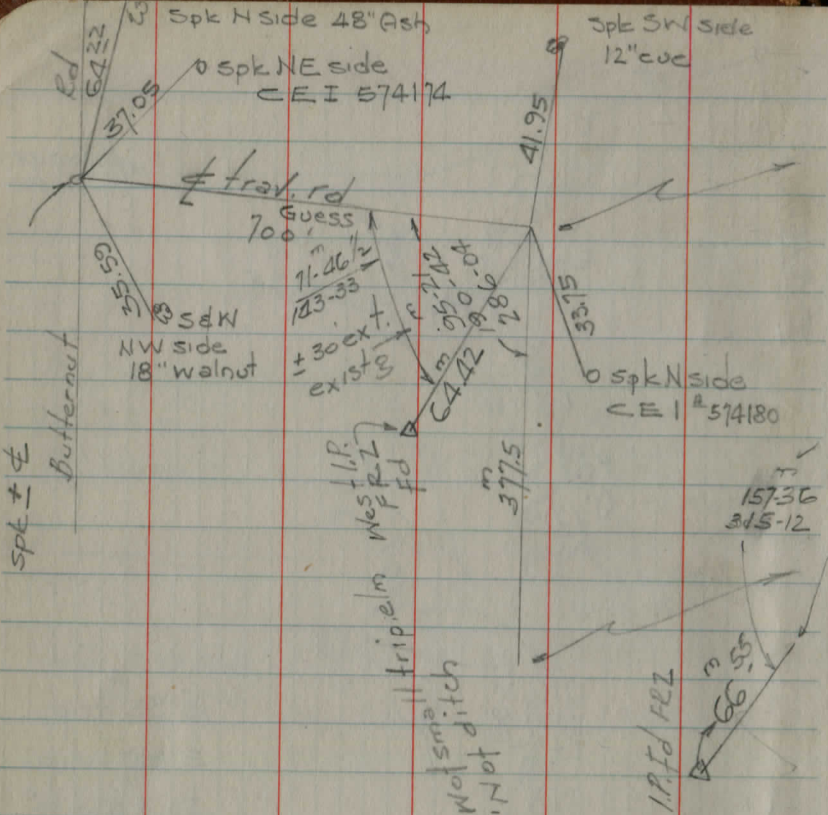

(3)
503
14.7
30" x ±18" x 70' stone culvt
347'
Spk SW side C.E.I. # 582382
1123.8
700' N berm
43.09
POT
KJ
I.P. Fd N edge metal 1' under
Fd. 10/13/64
40.67
S&W in N side 12" ash
886.1
600' 5' N
700' 5' N
30.13
P.O.T. Spk N edge road metal
JK
1374.35
70'
1.9 X 1.7 stone culvt
1134'
straighten somedat 3.5' ± 120' ③ deep
1000 5' N
800' 1' S
21' clear span 7-10" Eye beams Stone abuts
OK
7.3
SLL 5.7

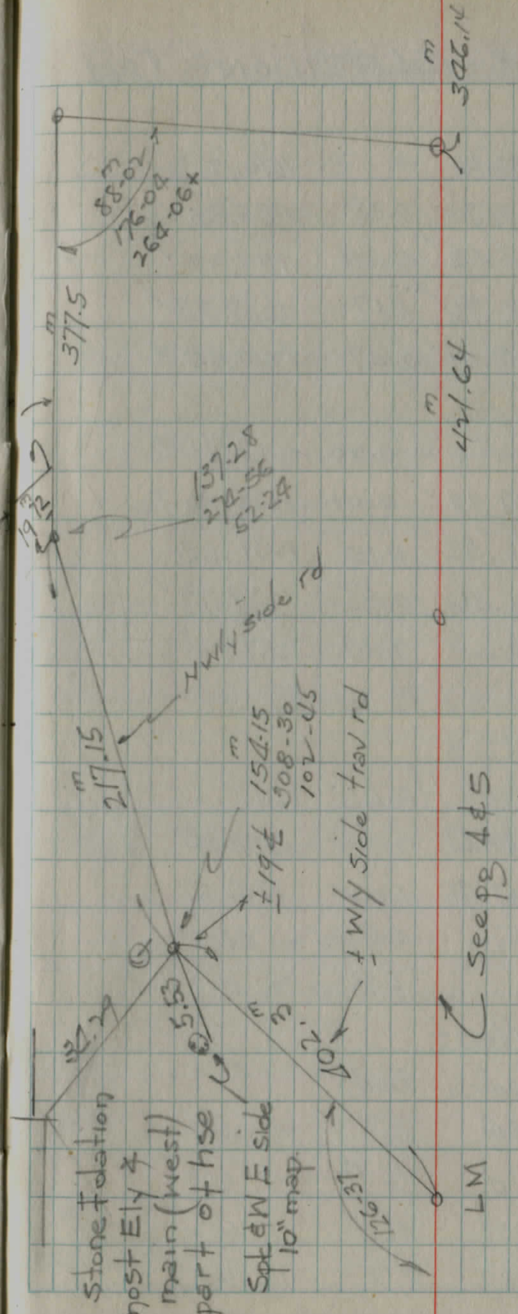

1191.95m
KL
P.O.T.
±28' spk ± ctr rd.
27.15
Spk E side CEI 575523
44.05
Vert spk NW root 24" map
754.9
H
13.2
6.6
2.7x±2'x20' Stone Culvt Fair
693
400' = S side S wheel track
179-30
359-04
178-36
Vert spk S root 36' Map
Fdation Gar
41.51
111.53
"K" spk 1'S occd
Vit. tile fdation hse
70.68
70.32
600' 4'N
Spk S side 18" (3d from West) Maple
1123.8
H


See pg 6-
275.19m
S&W in S root 26" Wh-wood
LM
180°
42.30
50.55
126-37
253-15
179-53
S&W in NW side CEI 575511
85.58
936.96
7'
11'
12" corr.
97
S&W in SE side 15" elm
45.43
42.64
Spk NE side CEI 575516
179-54
359-48
179-42
Spk 2' N ctr rd
1191.95m


346.14
spk SE side
14" maple
P.O.T.
1.5' N of S fence
PI spk set
11-16-53
25.15
29.10
421.64
cuc
spk SW side
10" maple
179-23
258-45
178-07
24.65
spk E side
14" map
POT
Spk set
11-16-53
P.C.
(on Twp. Line)
1½" I P Fd
275.19


5
Fd
℄ Butternut
℄ AUBURN RD.
111-34
243-21
335-21
30.03
0.28
0.02 S. of Twp Line
178-43
357-25
176-07
486.7
10' SE of trip.
5" (ea) tulip
50' NW of 30" Wal.
546.1
179-33
359-06
178-37
25' NE of 30" Ash
40' SE of 20" Walnut
346.14
blackberries & pucker brush N S.E & W


Spk N side 48" Ash
o spk NE side
CEI 574174
Spk SW side
12" cuc
rd
64.22
37.05
℄ trav. rd
Guess
700'
41.95
35.59
S&W
NW side
18" walnut
Butternut
spt ± ℄
71-46½
143-33
± 30 ext.
exist'g
64.42
33.75
o spk N side
CEI # 574180
I.P.
West Fd
377.5
trip. elm
5' W of small ditch
5' N of ditch
157-36
315-12
66.55
I.P. Fd Fez


326.16
88-02
176-04
264-06x
377.5
421.64
137-28
274-56
52-24
19.2
Wly side rd
217.15
154-15
308-30
102-45
± 19' ℄
± Wly side trav rd
See pg 4 & 5
Stone fdation
most Ely ℄
main (west)
part of hse
Spk & W E side
10" map.
5.53
10'
126-31
LM

10-16-53

LEVELS CLARIDON - TROY

BM	10.01	1186.18		1176.17
T.P.	11.91	1197.76	0.33	1185.85
T.P.	11.15	1208.52	0.39	1197.37
T.P	11.56	1218.91	1.17	1207.35
BM set	9.57	1228.01	0.47	1218.44
BM #9	#3 survey		0.20	1227.81
T.P.	11.78	1239.78	0.01	1228.00
T.P.	10.69	1250.32	0.15	1239.63
BM set	9.54	1259.31	0.55	1249.77
BM			2.07	1257.24

Levels Sly from HALL Rd

BM	5.46	1243.61		1238.15
T.P.	5.36	1247.95	1.02	1242.59
26+07			6.7	41.3
"			6.3	41.7

Set ℄ 26+0 BS West

ANG	Stadia	Rod	
88° Lt	30'	6.7	41.3
82° "	70'	6.7	41.3
83°30' "	120'	6.8	41.2
56° "	200'	7.9	40.1

RD (From B&O south to Hall Rd)

USC&G #D-15 4' S of CEI # 560442
135' E of ℄ #3 ℄ ±60' N of N rail.

Spk SE root 45" maple W side road ±80' S of Bart Warner drive
2nd large locust from S end S of B. Warner

Spk E root 30" map 30' west of ℄ ±100' S of W&W Krank house
X in Send S hdwl SW quad Hall ℄ Claridon - Troy

Spk SE root trip Oak 20+80

N rd ditch & contour ditch coming in from NE
S " " & semblance of outlet ditch ±S12°W

		1247.95		
Ang		Stadia	Rod	
47° left		250'	8.2	39.8
T.P.	5.15	1244.90	8.2	1239.75
Set here	BS & 76+0			
177° Lt		70'	5.6	39.3
160° Lt		150'	6.7	38.2

11-16-53

Levels Munson-Nevv

	+	HI	−	Elv
BM	1.45	1356.23		1351.78
T.P.	0.46	1344.92	11.77	1344.46
T.P.	1.43	1334.50	11.85	1333.07
T.P.	0.14	1322.85	11.79	1322.71
T.P.	0.20	1311.16	11.89	1310.96
T.P.	0.04	1299.37	11.83	1299.33
T.P.	0.16	1287.90	11.63	1287.74
BM			8.25	1279.65
T.P.	0.23	1276.73	11.40	1276.50
			10.3	1266.4
T.P.	0.80	1265.53	12.00	1264.73
			5.4	1260.1
T.P.	0.70	1254.56	11.67	1253.86
			1.6	1253.0
			8.2	1246.4
T.P.	0.73	1243.86	11.43	1243.13
			1.9	1242.0
			10.7	1233.2
T.P.	2.77	1234.78	11.85	1232.01
			6.6	1228.2
			4.6	1230.2

Twp line

(9)

CEDAR RD RELOC. PROP.

Ref Spk NW side 14" map 45.7 NE of P.I #4 & #21

V.I. pt E. side 18" WALNUT

400' N of end of curve on trav ℄

300' " " " " " " "

200' " " " " " " "

100' " " " " " "

P.T. = E edge trav rd (℄ = same elev)

PT to PT-25 15" wal, 11" pig hick, 11" pig hick & 28" elm to be removed

40' of 12" pipe reqd across exist rd

PT-100

PT-155 23' NW = 40" WALNUT (Not a GD Elm.)

PT-165 NEED 24 TO 36" PIPE

PT-167 19' SE = 50" WALNUT

PT-183

	+	1234.78 #1	−	Elv
			4.8	1230.0
			10.8	1224.0
TP.	1.83	1224.88	11.73	1223.05
			9.7	1215.2
TP	0.12	1213.27	11.73	1213.15
			5.6	1207.7
TP	1.64	1204.84	10.07	1203.20
			6.9	1197.9
BM.			0.00	1204.84
			6.5	1198.3
TP.	0.07	1193.86	11.05	1193.79
PC			5.5	1188.4
TP. of	0.31	1182.85	11.32	1182.54
100' W of PC			4.2	1178.7
160' " " "			10.0	1172.9
175 " " "			15.0	1167.9
187 " " "			9.9	1173.0
700 " " "			8.6	1174.3
T.P.	3.84	1179.52	7.17	1175.68
244			1.1	1178.4
360' W of trail ℄			4.6	1174.9
400'			11.8	1167.7
T.P.	0.39	1168.12	11.79	1167.73

P.T. - 200

P.T. - 300

P.T. - 400

P.T. - 500

P.T. - 600

Vert spk N root 36" elm 12' S of Twp line ±150' E of PC

Twp line 100' E of PC

30"-42" pipe reqd

Listing of trees etc see Fd bk #54 pgs 76, 77

		1168.12		
500' W of PC & trav ℄			6.1	1162.0
600'			9.2	1158.9
700			11.1	1157.0
800'			± 12.8	1155.3
BM			10.96	1157.16
T.P.	7.40	1220.55	1213.15	
700' E of PC & trav line			13.9	1206.7
300' " "			6.8	1213.8
T.P.	11.10	1230.82	0.83	1219.72
400'			3.9	1226.9
T.P.	10.02	1240.84	0.0	1230.82
500'			5.7	1235.1
T.P.	12.01	1251.55	1.30	1239.54
600'			10.5	1241.1
700			3.5	1248.1
TP.	11.75	1262.96	0.34	1251.21
800			5.7	1257.3
TP.	11.85	1274.21	0.60	1262.36
900			5.3	1268.9
TP.	11.52	1284.94	0.79	1273.42
1000			3.7	1281.7
T.P.	11.77	1295.88	0.83	1284.11
1100			3.1	1292.8
TP.	11.41	1305.94	1.35	1294.53
1200			2.3	1303.6

Spk in Rd face CEI # 575 513

To Goodman Ave

Spk S root 10" map 5' E of MN = ± 28'
E of P.I. prop curve

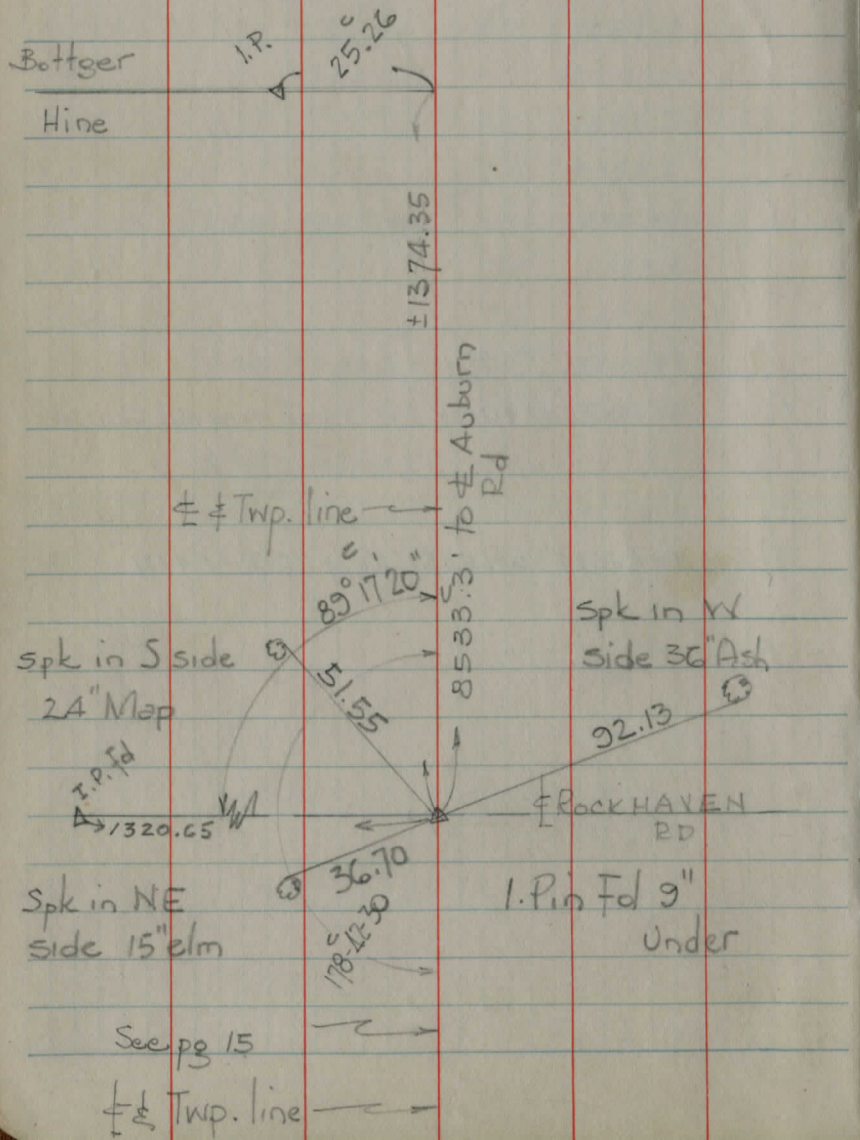
		1305.94		
	+	HI	−	Elv
	11.44	1316.81	0.57	1305.37
13+00			0.47	1316.3
TP	12.00	1328.54	0.27	1316.54
14+00			4.9	1323.7
TP	8.67	1336.33	0.88	1327.66
15+00			6.6	1329.7
16+00			2.5	1333.8
TP	9.75	1345.04	1.04	1335.29
17+00			7.4	1337.6
18+00			2.7	1342.3
TP	2.76	1344.21	3.59	1341.45
BM.			4.88	1339.33
TP.	9.98	1351.43		
TP	6.52	1356.06	1.99	1349.54
BM.			0.93	1355.13

