

DESIGN OF ROAD AND SEWER
SYSTEMS FOR A $\frac{1}{4}$ SECTION

Thesis for the Degree of B. S.
MICHIGAN STATE COLLEGE

C. G. Hansens

1942

THESIS

Ch. 1

SUPPLEMENTARY MATERIAL IN BACK OF BOOK

DESIGN OF ROAD AND SEWER SYSTEMS
FOR A $\frac{1}{4}$ SECTION

A Thesis Submitted to

The Faculty of
MICHIGAN STATE COLLEGE

of
AGRICULTURE AND APPLIED SCIENCE

by

C. G. Hansens

Candidate for the Degree of

Bachelor of Science

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THESIS

1991

DEDICATION

To the men now standing behind the guns while
we complete the assimilation of our education
in preparation to supplying them with more and
better arms, this book is respectfully dedicated.

A C K N O W L E D G E M E N T

The author wishes to express his appreciation to the faculty of Michigan State College for any assistance rendered in the preparation of this thesis and also, publicly to express his thanks to Mr. W. B. Williams of Grand Rapids, Michigan, for the loan of the contour map and traverse of the $\frac{1}{4}$ Section which formed the basis of the problem.

FOREWORD

The basis of this problem was a contour map and traverse of a $\frac{1}{4}$ Section from which a road system was to be designed and computed, the drainage areas estimated, the road grades designed, and a sewer system suitable for combined storm and sanitary sewage designed.

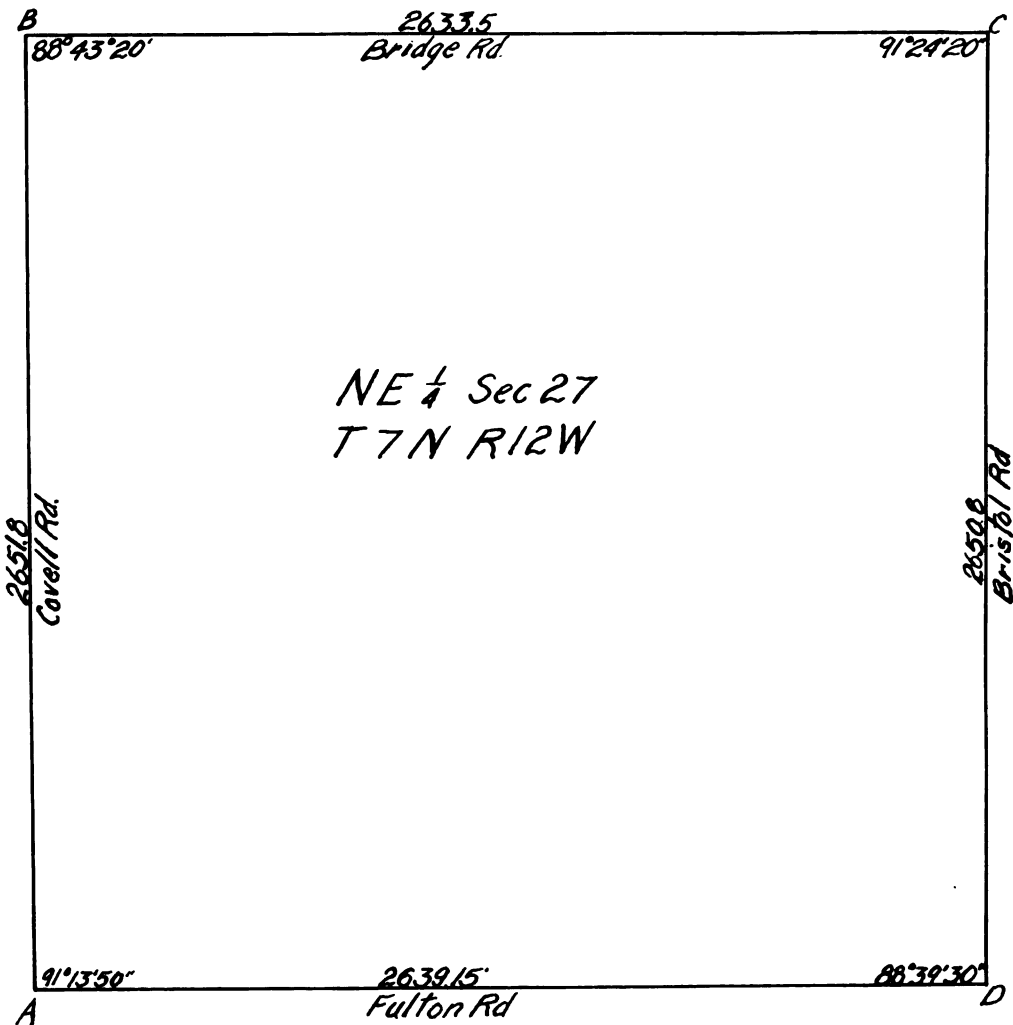
The road system was designed with a view of utilizing the natural drainage channels of the land and was precisely computed.

The drainage areas were estimated from the contour map and the grades so designed that the intersections of street center lines meet within .02', a difference which could easily be accounted for in construction.

The values of sewage flow used in the design data are of storm sewage from the Hill formula for rare storms with a runoff coefficient of .40. The volume of sanitary sewage in C.F.S. with the steep slopes and corresponding high velocities is so small as to be negligible. The system, however, is so designed as to serve all the lots.

The lot system as designed is not precisely dimensioned.

COORDINATES OF CORNERS



Covell Rd. is assumed to run true north (AB)

Bridge Rd. Bearing = S 88° 43' 20" E (BC)

Bristol Rd. " = S 0° 07' 40" E (CD)

Fulton Rd. " = N 88° 46' 10" W (DA)

Point	X	Y
A	0.00	0.00
B	0.00	2652.31
C	2632.75	2593.59
D	2638.75	- 56.69

LATITUDES, DEPARTURES, AND COORDINATES OF CORNERS

Line	Distance	Logs	Latitudes		Departures	
			+	-	+	-
AB	2651.8		2652.31 2651.8		0.00	0.00
				72 58.725		
		<u>1.768821</u>				
	Lcos	8.348287				
BC	2633.5	3.420534				
	Lsin	<u>9.999829</u>			75	
		3.420426			2632.85	
				28 2650.775		
		<u>3.423376</u>				
	Lcos	9.999999				
CD	2650.8	3.423377				
	Lsin	<u>7.347485</u>			5.90	
		0.770862				
			69 56.677			
		<u>1.753403</u>				
	Lcos	8.331939				
DA	2639.15	3.421464				
	Lsin	<u>9.999900</u>				
		3.421364				65 <u>2638.65</u>
	Totals		2708.477	2709.518	2638.75	2638.55
				<u>2708.477</u>	<u>2638.55</u>	
	Difference			1.041	.20	
	Correction		2709.00	2709.00	2638.65	2638.65

$$L_c = \frac{23^\circ 43' 10''}{2^\circ 05'} = 1,139.81'$$

<u>180° 07' 40"</u>			
<u>110° 00' 00"</u>			
N 70° 07' 40" W =	Bearing of EF		Coordinates of Pt. E
<u>23° 43' 10"</u>			X = 2636.78
N 46° 24' 30" W =	Bearing of FB		Y = 646.51

Logs	Lats	Deps	Coordinates Pt. F
<u>2.489673</u>	308.80	-	X Y
Lcos. 9.531381			955.31
2.958291			
Lsin. <u>9.973337</u>			
2.931628		- 854.34	1,782.44

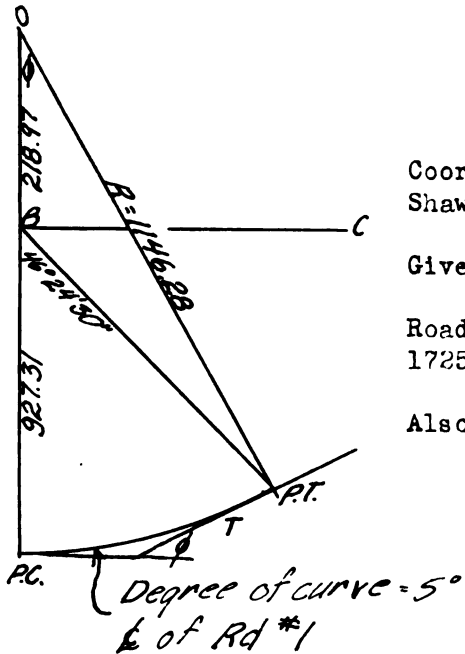
$$BF = 1782.44^2 + 1698^2$$

$$BF = 2,461.76$$

$$\text{Length of Shawmut Blvd.} = 3,354.28'$$

LOCATION OF ROADS

Rd #1



Coordinates of intersection of Rd #1 & Shawmut Blvd. desired

Given $D = 5^\circ$

Road #1 is perpendicular to Covell Rd
1725 ft. N. of Pt. "A"

Also find T & $\angle \phi$

$$\alpha = 46^\circ 24' 30''$$

d = distance from B to P.T.

$$r^2 = (L + d \cos. \alpha)^2 + (d \sin \alpha)^2$$

$$r^2 = L^2 + 2Ld \cos. \alpha + d^2 \cos. \alpha + d^2 \sin^2 \alpha$$

$$r^2 = L^2 + 2Ld \cos. \alpha + d^2 (\cos.^2 \alpha + \sin.^2 \alpha)$$

$$r^2 = L^2 + 2Ld \cos. \alpha + d^2$$

$$r^2 = 1,313,957.8384$$

$$1,313,957,8384 = 218.97^2 + 301.97d + d^2$$

$$d^2 + 301.97d - 1,266,009.9775 = 0$$

$$d = \frac{-301.97 \pm \sqrt{91195,8809 + 4 \cdot 1266009.9775}}{2}$$

$$d = \frac{-301.97 \pm 2270.51}{2} = 984.27$$

Coordinates of P. C.

$$X = 0.00$$

$$Y = 1725.00$$

Coordinates of P.T.

$$\begin{array}{rcl} \sin. 72427 & X = & 712.83 \\ 934.27 & & \\ \cos. 68951 & Y = & 678.56 \end{array}$$

Coordinates of P.T.

$$\begin{array}{rcl} X = & 712.83 \\ Y = & 1973.75 \end{array}$$

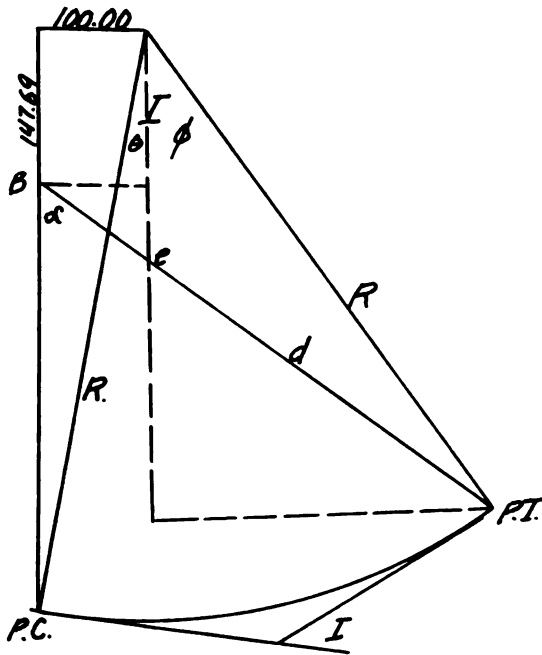
Intersection of Rd. 1 &
Shawmut Blvd.

$$\text{Tan. } \phi = \frac{712.83}{213.97 + 688.56} = \frac{712.83}{902.53}$$

$$\text{Tan. } \phi = .79427$$

$$\phi = 38^{\circ} 27' 30''$$

ROAD # 2



Given:

Degree of Curve = 4°

$\Delta = 1432.69$

Center at $X = 100.00$

$Y = 2800.00$

$\alpha = 46^{\circ} 24' 30''$

Find: d & Coordinates of P.T. ($d = B$ to P.T.)

L_c P.C.

$$R^2 = (d \sin. \alpha - 100)^2 + (147.69 + d \cos. \alpha)^2$$

$$R^2 = d^2 \sin.^2 \alpha - 200d \sin. \alpha + 10000 + d^2 \cos.^2 \alpha + 295.38d \cos. \alpha + 147.69^2$$

$$R^2 = d^2 - 200d \sin. \alpha + 295 d \cos. \alpha + 31,812.3361$$

$$2,052,600.6361 = d^2 - 200d \cdot .72427 + 295d \cdot .98951 + 31,812.3361$$

$$d^2 - 58.551d - 2020788.3 = 0$$

$$d = \frac{58.551 \pm 3428.2196}{2} + 8.083.153.2$$

$$d = \frac{58.551 \pm 8,079.724.98}{2}$$

$$d = \frac{58.551 \pm 2842.503}{2} = \frac{2786.95}{2} = 1393.48$$

Coordinates of P.T.

$$X = 1393.48 \sin. = 1393.48 \cdot .72427 = 1009.26$$

$$Y = 2652.31 - 1393.48 \cos. = 2652.31 - 1393.48 \cdot .68951$$

$$Y = 2652.31 - 960.82 = 1791.49$$

$$B - PC \neq 147.69 = \sqrt{R^2 - 100^2} = \sqrt{2,052,600.6361 - 10,000} \\ = \sqrt{2,042,600.6361} = 1429.20$$

$$B - PC = 1429.20 - 147.69 = 1281.51$$

Coordinates of P.C.

$$X = 0$$

$$Y = 1281.51$$

$$I = \theta \neq \phi = \arctan \frac{100}{1429.20} \neq \arctan \frac{1009.26 - 100}{960.82 \neq 147.69}$$

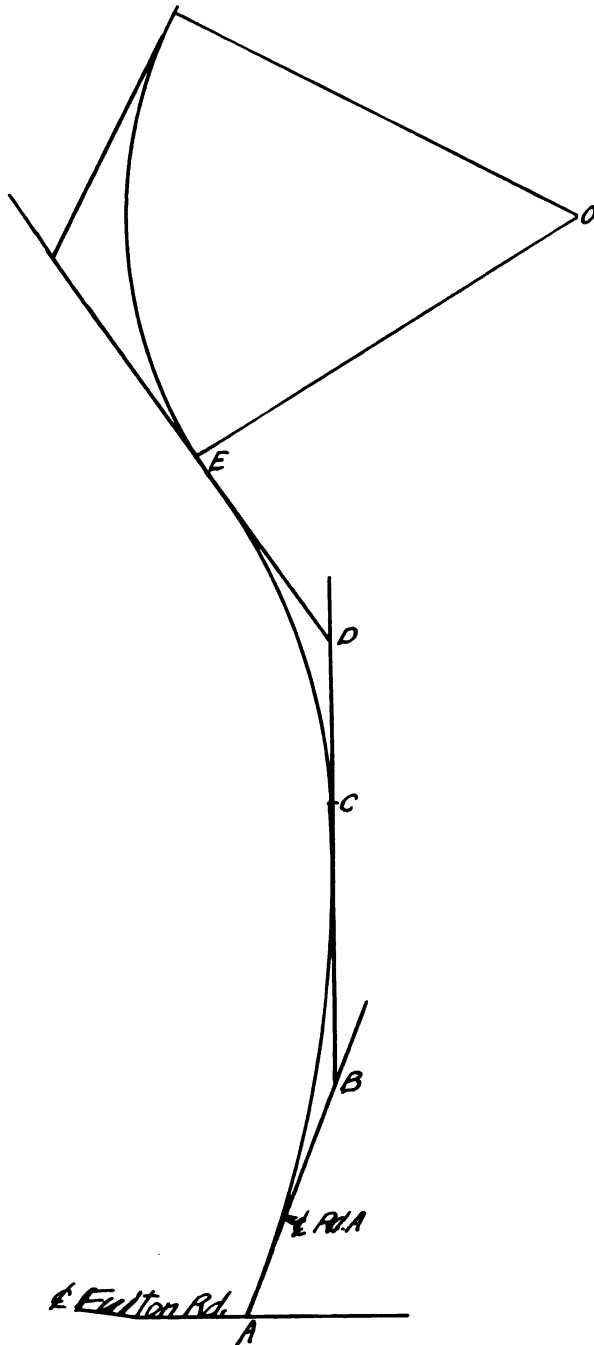
$$= \arctan \frac{100}{1429.20} \neq \arctan \frac{909.26}{1108.51}$$

$$I = \arctan .06996 \neq \arctan .82025$$

$$I = 4^\circ 0' 6" \neq 39^\circ 22' 39"$$

$$I = 43^\circ 22' 45"$$

ROAD A



Data

Bearing = N $70^{\circ} 14'$ E

Given: $D = 12^{\circ}$

$R = 478.34$

Bearing = N $19^{\circ} 46'$ W

Given: $D = 4^{\circ}$

$L_c = 433'$

$I = 17^{\circ} 20'$

Bearing = N $2^{\circ} 26'$ W

Given: $D = 1^{\circ}$

$L_c = 1302'$

$I = 13^{\circ} 01'$

Bearing = N $10^{\circ} 35'$ E

Coordinates of Pt. A

$X = 328.94$

$Y = -7.07$

Rd. A starts 329' E of corner of Fulton and Cornell Rds. and runs N.

