FINAL DRAINAGE REPORT FOR TOWNE PARC ADDITION
11-9-87

EXISTING CONDITIONS

Towne Parc Addition is located south of Pawnee Avenue between Rock and Webb Road, just east of Oak Knoll Addition. The site is more fully described as the north 1/4 of the west 1/2 of the northeast 1/4 of Section 5, Twp. 28-S, R-2-E, Sedgwick County, Kansas. The site, which is currently being used for farming, will be platted into single family lots. Towne Parc Addition lies in the north quarter of an 80 acre tract of land which will be fully developed in the future. This 80 acre tract currently drains from a high point near the center in all directions (See Map 1). Type "D" soil covers the entire site.

METHOD OF ANALYSIS

The rational formula is used to calculate runoff amounts for all sub-basin areas. For 1/6 acre lots and "D" soil for the entire site, runoff factors of 0.53 and 0.78 are used for the 2 year and the 100 year storms respectively. Drainage basins for the entire Towne Parc Addition as well as future platting to the south can be found on Map 1. The storm water sewer system for Towne Parc Addition is designed to accept runoff from the currently unplatted tract to the south in the fully developed condition as indicated on Map 1.

A summary of the system inlet capacities and bypass amounts for the 2 year storm can be found on Map 1. Pages 1 through 7a on the attached worksheets contain supporting calculations for all of the 2 year storm design. Pages 7b through 13 contain design checks for the 100 year storm. Pages 14 to 16 provide system checks for the storm water system as submitted.

Hydraulic grade line elevations were obtained using the Civilsoft "STORM" program.

SUMMARY OF RESULTS

The drainage system for Towne Parc Addition was designed in accordance with current City of Wichita standards. The system contains the 2 year storm within the curb, and the 100 year storm within the street right-of-way. Bypass amounts to Pawnee Avenue are limited to provide collector standards for future paving.

The transition from 30 inch R.C.P. to H.E.R.C.P. between station 1+55 and 2+01.8 is necessary to provide proper clearance between the storm sewer pipe and a 6 inch Conoco Gas Pipeline. Conoco requires four feet of clearance between the bottom of pavement and 1 foot clearance between any other underground utilities. The use of H.E.R.C.P. to clear the Gas Line allowed proper clearances while retaining an adequate grade for the storm sewer.

The use of reinforced concrete pipe on this project is necessary to achieve adequate sytem capacity. A computer run on the design system using C.M.P. is attached. The use of C.M.P. causes a much higher hydraulic grade line which does not meet the City of Wichita requirements for the 2 year storm.

Analysis of the storm water sewer system yields the following results for the design storm and the 100 year storm:

2 YEAR STORM:

Total Inlet capacity for the 2 year storm = 36.9 cfs.

Total system capacity = 36.9 cfs at a maximum hydraulic grade line located 6 inches below the flow line of the gutter at each inlet location.

Total system bypass to Pawnee Avenue during the 2 year storm = 4.5 cubic feet per second.

100 YEAR STORM:

Total available inlet capacity for the 100 year storm = 66.8 cfs

Total system capacity = 49.2 cfs at a maximum hydraulic grade line located at the right-of-way elevation at each inlet location.

Total system bypass to Pawnee Avenue during the 100 year storm = 74 cubic feet per second.

Maximum street capacity on the north end of Linden at right-of-way elevation = 111.2 cfs.

For complete storm water sewer performance results for the 2 year and the 100 year storms, see the attached Civilsoft "STORM" Program data sheets.

Drainage Calculations for Towne Park Addn. 9-1-87 CB

NW Quadrant

Area 1 = 5.85 Ac
Type D soil for all
1/6 Ac Lots
$C_2 = 0.53$ $C_{100} = 0.78$
15 min tc; $i_2 = 3.83$; $i_{100} = 7.37$
For All Drainage Areas

Two Year Storm Inlet Cap's.

Area 1 = 5.85 Ac
$Q_2 = 11.9$ cfs (West of Inlets)

Area 2 = 6.69 Ac
$Q_2 = 14.0$ cfs (South of Inlets)
Inlet Top = 206.7, overspill North @
Crown Elev = 206.66, Pond Depth = 0.51'

Double Inlet @ 0.51' depth, sump cond.
From Fig 1, Single Inlet Cap = 4.0 cfs
For Double Inlet Use 8 cfs

$Q_2 = 14.0$ cfs − 8 cfs Inlet = 6 cfs Byp. N.

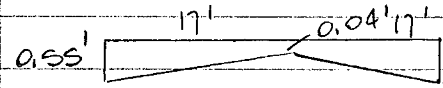
Assume 1/2 goes to Inlets on Either side (North) = 3 each

Inlet on Area 1; $Q_2 = 11.9$ cfs + Byp = 3
$Q_{inlet} = 14.9$ cfs

②

Inlet slope = 1% going North 9-1-87

@ 1% slope, street will hold:



A = 10.03 ft^2 WP = 35.10 R = 0.286

$V = \frac{1.48}{0.013} R^{2/3} S^{1/2} = 113.85(0.286)^{0.67}(0.01)^{1/2} = 4.9$ ft/sec

Q = VA = 10.03(4.9) = 49.4 cfs O.K.

Find Approach width of water

@ 0.4' ; T = 12.8' A = 2.56 R = 0.194

V = 3.79 f/s ; Q = 9.71 – (more)

@ 0.45 ; T = 14.4' A = 3.24 R = 0.218

V = 4.10 f/s ; Q = 13.3

Use depth @ 0.5' ; T = 16' ; A = 4.0 R = 0.242

V = 4.4 f/s ; Q = 17.62

$Q_{Approach}$ = 14.9 cfs – use T = 16'

To Chart # 4 ; W/T = 2/16 = 0.125

S_x = 0.0313 3/8 , S_w = 0.1146 , S_w/S_x = 3.7 – use 4

E_o = 0.37 ; To Chart 9 ; n = 0.016

Slope = 0.01 ; $S_e = S_x + S'_w E_o$ = 0.0313 + 0.0833(0.37)

S_e = 0.06 , Q = 14.9 ; L_T = 31 feet

To Chart 10 ; L/L_T = 5+1/31 = 0.19

Eff = 0.31 ; Q_{int} = 0.31(14.9) = 4.6 cfs

Inlet 3

A_3 = 0.56 Ac Q_2 = 1.1 + Byp = 3 ; Q_{ADD} = 4.1

For flows in curb, I will now use Neenah Flow Rate Calculator.

Input = trans slope, depth, long. slope, n = 0.016

Inlet 3 (cont.) 9-1-87

@ 4.1 cfs approach

Z= inv of trans. slope = 0.0313

@ Depth = 0.3 ; Q = 4.4 cfs — use this

T = 9.6' , To Chart 4 ; $W/T = 2/9.6 = 0.21$

$E_o = 0.59$; C#9 → $S_e = 0.0313 + 0.0833(0.59)$

$S_e = 0.08$; $L_T = 15'$; C10 → $L/L_T = 5+1/15$

= 0.4 ; Eff = 0.6

$Q_{int} = 0.6(4.1) = 2.5$ cfs ; B = 1.6 cfs

~~Inlet #4~~

~~$A_4 = 1.96$ Ac ; $Q_2 = 4.0$ cfs~~

~~+ Bypass South = 10.3 cfs + East = 0.4~~

~~$Q_A = 14.7$ cfs~~

~~slope = 1%~~

~~@ Q = 10.3 ; depth = 0.47' @ 1% slope~~

~~T = 15.0'~~

~~C#4 ; $W/T = 2/15 = 0.13$~~

~~$E_o = 0.39$; $S_e = 0.0313 + 0.0833(0.39) = 0.06$~~

~~C#9 → $L_T = 30'$; $L/L_T = 6/30 = 0.12$~~

~~C#10 → Eff = 0.33~~

~~$Q_i = 0.33(14.7) = 4.9$; $Q_B = 9.8$ cfs~~

revised

revised

Inlet #4

$Q_{4A} = 0.56$ Ac ; $Q_2 = 1.1$ cfs

+ Byp = 1.6

$Q_A = 2.7$ cfs ; slope = 1%

Depth = 0.25' , T = 8'

C#4 : $L/L_T = 2/8 = 0.25$; $E_o = 0.4$

$S_e = 0.0313 + 0.0833(0.4) = 0.06$

To Chart #9 → $L_T = 15'$

Inlet 4 (con't) 9-1-87

C10 → L/L_T = 6/15 = 0.4, Eff = 0.6,
Q_{int} = 0.6 (2.7) = 1.6 cfs ; B = 1.1 cfs

Inlet #5

A_5 = 0.41 Ac = Q_2 = 0.8 cfs
+ Bypass = 10.3 cfs + 1.1 cfs
Q_A = 12.2 cfs ; slope = 1.2
Depth = 0.44' ; T = 14.1 ft
C4 ⇒ W/T = 2/14.1 = 0.14
E_o = 0.41 S_e = 0.0313 + 0.0833 (0.41) = 0.07
C9 ⇒ L_T = 25' ; L/L_T = 6/25 = 0.24
Chart 10 ⇒ Eff = 0.38
Q_i = 0.38 (12.2) = 4.6 ; B = 7.6 cfs