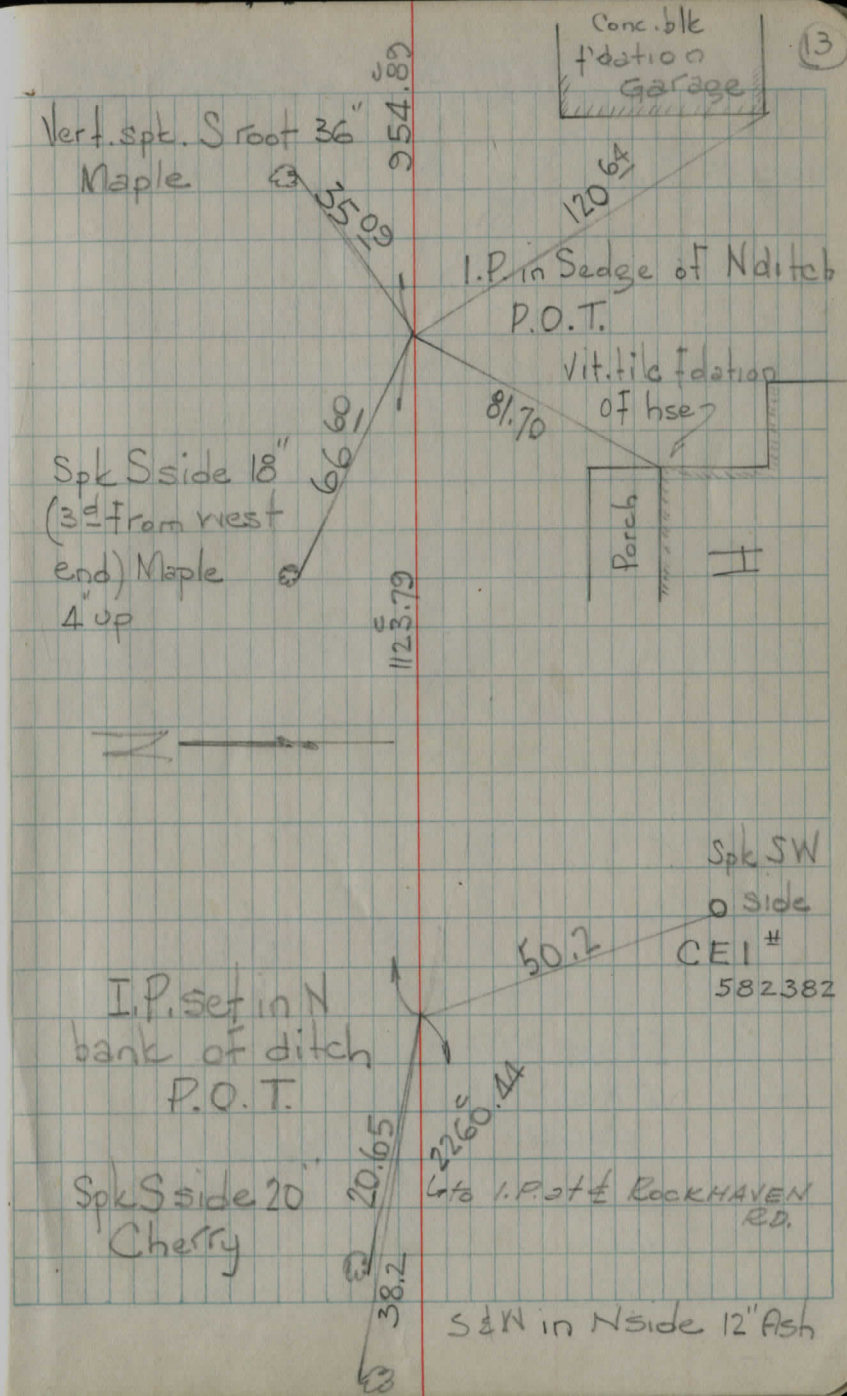
3½" Elm W. Side Ch. #4 ±100' S. of S. Line Maple Hill Cemetary

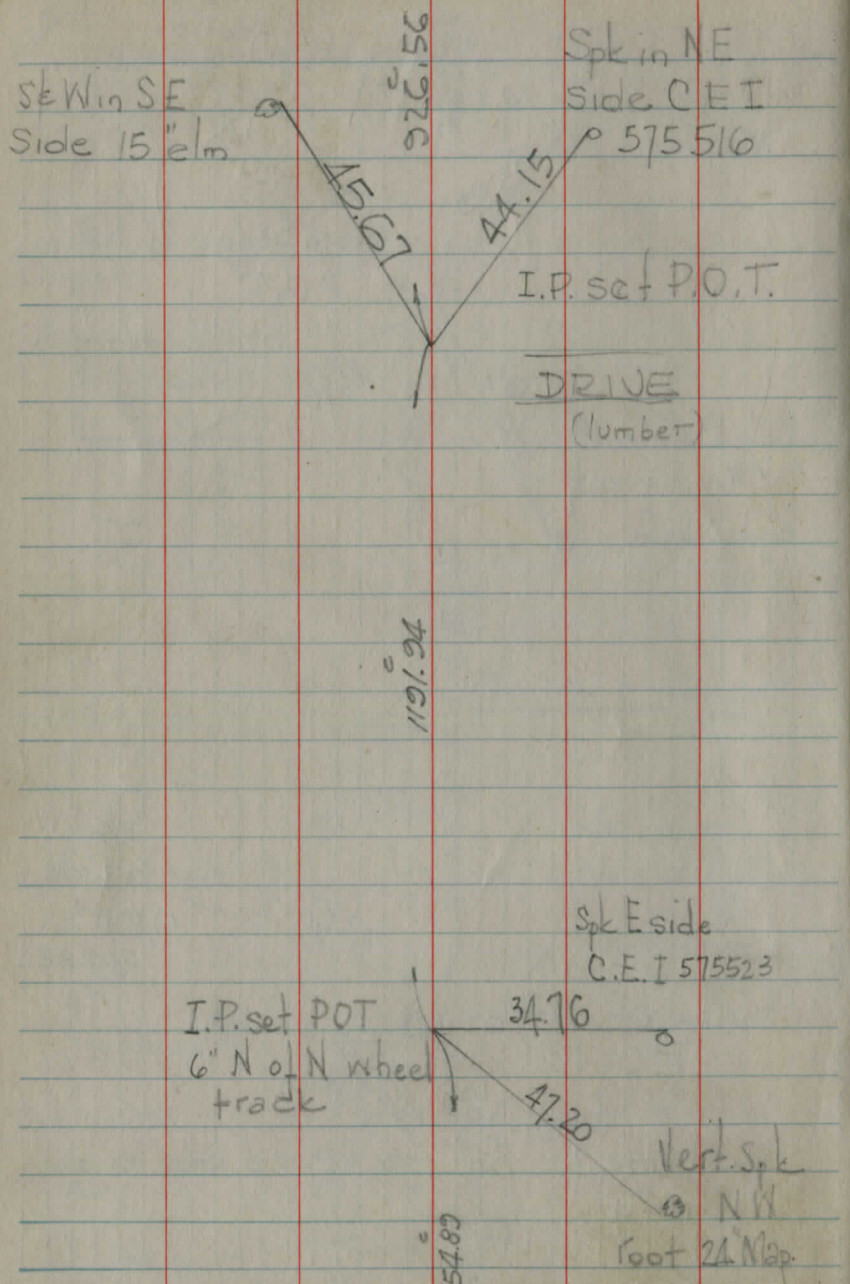
Ref Spk NW Side 14" Maple 45.7' NE of PI. 3 Ch. 4+21

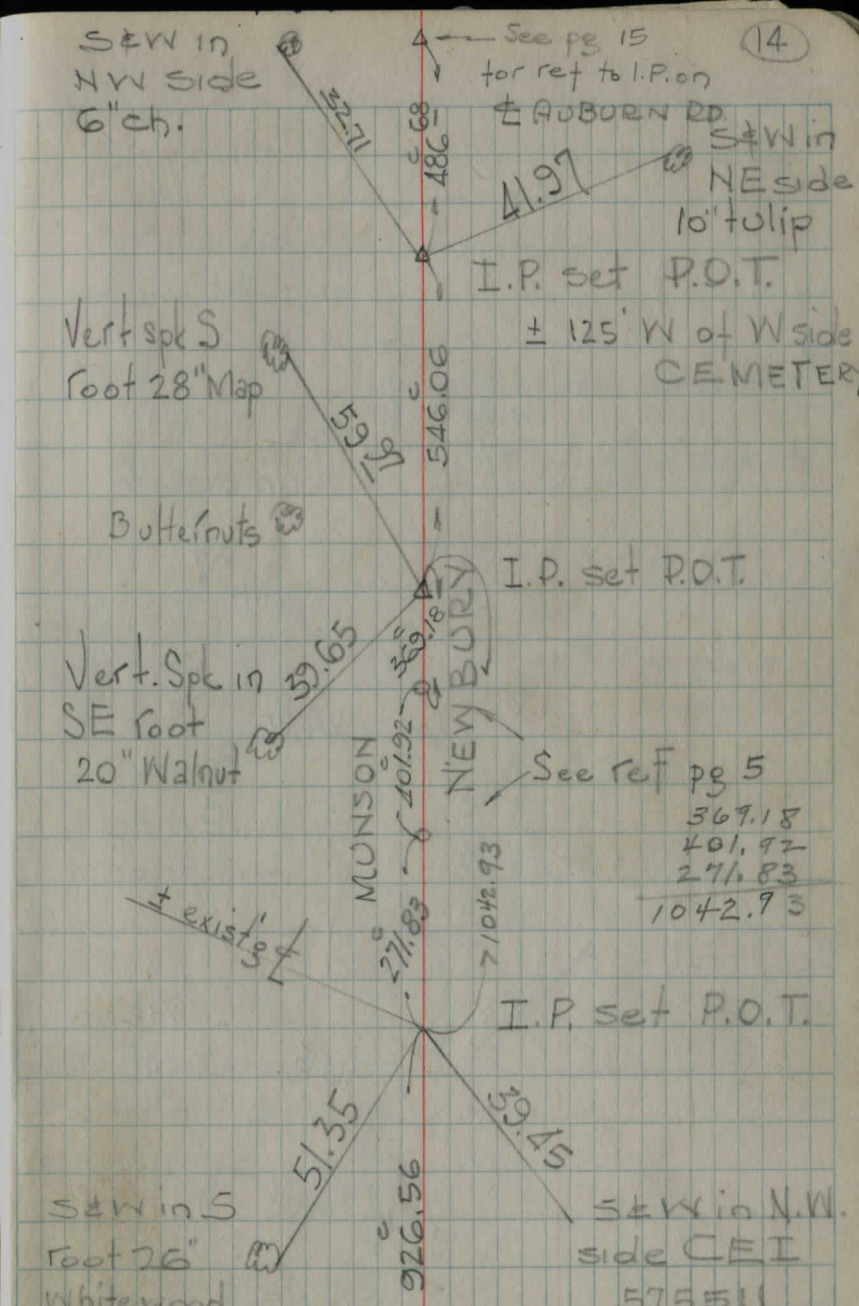
11-27-53

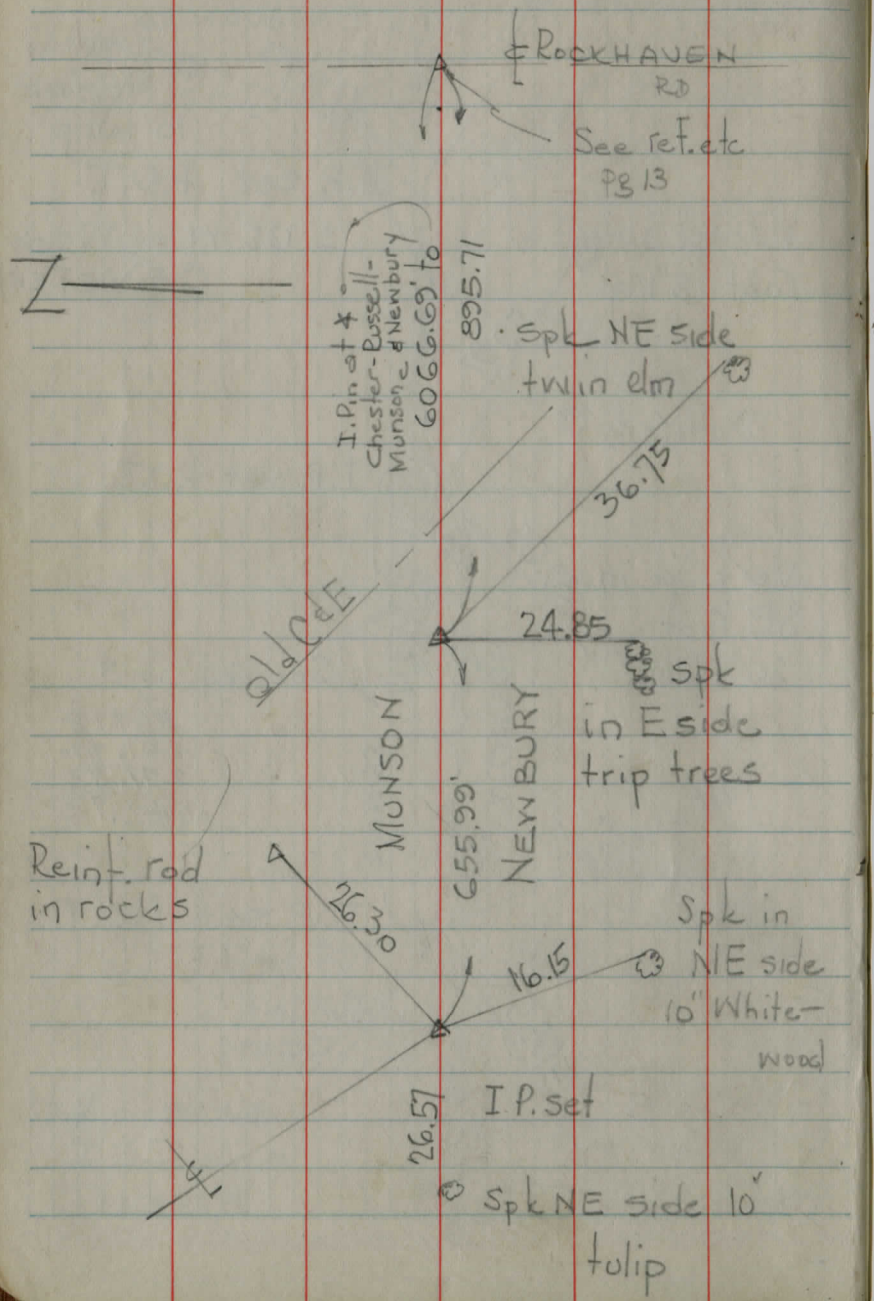
MUNSON - NEWBURY TWP. LINE AND CEDAR RD SEC F

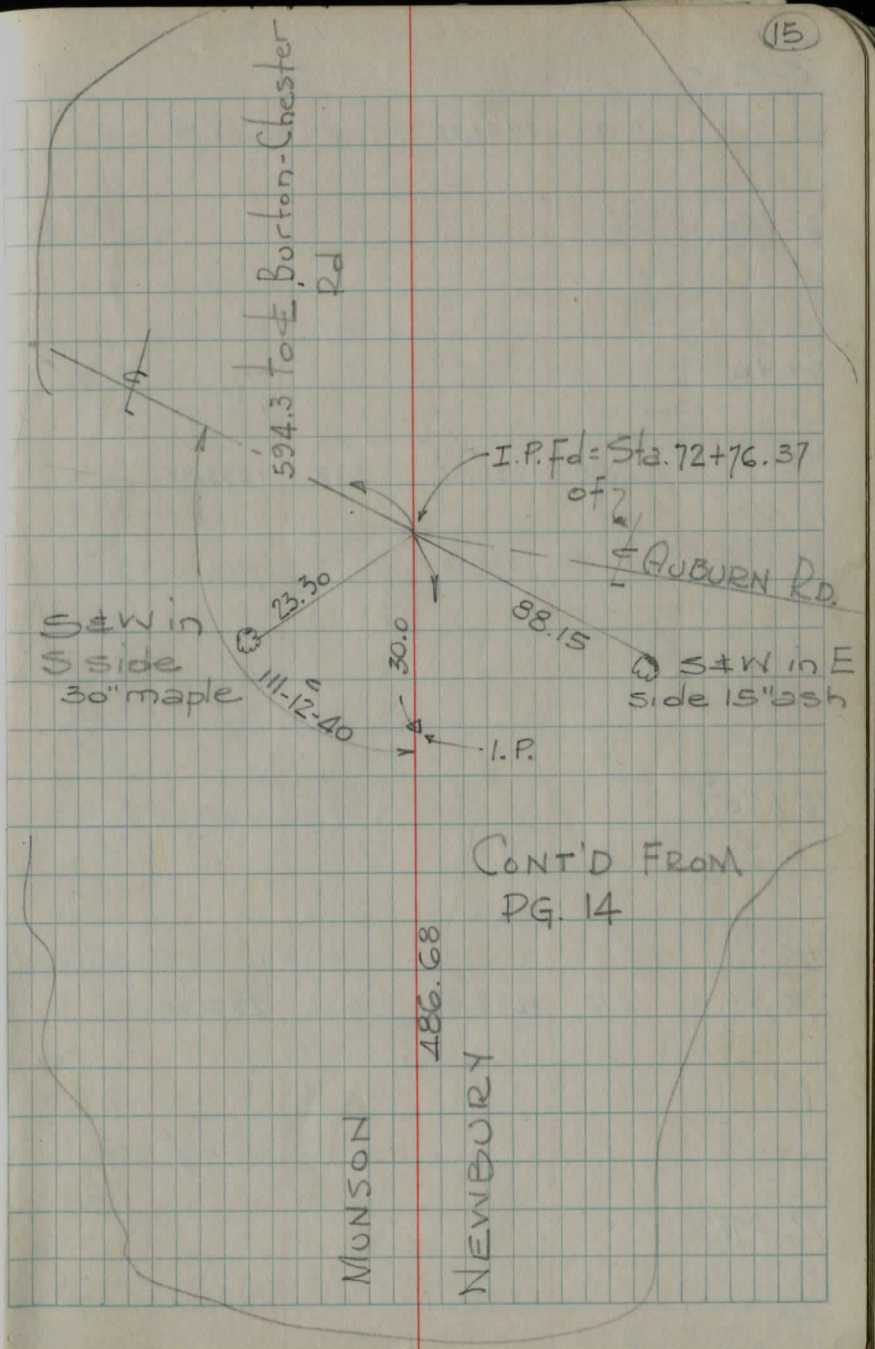





Spk in NE side C E I 575516
S & W in S E side 15" elm
926.56
45.67
44.15
I.P. set P.O.T.
DRIVE
(lumber)
119.94
Spk E side C.E.I 575523
I.P. set POT 6" N of N wheel track
34.76
47.26
Vert. Spk S. N W root 24" Map.
754.89