Coordinates

478.34 sin. = .95459 X = 456.62 X = 803.54 (Pt. O)
 cos. = .29793 Y = 142.51 Y = 1856.76

218.37 sin. = .29793 X = - 65.06 X = 346.92 (Pt. E)
 cos. = .95459 Y = 208.45 Y = 1714.25

$$\begin{array}{r} \text{Tan.} = 4) \underline{873.3} \\ \quad \underline{218.33} \\ \quad \quad \underline{.04} \\ \quad \quad \quad 218.37 = T \end{array}$$

872.07 sin. = .04246 X = - 37.03 X = 411.98 (Pt. O)
 cos. = .99910 Y = - 871.29 Y = 1505.80

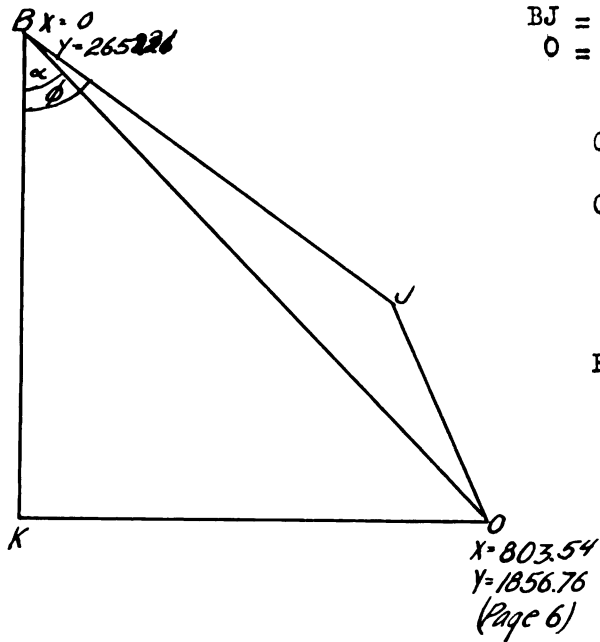
$$T = 653.70$$

653.70 sin. = .18367 X = 120.07 X = 449.01 (Pt. B)
 cos. = .98299 Y = 641.58 Y = 634.51

$$X = 328.94 \text{ (Pt. A)}$$

$$Y = - 7.07$$

INTERSECTION OF ROAD A AND SHAWMUT BOULEVARD



B = Corner Bridge & Covell Rds.
 BJ = Shawmut Rd.
 O = Center of curve forming
 B Rd. A

Given OJ = 478.34
 $\alpha = 46^{\circ}24'30''$
 Coordinates of B & O

Find coordinates of J

$$BK = 795.55$$

$$KO = 803.54$$

$$\tan \phi = \frac{803.54}{795.55} = 1.01004$$

$$\phi = 45^{\circ}17'10''$$

$$OB = \sqrt{795.55^2 + 803.54^2}$$

$$= \sqrt{1,278,576.3341} = 1130.74$$

$$\angle OBA = 46^{\circ}24'30''$$

$$\frac{45^{\circ}17'10''}{1^{\circ}7'20''}$$

$$\sin. OJB = \frac{\sin. 1^{\circ} 7' 20''}{478.34} \cdot 1130.74 = \frac{.01959}{478.34} \cdot 1130.74$$

$$\begin{aligned}\sin. OJB &= .04631 \\ OJB &= 187^{\circ} 20' 44''\end{aligned}$$

$$\begin{array}{rcl} 187^{\circ} 20' 44'' & & 189^{\circ} 59' 60'' \\ \underline{1^{\circ} 7' 20''} & & \underline{188^{\circ} 28' 04''} \\ 188^{\circ} 28' 04'' & & 1^{\circ} 31' 56'' = L BOJ \end{array}$$

$$BJ = \frac{478.34 \cdot \sin. 1^{\circ} 31' 56''}{\sin. 1^{\circ} 7' 20''}$$

$$= \frac{478.34 \cdot .02675}{.01959} = 653.17$$

653.17

$$\sin. = .72427 \quad X = 473.07$$

$$\cos. = .68951 \quad Y = 450.37$$

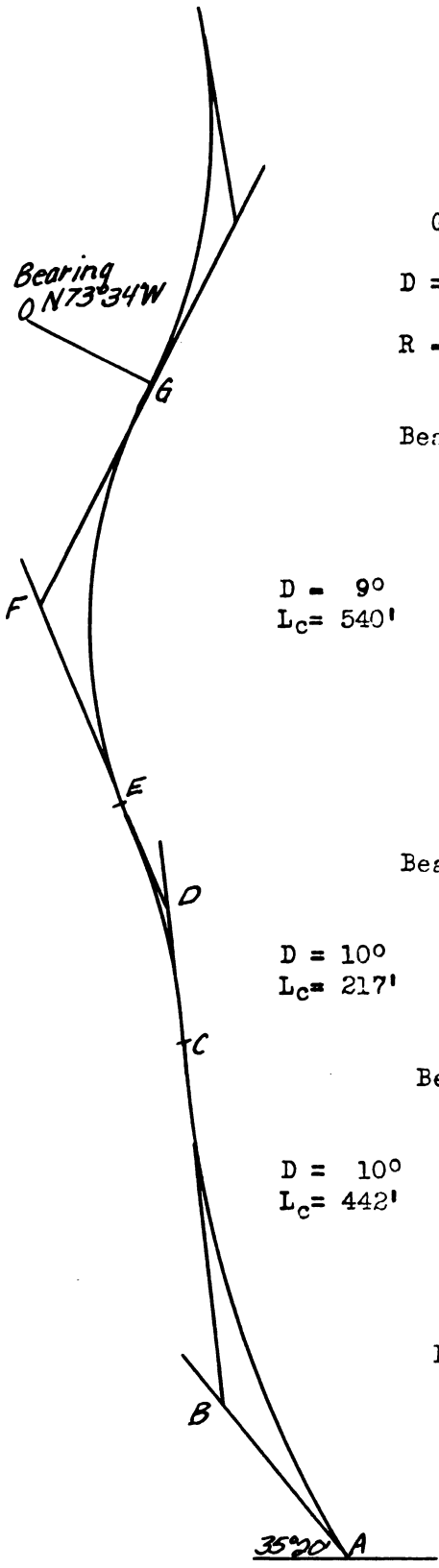
Coordinates

$$X = 473.07 \quad (\text{Pt. J})$$

$$Y = 2201.94$$

Intersection of
Rd. A & Shawmut Blvd.

$$\text{Bearing OJ} = N 44^{\circ} 52' 34'' W$$



ROAD C

Given Data

$$D = 6^{\circ} 30'$$

$$R = 881.95$$

$$\text{Bearing FG} = N 16^{\circ} 26' E$$

$$D = 9^{\circ}$$

$$L_c = 540'$$

$$I = 48^{\circ} 36' \quad R \text{ Tan. } 9) \underline{2587}$$

$$\quad \quad \quad 287.33$$

$$\quad \quad \quad \underline{.29}$$

$$\quad \quad \quad 287.62$$

$$\text{Bearing } N 32^{\circ} 10' W$$

$$D = 10^{\circ}$$

$$L_c = 217'$$

$$\text{Tan. } 109.82 \quad I = 21^{\circ} 42' L$$

$$\quad \quad \quad \underline{.14}$$

$$\quad \quad \quad 109.96$$

$$\text{Bearing} = N 10^{\circ} 28' W$$

$$D = 10^{\circ}$$

$$L_c = 442'$$

$$I = 44^{\circ} 12' R$$

$$\text{Tan. } 232.66$$

$$\quad \quad \quad \underline{.29}$$

$$\quad \quad \quad 232.95$$

$$\text{Bearing} = N 54^{\circ} 40' W$$

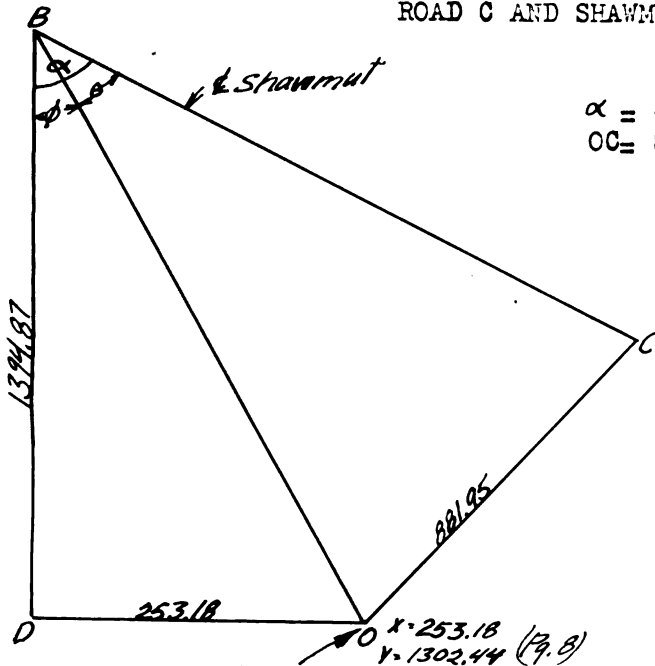
Coordinates

$$X = 1461.72 \text{ (Pt. A)}$$

$$Y = - 31.40$$

			Coordinates
881.95	sin. = .95915	X = 845.92	X = 253.18 (Pt. O)
	cos. = .28290	Y = 249.50	Y = 1302.44
287.62	sin. = .28290	X = 81.37	X = 1099.10 (Pt. G)
	cos. = .95915	Y = 275.87	Y = 1052.94
397.58	sin. = .53238	X = -211.66	X = 997.73 (Pt. F)
	cos. = .84650	Y = 336.55	Y = 777.07
342.91	sin. = .18166	X = - 62.29	X = 1209.39 (Pt. D)
	cos. = .98336	Y = 337.20	Y = 440.52
232.95	sin. = .81580	X = -190.04	X = 1271.69 (Pt. B)
	cos. 57833	Y = 134.72	Y = 103.32

ROAD C AND SHAWMUT BOULEVARD



$$\alpha = 46^{\circ}24'30''$$

$$OC = 881.95$$

Coordinates B

$$x = 0$$

$$y = 2652.31$$

Center of curve
forming L R/C

$$OB = \sqrt{253.18^2 + 1394.87^2} = 1368.42$$

$$\tan \phi = \frac{253.18}{1394.87} = .18756$$

$$\phi = 10^{\circ}37'20''$$

$$\theta = 35^{\circ}47'10''$$

$$\sin C = \frac{\sin 35^{\circ}47'10''}{881.95} \cdot 1368.42$$

$$= .90730$$

$$C = 65^{\circ}08'$$

$$BOC = 79^{\circ} 4' 50''$$

$$BC = \frac{\sin. 79^{\circ} 4' 50''}{\sin. 35^{\circ} 47' 10''} = 881.95$$

$$BC = 1480.91$$

$$\begin{array}{lcl} & \sin. = .72427 & X = 1068.58 \\ 1480.91 & \cos. = .69951 & Y = -1021.10 \end{array}$$

Coordinates of C

$$X = 1068.58$$

$$Y = 1631.21$$

Intersection of Rd. C
& Shawmut Rd.

ROAD B

$$D = 4^{\circ}$$

$$R = 1432.69$$

$$D = 22^{\circ}$$

$$R = 262.04$$

$$D = 6^{\circ} 45'$$

$$L_c = 425'$$

$$D = 6$$

$$L_c = 378'$$

Bearing PO = S $79^{\circ} 59' 33''$ E

Bearing NP = N $10^{\circ} 00' 27''$ E

$$I = 28^{\circ} 41' 15''$$

$$\text{Tan.} = 6.75 \frac{1465.1}{217.42}$$

$$\frac{.12}{217.54}$$

Bearing N $18^{\circ} 40' 48''$ W

$$I = 22^{\circ} 40' 48'' \angle$$

Bearing = N 4° E

$$\text{Tan.} = 6 \frac{1133.1}{188.85}$$

$$\frac{.09}{188.94}$$

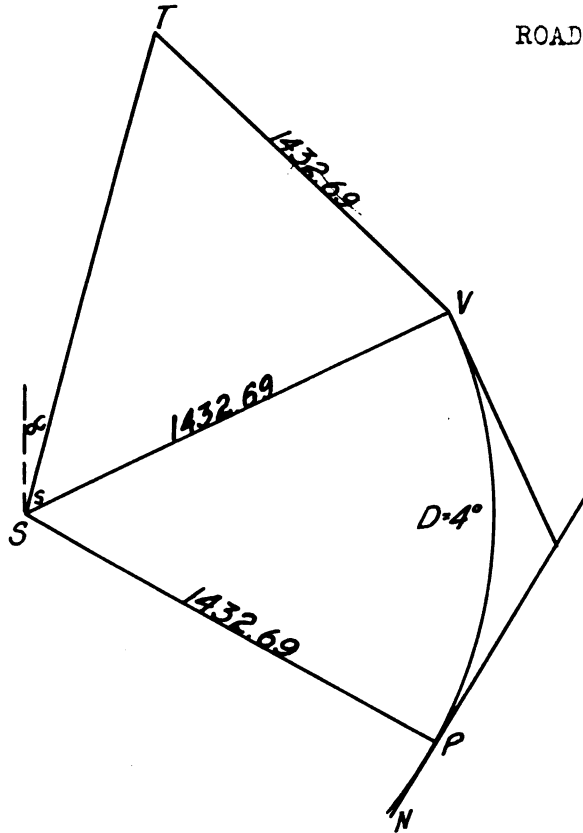
Coordinates of K

$$X = 807.85$$

$$Y = -17.36$$

			Coordinates
262.04	sin. = .98479	X = 258.05	X = 986.68 (Pt. O)
	cos. = .17377	Y = - 45.53	Y = 724.89
217.54	sin. = .17377	X = 37.80	X = 728.63 (Pt. P)
	cos. = .98479	Y = 214.23	Y = 770.38
406.48	sin. = .32030	X = -130.20	X = 690.83 (Pt. N)
	cos. = .94732	Y = 385.07	Y = 556.15
188.94	sin. = .06976	X = - 13.18	X = 821.03 (Pt. L)
	cos. = .99756	Y = 188.48	Y = 171.12

ROADS B & 2



Coordinates

X = 100 (Pt. T)

Y = 2800

X = 728.63 (Pt. P)

Y = 770.42

T = center of curve forming b Rd. 2

S = center of curve forming b Rd. B

Bearing NP N 10° 00' 27" E

Coordinates

1432.69 sin. = .98479 X = 1410.90 X = - 682.27 (Pt. S)
cos. = .17377 Y = 248.96 Y = 1019.38

$$TS = \sqrt{782.27^2 + 1780.62^2}$$

$$= \sqrt{3,782,553.9373}$$

$$TS = 1944.87$$

$$S = \frac{1}{2} a \angle b \angle c = 2405.13$$

$$\cos. \frac{S}{2} = \sqrt{\frac{S(S-A)}{bc}} = \sqrt{\frac{2405.13 \cdot 972.44}{1432.69 \cdot 1944.87}} = .91618$$

$$\frac{S}{2} = 23^{\circ} 37' 30''$$

$$S = 47^{\circ} 15'$$

Bearing ST

$$\tan. \alpha = \frac{782.27}{1780.62} = .43932$$

$$\alpha = 23^{\circ} 43'$$

$$\begin{array}{r} 23^{\circ} 43' \\ 47^{\circ} 15' \\ \hline 70^{\circ} 58' \end{array}$$

Bearing SV N 70° 48' E

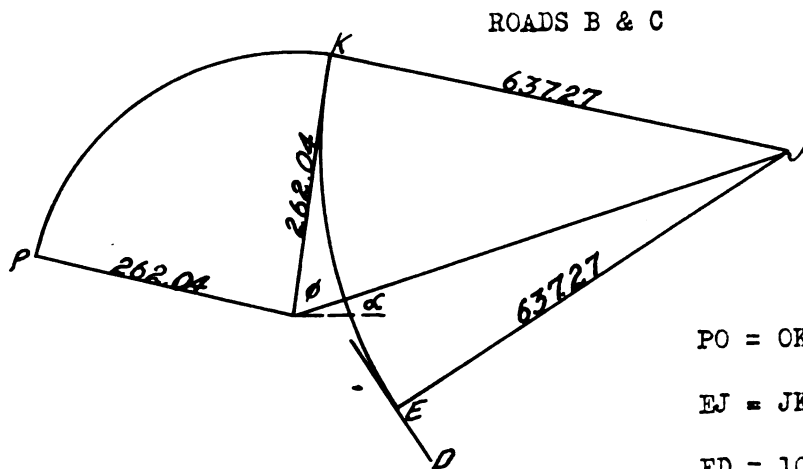
$$\begin{array}{lll} \sin. = .94533 & X = 1354.36 \\ 1432.69 \cos. = .32612 & Y = 467.23 \end{array}$$

