Kingspointe
Detention

B
A
X

STORMWATER DETENTION ANALYSIS

KINGSPOINTE

BAX PROJECT NO. 89-3030

PREPARED FOR:

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3910 OLD HIGHWAY 94 SOUTH, SUITE 114
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PREPARED BY:

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I. PURPOSE

The purpose of this report is to estimate the increase in the storm water runoff rate due to development of the tract of land known as "KINGSPOINTE" and to estimate the attenuation characteristics of the stormwater detention facilities that are proposed to be constructed as part of the site improvements. Based upon such estimates, a comparison is made between the pre-developed rate of stormwater runoff and the post-developed rate of stormwater runoff.

II. SCOPE

This report estimates the expected increase in stormwater runoff rate and attenuation characteristics during a 25 year frequency storm of 20 minutes duration, utilizing the rational method of estimating stormwater runoff to the detention facility. In addition, a storm of great intensity is checked for safe passage through the detention facility.

III. DETENTION CONCEPT

The proposed site improvements include construction of 2 dry detention basins at the west property line of the site. The storage volume and outflow rates have been proportioned to insure that the peak rates of runoff leaving the sub-watersheds of the site under post-developed conditions are less than or equal to the peak rates of runoff leaving the sub-watersheds of the site under pre-developed conditions for the design storm.

IV. STORMWATER RUNOFF INFORMATION

Runoff calculations for the tract and calculations of required attenuations are shown on Exhibit 'A'.

Estimate Inflow Hydrograph calculations for the design 25 year storm as well at the 15 year and 100 year storm are shown on Exhibit 'B'.

V. DETENTION BASIN CHARACTERISTICS

The depth-storage characteristics of the proposed detention basin are shown on Exhibit 'C'.

Outflow pipe performance calculations are shown on Exhibit 'D'.

VI. ROUTING PROCEDURE

The modified Puls routing procedure was used to estimate the effects of storage volume on outflow rate.

Exhibit 'E' details the development of the routing curves.

Exhibit 'F' displays the routing calculations.

VII. SUMMARY

The proposed detention basin will meet the outflow requirement which is based on the peak rate of runoff for the design storm under pre-developed conditions.

The south detention basin is allowed a maximum outflow of 14.64 c.f.s. when considering a 25 year frequency storm of 20 minute duration. The peak outflow for this storm is 12.9 c.f.s. from the basin. The north detenion basin is allowed a maximum outflow of 12.39 c.f.s. for a 25 year, 20 minute design storm. The peak outflow for this storm is 12.3 c.f.s. from the basin.

Overflow structure calculations for a 100 year storm have also been checked and shown on Exhibit 'G'.

Graphs of the basin's inflow-time characteristics, depth-storage characteristics, depth-outflow characteristics and the design routing curve hydrograph are all shown on Exhibit 'H'.

A drainage area map for the surrounding area is shown on Exhibit 'I'.

Routing of a 100 year storm is shown on Exhibit 'J'.

E X H I B I T S

GENERAL SITE DATA & RUNOFF CALCULATIONS

1.) The tract of land under pre-developed conditions is generally undeveloped, and for the purpose of this analysis, assumed to be 0% - 5% impervious. Therefore the following pre-developed P.I. factors shall be used.

15 year storm : 1.87 c.f.s. /Ac.
25 year storm : 2.31 c.f.s. /Ac.
100 year storm : 2.95 c.f.s. /Ac.

2.) The tract of land under post-developed conditions will be a P.U.D. (40% impervious) resulting in the following post-developed P.I. factors.

15 year storm : 2.64 c.f.s. /Ac.
25 year storm : 3.26 c.f.s. /Ac.
100 year storm : 4.17 c.f.s /Ac.

3.) The runoff from the tract of land shall discharge into two separate storm sewer systems. Due to this, the tract shall be divided into two sub-watersheds, each having a basin that has been analyzed and sized so that the peak pre-developed rate of runoff is greater than or equal to the peak post-developed rate of runoff for that sub-watershed. The entire tract shall then be checked to ensure that the peak pre-developed rate of runoff is greater than or equal to the peak post-developed rate of runoff for the entire site.

4.) Under pre-developed conditions, peak rate of runoff to the south detention basin sub watershed can be estimated as follows: (25 year storm)

6.52 A^c. x 2.31 c.f.s./A^c. = 15.06 c.f.s.

Peak rate of runoff to the north detention basin sub watershed can be estimated as follows: (25 year storm)

5.69 A^c x 2.31 c.f.s./A^c = 13.14 c.f.s.

5.) Under post-developed conditions, peak rates of runoff from the subject tract to the south detention basin sub watershed can be estimated as follows

6.37 A^c @ 3.26 C.F.S./A^c = 20.77 C.F.S. F.E.S. 100

0.89 A^c @ 3.26 C.F.S./A^c. = 2.90 C.F.S. F.E.S. 124

2.05 A^c @ 3.26 C.F.S./A^c. = 6.68 C.F.S. DIRECT TO BASIN

0.13 A^c @ 3.26 C.F.S. A^c = 0.42 C.F.S. DIRECT OFFSITE (BYPASSES BASIN)

30.77 C.F.S.

EXHIBIT 'A'

Sh't. 2 of 3

Peak rates of runoff from the subject tract to the north detention basin sub-watershed can be estimated as follows:

	5.66 A^c @ 3.26 C.F.S./A^c =	18.45 C.F.S.	F.E.S. 116
	1.34 A^c @ 3.26 C.F.S./A^c =	4.37 C.F.S.	F.E.S. 114
1.99	1.78 A^c @ 3.26 C.F.S./A^c =	5.80 C.F.S.	DIRECT TO BASIN
	0.23 A^c @ 3.26 C.F.S./A^c =	0.75 C.F.S.	DIRECT OFFSITE (BYPASSES BASIN)
		29.37 C.F.S.	

6.) The required attenuation can then be found:

SOUTH BASIN

Post-Developed Inflow to sub watershed − Pre-Developed Inflow to sub watershed.

= 30.77 C.F.S. − 15.06 C.F.S. = 15.71 C.F.S.

NORTH BASIN

Post-Developed Inflow to sub watershed − Pre-Developed Inflow to sub watershed.

= 29.37 C.F.S. − 13.14 C.F.S. = 16.23 C.F.S.

REQUIRED ATTENUATION OF ENTIRE TRACT:

AREA OF TRACK × Post-Developed P.I − Pre-Developed P.I

= 20.69 A^c × (3.26 C.F.S./A^c − 2.31 C.F.S./A^c)

= 20.69 A^c × 0.95 C.F.S. = 19.66 C.F.S.

TOTAL ATTENUATION OF 2 BASINS = 15.71 C.F.S. + 16.23 C.F.S. = 31.94 C.F.S.

∴ Attenuation of 2 basins will govern.

EXHIBIT 'A'

INFLOW HYDROGRAPH CALCULATIONS

1.) SOUTH BASIN:

A.) Of the flows that will inflow to the proposed south detention basin, the most remote point of origination lies at the east property line. It will travel approximately 400 feet overland where it will be picked up by an area inlet and then travel approximately 795 feet via storm sewer. Therefore, the time of concentration can be found as follows:

a.) 400 feet overland with a difference in elevation of approximately 6 feet results in a travel time of 7.8 minutes (3.9 min x 2 = 7.8 min. see *Exhibit 'B' sheet 8 of 8*)

b.) 795 feet with an estimated velocity of 7 feet per second results in a travel time of 1.89 minutes.

$$\left(\frac{795\text{ ft.}}{1} \times \frac{1}{7\text{ft./sec.}} \times \frac{1\text{ min.}}{60\text{ sec.}}\right)$$

∴ Time of concentration = 7.8 min + 1.89 min.

= 9.69 min. ⇒ use 10 minutes

NORTH BASIN:

B) The most remote point of origination of the flows that will inflow to the proposed north detention basin lies at the east property line. It will travel approximately 460 feet overland where it will be picked up by an area inlet and then travel approximately 740 feet via storm sewer. Therefore, the time of concentration can be found as follows:

a.) 460 feet overland with a difference in elevation of approximately 10 feet results in a travel time of 7.4 minutes (3.7 min × 2 = 7.4 min. see Exhibit 'B' sheet 8 of 8)

b.) 740 feet with an estimated velocity of 7 feet per second results in a travel time of 1.76 minutes.

$$\left(\frac{740\ ft}{1} \times \frac{1}{7\ ft./sec.} \times \frac{1\ min}{60\ sec.}\right)$$

∴ Time of Concentration = 7.4 min + 1.76 min.
= 9.16 min. ⇒ use 10 minutes

2.) From the drainage area map of the project, the estimated peak inflows to the basins are:

A.) South Basin: (25 Year Storm)

NOT THE SAME AS DRAIN SHEET BUT OK ON TOTAL

F.E.S. 100	7.05 Ac. × 3.26 C.F.S./Ac.	=	22.98 C.F.S.
F.E.S. 124	0.89 Ac. × 3.26 C.F.S./Ac.	=	2.90 C.F.S.
DIRECT RUNOFF	1.37 Ac. × 3.26 C.F.S./Ac.	=	4.47 C.F.S.
			30.35 C.F.S.

(15 Year Storm)

F.E.S. 100	7.05 Ac. × 2.64 C.F.S./Ac.	=	18.61 C.F.S.
F.E.S. 124	0.89 Ac. × 2.64 C.F.S./Ac.	=	2.35 C.F.S.
DIRECT RUNOFF	1.37 Ac. × 2.64 C.F.S./Ac.	=	3.62 C.F.S.
			24.58 C.F.S.

(100 Year Storm)

F.E.S. 100	7.05 Ac. × 4.17 C.F.S./Ac.	=	29.40 C.F.S.
F.E.S. 124	0.89 Ac. × 4.17 C.F.S./Ac.	=	3.71 C.F.S.
DIRECT RUNOFF	1.37 Ac. × 4.17 C.F.S./Ac.	=	5.71 C.F.S.
			38.82 C.F.S.

B. North Basin : (25 Year Storm)

F.E.S. 116 5.66 A^c x 3.26 C.F.S./A^c = 18.45 C.F.S.

F.E.S. 114 1.34 A^c x 3.26 C.F.S./A^c = 4.37 C.F.S.

DIRECT RUNOFF 1.78 A^c x 3.26 C.F.S./A^c = 5.80 C.F.S.

28.62 C.F.S. ✓ OK

(15 Year Storm)

F.E.S. 116 5.66 A^c x 2.64 C.F.S./A^c = 14.94 C.F.S.

F.E.S. 114 1.34 A^c x 2.64 C.F.S./A^c = 3.54 C.F.S.

DIRECT RUNOFF 1.78 A^c x 2.64 C.F.S./A^c = 4.70 C.F.S.

23.18 C.F.S.

(100 Year Storm)

F.E.S. 116 5.66 A^c x 4.17 C.F.S./A^c = 23.60 C.F.S.

F.E.S. 114 1.34 A^c x 4.17 C.F.S./A^c = 5.59 C.F.S.

DIRECT RUNOFF 1.78 A^c x 4.17 C.F.S./A^c = 7.42 C.F.S.

36.61 C.F.S.

3.) The permitted release rate of the basins for the purpose of this analysis is can be found as:

Permitted Release Rate = Inflow to basin - Required attenuation

Therefore the permitted release rates are as follows:

A.) South Basin

30.35 C.F.S. - 15.71 C.F.S. = 14.64 C.F.S.

B.) North Basin

28.62 C.F.S. - 16.23 C.F.S. = 12.39 C.F.S.

4) Inflow hydrograph for the 15, 25, and 100 year frequency storm of 20 minutes duration with t_c = 10 minutes.