14
S & W in N W side 6" ch.
See pg 15 for ref to I.P. on ℄ AUBURN RD
22.71
486.68
41.97
S & W in N E side 10" tulip
I.P. set P.O.T. ± 125' W of W side CEMETERY
Vert spk S root 28" Map
59.67
546.06
Butternuts
I.P. set P.O.T.
Vert. Spk in SE root 20" Walnut
39.65
369.18
401.92
MUNSON
NEW BURY
See ref pg 5
369.18
401.97
271.83
1042.93
± existing ℄
271.83
1042.93
I.P. set P.O.T.
51.35
39.45
S & W in S root 26" Whitewood
926.56
S & W in N.W. side C E I 575511


℄ ROCKHAVEN RD
See ref. etc Pg 13
I. Pin at ✱ Chester-Russell-Munson & Newbury
6066.69' to
895.71
Spk NE side twin elm
36.75
24.85
Spk in E side trip trees
Old C&E
MUNSON
655.99'
NEWBURY
Reinf. rod in rocks
26.03
16.15
Spk in NE side 10" White-wood
26.57
I.P. set
Spk NE side 10" tulip


594.3 to ℄ Burton-Chester Rd
I.P. Fd = Sta. 72+76.37
of ℄ ℄ AUBURN RD.
23.30
S ± W in S side 30" maple
111-12-40
30.0
98.15
S ± W in E side 15" oak
I.P.
CONT'D FROM PG. 14
486.68
MUNSON
NEWBURY

GRADES HALL RD Sec B

6-12-54

BM	3.00	1241.15 ✓		1238.15
20+50				
20+0				
TP.	3.89	1239.81 ✓	5.23	1235.92 ✓
19+50				
19+0				
18+50				
18				
TP.	4.14	1238.09 ✓	6.86	1233.95 ✓
17				
16+78				
16+0				

N

South (16)

Spk SE root trip Obs

41.15
1237.4 ✓
03.75
2.75 r C1' ✓

41.15
37.4
3.75 ✓
2.75 r C1' ✓

41.15
36.6 ✓
04.55
3.55 r C1' ✓

41.15
36.6
4.55
3.55 C1' ✓

39.8
36.2 ✓
3.6
2.1 r C1.5' ✓

39.8
36.2
3.6
2.6 C1' ✓

39.8
35.8 ✓
4.0
3.5 r C1.5' ✓

39.8
35.8
4.0
3.5 C0.5 ✓

39.8
35.4 ✓ No stks
4.4

39.8
35.0 ✓
4.8
3.8 r C1' ✓

39.8
35
4.8 G
4.8 r ✓

38.1
35.0 ✓
3.1
3.1 r G ✓

38.1
35
3.1
rod 4.1 F1' ✓

38.09
31.42 ✓
6.67
3.67 C3' F/L ✓

38.1
31.0
7.1
4.1 C3' ✓

38.1
35.0
3.1
3.1 C1' ✓

38.1
35
3.1
3.1 G ✓

		1238.09 ✓		
15+00				
BM	5.07	1243.22 ✓		1238.15
BM set			3.31	1239.91 ✓
21+00				
21+50				
22				
TP	7.18	1247.62 ✓	2.78	1240.44 ✓
25				
26				
27				
TP	4.81	1249.04 ✓	3.39	1244.23 ✓

N S (17)

38.1
35.0 ✓
3.1 C 2' ✓

38.1
35
3.1 ✓
2.6 C 0.5

Vert spk N root trip tree (4" iron w'd 8" 24" hick)
21 ± 42 Rt ± 40'

43.22
38.2 ✓
5.02
3.02 R C 2.0' ✓

43.22
38.2
5.02
3.52 R C 1.5 ✓

43.22
38.95 ✓
4.27
2.77 R C 2.0 ✓

43.22
38.95
4.27 ✓
2.777 C 1.5

43.22
39.7 ✓
3.5
0.5 R C 3' ✓

43.22
39.7
3.5 ✓
0.5 R C 3.0

43.1

47.6
43.1
4.5 ✓
3.5 R C 1'

43.6

47.6
43.6
4.0 ✓
4.0 G

44.2

47.6
44.2 ✓
3.4 R G

1249.04 ✓

28

29

30

31

Levels before Rock cuts HALL

		HI	+	
BM		1195.52 ✓	9.40	1186.12
T.P.	0.51	1206.70 ✓	11.69	1195.01 ✓
	9.3			97.4 96.6
	9.1			97.6 97.4
	7.5			99.2 97.9
	7.9			98.8 98.6
	7.3			99.4 99.2
	6.4			1200.3 00.2
	4.8			01.9 01.6
	5.0			01.7 02.0
	4.5			02.2 02.1
	4.0			02.7 02.4
	2.5			04.2 03.7

N S (18)

49.04
44.75

49.04
44.75
4.29 ✓
3.3R C1'

49
45.3
3.7

49
45.3
3.7 ✓
2.2R C 1.5'

49.
45.9
3.1
3.1R G ✓

49
45.9
3.1
0.9
2.2 C2' 2½"

49
45.9
4.9
0.9R C4'

49
46.95
2.6
1.6R C1' ✓

49.04
46.95
2.59

RD 7-22-54

Ref spk in elm SW quad. Halls Taylor

N. ditch sta. 1+90 (1+85 begin rock)

" " " 2+07

" " " 2+18

" " " 2+22

" " " 2+37

" " " 2+50

" " " 2+74

" " " 2+81

" " " 2+84

" " " 2+88

" " " ~~3+0~~ PT

	−	1206.70 HI	+	Elev.	
	1.2			05.5	05.5
	6.4			00.3	99.8
	5.3			01.4	00.3
	4.8			01.9	00.5
	3.3			03.4	01.4
	3.6			03.1	02.7
	3.8			02.9	01.2
	4.1			02.6	02.5
	5.0			01.2	01.7
	2.0			04.7	04.4
	1.1			05.6	05.6
T.P.	1.05	1216.07	10.42	1205.65	
	8.7			07.4	07.0
	7.9			08.2	08.3
	6.0			10.1	09.5
	3.5			12.6	11.6
	1.0			15.1	14.2
	0.8			15.3	14.9
	0.3			15.8	15.9
	6.4			09.7	09.5
	8.3			07.8	07.2
	9.7			06.4	04.7
T.P.	11.63	1204.72	0.28	1204.44	
T.P.	9.70	1195.97	0.95	1195.02	
B.M.	9.89			1186.08	(1186.12)

centerline sta. ~~310~~ PT
S. ditch down .7 no hit rock sta. 2+43
" " sta. 2+50
" " " 2+56
12.5' from ℄ 2+56
21' " " " "
S. ditch sta. 2+63
" " " 2+82 rock .3 down
℄ sta. 2+50
S. ditch at P.T. no rock .4 down
" " sta. 3+20

S. ditch sta. 3+50
℄ " "
S. ditch " 4+0
" " " 4+50
" " " 5+0
" " " 5+15 end of rock
℄ sta 5+0
N. ditch sta 3+89
" " " 3+50
" " " 3+27

Levels after Rock cuts

	+	HI	−	E
BM	11.81	1197.93		1186.12
P.I.	11.75	1209.23	0.45	1197.48
North 1+90			12.6	96.6
" 2+07			11.8	97.4
" 2+18			11.3	97.9
" 2+22			10.6	98.6
" 2+37			10.0	99.2
" 2+50			9.0	1200.2
" 2+74			7.6	01.6
" 2+81			7.2	02.0
" 2+84			7.1	02.1
" 2+88			6.8	02.4
~~" 3+00~~	PT		5.5	03.7
~~3+05~~	PT		3.7	05.5
South 2+43			9.4	1199.8
" 2+50			8.9	1200.3
" 2+56			8.7	00.5
" 2+63			8.0	01.2
" 2+82			6.7	02.5
℄ 2+50			7.5	01.7
South of PT			4.8	04.4
" 3+20			3.6	05.6
T.P.	9.98	1218.35	0.86	1208.37
South 3+50			11.4	07.0
" 4+0			8.9	09.5

HALL RD

Ref spk 3' up elm SW quad. Hall & Taylor wells

bottom ditch " to 8' wide = 0

01.4 02.7

7.8 6.5

17.5 21

08.3

10.1

℄

		1218.35			
S 4+50			6.8	11.6	←
" 5+0			4.2	14.2	←
" 5+15			3.5	14.9	
N 3+89			8.9	09.5	
" 3+50			11.2	07.2	
" 3+27			13.7	04.7	
T.P.	0.39	1208.76	9.98	1208.37	(1208.37)
T.P.	1.48	1198.95	11.29	1197.47	(1197.48)
BM			12.79	1186.16	

6.8
6.5
6.75
7.0
7.5
7.7
8.4
10.2

15.9 / 2.5 / E

13.5 / 4.9 / E

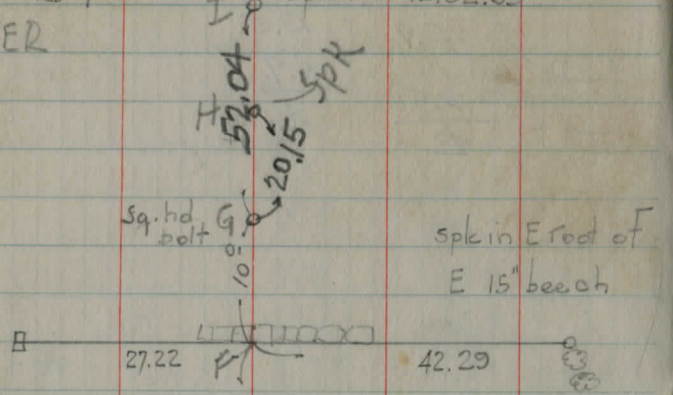
N rd ditch & E by contour ditch Meyers
contour ditch 15' N E of above
50' W
100' W
150' W
200' W
300' W
400' W

S side
2 boulders at PT ± 3+0

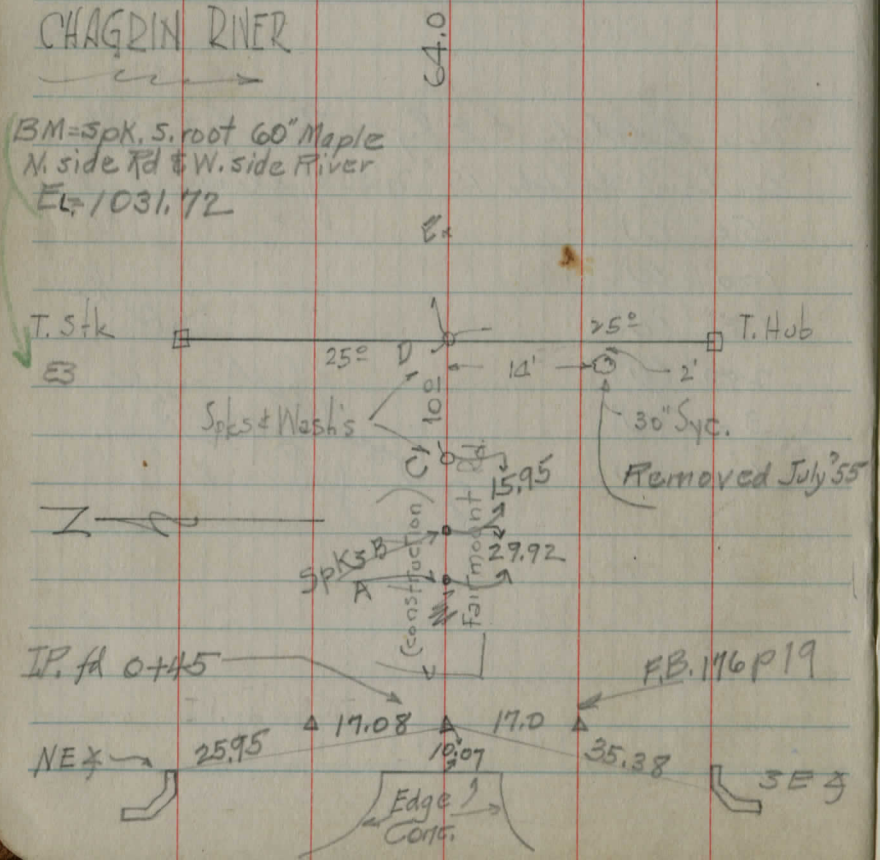
5-9-55

FAIRMOUNT RD ℄

CHAG. RIVER



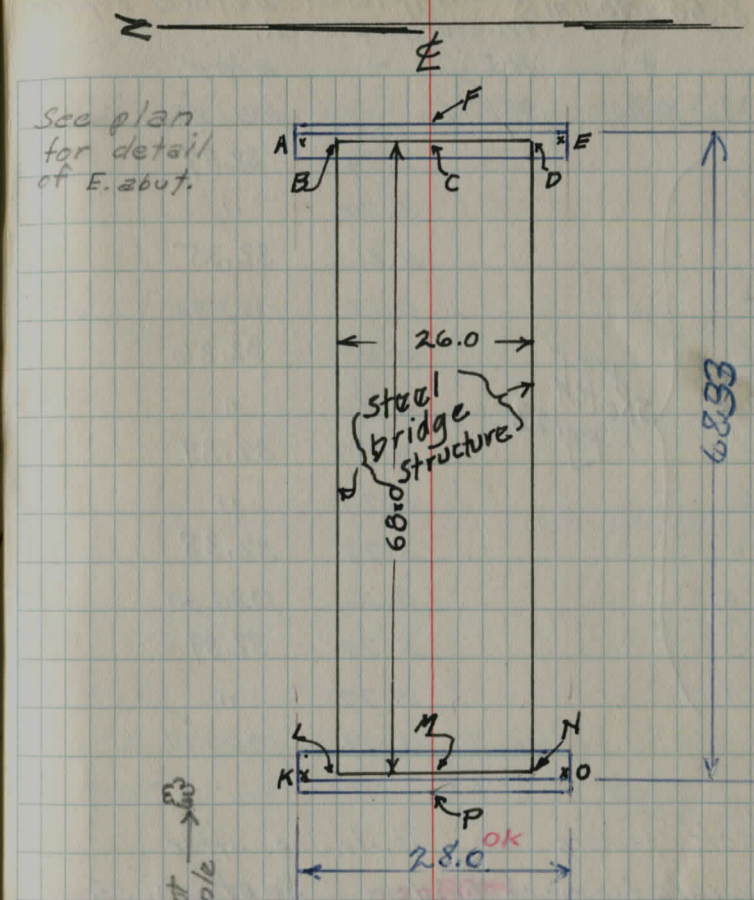
CHAGRIN RIVER



7/15/55

	BS	HI	FS. on ℄	Elev 22
	6.74	1038.46		1031.72
50' W of A			4.70	33.76
A			4.44	34.02
B			4.47	33.99
C			4.64	33.82
D			4.70	33.76
E			5.21	33.25
F			5.09	33.37
G			4.82	33.64
H			4.62	33.84
I			4.41	34.05
NE (Top) batter 1:3			4.40	34.06
" (bot) " "			10.40	28.06
NW " "			4.22	34.24
SW " "			4.59	33.87

Make Final Grade 1034.0



See plan for detail of E. abut.

BM. = Spk-5. root 60" maple
E = 1031.72

See page 24 for elev. 8/8/55

BM. Hor. bent Spk N.W. Triple elm ±11.5 W. of bdge E = 1029.97

Aug. 8-55 Abutm'ts completed before superstructure placed.