Inlet #6

A_6 = 1.55 Ac = Q_2 = 3.1 cfs
+ Bypass = 7.6
Q_A = 10.7 cfs ; slope = 1.42
Depth = 0.39' ; T = 12.5 ft
C4 = W/T = 2/12.5 = 0.16 ; E_o = 0.46
S_e = 0.0313 + 0.46 (0.0833) = 0.07
Chart 9 ; Q_A = 10.7 ; L_T = 26' ;
To Chart 10, L/L_T = 6/26 = 0.23
Eff = 0.36 ; Q_i = 0.36 (10.7) = 3.9 cfs
Q_{Byp} = 6.8 cfs

Inlet #7

A_7 = 1.1 Ac ; Q_2 = 2.2 cfs ; No Bypass
Depth @ slope = 1.42 = 0.21' ; T = 6.7'
C#4 → W/T = 2/6.7 = 0.3 ; E_o = 0.76
S_e = 0.0313 + 0.76 (0.0833) = 0.09
C#9 → L_T = 11' ; L/L_T = 6/11 = 0.55 →

Inlet #7 (con't) 9-1-87

Eff = 0.76 ; Q_i = 0.76(2.2) = 1.7 cfs

Q_B = 0.5 cfs

Inlet #8

A_8 = 1.51 Ac , Q_2 = 3.1 cfs

+B = 6.8

Q_A = 9.9 cfs ; slope = 0.09

Depth = 0.4' ; T = 12.8'

C#4 → W/T = 2/12.8 = 0.16

E_0 = 0.46 ; S_e = 0.0313 + 0.46(0.0833) = 0.07

C#9 → L_T = 23' ; L/L_T = 6/23 = 0.26

C#10 → Eff = 0.41

Q_i = 0.41(9.9) = 4.1 cfs ; B = 5.8

{ [Double Inlet] L/L_T = 11/23 = 0.48 ; Eff = 0.69
Q_i = 0.69(9.9) = 6.8 cfs B = 3.1 }

Inlet #9

A_9 = 3.01 Ac , Q_2 = 6.1 cfs

+B = 0.5

Q_A = 6.6 cfs slope = 0.92

Depth = 0.35' ; T = 11.2 ; W/T = 2/11.2 = 0.18

C#4 → E_0 = 0.52

S_e = 0.0313 + 0.0833(0.52) = 0.07

Chart #9: → L_T = 19' ; L/L_T = 6/19 = 0.32

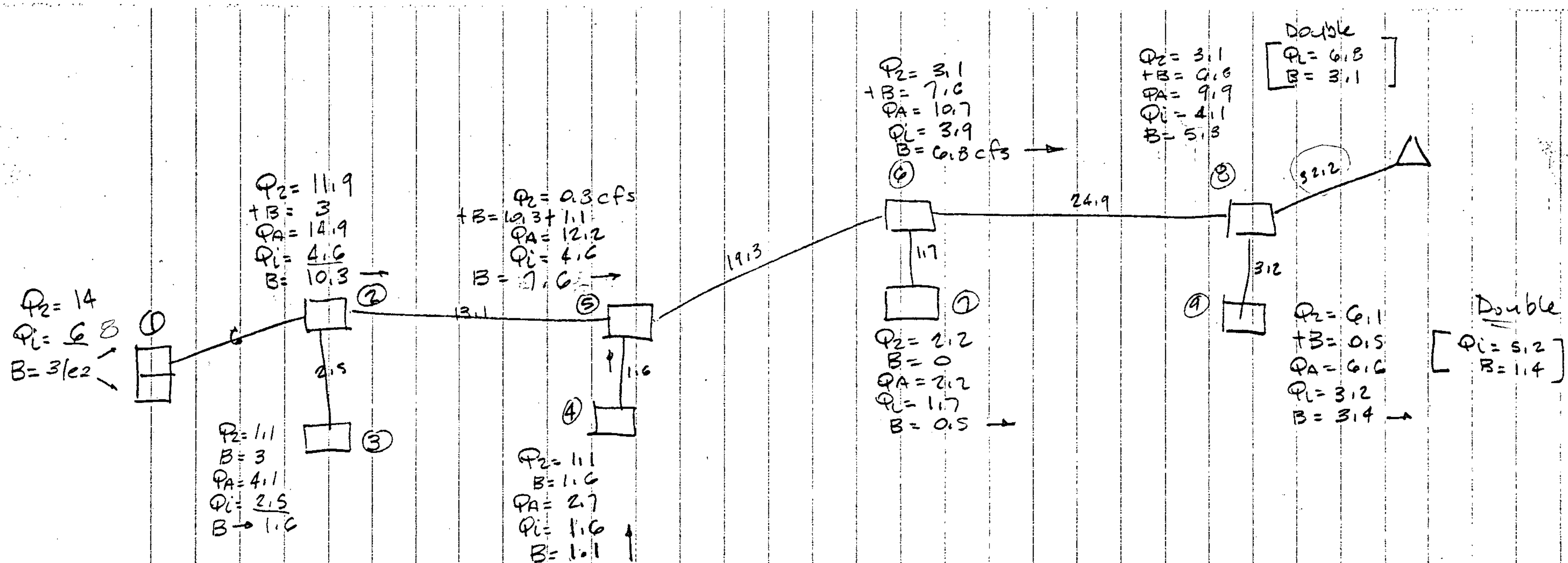
Chart #10: Eff = 0.49

Q_i = 0.49(6.6) = 3.2 cfs

B = 3.4 cfs

{ Double ; L/L_T = 11/19 = 0.58
Eff = 0.79 Q_i = (0.79)(6.6) = 5.2
B = 1.4 cfs }

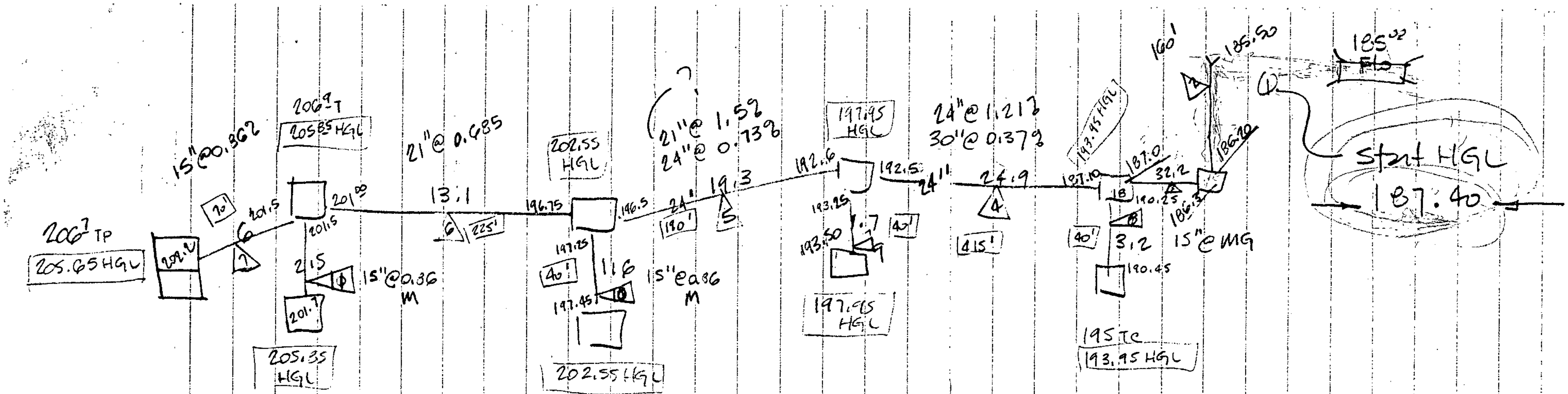
9-1-87



SAVE

2 year

Northwest Quadrant Inlet Capacity



SMALLER SYSTEM

TNP1.DAT — 2 YEAR
.OUT

TNP2.DAT — 100 YEAR
.OUT

With this system
use Start HGL
@ Crit depth
@ Max Inlet Cap

2.5' pipe w/ 32.2 cfs ± 1.9'
(Pg 202, Conc. Pipe Dsg. Book)

USE OTHER SYSTEM
(TRIAL #1)

(2)A

7B

100 year storm Inlet Caps. 9-2-67

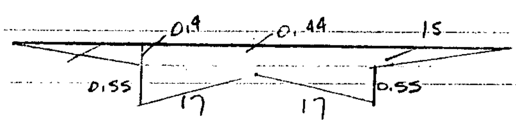
Area #1 = Inlet #1

Inlet In sump Condition
A_2 = 6.89 Ac i_{100} = 7.37 C_{100} = 0.78
Q_{100} = 39.6 cfs to Inlet #1
Overspill @ same Elevation, Inlet Cap.
same as 2 year = 8 cfs
Q_i = 8 cfs
B = 31.6 cfs North, assume 15.8 Both sides.

Inlet #2

Area #1 ; 5.85 Ac , Q_{100} = 33.6 cfs
+B = 15.8 = 49.2 cfs

Check R/W Cap @ 0.4' above T.C.