A.) SOUTH BASIN

TIME (minutes)	INFLOW RATES 15 YR. (C.F.S.)	25 YR (C.F.S.)	100 YR (C.F.S.)	REMARKS
0	0.0	0.0	0.0	Design Rain Begins
2	4.92	6.07	7.76	↕
4	9.83	12.14	15.53	
6	14.75	18.21	23.29	
8	19.66	24.28	31.06	
10	24.58	30.35	38.82	All Areas Contributing Begin Peak Inflow
12	24.58	30.35	38.82	↕ Inflow Rate Constant @ Peak Inflow Rate
14	24.58	30.35	38.82	
16	24.58	30.35	38.82	
18	24.58	30.35	38.82	
20	24.58	30.35	38.82	Design Rain Ends
22	19.66	24.28	31.06	↕
24	14.75	18.21	23.29	
26	9.83	12.14	15.53	
28	4.92	6.07	7.76	
30	0.0	0.0	0.0	Inflow Ends

B.) NORTH BASIN

TIME (minutes)	INFLOW RATES 15 YR. (c.f.s.)	25 YR. (c.f.s.)	100 YR. (c.f.s.)	REMARKS
0	0.0	0.0	0.0	Design Rain Begins
2	4.64	5.72	7.32	↕
4	9.27	11.45	14.64	
6	13.91	17.17	21.97	
8	18.54	22.90	29.29	
10	23.18	28.62	36.61	All Areas Contributing Begin Peak Inflow
12	23.18	28.62	36.61	↕ Inflow Rate Constant @ Peak Inflow Rate
14	23.18	28.62	36.61	
16	23.18	28.62	36.61	
18	23.18	28.62	36.61	
20	23.18	28.62	36.61	Design Rain Ends
22	18.54	22.90	29.29	↕
24	13.91	17.17	21.97	
26	9.27	11.45	14.64	
28	4.64	5.72	7.32	
30	0.0	0.0	0.0	Inflow Ends

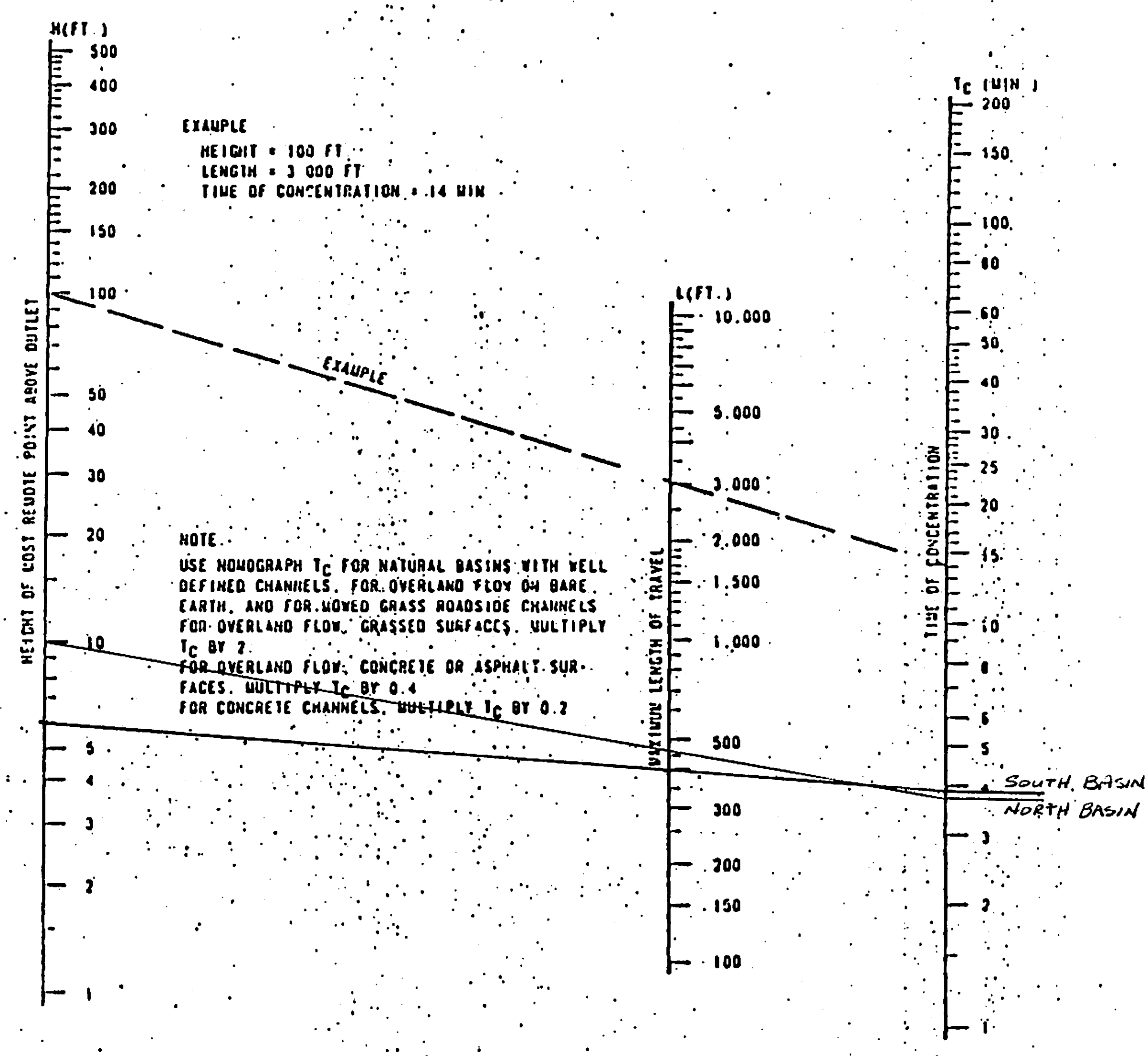


FIGURE 1

TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS

DEPTH-STORAGE VOLUME CALCULATION

SOUTH BASIN

ELEVATION	AREA (Ac.)	AVERAGE AREA (Ac)	INCREMENT OF DEPTH (FT.)	INCREMENT OF VOLUME (Ac-FT.)	TOTAL VOLUME (Ac-FT.)
558^{5}	0				
		0.0505	1.5	0.076	
560^{0}	0.101				0.076
		0.163	2.0	0.326	
562^{0}	0.225				0.402
		0.277	2.0	0.554	
564^{0}	0.329				0.956
		0.392	2.0	0.784	
566^{0}	0.455				1.740

EXHIBIT 'C'

Sh't. 1 OF 2

DEPTH-STORAGE VOLUME CALCULATION

NORTH BASIN

ELEVATION	AREA (A^{c}.)	AVERAGE AREA (A^{c}.)	INCREMENT OF DEPTH (FT.)	INCREMENT OF VOLUME (A^{c}- FT.)	TOTAL VOLUME (A^{c}- FT.)
554^{5}	0.0				
		0.0595	1.5	.089	
556^{0}	0.119				.089
		0.171	2.0	0.342	
558^{0}	0.223				.431
		0.2725	2.0	0.545	
560^{0}	0.322				.976
		0.3795	2.0	0.759	
562^{0}	0.437				1.735

EXHIBIT 'C'

Sh't. 2 OF 2

DEPTH-OUTFLOW CALCULATIONS

SOUTH BASIN

1.) OUTFLOW PIPE : 15" Ø R.C.P. W/G.E.P.

℄ ELEV. = 558.5

2.) PERFORMANCE CALCULATIONS

ELEVATION	H (ft.)	Hw/D	Q_{OUT} (c.f.s.)
558.5	0	0	0.0
559.0	0.5	0.4	2.1*
560.0	1.5	1.2	5.7
561.0	2.5	2.0	9.0
562.0	3.5	2.8	12.0
563.0	4.5	3.6	14.0
564.0	5.5	4.4	16.0

* FROM DEPTH VS. OUTFLOW CURVE

EXHIBIT 'D'

DEPTH-OUTFLOW CALCULATIONS

NORTH BASIN

1.) OUTFLOW PIPE : 15" Ø R.C.P. W/G.E.P.

℄ ELEV. = 554.5

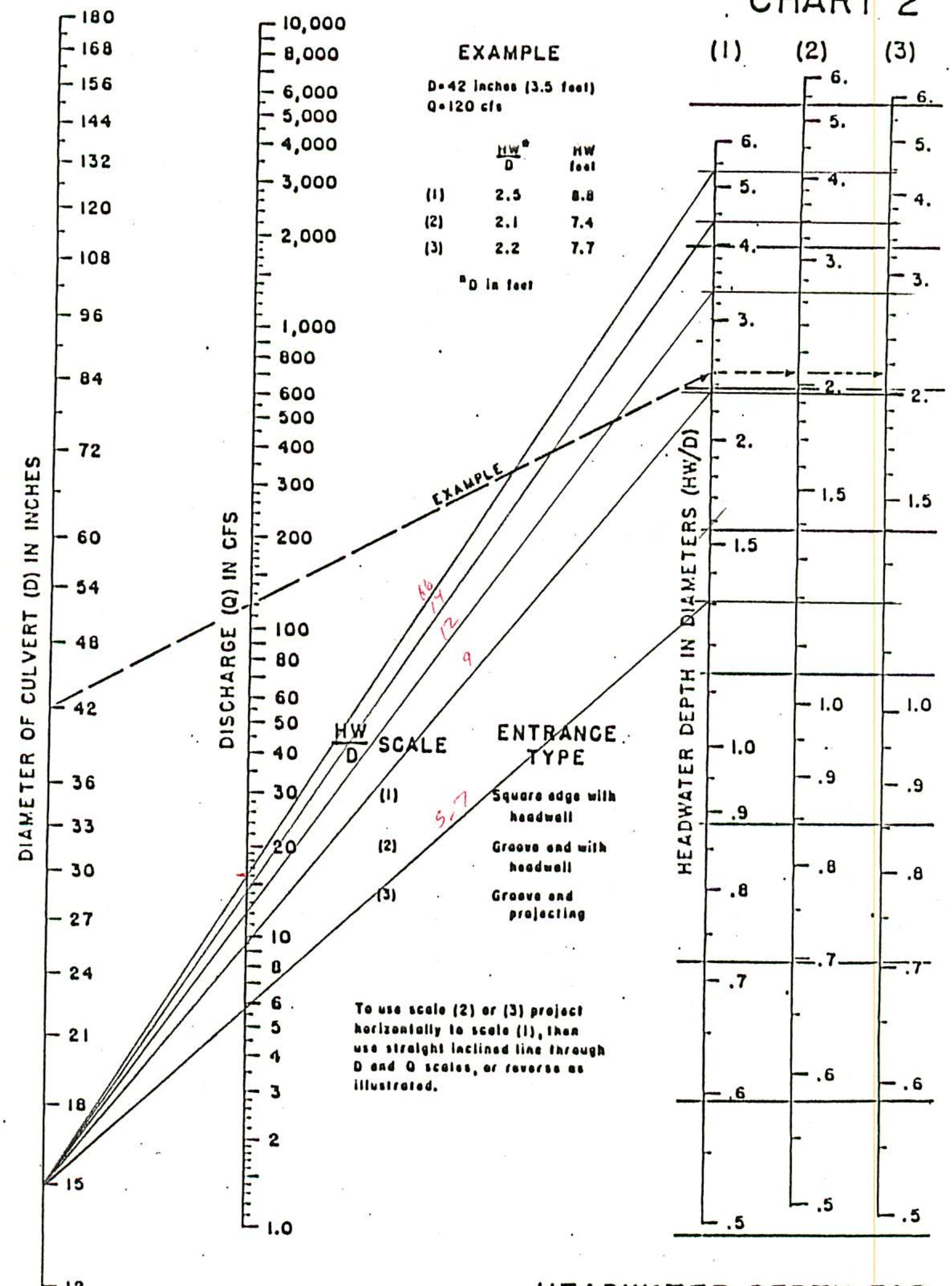
2.) PERFORMANCE CALCULATIONS

ELEVATION	H (ft.)	HW/D	Q_{OUT} (c.f.s.)
554.5	0	0	0.0
555.0	0.5	0.4	2.1
556.0	1.5	1.2	5.7
557.0	2.5	2.0	9.0
558.0	3.5	2.8	12.0
559.0	4.5	3.6	14.0
560.0	5.5	4.4	16.0

EXHIBIT 'D'

Sh't. 2 OF 3

CHART 2



HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

BAX ENGINEERING CO., INC.

LAND PLANNING — LAND SURVEYING — SITE ENGINEERING

EXHIBIT 'D'
Sh't. 3 OF 3

ROUTING CURVE COMPUTATIONS

(SOUTH BASIN)

Let Δt = 2 minutes = 0.033 hours

Then $\frac{2S}{\Delta t}$ + outflow = $\frac{2S\,(\text{Ac-Ft.})}{\Delta t\,(\text{hrs.})} \times \frac{24\,(\text{hrs/day})}{1.98\,(\text{Ac-Ft/c.f.s.-day})}$ + O (c.f.s.)

$\frac{2S}{\Delta t}$ + O = 727.27 S + O c.f.s.

ELEVATION	S (Ac-Ft.)	O (c.f.s.)	$\frac{2S}{\Delta t}$ + O (c.f.s.)
558.5	0	0.0	0.0
559.0	0.012 *	2.1	10.83
560.0	0.076	5.7	60.97
561.0	0.211 *	9.0	162.45
562.0	0.402	12.0	304.36
563.0	0.645 *	14.0	483.09
564.0	0.956	16.0	711.27

* FROM DEPTH STORAGE CURVE

EXHIBIT 'E'
Sh't. 1 OF 2

ROUTING CURVE COMPUTATIONS
(NORTH BASIN)

Let $\Delta t = 2$ minutes $= 0.033$ hours

Then $\frac{2S}{\Delta t} + \text{outflow} = \frac{2S\ (\text{Ac-Ft.})}{\Delta t\ (\text{hrs.})} \times \frac{24\ (\text{hrs./day})}{1.98\ (\text{Ac-Ft./c.f.s.-day})} + O\ (\text{c.f.s.})$

$\frac{2S}{\Delta t} + O = 727.27\ S + O$ c.f.s.