	+	HI	−	elev
BM	6.44	1038.16		1031.22
point K			5.79	32.37
L			5.79	"
M			5.81	32.35
P			4.18	1033.98
N			5.80	32.36
O			5.80	"
E			5.77	32.39
D			5.77	"
C			5.78	32.38
F			4.16	1034.00
B			5.77	32.39
A			5.77	"
B.M.			8.19	1029.97

per sketch Pg. 23

A. Temple
K. Patterson

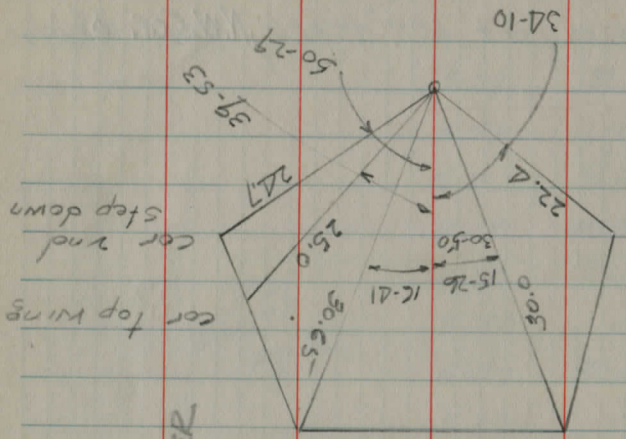
Check levels on Abutm'ts after completion of bridge Sept. 8, 55

	+	HI	−	elev
BM.	6.22	1037.94		1031.72
K			5.58	32.36
P on steel angle iron			3.93	34.01
O			5.60	32.34
E			5.59	32.35
A on steel plate			5.44	32.50
F on steel angle iron			3.92	34.02
BM			6.22	1031.72

Vert spk S.W. root 60" Maple, N.W. Cor. bridge

Hor. bent spk. NW side Triple dead elm ±115' W of bridge (S. side Rd.)

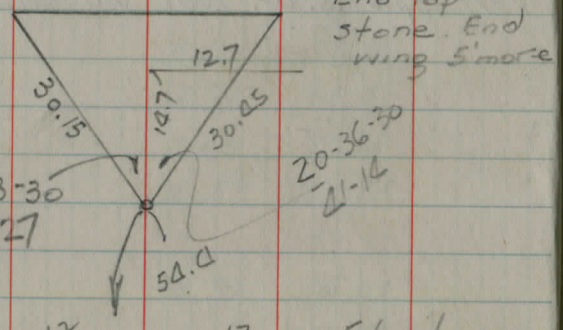
Vert spk S.W. root 60" Maple, NW of bridge



SPERRY RD & CHAGRIN RIVER

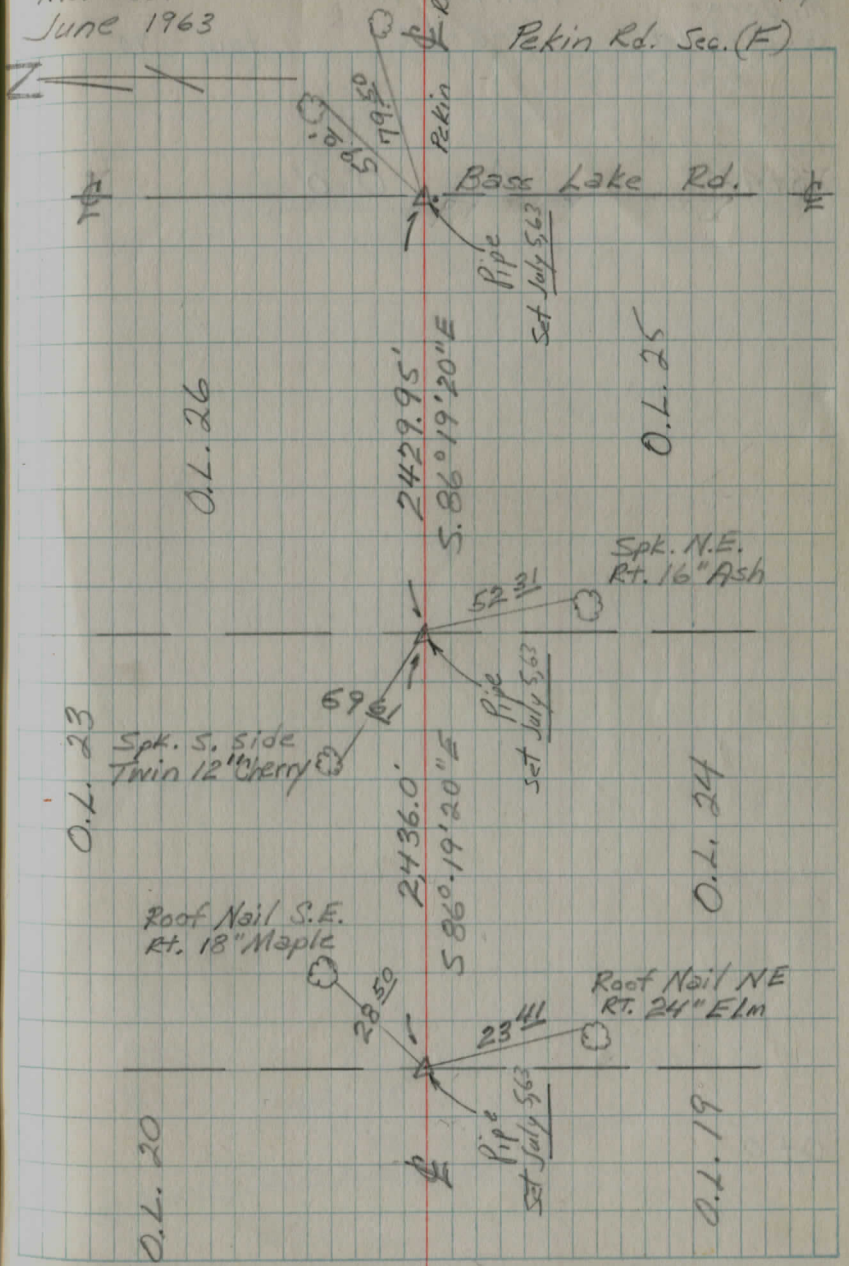
114.10 Spk/Spk

N



171.90 to PI Sta.

T.R. Root
June 1963



H. Patterson
M. Doran
G. Diodoian

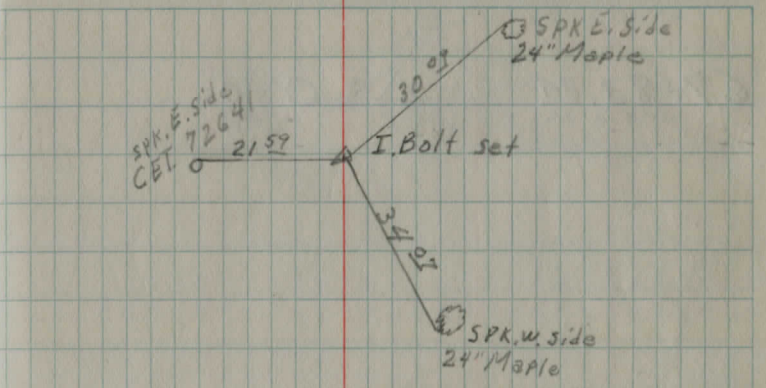
Pekin Rd
6-6-62

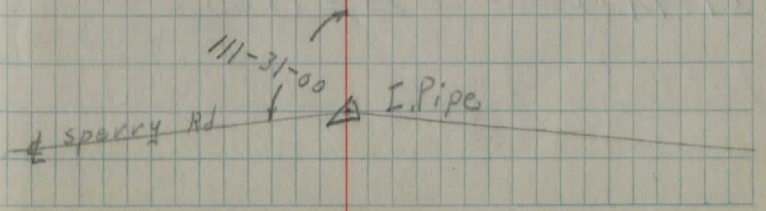
fair 70°

26+47.60

Δ = 0° 0'

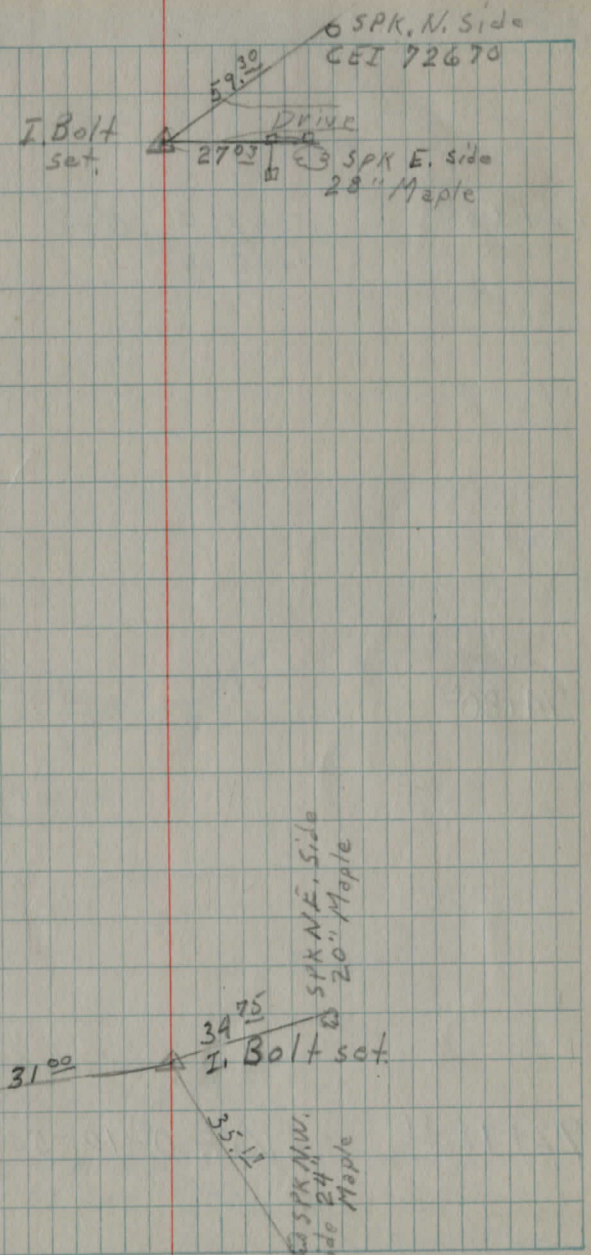
0+0





67+83.84 $\Delta = 0°-0'$

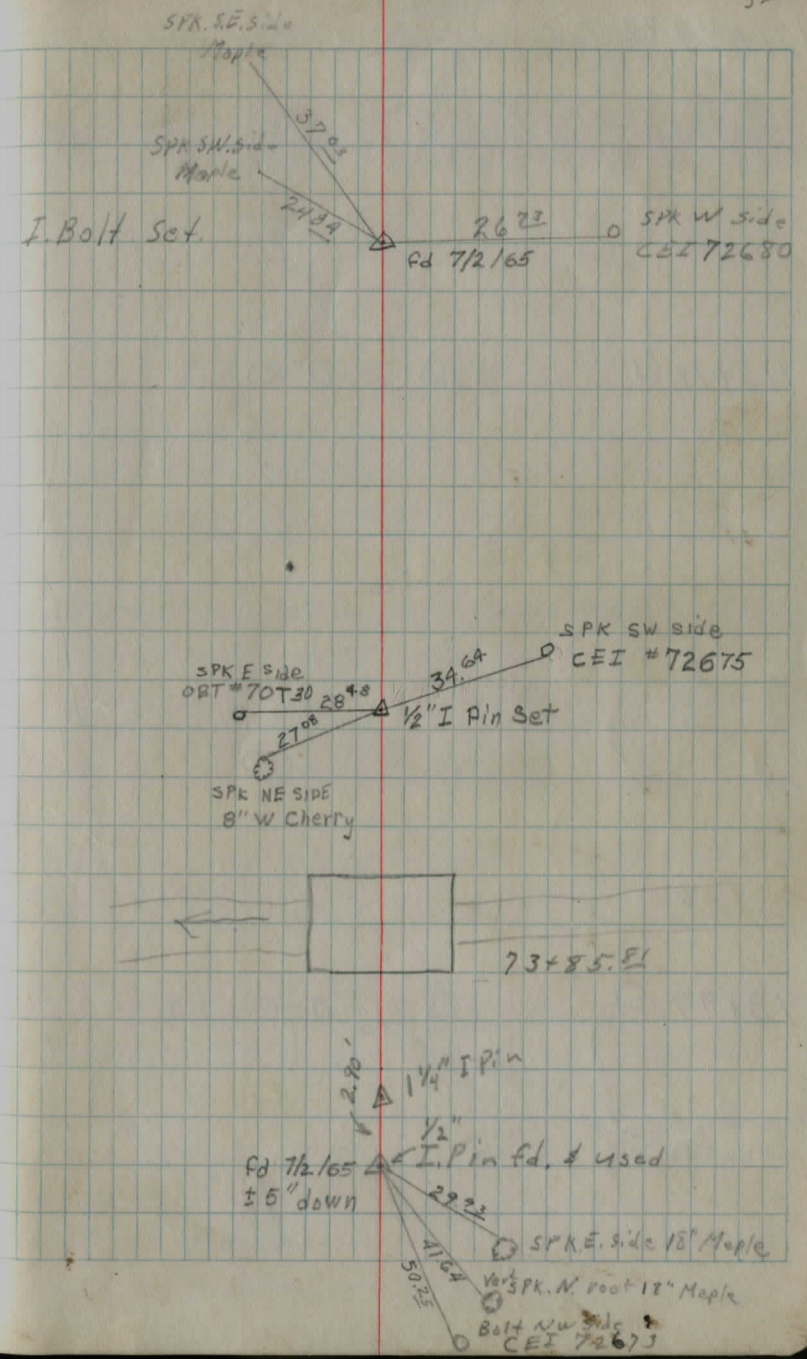
57+94.74 $\Delta = 0°-0'$



82+53.91 Δ = 0°-0'

74+80.00

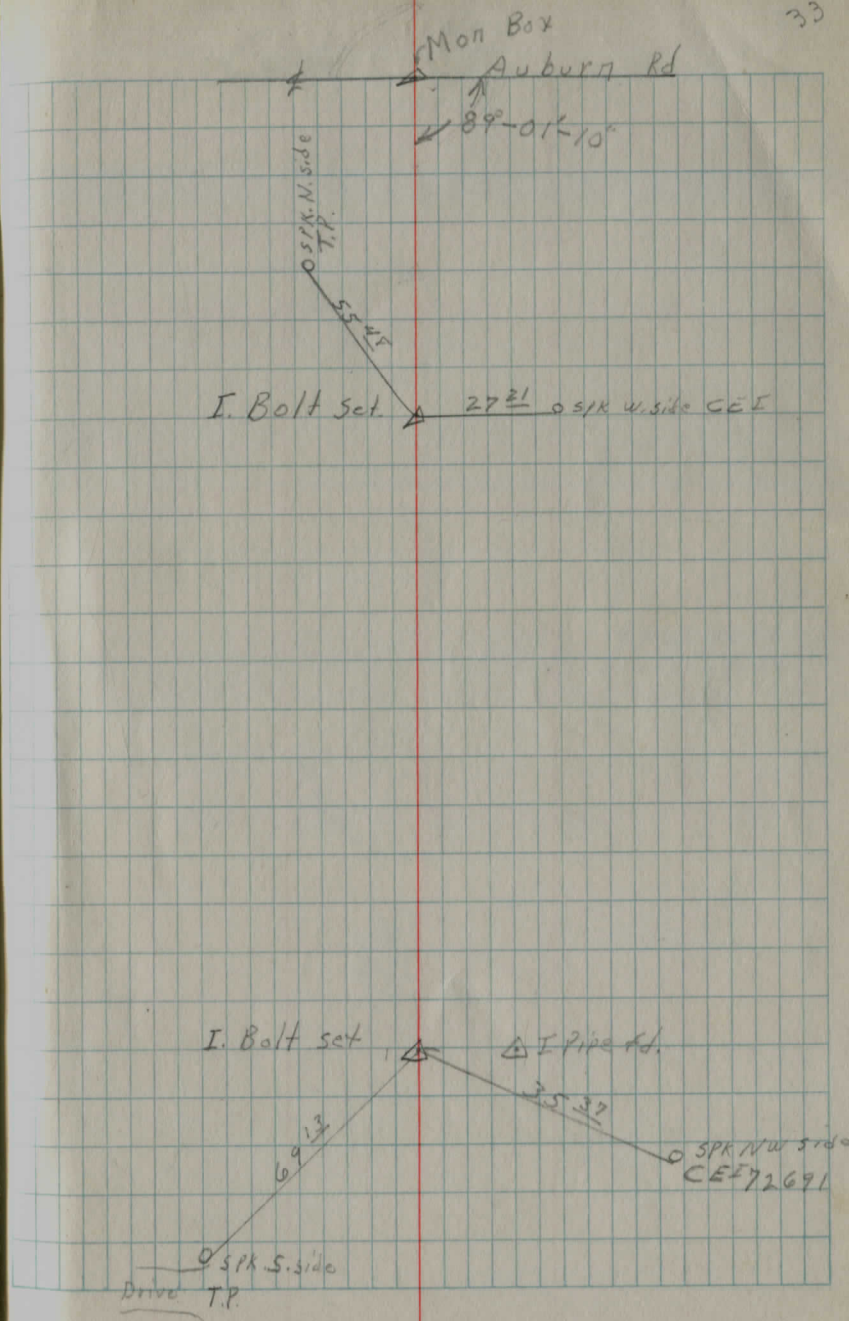
72+98.81 Δ = 0°-10'-56" Rt.