Coordinates of V

$$X = 672.09$$

$$Y = 1486.61$$

V - Intersection of Rds. 2 & B



$$PO = OK = 262.04$$

$$EJ = JK = 637.27$$

$$ED = 109.96$$

$$\text{Bearing ED} = N 32^{\circ} 10' W$$

Coordinates

$$X = 986.68 \quad (\text{Pt. O})$$

$$Y = 724.89$$

$$X = 1209.39 \quad (\text{Pt. D})$$

$$Y = 440.52$$

109.96	sin. = .53238	X = - 58.54	X = 1150.85 (Pt. E)
	cos. = .84650	Y = 93.08	Y = 533.60

637.27	sin. = .84650	X = 539.45	X = 1690.30 (Pt. J)
	cos. = .53238	Y = 339.27	Y = 892.87

$$OJ = \sqrt{167.98^2 + 703.62^2}$$

$$OJ = 723.39$$

Bearing OK

$$\text{Tan. } \alpha = \frac{176.98}{703.62} = .25870$$

$$\alpha = 13^{\circ} 25' 30''$$

$$\cos. \frac{\phi}{2} = \sqrt{\frac{s(s-a)}{bc}} = \sqrt{\frac{811.35 \cdot 174.08}{262.04 \cdot 723.39}} = \sqrt{.745104226}$$

$$\cos. \frac{\phi}{2} = .86315 \quad \frac{\phi}{2} = 30^{\circ} 20' \quad \phi = 60^{\circ} 40'$$
$$\begin{array}{r} 13^{\circ} 25' 30'' \\ \hline 74^{\circ} 05' 30'' \end{array}$$

Bearing OK = N 15° 54' 30" E

$$\begin{array}{ll} \sin. = .27410 & X = 71.83 \\ 262.04 & \\ \cos. = .96170 & Y = 252.00 \end{array}$$

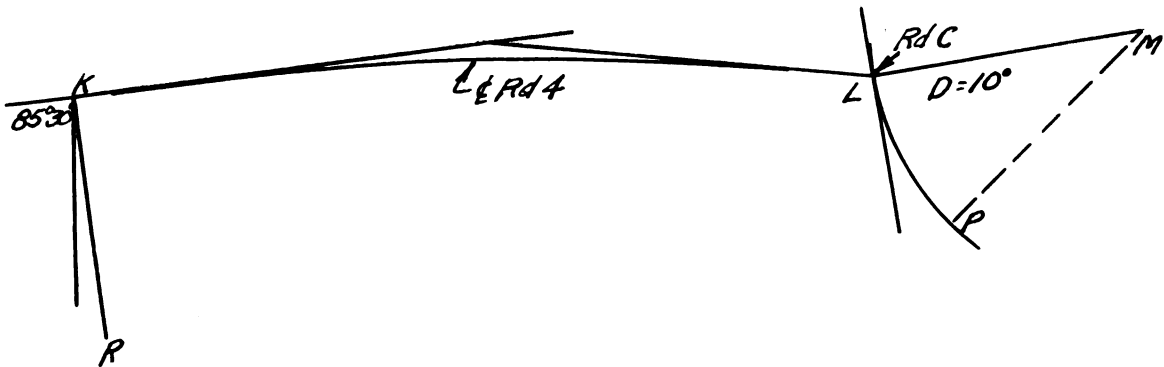
Coordinates

$$X = 1058.51$$

$$Y = 976.89$$

Intersection of Rds. B & C

ROAD 4



Coordinates

X = 1461.72 (Pt. P)

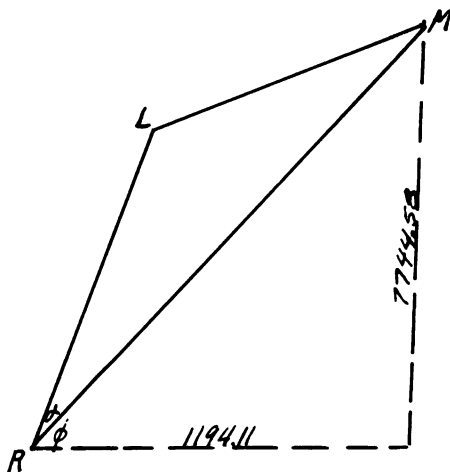
Y = - 31.40

573.69	sin. = .57833	X = 331.78	X = 1793.50 (Pt. M)
	cos. = .81580	Y = 468.02	Y = 436.62

7639.49	sin. = .07846	X = 599.39	X = 0 (Pt. K)
	cos. = .99692	Y = 7615.96	Y = 308

X = 599.39 (Pt. R)

Y = -7307.96



Coordinates of M

$$x = 1793.50$$

$$y = 436.62$$

Coordinates of K

$$x = 599.39$$

$$y = -7307.96$$

$$RL = 7639.49$$

$$LM = 573.69$$

$$RM = \sqrt{7744.58^2 + 1194.11^2}$$

$$= 7836.10$$

$$\cotan \phi = \frac{1194.11}{7744.58} = .15419 \quad \phi = 81^{\circ}14'04'' \quad \text{Bearing RM}$$

$$\cos \frac{\alpha}{2} = \sqrt{\frac{s(s-a)}{bc}} = \sqrt{\frac{8024.64 \cdot 7450.95}{7639.49 \cdot 7836.10}}$$

$$\cos \frac{\alpha}{2} = .99939$$

$$\frac{\alpha}{2} = 2^{\circ}$$

$$\alpha = 4^{\circ}$$

$$81^{\circ}14'09''$$

$$4^{\circ}$$

$$85^{\circ}14'04''$$

L = intersection Rds. 4 & C

N $4^{\circ}45'56''$ E

$$7639.49$$

$$\sin = .08308$$

$$x = 634.69$$

Coordinates of L

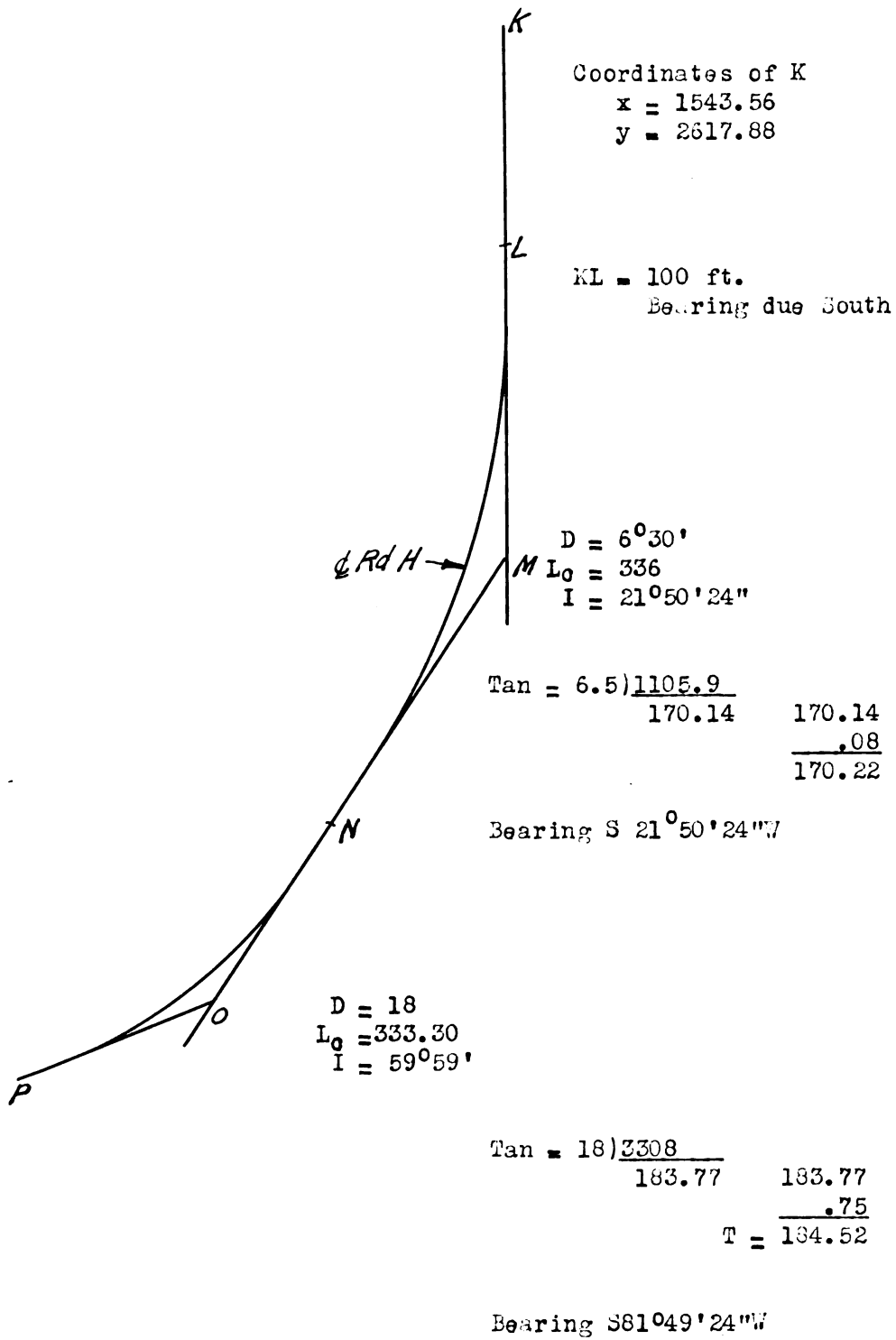
$$x = 1234.08$$

$$\cos = .99654$$

$$y = 7613.06$$

$$y = 305.10$$

ROAD H

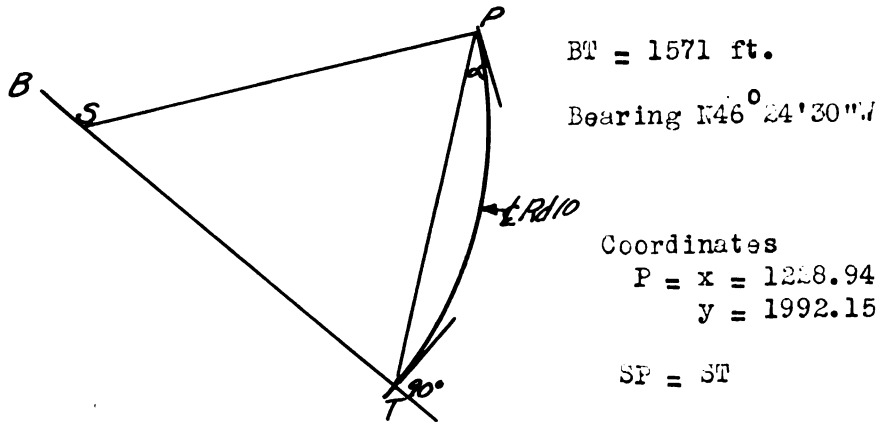


270.22	sin .00000	x = 0.00	Coordinates	
	cos 1.0000	y = -270.22	x = 1543.56	(pt. M)
			y = 2347.66	

354.74	sin .37202	x = -131.97	x = 1411.59	
	cos .92823	y = -329.28	y = 2017.38	(pt. O)

184.52	sin .98988	x = -182.65	x = 1228.94	
	cos .14217	y = -26.23	y = 1992.15	(pt. P)

ROAD 10



1571	$\sin .72427$	$x = 1137.83$	Coordinates	
	$\cos .68951$	$y = 1083.22$	$x = 1137.83$	(pt. T)
			$y = 1569.09$	

$$PT = \sqrt{91.11^2 + 423.06^2}$$

$$PT = 432.76$$

$$\tan \alpha = \frac{91.11}{432.06} = .21536$$

$$\alpha = 12^{\circ}09'12''$$

$$\begin{array}{r} 12^{\circ}09'12'' \\ 46^{\circ}24'30'' \\ \hline 58^{\circ}33'42'' \\ \hline 2 \\ \hline 117^{\circ}07'24'' \end{array}$$

$$\angle T = \angle P = 58^{\circ}33'42''$$

$$\angle S = 62^{\circ}52'36''$$

$$SP = ST = \frac{\sin 58^{\circ}33'42'' \cdot 432.76}{\sin 62^{\circ}52'36''}$$

$$ST = \frac{.85231 \cdot 432.76}{.88995} = 414.89 = \text{Radius of curve}$$

$$\text{Degree of Curve} = 13^{\circ}51'18''$$

TS

414.89

sin .72427

x = -300.49

Coordinates

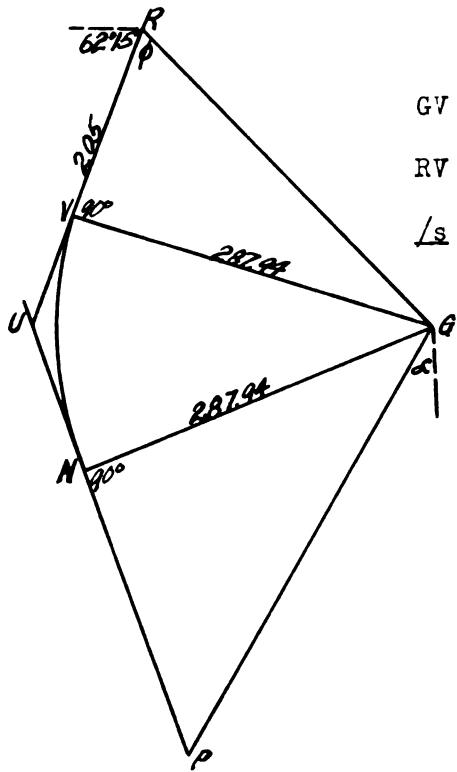
x = 837.34

(pt. S)

cos .68951

y = 286.07

y = 1855.16



ROAD 10

$$GV = GH = 287.94$$

$$RV = 205$$

$$\angle RVG \text{ \& GHP } = 90^\circ$$

Coordinates

$$\begin{array}{ll} P & x = 1228.94 \quad (\text{intersection of Rds. 7 \& 8}) \\ & y = 1992.15 \end{array}$$

$$\begin{array}{ll} R & x = 1175.67 \\ & y = 2626.08 \end{array}$$

$$RG = \sqrt{205^2 + 287.94^2}$$

$$RG = 353.46$$

Bearing of RG

$$\tan \phi = \frac{287.94}{205} = 1.40459$$

$$\phi = 54^\circ 33'$$

Bearing RG
N.26°48'W

$$\angle RGV = 35^\circ 27'$$

353.46 sin .45088 x = 159.37 Coordinates
 cos .89259 y = -215.49 x = 1335.04 (pt. G)
 y = 2310.59

$$GP = \sqrt{318.44^2 + 106.10^2}$$

$$GP = 335.65$$

$$FH = \sqrt{335.65^2 - 287.94^2}$$

$$FH = 172.49$$

Bearing FH

$$\tan \alpha = \frac{106.10}{318.44} = .33219$$

$$\alpha = 18^{\circ}25'38''$$

$$\tan P = \frac{287.94}{172.49} = 1.66931$$

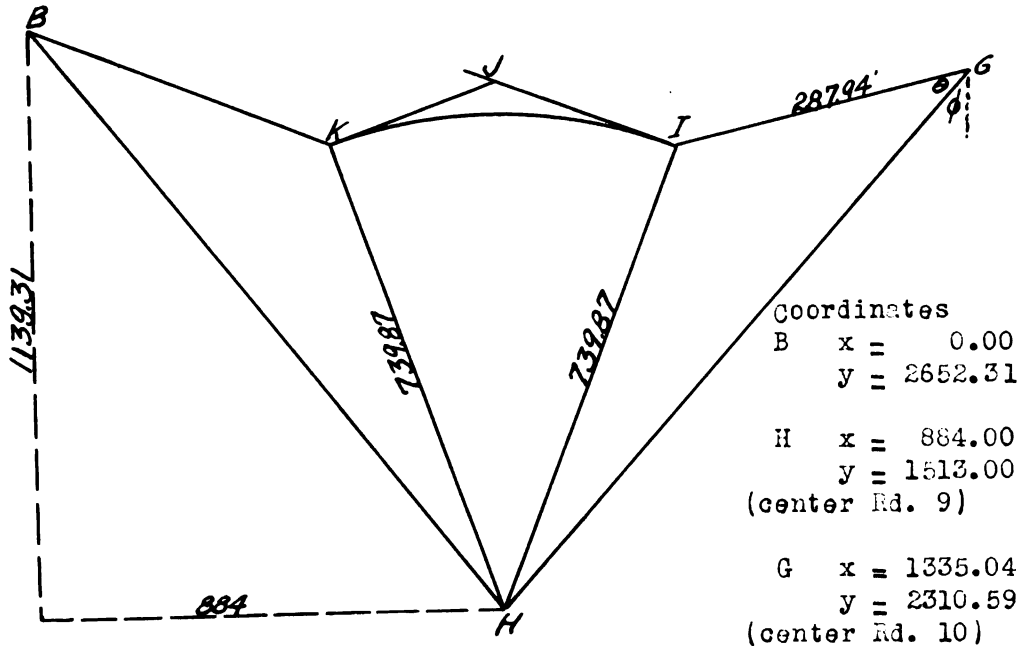
$$P = 59^{\circ}04'38''$$

$$\begin{array}{r} 59^{\circ}04'38'' \\ 18^{\circ}25'38'' \\ \hline N40^{\circ}39'W \text{ Bearing FH} \end{array}$$

$$\begin{array}{r} 89^{\circ}60' \\ 62^{\circ}15' \\ \hline 27^{\circ}45' \end{array}$$

$$\begin{array}{r} 27^{\circ}45' \\ 40^{\circ}39' \\ \hline 68^{\circ}24' = \angle U \end{array}$$