$A = 0.4(15) + 2\left(\frac{0.95+0.94}{2}\right)17 = 17.82\ ft^2$
WP = 35.1 , R = 0.508
$V = 1.48/0.016\,(0.508)^{0.67}(0.01)^{1/2} = 5.87$ f/s
Q = VA = 104.67 cfs Cap. **O.K.**

With this much water approaching, assume approach spread = 17' (1/2 street width)

C4: W/T = 2/17 = 0.11 ; S_w/S_x = 3.7 – use 4
E_o = 0.33 ; S_e = 0.0313 + 0.33(0.0333) = 0.06
C9 → L_T = 50 ; L/L_T = 6/50 = 0.12 ; C10 →
Eff = 0.2 ; Q_i = 0.2(49.2) = 9.8 , B = 39.4

Inlet # 3

9-2-87

A_3 = 0.56 AC ; Q_{100} = 3.2 cfs
+B = 15.8
QA = 19.0 cfs ; Depth = 0.55 , T = 17
Se = 0.06 (as Before)
C9 ⇒ L_T = 34' ; L/L_T = 6/34 = 0.18
C10 → Eff = 0.29 , Q_i = 0.29(19) = 5.5 cfs
B = 13.5

Inlet # 4

A_4 = 0.56 Ac ; Q_{100} = 3.2 cfs
+B = 13.5
QA = 16.7 cfs
Depth @ 1% slope = 0.49' , T = 15.7'
C#4 ; W/T = 2/15.7 = 0.13 ; E_o = 0.39
Se = 0.0313 + 0.0833(0.39) = 0.06
C#9 → L_T = 32' ; L/L_T = 6/32 = 0.19
C#10 → Eff = 0.32 ; Q_i = 0.32(16.7) = 5.3
B = 11.4 cfs

Inlet # 5

A_5 = 0.41 Ac ; Q_{100} = 2.4 cfs
+B = 39.4
QA = 41.8 cfs
Use T = 17' ; Se = 0.06
C#9 → L_T = 47' ; L/L_T = 6/47 = 0.13 ; C10 →
Eff = 0.22 ; Q_i = 0.22(41.8) = 9.2 cfs
B = 32.6

Inlet #6

$A_6 = 1.155$ Ac ; $Q_{100} = 8.9$ cfs
+B = 32.6 + 11.4
$Q_A = 52.9$ cfs
Use T = 17' @ slope = 1.4%
$S_e = 0.0625$ before @ 17' spread
Chart #9 → $L_T = 55'$
$L/L_T = 6/51 = 0.11$; C10 → Eff = 0.18
$Q_i = 0.2(52.9) = 9.5$ cfs
B = 43.4 cfs

Inlet #7

$A_7 = 1.10$ Ac ; $Q_{100} = 6.3$ cfs
+B = 0
$Q_A = 6.3$ cfs
Depth @ 1.4% Slope = 0.32'
T = 10.2' ; $W/T = 2/10.2 = 0.20$ C4 → $E_0 = 0.56$
$S_e = 0.0313 + 0.56(0.0833) = 0.08$
C#9 ; $L_T = 18.5'$; C10 → $L/L_T = 6/18.5 = 0.32$
Eff = 0.5 ; $Q_i = 3.2$, B = 3.1

Inlet #8

$A_8 = 1.51$ Ac ; $Q_{100} = 8.7$ cfs
+B = 43.4
$Q_A = 52.1$ cfs
Use T = 17 ; Se = 0.06 ; slope = 0.09%
C9 → $L_T = 50'$ $L/L_T = 6/50 = 0.12$,
C10 → Eff = 0.2
$Q_i = 10.4$ cfs , $Q_B = 41.7$ cfs

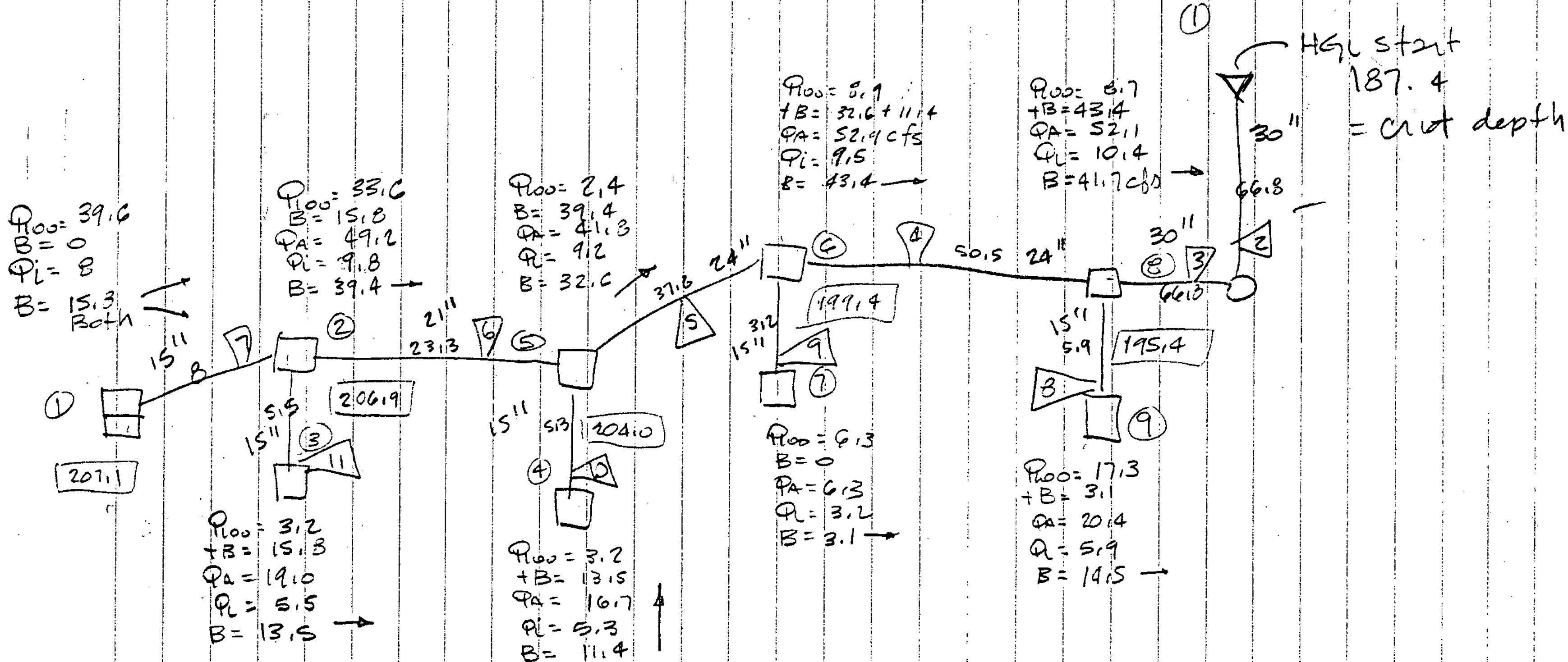
9-2-87

Inlet #9:

A_9 = 3.01 Ac ; Q_{100} = 17.3
+B = 3.1
Q_A = 20.4 cfs Slope = 0.092
Depth @ slope = Above T.C. ; use 17' spread
S_c = 0.06
Chart #9; L_T = 34' ; L/L_T = 6/34 = 0.18
Chart #10; Eff = 0.29
Q_i = 0.29(20.4) = 5.9 cfs ; B = 14.5

Total 100 year Bypass to Pawnee (Inlet Cap)
= 56.2 ; Easily Retained in R/W

Run Config to determine pipe
Capacity (66")