ELEVATION	S (Ac-Ft.)	O (c.f.s.)	$\frac{2S}{\Delta t}+O$ (c.f.s.)
554.5	0	0.0	0.0
555.0	0.015*	2.1	13.01
556.0	0.089	5.7	70.43
557.0	0.238*	9.0	182.09
558.0	0.431	12.0	325.45
559.0	0.672*	14.0	502.73
560.0	0.976	16.0	725.82

*FROM DEPTH STORAGE CURVE

EXHIBIT 'E'
Sh't 2 OF 2

Design Pond Routing

SOUTH BASIN

FORM 102	0	1	2	3	4	5	6	7
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2
1	0	0.0			0		0	
2	2	6.07	6.07	0	6.07		1.5	
3	4	12.14	18.21	3.07	21.28		3.2	
4	6	18.21	30.35	14.88	45.23		4.8	
5	8	24.28	42.49	35.63	78.12		6.4	
6	10	30.35	54.63	65.32	119.95		7.8	
7	12	30.35	60.70	104.35	165.05		9.1	
8	14	30.35	60.70	146.85	207.55		10.2	
9	16	30.35	60.70	187.15	247.85		11.0	
10	18	30.35	60.70	225.85	286.55		11.7	
11	20	30.35	60.70	263.15	323.85		12.3	
12	22	24.28	54.63	299.25	353.83		12.6	
13	24	18.21	42.49	328.68	371.17		12.8	
14	26	12.14	30.35	345.57	375.92	562.45	12.9	0.50 AC-FT. 21,780 Cu. Ft.
15	28	6.07	18.21	350.12	368.33		12.8	

← PEAK OUTFLOW (line 14)

EXHIBIT 'F'
Sh't. 1 of 4

Design Pond Routing

SOUTH BASIN

FORM 102	0	1	2	3	4	5	6	7
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2
1	30	0.0	6.07	342.73	348.80		12.6	
2	32	0.0	0.00	323.60	323.60		12.3	
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

EXHIBIT 'F'
Sh't. 2 OF 4

Design Pond Routing

NORTH BASIN

FORM 102	0	1	2	3	4	5	6	7
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2
1	0	0.0			0		0	
2	2	5.72	5.72	0	5.72		0.9	
3	4	11.45	17.17	3.92	21.09		2.9	
4	6	17.17	28.62	15.29	43.91		4.5	
5	8	22.90	40.07	34.91	74.98		5.9	
6	10	28.62	51.52	63.18	114.70		7.1	
7	12	28.62	57.24	100.50	157.74		8.4	
8	14	28.62	57.24	140.94	198.18		9.4	
9	16	28.62	57.24	179.38	236.62		10.3	
10	18	28.62	57.24	216.02	273.26		11.1	
11	20	28.62	57.24	251.06	308.3		11.7	
12	22	22.90	51.52	284.90	336.42		12.1	
13	24	17.17	40.07	312.22	352.29		12.3	
14	26	11.45	28.62	327.69	356.31	558.15	12.3	0.46 Ac-Ft. 20,038 Cu. Ft.
15	28	5.72	17.17	331.71	348.88		12.2	

← PEAK OUTFLOW (line 14)

EXHIBIT 'F'
Sh't. 3 of 4

Design Pond Routing

NORTH BASIN

FORM 102	0	1	2	3	4	5	6	7
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2
1	30	0.0	5.72	324.48	330.20		12.0	
2	32	0.0	0.0	306.20	306.20		11.7	
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

EXHIBIT 'F'
Sh't. 4 OF 4

OVERFLOW STRUCTURE CALCULATIONS

SOUTH BASIN

CONSIDER 100 YEAR STORM, INFLOW Q_{100} = 38.82 C.F.S.

STRUCTURE WILL BE AN AREA INLET

$Q = CLH^{3/2}$ (assume outflow pipe blocked)

Q = 38.82 c.f.s.

C = 3.0

FIND REQUIRED H IF SINGLE AREA INLET IS DESIRED

$Q = CLH^{3/2}$

$H^{3/2} = Q/CL$ WHERE L = PERIMETER OF AREA INLET

$H = \left[\frac{38.82}{3 \times 11.67}\right]^{2/3}$ Length of sides: 2@ 38 IN.

= 1.07 ok use 1.1 2@ 32 IN.

TOTAL = 140 IN. = 11.67 Ft.

ELEVATION HIGH WATER 25 YEAR STORM	562.45
ELEVATION OF SILL	563.00
ELEVATION OF INSIDE BOTTOM OF TOP OF INLET	564.10
ELEVATION OF TOP OF INLET	564.52

* SEE 100 YEAR STORM ROUTING ON EXHIBIT 'J' *

EXHIBIT 'G'

Sh't. 1 OF 2

NORTH BASIN

CONSIDER 100 YEAR STORM, INFLOW $Q_{100} = 36.61$ C.F.S.

STRUCTURE WILL BE AN AREA INLET

$Q = CLH^{3/2}$ (assume outflow pipe blocked)

$Q = 36.61$ c.f.s.

$C = 3.0$

FIND REQUIRED H IF SINGLE AREA INLET IS DESIRED

$Q = CLH^{3/2}$

$H^{3/2} = Q/CL$ WHERE $L = 11.67$ Ft.

$H = \left[36.61 / 3 \times 11.67 \right]^{2/3}$

$= 1.03$ ok use 1.1

ELEVATION HIGH WATER 25 YEAR STORM	558.15
ELEVATION OF SILL	558.50
ELEVATION OF INSIDE BOTTOM OF TOP OF INLET	559.60
ELEVATION OF TOP OF INLET	560.02