ROADS 9 AND 10



Bearing BK = N46°24'30"

$$BH = \sqrt{884^2 + 1139.31^2} = \sqrt{2,010,363.2761}$$

$$BH = 1417.87$$

$$\tan \alpha = \frac{884}{1139.31} = .77591$$

$$\alpha = 37^{\circ}48'30''$$

$$46^{\circ}24'30''$$

$$37^{\circ}48'30''$$

$$8^{\circ}36' = \angle HBK$$

$$\sin BKH = \frac{\sin 8^{\circ}36' \cdot 1417.87}{739.87} = \frac{.14954 \cdot 1417.87}{739.87}$$

$$\sin BKH = .28658$$

$$BKH = 16^{\circ}39'15'' \text{ or } 163^{\circ}20'45''$$

Bearing KH

$$\begin{array}{r} 46^{\circ} 24' 30'' \\ \underline{16^{\circ} 39' 15''} \\ N 29^{\circ} 45' 15'' W = \text{Bearing KH} \end{array}$$

Coordinates

739.87

$$\begin{array}{lll} \sin. = .49628 & X = -367.18 & X = 516.82 \text{ (Pt. K)} \\ \cos. = .868.16 & Y = 642.33 & Y = 2155.33 \end{array}$$

K = Pt. of intersection of Rd 10 & Shawmut Blvd.

$$HG = \sqrt{451.04^2 + 797.59^2}$$

$$HG = 916.29$$

$$\tan. \phi = \frac{451.04}{797.59} = .57955$$

$$S = 972.05$$

$$\phi = 30^{\circ} 5' 40''$$

$$\cos. \frac{Q}{2} = \sqrt{\frac{s(s-a)}{bd}} = \sqrt{\frac{972.05 \cdot 232.18}{287.94 \cdot 916.29}} = \sqrt{.855418161}$$

$$\cos. \frac{Q}{2} = .92489$$

$$\frac{Q}{2} = 22^{\circ} 21'$$

$$Q = 44^{\circ} 42'$$

Bearing GI $30^{\circ} 05' 40''$
 $\frac{44 \quad 42'}{0}$
 S $74^{\circ} 47' 40''$ W

287.94 sin. = .96500 X = -277.86
 cos. = .26227 Y = - 75.52

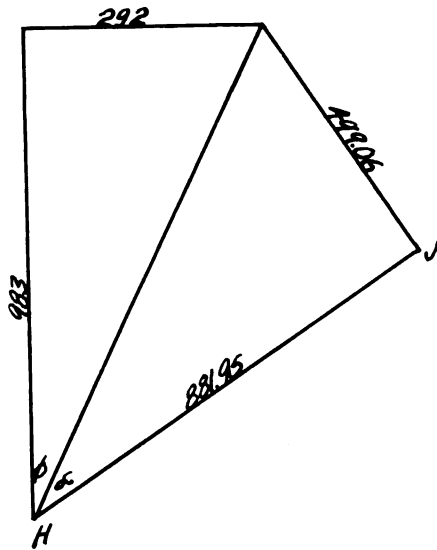
Coordinates

X = 1058.18 (Pt. I)

Y = 2235.07

Intersection of Rds. 10 & 9

INTERSECTION OF ROADS 6 & 7



G = Center of curve - Rd. 6

H = Center of curve - Rd. 7

Rd. 6 - $11^{\circ} 30'$ = D R = 499.06

Rd. 7 - $6^{\circ} 30'$ = D R = 881.95

Coordinates

X = 1750 (Pt. H)

Y = 867

X = 2042 (Pt. G)

Y = 1850

G = Center of curve forming Rd. 6

H = Center of curve forming Rd. 7

$$GH = \sqrt{292^2 + 983^2}$$

$$GH = 1025.35'$$

$$\tan \phi = \frac{292}{983} = .29735$$

$$\phi = 16^{\circ} 33' 40'' \quad S = 1203.18$$

$$\cos. \frac{J}{2} = \frac{\sqrt{s(s-a)}}{bc} = \frac{\sqrt{1203.18 \cdot 177.83}}{881.95 \cdot 499.06}$$

$$\cos. \frac{J}{2} = .69721 \quad \frac{J}{2} = 45^{\circ} 47' 50''$$

$$J = 91^{\circ} 35' 40''$$

$$\frac{\sin. J}{1025.35} = \frac{\sin. \alpha}{499.06}$$

$$\sin. \alpha = \frac{99962 \cdot 499.06}{1025.35} = .48654$$

$$\begin{array}{r} \alpha = 29^{\circ} 06' 50'' \\ \quad 16^{\circ} 33' 40'' \\ \hline N \quad 45^{\circ} 40' 30'' \quad E = \text{Bearing of HJ} \end{array}$$

$$881.95 \quad \sin. = .71539 \quad X = 630.94$$

$$\cos. = .69873 \quad Y = 616.24$$

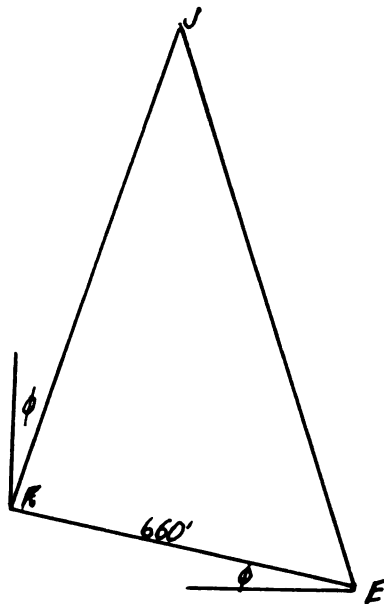
Coordinates

$$X = 2380.94 \quad (\text{Pt. J})$$

$$Y = 1483.24$$

Intersection of Rds. 6 & 7

ROAD F



Coordinates

$$X = 2380.94 \quad (\text{Pt. J})$$

$$Y = 1483.24$$

$$X = 2636.78 \quad (\text{Pt. E})$$

$$Y = 646.51$$

$$BK = 660'$$

$$\phi = 19^{\circ} 52' 20''$$

$$EJ = \sqrt{836.73^2 + 255.84^2}$$

$$EJ = 874.97$$

Coordinates

$$\sin. = .94046 \quad X = 620.70$$

$$X = 2016.08 \quad (\text{Pt. K})$$

$$\cos. = .34000 \quad Y = 224.40$$

$$Y = 870.91$$

660

$$JK = \sqrt{364.86^2 + 612.33^2}$$

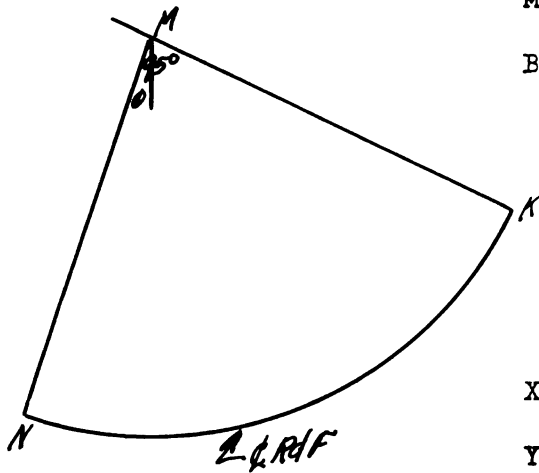
$$JK = 705.03$$

Pt. K = Intersection of Rds. F & Shawmut Blvd.

$$\tan \phi = \frac{364.86}{612.33} = .59586$$

$$\phi = 30^{\circ} 47' 20''$$

ROAD F



$$M = 95^{\circ}$$

$$\text{Bearing MK} = N 59^{\circ}12'40'' W$$

$$\phi = 35^{\circ}47'20''$$

M = Center of curve
forming Rd. F

Coordinates

$$X = 2016.08 \quad (\text{Pt. K})$$

$$Y = 870.91$$

Rd. F

$$D = 19^{\circ} \quad R = 302.94$$

$$L_c = 500.00'$$

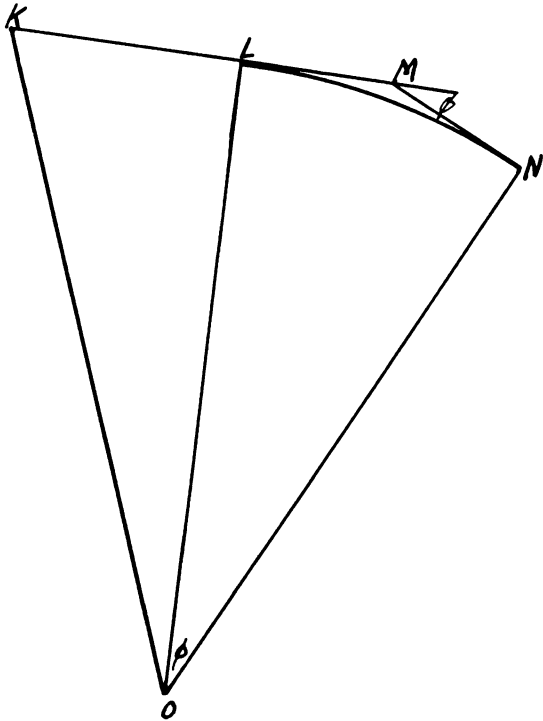
Coordinates

302.94	Sin. = .85901	X = -260.23	X = 1755.85 (Pt. M)
	Cos. = .51196	Y = 155.09	Y = 1026.00

$$\text{Bearing MN} = S 35^{\circ}47'20'' W$$

302.94	Sin. = .58480	X = -177.16	X = 1578.69 (Pt. N)
	Cos. = .81117	Y = -245.74	Y = 730.26

ROAD F



Bearing KLM = S 74° 05' 30" E

Bearing NO = S 35° 47' 12" W

Coordinates

X = 1578.69 (Pt. N)

Y = 780.26

X = 1058.51 (Pt. K)

Y = 976.89

Curve D = 5° 45' R = 996.87 = LO = ON
(NO)

996.97 sin. = .58480 X = -582.97 X = 995.72 (Pt. O)
cos. = .81117 Y = -808.63 Y = -28.37

Bearing MN = N 54° 12' 40" W

Bearing KL = S 74° 05' 30" E

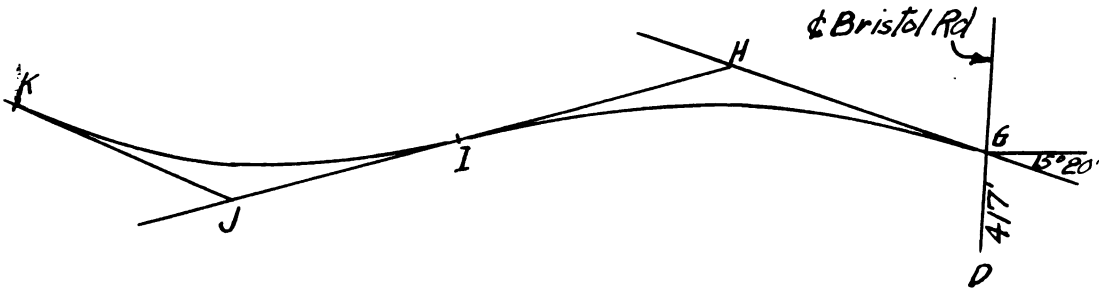
ϕ = 19° 52' 50"

Bearing OL = N 15° 54' 30" E

996.87 sin. = .27410 X = 273.24 X = 1268.96 (Pt. L)
cos. = .96170 Y = 958.69 Y = 930.32

KL = 215.54

ROAD 5



D = 8°
Lc = 309'
Δ = 24° 43' 12" R

D = 5° 30'
L_C = 465'
A = 25° 34' 30" L

$$\begin{array}{r} \text{Tan.} = 8(1255.6 \\ 158.95 \\ \hline .13 \\ 159.08 \end{array}$$

$$\begin{array}{r} \text{Tan.} = 5.5) \underline{1300.500} \\ \underline{236.45} \\ \underline{ .08} \\ 236.53 \end{array}$$

Coordinates

X = 2638.65 (Pt. D)

$$Y = -56.69$$

Bearing DG = N 0° 7' 40" W

417 sin. = .00204 X = .085 X = 2638.57 (Pt. G)
cos. = 1.00000 Y = 417 Y = 360.31

Bearing CH = N 74° 40' W

Coordinates

236.53 sin. = .96440 X = - 228.11 X = 2410.46 (Pt. H)
cos. = .26443 Y = 62.55 Y = 422.86

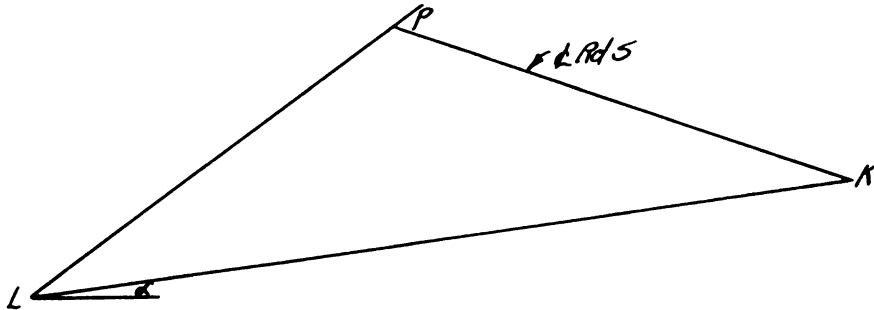
Bearing HJ = S 79° 45' 30" W

395.61 sin. = .98406 X = - 389.30 X = 2021.16 (Pt. J)
cos. = .17780 Y = - 70.34 Y = 352.52

Bearing JK = N 75° 31' 18" W

159.08 sin. = .96824 X = - 154.03 X = 1867.13 (Pt. K)
cos. = .25000 Y = 39.77 Y = 392.29

INTERSECTION ROADS D & 5



Coordinates

Bearing LP = N 53°18'10"E

X = 1234.08 (Pt. L)

Y = 305.10

Bearing KP = N 75°31'18"W

X = 1867.13 (Pt. K)

Y = 392.29

LK = $633.05^2 + 87.19$

LK = 639.03

$\text{Tan. } \alpha = \frac{87.19}{633.05} = .13773$

$\alpha = 7^\circ 50' 30''$

Bearing LK = N 82° 9' 30"E

$\angle P = 128^\circ 49' 28''$

$\angle K = 22^\circ 19' 12''$

$\angle L = 28^\circ 51' 20''$

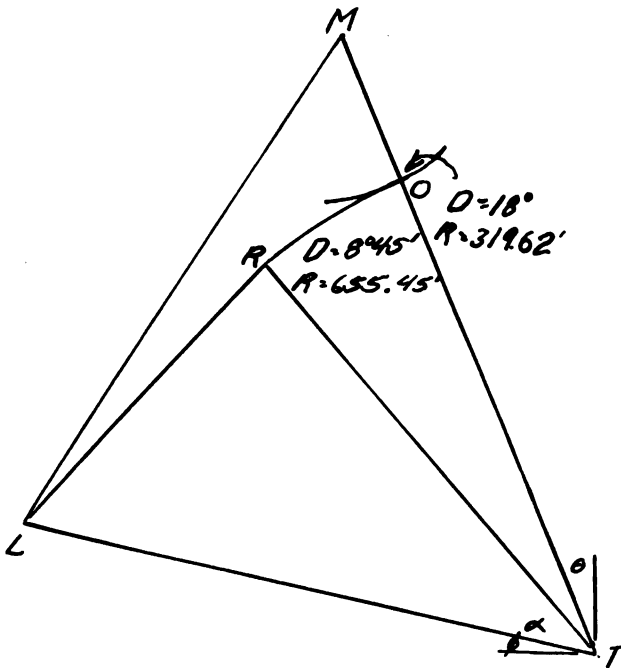
$$\frac{\sin. P}{LK} = \frac{\sin. L}{P'}$$

$$KP = \frac{639.03 \cdot 482.60}{.77907} = 395.85$$

Coordinates

395.85	sin. = .96824	X = -383.28	X = 1483.85 (Pt. P)
	cos. = .25000	Y = 98.96	Y = 491.25