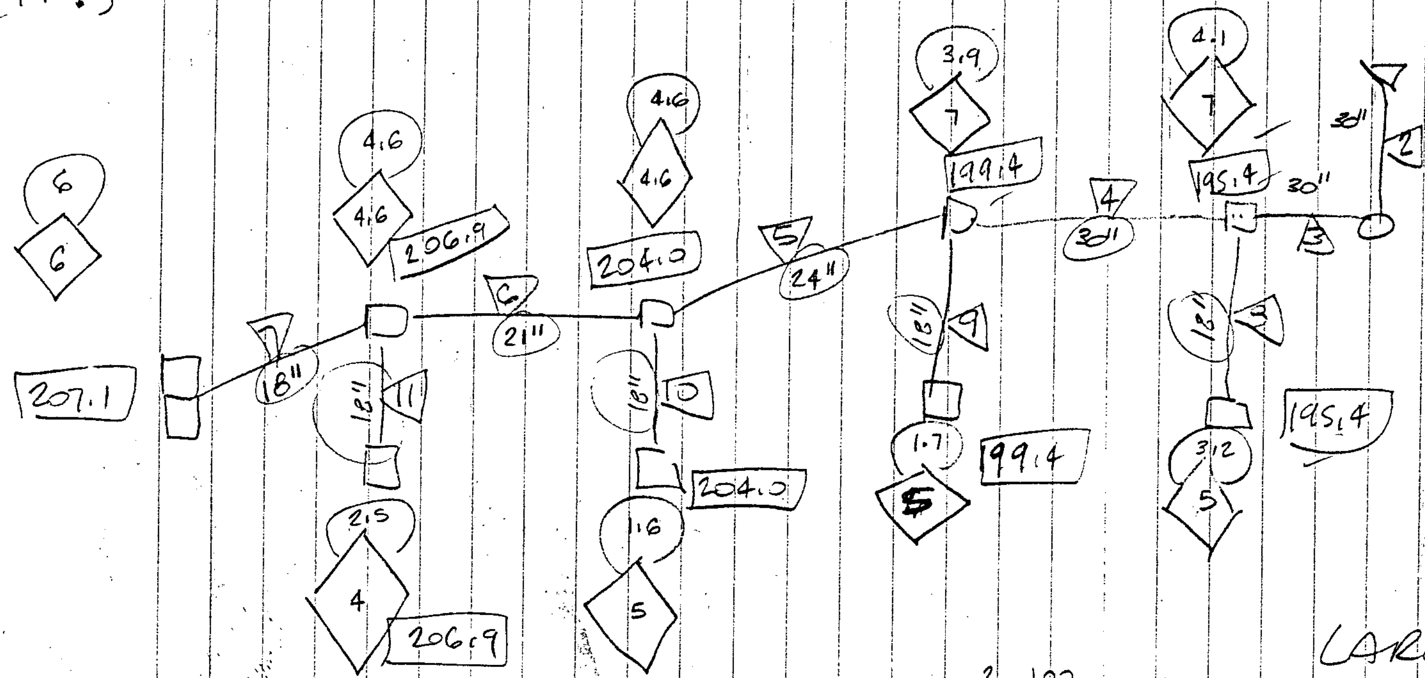
Total Inlet 100 year
Bypass = 41.7 + 14.5 = 56.2

TWNPACZ.DAT
TWNPACZ.OUT
SAVE!

SAVE

(11)

{TP2} {TP1} Both Work



2 year = {TP1.DAT {TP1.OUT

LARGER PIPE SYSTEM

TRIAL #2

	2	100
A	32.2	49.6
B	24.9	37.2
C	19.3	24.2
D	13.1	14.6
E	.6	6
F	3.2	5
G	1.7	7
H	1.6	5
I	2.5	4

Inlet Amt

2yr

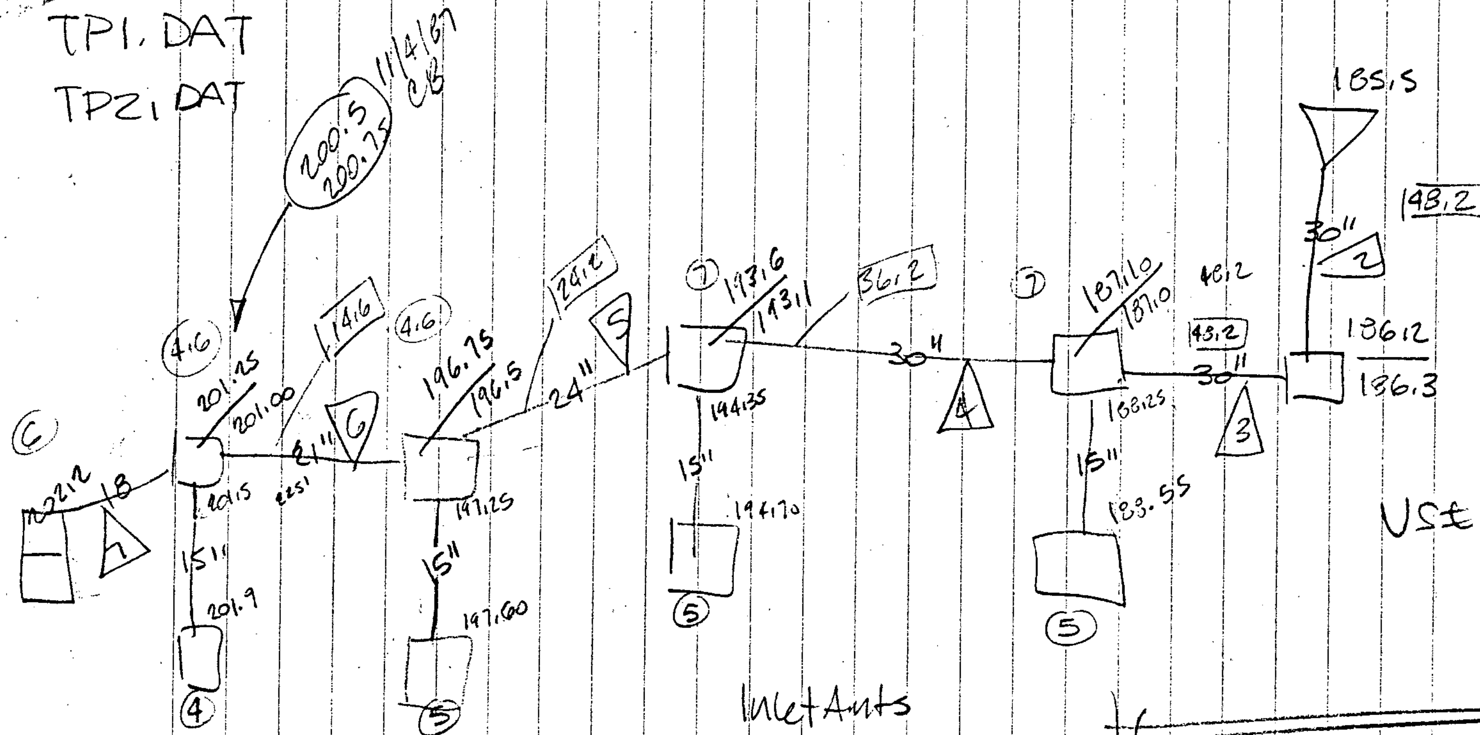
100yr

2 year Bypass = 9.2 cfs

100 year Bypass = 123.2 − 49.2 = 74.0 cfs

To Pawnee

TP1. DAT
TP21 DAT



USE THIS CONFIG

Inlet Ants

32.2	48.2
32.2	48.2
24.9	36.2
19.3	24.2
13.1	14.6
6	6
3.2	5
1.7	5
1.6	5
2.5	4

24R

USE THIS

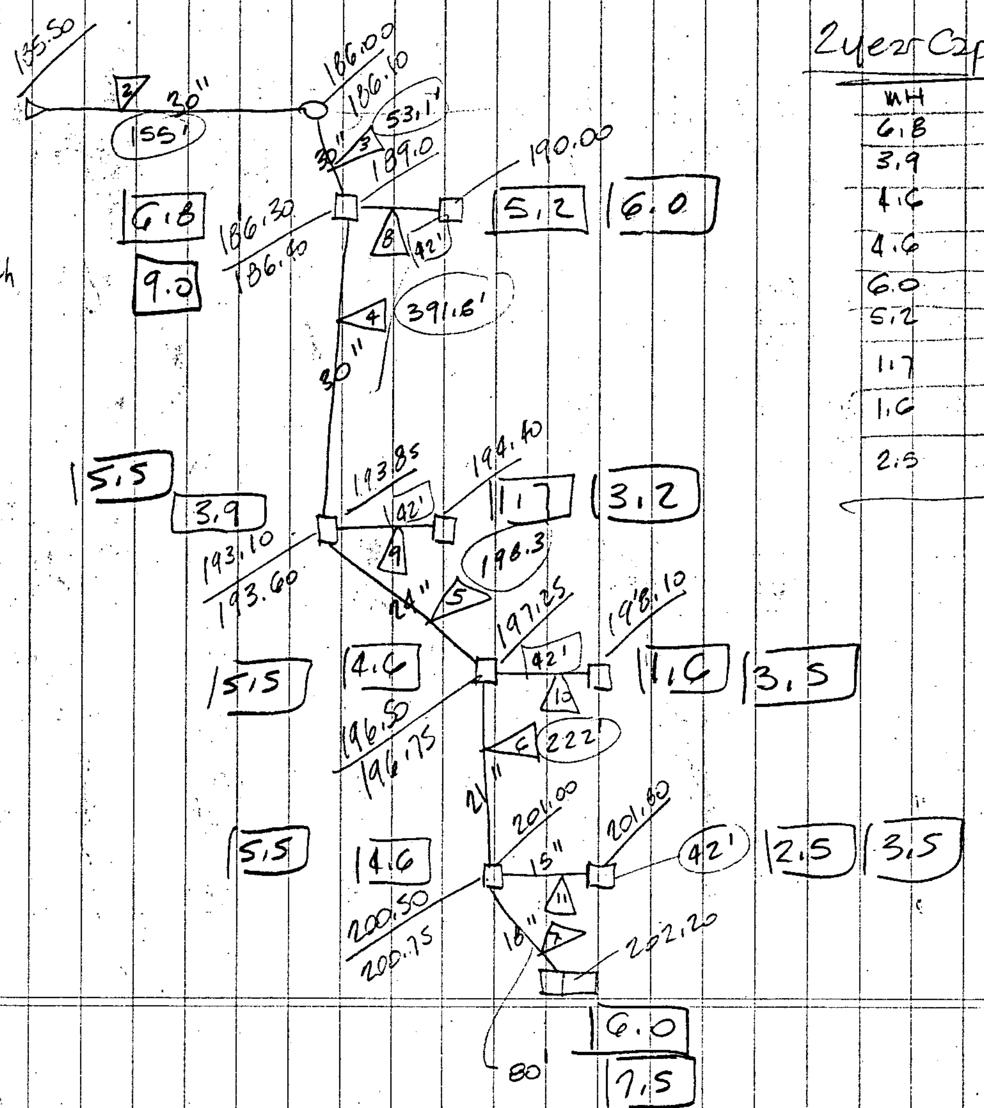
(13)