* SEE 100 YEAR STORM ROUTING ON EXHIBIT 'I' *

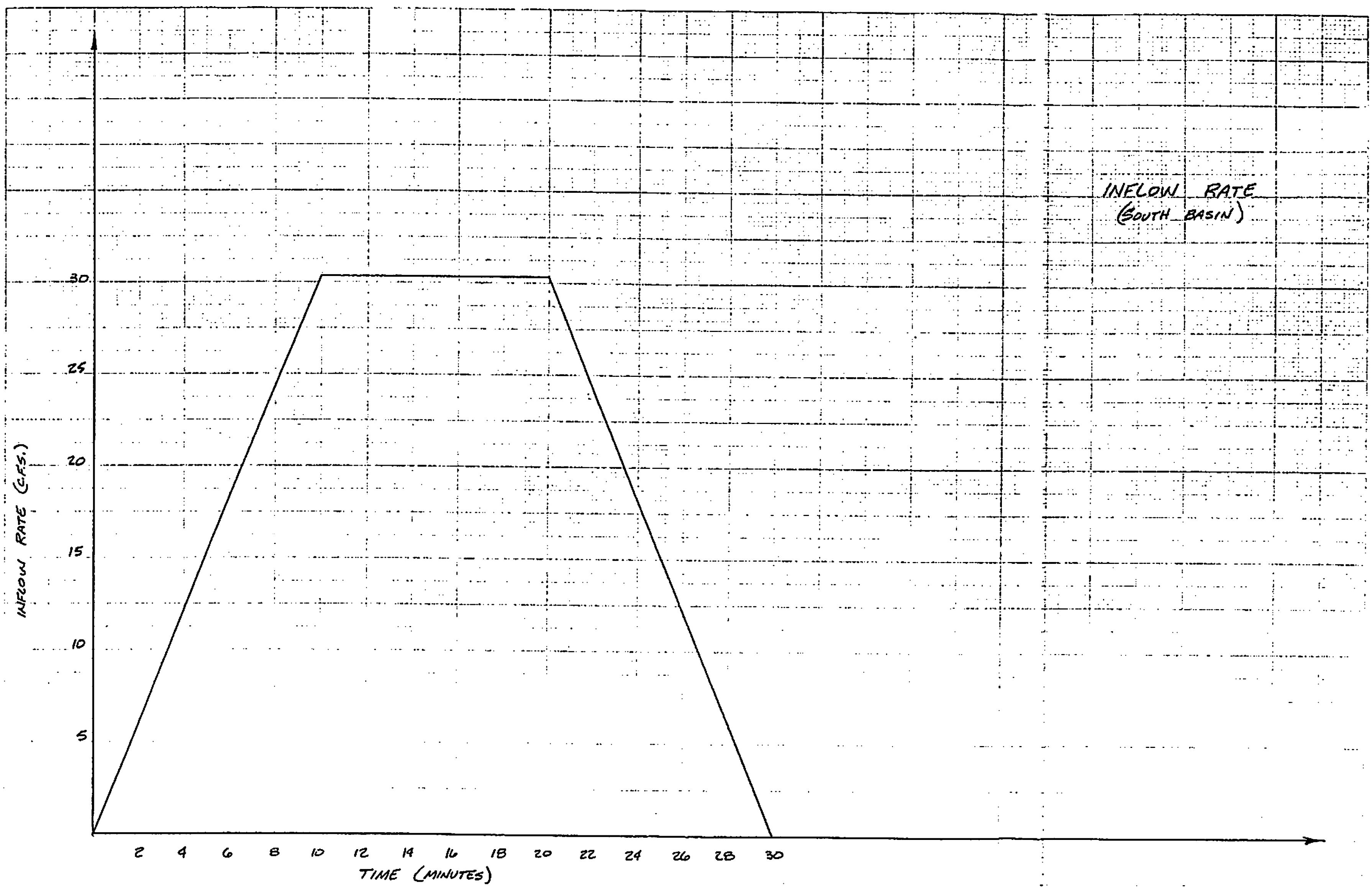


EXHIBIT 'H'
Sh't 1 of 8

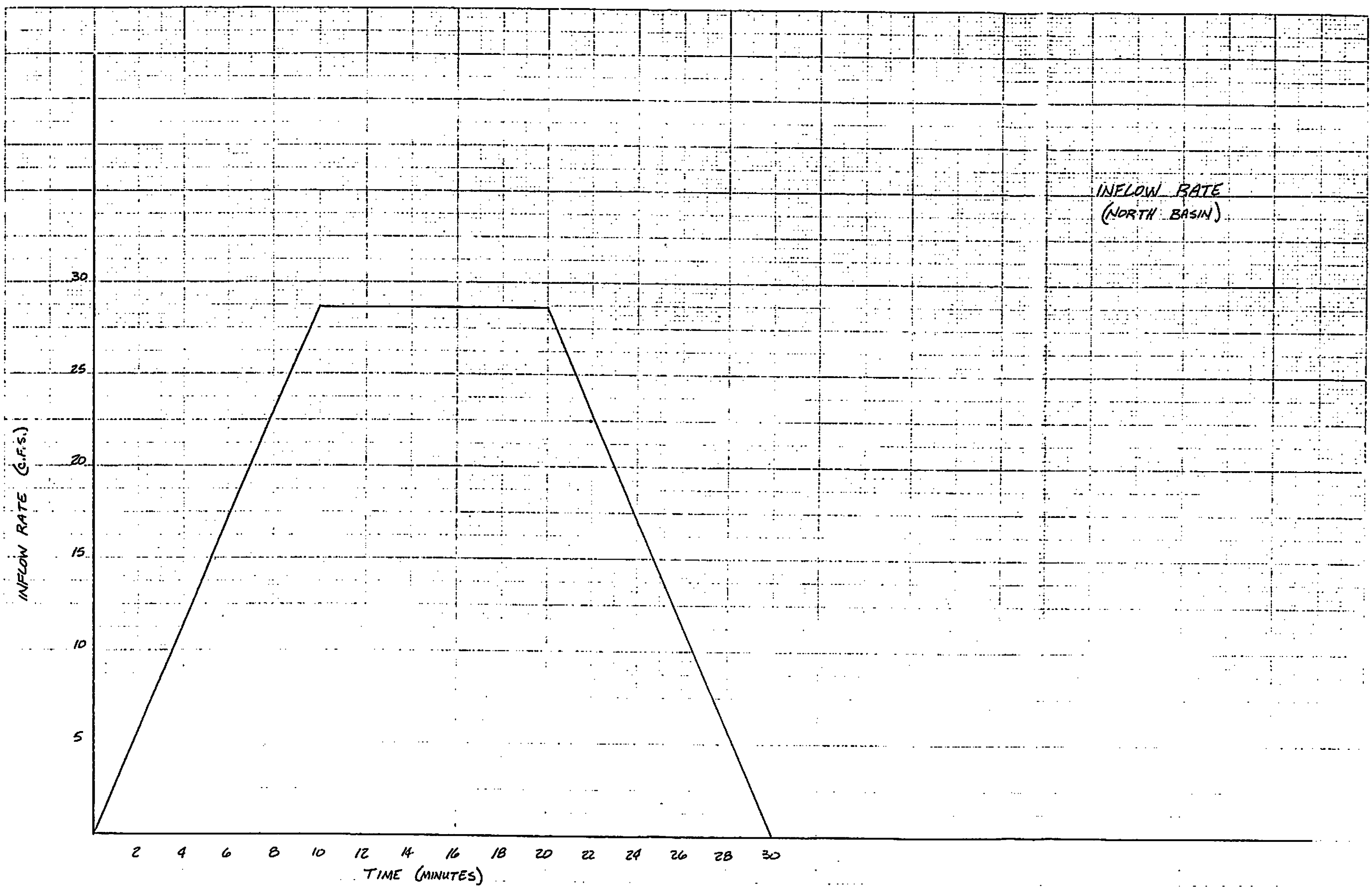


EXHIBIT 'H'
Sh't 2 of 8

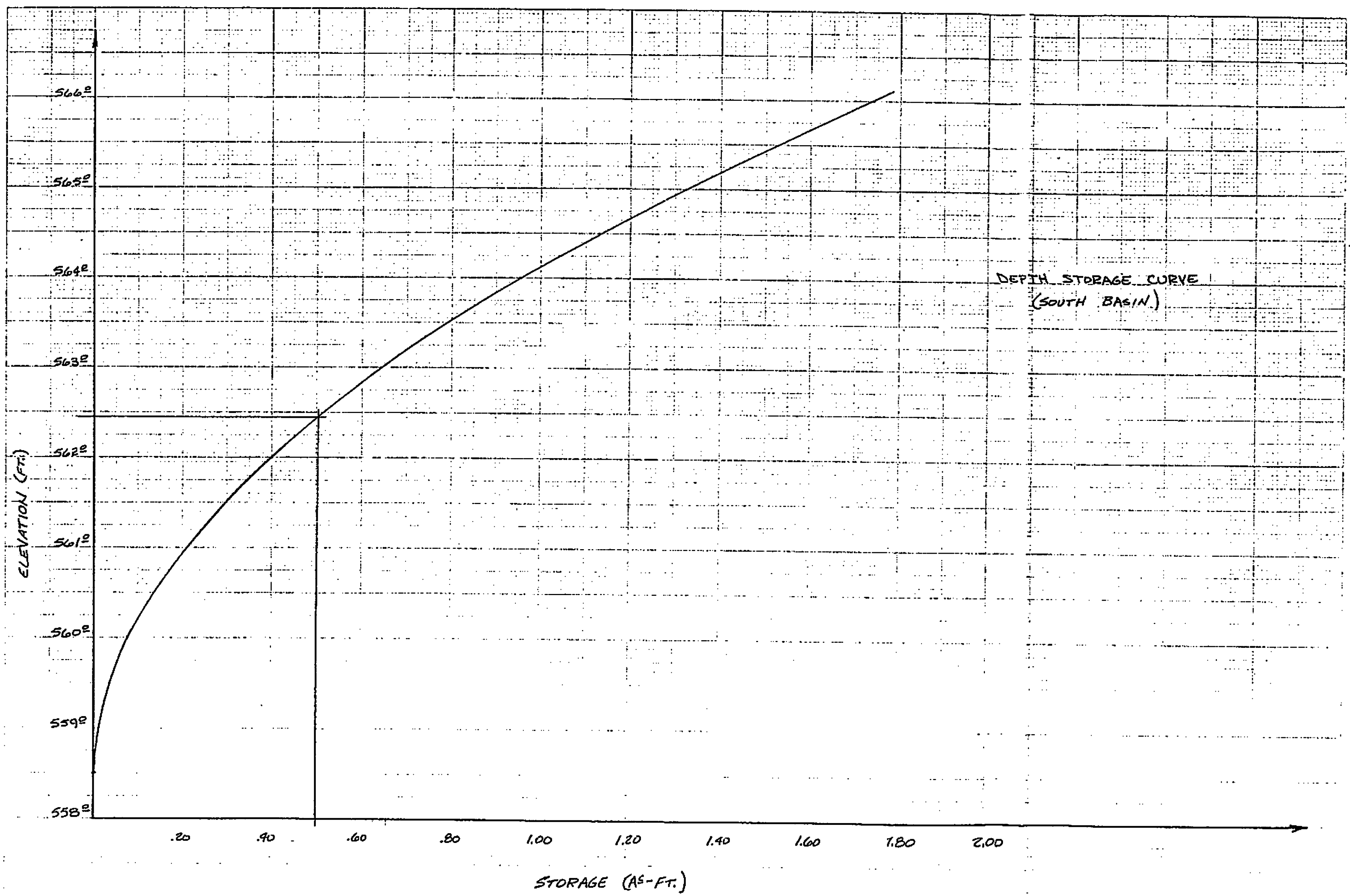


EXHIBIT 'H'
Sh't. 3 of 8

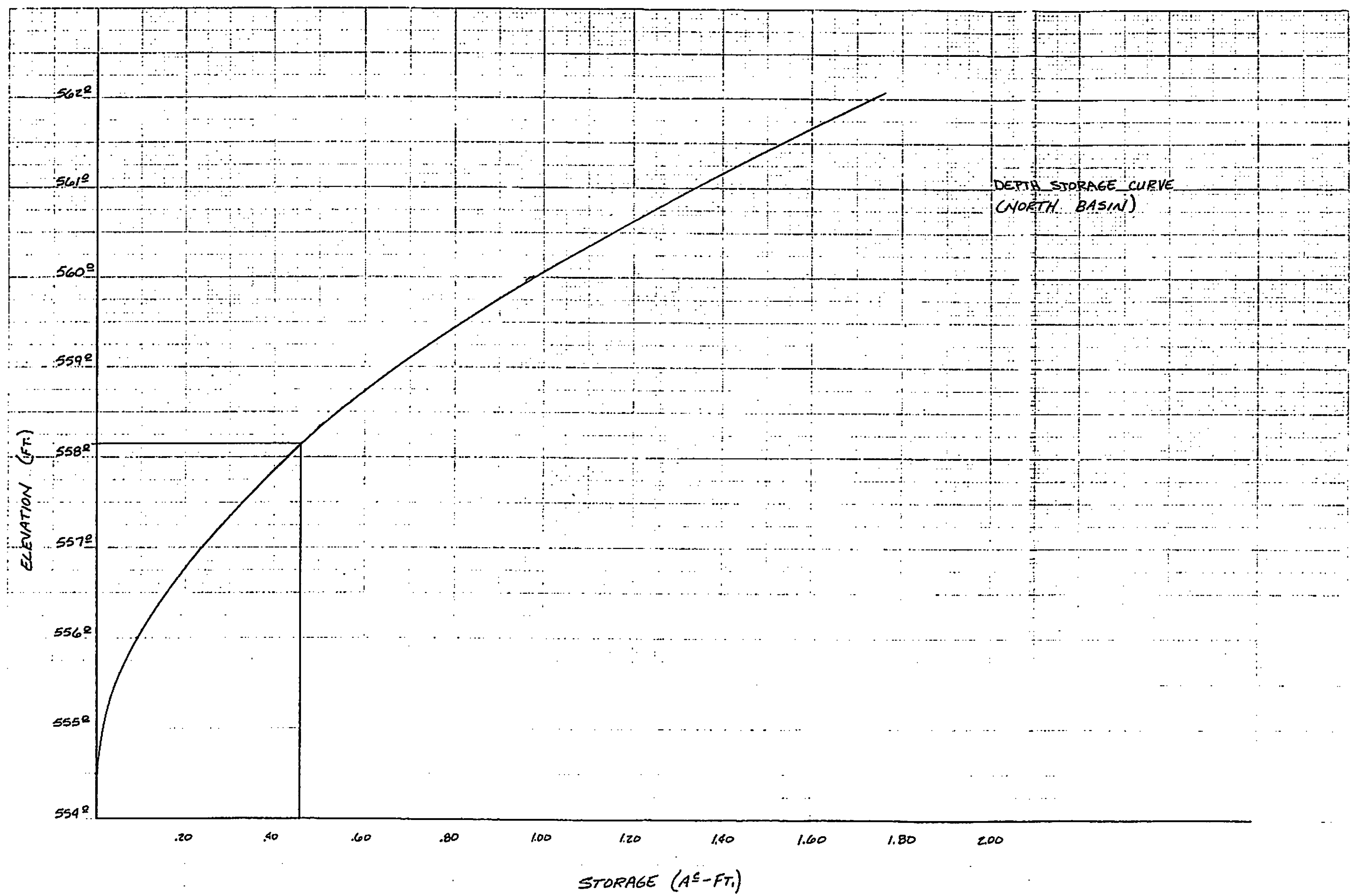


EXHIBIT 'H'
Sh't. 4 of 8

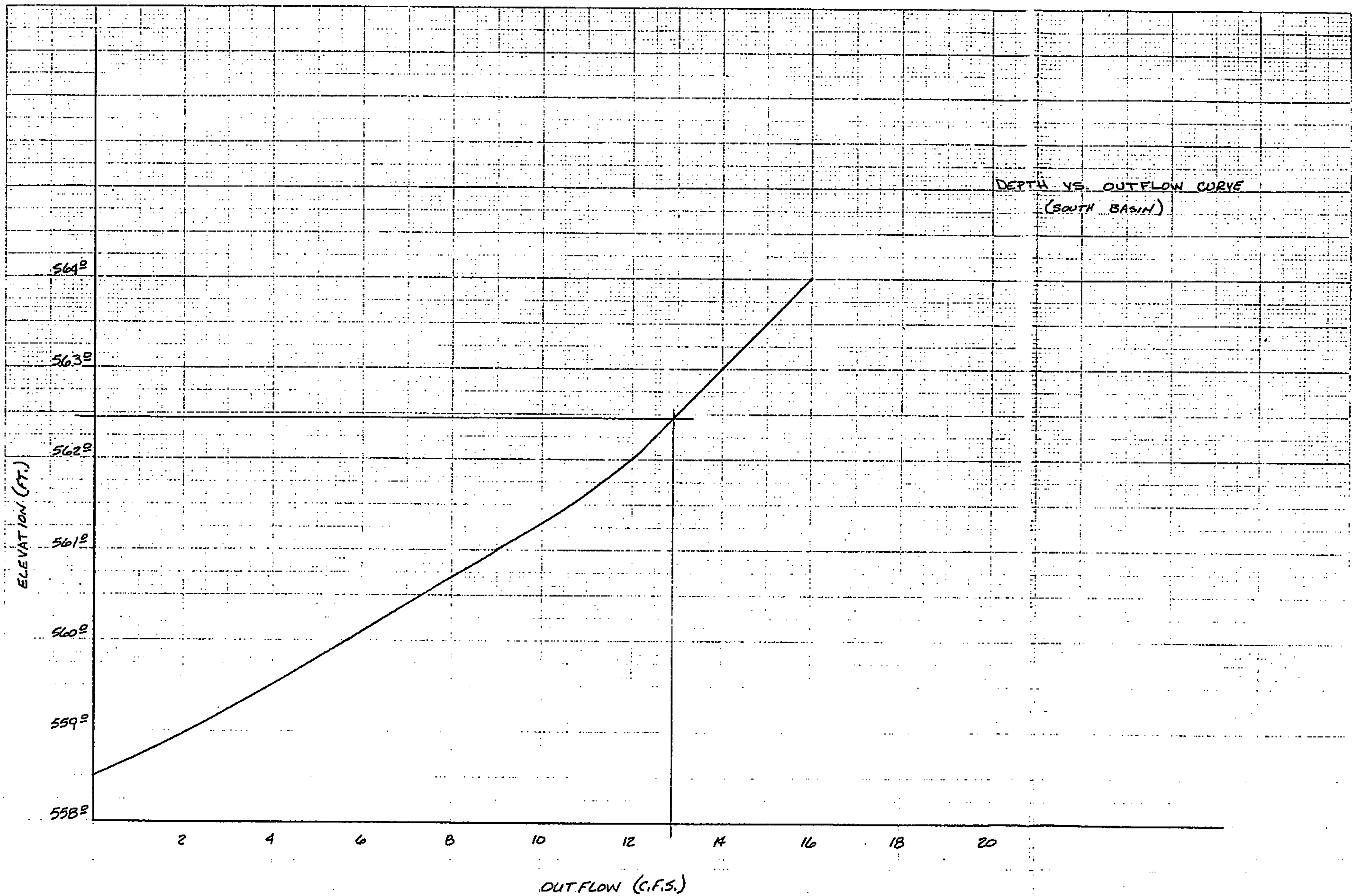


EXHIBIT 'H'
Sh't. 5 of 8

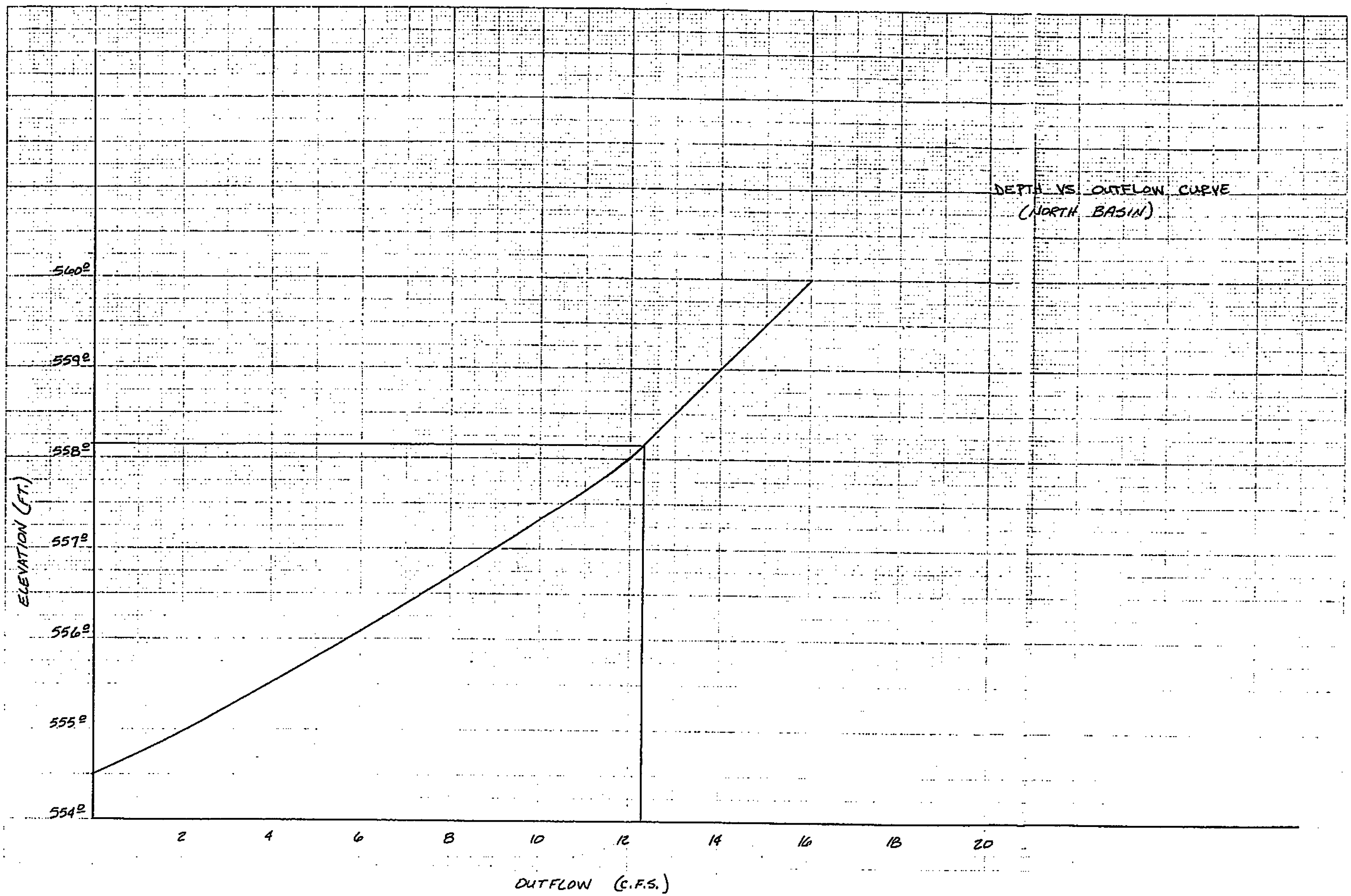


EXHIBIT 'H'
Sht. 6 of 8

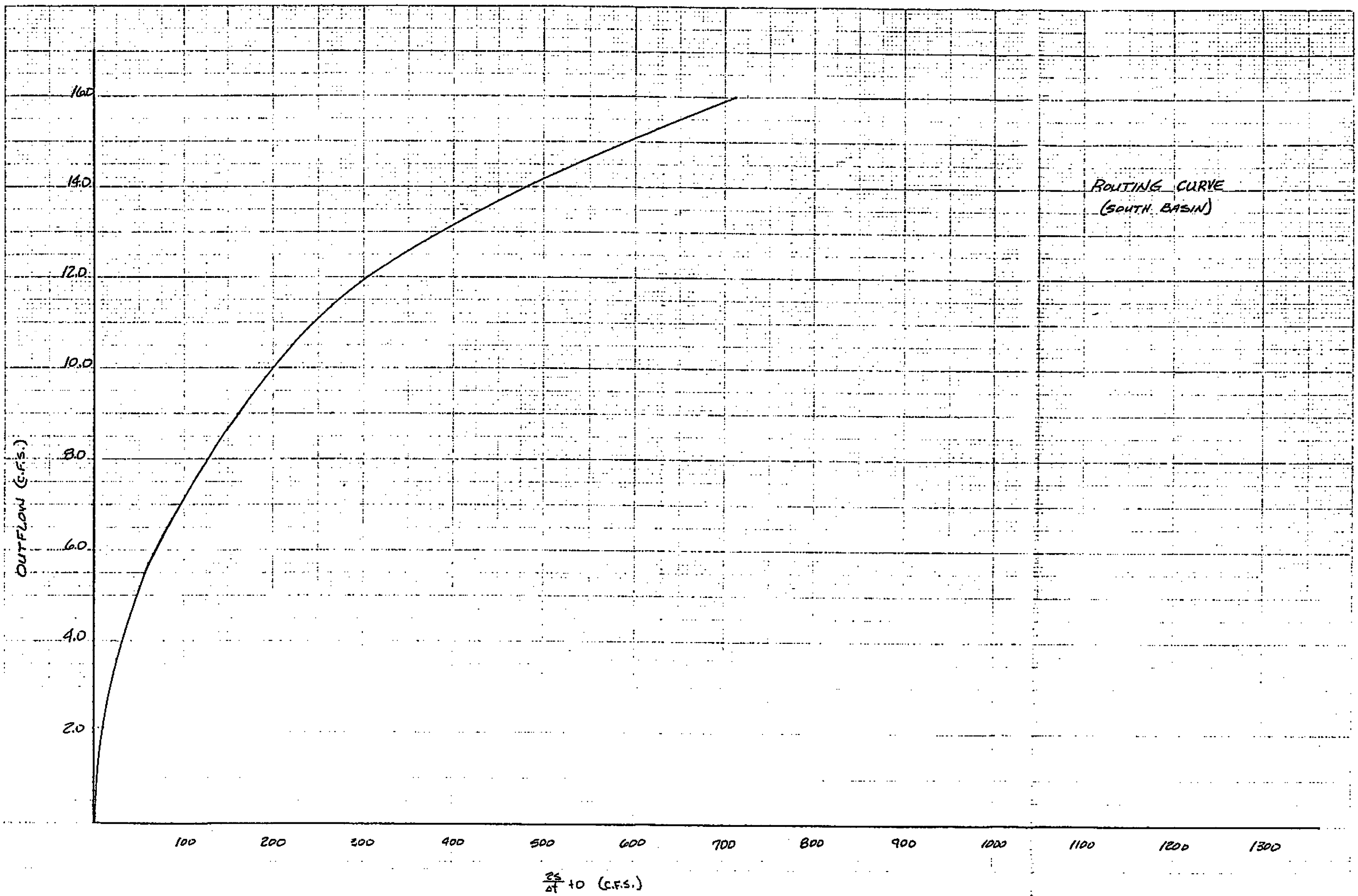


EXHIBIT 'H'
Sh't. 7 OF 8

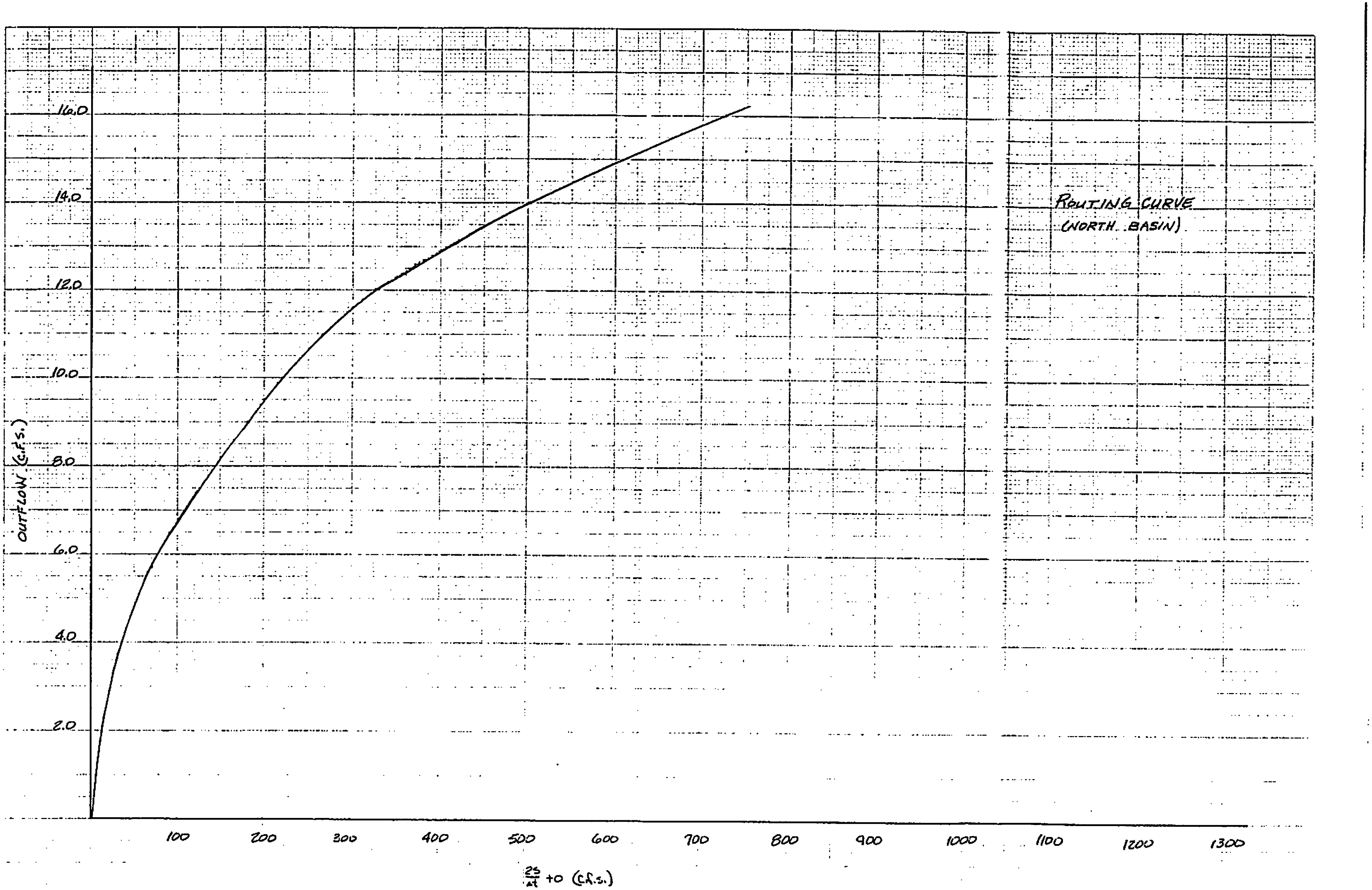
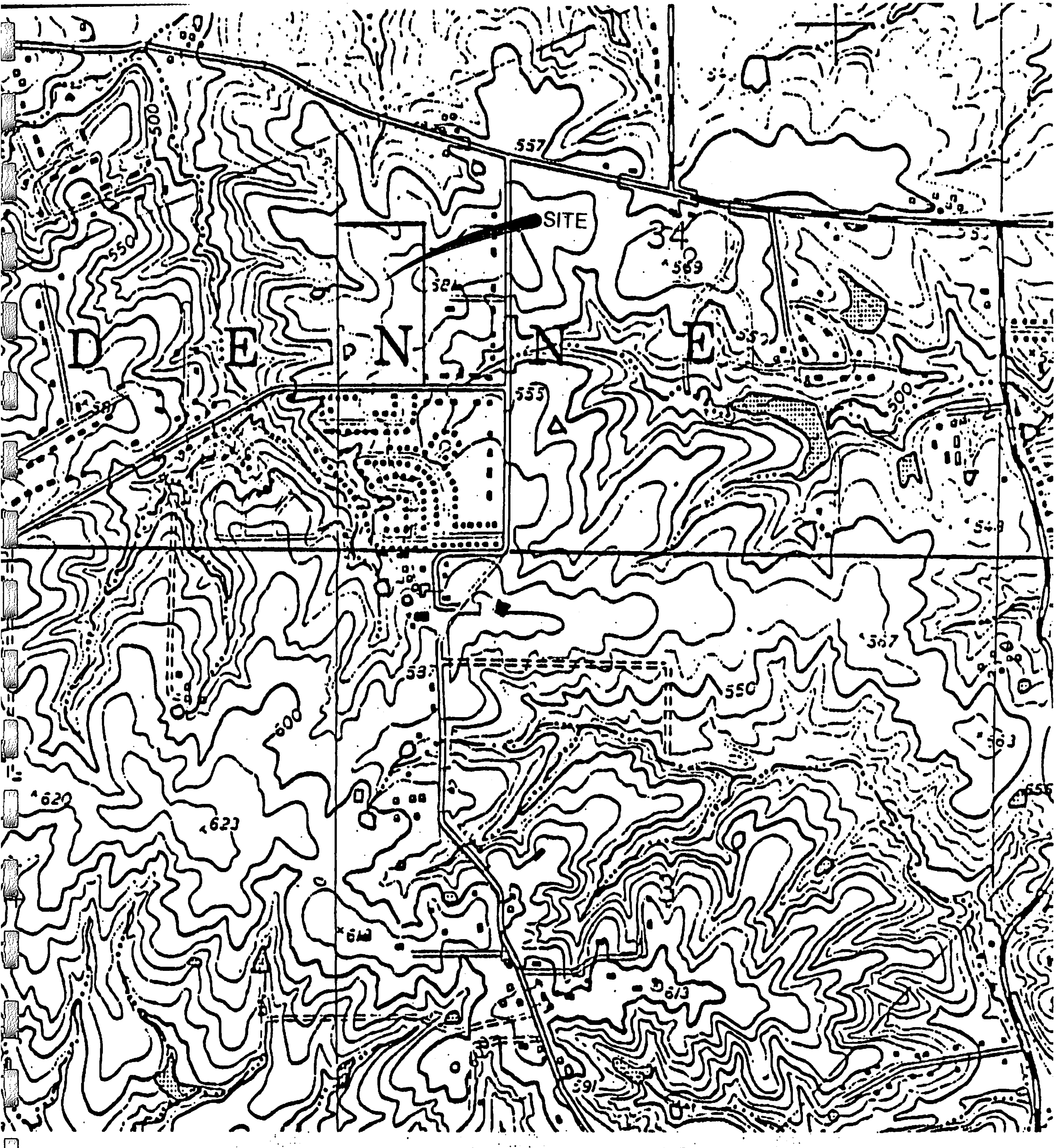


EXHIBIT 'H'
Sh't. 8 of 8



DRAINAGE AREA MAP

SCALE: 1"=1000'

EXHIBIT 'I'
Sh't. 1 OF 1

