Manderly Det. Report

ENGINEERING

PLANNING

SURVEYING

STORMWATER DETENTION ANALYSIS
MANDERLEY ESTATES - O'FALLON
PREPARED BY: BAX ENGINEERING CO., INC.
BAX PROJECT NO. 96-8169
NOVEMBER 15, 1996
REVISED DECEMBER 11, 1996
REVISED FEBRUARY 6, 1997

INTRODUCTION:

The tract of land is presently an undeveloped site located in the City of O'Fallon, Missouri. It is proposed that the tract, consisting of 52.50 acres, be developed into a single family residential subdivision. An existing lake and stormwater detention basin near the Northeast corner of the site will provide detention for the development, along with detention for Lone Star Industrial Park which consists of 105.76 Acres, as required by the City of O'Fallon. The storage volume and outflow rates shall be proportioned to insure that the peak rate of runoff leaving the site under post-developed conditions is less than or equal to the peak rate of runoff leaving the site under pre-developed conditions for the required design storms. The basin shall be analyzed for both the 15 year frequency - 20 minute and the 25 year frequency - 20 minute duration design storms. The 100 year frequency - 20 minute design storm will be checked for safe passage.

GENERAL SITE DATA AND RUNOFF CALCULATIONS:

Site area: 52.50 Acres

The pre-developed P.I. factors to be used for analysis are:

ONSITE: 15 year - 20 minute storm (assumed 5% impervious): 1.87 c.f.s./Ac
LONE STAR IND. PARK: 15 year - 20 minute storm (assumed 5% impervious): 1.87 c.f.s./Ac
OFFSITE: 15 year - 20 minute storm (assumed 40% impervious): 2.64 c.f.s./Ac.
OFFSITE: 15 year - 20 minutes storm (assumed 100% impervious): 3.85 c.f.s./Ac.

The post-developed P.I. factors to be used for analysis are:

ONSITE: 15 year - 20 minute storm (developed single family): 2.09 c.f.s./Ac
LONE STAR IND. PARK: 15 year - 20 minute storm (developed heavy industrial): 3.85 c.f.s./Ac
OFFSITE: 15 year - 20 minute storm (assumed 40% impervious): 2.64 c.f.s./Ac.
OFFSITE: 15 year - 20 minute storm (assumed 100% impervious): 3.85 c.f.s./Ac.

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The pre-developed P.I. factors to be used for analysis are:

ONSITE: 25 year - 20 minute storm (assumed 5% impervious): 2.31 c.f.s./Ac
LONE STAR IND. PARK: 25 year - 20 minute storm (assumed 5% impervious): 2.31 c.f.s./Ac
OFFSITE: 25 year - 20 minute storm (assumed 40% impervious): 3.26 c.f.s./Ac.
OFFSITE: 25 year - 20 minutes storm (assumed 100% impervious): 4.75 c.f.s./Ac.

The post-developed P.I. factors to be used for analysis are:

ONSITE: 25 year - 20 minute storm (developed single family): 2.58 c.f.s./Ac
LONE STAR IND. PARK: 25 year - 20 minute storm (developed heavy industrial): 4.75 c.f.s./Ac
OFFSITE: 25 year - 20 minute storm (assumed 40% impervious): 3.26 c.f.s./Ac.
OFFSITE: 25 year - 20 minute storm (assumed 100% impervious): 4.75 c.f.s./Ac.

TIME OF CONCENTRATION:

Of the inflows to the basin, the most remote point of origination lies offsite to the Southwest. It will flow approximately 1,400 feet over pavement, then an additional 1,300 feet overland, then an additional 200 feet via storm sewer and then another 335 feet overland to the detention basin. Time of concentration is estimated as follows:

T(pavement): L = 1,400 feet
Elevation difference = 580 - 520 = 60 feet
T(pavement) = 2.80 minutes: See Figure 1

T(overland): L = 1,300 feet
Elevation difference = 520 - 480 = 40 feet
T(overland) = 7.5 minutes: See Figure 1

T(stormpipe): L = 200 feet
Estimated velocity 7 feet/second
T(stormpipe) = 200 feet/7 feet/sec
= 28.57 seconds = 0.48 minutes

T(overland): L = 335 feet
Elevation difference = 476 - 468.5 = 7.5 feet
T(overland) = 2.85 minutes: See Figure 1

Total Time: T(overland) + T(storm pipe) + T(overland) + T(pavement)
= 2.85 min. + 0.48 min. + 7.50 min. + 2.80 min. = 13.63 min. => use 13.0 minutes

REQUIRED ATTENUATION

Tract Area x [PI(post) - PI(pre)]

15 year - 20 minutes storm

On-site = 52.50 x (2.09 - 1.87) = 11.55 c.f.s.

+ 83.26 - 52.50 = 30.76 (3.85-1.87) = 60.90

Lone Star Industrial Park = 105.76 x (3.85 - 1.87) = 209.40 c.f.s.

Total 220.95 c.f.s.

↳ 281.85

BASIN PEAK INFLOW

Inflows to the basin have been estimated from the drainage area map of the project. (See Construction Plans)

PRE-DEVELOPED RUNOFF (15 year - 20 minute storm)

Flow going to the basin:

On-site areas (assumed 5% impervious)
15 year - 20 minute storm Q_{pre} = 30.19 acres @ 1.87 = 56.46 c.f.s.

Lone Star Industrial Park areas (assumed 5% impervious)
15 year - 20 minute storm Q_{pre} = 51.81 acres @ 1.87 = 96.88 c.f.s.

Off-site areas (assumed 100% impervious)
15 year - 20 minute storm Q_{pre} = 49.19 acres @ 3.85 = 189.38 c.f.s.

Off-site areas (assumed 40% impervious)
15 year - 20 minute storm Q_{pre} = 11.43 acres @ 2.64 = 30.18 c.f.s.

Total 372.90 c.f.s.

100 year - 20 minute storm = 15 year - 20 minute storm x 1.58
= 372.90 c.f.s. x 1.58 = 589.18 c.f.s.

Flow Bypassing the Basin:

On-site areas (assumed 5% impervious)
15 year - 20 minute storm Q_{pre} = 22.28 acres @ 1.87 = 41.66 c.f.s.

Lone Star Industrial Park areas (assumed 5% impervious)
15 year - 20 minute storm Q_{pre} = 53.95 acres @ 1.87 = 100.89 c.f.s.

Off-site areas (assumed 40% impervious)
15 year - 20 minute storm Q_{pre} = 27.0 acres @ 2.64 = 71.28 c.f.s.

Total 213.83 c.f.s.

100 year - 20 minute storm = 15 year - 20 minute storm x 1.58
= 213.83 c.f.s. x 1.58 = 337.85 c.f.s.

POST-DEVELOPED RUNOFF (15 year - 20 minute storm)
Flow going to the Basin:

On-site areas (assumed 15% impervious)
15 year - 20 minute storm Q_{post} = 30.19 acres @ 2.09 = 63.10 c.f.s.

Lone Star Industrial Park (assumed 100% impervious)
15 year - 20 minute storm Q_{post} = 51.81 acres @ 3.85 = 199.47 c.f.s.

Off-site areas (assumed 100% impervious)
15 year - 20 minute storm Q_{post} = 49.19 acres @ 3.85 = 189.38 c.f.s.

Off-site areas (assumed 40% impervious)
15 year - 20 minute storm Q_{post} = 11.43 acres @ 2.64 = 30.18 c.f.s.

Total 482.13 c.f.s.

100 year - 20 minute storm = 15 year - 20 minute storm x 1.58

= 482.13 c.f.s. x 1.58 = 761.77 c.f.s.

Flow Bypassing the Basin:

On-site areas (assumed 15% impervious)
15 year - 20 minute storm Q_{post} = 22.28 acres @ 2.09 = 46.57 c.f.s.

Lone Star Industrial Park areas (assumed 100% impervious)
15 year - 20 minute storm Q_{post} = 53.95 acres @ 3.85 = 207.71 c.f.s.

Off-site areas (assumed 40% impervious)
15 year - 20 minute storm Q_{post} = 27.0 acres @ 2.64 = 71.28 c.f.s.

Total 325.56 c.f.s.

100 year - 20 minute storm = 15 year - 20 minute storm x 1.58
= 325.56 c.f.s.x 1.58 = 514.38 c.f.s.

PERMITTED RELEASE RATE

The permitted release rate of the detention basin is found by subtracting the total required attenuation from the post-developed peak inflow to the basin for the design storm.

15 year - 20 minute storm 281.85 = 200.28
Permitted release rate = 482.13 c.f.s. - 220.95 c.f.s.
= 261.18 c.f.s.

ROUTING CALCULATIONS AND RESULTS

A computer program "Pondpack" was utilitzed in routing the design storms through the basin. As found in the routing calculations, the results of each analysis are as follows:

15 year - 20 minute storm:
Peak release rate = 33.43 (< 261.18 c.f.s.)
Peak elevation = 470.70

REQUIRED ATTENUATION

Tract Area x [PI(post) - PI(pre)]

25 year - 20 minutes storm

On-site = 52.50 x (2.58 - 2.31) = 14.18 c.f.s. + 30.76 (4.75 - 2.31) = 75.05

Lone Star Industrial Park = 105.76 x (4.75 - 2.31) = 258.05 c.f.s.

Total 272.23 c.f.s.
347.28

BASIN PEAK INFLOW

Inflows to the basin have been estimated from the drainage area map of the project. (See Construction Plans)

PRE-DEVELOPED RUNOFF (25 year - 20 minute storm)

Flow going to the basin:

On-site areas (assumed 5% impervious)

25 year - 20 minute storm Q_{pre} = 30.19 acres @ 2.31 = 69.74 c.f.s.

Lone Star Industrial Park areas (assumed 5% impervious)

25 year - 20 minute storm Q_{pre} = 51.81 acres @ 2.31 = 119.68 c.f.s.

Off-site areas (assumed 100% impervious)

25 year - 20 minute storm Q_{pre} = 49.19 acres @ 4.75 = 233.65 c.f.s.

Off-site areas (assumed 40% impervious)

25 year - 20 minute storm Q_{pre} = 11.43 acres @ 3.26 = 37.26 c.f.s.

Total 460.33 c.f.s.

100 year - 20 minute storm = 25 year - 20 minute storm x 1.28
= 460.33 c.f.s. x 1.28 = 589.22 c.f.s.

Flow Bypassing the Basin:

On-site areas (assumed 5% impervious)

25 year - 20 minute storm Q_{pre} = 22.28 acres @ 2.31 = 51.47 c.f.s.