RESULTS

Inlet	Intercept	T.C	ALL. 2YR HGL	CALC 2YR HGL	ALL 100YR HGL	CALC 100YR HGL
1	6	206.7	205.65	203.76	207.1	206.12
2	4.6	206.9	205.85	203.54	206.9	205.89
3	2.5	206.9	205.85	202.99	206.9	205.46
4	1.6	203.6	202.55	198.64	204.0	202.34
5	4.6	203.6	202.55	199.16	204.0	202.81
6	3.9	199.0	197.95	195.64	199.4	199.20
7	1.7	199.0	197.95	195.22	199.4	199.13
8	4.1	195.0	193.95	190.71	195.4	194.88
9	3.2	195.0	193.95	190.53	195.4	194.44

See Computer Runs for Complete HGL Information.

11/5/07
System Calcs
@ Drum



187.40 start HGL (crit. depth @ Flow for 30")

2year Cap	2year		TC	HGL All	Calc HGL
MH	2	36.9	194.60	194.80	
6.8	3	36.9	195.57	194.52	191.68
3.9	4	24.9	199.58	198.53	195.76
4.6	5	19.3	202.47	201.42	199.21
4.6	6	13.1	206.9	205.85	203.04
6.0	7	6.0	206.7	205.65	203.14
5.2	8	5.2	195.58	194.53	191.65
1.7	9	1.7	199.58	196.53	195.28
1.6	10	1.6	202.47	201.42	196.60
2.5	11	2.5	206.9	205.85	202.43

All OK

11/9/07 Revised T.C. All OK

Need Angles to Run on CIVILSOFT

11/5/87
OB

(16)

100 year information

TC+0.3

	Inlet 100 yr Cap		Actual Inlet	Q	T.C.	HGL All	Calc HGL	
	MH	2	- -	45 44.2	194.80	195.10		
4-8-3	10.4 (sing)	3	8 9	45 44.2	195.57	195.67	95.23	193.74
5-9-4	9.5	4	5 5.5	34 34.2	199.58	199.88	98.96	76.75
6-10-5	9.2	5	5 5.5	28 25.5	202.47	202.77	02.90	98.50
7-11-6	9.8	6	5 5.5	18 16.5	206.9	207.2	6.70	03.33
	8	7	7 7.5	7.5	206.7	207.0	7.11	203.65
	5.9 (single)	8	6 6	6	195.58	195.88	96.73	93.50
	3.2	9	3 3.2	3 3.2	199.58	199.88	98.68	96.65
	5.3	10	3 3.5	3 3.5	202.47	202.77	202.40	98.79
	5.5	11	3 3.5	3 3.5	206.9	207.2	206.21	02.60

O.K.

Checked
11/9/87
OB

11/5/87

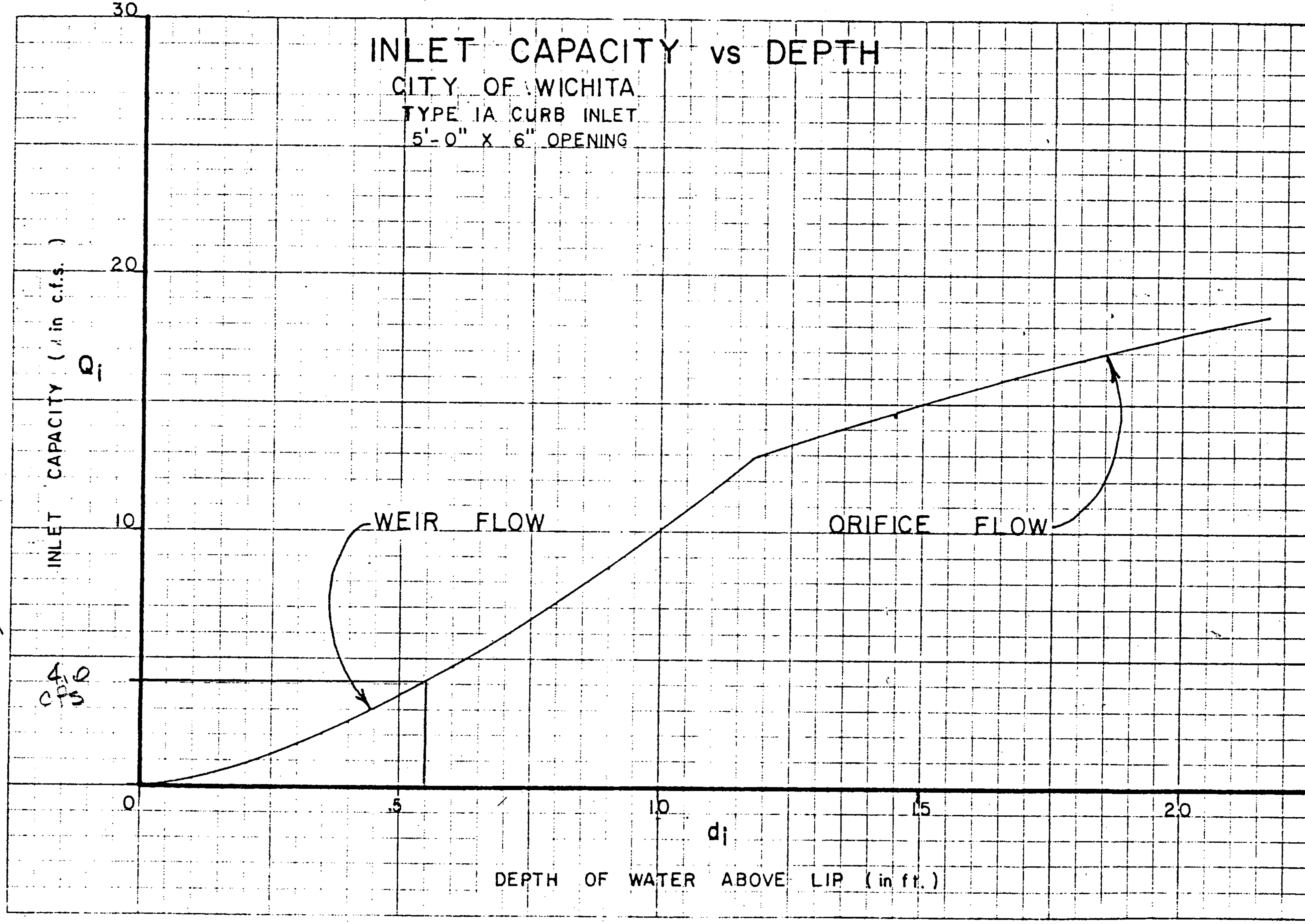


Fig 1

FIG. 1 (24)

(17)

(18)