ROAD D



Bearing MT = N 18° 20' W

Coordinates

X = 1755.85 (Pt. M) (Page 21)

Y = 1026.00

MT = 975.07

X = 1234.08 (Pt. L)

Y = 305.10

MT

975.07	sin. = .31454	X = 306.70	X = 2062.55 (Pt. T)
	cos. = .94924	Y = -925.58	Y = 100.42

$$LT = \sqrt{205.72^2 + 828.47^2}$$

$$LT = 853.63$$

$$LR = \sqrt{853.90^2 - 655.45^2}$$

$$LR = 546.82$$

$$\text{Tan. } \alpha = \frac{546.82}{655.45} = .83427$$

$$\alpha = 39^{\circ} 50' 15''$$

$$\text{Tan. } \phi = \frac{204.68}{828.47} = .24705$$

$$\phi = 13^{\circ} 52' 30''$$

$$\text{Bearing TR} = \text{N } 36^{\circ} 17' 15''$$

Coordinates

655.45	sin. = .59184	X = -387.92	X = 1674.63 (Pt.R)
	cos. = .80606	Y = 528.33	Y = 628.75

$$\text{Tan. } \phi = \frac{306.70}{925.58} = .33136$$

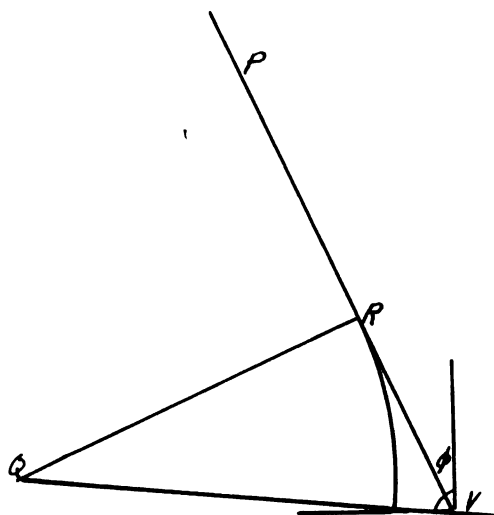
$$\phi = 18^{\circ} 20'$$

$$\text{Bearing TM} = \text{N } 18^{\circ} 20' \text{ W}$$

655.45	sin. = .31454	X = -206.77	X = 1835.57 (Pt. 0)
	cos. = .94924	Y = 622.18	Y = 719.74

$$\text{Tan. } \phi = \frac{440.55}{323.65} = 1.36119$$

$$\text{Bearing LR} = \text{N } 53^{\circ} 18' 10'' \text{ E}$$



ROAD E

Coordinates

$$X = 1836.00 \text{ (Pt. V)}$$

$$Y = -39.44$$

$$X = 1483.85 \text{ (Pt. P)}$$

$$Y = 491.25$$

$$\text{Bearing TV} = N 88^{\circ}46'10'' W$$

$$PV = \sqrt{353.15^2 + 530.69^2}$$

$$PV = 637.45$$

$$\tan. \phi = \frac{353.15}{530.69} = .66545$$

$$\phi = 33^{\circ} 38' 30''$$

$$\text{Bearing PV} = N 33^{\circ}38'30'' W$$

$$\angle PVT = 55^{\circ} 07' 40''$$

$$\angle O = 34^{\circ} 52' 20''$$

$$\text{Bearing RO} = S 56^{\circ}21'30'' W$$

$$D = 25^{\circ} \text{ (assumed)}$$

$$OR = 250.79$$

$$RV = OR \tan O$$

$$RV = 250.79 \cdot .69689$$

$$RV = 174.77$$

$$TV = \text{external} = \frac{276}{23} = 12.00'$$

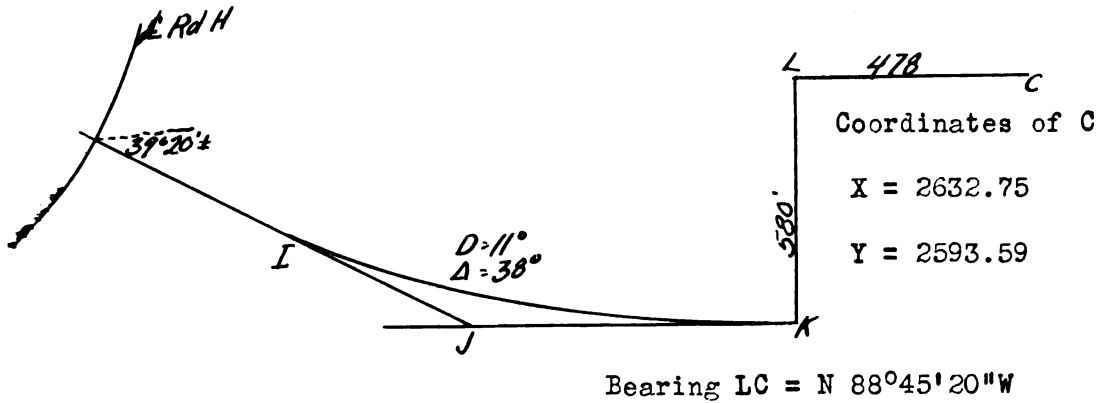
Coordinates

12.00	sin. = .99976	X = 12.00	X = 1824.00 (Pt. T)
	cos. = .02149	Y = 2.58	Y = -36.86

Pt. T = intersection of Fulton Rd. and Rd. E

$$L_c = \frac{34^{\circ}52'20''}{23} = \frac{34.87222^{\circ} \cdot 100}{23} = 151.62'$$

ROAD 8



Coordinates

478 sin. = .99975 X = -477.88 X = 2154.87 (Pt. L)
 cos. = .02230 Y = 10.66 Y = 2604.25

Bearing LK = S 0°7'40"E

580 sin. = .00224 X = 1.30 X = 2156.17 (Pt. K)
 cos. = 1.00000 Y = -580.00 Y = 2024.25

Bearing JK = N 88°43'20"W

T = 11)1972.9
 179.35
 .27
 179.62

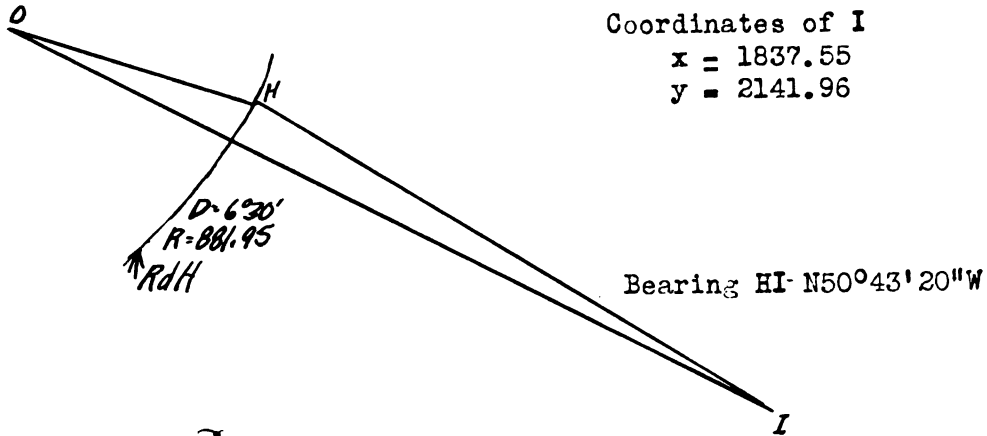
179.62 sin. = .99975 X = -179.58 X = 1976.59 (Pt. J)
 cos. = .02230 Y = 4.00 Y = 2028.25

Bearing JI = N 50°43'20"W

179.62 sin. = .77408 X = -139.04 X = 1837.55 (Pt. I)
 cos. = .63308 Y = 113.71 Y = 2141.96

1

ROADS 8 and H



Coordinates of I

$$x = 1837.55$$

$$y = 2141.96$$

Bearing HI = N50°43'20\"W

Coordinates of O

$$x = 661.61$$

$$y = 2517.88$$

$$OH = 881.95$$

$$OI = \sqrt{1175.94^2 + 375.92^2}$$

$$OI = 1234.63$$

Bearing OI

$$\tan = \frac{1175.94}{375.92} = 3.12816$$

$$\text{Bearing} = N72^\circ 16' 30''$$

$$\angle I = 21^\circ 33' 10''$$

$$\frac{\sin I}{881.95} = \frac{\sin H}{1234.63}$$

$$\sin H = \frac{1234.63 \cdot .36745}{881.95} = .51439$$

$$H = 30^\circ 57' 24'' \text{ or } 149^\circ 02' 36''$$

Bearing OH

$$N81^\circ 40' 45'' W$$

881.95

$$\sin = .98946$$

$$x = 872.65$$

Coordinates

$$x = 1534.26 \quad (\text{pt. H})$$

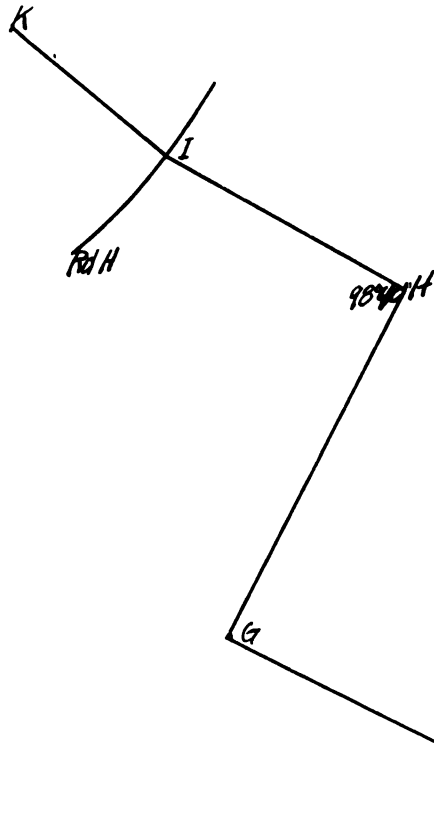
$$\cos = .14479$$

$$y = -127.70$$

$$y = 2390.18$$

Pt. H = Intersection of Rd. H & O

ROAD G



Coordinates

X = 1782.44 (Pt. F)

Y = 955.31

GF = N46°24'30"W

GH = N27°20'E

GF = 519'

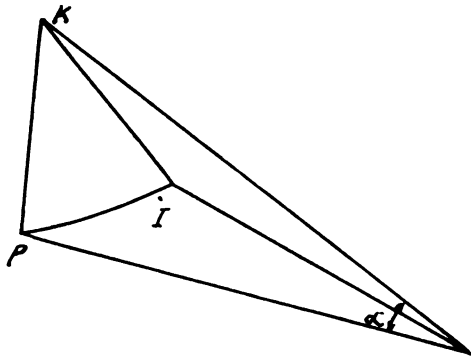
GH = 593'

HI = N54°W

Coordinates

519.00	sin. = .72427	X = -375.90	X = 1406.54 (Pt. G)
	cos. = .68951	Y = 357.86	Y = 1313.17
593.00	sin. = .45917	X = 272.29	X = 1678.83 (Pt. H)
	cos. = .88835	Y = 526.69	Y = 1839.96

ROADS G & H



Coordinates

$$X = 1228.94 \text{ (Pt. P)}$$

$$Y = 1992.15$$

$$HI = N 54^{\circ} W$$

$$PK = N 9^{\circ}10'36''W$$

$$PK = 319.93 = KI$$

PK

319.93

$$\sin. = .15945 \quad X = - 51.01 \quad X = 1177.93 \text{ (Pt. K)}$$

$$\cos. = .98720 \quad Y = 315.75 \quad Y = 2307.90$$

$$KH = \sqrt{500.90^2 + 467.94^2}$$

$$KH = 685.66$$

$$\tan. \alpha = \frac{467.94}{500.90} = .93367 =$$

$$\text{Bearing KH} = N 46^{\circ}56'55''W$$

$$\alpha = 43^{\circ}3'05''$$

$$\angle IHK = 7^{\circ} 03' 5''$$

$$\frac{\sin. H}{319.62} = \frac{\sin. I}{685.22}$$

$$\sin. I = \frac{685.66 \cdot .12276}{319.93} = .26394$$

$$I = 14^{\circ}47'10'' \text{ or } 165^{\circ} 12'50''$$

$$\angle sK = 7^{\circ}44'05''$$

$$\text{Bearing KI} = N 39^{\circ}12'50''$$

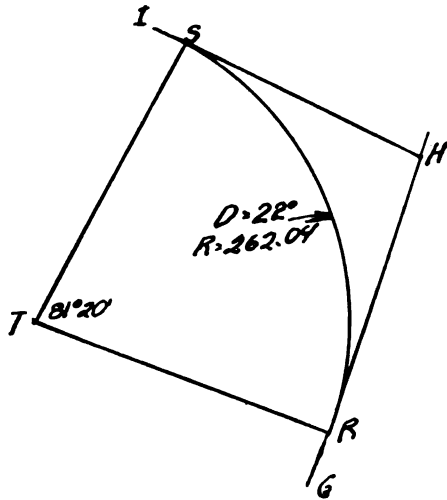
319.93

$$\sin. = .63221 \quad X = 202.26 \quad X = 1380.19 \text{ (Pt. I)}$$

$$\cos. = .77479 \quad Y = 247.88 \quad Y = 2060.02$$

Pt. I is intersection of Rds. G & H.

ROAD G



Coordinates

X = 1678.83 (Pt. H)

Y = 1839.96

HG = N 27° 20' E

HI = N 54° W

Tan. = $22 \frac{4836.2}{215.26}$

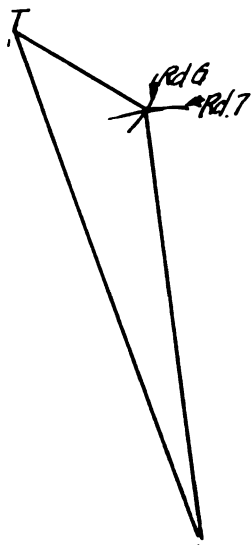
Coordinates

215.26 sin. $\bar{.45917}$ X = - 98.84 X = 1579.99 (Pt. R)
 cos. $\bar{.88835}$ Y = -191.23 Y = 1648.73

262.04 sin. $\bar{.88835}$ X = -232.78 X = 1347.21 (Pt. T)
 cos. $\bar{.45917}$ Y = 120.32 Y = 1769.05

Pt. T is center of curve
 forming Rd. G

215.26 sin. $\bar{.80902}$ X = -174.15 X = 1504.68 (Pt. S)
 cos. $\bar{.58779}$ Y = 126.53 Y = 1966.49