Lone Star Industrial Park areas (assumed 5% impervious)

25 year - 20 minute storm Q_{pre} = 53.95 acres @ 2.31 = 124.62 c.f.s.

Off-site areas (assumed 40% impervious)

25 year - 20 minute storm Q_{pre} = 27.0 acres @ 3.26 = 88.02 c.f.s.

Total 264.11 c.f.s.

100 year - 20 minute storm = 25 year - 20 minute storm x 1.28
= 264.11 c.f.s. x 1.28 = 338.06 c.f.s.

POST-DEVELOPED RUNOFF (25 year - 20 minute storm)

Flow going to the Basin:

On-site areas (assumed 15% impervious)

25 year - 20 minute storm Q_{post} = 30.19 acres @ 2.58 = 77.89 c.f.s.

Lone Star Industrial Park (assumed 100% impervious)
25 year - 20 minute storm Q_{post} = 51.81 acres @ 4.75 = 246.10 c.f.s.

Off-site areas (assumed 100% impervious)
25 year - 20 minute storm Q_{post} = 49.19 acres @ 4.75 = 233.65 c.f.s.

Off-site areas (assumed 40% impervious)
25 year - 20 minute storm Q_{post} = 11.43 acres @ 3.26 = 37.26 c.f.s.

Total 594.90 c.f.s.

100 year - 20 minute storm = 25 year - 20 minute storm x 1.28

= 594.90 c.f.s. x 1.28 = 761.47 c.f.s.

Flow Bypassing the Basin:

On-site areas (assumed 15% impervious)
25 year - 20 minute storm Q_{post} = 22.28 acres @ 2.58 = 57.48 c.f.s.

Lone Star Industrial Park areas (assumed 100% impervious)
25 year - 20 minute storm Q_{post} = 53.95 acres @ 4.75 = 256.26 c.f.s.

Off-site areas (assumed 40% impervious)
25 year - 20 minute storm Q_{post} = 27.0 acres @ 3.26 = 88.02 c.f.s.

Total 401.76 c.f.s.

100 year - 20 minute storm = 25 year - 20 minute storm x 1.28
= 401.76 c.f.s.x 1.28 = 514.25 c.f.s.

PERMITTED RELEASE RATE

The permitted release rate of the detention basin is found by subtracting the total required attenuation from the post-developed peak inflow to the basin for the design storm.

25 year - 20 minute storm - 347.28 = 247.62
Permitted release rate = 594.90 c.f.s. - 272.23 c.f.s.
= 322.67 c.f.s.

ROUTING CALCULATIONS AND RESULTS

A computer program "Pondpack" was utilitzed in routing the design storms through the basin. As found in the routing calculations, the results of each analysis are as follows:

25 year - 20 minute storm:
Peak release rate = 42.37 (< 322.67 c.f.s.)
Peak elevation = 471.31

*100 year - 20 minute storm: (worst case)

Weir Elevation = 471.50
$Q = CLH^{1.5}$
Q = 761.77 c.f.s.
C = 3.0
L = 46.0 feet
H = 3.20 feet
Elev. = 474.70
Freeboard = 476.00 - 474.70 = 1.30 feet

Check
$Q = 3.0\ (46.0)(3.20)^{1.5}$
Q = 789.96 c.f.s.
789.96 c.f.s. > 761.77 c.f.s.

CHECKING DISCHARGE PIPES

100 year - 20 minute storm: (see Page 10)
Q = 761.77 c.f.s.
Existing Discharge Pipes: 2-72" CMP
Flowline of Existing Pipes: 462.50
Check under inlet control
HW/D = 1.7 => 1.7 x 72" = 10.2 feet
Elevation = 462.50 + 10.2 = 472.70 Controls

DETENTION BASIN CHARACTERISTICS SUMMARY:

15 year - 20 minute storm highwater = 470.70
25 year - 20 minute storm highwater = 471.31
100 year - 20 minute storm highwater = 474.70

Overflow Structure:

Existing concrete structure with grate inlet top
Flowline of the two existing 72" CMP = 462.50
Flowline of low flow slot - (13.2" w x 30" h) = 467.75
Flowline of emergency overflow = 471.50

*Note: The 100 year - 20 minute storm was checked for safe passage through the basin in a worst case situation with the low flow opening blocked.

D= 2 Existing 72" CMP

TQ = 761.77 c.f.s.

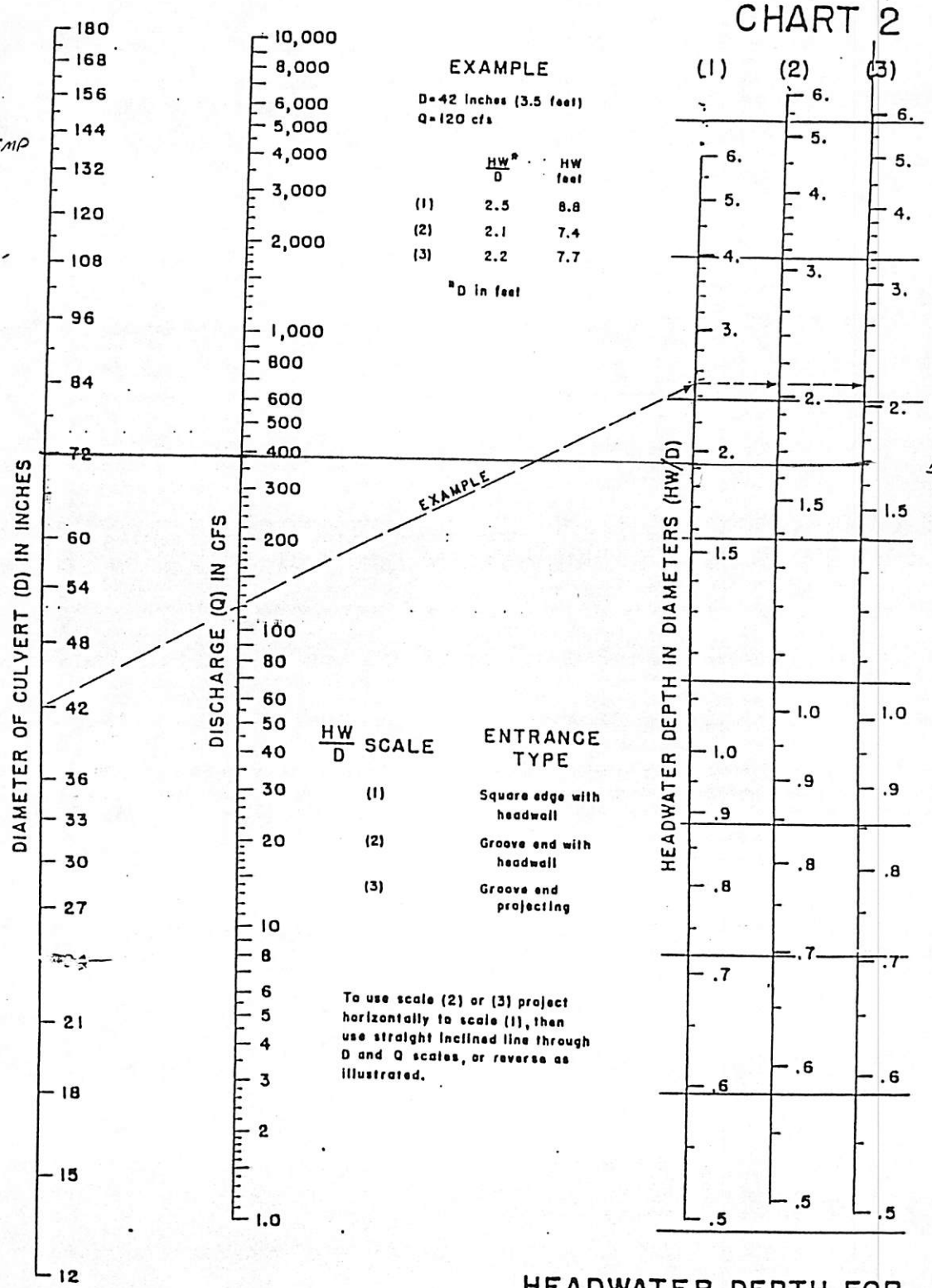
$\frac{TQ}{2}$ = 380.89 c.f.s.

D= 72"

HL = 462.50

Hw+HL = 472.50

CHART 2



EXAMPLE

D=42 inches (3.5 feet)
Q=120 cfs

	$\frac{HW}{D}$	HW feet
(1)	2.5	8.8
(2)	2.1	7.4
(3)	2.2	7.7

*D in feet

$\frac{Hw}{D}$ = 1.7

Hw = 1.7(6) = 10.20

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

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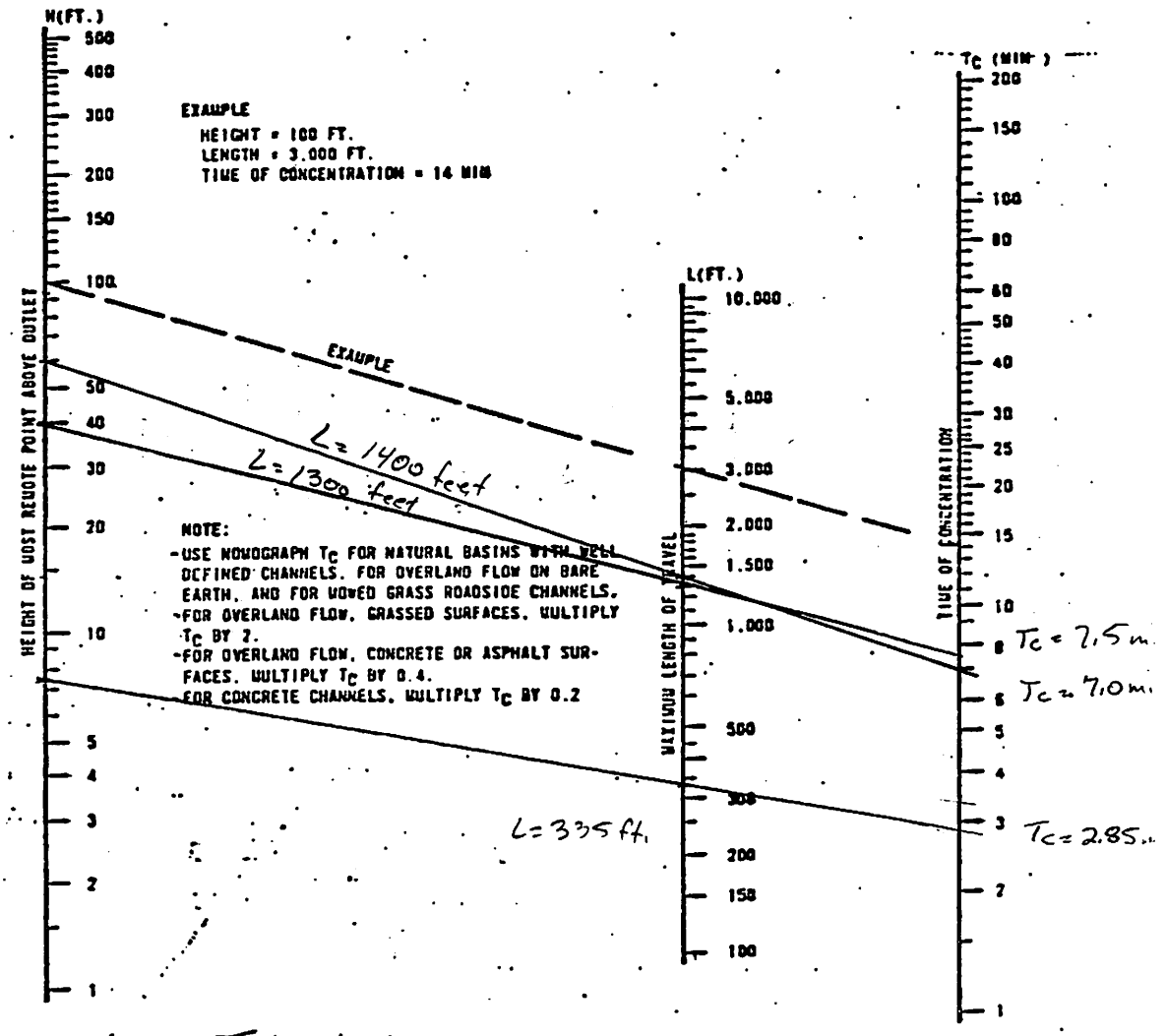
MANDERLEY ESTATES
96-8169