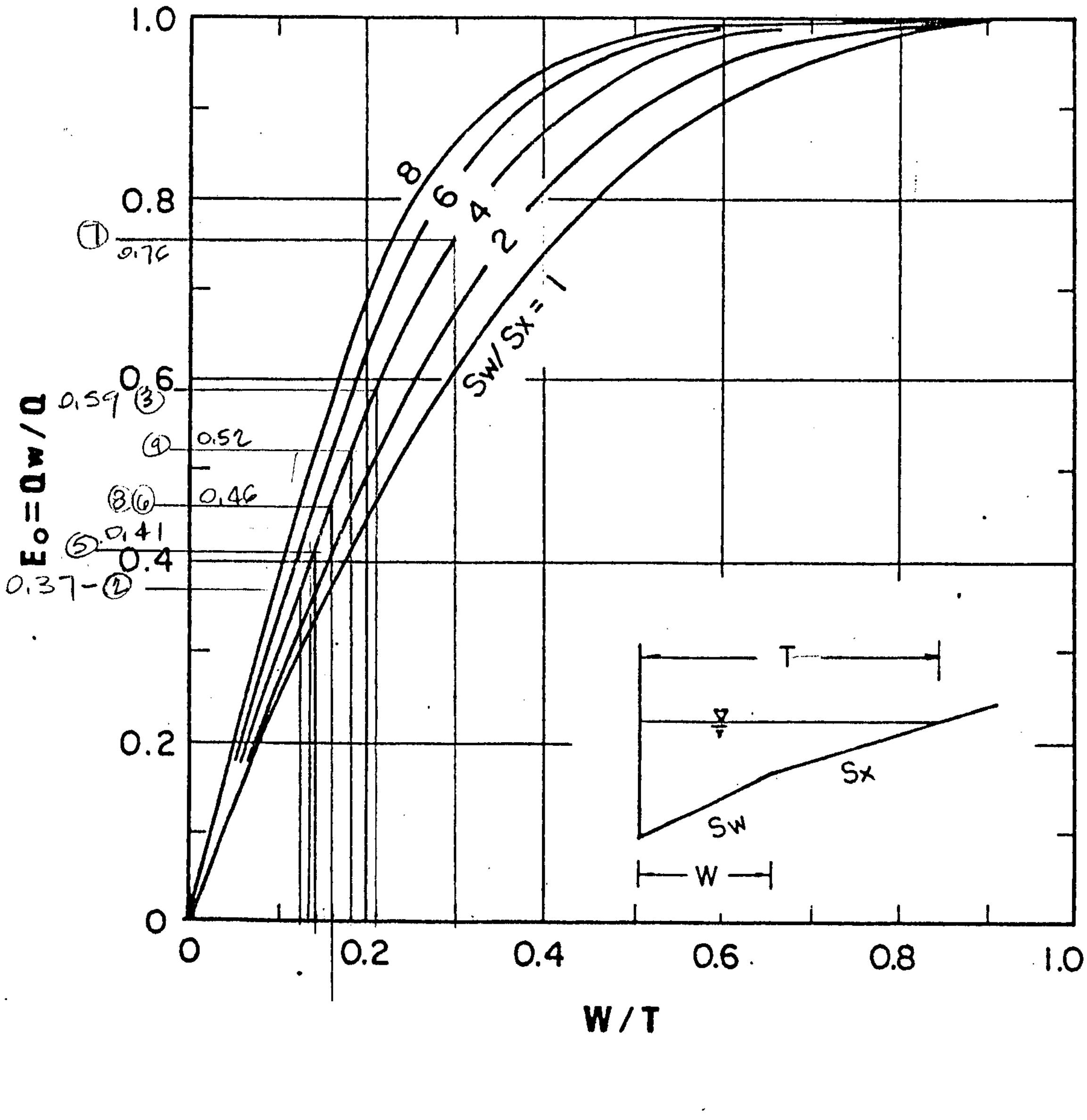


CHART 4. Ratio of frontal flow to total gutter flow.

FIG 2 (2yr)

(19)

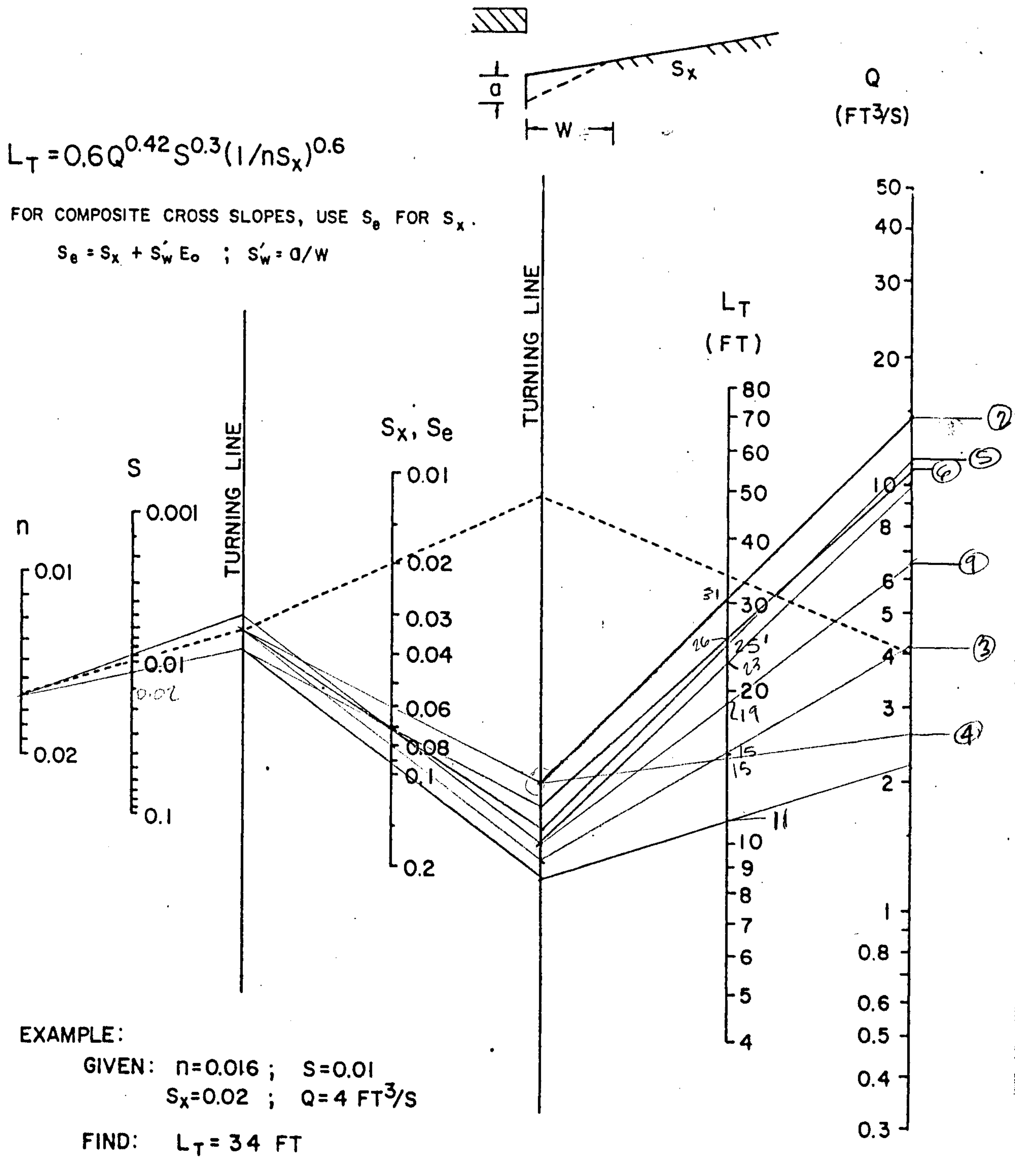
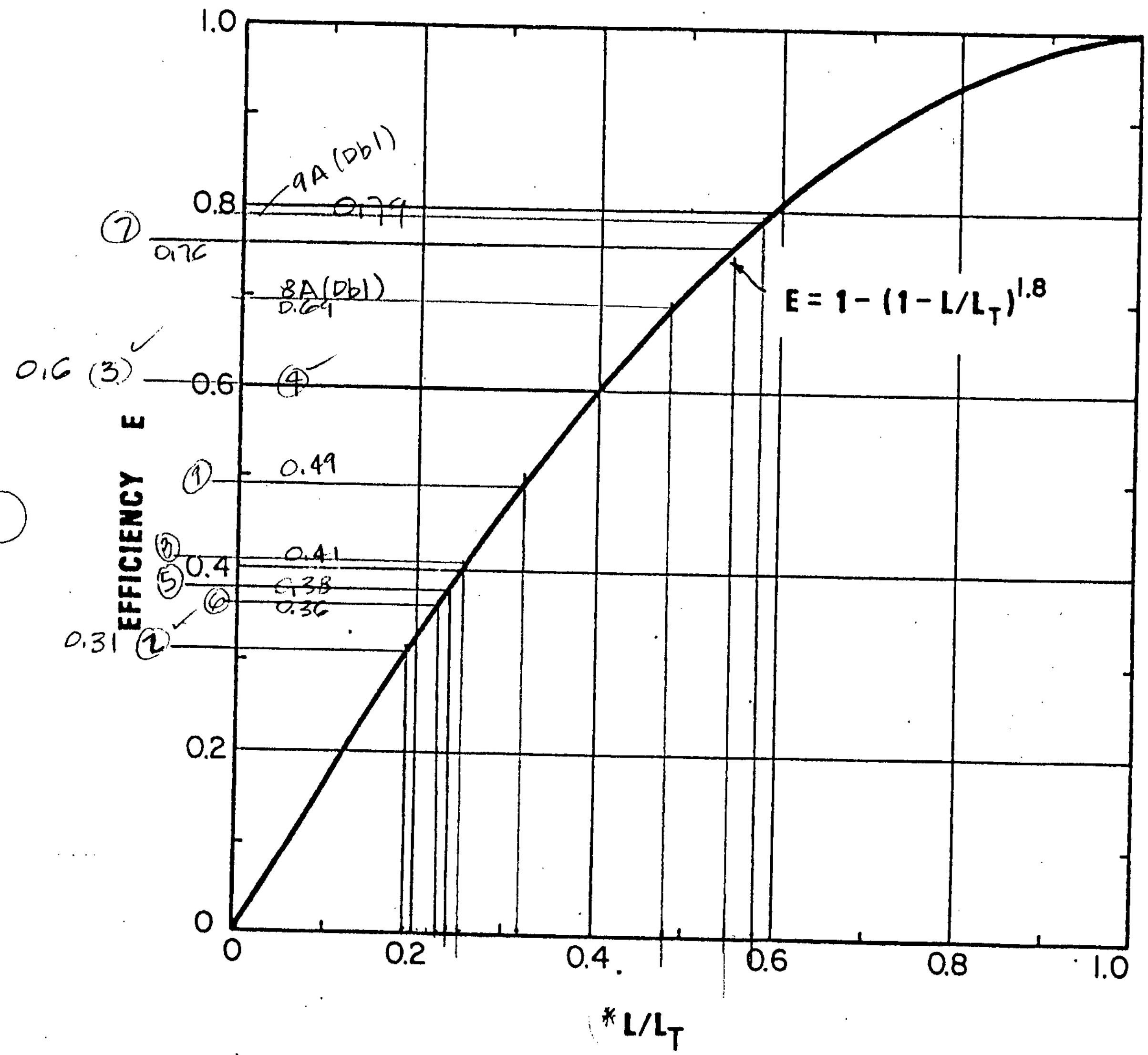


CHART 9. Curb–opening and slotted drain inlet length for total interception.