DEPTH - OUTFLOW CALCULATIONS (100 YEAR STORM)

SOUTH BASIN

1.) OUTFLOW PIPE: 15" Ø R.C.P. W/G.E.P. TO ELEVATION 563.00

AT 563.00 RUNOFF WILL BE ALLOWED TO EXIT BASIN VIA OVERFLOW STRUCTURE AND THROUGH 18" PIPE

2.) DISCHARGE FROM BASIN:

ELEVATION	$Q_{OVERSILL}$	H	HW/D	$Q_{18"ALLOWED}$	$Q_{15"}$	Q_{OUT}	
558.5	—				0.0	0.0	
559.0	—				2.1	2.1	
560.0	—				5.7	5.7	
561.0	—				9.0	9.0	
562.0	—				12.0	12.0	
563.0	—				14.0	14.0	18" Ø PIPE CONTROLS
563.5	12.38	5.0	3.33	20.0	15.0	20.0	
564.0	35.01	5.5	3.67	21.0	16.0	21.0	
564.5		6.0	4.0	23.0		23.0	
565.0		6.5	4.33	24.0		24.0	
565.5		7.0	4.67	25.0		25.0	
566.0		7.5	5.0	26.0		26.0	

EXHIBIT 'J'

FLOW OVER SILL:

$Q = CLH^{3/2}$

H = 0.5 ft.