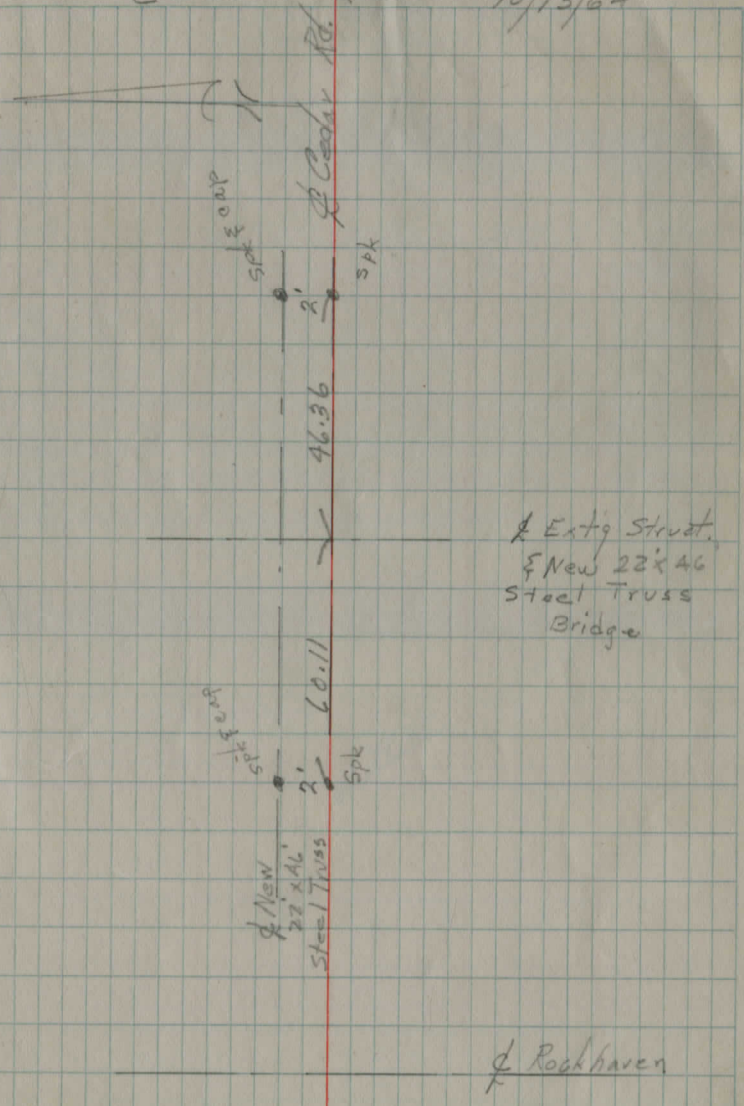
121+79.70

115+19.61 Δ = 0°-0

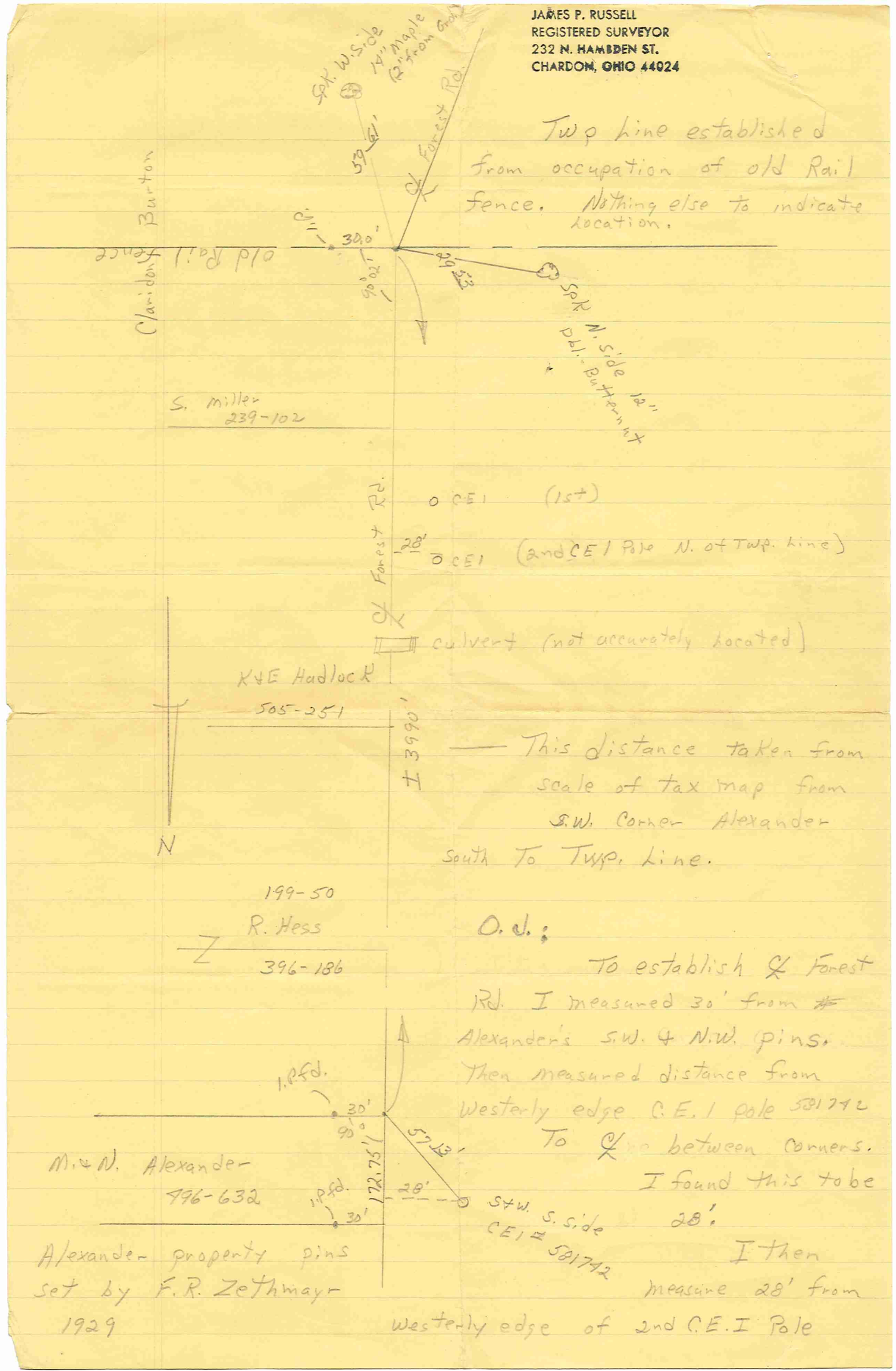
98+97.69 Δ = 0°-0



Cedar Rd. 10/13/64



JAMES P. RUSSELL
REGISTERED SURVEYOR
232 N. HAMBDEN ST.
CHARDON, OHIO 44024



Twp line established from occupation of old Rail fence. Nothing else to indicate location.

Alexander property pins set by F. R. Zethmayr 1929

This distance taken from scale of tax map from S.W. Corner Alexander South To Twp. Line.

O. J.:

To establish ℄ Forest Rd. I measured 30' from ~~the~~ Alexander's S.W. & N.W. pins. Then measured distance from Westerly edge C.E.I pole 581742 To ℄ between corners. I found this to be 28'. I then measure 28' from Westerly edge of 2nd C.E.I Pole

north of Twp. Line and prolonged this Line, from Alexander's S.W. Corner to last mentioned point; South to Twp. Line. This Line comes close to splitting headwalls of 1st. Culvert N. of Twp. Line.

The roadway wanders the ℄ appearing Near the westerly margin of pavement in Some places and near easterly margin of pavement in others.

I did not feel it warranted an angle point in this distance. However, I do think that an angle will be necessary at Alexander's S.W. Corner to bring the ℄ to the intersection of Ensign + Forest Rds.

I hope this information is satisfactory. I felt that it was necessary to use Frank's Pins and, as my ℄ intersection with Twp. Line

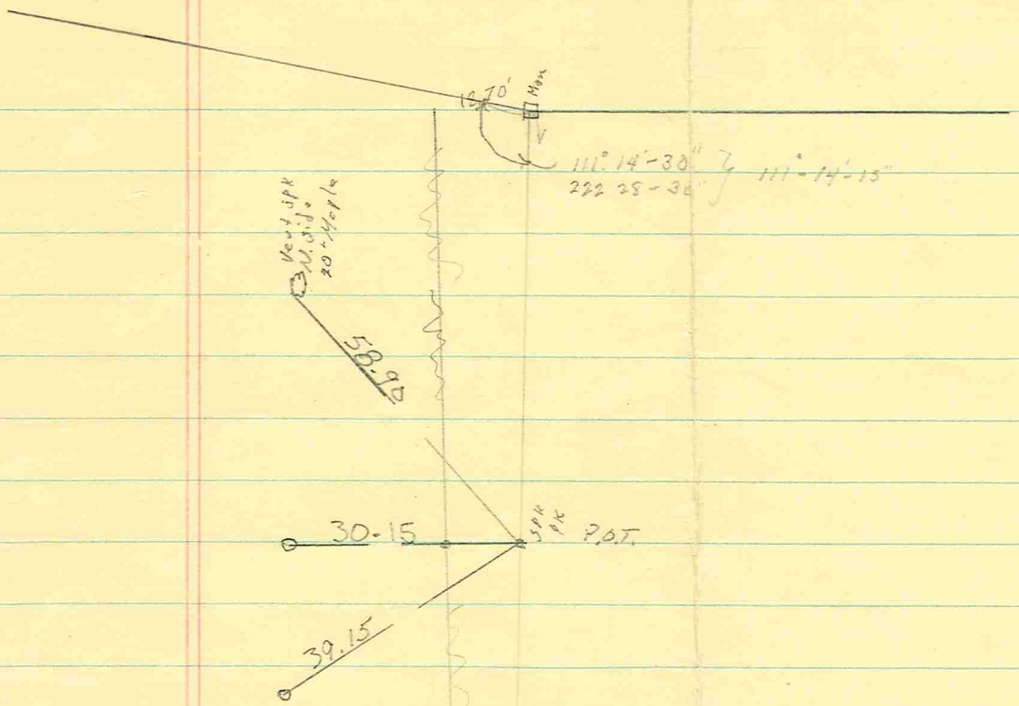
Came on the easterly margin of the occupied Roadway, I felt the other work was sufficiently accurate.

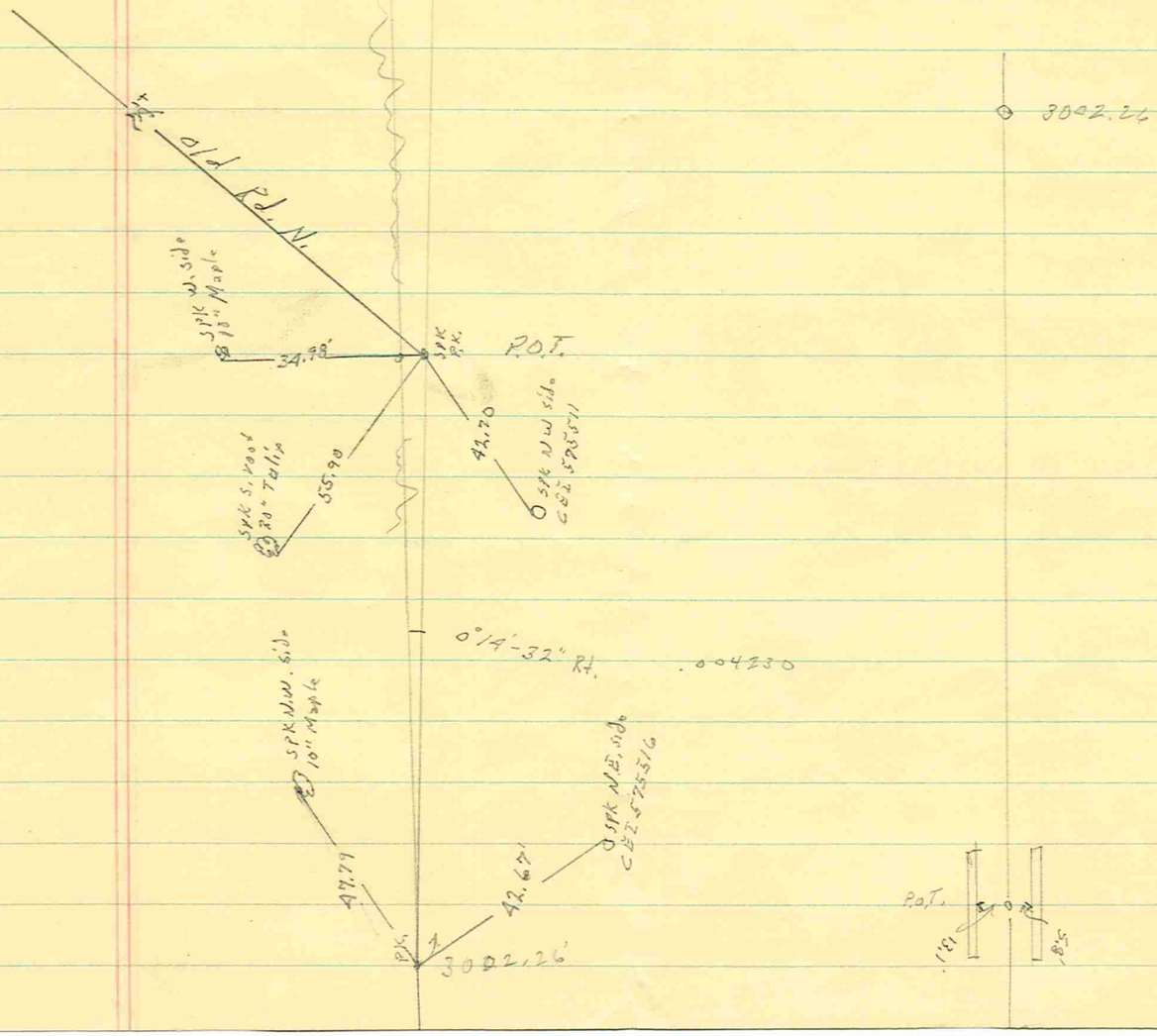
Sincerely

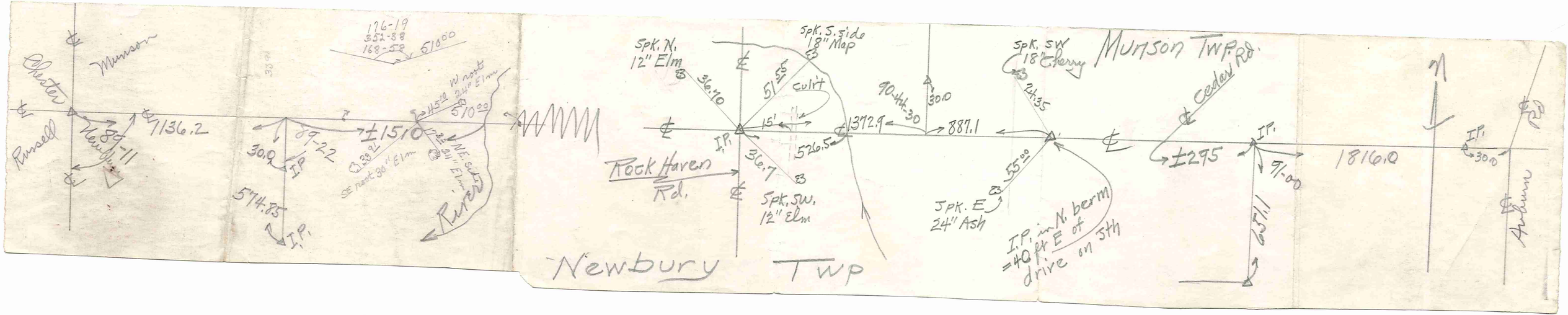
James P. Russell
Reg. Surveyor 5579

12.70

CEDAR RD. 8-15-77






Chester
Munson
Russell
Newbury
S 89-11 W
7136.2
176-19
352-38
168-58
51000
89-22
±1510
30.0
I.P.
574.85
I.P.
W root 24" Elm
45°
510.00
NE side 21" Elm
SE root 30" Elm
River
Spk. N. 12" Elm
36.10
Spk. S. side 18" Map
51.55
Culvt
15'
I.P.
36.7
Spk. SW. 12" Elm
Rock Haven Rd.
1372.9
90 Mh-30
30.0
887.1
526.5
Spk. SW 18" Cherry
24.35
Spk. E 24" Ash
55.00
I.P. in N. berm ±40 ft E of drive on 5th
Munson Twp. Rd.
Cedar Rd.
±295
I.P.
91.00
637.1
1816.10
I.P.
30.0
Autumn
Newbury Twp

CURVE TABLES.

Published by KEUFFEL & ESSER CO.

HOW TO USE CURVE TABLES.

Table I. 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 I.: 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.

EXAMPLE.

Wanted a Curve with an Ext. of about 12 ft. Angle of Intersection or I. P. = 23° 20′ to the R. at Station 542+72.

Ext. in Tab. I opposite 23° 20′ = 120.87
120.87 ÷ 12 = 10.07. Say a 10° Curve.

Tan. in Tab. I opp. 23° 20′ = 1183.1
1183.1 ÷ 10 = 118.31.

Correction for A. 23° 20′ for a 10° Cur. = 0.16
118.31 + 0.16 = 118.47 = corrected Tangent.

(If corrected Ext. is required find in same way)
Ang. 23° 20′ = 23.33° ÷ 10 = 2.3333 = L. C.

2° 19½′ = def. for sta.	542	I. P. = sta.	542+72
4° 49½′ = " " "	+50	Tan. =	1.18.47
7° 19½′ = " " "	543	B. C. = sta.	541+53.53
9° 49½′ = " " "	+50	L. C. =	2.33.33
11° 40′ = " " "	543+	E. C. = Sta.	543+86 86
	86.86		

100 − 53.53 = 46.47 × 3′ (def. for 1 ft. of 10° Cur.) = 139.41′ =
2° 19½′ = def. for sta. 542.

Def. for 50 ft. = 2° 30′ for a 10° Curve.