ROADS 7 AND G

Coordinates

$$X = 1347.21 \quad (\text{Pt. T})$$

$$Y = 1769.05$$

$$X = 1750.00 \quad (\text{Pt. H})$$

$$Y = 867.00$$

$$TK = 262.04 \quad HK = 881.95$$

$$TH = 402.79^2 + 902.05^2$$

$$TH = 987.89$$

Bearing TH

$$\text{Tan.} = \frac{402.79}{902.05} = .44653$$

Bearing N $24^{\circ} 3' 45''$ W

$$\cos. \frac{H}{2} = \frac{1065.94 \cdot 803.9}{881.95 \cdot 987.89}$$

$$\cos. \frac{H}{2} = .99173$$

$$\frac{H}{2} = 7^{\circ} 22' 35''$$

$$H = 14^{\circ} 45' 10''$$

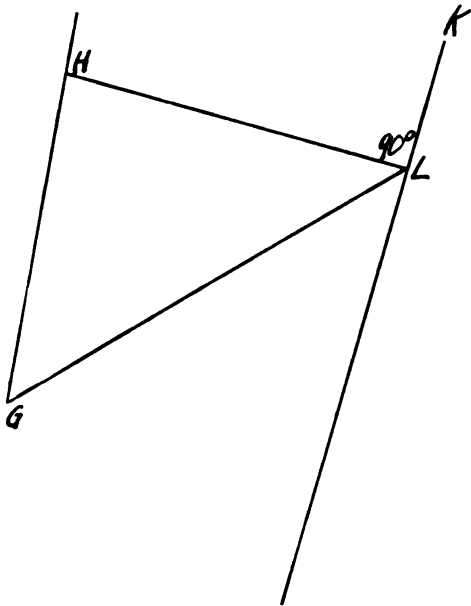
Bearing HK = N $9^{\circ} 18' 35''$ W

$$881.95 \sin. = .16175 \quad X = -142.66 \quad X = 1607.34 \quad (\text{Pt. K})$$

$$\cos. = .98683 \quad Y = 870.33 \quad Y = 1737.33$$

K = Intersection of $\mathbf{L}$ of Rds. 7 & G

ROADS 6 AND G



$$KL = N 33^{\circ} E$$

$$GH = N 27^{\circ} 20' E$$

$$KL = 499.06' \quad (\text{Page 19})$$

Coordinates

$$X = 2042 \quad (\text{Pt. K})$$

$$Y = 1850$$

$$X = 1406.54 \quad (\text{Pt. G})$$

$$Y = 1313.17$$

499.06

$$\sin. = .54464 \quad X = -271.81 \quad X = 1770.19 \quad (\text{Pt. L})$$

$$\cos. = .83867 \quad Y = -418.55 \quad Y = 1431.45$$

$$GL = \sqrt{363.65^2 + 118.28^2}$$

$$GL = 382.40$$

$$\text{Tan.} = \frac{363.65}{118.28} = 3.07448$$

$$\text{Bearing GL} = N 71^{\circ} 58' 57''$$

$$\angle s G = 44^{\circ}39'$$

Bearing of LH
N57°W

$$\angle s H = 84^{\circ}20'$$

$$\angle s L = 51^{\circ}1'$$

$$\frac{\sin H}{382.40} = \frac{\sin G}{HL}$$

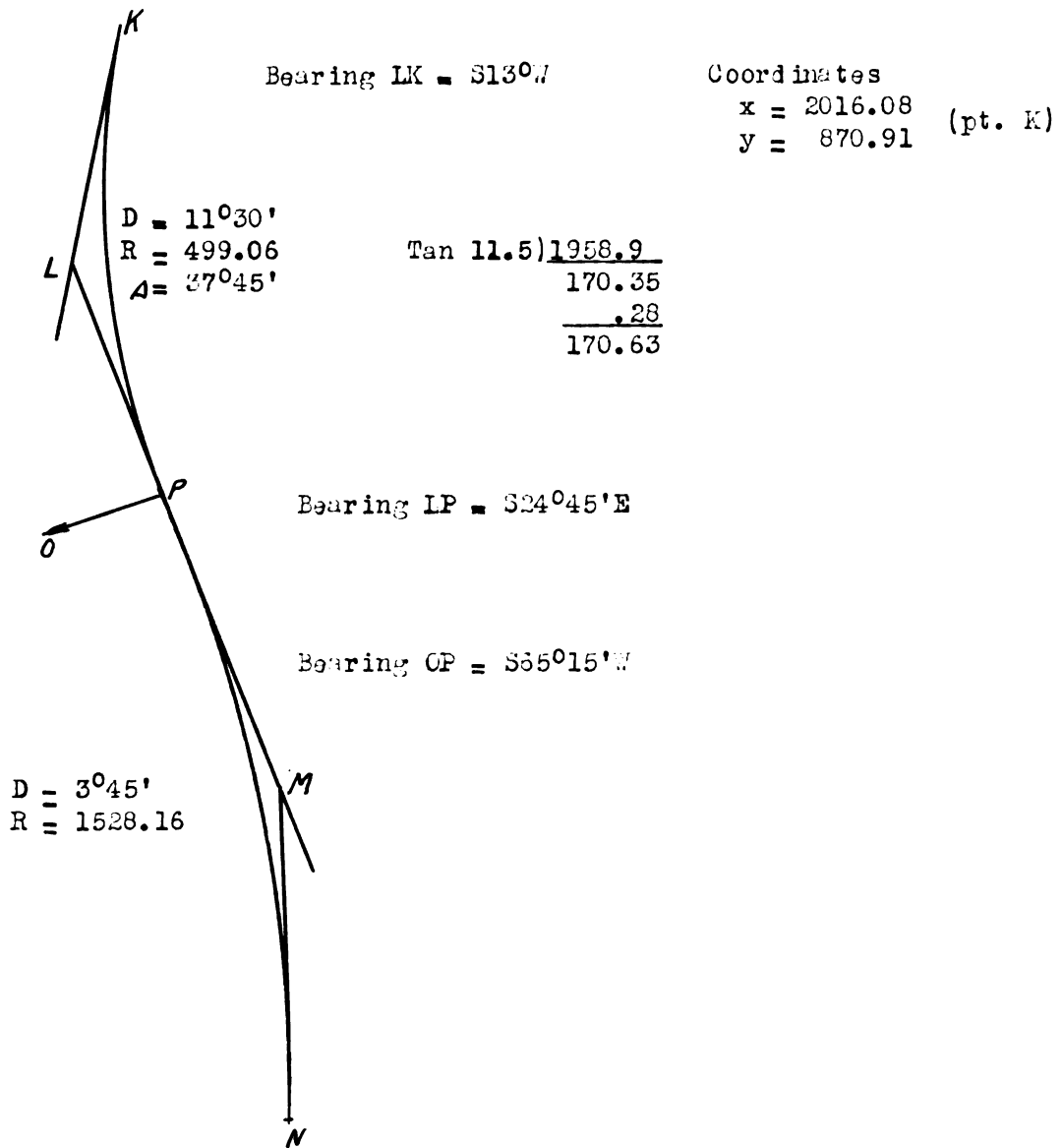
$$HL = \frac{.70277 \cdot 382.40}{.99511}$$

$$HL = 270.06$$

270.06	$\sin .83867$	$x = -226.49$	Coordinates	
	$\cos .54464$	$y = 147.09$	$x = 1543.70$ $y = 1578.54$	(pt. H)

H is the intersection of Rds. 6 & G

ROAD K

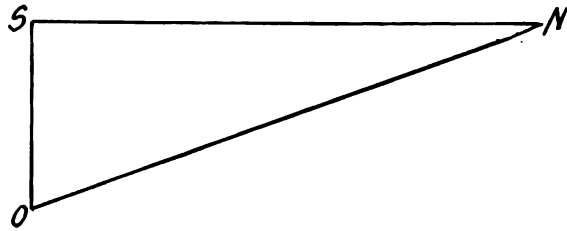


170.63	sin .22495	x = - 38.38	Coordinates	(pt. L)
	cos .97437	y = -163.26	x = 1977.70 y = 704.65	

170.63	sin .41866	x = 71.44	x = 2049.14 y = 549.69	(pt. P)
	cos .90814	y = -154.96		

1528.16	sin .90814	x = -1387.78	x = +661.36 y = - 90.09	(Pt. O)
	cos .41866	y = - 639.78		

INTERSECTION OF FULTON ROAD AND ROAD K



Coordinates

$$\begin{aligned} O = x &= 661.36 \\ y &= -90.09 \end{aligned}$$

$$ON = 1528.16$$

Bearings

$$SN = S88^{\circ}46'10''E$$

$$OS = \text{Due North}$$

Coordinates

$$\begin{aligned} S = x &= 661.36 \\ y &= -14.29 \end{aligned}$$

$$OS = 75.80$$

$$\angle S = 88^{\circ}46'10''$$

$$\frac{\sin S}{1528.16} = \frac{\sin N}{75.80}$$

$$\sin N = \frac{75.80 \cdot .99977}{1528.16} = .04960$$

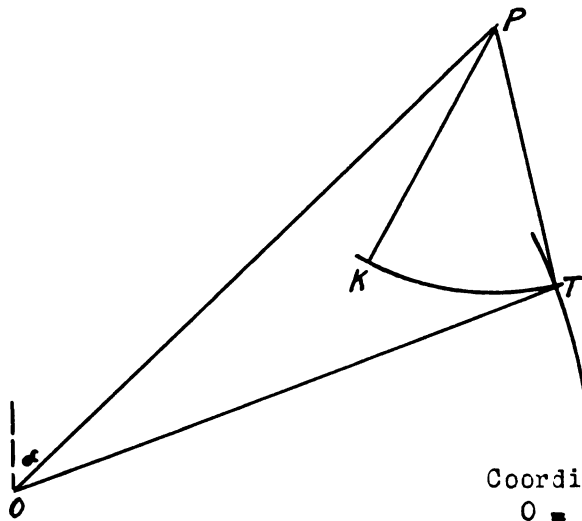
$$N = 2^{\circ}50'35''$$

$$\text{Bearing ON} = N88^{\circ}23'15''E$$

$$\begin{array}{llll} 1528.16 & \sin .99960 & x = 1527.55 & \\ & \cos .02814 & y = 43.00 & \\ & & & x = 2188.91 \text{ (Pt. N)} \\ & & & y = -47.09 \end{array}$$

Pt. N = Intersection of Rds. K
& Fulton Rd.

ROADS 5 AND K



$$\begin{aligned} OT &= 1528.16 \\ FK &= PT = 716.78 \end{aligned}$$

$$\text{Bearing KP} = \text{N}14^{\circ}28'42''\text{E}$$

Coordinates

$$\begin{aligned} O = x &= 661.36 \\ y &= -90.09 \end{aligned}$$

$$\begin{aligned} K = x &= 1867.13 \\ y &= 392.29 \end{aligned}$$

$$\begin{array}{llll} 716.78 & \sin .25000 & x = 179.20 & x = 2076.33 \\ & \cos .96824 & y = 694.04 & y = 1086.31 \end{array} \quad (\text{pt. P})$$

$$OP = \sqrt{1414.97^2 + 1176.40^2}$$

$$= 1839.85 \text{ ft.}$$

$$\tan \alpha = \frac{1414.97}{1176.40} = 1.20279$$

$$\alpha = 50^{\circ}15'40''$$

$$\text{Bearing OP} = \text{N}50^{\circ}15'40''\text{E}$$

$$\cos \frac{P}{2} = \frac{\sqrt{2042.40 \cdot 514.24}}{1839.85 \cdot 716.78} = .89241$$

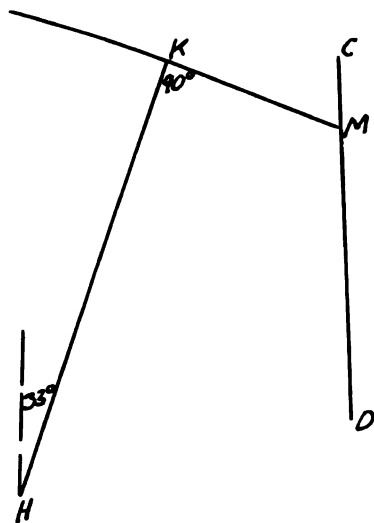
$$\frac{P}{2} = 26^{\circ}49'20'' \quad P = 53^{\circ}28'40''$$

Bearing FT = N3°13'W

$$\begin{array}{llll} 716.78 & \sin .05611 & x = 40.22 & \\ & \cos .99842 & y = -715.65 & \end{array} \quad \begin{array}{ll} x = 2116.55 & \\ y = 370.65 & \end{array} \quad (\text{pt. T})$$

Pt. T is the intersection of Lds. 5 & K

ROAD 7



$$HK = 881.95$$

$$\text{Bearing HK} = N57^{\circ}E$$

Coordinates H

$$x = 1750$$

$$y = 867$$

$$881.95$$

$$\sin .83867$$

$$x = 739.66$$

Coordinates

$$x = 2489.66$$

$$\cos .54464$$

$$y = 480.35$$

$$y = 1347.35$$

Approximate x coordinate of M = 1127

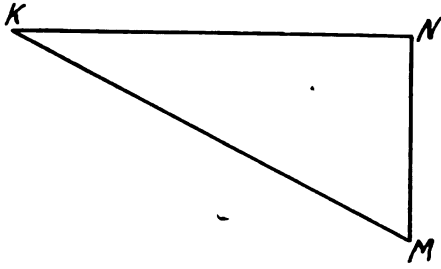
$$\frac{5.90}{2650} = \frac{x}{1127}$$

$$x = \frac{5.90 \cdot 1127}{2650} = 2.51$$

$$2638.65 = x \text{ of } O$$

$$\underline{2.51}$$

$$2636.14 = x \text{ of } M$$



$$KM = S33^{\circ}E$$

Coordinates

$$K = x = 2489.66$$

$$y = 1347.35$$

$$KN = \text{Due N}$$

$$KM = \text{Due E}$$

$$M = x = 2636.14$$

$$KN = 146.48$$

$$\angle K = 57^{\circ}$$

$$\tan 57^{\circ} = \frac{NM}{KN}$$

$$NM = 146.48 \cdot 1.53986$$

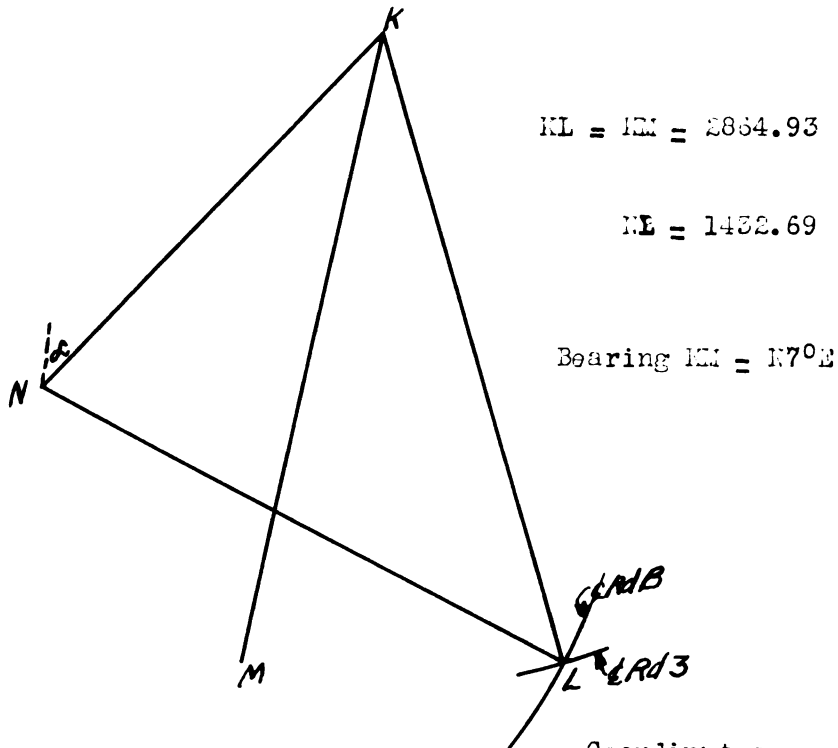
$$NM = 225.56$$

Coordinates of M

$$x = 2636.15$$

$$y = 1121.79$$

ROADS B AND 3



$$KL = LM = 2864.93$$

$$NL = 1432.69$$

$$\text{Bearing LM} = N7^{\circ}E$$

Coordinates

$$\begin{aligned} N = x &= -682.27 \\ y &= 1019.58 \quad (\text{p. 11}) \end{aligned}$$

Coordinates

$$\begin{aligned} M = x &= 0 \\ y &= 809 \end{aligned}$$

MK

$$2864.93$$

$$\sin .12187$$

$$x = 349.15$$

Coordinates

$$x = 349.15$$

$$\cos .99255$$

$$y = 2843.59$$

$$y = 3652.59$$

$$MK = \sqrt{1031.42^2 + 2633.21^2}$$

$$MK = 2828.00$$

Bearing NK

$$\text{Tan. } \alpha = \frac{1031.42}{2633.21} = .39170$$

$$\alpha = 21^{\circ} 23' 30''$$

Bearing = N $21^{\circ} 23' 30''$ E

$$S = 3562.81$$

$$\cos. \frac{N}{2} = \sqrt{\frac{S(S-A)}{bc}} = \sqrt{\frac{3562.81 \cdot 697.88}{2828.00 \cdot 1432.69}}$$

$$\cos. \frac{N}{2} = .78338$$

$$\frac{N}{2} = 38^{\circ} 25' 15''$$

$$N = 76^{\circ} 50' 30''$$

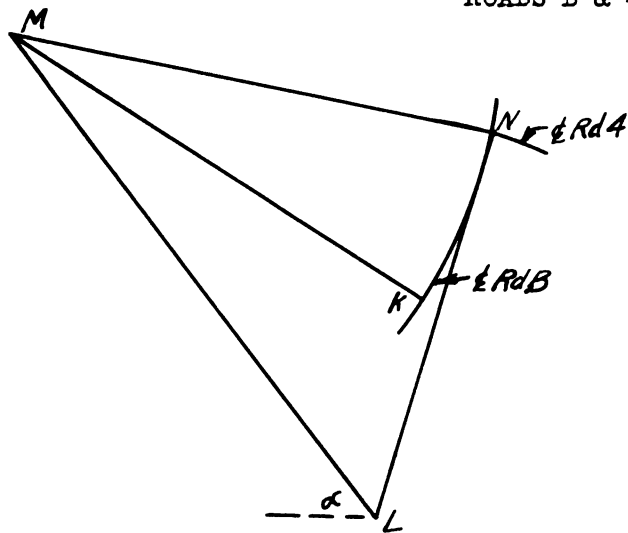
Bearing NL = S $81^{\circ} 46'$ E

Coordinates

	sin. =	.98969	X = 1417.92	X = 735.65 (Pt. L)
1432.69	cos. =	.14320	Y = -205.16	Y = 814.22

Intersection of Rds. 3 & B

ROADS B & 4



Coordinates

X = 807.85 (Pt. K)
Y = -17.36
(Page 10)

X = 599.39 (Pt. L)
Y = -7307.96
(Page 13)