L = 11.67 ft. (4 SIDES OPEN)

C = 3.0

$Q = (3)(11.67)(0.5)^{3/2}$

Q = 12.38

H = 1.0 ft.

L = 11.67 ft. (4 SIDES OPEN)

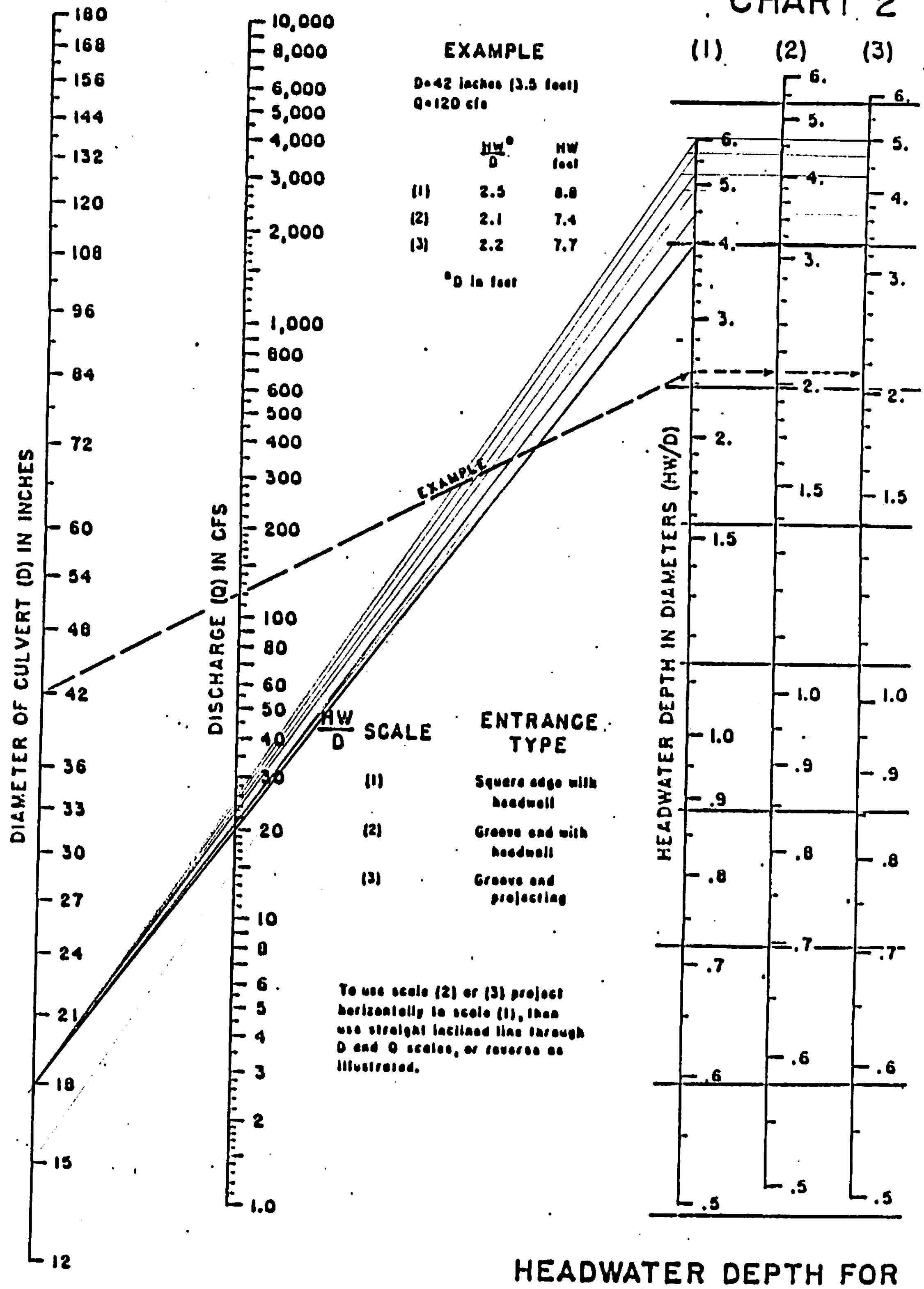
C = 3.0

$Q = (3)(11.67)(1.0)^{3/2}$

Q = 35.01

EXHIBIT 'J'

CHART 2



HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

BAX ENGINEERING CO., INC.

LAND PLANNING — LAND SURVEYING — SITE ENGINEERING

EXHIBIT 'J'
Sh't. 3 OF 17

ROUTING CURVE COMPUTATIONS (100 YEAR STORM)

(SOUTH BASIN)

Let Δt = 2 minutes = 0.033 hours

Then $\frac{2S}{\Delta t}$ + outflow = $\frac{2S\ (\text{Ac-Ft.})}{\Delta t\ (\text{hrs})} \times \frac{24\ (\text{hrs./day})}{1.98\ (\text{Ac-Ft./c.f.s.-day})}$ + O (c.f.s.)

$\frac{2S}{\Delta t} + O = 727.27\ S + O$ c.f.s.

ELEVATION	S (Ac-Ft.)	O (c.f.s.)	$\frac{2S}{\Delta t} + O$ (c.f.s.)
558.5	0.0	0.0	0.0
559.0	0.012	2.1	10.83
560.0	0.076	5.7	60.97
561.0	0.211	9.0	162.45
562.0	0.402	12.0	304.36
563.0	0.645	14.0	483.09
564.0	0.956	21.0	716.27
564.5	1.135	23.0	848.45
565.0	1.325	24.0	987.63
565.5	1.528	25.0	1136.27
566.0	1.740	26.0	1291.45

EXHIBIT 'J'

Design Pond Routing

SOUTH BASIN (100 YEAR STORM)

FORM 102	0	1	2	3	4	5	6	7
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2
1	0	0.0	0.0		0.0		0.0	
2	2	7.76	7.76	0	7.76		1.8	
3	4	15.53	23.29	4.16	27.45		3.6	
4	6	23.29	38.82	20.25	59.07		5.5	
5	8	31.06	54.35	48.07	102.42		7.3	
6	10	38.82	69.88	87.82	157.70		8.9	
7	12	38.82	77.64	139.90	217.54		10.4	
8	14	38.82	77.64	196.74	274.38		11.6	
9	16	38.82	77.64	251.18	328.82		12.4	
10	18	38.82	77.64	304.02	381.66		13.0	
11	20	38.82	77.64	355.66	433.30		13.5	
12	22	31.06	69.88	406.30	476.18		13.9	
13	24	23.29	54.35	448.38	502.73		14.4	
14	26	15.53	38.82	473.93	512.75	563.05	14.7	0.66 Ac-Ft 28,750 Cu. Ft.
15	28	7.76	23.29	483.35	506.64		14.5	

PEAK OUTFLOW

EXHIBIT 'J'
Sht. 5 OF 17

Design Pond Routing

FORM 102	0	1	2	3	4	5	6	7
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2
1	30	0.0	7.76	477.64	485.40		14.1	
2	32	0.0	0.0	457.20	457.20		13.8	
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