Def. for 36.86 ft. = 1° 50½′ for a 10° Curve.

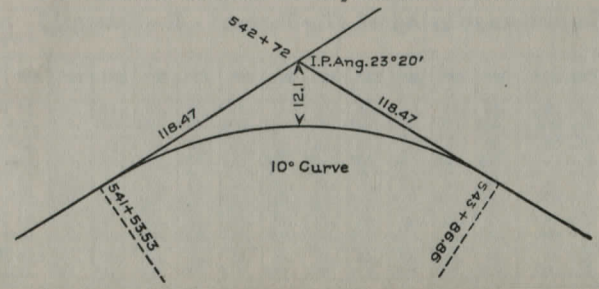


TABLE I. — Tangents and Externals to a 1° Curve.

Chord = 100 ft.

Int. Angle	Tangent	External	Int. Angle	Tangent	External	Int. Angle	Tangent	External
1°	50.00	.22	8°	400.66	13.99	15°	754.32	49.44
10′	58.34	.30	10′	409.03	14.58	10′	762.80	50.55
20	66.67	.39	20	417.41	15.18	20	771.29	51.68
30	75.01	.49	30	425.79	15.80	30	779.77	52.82
40	83.34	.61	40	434.17	16.43	40	788.26	53.97
50	91.68	.73	50	442.55	17.07	50	796.75	55.13
2	100.01	.87	9	450.93	17.72	16	805.25	56.31
10	108.35	1.02	10	459.32	18.38	10	813.75	57.50
20	116.68	1.19	20	467.71	19.06	20	822.25	58.70
30	125.02	1.36	30	476.10	19.75	30	830.76	59.91
40	133.36	1.55	40	484.49	20.45	40	839.27	61.14
50	141.70	1.75	50	492.88	21.16	50	847.78	62.38
3	150.04	1.96	10	501.28	21.89	17	856.30	63.63
10	158.38	2.19	10	509.68	22.62	10	864.82	64.90
20	166.72	2.43	20	518.08	23.38	20	873.35	66.18
30	175.06	2.67	30	526.48	24.14	30	881.88	67.47
40	183.40	2.93	40	534.89	24.91	40	890.41	68.77
50	191.74	3.21	50	543.29	25.70	50	898.95	70.09
4	200.08	3.49	11	551.70	26.50	18	907.49	71.42
10	208.43	3.79	10	560.11	27.31	10	916.03	72.76
20	216.77	4.10	20	568.53	28.14	20	924.58	74.12
30	225.12	4.42	30	576.95	28.97	30	933.13	75.49
40	233.47	4.76	40	585.36	29.82	40	941.69	76.86
50	241.81	5.10	50	593.79	30.68	50	950.25	78.26
5	250.16	5.46	12	602.21	31.56	19	958.81	79.67
10	258.51	5.83	10	610.64	32.45	10	967.38	81.09
20	266.86	6.21	20	619.07	33.35	20	975.96	82.53
30	275.21	6.61	30	627.50	34.26	30	984.53	83.97
40	283.57	7.01	40	635.93	35.18	40	993.12	85.43
50	291.92	7.43	50	644.37	36.12	50	1001.7	86.90
6	300.28	7.86	13	652.81	37.07	20	1010.3	88.39
10	308.64	8.31	10	661.25	38.03	10	1018.9	89.89
20	316.99	8.76	20	669.70	39.01	20	1027.5	91.40
30	325.35	9.23	30	678.15	39.99	30	1036.1	92.92
40	333.71	9.71	40	686.60	40.99	40	1044.7	94.46
50	342.08	10.20	50	695.06	42.00	50	1053.3	96.01
7	350.44	10.71	14	703.51	43.03	21	1061.9	97.57
10	358.81	11.22	10	711.97	44.07	10	1070.6	99.16
20	367.17	11.75	20	720.44	45.12	20	1079.2	100.75
30	375.54	12.29	30	728.90	46.18	30	1087.8	102.35
40	383.91	12.85	40	737.37	47.25	40	1096.4	103.97
50	392.28	13.41	50	745.85	48.34	50	1105.1	105.60

Corrections to be Added (T = Tangent. E = External.)

Int. Angle	Curve 5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
5°	T=.02	.03	.05	.06	.08	.10	.11	.13	.15	.16	.18	.20	.21	.23
	E=.000	.000	.001	.001	.002	.002	.002	.003	.003	.004	.004	.004	.005	.005
10°	T=.03	.05	.09	.13	.16	.19	.22	.25	.28	.31	.34	.38	.42	.46
	E=.001	.003	.004	.006	.007	.008	.009	.011	.012	.014	.015	.017	.018	.020
15°	T=.04	.10	.14	.19	.24	.29	.34	.39	.45	.51	.53	.58	.63	.68
	E=.003	.007	.010	.014	.018	.023	.027	.029	.032	.035	.039	.043	.047	.051
20°	T=.06	.13	.19	.26	.32	.39	.45	.51	.58	.65	.72	.79	.84	.90
	E=.006	.011	.017	.022	.028	.034	.038	.045	.051	.057	.063	.070	.076	.083
25°	T=.08	.16	.24	.33	.40	.49	.58	.67	.75	.83	.90	.99	1.06	1.14
	E=.009	.018	.027	.036	.046	.056	.065	.074	.083	.093	.106	.120	.127	.135

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

Chord = 100 ft.

Int. Angle	Tangent	External	Int. Angle	Tangent	External	Int. Angle	Tangent	External
22°	1113.7	107.24	29°	1481.8	188.51	36°	1861.7	294.9
10′	1122.4	108.90	10′	1490.7	190.74	10′	1870.9	297.7
20	1131.0	110.57	20	1499.6	192.99	20	1880.1	300.6
30	1139.7	112.25	30	1508.5	195.25	30	1889.4	303.5
40	1148.4	113.95	40	1517.4	197.53	40	1898.6	306.4
50	1157.0	115.66	50	1526.3	199.82	50	1907.9	309.3
23	1165.7	117.38	30	1535.3	202.12	37	1917.1	312.2
10	1174.4	119.12	10	1544.2	204.44	10	1926.4	315.2
20	1183.1	120.87	20	1553.1	206.77	20	1935.7	318.1
30	1191.8	122.63	30	1562.1	209.12	30	1945.0	321.1
40	1200.5	124.41	40	1571.0	211.48	40	1954.3	324.1
50	1209.2	126.20	50	1580.0	213.86	50	1963.6	327.1
24	1217.9	128.00	31	1589.0	216.3	38	1972.9	330.2
10	1226.6	129.82	10	1598.0	218.7	10	1982.2	333.2
20	1235.3	131.65	20	1606.9	221.1	20	1991.5	336.3
30	1244.0	133.50	30	1615.9	223.5	30	2000.9	339.3
40	1252.8	135.35	40	1624.9	226.0	40	2010.2	342.4
50	1261.5	137.23	50	1633.9	228.4	50	2019.6	345.5
25	1270.2	139.11	32	1643.0	230.9	39	2029.0	348.6
10	1279.0	141.01	10	1652.0	233.4	10	2038.4	351.8
20	1287.7	142.93	20	1661.0	235.9	20	2047.8	354.9
30	1296.5	144.85	30	1670.0	238.4	30	2057.2	358.1
40	1305.3	146.79	40	1679.1	241.0	40	2066.6	361.3
50	1314.0	148.75	50	1688.1	243.5	50	2076.0	364.5
26	1322.8	150.71	33	1697.2	246.1	40	2085.4	367.7
10	1331.6	152.69	10	1706.3	248.7	10	2094.9	371.0
20	1340.4	154.69	20	1715.3	251.3	20	2104.3	374.2
30	1349.2	156.70	30	1724.4	253.9	30	2113.8	377.5
40	1358.0	158.72	40	1733.5	256.5	40	2123.3	380.8
50	1366.8	160.76	50	1742.6	259.1	50	2132.7	384.1
27	1375.6	162.81	34	1751.7	261.8	41	2142.2	387.4
10	1384.4	164.86	10	1760.8	264.5	10	2151.7	390.7
20	1393.2	166.95	20	1770.0	267.2	20	2161.2	394.1
30	1402.0	169.04	30	1779.1	269.9	30	2170.8	397.4
40	1410.9	171.15	40	1788.2	272.6	40	2180.3	400.8
50	1419.7	173.27	50	1797.4	275.3	50	2189.9	404.2
28	1428.6	175.41	35	1806.6	278.1	42	2199.4	407.6
10	1437.4	177.55	10	1815.7	280.8	10	2209.0	411.1
20	1446.3	179.72	20	1824.9	283.6	20	2218.6	414.5
30	1455.1	181.89	30	1834.1	286.4	30	2228.1	418.0
40	1464.0	184.08	40	1843.3	289.2	40	2237.7	421.4
50	1472.9	186.29	50	1852.5	292.0	50	2247.3	425.0

Corrections to be Added (T = Tangent. E = External.)

Int. Angle	Curve 5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
20°	T=.06	.13	.19	.26	.32	.39	.45	.51	.58	.65	.72	.79	.84	.90
	E=.006	.011	.017	.022	.028	.034	.038	.045	.051	.057	.063	.070	.076	.083
25°	T=.08	.16	.24	.33	.40	.49	.58	.67	.75	.83	.90	.99	1.06	1.14
	E=.009	.018	.027	.036	.046	.056	.065	.074	.083	.093	.106	.120	.127	.135
30°	T=.10	.19	.29	.39	.49	.59	.69	.79	.89	.99	1.09	1.20	1.29	1.39
	E=.013	.025	.038	.051	.065	.078	.090	.103	.116	.129	.149	.170	.179	.188
35°	T=.11	.22	.34	.47	.58	.69	.80	.93	1.05	1.17	1.29	1.42	1.54	1.66
	E=.018	.035	.054	.072	.086	.109	.131	.153	.175	.197	.213	.230	.247	.264
40°	T=.13	.26	.40	.53	.67	.80	.93	1.06	1.20	1.34	1.49	1.64	1.79	1.94
	E=.023	.046	.070	.093	.117	.141	.172	.203	.234	.265	.277	.290	.315	.341
45°	T=.15	.30	.44	.60	.76	.91	1.06	1.21	1.37	1.52	1.70	1.87	2.04	2.21
	E=.030	.060	.093	.119	.153	.184	.216	.254	.289	.325	.351	.378	.411	.445

Table I. — Tangents and Externals to a 1° Curve.

Chord = 100 ft.

Int. Angle	Tangent	External	Int. Angle	Tangent	External	Int. Angle	Tangent	External
43°	2257.0	428.5	**50°**	2671.8	592.3	**57°**	3110.9	790.1
10′	2266.6	432.0	10′	2681.9	596.6	10′	3121.7	795.2
20	2276.2	435.6	20	2692.1	600.9	20	3132.6	800.4
30	2285.9	439.2	30	2702.3	605.3	30	3143.4	805.6
40	2295.6	442.8	40	2712.5	609.6	40	3154.2	810.9
50	2305.2	446.4	50	2722.7	614.0	50	3165.1	816.1
44	2314.9	450.0	**51**	2732.9	618.4	**58**	3176.0	821.4
10	2324.6	453.6	10	2743.1	622.8	10	3186.9	826.7
20	2334.3	457.3	20	2753.4	627.2	20	3197.8	832.0
30	2344.1	461.0	30	2763.7	631.7	30	3208.8	837.3
40	2353.8	464.6	40	2773.9	636.2	40	3219.7	842.7
50	2363.5	468.4	50	2784.2	640.7	50	3230.7	848.1
45	2373.3	472.1	**52**	2794.5	645.2	**59**	3241.7	853.5
10	2383.1	475.8	10	2804.9	649.7	10	3252.7	858.9
20	2392.8	479.6	20	2815.2	654.3	20	3263.7	864.3
30	2402.6	483.4	30	2825.6	658.8	30	3274.8	869.8
40	2412.4	487.2	40	2835.9	663.4	40	3285.8	875.3
50	2422.3	491.0	50	2846.3	668.0	50	3296.9	880.8
46	2432.1	494.8	**53**	2856.7	672.7	**60**	3308.0	886.4
10	2441.9	498.7	10	2867.1	677.3	10	3319.1	892.0
20	2451.8	502.5	20	2877.5	682.0	20	3330.3	897.5
30	2461.7	506.4	30	2888.0	686.7	30	3341.4	903.2
40	2471.5	510.3	40	2898.4	691.4	40	3352.6	908.8
50	2481.4	514.3	50	2908.9	696.1	50	3363.8	914.5
47	2491.3	518.2	**54**	2919.4	700.9	**61**	3375.0	920.2
10	2501.2	522.2	10	2929.9	705.7	10	3386.3	925.9
20	2511.2	526.1	20	2940.4	710.5	20	3397.5	931.6
30	2521.1	530.1	30	2951.0	715.3	30	3408.8	937.3
40	2531.1	534.2	40	2961.5	720.1	40	3420.1	943.1
50	2541.0	538.2	50	2972.1	725.0	50	3431.4	948.9
48	2551.0	542.2	**55**	2982.7	729.9	**62**	3442.7	954.8
10	2561.0	546.3	10	2993.3	734.8	10	3454.1	960.6
20	2571.0	550.4	20	3003.9	739.7	20	3465.4	966.5
30	2581.0	554.5	30	3014.5	744.6	30	3476.8	972.4
40	2591.0	558.6	40	3025.2	749.6	40	3488.3	978.3
50	2601.1	562.8	50	3035.8	754.6	50	3499.7	984.3
49	2611.2	566.9	**56**	3046.5	759.6	**63**	3511.1	990.2
10	2621.2	571.1	10	3057.2	764.6	10	3522.6	996.2
20	2631.3	575.3	20	3067.9	769.7	20	3534.1	1002.3
30	2641.4	579.5	30	3078.7	774.7	30	3545.6	1008.3
40	2651.5	583.8	40	3089.4	779.8	40	3557.2	1014.4
50	2661.6	588.0	50	3100.2	784.9	50	3568.7	1020.5

Corrections to be Added (T = Tangent. E = External.)

Int. Angle	Curve 5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
40°	T=.13	.26	.40	.53	.67	.80	.93	.106	1.20	1.34	1.49	1.64	1.79	1.94
	E=.023	.046	.070	.093	.117	.141	.172	.203	.234	.265	.277	.290	.315	.341
45°	T=.15	.30	.44	.60	.76	.91	1.06	1.21	1.37	1.52	1.70	1.87	2.04	2.21
	E=.030	.060	.093	.119	.153	.184	.216	.254	.289	.325	.351	.378	.411	.445
50°	T=.17	.34	.51	.68	.85	1.02	1.19	1.36	1.54	1.72	1.91	2.10	2.29	2.48
	E=.037	.075	.116	.151	.189	.227	.266	.305	.345	.384	.425	.467	.508	.550
55°	T=.19	.38	.57	.76	.95	1.14	1.32	1.52	1.72	1.92	2.14	2.35	2.56	2.77
	E=.046	.093	.142	.188	.236	.283	.332	3.81	.420	.479	.530	.582	.641	.700
60°	T=.21	.42	.63	.84	1.05	1.27	1.49	1.71	1.94	2.17	2.38	2.60	2.83	3.07
	E=.056	.112	.168	.225	.283	.340	.398	.457	.516	.575	.636	.697	.774	.851
65°	T=.23	.46	.69	.93	1.16	1.40	1.64	1.88	2.13	2.38	2.63	2.88	3.13	3.39
	E=.067	.135	.204	.273	.343	.412	.483	.554	.625	.697	.711	.845	.922	1.01

Table I. — Tangents and Externals to a 1° Curve.

Chord = 100 ft.