$H_p = 60$ ft.

$H_o = 40$ ft

$H = 7.50$ feet

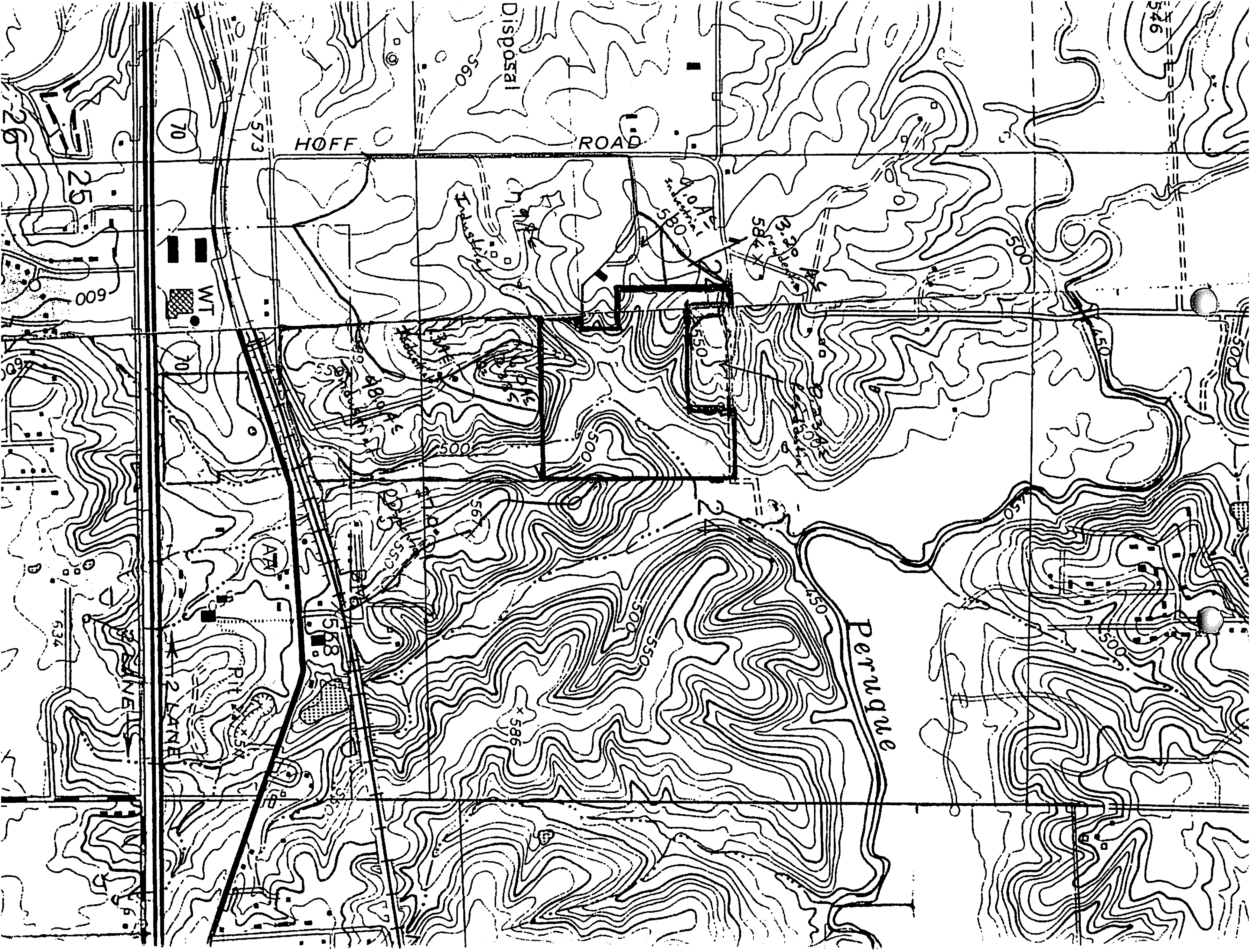
T_{c_1} (overland) = 7.5 minutes

T_c (pavement) = 7.0 min. x 0.4 = 2.80 minutes

T_{c_2} (overland) = 2.85 minutes

FIGURE 1

TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS


HOFF ROAD
Disposal
WT
Perque
2 LANE
Industrial
560
573
580
584
586
600
500
550
450
634
546
25
26
24
70

POND-2 Version: 5.17 S/N:

>>>>> HYDROGRAPH PRINTOUT <<<<<

02-06-1997 13:05:28

Hydrograph file: 8169-15 .HYD

HYDROGRAPH ORDINATES (cfs)
Time increment = 1.00 Minutes
Time on left represents time for first Q in each row.

Time Minutes							
0.00	0.00	37.09	74.17	111.26	148.35	185.44	222.52
7.00	259.61	296.70	333.78	370.87	407.96	445.04	482.13
14.00	482.13	482.13	482.13	482.13	482.13	482.13	482.13
21.00	445.04	407.96	370.87	333.78	296.70	259.61	222.52
28.00	185.44	148.35	111.26	74.17	37.09	0.00	

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*
* MANDERLEY ESTATES
* DETENTION ANALYSIS
* PREPARED BY: BAX ENGINEERING CO., INC.
* FEBRUARY 06, 1997
*
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Inflow Hydrograph: 8169-15 .HYD
Rating Table file: 8169 .PND

----INITIAL CONDITIONS----
Elevation = 467.75 ft
Outflow = 0.00 cfs
Storage = 0.00 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
467.75	0.0	0.000
468.25	2.3	2.024
468.75	6.6	4.092
469.25	12.1	6.205
469.75	18.7	8.364
470.25	26.1	10.573
470.75	34.3	12.858
471.25	39.7	15.224
471.75	61.2	17.674
472.25	137.4	20.210
472.75	244.1	22.840
473.25	374.1	25.567
473.75	523.5	28.393
474.25	690.0	31.320
474.75	872.0	34.354
475.25	1068.3	37.497
475.75	1277.9	40.751

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
0.0	0.0
2938.7	2941.0
5941.8	5948.4
9010.2	9022.3
12144.5	12163.2
15351.5	15377.6
18669.1	18703.4
22105.7	22145.4
25663.1	25724.3
29345.2	29482.6
33164.0	33408.1
37123.6	37497.7
41226.5	41750.0
45476.3	46166.3
49881.3	50753.3
54445.1	55513.4
59170.7	60448.6

Time increment (t) = 1.0 min.

POND-2 Version: 5.17 S/N:
EXECUTED: 02-06-1997 13:08:23

Pond File: 8169 .PND
Inflow Hydrograph: 8169-15 .HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH

TIME (min)	INFLOW (cfs)
0.0	0.00
1.0	37.09
2.0	74.17
3.0	111.26
4.0	148.35
5.0	185.44
6.0	222.52
7.0	259.61
8.0	296.70
9.0	333.78
10.0	370.87
11.0	407.96
12.0	445.04
13.0	482.13
14.0	482.13
15.0	482.13
16.0	482.13
17.0	482.13
18.0	482.13
19.0	482.13
20.0	482.13
21.0	445.04
22.0	407.96
23.0	370.87
24.0	333.78
25.0	296.70
26.0	259.61
27.0	222.52
28.0	185.44
29.0	148.35
30.0	111.26
31.0	74.17
32.0	37.09
33.0	0.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
-----	0.0	0.0	0.00	467.75
37.1	37.0	37.1	0.03	467.76
111.3	148.1	148.3	0.12	467.78
185.4	333.0	333.5	0.26	467.81
259.6	591.7	592.6	0.46	467.85
333.8	924.0	925.4	0.72	467.91
408.0	1329.9	1332.0	1.04	467.98
482.1	1809.2	1812.0	1.42	468.06
556.3	2361.8	2365.5	1.85	468.15
630.5	2987.5	2992.3	2.37	468.26
704.7	3685.4	3692.2	3.37	468.37
778.8	4455.3	4464.2	4.48	468.50
853.0	5296.9	5308.3	5.68	468.64
927.2	6209.9	6224.1	7.09	468.79
964.3	7156.6	7174.2	8.79	468.95
964.3	8099.9	8120.8	10.49	469.10
964.3	9039.7	9064.1	12.19	469.26
964.3	9975.7	10004.0	14.16	469.41
964.3	10907.7	10939.9	16.13	469.56
964.3	11835.8	11871.9	18.09	469.70
964.3	12759.7	12800.0	20.17	469.85
927.2	13642.4	13686.9	22.21	469.99
853.0	14447.3	14495.4	24.07	470.11
778.8	15174.6	15226.1	25.75	470.23
704.7	15824.6	15879.3	27.34	470.33
630.5	16397.6	16455.1	28.76	470.41
556.3	16893.9	16953.9	29.99	470.49
482.1	17314.0	17376.0	31.03	470.55
408.0	17658.2	17721.9	31.88	470.60
333.8	17926.9	17992.0	32.55	470.64
259.6	18120.4	18186.5	33.03	470.67
185.4	18239.2	18305.9	33.32	470.69
111.3	18283.6	18350.5	33.43	470.70
37.1	18254.0	18320.7	33.36	470.69