EXHIBIT 'J'
Sh't. 6 OF 17

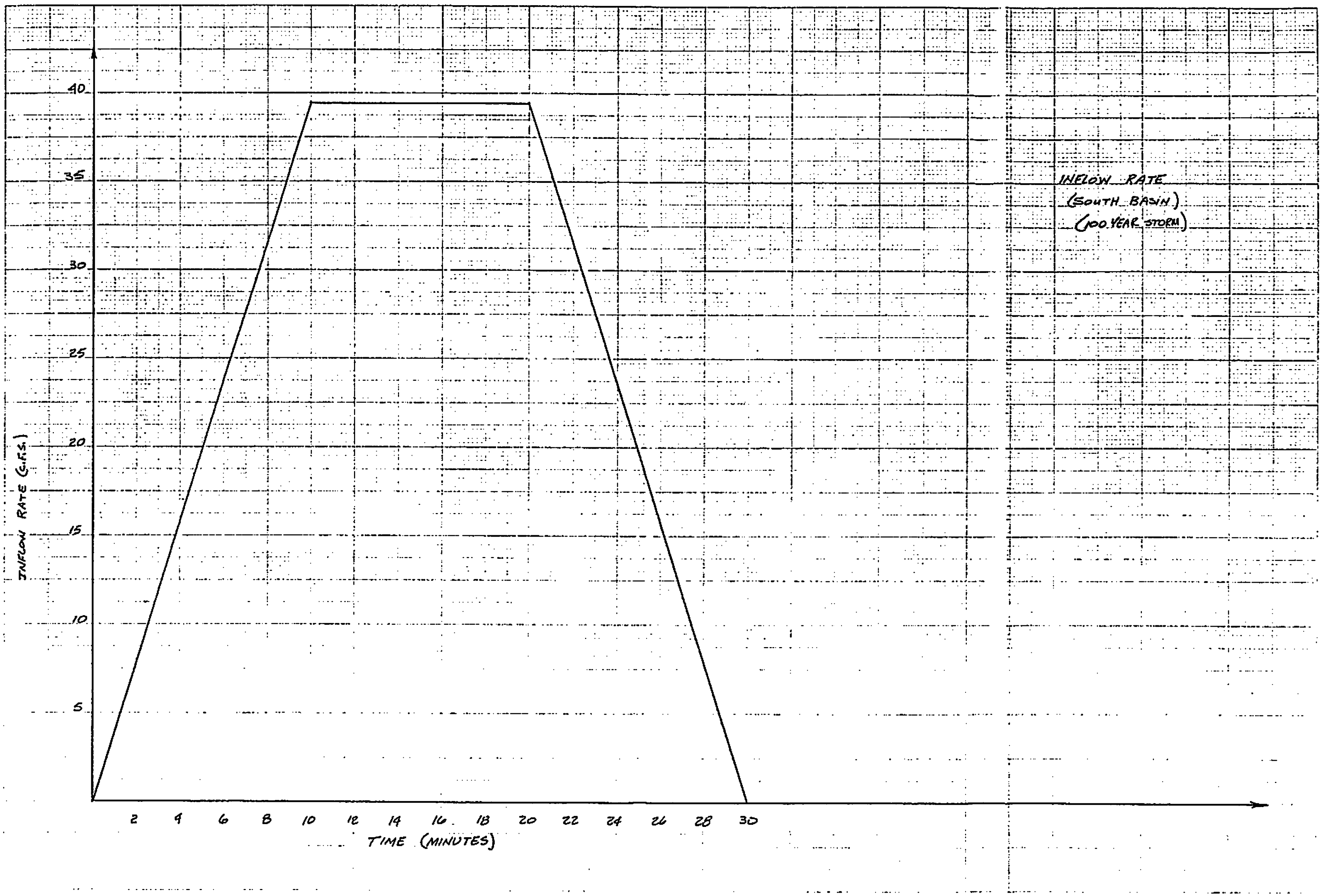


EXHIBIT 'J'
Sh't. 7 OF 17

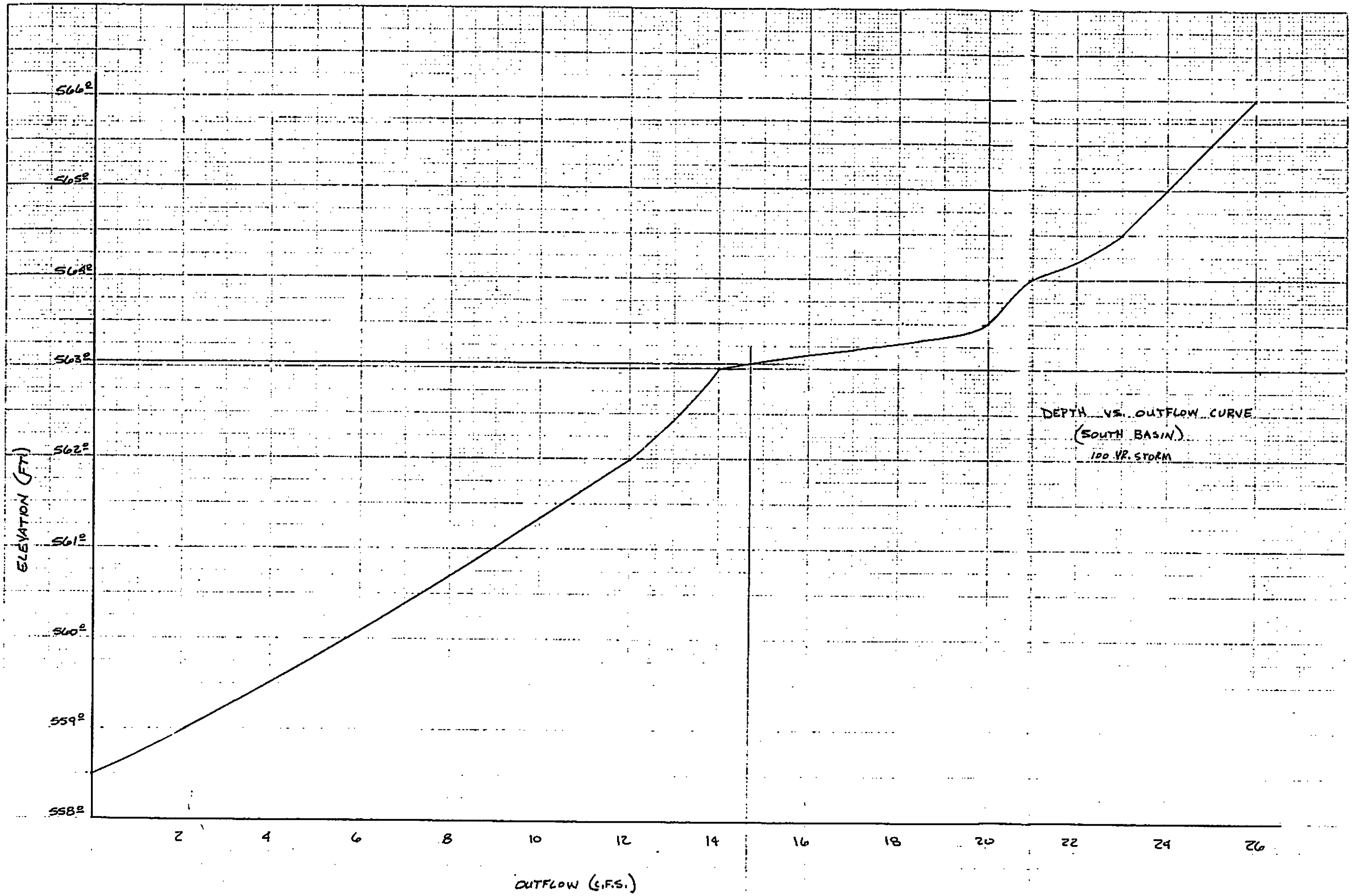


EXHIBIT 'J'
Sh't. 8 OF 17

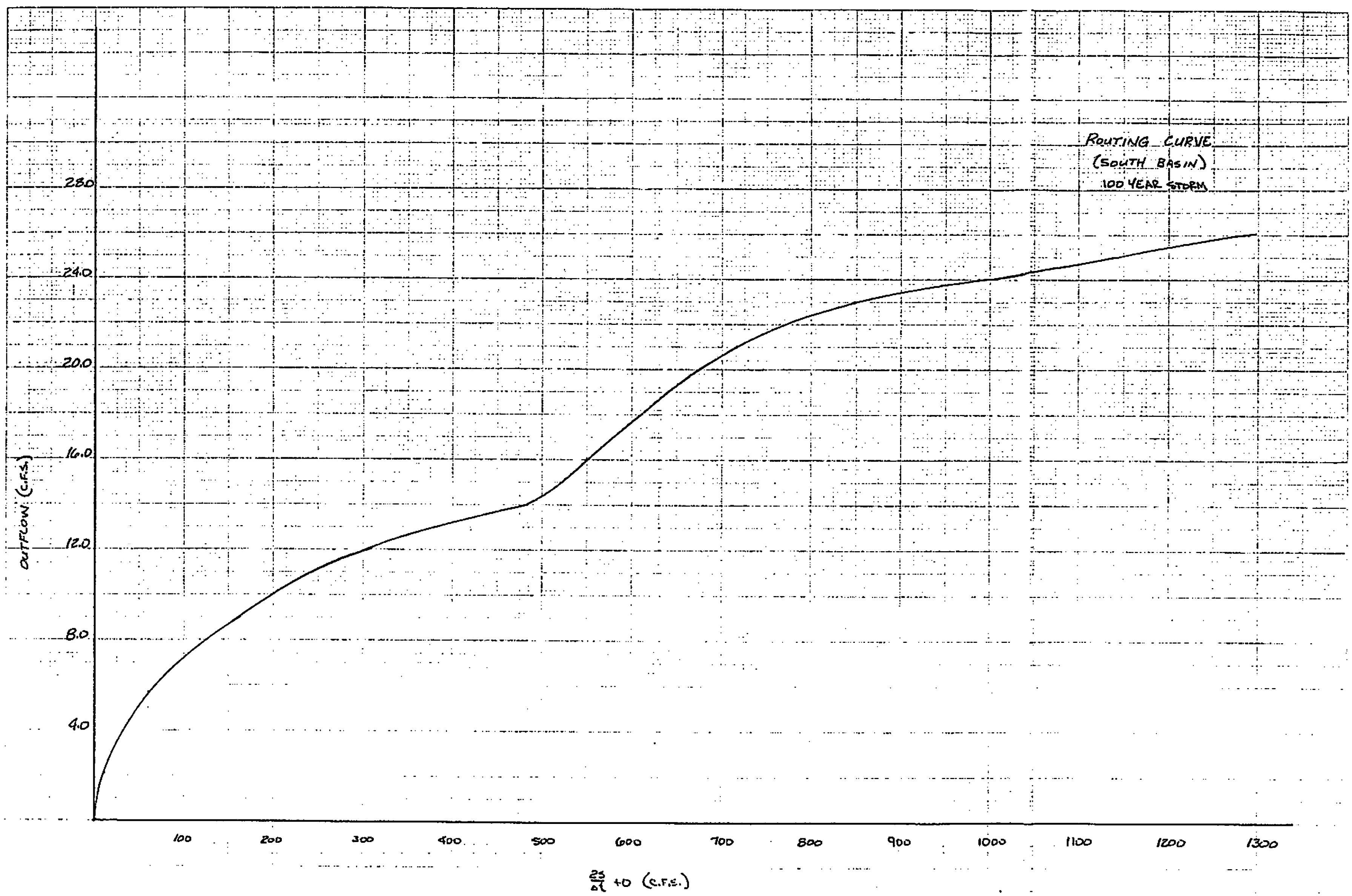


EXHIBIT 'J'
Sh't. 9 OF 17

DEPTH-OUTFLOW CALCULATIONS (100 YEAR STORM)

NORTH BASIN

1.) OUTFLOW PIPE : 15" Ø R.C.P. W/G.E.P. TO ELEVATION 558.50

AT 558.50 RUNOFF WILL BE ALLOWED TO EXIT BASIN VIA OVERFLOW STRUCTURE AND THROUGH 18" PIPE

2.) DISCHARGE FROM BASIN :

ELEVATION	$Q_{OVERSILL}$	H	H_{W}/D	$Q_{18''\ ALLOWED}$	$Q_{15''}$	Q_{OUT}	
554.5	–				0.0	0.0	
555.0	–				2.1	2.1	
556.0	–				5.7	5.7	
557.0	–				9.0	9.0	
558.0	–				12.0	12.0	18" Ø PIPE CONTROLS
559.0	12.38	4.5	3	19.0	14.0	19.0	
559.5	35.01	5	3.33	20.0	15.0	20.0	
560.0		5.5	3.67	21.0	16.0	21.0	

EXHIBIT 'I'

ROUTING CURVE COMPUTATIONS (100 YEAR STORM)
(NORTH BASIN)

Let Δt = 2 minutes = 0.033 hours

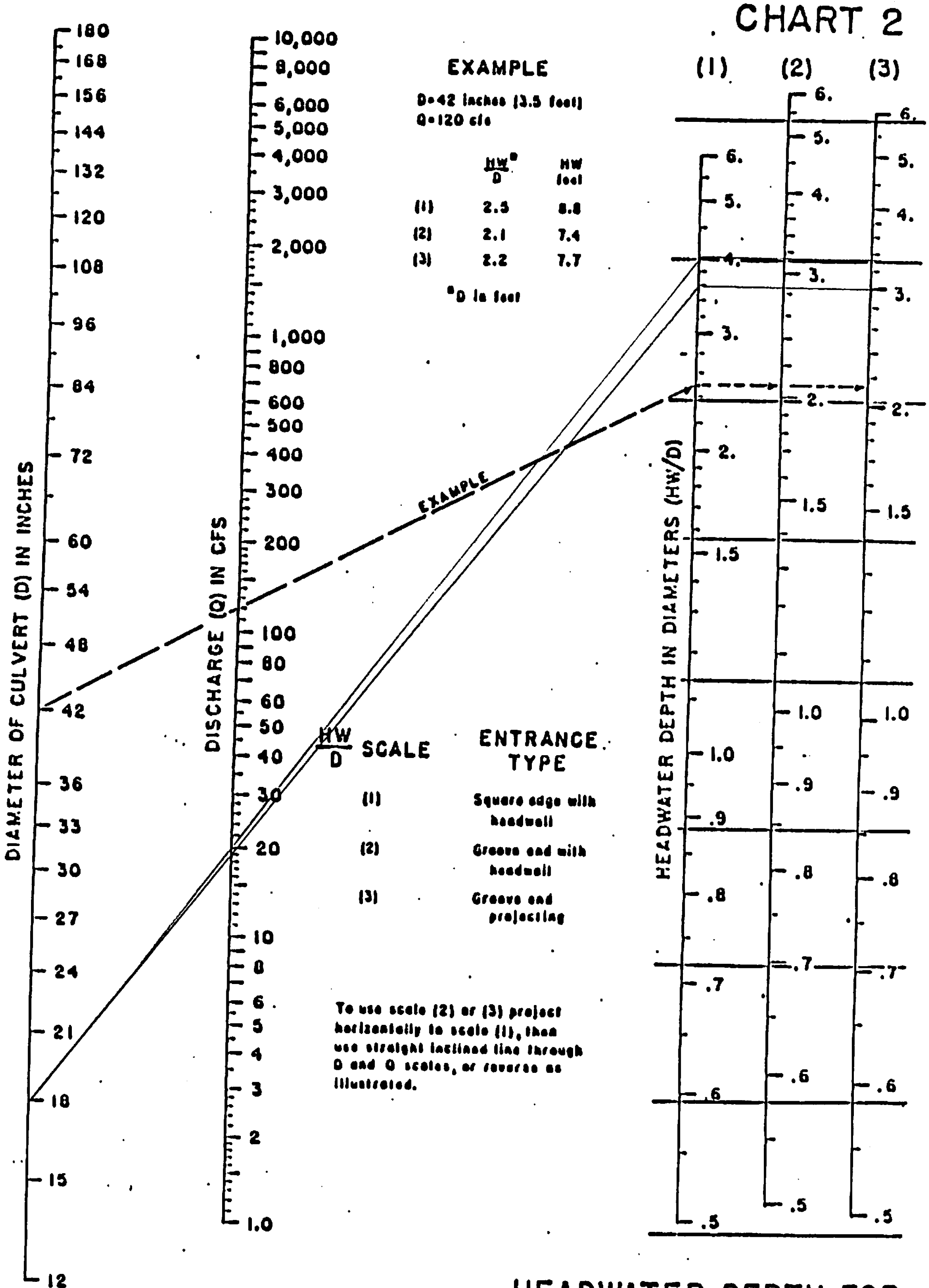
Then $\frac{2S}{\Delta t}$ + outflow = $\frac{2S\,(\text{Ac-Ft.})}{\Delta t\,(\text{hrs})} \times \frac{24\,(\text{hrs/day})}{1.98\,(\text{Ac-Ft/c.f.s.-day})}$ + O (c.f.s.)

$\frac{2S}{\Delta t}$ + O = 727.27 S + O c.f.s.

ELEVATION	S (Ac-Ft.)	O (c.f.s.)	$\frac{2S}{\Delta t}$ + O (c.f.s.)
554.5	0	0.0	0.0
555.0	0.015	2.1	13.01
556.0	0.089	5.7	70.43
557.0	0.238	9.0	182.09
558.0	0.431	12.0	325.45
559.0	0.672	19.0	507.73
559.5	0.818	20.0	614.91
560.0	0.976	21.0	730.82

EXHIBIT 'I'
Sh't. 11 OF 17

CHART 2



HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

BAX ENGINEERING CO., INC.