FIG 3 (245)

(20)



*For type 1A Inlets use $\frac{L+1}{L_T}$

CHART 10. Curb–opening and slotted drain inlet interception efficiency.

FIG 4 (2 41)

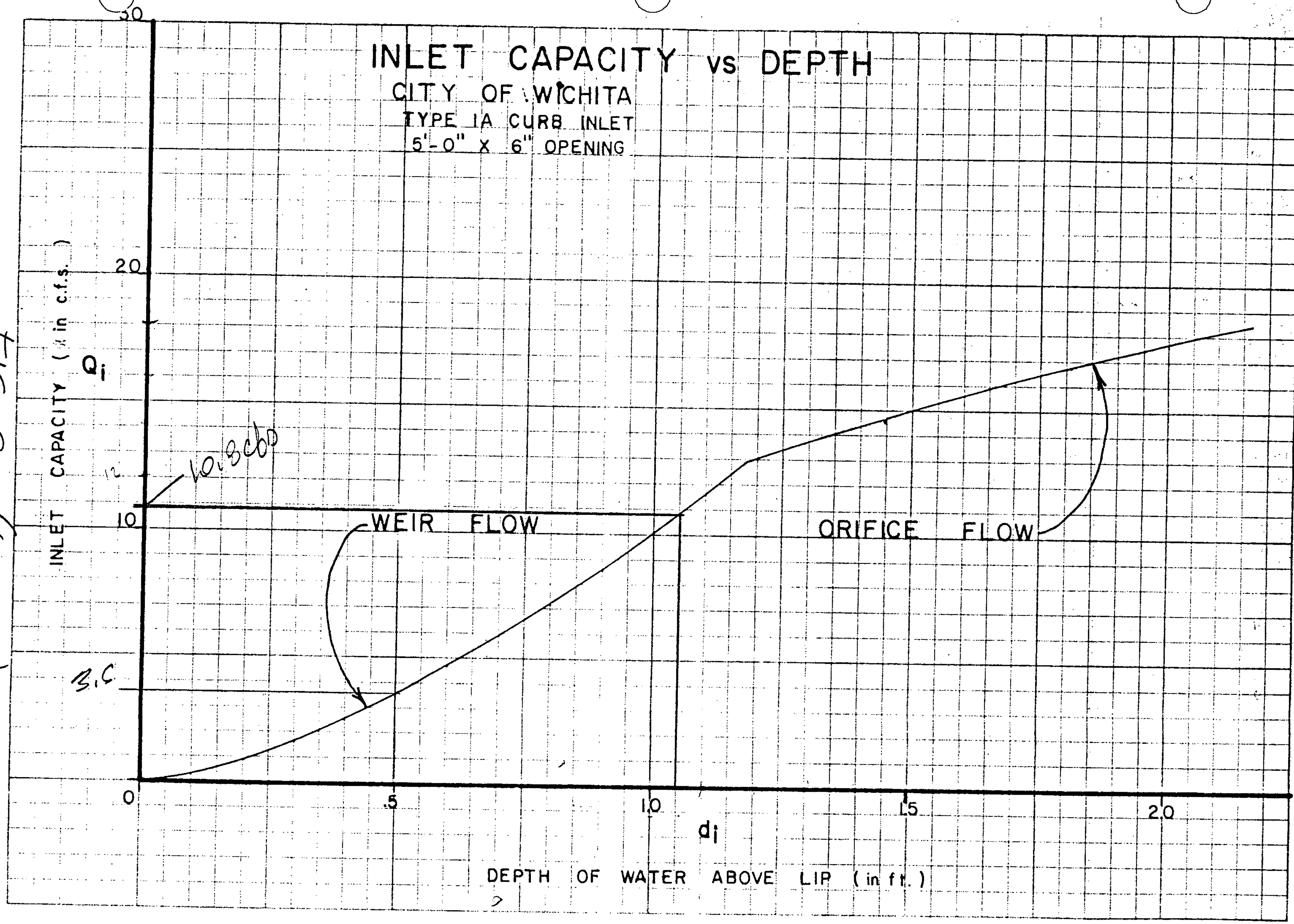


FIG 5 (100 yr)

(21)

(22)

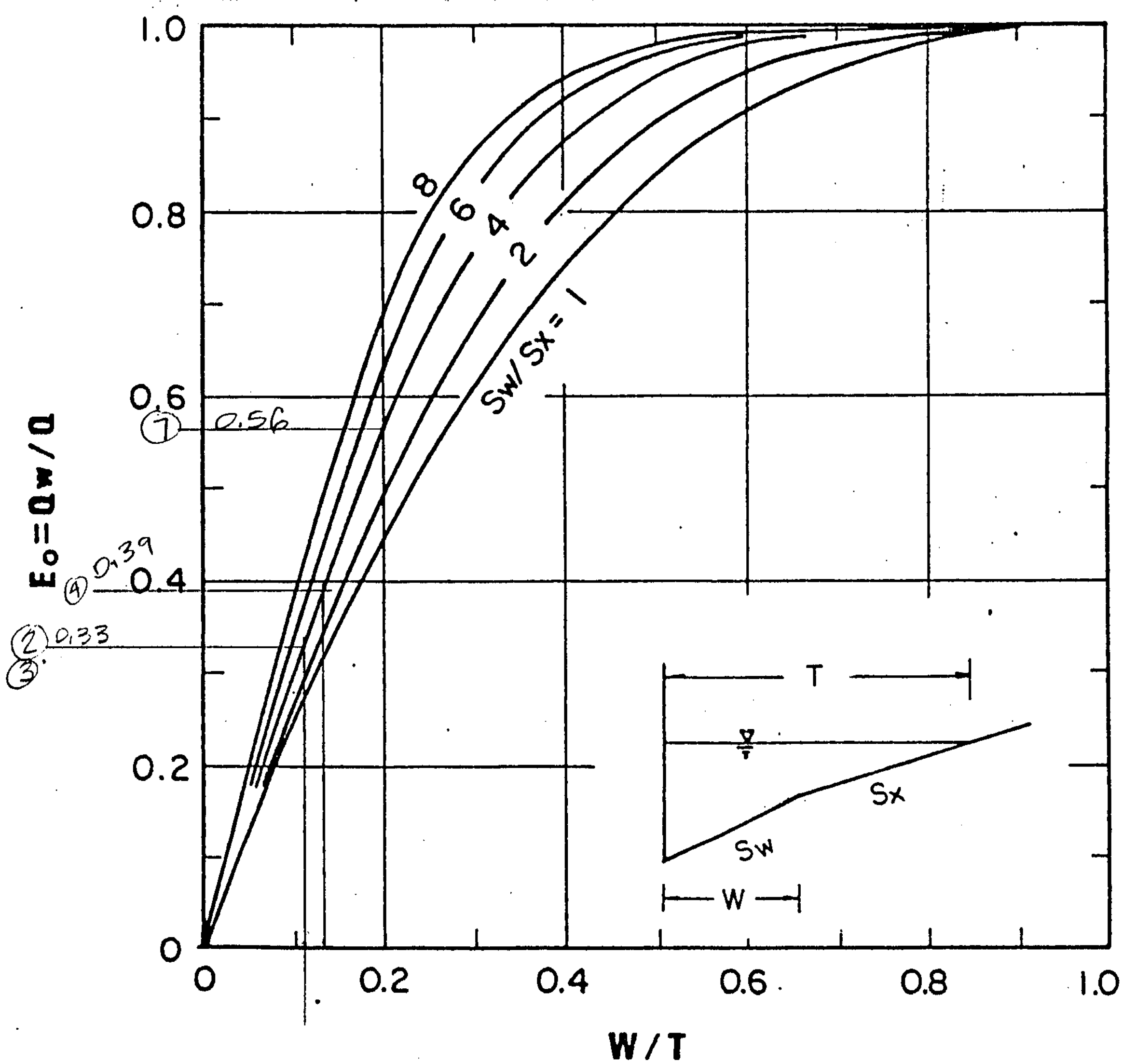


CHART 4. Ratio of frontal flow to total gutter flow.