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: 8169 .PND
Inflow Hydrograph: 8169-15 .HYD
Outflow Hydrograph: OUT .HYD

Starting Pond W.S. Elevation = 467.75 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow	=	482.13 cfs
Peak Outflow	=	33.43 cfs
Peak Elevation	=	470.70 ft

***** Summary of Approximate Peak Storage *****

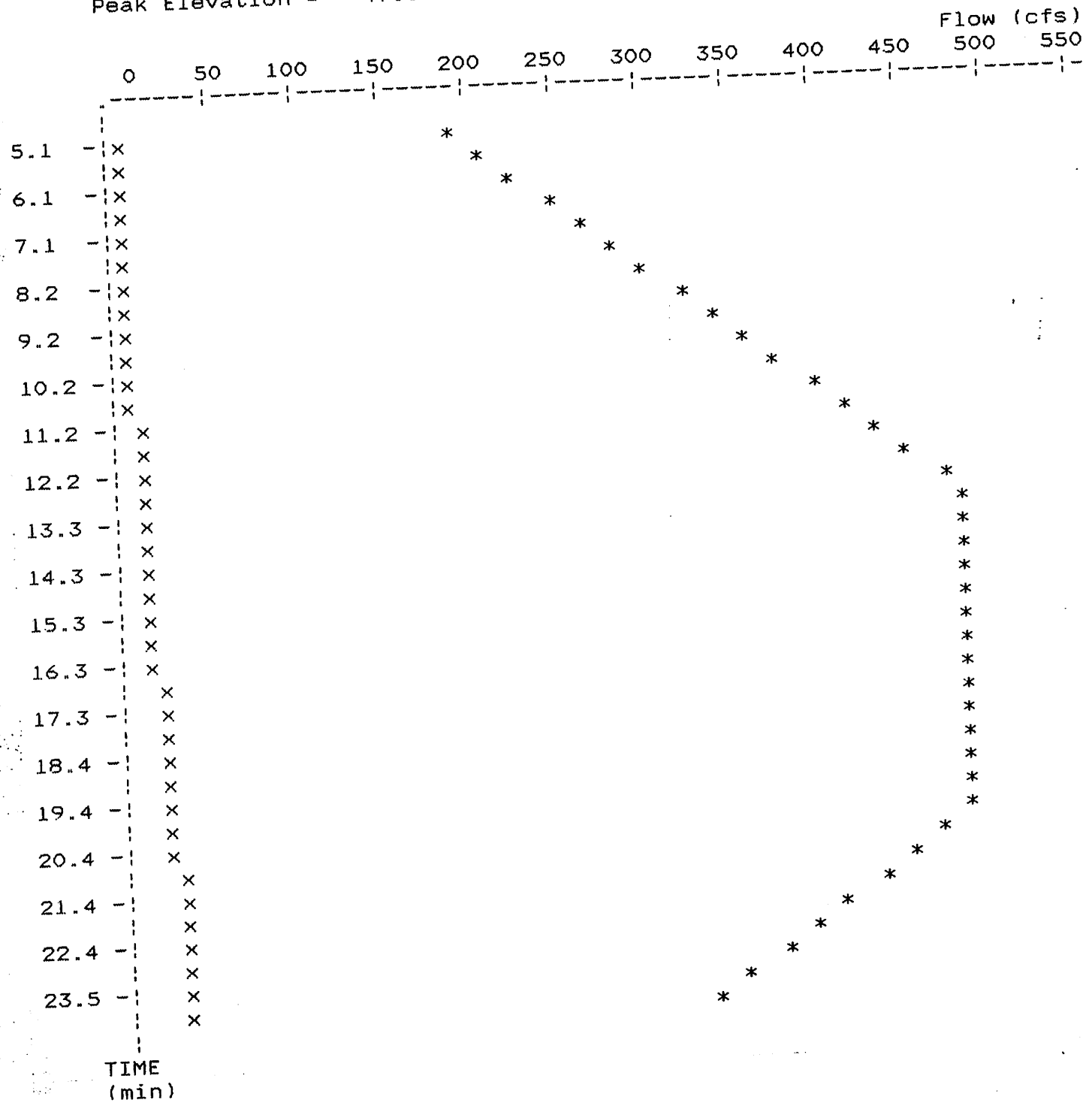
Initial Storage	=	0.00 ac-ft
Peak Storage From Storm	=	12.62 ac-ft
Total Storage in Pond	=	12.62 ac-ft

POND-2 Version: 5.17 S/N:

Pond File: 8169 .PND
Inflow Hydrograph: 8169-15 .HYD
Outflow Hydrograph: OUT .HYD

EXECUTED: 02-06-1997
13:08:23

Peak Inflow = 482.13 cfs
Peak Outflow = 33.43 cfs
Peak Elevation = 470.70 ft



× File: 8169-15 .HYD Qmax = 33.4 cfs
* File: OUT .HYD Qmax = 482.1 cfs

POND-2 Version: 5.1 S/N:

>>>>> HYDROGRAPH PRINTOUT <<<<<

02-06-1997 13:05:48

Hydrograph file: 8169-25 .HYD

HYDROGRAPH ORDINATES (cfs)
Time increment = 1.00 Minutes
Time on left represents time for first Q in each row.

Time Minutes							
0.00	0.00	45.76	91.52	137.28	183.04	228.80	274.56
7.00	320.33	366.09	411.85	457.59	503.37	549.13	594.90
14.00	594.90	594.90	594.90	594.90	594.90	594.90	594.90
21.00	549.13	503.37	457.59	411.85	366.09	320.33	274.56
28.00	228.80	183.04	137.28	91.52	45.76	0.00	

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* MANDERLEY ESTATES *
* DETENTION ANALYSIS *
* PREPARED BY: BAX ENGINEERING CO., INC. *
* FEBRUARY 06, 1997 *
*
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Inflow Hydrograph: 8169-25 .HYD
Rating Table file: 8169 .PND

----INITIAL CONDITIONS----
Elevation = 467.75 ft
Outflow = 0.00 cfs
Storage = 0.00 ac-ft

GIVEN POND DATA			INTERMEDIATE ROUTING COMPUTATIONS	
ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)	2S/t (cfs)	2S/t + O (cfs)
467.75	0.0	0.000	0.0	0.0
468.25	2.3	2.024	2938.7	2941.0
468.75	6.6	4.092	5941.8	5948.4
469.25	12.1	6.205	9010.2	9022.3
469.75	18.7	8.364	12144.5	12163.2
470.25	26.1	10.573	15351.5	15377.6
470.75	34.3	12.858	18669.1	18703.4
471.25	39.7	15.224	22105.7	22145.4
471.75	61.2	17.674	25663.1	25724.3
472.25	137.4	20.210	29345.2	29482.6
472.75	244.1	22.840	33164.0	33408.1
473.25	374.1	25.567	37123.6	37497.7
473.75	523.5	28.393	41226.5	41750.0
474.25	690.0	31.320	45476.3	46166.3
474.75	872.0	34.354	49881.3	50753.3
475.25	1068.3	37.497	54445.1	55513.4
475.75	1277.9	40.751	59170.7	60448.6

Time increment (t) = 1.0 min.

POND-2 Version: 5.17 S/N:
EXECUTED: 02-06-1997 13:09:06

Pond File: 8169 .PND
Inflow Hydrograph: 8169-25 .HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH

TIME (min)	INFLOW (cfs)
0.0	0.00
1.0	45.76
2.0	91.52
3.0	137.28
4.0	183.04
5.0	228.80
6.0	274.56
7.0	320.33
8.0	366.09
9.0	411.85
10.0	457.59
11.0	503.37
12.0	549.13
13.0	594.90
14.0	594.90
15.0	594.90
16.0	594.90
17.0	594.90
18.0	594.90
19.0	594.90
20.0	594.90
21.0	549.13
22.0	503.37
23.0	457.59
24.0	411.85
25.0	366.09
26.0	320.33
27.0	274.56
28.0	228.80
29.0	183.04
30.0	137.28
31.0	91.52
32.0	45.76
33.0	0.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
-----	0.0	0.0	0.00	467.75
45.8	45.7	45.8	0.04	467.76
137.3	182.7	183.0	0.14	467.78
228.8	410.8	411.5	0.32	467.82
320.3	730.0	731.2	0.57	467.87
411.8	1140.1	1141.9	0.89	467.94
503.4	1640.9	1643.4	1.29	468.03
594.9	2232.3	2235.7	1.75	468.13
686.4	2914.1	2918.7	2.28	468.25
777.9	3685.3	3692.0	3.37	468.37
869.4	4545.5	4554.7	4.61	468.52
961.0	5494.5	5506.5	5.97	468.68
1052.5	6531.7	6547.0	7.67	468.85
1144.0	7656.4	7675.7	9.69	469.03
1189.8	8822.6	8846.2	11.78	469.22
1189.8	9984.0	10012.4	14.18	469.41
1189.8	11140.6	11173.8	16.62	469.59
1189.8	12292.2	12330.4	19.08	469.78
1189.8	13438.5	13482.0	21.74	469.96
1189.8	14579.6	14628.3	24.38	470.13
1189.8	15715.3	15769.4	27.07	470.31
1189.8	16799.8	16859.3	29.75	470.47
1144.0	17787.9	17852.3	32.20	470.62
1052.5	18680.1	18748.8	34.37	470.76
961.0	19478.3	19549.5	35.63	470.87
869.4	20182.7	20256.2	36.74	470.98
777.9	20793.8	20869.2	37.70	471.06
686.4	21311.6	21388.7	38.51	471.14
594.9	21736.6	21815.0	39.18	471.20
503.4	22069.0	22148.5	39.72	471.25
411.8	22307.0	22389.4	41.17	471.28
320.3	22451.7	22535.8	42.05	471.30
228.8	22504.3	22589.0	42.37	471.31
137.3	22465.8	22550.0	42.13	471.31
45.8				

POND-2 Version: 5.17 S/N:
EXECUTED: 02-06-1997 13:09:06

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File:	8169	.PND
Inflow Hydrograph:	8169-25	.HYD
Outflow Hydrograph:	OUT	.HYD