LAND PLANNING — LAND SURVEYING — SITE ENGINEERING

EXHIBIT 'J'

Sh't. 12 OF 17

Design Pond Routing

NORTH BASIN (100 YEAR STORM)

FORM 102	0	1	2	3	4	5	6	7
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2
1	0	0.0			0.0		0.0	
2	2	7.32	7.32	0.0	7.32		1.0	
3	4	14.64	21.96	5.32	27.28		3.5	
4	6	21.97	36.61	20.28	56.89		5.1	
5	8	29.29	51.26	46.69	97.95		6.6	
6	10	36.61	65.90	84.75	150.65		8.2	
7	12	36.61	73.22	134.25	207.47		9.6	
8	14	36.61	73.22	188.27	261.49		10.8	
9	16	36.61	73.22	239.89	313.11		11.8	
10	18	36.61	73.22	289.51	362.73		13.0	
11	20	36.61	73.22	336.73	409.95		14.6	
12	22	29.29	65.90	380.75	446.65		16.2	
13	24	21.97	51.26	414.25	465.51		17.2	
14	26	14.64	36.61	431.11	467.72	558.80	17.3	0.62 Ac-Ft. 27,007 Cu. Ft.
15	28	7.32	21.96	433.12	455.08		16.6	

← PEAK OUTFLOW

EXHIBIT 'J'
Sht. 13 OF 17

Design Pond Routing

FORM 102	0	1	2	3	4	5	6	7
Line	Time	I_1	I_1+I_2	$\frac{2S_1}{\Delta t} - O_1$	$\frac{2S_2}{t} + O_2$	Elev	Outflow O_2	Storage S_2
1	30	0.0	7.32	421.88	429.20		15.4	
2	32	0.0	0.0	398.40	398.40		14.2	
3								
4								
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9								
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11								
12								
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14								
15								

EXHIBIT 'J'
Sh't. 14 OF 17

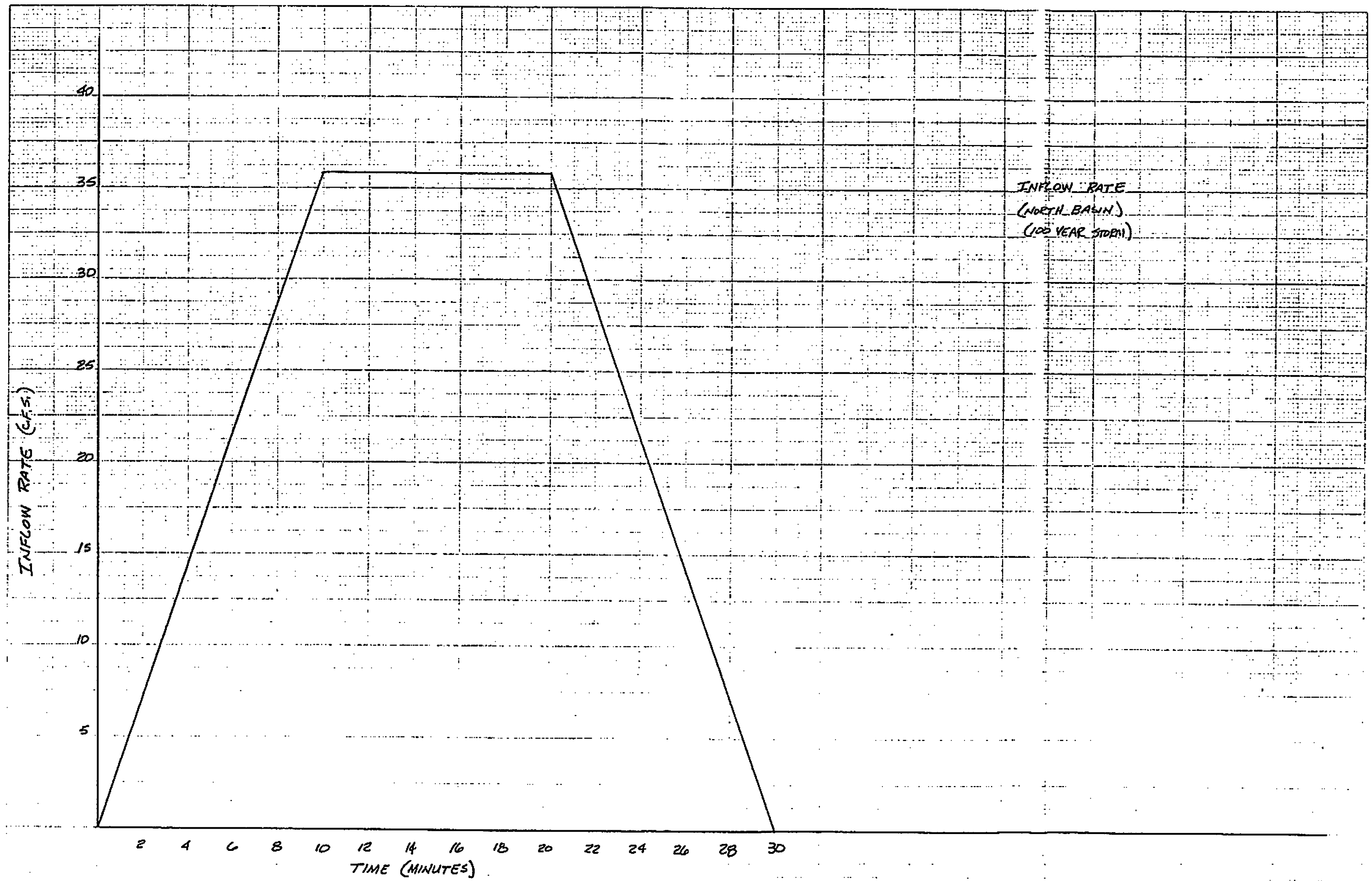

EXHIBIT 'J'
Sh't. 15 OF 17

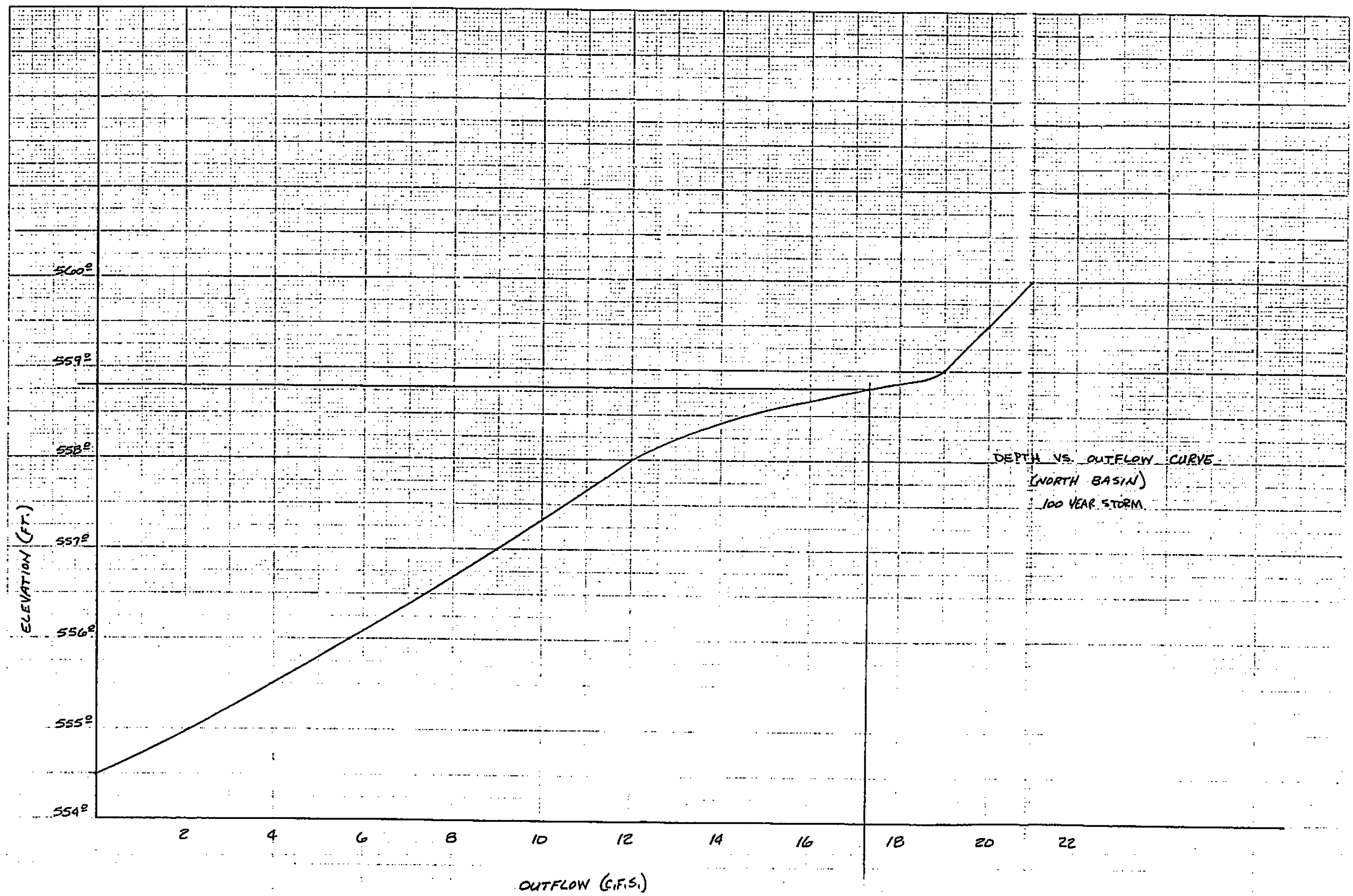

EXHIBIT 'J'
Sh't. 16 OF 17

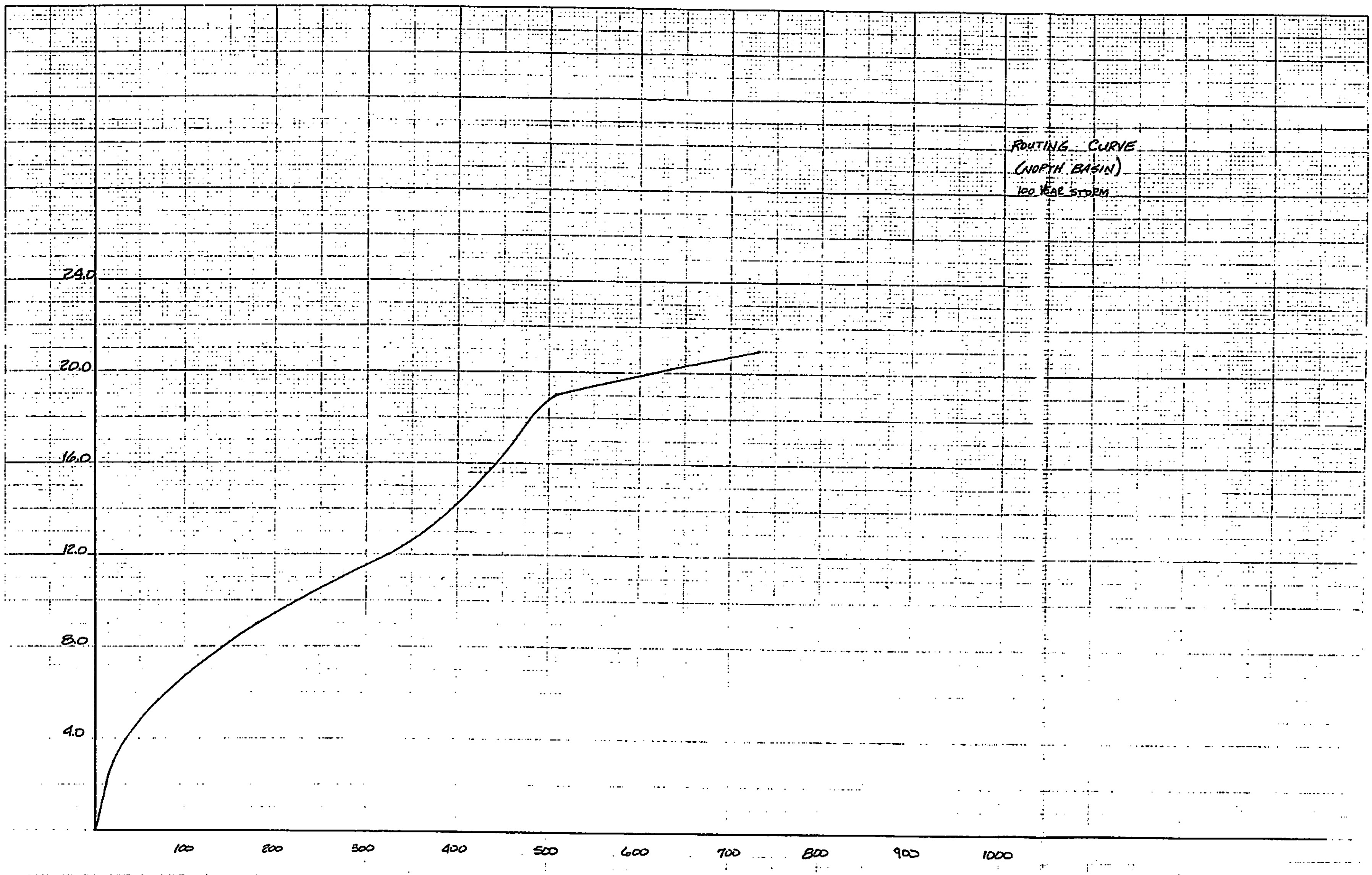

EXHIBIT 'J'
Sh't. 17 OF 17