Int. Angle	Tangent	External	Int. Angle	Tangent	External	Int. Angle	Tangent	External
64°	3580.3	1026.6	**71°**	4086.9	1308.2	**78°**	4639.8	1643.0
10′	3591.9	1032.8	10′	4099.5	1315.6	10′	4653.6	1651.7
20	3603.5	1039.0	20	4112.1	1322.9	20	4667.4	1660.5
30	3615.1	1045.2	30	4124.8	1330.3	30	4681.3	1669.2
40	3626.8	1051.4	40	4137.4	1337.7	40	4695.2	1678.1
50	3638.5	1057.7	50	4150.1	1345.1	50	4709.2	1686.9
65	3650.2	1063.9	**72**	4162.8	1352.6	**79**	4723.2	1695.8
10	3661.9	1070.2	10	4175.6	1360.1	10	4737.2	1704.7
20	3673.7	1076.6	20	4188.5	1367.6	20	4751.2	1713.7
30	3685.4	1082.9	30	4201.2	1375.2	30	4765.3	1722.7
40	3697.2	1089.3	40	4214.0	1382.8	40	4779.4	1731.7
50	3709.0	1095.7	50	4226.8	1390.4	50	4793.6	1740.8
66	3720.9	1102.2	**73**	4239.7	1398.0	**80**	4807.7	1749.9
10	3732.7	1108.6	10	4252.6	1405.7	10	4822.0	1759.0
20	3744.6	1115.1	20	4265.6	1413.5	20	4836.2	1768.2
30	3756.5	1121.7	30	4278.5	1421.2	30	4850.5	1777.4
40	3768.5	1128.2	40	4291.5	1429.0	40	4864.8	1786.7
50	3780.4	1134.8	50	4304.6	1436.8	50	4879.2	1796.0
67	3792.4	1141.4	**74**	4317.6	1444.6	**81**	4893.6	1805.3
10	3804.4	1148.0	10	4330.7	1452.5	10	4908.0	1814.7
20	3816.4	1154.7	20	4343.8	1460.4	20	4922.5	1824.1
30	3828.4	1161.3	30	4356.9	1468.4	30	4937.0	1833.6
40	3840.5	1168.1	40	4370.1	1476.4	40	4951.5	1843.1
50	3852.6	1174.8	50	4383.3	1484.4	50	4966.1	1852.6
68	3864.7	1181.6	**75**	4396.5	1492.4	**82**	4980.7	1862.2
10	3876.8	1188.4	10	4409.8	1500.5	10	4995.4	1871.8
20	3889.0	1195.2	20	4423.1	1508.6	20	5010.0	1881.5
30	3901.2	1202.0	30	4436.4	1516.7	30	5024.8	1891.2
40	3913.4	1208.9	40	4449.7	1524.9	40	5039.5	1900.9
50	3925.6	1215.8	50	4463.1	1533.1	50	5054.3	1910.7
69	3937.9	1222.7	**76**	4476.5	1541.4	**83**	5069.2	1920.5
10	3950.2	1229.7	10	4489.9	1549.7	10	5084.0	1930.4
20	3962.5	1236.7	20	4503.4	1558.0	20	5099.0	1940.3
30	3974.8	1243.7	30	4516.9	1566.3	30	5113.9	1950.3
40	3987.2	1250.8	40	4530.4	1574.7	40	5128.9	1960.2
50	3999.5	1257.9	50	4544.0	1583.1	50	5143.9	1970.3
70	4011.9	1265.0	**77**	4557.6	1591.6	**84**	5159.0	1980.4
10	4024.4	1272.1	10	4571.2	1600.1	10	5174.1	1990.5
20	4036.8	1279.3	20	4584.8	1608.6	20	5189.3	2000.6
30	4049.3	1286.5	30	4598.5	1617.1	30	5204.4	2010.8
40	4061.8	1293.6	40	4612.2	1625.7	40	5219.7	2021.1
50	4074.4	1300.9	50	4626.0	1634.4	50	5234.9	2031.4

Corrections to be Added (T = Tangent. E = External.)

Int. Angle	Curve 5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
60°	T=.21	.42	.63	.84	1.05	1.27	1.49	1.71	1.94	2.17	2.38	2 60	2.83	3 07
	E=.056	.112	.168	.225	.283	.340	.398	.457	.516	.575	.636	.697	.774	.851
65°	T=.23	.46	.69	.93	1.16	1.40	1.64	1.88	2.13	2.38	2.63	2.88	3.13	3.39
	E=.067	.135	.204	.273	.343	.412	.483	.554	.625	.697	.711	.845	.922	1.01
70°	T=.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
	E=.080	.159	.240	.321	.403	.485	.568	.652	.735	.819	.906	.994	1.08	1.17
75°	T=.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
	E=.095	.182	.286	.383	.480	.578	.678	.777	.877	.977	1.07	1.18	1.29	1.39
80°	T=.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
	E=.110	.220	.332	.445	.558	.671	.787	.903	1.02	1.13	1.25	1.38	1.50	1.62
85°	T=.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
	E=.128	.259	.391	.524	.657	.790	.926	1.06	1.20	1.34	1.47	1.62	1.76	1.91

Table I. — Tangents and Externals to a 1° Curve.

Chord = 100 ft.

Int. Angle	Tangent	External	Int. Angle	Tangent	External	Int. Angle	Tangent	External
85°	5250.3	2041.7	**92°**	5933.2	2518.5	**99°**	6708.6	3092.7
10′	5265.6	2052.1	10′	5950.5	2531.0	10′	6728.4	3107.7
20	5281.0	2062.5	20	5967.9	2543.5	20	6748.2	3122.9
30	5296.4	2073.0	30	5985.3	2556.0	30	6768.1	3138.1
40	5311.9	2083.5	40	6002.7	2568.6	40	6788.1	3153.3
50	5327.4	2094.1	50	6020.2	2581.3	50	6808.2	3168.7
86	5343.0	2104.7	**93**	6037.8	2594.0	**100**	6828.3	3184.1
10	5358.6	2115.3	10	6055.4	2606.8	10	6848.5	3199.6
20	5374.2	2126.0	20	6073.1	2619.7	20	6868.8	3215.1
30	5389.9	2136.7	30	6090.8	2632.6	30	6889.2	3230.8
40	5405.6	2147.5	40	6108.6	2645.5	40	6909.6	3246.5
50	5421.4	2158.4	50	6126.4	2658.5	50	6930.1	3262.3
87	5437.2	2169.2	**94**	6144.3	2671.6	**101**	6950.6	3278.1
10	5453.1	2180.2	10	6162.6	2684.7	10	6971.3	3294.1
20	5469.0	2191.1	20	6180.2	2697.9	20	6992.0	3310.1
30	5484.9	2202.2	30	6198.3	2711.2	30	7012.7	3326.1
40	5500.9	2213.2	40	6216.4	2724.5	40	7033.6	3342.3
50	5517.0	2224.3	50	6234.6	2737.9	50	7054.5	3358.5
88	5533.1	2235.5	**95**	6252.8	2751.3	**102**	7075.5	3374.9
10	5549.2	2246.7	10	6271.1	2764.8	10	7096.6	3391.2
20	5565.4	2258.0	20	6289.4	2778.3	20	7117.8	3407.7
30	5581.6	2269.3	30	6307.9	2792.0	30	7139.0	3424.3
40	5597.8	2280.6	40	6326.3	2805.6	40	7160.3	3440.9
50	5614.2	2292.0	50	6344.8	2819.4	50	7181.7	3457.6
89	5630.5	2303.5	**96**	6363.4	2833.2	**103**	7203.2	3474.4
10	5646.9	2315.0	10	6382.1	2847.0	10	7224.7	3491.3
20	5663.4	2326.6	20	6400.8	2861.0	20	7246.3	3508.2
30	5679.9	2338.2	30	6419.5	2875.0	30	7268.0	3525.2
40	5696.4	2349.8	40	6438.4	2889.0	40	7289.8	3542.4
50	5713.0	2361.5	50	6457.3	2903.1	50	7311.7	3559.6
90	5729.7	2373.3	**97**	6476.2	2917.3	**104**	7333.6	3576.8
10	5746.3	2385.1	10	6495.2	2931.6	10	7355.6	3594.2
20	5763.1	2397.0	20	6514.3	2945.9	20	7377.8	3611.7
30	5779.9	2408.9	30	6533.4	2960.3	30	7399.9	3629.2
40	5796.7	2420.9	40	6552.6	2974.7	40	7422.2	3646.8
50	5813.6	2432.9	50	6571.9	2989.2	50	7444.6	3664.5
91	5830.5	2444.9	**98**	6591.2	3003.8	**105**	7467.0	3682.3
10	5847.5	2457.1	10	6610.6	3018.4	10	7489.6	3700.2
20	5864.6	2469.3	20	6630.1	3033.1	20	7512.2	3718.2
30	5881.7	2481.5	30	6649.6	3047.9	30	7534.9	3736.2
40	5898.8	2493.8	40	6669.2	3062.8	40	7557.7	3754.4
50	5916.0	2506.1	50	6688.8	3077.7	50	7580.5	3772.6

Corrections to be Added (T = Tangent. E. = External.)

Int. Angle	Curve 5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
85°	T=.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
	E=.128	.259	.391	.524	.657	.790	.926	1.06	1.20	1.34	1.47	1.62	1.76	1.91
90°	T=.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
	E=.149	.299	.450	.603	.756	.910	1.07	1.22	1.38	1.54	1.70	1.87	2.03	2.20
95°	T=.39	.79	1.19	1.55	2.00	2.40	2.80	3.20	3.61	4.02	4.49	4.98	5.38	5.83
	E=.174	.350	.522	.706	.985	1.06	1.25	1.43	1.62	1.80	1.99	2.18	2.38	2.58
100°	T=.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
	E=.200	.401	.604	.809	1.01	1.22	1.43	1.64	1.85	2.06	2.28	2.50	2.73	2.96
105°	T=.46	.94	1.42	1.90	2.38	2.87	3.34	3.84	4.35	4.84	5.35	5.87	6.40	6.93
	E=.230	.470	.700	.938	1.17	1.42	1.65	1.90	2.14	2.39	2.64	2.90	3.16	3.41

Table I. — Tangents and Externals to a 1° Curve.

Chord = 100 ft.

Int. Angle	Tangent	External	Int. Angle	Tangent	External	Int. Angle	Tangent	External
106°	7603.5	3791.0	**111°**	8336.7	4386.1	**116°**	9169.4	5082.7
10′	7626.6	3809.4	10′	8362.7	4407.6	10′	9199.1	5107.9
20	7649.7	3827.9	20	8388.9	4429.2	20	9229.0	5133.3
30	7672.9	3846.5	20	8415.1	4450.9	30	9259.0	5158.8
40	7696.3	3865.2	40	8441.5	4472.7	40	9289.2	5184.5
50	7719.7	3884.0	50	8468.0	4494.6	50	9319.5	5210.3
107	7743.2	3902.9	**112**	8494.6	4516.6	**117**	9349.9	5236.2
10	7766.8	3921.9	10	8521.3	4538.8	10	9380.5	5262.3
20	7790.5	3940.9	20	8548.1	4561.1	20	9411.3	5288.6
30	7814.3	3960.1	30	8575.0	4583.4	30	9442.2	5315.0
40	7838.1	3979.4	40	8602.1	4606.0	40	9473.2	5341.5
50	7862.1	3998.7	50	8629.3	4628.6	50	9504.4	5368.2
108	7886.2	4018.2	**113**	8656.6	4651.3	**118**	9535.7	5395.1
10	7910.4	4037.8	10	8684.0	4674.2	10	9567.2	5422.1
20	7934.6	4057.4	20	8711.5	4697.2	20	9598.9	5449.2
30	7959.0	4077.2	30	8739.2	4720.3	30	9630.7	5476.5
40	7983.5	4097.1	40	8767.0	4743.6	40	9662.6	5504.0
50	8008.0	4117.0	50	8794.9	4766.9	50	9694.7	5531.7
109	8032.7	4137.1	**114**	8822.9	4790.4	**119**	9727.0	5559.4
10	8057.4	4157.3	10	8851.0	4814.1	10	9759.4	5587.4
20	8082.3	4177.5	20	8879.3	4837.8	20	9792.0	5615.5
30	8107.3	4197.9	30	8907.7	4861.7	30	9824.8	5643.8
40	8132.3	4218.4	40	8936.3	4885.7	40	9857.7	5672.3
50	8157.5	4239.0	50	8965.0	4909.9	50	9890.8	5700.9
110	8182.8	4259.7	**115**	8993.8	4934.1	**120**	9924.0	5729.7
10	8208.2	4280.5	10	9022.7	4958.6	10	9957.5	5758.6
20	8233.7	4301.4	20	9051.7	4983.1	20	9991.0	5787.7
30	8259.3	4322.4	30	9080.9	5007.8	30	10025.0	5817.0
40	8285.0	4343.6	40	9110.3	5032.6	40	10059.0	5846.5
50	8310.8	4364.8	50	9139.8	5057.6	50	10093.0	5876.1

Corrections to be Added (T = Tangent. E = External.)

Int. Angle	Curve 5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
100°	T=.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
	E=.200	.401	.604	.809	1.01	1.22	1.43	1.64	1.85	2.06	2.28	2.50	2.73	2.96
105°	T=.46	.94	1.42	1.90	2.38	2.87	3.34	3.84	4.35	4.84	5.35	5.87	6.40	6.93
	E=.230	.470	.700	.938	1.17	1.42	1.65	1.90	2.14	2.39	2.64	2.90	3.16	3.41
110°	T=.50	1.03	1.55	2.08	2.60	3.14	3.66	4.21	4.76	5.31	5.86	6.43	7.01	7.59
	E=.260	.535	.808	1.08	1.36	1.63	1.91	2.19	2.49	2.61	3.05	3.35	3.65	3.95
115°	T=.54	1.13	1.70	2.29	2.86	3.45	4.03	4.63	5.23	5.83	6.44	7.07	7.70	8.35
	E=.307	624	.939	1.26	1.57	1.89	2.21	2.54	2.87	3.20	3.53	3.88	4.23	4.58
120°	T=.61	1.25	1.89	2.52	3.16	3.81	4.44	5.11	5.78	6.44	7.11	7.80	8.51	9.21
	E=.339	.720	1.08	1.45	1.82	2.20	2.56	2.95	3.33	3.72	4.10	4.50	4.91	5.32

TABLE II. — Radii, Ordinates and Deflections. Chord = 100 ft.

Deg.	Radius	Mid. Ord.	Tan. Dist.	Def. Dist.	Def. for 1 Ft.	Deg.	Radius	Mid. Ord.	Tan. Dist.	Def. Dist.	Def. for 1 Ft.
	ft.	ft.	ft.	ft.	′		ft.	ft.	ft.	ft.	′
0° 10′	34377.	.036	.145	.291	0.05	7°	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	8	716.8	1.746	6.976	13.95	2.40
1	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	9	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
2	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	10	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	11	521.7	2.402	9.585	19.16	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	12	478.3	2.620	10.45	20.91	3.60
3	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	13	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	14	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	15	383.1	3.277	13.05	26.11	4.50
4	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	16	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	17	338.3	3.716	14.78	29.56	5.10
40	1228.1	1.018	4.071	8.143	1.40	18	319.6	3.935	15.64	31.29	5.40
50	1185.8	1.055	4.217	8.433	1.45	19	302.9	4.155	16.51	33.01	5.70
5	1146.3	1.091	4.362	8.724	1.50	20	287.9	4.374	17.37	34.73	6.00
10	1109.3	1.127	4.507	9.014	1.55	21	274.4	4.594	18.22	36.44	6.30
20	1074.7	1.164	4.653	9.305	1.60	22	262.0	4.814	19.08	38.16	6.60
30	1042.1	1.200	4.798	9.596	1.65	23	250.8	5.035	19.94	39.87	6.90
40	1011.5	1.237	4.943	9.886	1.70	24	240.5	5.255	20.79	41.58	7.20
50	982.6	1.273	5.088	10.18	1.75	25	231.0	5.476	21.64	43.28	7.50
6	955.4	1.309	5.234	10.47	1.80	26	222.3	5.697	22.50	44.99	7.80
10	929.6	1.346	5.379	10.76	1.85	27	214.2	5.918	23.35	46.69	8.10
20	905.1	1.382	5.524	11.05	1.90	28	206.7	6.139	24.19	48.38	8.40
30	881.9	1.418	5.669	11.34	1.95	29	199.7	6.360	25.04	50.07	8.70
40	859.9	1.455	5.814	11.63	2.00	30	193.2	6.583	25.88	51.76	9.00

The middle ordinate in inches for any cord of length (C) is equal to .0012 C^2 multiplied by the middle ordinate taken from the above table. Thus, if it desired to bend a 30 ft. rail to fit a 10 degree curve, its middle ordinate should be .0012×900×2.183 or 2.36 inches.

TABLE III. Deflections for Sub Chords for Short Radius Curves.

Degree of Curve	Radius 50 / sin. ½ def. ang.	½ sub chord / R = sin of ½ def. angle 12.5 Ft.	15 Ft.	20 Ft.	25 Ft.	Length of arc for 100 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

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

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

$\text{Sin. } \frac{1}{2} D = \frac{50}{R}$

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

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

$R = \frac{50}{\text{Sin. } \frac{1}{2} D}$

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

$E = T \tan \frac{1}{4} I$

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

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

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

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

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft. see Table II.), 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.

GENERAL DATA

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.

LEVELING. The correction for curvature and refraction, in feet and decimals of feet is equal to $0.5774\,d^2$, where d is the distance in miles. The correction for curvature alone is closely, $\frac{2}{3}d^2$. Both corrections are negative.

PROBABLE ERROR. If d_1, d_2, d_3, etc. are the discrepancies of various results from the mean, and if Σd^2 = the sum of the squares of these differences and n = the number of observations, then the probable error of the mean $= \pm 0.6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$

SOLAR EPHEMERIS. Attention is called to the Solar Ephemeris for the current year, published by Keuffel & Esser Co., and furnished free of charge upon request, which is $3\frac{1}{4} \times 5\frac{1}{2}$ in., with about 90 pages of data very useful to the Surveyor; such as the adjustments of transits, levels and solar attachments; directions and tables for determining the meridian and the latitude from observations on the sun and Polaris; stadia measurements; magnetic declination; arithmetic constants; English and Metric conversions; trigonometric formulas; Natural and Logarithmic Functions; and Logarithms of Numbers.

TABLE IV. — 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 V. — Inches in Decimals of a Foot.