Starting Pond W.S. Elevation = 467.75 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow	=	594.90 cfs
Peak Outflow	=	42.37 cfs
Peak Elevation	=	471.31 ft

***** Summary of Approximate Peak Storage *****

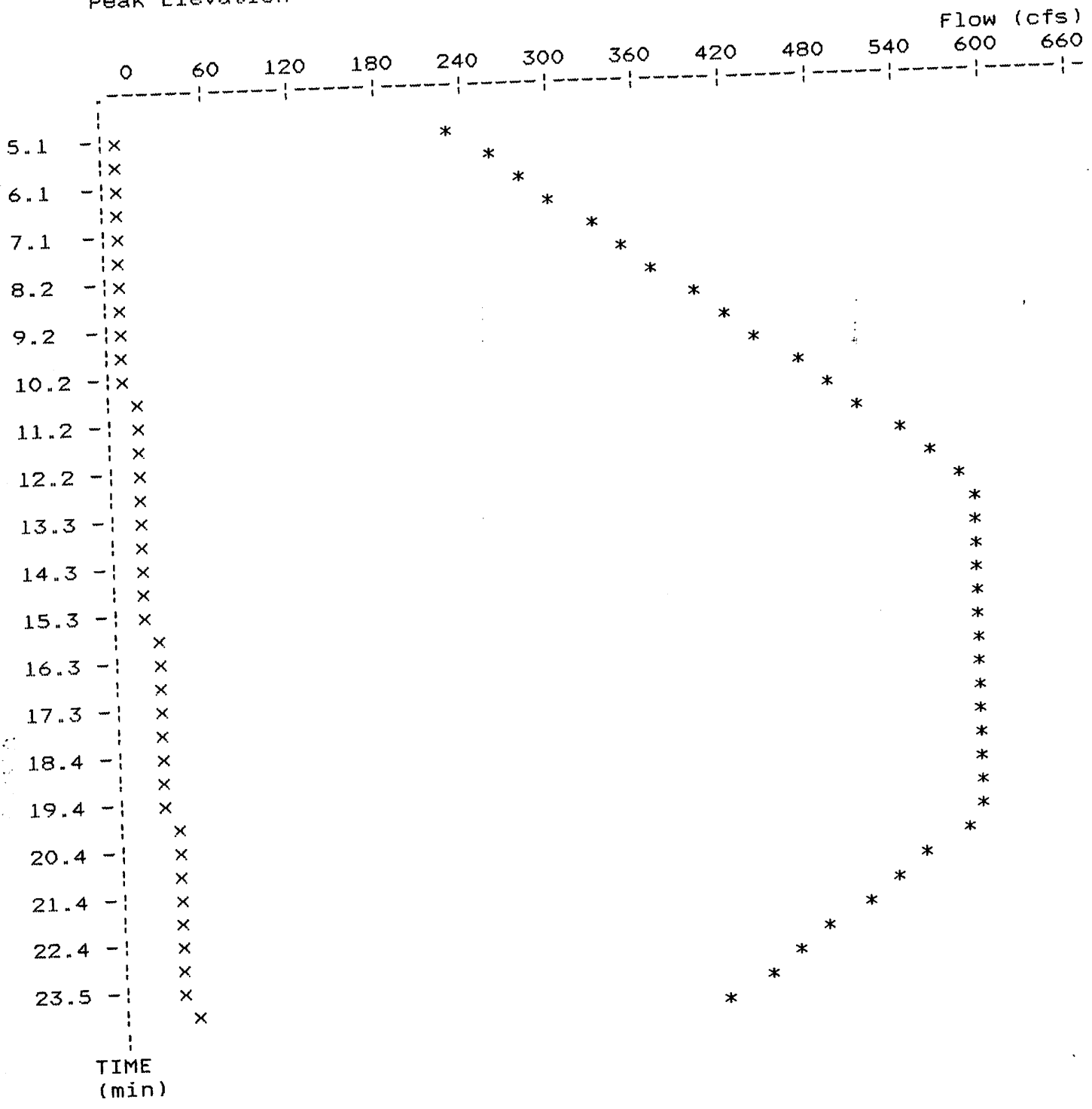
Initial Storage	=	0.00 ac-ft
Peak Storage From Storm	=	15.53 ac-ft
Total Storage in Pond	=	15.53 ac-ft

POND-2 Version: 5.17 S/N:

Pond File: 8169 .PND
Inflow Hydrograph: 8169-25 .HYD
Outflow Hydrograph: OUT .HYD

EXECUTED: 02-06-1997
13:09:06

Peak Inflow = 594.90 cfs
Peak Outflow = 42.37 cfs
Peak Elevation = 471.31 ft



× File: 8169-25 .HYD Qmax = 42.4 cfs
* File: OUT .HYD Qmax = 594.9 cfs

POND-2 Version: 5.17
S/N:

MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997

CALCULATED 02-06-1997 13:06:13
DISK FILE: 8169 .VOL

Planimeter scale: 1 inch = 50 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	* Volume (acre-ft)	Volume Sum (acre-ft)
467.75	69.76	4.00	0.00	0.00	0.00
470.00	76.82	4.41	12.61	9.46	9.46
472.00	88.33	5.07	14.21	9.47	18.93
474.00	101.97	5.85	16.37	10.91	29.84
476.00	117.36	6.74	18.87	12.58	42.42

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

***** COMPOSITE OUTFLOW SUMMARY ****

Elevation (ft)	Q (cfs)	Contributing Structures
467.75	0.0	1 +3
468.25	2.3	1 +3
468.75	6.6	1 +3
469.25	12.1	1 +3
469.75	18.7	1 +3
470.25	26.1	1 +3
470.75	34.3	1 +3
471.25	39.7	2 +4
471.75	61.2	2 +4 +5
472.25	137.4	2 +4 +5
472.75	244.1	2 +4 +5
473.25	374.1	2 +4 +5
473.75	523.5	2 +4 +5
474.25	690.0	2 +4 +5
474.75	872.0	2 +4 +5
475.25	1068.3	2 +4 +5
475.75	1277.9	2 +4 +5
476.00	0.0	

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

Outlet Structure File: 8169 .STR
Planimeter Input File: 8169 .VOL
Rating Table Output File: 8169 .PND

Min. Elev.(ft) = 467.75 Max. Elev.(ft) = 476 Incr.(ft) = .5

Additional elevations (ft) to be included in table:
* *

****
SYSTEM CONNECTIVITY
****

Structure	No.	Q Table		Q Table
	1		->	1
WEIR-VR	2	? 1	->	A
ORIFICE	3		->	3
WEIR-VR	4	? 3	->	B
ORIFICE	5		->	5
WEIR-VR				

Outflow rating table summary was stored in file:
8169 .PND

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

>>>>>> Structure No. 1 <<<<<<
(Input Data)

WEIR-VR
Weir - Vertical Rectangular

E1 elev.(ft)?	467.75
E2 elev.(ft)?	476.00
Weir coefficient?	3
Weir elev.(ft)?	467.75
Length (ft)?	1.10
Contracted/Suppressed (C/S)?	S

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

>>>>>> Structure No. 2 <<<<<<
(Input Data)

ORIFICE
Orifice - Based on Area and Datum Elevation

E1 elev.(ft)?	469.00
E2 elev.(ft)?	476.00
Orifice coeff.?	.6
Invert elev.(ft)?	467.75
Datum elev.(ft) ?	469.00
Orifice area (sq ft)?	2.75

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

>>>>>> Structure No. 3 <<<<<<
(Input Data)

WEIR-VR
Weir - Vertical Rectangular

E1 elev.(ft)?	467.75
E2 elev.(ft)?	476.0
Weir coefficient?	3
Weir elev.(ft)?	467.75
Length (ft)?	1.10
Contracted/Suppressed (C/S)?	S

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

>>>>>> Structure No. 4 <<<<<<
(Input Data)

ORIFICE
Orifice - Based on Area and Datum Elevation

E1 elev.(ft)?	469.00
E2 elev.(ft)?	476.0
Orifice coeff.?	.6
Invert elev.(ft)?	467.75
Datum elev.(ft) ?	469.00
Orifice area (sq ft)?	2.75

Outlet Structures File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

>>>>>> Structure No. 5 <<<<<<
(Input Data)

WEIR-VR
Weir - Vertical Rectangular

E1 elev.(ft)?	471.50
E2 elev.(ft)?	476.00
Weir coefficient?	3
Weir elev.(ft)?	471.50
Length (ft)?	46.00
Contracted/Suppressed (C/S)?	S

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06, 1997
****

Outflow Rating Table for Structure #1
WEIR-VR Weir - Vertical Rectangular

***** INLET CONTROL ASSUMED *****

Elevation (ft)	Q (cfs)	Computation Messages
467.75	0.0	H =0.0
468.25	1.2	H =.5
468.75	3.3	H =1.0
469.25	6.1	H =1.5
469.75	9.3	H =2.0
470.25	13.0	H =2.5
470.75	17.1	H =3.0
471.25	21.6	H =3.5
471.75	26.4	H =4.0
472.25	31.5	H =4.5
472.75	36.9	H =5.0
473.25	42.6	H =5.5
473.75	48.5	H =6.0
474.25	54.7	H =6.5
474.75	61.1	H =7.0
475.25	67.8	H =7.5
475.75	74.7	H =8.0
476.00	0.0	E = or > E2=476.00

C = 3 L (ft) = 1.1
H (ft) = Table elev. - Invert elev. (467.75 ft)
Q (cfs) = C * L * (H**1.5) -- Suppressed Weir

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

Outflow Rating Table for Structure #2
ORIFICE Orifice - Based on Area and Datum Elevation

Elevation (ft)	Q (cfs)	Computation Messages
467.75	0.0	E < E1=469.00
468.25	0.0	E < E1=469.00
468.75	0.0	E < E1=469.00
469.25	6.6	H =.25
469.75	11.5	H =.750
470.25	14.8	H =1.25
470.75	17.5	H =1.75
471.25	19.9	H =2.25
471.75	22.0	H =2.75
472.25	23.9	H =3.25
472.75	25.6	H =3.75
473.25	27.3	H =4.25
473.75	28.9	H =4.75
474.25	30.3	H =5.25
474.75	31.8	H =5.75
475.25	33.1	H =6.25
475.75	34.4	H =6.75
476.00	0.0	E = or > E2=476.00

C = .6 A = 2.75 sq.ft.
H (ft) = Table elev. - Datum elev. (469 ft)
Q (cfs) = C * A * sqr(2g * H)