FIG 6 (100YR)

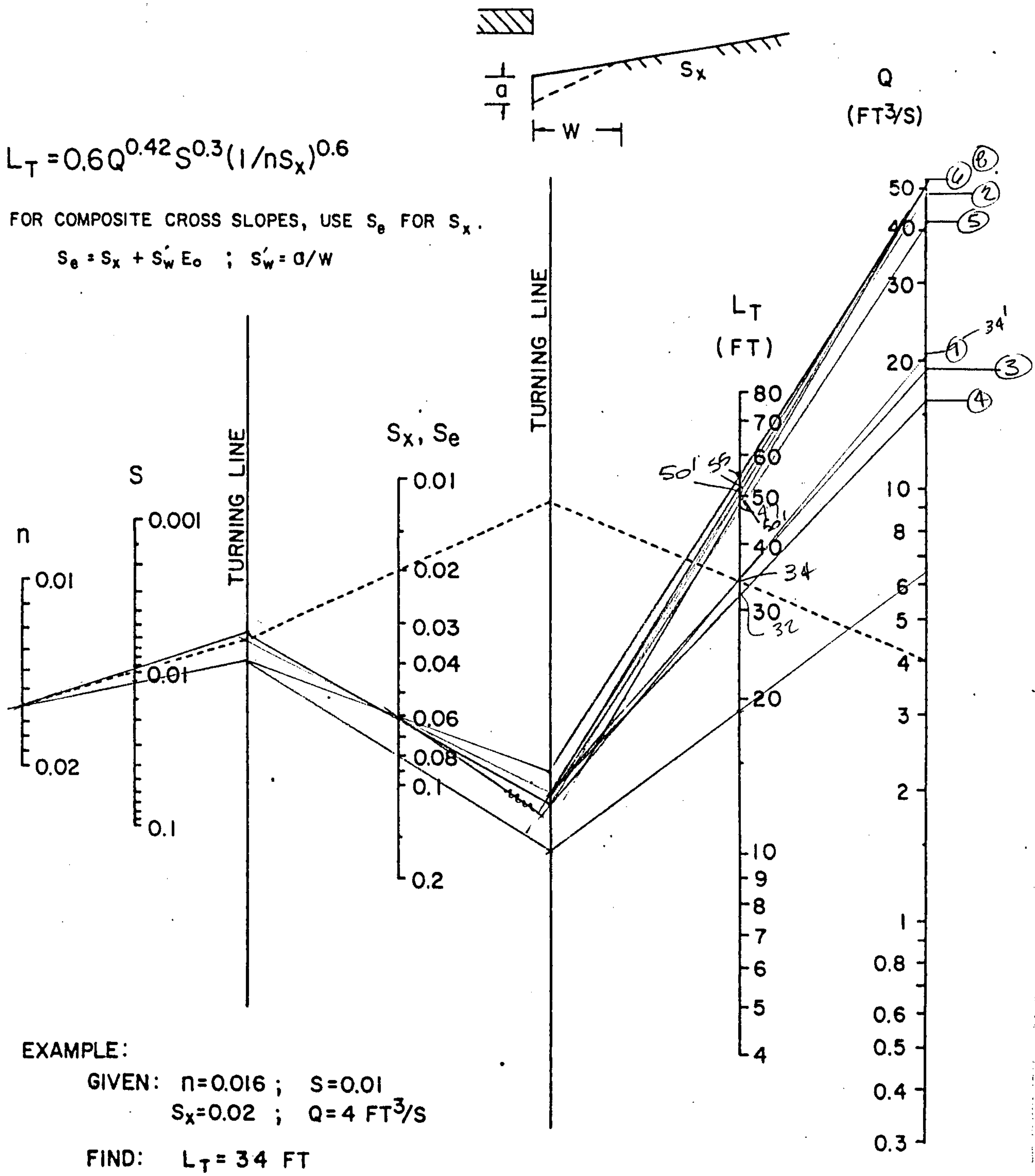
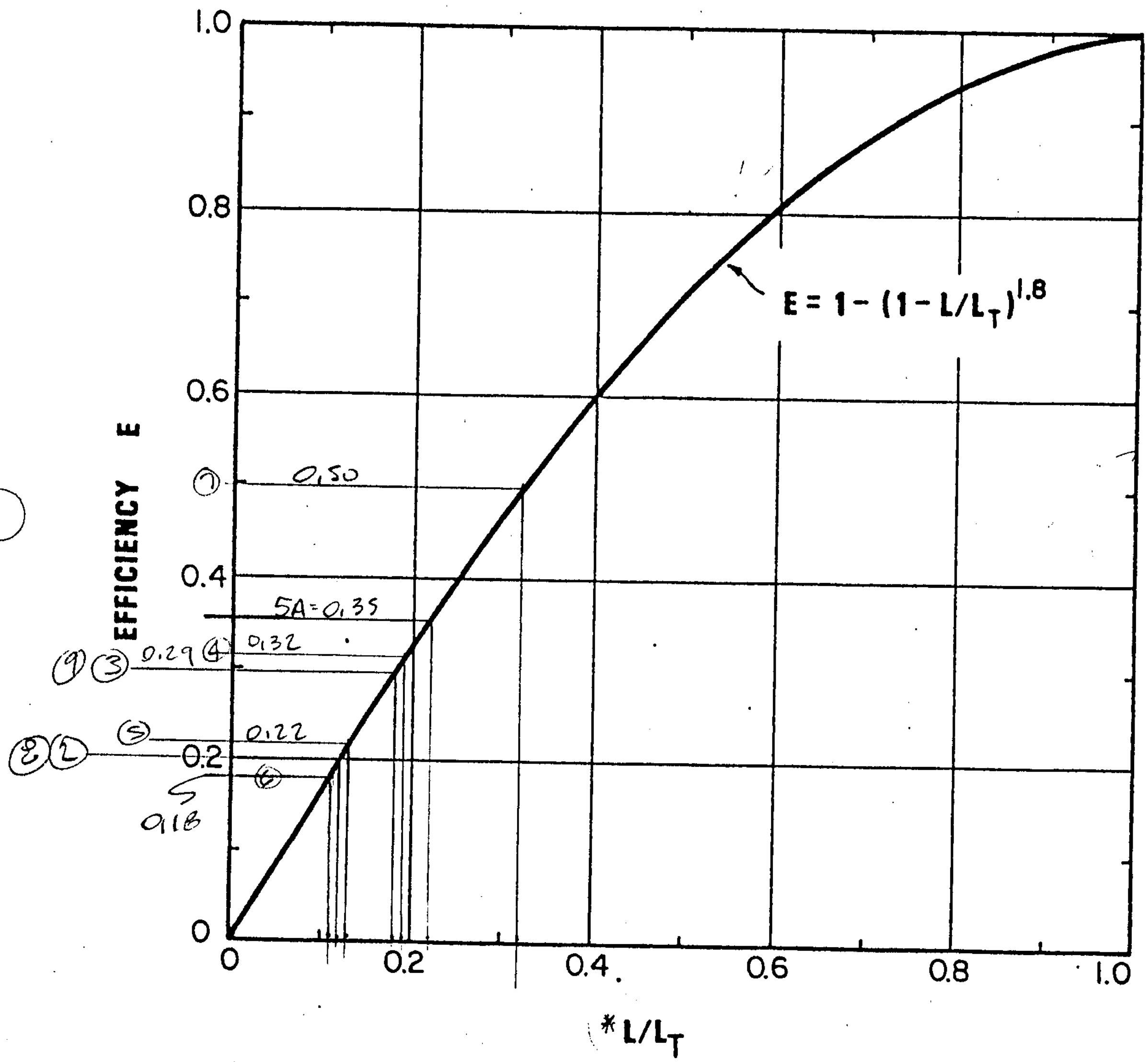


CHART 9. Curb-opening and slotted drain inlet length for total interception.

FIG 7 (1995)

(24)



*For type 1A Inlets use $\frac{L+1}{L_T}$

CHART 10. Curb–opening and slotted drain inlet interception efficiency.

FIG 8 (1001 cf)

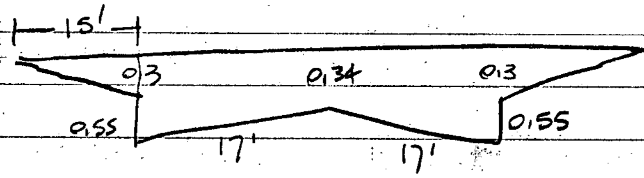
Final Summary 11/9/07

2 year storm, all inlet capacities met, total Bypass to Prince Avenue = 3.1 cfs west + 1.4 cfs east = 4.5 cfs total

100 year storm:
Total storm = 123.2 cfs − 49.2 system cap = 74.0 cfs.

Check street cap @ 74.0 cfs

Min Grade @ Base of Project = 0.895 %



$A = (15)(0.3) + (0.83+0.34)17 = 24.39\ ft^2$

$n = 0.016$

$WP = 64 + 2(0.55) = 65.1\ ft$ $\quad R = A/wp = 24.39/65.1 = 0.3747$

$V = 1.49/0.016\,(0.3747)^{0.67}(0.00895)^{1/2}$

$V = 4.56$ ft/sec

$Q = VA = (4.56)(24.39) = 111.22$ cfs > 74 o.k.