Bearing KM = N 86° W

MN = 955.37 = KM

LN = 7639.49

Pt. L is center of curve forming Rd. 4

Pt. M is center of curve forming Rd. B

KM

Coordinates

955.37	sin. = .99756	X = -953.04	X = -145.19 (Pt. M)
	cos. = .06976	Y = 66.65	Y = 48.29

$$ML = \sqrt{744.58^2 + 7356.25^2}$$

$$ML = 7393.83$$

$$\tan. \alpha = \frac{7356.25}{744.58} = 9.87975$$

$$\alpha = 84^\circ 13' 10''$$

Bearing LM = N 5° 46' 50" W

$$s = 7994.35$$

$$\cos \frac{L}{2} = \sqrt{\frac{7994.35 \cdot 7038.98}{7639.49 \cdot 7393.83}}$$

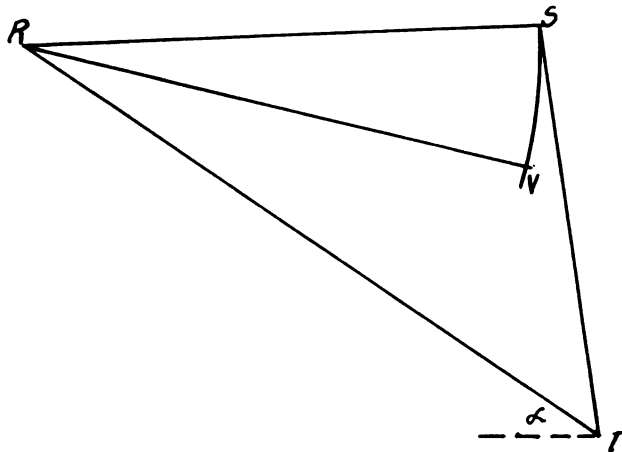
$$\cos \frac{L}{2} = .99811 \quad \frac{L}{2} = 3^{\circ}31'30'' \quad L = 7^{\circ}03'$$

Bearing LN = N1°16'10"E

7639.49	sin .02214	x = 169.14	Coordinates
	cos .99976	y = 7637.66	x = 768.43 (Pt. N)
			y = 329.70

Point N = intersection of Rds. 4 & B

ROADS A AND 4



Coordinates

$$V = x = 328.94 \quad (p. 6)$$

$$y = -7.07$$

$$T = x = 599.39$$

$$y = -7307.93$$

$$ST = 7369.49$$

$$RV = RS = 7639.49$$

$$\text{Bearing } RV = N79^{\circ}25'W$$

R = center of curve forming Rd. A

T = " " " " Rd. 4

$$RV = 5729.65$$

$$\sin .98299 \quad x = -5632.19$$

$$\cos .18367 \quad y = 1052.36$$

Coordinates

$$x = -5303.25 \quad (\text{Pt. R})$$

$$y = 1045.29$$

$$RT = \sqrt{5902.64^2 + 8353.22^2}$$

$$RT = 1022.830$$

$$\tan \alpha = \frac{8353.22}{5902.64} = 1.41517$$

$$\alpha = 54^{\circ}45'15''$$

$$\text{Bearing } RT = N35^{\circ}14'45''W$$

$$s = 11798.72$$

$$\cos \frac{T}{2} = \sqrt{\frac{11798.72 \cdot 6069.07}{7639.49 \cdot .0228.30}}$$

$$\cos \frac{T}{2} = .95738 \qquad \frac{T}{2} = 16^{\circ}47'15''$$

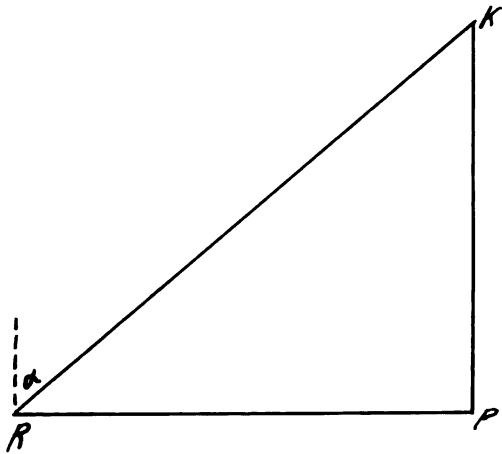
$$T = 33^{\circ}34'30''$$

$$\text{Bearing TS} = N1^{\circ}40'15''W$$

7639.49	sin .02915	x = -222.69	Coordinates
	cos .99958	y = 7626.72	x = 376.70 y = 318.79

Pt. S = intersection of Lds. A & 4

ROADS A AND 3



Coordinates

K $x = 349.15$
 $y = 3652.59$

R $x = -5303.25$
 $y = 1045.29$

RP = 5729.65

KP = 2864.93

K = center of curve forming Rd. 3

R = " " " " Rd. A

$$RK = \sqrt{5652.40^2 + 2607.30^2}$$

$$RK = 6224.76$$

$$\tan \alpha = \frac{5652.40}{2607.30} = 2.16791$$

$$\alpha = 35^{\circ}14'36''$$

$$s = 7409.67$$

$$\cos \frac{R}{2} = \sqrt{\frac{7409.67 \cdot 4544.74}{6224.76 \cdot 5729.65}}$$

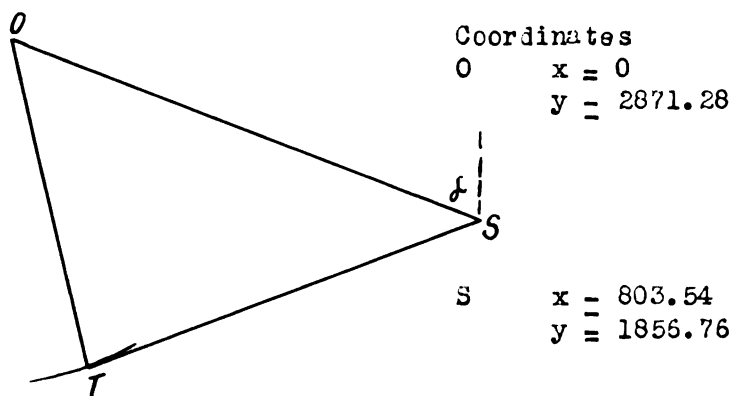
$$\cos \frac{R}{2} = .97175 \quad \frac{R}{2} = 13^{\circ}39'10''$$

$$R = 27^{\circ}18'20''$$

$$\text{Bearing EP} = S87^{\circ}27'E$$

5729.65	$\sin .99901$	$x = 5723.98$	Coordinates
	$\cos .04449$	$y = -254.91$	$x = 420.73$
			$y = 790.38$

ROADS A AND 1



$$OT = 1146.28$$

$$ST = 478.34$$

O = center of curve forming Rd. 1
S = " " " " " Rd. A

$$OS = \sqrt{803.54^2 + 1014.52^2}$$

$$OS = 1094.19$$

$$\tan \alpha = \frac{803.54}{1014.52} = .79204$$

$$\tan \alpha = .79204 \quad \alpha = 38^\circ 22' 50''$$

$$\text{Bearing OS} = N38^\circ 22' 50'' W$$

$$s = 1459.40$$

$$\cos \frac{s}{2} = \sqrt{\frac{1459.40 \cdot 612.12}{478.34 \cdot 1294.19}}$$

$$\cos \frac{s}{2} = .85779 \quad \frac{s}{2} = 30^{\circ}55'50''$$

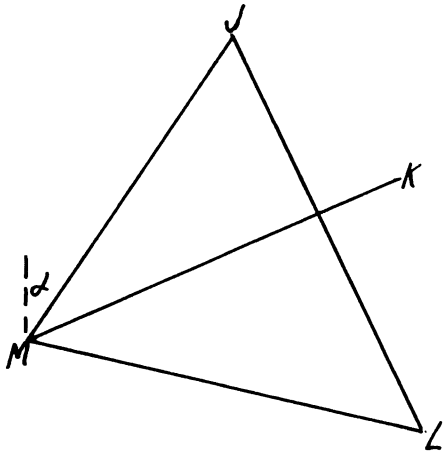
$$s = 61^{\circ}51'40''$$

$$\text{Bearing ST} = S79^{\circ}45'30''W$$

478.34	$\sin .98407$	$x = -470.72$	Coordinates
	$\cos .17780$	$y = -85.05$	$x = 352.85$
			$y = 1771.71$

Pt. T = intersection of Lds. A & 1

ROADS 2 AND A



Coordinates

$$\begin{aligned} J \quad x &= 100.00 \\ y &= 2800.00 \end{aligned} \quad (\text{p. 5})$$

$$\begin{aligned} K \quad x &= 346.92 \\ y &= 1714.25 \end{aligned} \quad (\text{p. 6})$$

$$\text{Bearing JM} = S70^{\circ}14'W$$

$$\begin{aligned} KM &= ML = 1432.69 \\ JL &= 1432.69 \end{aligned}$$

J = center of curve forming 2
M = " " " " A

KM

1432.69

$$\sin .95459 \quad x = -1367.63$$

$$\cos .29793 \quad y = -426.85$$

Coordinates

$$\begin{aligned} x &= -1020.71 \\ y &= 1287.40 \end{aligned} \quad (\text{pt. M})$$

$$JM = \sqrt{1120.71^2 + 1512.60^2}$$

$$JM = 1879.88$$

$$\tan \alpha = \frac{1120.71}{1512.60} = .74092$$

$$\alpha = 36^{\circ}32'10''$$

$$\text{Bearing MJ} = N36^{\circ}32'10''E$$

$$s = 2372.63$$

$$\cos \frac{J}{2} = \sqrt{\frac{2372.63 \cdot 939.94}{1432.69 \cdot 1679.86}}$$

$$\cos \frac{J}{2} = .91017 \qquad \frac{J}{2} = 24^{\circ}28'15''$$

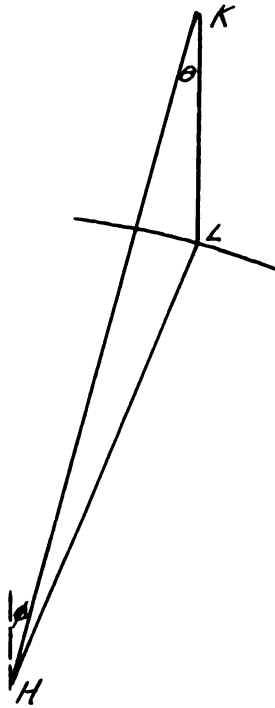
$$J = 48^{\circ}56'30''$$

$$\text{Bearing JL} = S12^{\circ}24'20''E$$

1432.69	$\sin .21483$	$x = 307.78$	Coordinates	
	$\cos .97665$	$y = -1399.24$	$x = 407.78$ $y = 1400.76$	(pt. L)

Pt. L is the intersection of Lds. A & 2

ROAD J



Coordinates

$$X = 2156.17 \quad (\text{Pt. K})$$

$$Y = 2024.25$$

$$X = 1750 \quad (\text{Pt. H})$$

$$Y = 867$$

$$\text{Bearing KL} = S 007'40''E$$

$$KH = \sqrt{406.17^2 + 1157.25^2}$$

$$KH = 1226.46$$

$$\tan. \phi = \frac{406.17}{1157.25} = 35098$$

$$\phi = 19^{\circ}20'20''$$

$$\phi = 19^{\circ} 28'$$

$$\frac{\sin. 19^{\circ}28'}{681.95} = \frac{\sin. L}{1226.46}$$

$$\sin. L = \frac{1226.46 \cdot .33326}{881.95} =$$

$$\sin. L = .46294$$

$$L = 27^{\circ}34'30''$$

or

$$152^{\circ} 25' 30''$$

$$\underline{19^{\circ} 20' 20''}$$

$$171^{\circ} 45' 50''$$

$$\angle H = 8^{\circ} 14' 10''$$

$$\frac{\sin. 8^{\circ}14'10''}{KL} = \frac{\sin. 19^{\circ} 28'}{881.95}$$

$$KL = \frac{881.95 \cdot .14323}{.33326} =$$

$$KL = 379.05'$$

LENGTH OF ROADS

$$\text{Rd. 1} = \frac{38^{\circ}27'30'' \cdot 100}{5^{\circ}} = \frac{38.45833 \cdot 100}{5} = 769.17'$$

$$\text{Rd. 2} = \frac{43^{\circ}22'45'' \cdot 100}{4^{\circ}} = \frac{43.37888 \cdot 100}{4} = 1084.47'$$

$$\text{Rd. 3} = \frac{14^{\circ}45'6'' \cdot 100}{2^{\circ}} = \frac{14.75167 \cdot 100}{2} = 737.58'$$

$$\text{Rd. 4} = \frac{9^{\circ}19'56'' \cdot 100}{0^{\circ}45'} = \frac{9.19888 \cdot 100}{.75} = 1226.52'$$

$$\text{Rd. A} = 1302 \nmid 433 \cdot \frac{64^{\circ}54'26'' \cdot 100}{12} =$$

$$1735 \nmid \frac{64.8905 \cdot 100}{12} = 1735 \nmid 540.754 =$$

$$2275.75'$$

$$\text{Rd. B to fork} = 425 \nmid 378 = 803'$$

$$\text{West fork} = \frac{29^{\circ}12'27'' \cdot 100}{4^{\circ}} = \frac{29.2075 \cdot 100}{4} = 730.18'$$

$$\text{East fork} = \frac{95^{\circ}54'03'' \cdot 100}{22^{\circ}} = \frac{95.90083 \cdot 100}{22} = 435.95$$

$$\text{Rd. C} = 442 \nmid 217 \nmid 540 \nmid \frac{37^{\circ}50'30'' \cdot 100}{6^{\circ}30'} =$$

$$1199 \nmid \frac{37.975^{\circ} \cdot 100}{6.5^{\circ}} = 1199 \nmid 584.23 = 1783.23'$$

$$\text{Rd. D} = 546.82 \nmid \frac{17^{\circ}57'15'' \cdot 100}{8^{\circ}45'} = 546.82 \nmid \frac{17.95417^{\circ} \cdot 100}{8.75^{\circ}} =$$

$$546.82 \nmid 205.19 = 752.01'$$

LENGTH OF ROADS (Cont'd)

$$\text{Rd. E} = 637.45 - 174.77 \neq 151.62 = 614.30$$

$$\text{Rd. F} = 215.54 \neq \frac{19^{\circ}52'50''}{5^{\circ}45'} \neq \frac{95^{\circ}}{19^{\circ}} \neq 705.03 =$$

$$215.54 \neq \left(\frac{19.88056}{5.75} \neq \frac{95}{19} \right) \cdot 100 \neq 705.03 =$$

$$920.57 \neq 345.75 \neq 500.00 = 1766.32'$$

$$\text{Rd. K} = \left(\frac{37^{\circ}45'}{11^{\circ}30'} \neq \frac{23^{\circ}8'15''}{3^{\circ}45'} \right) \cdot 100 = \left(\frac{37.75^{\circ}}{11.5^{\circ}} \neq \frac{23.1375^{\circ}}{3.75^{\circ}} \right) \cdot 100 =$$

$$328.26 \neq 616.93 = 945.19'$$

$$\text{Rd. 5} = 465 \neq 309 \neq 395.85 = 1169.85'$$

$$\text{Rd. 6} = \frac{78^{\circ}55'10'' \cdot 100}{11^{\circ}30'} \neq 270.06 = \frac{7891.94}{11.5} \neq 270.06 =$$

$$686.26 \neq 270.06 = 956.32'$$

$$\text{Rd. 7} = \frac{66^{\circ}18'35'' \cdot 100}{6^{\circ}30'} \neq 268.95 = \frac{66.3097 \cdot 100}{6.5} \neq 268.95 =$$

$$1020.15 \neq 268.95 = 1289.10'$$

$$\text{Rd. 8} = \frac{38}{11} \cdot 100 \neq 391.92 = 345.45 \neq 391.92 =$$

$$736.37$$

$$\text{Rd. 9} = \frac{43^{\circ}18'55'' \cdot 100}{7^{\circ}45'} = \frac{43.315.28 \cdot 100}{7.75} = 558.91$$