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

Outflow Rating Table for Structure #3
WEIR-VR Weir - Vertical Rectangular

***** INLET CONTROL ASSUMED *****

Elevation (ft)	Q (cfs)	Computation Messages
467.75	0.0	H =0.0
468.25	1.2	H =.5
468.75	3.3	H =1.0
469.25	6.1	H =1.5
469.75	9.3	H =2.0
470.25	13.0	H =2.5
470.75	17.1	H =3.0
471.25	21.6	H =3.5
471.75	26.4	H =4.0
472.25	31.5	H =4.5
472.75	36.9	H =5.0
473.25	42.6	H =5.5
473.75	48.5	H =6.0
474.25	54.7	H =6.5
474.75	61.1	H =7.0
475.25	67.8	H =7.5
475.75	74.7	H =8.0
476.00	0.0	E = or > E2=476.0

C = 3 L (ft) = 1.1
H (ft) = Table elev. - Invert elev. (467.75 ft)
Q (cfs) = C * L * (H**1.5) -- Suppressed Weir

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

Outflow Rating Table for Structure #4
ORIFICE Orifice - Based on Area and Datum Elevation

Elevation (ft)	Q (cfs)	Computation Messages
467.75	0.0	E < E1=469.00
468.25	0.0	E < E1=469.00
468.75	0.0	E < E1=469.00
469.25	6.6	H =.25
469.75	11.5	H =.750
470.25	14.8	H =1.25
470.75	17.5	H =1.75
471.25	19.9	H =2.25
471.75	22.0	H =2.75
472.25	23.9	H =3.25
472.75	25.6	H =3.75
473.25	27.3	H =4.25
473.75	28.9	H =4.75
474.25	30.3	H =5.25
474.75	31.8	H =5.75
475.25	33.1	H =6.25
475.75	34.4	H =6.75
476.00	0.0	E = or > E2=476.0

C = .6 A = 2.75 sq.ft.
H (ft) = Table elev. - Datum elev. (469 ft)
Q (cfs) = C * A * sqr(2g * H)

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

Outflow Rating Table for Structure #5
WEIR-VR Weir - Vertical Rectangular

***** INLET CONTROL ASSUMED *****

Elevation (ft)	Q (cfs)	Computation Messages
467.75	0.0	E < Inv.El.= 471.5
468.25	0.0	E < Inv.El.= 471.5
468.75	0.0	E < Inv.El.= 471.5
469.25	0.0	E < Inv.El.= 471.5
469.75	0.0	E < Inv.El.= 471.5
470.25	0.0	E < Inv.El.= 471.5
470.75	0.0	E < Inv.El.= 471.5
471.25	0.0	E < Inv.El.= 471.5
471.75	17.3	H =.25
472.25	89.6	H =.750
472.75	192.9	H =1.25
473.25	319.5	H =1.75
473.75	465.8	H =2.25
474.25	629.3	H =2.75
474.75	808.5	H =3.25
475.25	1002.1	H =3.75
475.75	1209.1	H =4.25
476.00	0.0	E = or > E2=476.00

C = 3 L (ft) = 46
H (ft) = Table elev. - Invert elev. (471.5 ft)
Q (cfs) = C * L * (H**1.5) -- Suppressed Weir

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

Outflow Rating Table A
Table A = 1 ? 2

Elevation (ft)	Q (cfs)	Contributing Structures
467.75	0.0	1
468.25	1.2	1
468.75	3.3	1
469.25	6.1	1
469.75	9.3	1
470.25	13.0	1
470.75	17.1	1
471.25	19.9	2
471.75	22.0	2
472.25	23.9	2
472.75	25.6	2
473.25	27.3	2
473.75	28.9	2
474.25	30.3	2
474.75	31.8	2
475.25	33.1	2
475.75	34.4	2
476.00	0.0	-

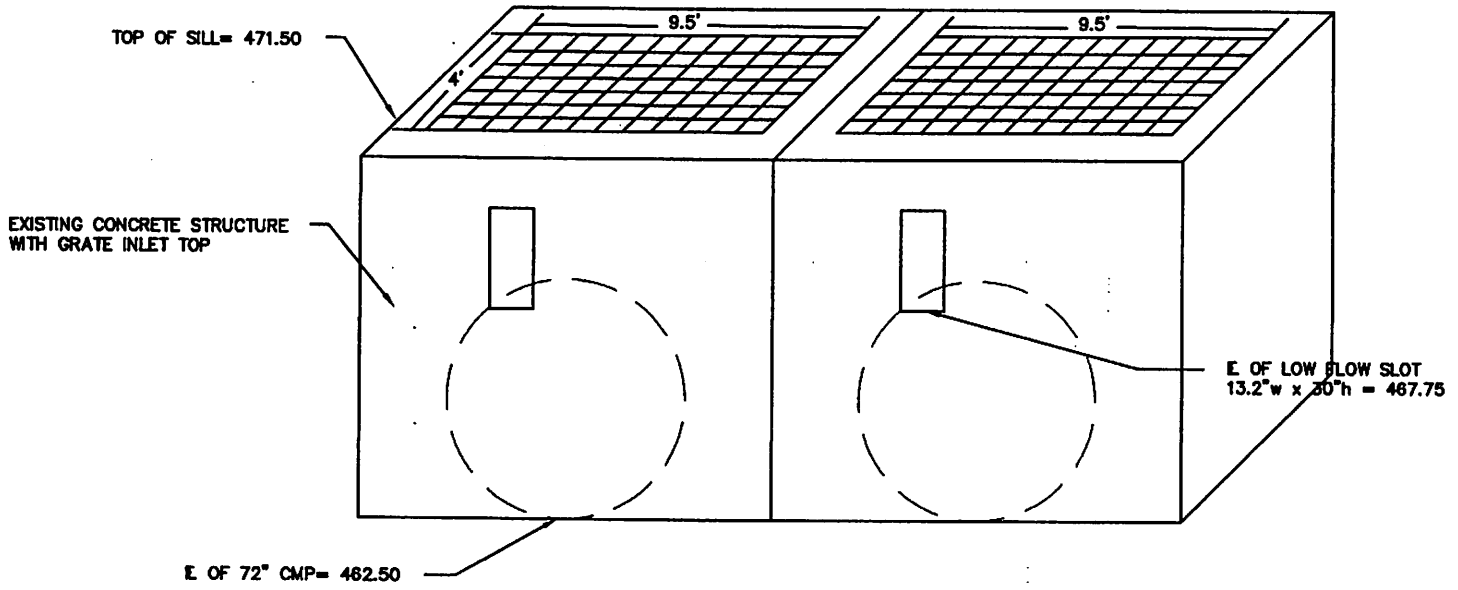
Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

Outflow Rating Table B
Table B = 3 ? 4

Elevation (ft)	Q (cfs)	Contributing Structures
467.75	0.0	3
468.25	1.2	3
468.75	3.3	3
469.25	6.1	3
469.75	9.3	3
470.25	13.0	3
470.75	17.1	3
471.25	19.9	4
471.75	22.0	4
472.25	23.9	4
472.75	25.6	4
473.25	27.3	4
473.75	28.9	4
474.25	30.3	4
474.75	31.8	4
475.25	33.1	4
475.75	34.4	4
476.00	0.0	-


TOP OF SILL= 471.50
9.5'
9.5'
4'
EXISTING CONCRETE STRUCTURE
WITH GRATE INLET TOP
E. OF LOW FLOW SLOT
13.2"w x 30"h = 467.75
E. OF 72" CMP= 462.50

PICKETT RAY & SILVER

Civil Engineers
Planners
Land Surveyors

333 Mid Rivers Mall Dr
St. Peters, MO 63376

441-1211
278-1211

PROJECT NAME LONE STAR PHASE II
PROJECT #/JOB ORDER # 86-155F
DATE 9-18-89
DESIGNER DWB. REV. BY JES 9/22/89
PAGE 1 OF 4

DETENTION BASIN CALCS:

AREA BEING DEVELOPED:

105.76 ACRES COMMERCIAL @ 4.75 = 502.36 cfs
83.26 ACRES RESIDENTIAL @ 3.26 = 271.43 cfs
TOTAL = 189.02 ACRES
773.79 cfs
(DEVELOPED 25 YEAR STORM)

UNDEVELOPED "Q" = 189.02 AC. @ 2.31 cfs = 436.64 cfs

DIFFERENTIAL:

773.79 cfs DEVELOPED (25 YEAR STORM)
- 436.64 cfs UNDEVELOPED (25 YEAR STORM)
337.15 cfs TO BE STORED

DETENTION:

337.15 cfs x 30 MIN. x 60 SEC/MIN = 606,870 CU. FT. STORAGE (25 YEAR)

STORAGE OF LAKE:

ELEV	AREA SQ. FT.	AVG. SQ. FT.	CU. FT.	CUMMULATIVE CU. FT.	
467.75	0	0	0	0	
469.00	186,500	93,894	117,368	117,368	
470.00	193,788	190,144	190,144	307,512	(STORAGE)
471.00	203,314	198,551	198,551	506,063	ELEV. 471.50 608,911 CU. FT. VOLUME Q_{25}
472.00	212,840	208,077	208,077	714,140	
474.00	231,761	222,301	444,602	1,158,742	
476.00	257,864	244,813	489,626	1,648,368	

STORAGE: 25 YEAR/30 MIN STORM ELEV. 471.50 = 608,911 CU. FT.