1-16	3-32	1/8	3-16	1/4	5-16	3/8	1/2	5/8	3/4	7/8
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	0729

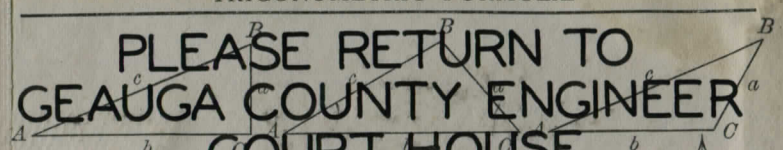
1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

Angle.	Sin.	Tan.	Sec.	Cosec.	Cotg.	Cosin.	
° ′							
0	0	0	1.	∞	∞	1.	90
10	0029	.0029		343.8	343.8	1.	50
20	.0058	.0058		171.9	171.9	.99998	40
30	.0087	.0087		114.6	114.6	.99996	30
40	.0116	.0116	1.0001	85.94	85.94	.99993	20
50	.0145	.0145	1.0001	68.76	68.75	.99989	10
1	.0175	.0175	1.0002	57.30	57.29	.99985	89
10	.0204	.0204	1.0002	49.11	49.10	.99979	50
20	.0233	.0233	1.0003	42.98	42.96	.99973	40
30	.0262	.0262	1.0003	38.20	38.19	.99966	30
40	.0291	.0291	1.0004	34.38	34.37	.99958	20
50	.0320	.0320	1.0005	31.26	31.24	.99949	10
2	.0349	.0349	1.0006	28.65	28.64	.99939	88
10	.0378	.0378	1.0007	26.45	26.43	.99929	50
20	.0407	.0407	1.0008	24.56	24.54	.99917	40
30	.0436	.0437	1.0010	22.93	22.90	.99905	30
40	.0465	.0466	1.0011	21.49	21.47	.99892	20
50	.0494	.0495	1.0012	20.23	20.21	.99878	10
3	.0523	.0524	1.0014	19.11	19.08	.99863	87
10	.0552	.0553	1.0015	18.10	18.07	.99847	50
20	.0581	.0582	1.0017	17.20	17.17	.99831	40
30	.0610	.0612	1.0019	16.38	16.35	.99813	30
40	.0640	.0641	1.0020	15.64	15.60	.99795	20
50	.0669	.0670	1.0022	14.96	14.92	.99776	10
4	.0698	.0699	1.0024	14.34	14.30	.99756	86
10	.0727	.0729	1.0027	13.76	13.73	.99736	50
20	.0756	.0758	1.0029	13.23	13.20	.99714	40
30	.0785	.0787	1.0031	12.75	12.71	.99692	30
40	.0814	.0816	1.0033	12.29	12.25	.99668	20
50	.0843	.0846	1.0036	11.87	11.83	.99644	10
5	.0872	.0875	1.0038	11.47	11.43	.99619	85
10	.0901	.0904	1.0041	11.10	11.06	.99594	50
20	.0929	.0934	1.0043	10.76	10.71	.99567	40
30	.0958	.0963	1.0046	10.43	10.39	.99540	30
40	.0987	.0992	1.0049	10.13	10.08	.99511	20
50	.1016	.1022	1.0052	9.839	9.788	.99482	10
6	.1045	.1051	1.0055	9.567	9.514	.99452	84
10	.1074	.1080	1.0058	9.309	9.255	.99421	50
20	.1103	.1110	1.0061	9.065	9.010	.99390	40
30	.1132	.1139	1.0065	8.834	8.777	.99357	30
40	.1161	.1169	1.0068	8.614	8.556	.99324	20
50	.1190	.1198	1.0072	8.405	8.345	.99290	10
7	.1219	.1228	1.0075	8.206	8.144	.99255	83
10	.1248	.1257	1.0079	8.016	7.953	.99219	50
20	.1276	.1287	1.0082	7.834	7.770	.99182	40
30	.1305	.1317	1.0086	7.661	7.596	.99144	30
40	.1334	.1346	1.0090	7.496	7.429	.99106	20
50	.1363	.1376	1.0094	7.337	7.269	.99067	10
							82
	Cosin.	Cotg.	Cosec.	Sec.	Tan.	Sin.	Angle ° ′

Angle.	Sin.	Tan.	Sec.	Cosec.	Cotg.	Cosin.	
° ′							
8	.1392	.1405	1.0098	7 185	7.115	.99027	82
10	.1421	.1435	1.0102	7.040	6.968	.98986	50
20	.1449	.1465	1.0107	6.900	6.827	.98944	40
30	.1478	.1495	1.0111	6.766	6.691	.98902	30
40	.1507	.1524	1.0115	6.636	6.561	.98858	20
50	.1536	.1554	1.0120	6.512	6.435	.98814	10
9	.1564	.1584	1.0125	6.394	6.314	.98769	81
10	.1593	.1614	1.0129	6.277	6.197	.98723	50
20	.1622	.1644	1.0134	6.166	6.084	.98676	40
30	.1650	.1673	1.0139	6.059	5.976	.98629	30
40	.1679	.1703	1.0144	5.955	5.871	.98580	20
50	.1708	.1733	1.0149	5.855	5.769	.98531	10
10	.1736	.1763	1.0154	5.759	5.671	.98481	80
10	.1765	.1793	1.0160	5.665	5.576	.98430	50
20	.1794	.1823	1.0165	5.575	5.485	.98378	40
30	.1822	.1853	1.0170	5.488	5.396	.98325	30
40	.1851	.1883	1.0176	5.403	5.309	.98272	20
50	.1880	.1914	1.0181	5.320	5.226	.98218	10
11	.1908	.1944	1.0187	5.241	5.145	.98163	79
10	.1937	.1974	1.0193	5.164	5.066	.98107	50
20	.1965	.2004	1.0199	5.089	4.989	.98050	40
30	.1994	.2035	1.0205	5.016	4.915	.97992	30
40	.2022	.2065	1.0211	4.945	4.843	.97934	20
50	.2051	.2095	1.0217	4.877	4.773	.97875	10
12	.2079	.2126	1.0223	4.810	4.705	.97815	78
10	.2108	.2156	1.0230	4.745	4.638	.97754	50
20	.2136	.2186	1.0236	4.682	4.574	.97692	40
30	.2164	.2217	1.0243	4.620	4.511	.97630	30
40	.2193	.2247	1.0249	4.560	4.449	.97566	20
50	.2221	.2278	1.0256	4.502	4.390	.97502	10
13	.2250	.2309	1.0263	4.445	4.331	.97437	77
10	.2278	.2339	1.0270	4.390	4.275	.97371	50
20	.2306	.2370	1.0277	4.336	4.219	.97304	40
30	.2334	.2401	1.0284	4.284	4.165	.97237	30
40	.2363	.2432	1.0291	4.232	4.113	.97169	20
50	.2391	.2462	1.0299	4.182	4.061	.97100	10
14	.2419	.2493	1.0306	4.133	4.011	.97030	76
10	.2447	.2524	1.0314	4.086	3.962	.96959	50
20	.2476	.2555	1.0321	4.039	3.914	.96887	40
30	.2504	.2586	1.0329	3.994	3.867	.96815	30
40	.2532	.2617	1.0337	3.949	3.821	.96742	20
50	.2560	.2648	1.0345	3.906	3.776	.96667	10
15	.2588	.2679	1.0353	3.864	3.732	.96593	75
10	.2616	.2711	1.0361	3.822	3.689	.96517	50
20	.2644	.2742	1.0369	3.782	3.647	.96440	40
30	.2672	.2773	1.0377	3.742	3.606	.96363	30
40	.2700	.2805	1.0386	3.703	3.566	.96285	20
50	.2728	.2836	1.0394	3.665	3.526	.96206	10
							74
	Cosin.	Cotg.	Cosec.	Sec.	Tan.	Sin.	Angle ° ′

Angle.	Sin.	Tan.	Sec.	Cosec.	Cotg.	Cosin.	
° ′							
16	.2756	.2867	1.0403	3.628	3.487	.96126	74
10	.2784	.2899	1.0412	3.592	3.450	.96046	50
20	.2812	.2931	1.0423	3.556	3.412	.95964	40
30	.2840	.2962	1.0429	3.521	3.376	.95882	30
40	.2868	.2994	1.0438	3.487	3.340	.95799	20
50	.2896	.3026	1.0448	3.453	3.305	.95715	10
17	.2924	.3057	1.0457	3.420	3.271	.95630	73
10	.2952	.3089	1.0466	3.388	3.237	.95545	50
20	.2979	.3121	1.0476	3.357	3.204	.95459	40
30	.3007	.3153	1.0485	3.326	3.172	.95372	30
40	.3035	.3185	1.0495	3.295	3.140	.95284	20
50	.3062	.3217	1.0505	3.265	3.108	.95195	10
18	.3090	.3249	1.0515	3.236	3.078	.95106	72
10	.3118	.3281	1.0525	3.207	3.048	.95015	50
20	.3145	.3314	1.0535	3.179	3.018	.94924	40
30	.3173	.3346	1.0545	3.152	2.989	.94832	30
40	.3201	.3378	1.0555	3.124	2.960	.94740	20
50	.3228	.3411	1.0566	3.098	2.932	.94646	10
19	.3256	.3443	1.0576	3.072	2.904	.94552	71
10	.3283	.3476	1.0587	3.046	2.877	.94457	50
20	.3311	.3508	1.0598	3.020	2.850	.94361	40
30	.3338	.3541	1.0608	2.996	2.824	.94264	30
40	.3365	.3574	1.0619	2.971	2.798	.94167	20
50	.3393	.3607	1.0631	2.947	2.773	.94068	10
20	.3420	.3640	1.0642	2.924	2.747	.93969	70
10	.3448	.3673	1.0653	2.900	2.723	.93869	50
20	.3475	.3706	1.0665	2.878	2.699	.93769	40
30	.3502	.3739	1.0676	2.856	2.675	.93667	30
40	.3529	.3772	1.0688	2.833	2.651	.93565	20
50	.3557	.3805	1.0700	2.811	2.628	.93462	10
21	.3584	.3839	1.0711	2.790	2.605	.93358	69
10	.3611	.3872	1.0723	2.769	2.583	.93253	50
20	.3638	.3906	1.0736	2.749	2.560	.93148	40
30	.3665	.3939	1.0748	2.729	2.539	.93042	30
40	.3692	.3973	1.0760	2.709	2.517	.92935	20
50	.3719	.4006	1.0773	2.689	2.496	.92827	10
22	.3746	.4040	1.0785	2.670	2.475	.92718	68
10	.3773	.4074	1.0798	2.650	2.455	.92609	50
20	.3800	.4108	1.0811	2.632	2.434	.92499	40
30	.3827	.4142	1.0824	2.613	2.414	.92388	30
40	.3854	.4176	1.0837	2.595	2.394	.92276	20
50	.3881	.4210	1.0850	2.577	2.375	.92164	10
23	.3907	.4245	1.0864	2.559	2.356	.92050	67
10	.3934	.4279	1.0877	2.542	2.337	.91936	50
20	.3961	.4314	1.0891	2.525	2.318	.91822	40
30	.3987	.4348	1.0904	2.508	2.300	.91706	30
40	.4014	.4383	1.0918	2.491	2.282	.91590	20
50	.4041	.4417	1.0932	2.475	2.264	.91472	10
							66
	Cosin.	Cotg.	Cosec.	Sec.	Tan.	Sin.	Angle ° ′

Angle.	Sin.	Tan.	Sec.	Cosec.	Cotg.	Cosin.	
° ′							
24	.4067	.4452	1.0946	2.459	2.246	.91355	66
10	.4094	.4487	1.0961	2.443	2.229	.91236	50
20	.4120	.4522	1.0975	2.427	2.211	.91116	40
30	.4147	.4557	1.0989	2.411	2.194	.90996	30
40	.4173	.4592	1.1004	2.396	2.177	.90875	20
50	.4200	.4628	1.1019	2.381	2.161	.90753	10
25	.4226	.4663	1.1034	2.366	2.145	.90631	65
10	.4253	.4699	1.1049	2.351	2.128	.90507	50
20	.4279	.4734	1.1064	2.337	2.112	.09383	40
30	.4305	.4770	1.1079	2.323	2.097	.90259	30
40	.4331	.4806	1.1095	2.309	2.081	.90133	20
50	.4358	.4841	1.1110	2.295	2.066	.90007	10
26	.4384	.4877	1.1126	2.281	2.050	.89879	64
10	.4410	.4913	1.1142	2.268	2.035	.89752	50
20	.4436	.4950	1.1158	2.254	2.020	.89623	40
30	.4462	.4986	1.1174	2.241	2.006	.89493	30
40	.4488	.5022	1.1190	2.228	1.991	.89363	20
50	.4514	.5059	1.1207	2.215	1.977	.89232	10
27	.4540	.5095	1.1223	2.203	1.963	.89101	63
10	.4566	.5132	1.1240	2.190	1.949	.88968	50
20	.4592	.5169	1.1257	2.178	1.935	.88835	40
30	.4617	.5206	1.1274	2.166	1.921	.88701	30
40	.4643	.5243	1.1291	2.154	1.907	.88566	20
50	.4669	.5280	1.1308	2.142	1.894	.88431	10
28	.4695	.5317	1.1326	2.130	1.881	.88295	62
10	.4720	.5354	1.1343	2.119	1.868	.88158	50
20	.4746	.5392	1.1361	2.107	1.855	.88020	40
30	.4772	.5430	1.1379	2.096	1.842	.87882	30
40	.4797	.5467	1.1397	2.085	1.829	.87743	20
50	.4823	.5505	1.1415	2.073	1.816	.87603	10
29	.4848	.5543	1.1434	2.063	1.804	.87462	61
10	.4874	.5581	1.1452	2.052	1.792	.87321	50
20	.4899	.5619	1.1471	2.041	1.780	.87178	40
30	.4924	.5658	1.1490	2.031	1.767	.87036	30
40	.4950	.5696	1.1509	2.020	1.756	.86892	20
50	.4975	.5735	1.1528	2.010	1.744	.86748	10
30	.5000	.5774	1.1547	2.000	1.732	.86603	60
10	.5025	.5812	1.1566	1.990	1.720	.86457	50
20	.5050	.5851	1.1586	1.980	1.709	.86310	40
30	.5075	.5890	1.1606	1.970	1.698	.86163	30
40	.5100	.5930	1.1626	1.961	1.686	.86015	20
50	.5125	.5969	1.1646	1.951	1.675	.85866	10
31	.5150	.6009	1.1666	1.942	1.664	.85717	59
10	.5175	.6048	1.1687	1.932	1.653	.85567	50
20	.5200	.6088	1.1707	1.923	1.643	.85416	40
30	.5225	.6128	1.1728	1.914	1.632	.85264	30
40	.5250	.6168	1.1749	1.905	1.621	.85112	20
50	.5275	.6208	1.1770	1.896	1.611	.84959	10
							58
	Cosin.	Cotg.	Cosec.	Sec.	Tan.	Sin.	Angle ° ′



Right Triangle — Oblique Triangles

Solution of Right Triangles

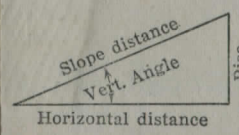
For Angle A. $\sin = \frac{a}{c}$, $\cos = \frac{b}{c}$, $\tan = \frac{a}{b}$, $\cot = \frac{b}{a}$, $\sec = \frac{c}{b}$, $\operatorname{cosec} = \frac{c}{a}$

Given	Required	
a, b	A, B, c	$\tan A = \frac{a}{b} = \cot B, c = \sqrt{a^2 + b^2} = a\sqrt{1 + \frac{b^2}{a^2}}$
a, c	A, B, b	$\sin A = \frac{a}{c} = \cos B, b = \sqrt{(c+a)(c-a)} = c\sqrt{1 - \frac{a^2}{c^2}}$
A, a	B, b, c	$B = 90° - A, b = a \cot A, c = \frac{a}{\sin A}$
A, b	B, a, c	$B = 90° - A, a = b \tan A, c = \frac{b}{\cos A}$
A, c	B, a, b	$B = 90° - A, a = c \sin A, b = c \cos A,$

Solution of Oblique Triangles

Given	Required	
A, B, a	b, c, C	$b = \frac{a \sin B}{\sin A}, C = 180° - (A + B), c = \frac{a \sin C}{\sin A}$
A, a, b	B, c, C	$\sin B = \frac{b \sin A}{a}, C = 180° - (A + B), c = \frac{a \sin C}{\sin A}$
a, b, C	A, B, c	$A + B = 180° - C, \tan \frac{1}{2}(A - B) = \frac{(a-b)\tan \frac{1}{2}(A+B)}{a+b}, c = \frac{a \sin C}{\sin A}$
a, b, c	A, B, C	$s = \frac{a+b+c}{2}, \sin \frac{1}{2}A = \sqrt{\frac{(s-b)(s-c)}{b\,c}}, \sin \frac{1}{2}B = \sqrt{\frac{(s-a)(s-c)}{a\,c}}, C = 180° - (A+B)$
a, b, c	Area	$s = \frac{a+b+c}{2}$, area $= \sqrt{s(s-a)(s-b)(s-c)}$
A, b, c	Area	area $= \frac{b\,c \sin A}{2}$
A, B, C, a	Area	area $= \frac{a^2 \sin B \sin C}{2 \sin A}$

REDUCTION TO HORIZONTAL



Horizontal distance = Slope distance multiplied by the cosine of the vertical angle. Thus: slope distance = 319.4 ft. Vert. angle = 5° 10′. From Table, Page IX. cos 5° 10′ = .9959. Horizontal distance = 319.4 × .9959 = 318.09 ft.

Horizontal distance also = Slope distance minus slope distance times (1 — cosine of vertical angle). With the same figures as in the preceding example, the following result is obtained. Cosine 5° 10′ = .9959. 1 — .9959 = .0041. 319.4 × .0041 = 1.31. 319.4 — 1.31 = 318.09 ft.

When the rise is known, the horizontal distance is approximately:—the slope distance less the square of the rise divided by twice the slope distance. Thus: rise = 14 ft., slope distance = 302.6 ft. Horizontal distance $= 302.6 - \frac{14 \times 14}{2 \times 302.6} = 302.6 - 0.32 = 302.28$ ft.

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