LENGTH OF ROADS (Cont'd)

$$\text{Rd. 10} = \left(\frac{62^{\circ}52'36''}{13^{\circ}51'18''} \div \frac{68^{\circ}24'}{20^{\circ}} \right) \cdot 100 \div 205 \div 172.49 =$$

$$\left(\frac{62.87666}{13.855} \div \frac{68.4}{20} \right) \cdot 100 \div 377.49 =$$

$$453.82 \div 342.00 \div 377.49 = 1173.31$$

$$\text{Rd. G} = 593 \div 339.59 - 430.52 \div \frac{81^{\circ}20'}{22^{\circ}} \cdot 100 =$$

$$502.07 \div \frac{81.333}{22^{\circ}} \cdot 100 = 502.07 \div 369.69 =$$

$$871.76'$$

$$\text{Rd. H} = 100 \div 336 \div 333.30 = 769.30'$$

$$\text{Rd. J} = 580.00 \div 379.05 = 959.05'$$

$$\text{Rd. K} = \left(\frac{37^{\circ}45'}{11^{\circ}30'} \div \frac{23^{\circ}8'15''}{3^{\circ}45'} \right) \cdot 100 =$$

$$\left(\frac{37.73^{\circ}}{11.5^{\circ}} \div \frac{23.1375^{\circ}}{3.75^{\circ}} \right) \cdot 100 = 328.26 \div 614.33 =$$

$$1242.59^{\circ}$$

SEWER DESIGN DATA

Line MH to MH	Len.	Area		Ground Top	Elev. Lower	Time of Flow		In Sect.	Run Off CFS/A	Off Tot.
		Incre.	Total			Min to Up.	End			
7	6	291	1.39	1.39	185.1	170.8	15.0	1.6	1.60	2.2
47	6	122	.33	.33	183.2	170.8	15.0	.2	1.60	.5
46	5	284	1.45	1.45	185.6	158.2	15.0	.7	1.60	2.3
6	5	244	1.49	3.20	170.8	158.2	16.6	.5	1.56	5.0
5	4	381	2.78	7.43	158.2	143.0	17.1	.6	1.54	14.5
4	3	381	2.91	10.34	143.0	133.1	17.6	.6	1.52	15.9
34	3	233	1.78	1.78	149.2	133.1	15.0	.4	1.60	2.9
31	29	325	1.69	1.69	182.7	181.0	15.0	.9	1.60	2.7
30	29	167	.78	.78	182.1	181.0	15.0	.4	1.60	1.3
33	32	211	1.31	1.31	177.3	176.0	15.0	.7	1.60	2.1
32	29	196	.68	2.00	176.0	181.0	15.7	.5	1.58	3.2
29	28	353	1.93	6.39	181.0	156.0	16.2	.5	1.57	10.0
28	24	357	3.39	9.78	156.0	137.2	16.7	.4	1.55	15.3
27	26	395	2.74	2.74	179.4	175.0	15.0	1.0	1.60	4.4
26	25	318	1.76	4.50	175.0	155.3	16.0	.5	1.57	7.1
25	24	310	1.81	6.30	155.3	137.2	16.5	.5	1.56	9.8
24	22	273	1.70	17.77	137.2	133.2	17.0	.6	1.54	27.4
23	22	203	.57	.58	149.8	133.2	15.0	.4	1.60	.9
22	3	94	.28	18.63	133.2	133.1	17.6	.2	1.52	28.5
3	2	320	2.22	33.01	133.1	129.8	17.7	.7	1.52	50.5
2	1	334	2.63	35.64	129.8	128.0	18.4	.7	1.50	53.8
21	20	207	1.05	1.05	179.2	177.0	15.0	.6	1.60	1.7
20	19	319	.87	1.92	177.0	165.0	15.6	.7	1.59	3.0

Line MH to MH		Vel.	Cap.	Diam. Inches	Slope	Fall	Invert Top	Elevation Lower
7	6	6.5	2.8	9	.0515	15.00	177.00	162.00
47	6	9.0	4.0	9	.1065	13.00	175.00	162.00
46	5	11.4	5.2	9	.095	27.00	177.00	150.00
6	5	8.0	6.3	12	.050	12.20	161.75	149.55
5	4	12.0	22.3	18	.038	14.48	149.38	134.90
4	3	9.9	18.0	18	.026	9.92	134.90	124.98
34	3	8.5	3.8	9	.050	11.65	136.70	125.05
31	29	6.0	4.0	12	.014	4.55	174.55	170.00
30	29	6.8	2.7	9	.027	4.52	174.52	170.00
33	32	4.8	3.3	12	.010	2.11	170.05	167.94
32	29	6.2	4.2	12	.015	2.94	167.94	165.00
29	28	12.0	14.4	15	.050	17.65	164.82	147.17
28	24	14.0	22.0	18	.037	13.21	141.57	128.36
27	26	7.0	4.9	12	.020	7.90	171.05	163.15
26	25	10.0	7.4	12	.050	15.90	163.15	147.25
25	24	12.5	10.9	12	.060	18.60	147.25	128.65
24	22	7.4	27.5	27	.0081	2.21	127.61	125.40
23	22	10.5	5.0	9	.008	16.24	142.00	125.76
22	3	7.8	28.5	27	.009	.85	125.76	124.91
3	2	9.4	53.0	33	.010	3.20	124.41	121.21
2	1	9.8	56.0	33	.011	3.67	121.21	117.54
21	20	5.8	2.3	9	.020	4.14	171.14	167.00
20	19	7.6	3.1	9	.037	11.80	167.00	156.79

Line MH to MH		Vel.	Cap.	Diam Inches	Slope	Fall	Invert Top	Elevation Lower
19	17	8.7	6.2	12	.036	11.48	156.54	145.06
18	17	8.0	3.2	9	.040	10.36	155.36	145.00
17	15	8.9	10.6	15	.027	9.94	144.75	134.81
16	15	7.4	5.8	12	.025	10.07	144.87	134.80
15	14	5.0	11.7	21	.0052	1.94	134.31	132.37
14	13	6.3	14.6	21	.008	3.64	132.37	128.73
13	8	6.5	15.0	21	.0085	3.58	128.73	125.15
12	10	7.0	3.8	9	.030	8.55	146.55	138.00
11	10	5.1	2.1	9	.016	7.26	141.87	138.00
10	9	8.1	9.6	15	.022	5.57	137.50	131.93
9	8	9.6	17.5	18	.0235	6.27	131.68	125.41
8	1	11.2	26.4	21	.027	7.56	125.15	117.59
45	43	7.4	5.2	12	.023	7.98	161.98	154.00
44	43	7.5	3.0	9	.033	6.54	160.54	154.00
43	41	11.0	7.6	12	.050	17.40	153.75	136.35
42	41	9.3	7.4	12	.040	12.68	156.78	144.10
41	37	11.0	21.0	18	.034	9.96	143.60	133.54
40	39	8.3	3.8	9	.050	16.20	160.20	144.00
39	37	7.8	6.1	12	.028	10.05	143.75	133.70
38	37	6.5	2.5	9	.025	7.75	142.75	135.00
37	35	9.8	26.0	24	.014	6.08	133.30	127.22
36	35	5.9	2.3	9	.020	6.56	135.56	129.00
35	1	11.5	27.0	21	.029	14.12	127.22	113.10
1	out	11.3	100.0	42	.013	---	113.10	---

Line MH to MH		Len.	Area		Ground Elev.		Time of Flow Min.to In		Run Off	
			Incre.	Total	Top	Lower	Up.	End Sect.	CFS/A	Tot.
19	17	319	.69	2.61	165.0	153.5	16.3	.6	1.56	4.1
18	17	259	1.62	1.62	165.0	153.5	15.0	.6	1.60	2.6
17	15	368	.96	5.18	153.5	143.1	16.9	.7	1.55	8.1
16	15	403	2.46	2.46	158.3	143.1	15.0	.9	1.60	3.9
15	14	373	1.64	7.64	143.1	140.0	17.6	1.3	1.52	11.7
14	13	454	1.92	9.56	140.0	140.0	18.9	1.2	1.48	14.4
13	8	422	.77	10.34	140.0	143.7	20.1	1.1	1.44	14.9
12	10	285	2.25	2.25	154.3	146.0	15.0	.7	1.60	3.6
11	10	242	1.16	1.16	151.6	146.0	15.0	.6	1.60	1.7
10	9	253	2.22	5.63	146.0	140.6	15.7	.5	1.58	8.9
9.	8	267	1.27	6.90	140.6	143.7	16.2	.5	1.57	10.8
8	1	280	.51	17.74	143.7	128.0	21.2	.4	1.40	24.9
45	43	347	3.15	3.15	170.8	162.3	15.0	.8	1.60	5.0
44	43	198	.71	.71	168.8	162.3	15.0	.5	1.60	1.1
43	41	348	.61	4.47	162.3	152.6	15.8	.6	1.58	7.0
42	41	317	2.99	2.99	167.0	152.6	15.0	.5	1.60	4.8
41	37	293	.83	8.30	152.6	142.0	16.4	.9	1.56	12.9
40	39	324	2.08	2.08	175.2	151.3	15.0	.6	1.60	3.3
39	37	359	1.66	3.74	151.3	142.0	15.6	.8	1.59	6.0
38	37	310	1.23	1.23	150.5	142.0	15.0	.8	1.60	2.0
37	35	434	1.48	14.75	142.0	136.8	17.3	.8	1.53	22.5
36	35	328	.92	.92	143.4	136.8	15.0	1.0	1.60	1.5
35	1	487	.84	16.51	136.8	128.0	18.1	.9	1.51	24.9
1	out	---	---	69.89	128.0	---	21.6	---	1.40	98.0

Line		Len.	Area		Ground Elev.		Time of Flow		Run Off	Tot.
MH to MH			Incre.	Total	Top	Lower	Min. to Up.	In Sect.		
61	59	332	1.83	1.83	180.0	180.1	15.0	1.0	1.60	2.9
60	59	325	1.51	1.51	184.0	180.1	15.0	.9	1.60	2.4
59	48	505	1.61	4.95	180.1	171.5	16.0	1.3	1.57	7.8
49	48	305	1.33	1.33	176.2	171.5	15.0	.9	1.60	2.1
58	57	212	1.79	1.79	188.0	182.7	15.0	.6	1.60	2.4
57	55	259	1.85	3.64	182.7	180.2	15.6	.6	1.59	5.8
56	55	301	2.55	2.55	177.7	180.2	15.0	1.5	1.60	4.1
55	53	307	1.30	7.48	180.2	181.2	16.5	1.0	1.56	11.7
54	53	376	2.71	2.71	186.6	181.2	15.0	.9	1.60	4.3
53	50	465	2.72	12.92	181.2	172.0	17.5	.9	1.53	19.8
52	50	386	2.15	2.15	179.6	172.0	15.0	1.0	1.60	3.4
51	50	336	1.79	1.79	179.8	172.0	15.0	.8	1.60	2.9
50	48	384	1.23	18.09	172.0	171.5	18.4	.8	1.50	27.1
48	out	---	---	24.37	171.5	---	19.2	---	1.47	35.8
72	71	205	2.94	2.94	190.3	189.4	15.0	.9	1.60	4.7
71	70	271	1.61	4.55	189.4	186.3	15.9	.8	1.58	7.2
73	70	414	1.25	1.25	182.5	186.3	15.0	2.3	1.60	2.0
70	68	378	.98	6.78	186.3	181.0	17.3	1.4	1.53	10.4
69	68	212	1.74	1.74	183.0	181.0	15.0	.6	1.60	2.3
68	67	241	1.50	10.02	181.0	177.5	18.7	.6	1.49	14.9
67	64	230	1.24	11.26	177.5	175.4	19.3	.5	1.47	16.6
66	65	298	2.16	2.16	184.7	180.2	15.0	.9	1.60	3.5
65	64	330	1.48	3.65	180.2	175.4	15.9	.9	1.58	5.8
64	63	325	2.26	17.17	175.4	170.7	19.8	.8	1.45	25.9

MH	Line to MH	Vel.	Cap.	Diam. Inches	Slope	Fall	Invert Top	Elevation Lower
61	59	5.8	3.8	12	.0125	4.15	174.00	169.85
60	59	6.2	2.5	9	.022	7.15	177.25	170.10
59	48	6.8	7.9	15	.015	7.68	169.60	162.00
49	48	5.8	2.3	9	.020	6.10	162.10	156.00
58	57	6.6	2.6	9	.025	5.30	180.00	174.70
57	55	7.2	8.5	15	.0170	4.40	174.20	169.80
56	55	3.4	4.3	15	.004	1.20	171.00	169.80
55	53	5.2	12.1	21	.006	1.84	169.30	167.46
54	53	5.8	4.6	12	.015	5.64	179.00	171.36
53	50	8.5	20.4	21	.015	6.98	167.46	160.48
52	50	6.7	5.2	12	.020	7.72	171.72	164.00
51	50	7.2	5.6	12	.023	7.73	171.73	164.00
50	48	7.7	28.2	27	.009	3.46	159.98	156.52
48	out	7.9	37.0	30	.008	---	156.52	---
52	51	3.9	4.8	15	.005	1.03	182.03	181.00
71	70	6.0	7.2	15	.012	3.25	181.00	175.75
73	70	3.0	2.3	12	.0045	1.86	175.50	173.64
70	68	4.5	11.0	21	.0045	1.70	173.64	171.94
69	68	5.8	2.3	9	.020	4.24	176.18	171.94
68	67	7.0	15.2	21	.010	2.41	171.94	169.53
67	64	7.3	17.0	21	.011	2.53	169.53	167.00
66	65	5.8	4.6	12	.015	4.47	176.34	171.87
65	64	6.5	7.7	15	.014	4.62	171.62	167.00
64	63	7.3	26.8	27	.008	2.60	166.50	163.90

Line MH to MH	Len.	Area		Ground Elev.		Time of Flow		Run Off	
		Incre.	Total	Top	Lower	Min. to Up. End	In Sect.	CFS/A	Tot.
63 62	325	1.77	18.93	170.7	170.0	20.6	.7	1.42	27.9
77 76	148	1.07	1.07	178.1	176.3	15.0	.6	1.60	1.7
76 75	310	1.36	2.43	176.3	176.0	15.6	1.3	1.59	3.9
75 74	312	1.30	3.73	176.0	172.0	16.9	1.1	1.55	5.8
74 62	312	.72	4.46	172.0	170.0	18.0	.9	1.51	6.7
62 out	---	---	23.39	170.0	---	21.3	---	1.40	32.7
80 79	365	1.69	1.69	170.0	163.5	15.0	1.0	1.60	2.7
79 78	365	2.12	3.81	163.5	149.2	16.0	.7	1.57	6.0
85 84	223	1.94	1.94	183.7	174.7	15.0	.5	1.60	3.1
84 82	308	2.72	4.66	174.7	153.6	15.5	.5	1.59	7.4
83 82	328	1.74	1.74	167.3	153.6	15.0	.7	1.60	2.7
82 81	151	1.07	7.47	153.6	149.3	16.0	.3	1.57	11.7
81 78	269	1.46	8.92	149.3	149.2	16.3	.8	1.56	13.9
78 86	374	.74	13.4	149.2	142.0	17.1	---	1.54	20.8
93 92	221	1.11	1.11	186.7	186.0	15.0	1.1	1.60	1.7
92 91	266	1.59	2.70	186.0	173.5	16.1	.6	1.57	4.2
91 90	362	2.24	4.94	173.5	153.4	16.7	.6	1.55	7.7
94 90	266	1.43	1.43	186.0	153.4	15.0	.5	1.60	2.3
90 86	237	2.42	8.78	153.4	142.0	17.3	.4	1.53	13.4
89 88	282	.95	.95	164.8	143.8	15.0	.5	1.60	1.6
88 87	305	1.28	2.23	143.8	142.1	15.5	1.7	1.57	3.5
87 86	305	1.28	3.50	142.1	142.0	17.2	1.2	1.52	5.3
86 out	---	---	25.76	142.0	---	18.4	---	1.45	37.3

Line MH to MH		Vel.	Cap.	Diam. Inches	Slope	Fall	Invert Top	Elevation Lower
63	62	8.1	30.0	27	.010	3.25	163.90	160.65
77	76	4.3	1.8	9	.012	1.78	170.80	168.50
76	75	4.0	5.1	15	.006	1.86	168.00	166.14
75	74	4.9	5.8	15	.008	2.50	166.14	163.64
74	62	5.8	6.8	15	.011	3.43	163.64	160.21
62	out	8.8	33.0	27	.012	---	160.21	---
80	79	6.5	4.5	12	.017	6.58	162.00	155.42
79	78	8.5	6.4	12	.038	13.87	155.42	141.55
85	84	7.6	3.4	9	.040	8.92	175.82	166.90
84	82	12.0	9.5	12	.067	20.65	166.65	146.00
83	82	7.7	3.5	9	.042	13.78	159.78	146.00
82	81	10.0	18.5	18	.026	3.93	145.50	141.57
81	78	6.0	14.1	21	.0075	2.02	141.32	139.30
78	86	8.6	25.0	24	.013	4.86	139.05	134.19
93	92	4.3	1.8	9	.012	2.65	180.65	178.00
92	91	9.7	7.6	12	.045	12.00	177.75	165.75
91	90	10.7	8.5	12	.055	19.90	165.75	145.85
94	90	8.5	3.9	9	.051	13.57	159.67	146.10
90	86	11.3	13.7	15	.045	10.67	145.60	134.39
89	88	8.0	3.5	9	.045	12.69	149.10	136.41
88	87	3.1	3.8	15	.0031	.95	135.91	134.96
87	86	4.4	5.5	15	.007	2.14	134.96	132.82
86	out	12.0	39.0	24	.030	---	132.82	---

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