PICKETT RAY & SILVER

Civil Engineers
Planners
Land Surveyors

333 Mid Rivers Mall Dr
St. Peters, MO 63376

441-1211
278-1211

PROJECT NAME LONE STAR PHASE II
PROJECT #/JOB ORDER # 86-155F
DATE 9-18-89
DESIGNER D.W.B. REV. BY J.E.S. 9/22/89
PAGE 2 OF 4

DRAINAGE AREAS TO BASIN : (15 YEAR STORM)

DA#1	28.7 Ac.	@	3.85 cfs	= 110.50 cfs
DA#3	55.3 Ac.	@	2.64 cfs	= 145.99 cfs
DA#4	52.7 Ac.	@	2.64 cfs	= 139.13 cfs

TOTAL "Q" TO BASIN = 395.62 cfs (15 YEAR STORM)

DEVELOPED AREAS BY PASSING BASIN : (15 YEAR STORM)

DA#2	65.5 Ac.	@	3.85	= 252.18 cfs
DA#5	22.0 Ac.	@	2.64	= 58.08 cfs

TOTAL "Q" BY-PASSING BASIN = 310.26 cfs

ALLOWABLE OUTFLOW : =±208 cfs

353.47 cfs UNDEVELOPED "Q"15
310.26 cfs BY-PASS

43.21 cfs (MAXIMUM ALLOWABLE OUTFALL FROM SLOTS)

LOW FLOW CALCULATIONS :

ORIFICE FORMULA — $Q = C a \sqrt{2gh}$

$Q = 0.61 \times 2.76 \times \sqrt{(2)(32.2)(2.50)}$

$Q = 1.68 \times 12.69$

$Q = 21.32$ cfs (PER SLOT RELEASE)

2 SLOTS @ 21.32 cfs = 42.64 cfs @ ELEV. 475.50

OVERFLOW STRUCTURE : (15 YEAR STORM)

WEIR FORMULA — $Q = CLH^{3/2}$

$395.62 \text{ cfs} = 3.0 \times 46 \times H^{3/2}$

$2.87 = H^{3/2}$

$2.02 = H$

$471.50 + 2.02 =$ 473.52 — ELEV. TO PASS 15 YEAR STORM

PICKETT RAY & SILVER

Civil Engineers
Planners
Land Surveyors

333 Mid Rivers Mall Dr
St. Peters, MO 63378

441-1211
278-1211

PROJECT NAME LONE STAR PHASE II
PROJECT #/JOB ORDER # 86-155F
DATE 9-18-89
DESIGNER DWB REV. BY JES 9/22/89
PAGE 3 OF 4

DRAINAGE 25 YEAR STORM TO BASIN:

DA #1	28.7 Ac @ 4.75	=	136.33 cfs
DA #3	55.3 Ac @ 3.26	=	180.28 cfs
DA #4	52.7 Ac @ 3.26	=	171.80 cfs

TOTAL "Q_{25}" TO BASIN = 488.41 cfs (25 YEAR STORM)

OVERFLOW STRUCTURE:

$Q_{25} = CLH^{3/2}$

$488.41 \text{ cfs} = 3.0 \times 46 \times H^{3/2}$

$3.54 = H^{3/2}$

$2.32 = H$

$471.50 + 2.32 = 473.82$ - ELEV. TO PASS 25 YEAR STORM

DRAINAGE 100 YEAR STORM TO BASIN:

DA #1	28.7 Ac. @	6.08 cfs	= 174.50 cfs
DA #3	55.3 Ac. @	4.17 cfs	= 230.60 cfs
DA #4	52.7 Ac. @	4.17 cfs	= 219.76 cfs

TOTAL "Q_{100}" TO BASIN = 624.86 cfs (100 YEAR STORM)

OVERFLOW STRUCTURE:

$Q = CLH^{3/2}$

$624.86 \text{ cfs} = 3.0 \times 46 \times H^{3/2}$

$4.52 = H^{3/2}$

$2.73 = H$

$471.50 + 2.73 = 474.24$ - ELEV. TO PASS 100 YEAR STORM

NOTE: SET TOP OF DAM @ $474.24 + 1.76$ (FREEBOARD) = 476.00 MIN.

OK

PICKETT RAY & SILVER

Civil Engineers
Planners
Land Surveyors

441-1211
278-1211

333 Mid Rivers Mall Dr
St. Peters, MO 63376

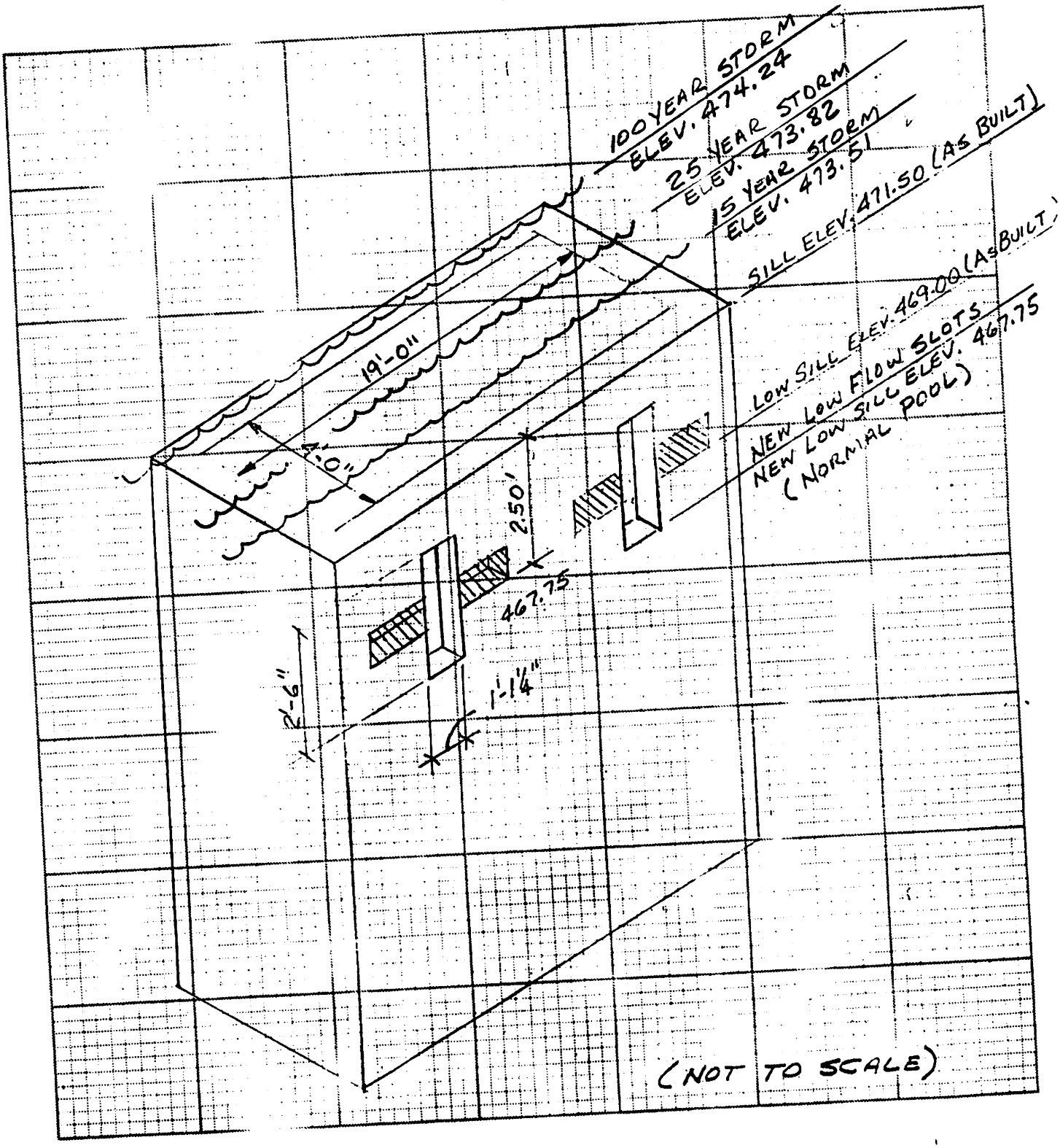
PROJECT NAME LONE STAR PHASE II

PROJECT #/JOB ORDER # 86-155F

DATE REV. 9-18-89

DESIGNER DWB REV. BY M.G.G. REV. J.E.S.

PAGE 4 OF 4



ENGINEERING

PLANNING

SURVEYING

STORMWATER DETENTION ANALYSIS
MANDERLEY ESTATES - O'FALLON
PREPARED BY: BAX ENGINEERING CO., INC.
BAX PROJECT NO. 96-8169
NOVEMBER 15, 1996
REVISED DECEMBER 11, 1996
REVISED FEBRUARY 6, 1997

INTRODUCTION:

The tract of land is presently an undeveloped site located in the City of O'Fallon, Missouri. It is proposed that the tract, consisting of 52.50 acres, be developed into a single family residential subdivision. An existing lake and stormwater detention basin near the Northeast corner of the site will provide detention for the development, along with detention for Lone Star Industrial Park which consists of 105.76 Acres, as required by the City of O'Fallon. The storage volume and outflow rates shall be proportioned to insure that the peak rate of runoff leaving the site under post-developed conditions is less than or equal to the peak rate of runoff leaving the site under pre-developed conditions for the required design storms. The basin shall be analyzed for both the 15 year frequency - 20 minute and the 25 year frequency - 20 minute duration design storms. The 100 year frequency - 20 minute design storm will be checked for safe passage.

GENERAL SITE DATA AND RUNOFF CALCULATIONS:

Site area: 52.50 Acres

The pre-developed P.I. factors to be used for analysis are:

ONSITE: 15 year - 20 minute storm (assumed 5% impervious): 1.87 c.f.s./Ac
LONE STAR IND. PARK: 15 year - 20 minute storm (assumed 5% impervious): 1.87 c.f.s./Ac
OFFSITE: 15 year - 20 minute storm (assumed 40% impervious): 2.64 c.f.s./Ac.
OFFSITE: 15 year - 20 minutes storm (assumed 100% impervious): 3.85 c.f.s./Ac.

The post-developed P.I. factors to be used for analysis are:

ONSITE: 15 year - 20 minute storm (developed single family): 2.09 c.f.s./Ac
LONE STAR IND. PARK: 15 year - 20 minute storm (developed heavy industrial): 3.85 c.f.s./Ac
OFFSITE: 15 year - 20 minute storm (assumed 40% impervious): 2.64 c.f.s./Ac.
OFFSITE: 15 year - 20 minute storm (assumed 100% impervious): 3.85 c.f.s./Ac.

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The pre-developed P.I. factors to be used for analysis are:

ONSITE: 25 year - 20 minute storm (assumed 5% impervious): 2.31 c.f.s./Ac
LONE STAR IND. PARK: 25 year - 20 minute storm (assumed 5% impervious): 2.31 c.f.s./Ac
OFFSITE: 25 year - 20 minute storm (assumed 40% impervious): 3.26 c.f.s./Ac.
OFFSITE: 25 year - 20 minutes storm (assumed 100% impervious): 4.75 c.f.s./Ac.

The post-developed P.I. factors to be used for analysis are:

ONSITE: 25 year - 20 minute storm (developed single family): 2.58 c.f.s./Ac
LONE STAR IND. PARK: 25 year - 20 minute storm (developed heavy industrial): 4.75 c.f.s./Ac
OFFSITE: 25 year - 20 minute storm (assumed 40% impervious): 3.26 c.f.s./Ac.
OFFSITE: 25 year - 20 minute storm (assumed 100% impervious): 4.75 c.f.s./Ac.

TIME OF CONCENTRATION:

Of the inflows to the basin, the most remote point of origination lies offsite to the Southwest. It will flow approximately 1,400 feet over pavement, then an additional 1,300 feet overland, then an additional 200 feet via storm sewer and then another 335 feet overland to the detention basin. Time of concentration is estimated as follows:

T(pavement): L = 1,400 feet
Elevation difference = 580 - 520 = 60 feet
T(pavement) = 2.80 minutes: See Figure 1

T(overland): L = 1,300 feet
Elevation difference = 520 - 480 = 40 feet
T(overland) = 7.5 minutes: See Figure 1

T(stormpipe): L = 200 feet
Estimated velocity 7 feet/second
T(stormpipe) = 200 feet/7 feet/sec
= 28.57 seconds = 0.48 minutes

T(overland): L = 335 feet
Elevation difference = 476 - 468.5 = 7.5 feet
T(overland) = 2.85 minutes: See Figure 1

Total Time: T(overland) + T(storm pipe) + T(overland) + T(pavement)
= 2.85 min. + 0.48 min. + 7.50 min. + 2.80 min. = 13.63 min. => use 13.0 minutes

REQUIRED ATTENUATION

Tract Area x [PI(post) - PI(pre)]

15 year - 20 minutes storm

On-site = 52.50 x (2.09 - 1.87) = 11.55 c.f.s.

Lone Star Industrial Park = 105.76 x (3.85 - 1.87) = 209.40 c.f.s.

Total 220.95 c.f.s.

BASIN PEAK INFLOW

Inflows to the basin have been estimated from the drainage area map of the project. (See Construction Plans)

PRE-DEVELOPED RUNOFF (15 year - 20 minute storm)

Flow going to the basin:

On-site areas (assumed 5% impervious)
15 year - 20 minute storm Q_{pre} = 30.19 acres @ 1.87 = 56.46 c.f.s.

Lone Star Industrial Park areas (assumed 5% impervious)
15 year - 20 minute storm Q_{pre} = 51.81 acres @ 1.87 = 96.88 c.f.s.

Off-site areas (assumed 100% impervious)
15 year - 20 minute storm Q_{pre} = 49.19 acres @ 3.85 = 189.38 c.f.s.

Off-site areas (assumed 40% impervious)
15 year - 20 minute storm Q_{pre} = 11.43 acres @ 2.64 = 30.18 c.f.s.

Total 372.90 c.f.s.

100 year - 20 minute storm = 15 year - 20 minute storm x 1.58
= 372.90 c.f.s. x 1.58 = 589.18 c.f.s.

Flow Bypassing the Basin:

On-site areas (assumed 5% impervious)
15 year - 20 minute storm Q_{pre} = 22.28 acres @ 1.87 = 41.66 c.f.s.

Lone Star Industrial Park areas (assumed 5% impervious)
15 year - 20 minute storm Q_{pre} = 53.95 acres @ 1.87 = 100.89 c.f.s.

Off-site areas (assumed 40% impervious)
15 year - 20 minute storm Q_{pre} = 27.0 acres @ 2.64 = 71.28 c.f.s.

Total 213.83 c.f.s.

100 year - 20 minute storm = 15 year - 20 minute storm x 1.58
= 213.83 c.f.s. x 1.58 = 337.85 c.f.s.

POST-DEVELOPED RUNOFF (15 year - 20 minute storm)
Flow going to the Basin:

On-site areas (assumed 15% impervious)
15 year - 20 minute storm Q_{post} = 30.19 acres @ 2.09 = 63.10 c.f.s.

Lone Star Industrial Park (assumed 100% impervious)
15 year - 20 minute storm Q_{post} = 51.81 acres @ 3.85 = 199.47 c.f.s.

Off-site areas (assumed 100% impervious)
15 year - 20 minute storm Q_{post} = 49.19 acres @ 3.85 = 189.38 c.f.s.

Off-site areas (assumed 40% impervious)
15 year - 20 minute storm Q_{post} = 11.43 acres @ 2.64 = 30.18 c.f.s.

Total 482.13 c.f.s.

100 year - 20 minute storm = 15 year - 20 minute storm x 1.58

= 482.13 c.f.s. x 1.58 = 761.77 c.f.s.

Flow Bypassing the Basin:

On-site areas (assumed 15% impervious)
15 year - 20 minute storm Q_{post} = 22.28 acres @ 2.09 = 46.57 c.f.s.

Lone Star Industrial Park areas (assumed 100% impervious)
15 year - 20 minute storm Q_{post} = 53.95 acres @ 3.85 = 207.71 c.f.s.

Off-site areas (assumed 40% impervious)
15 year - 20 minute storm Q_{post} = 27.0 acres @ 2.64 = 71.28 c.f.s.

Total 325.56 c.f.s.

100 year - 20 minute storm = 15 year - 20 minute storm x 1.58
= 325.56 c.f.s.x 1.58 = 514.38 c.f.s.

PERMITTED RELEASE RATE

The permitted release rate of the detention basin is found by subtracting the total required attenuation from the post-developed peak inflow to the basin for the design storm.

15 year - 20 minute storm
Permitted release rate = 482.13 c.f.s. - 220.95 c.f.s.
= 261.18 c.f.s.

ROUTING CALCULATIONS AND RESULTS

A computer program "Pondpack" was utilitzed in routing the design storms through the basin. As found in the routing calculations, the results of each analysis are as follows:

15 year - 20 minute storm:
Peak release rate = 33.43 (< 261.18 c.f.s.)
Peak elevation = 470.70

REQUIRED ATTENUATION

Tract Area x [PI(post) - PI(pre)]

25 year - 20 minutes storm

On-site = 52.50 x (2.58 - 2.31) = 14.18 c.f.s.

Lone Star Industrial Park = 105.76 x (4.75 - 2.31) = 258.05 c.f.s.

Total 272.23 c.f.s.

BASIN PEAK INFLOW

Inflows to the basin have been estimated from the drainage area map of the project. (See Construction Plans)

PRE-DEVELOPED RUNOFF (25 year - 20 minute storm)

Flow going to the basin:

On-site areas (assumed 5% impervious)
25 year - 20 minute storm Q_{pre} = 30.19 acres @ 2.31 = 69.74 c.f.s.

Lone Star Industrial Park areas (assumed 5% impervious)
25 year - 20 minute storm Q_{pre} = 51.81 acres @ 2.31 = 119.68 c.f.s.

Off-site areas (assumed 100% impervious)
25 year - 20 minute storm Q_{pre} = 49.19 acres @ 4.75 = 233.65 c.f.s.

Off-site areas (assumed 40% impervious)
25 year - 20 minute storm Q_{pre} = 11.43 acres @ 3.26 = 37.26 c.f.s.

Total 460.33 c.f.s.

100 year - 20 minute storm = 25 year - 20 minute storm x 1.28
= 460.33 c.f.s. x 1.28 = 589.22 c.f.s.

Flow Bypassing the Basin:

On-site areas (assumed 5% impervious)
25 year - 20 minute storm Q_{pre} = 22.28 acres @ 2.31 = 51.47 c.f.s.

Lone Star Industrial Park areas (assumed 5% impervious)
25 year - 20 minute storm Q_{pre} = 53.95 acres @ 2.31 = 124.62 c.f.s.

Off-site areas (assumed 40% impervious)
25 year - 20 minute storm Q_{pre} = 27.0 acres @ 3.26 = 88.02 c.f.s.

Total 264.11 c.f.s.

100 year - 20 minute storm = 25 year - 20 minute storm x 1.28
= 264.11 c.f.s. x 1.28 = 338.06 c.f.s.

POST-DEVELOPED RUNOFF (25 year - 20 minute storm)

Flow going to the Basin:

On-site areas (assumed 15% impervious)
25 year - 20 minute storm Q_{post} = 30.19 acres @ 2.58 = 77.89 c.f.s.

Lone Star Industrial Park (assumed 100% impervious)
25 year - 20 minute storm Q_{post} = 51.81 acres @ 4.75 = 246.10 c.f.s.

Off-site areas (assumed 100% impervious)
25 year - 20 minute storm Q_{post} = 49.19 acres @ 4.75 = 233.65 c.f.s.

Off-site areas (assumed 40% impervious)
25 year - 20 minute storm Q_{post} = 11.43 acres @ 3.26 = 37.26 c.f.s.

Total 594.90 c.f.s.

100 year - 20 minute storm = 25 year - 20 minute storm x 1.28

= 594.90 c.f.s. x 1.28 = 761.47 c.f.s.

Flow Bypassing the Basin:

On-site areas (assumed 15% impervious)
25 year - 20 minute storm Q_{post} = 22.28 acres @ 2.58 = 57.48 c.f.s.

Lone Star Industrial Park areas (assumed 100% impervious)
25 year - 20 minute storm Q_{post} = 53.95 acres @ 4.75 = 256.26 c.f.s.

Off-site areas (assumed 40% impervious)
25 year - 20 minute storm Q_{post} = 27.0 acres @ 3.26 = 88.02 c.f.s.

Total 401.76 c.f.s.

100 year - 20 minute storm = 25 year - 20 minute storm x 1.28
= 401.76 c.f.s.x 1.28 = 514.25 c.f.s.

PERMITTED RELEASE RATE

The permitted release rate of the detention basin is found by subtracting the total required attenuation from the post-developed peak inflow to the basin for the design storm.

25 year - 20 minute storm
Permitted release rate = 594.90 c.f.s. - 272.23 c.f.s.
= 322.67 c.f.s.

ROUTING CALCULATIONS AND RESULTS

A computer program "Pondpack" was utilitzed in routing the design storms through the basin. As found in the routing calculations, the results of each analysis are as follows:

25 year - 20 minute storm:
Peak release rate = 42.37 (< 322.67 c.f.s.)
Peak elevation = 471.31

*100 year - 20 minute storm: (worst case)

Weir Elevation = 471.50
$Q = CLH^{1.5}$
Q = 761.77 c.f.s.
C = 3.0
L = 46.0 feet
H = 3.20 feet
Elev. = 474.70
Freeboard = 476.00 - 474.70 = 1.30 feet

Check
$Q = 3.0\ (46.0)(3.20)^{1.5}$
Q = 789.96 c.f.s.
789.96 c.f.s. > 761.77 c.f.s.

CHECKING DISCHARGE PIPES

100 year - 20 minute storm: (see Page 10)
Q = 761.77 c.f.s.
Existing Discharge Pipes: 2-72" CMP
Flowline of Existing Pipes: 462.50
Check under inlet control
HW/D = 1.7 => 1.7 x 72" = 10.2 feet
Elevation = 462.50 + 10.2 = 472.70 Controls

DETENTION BASIN CHARACTERISTICS SUMMARY:

15 year - 20 minute storm highwater = 470.70
25 year - 20 minute storm highwater = 471.31
100 year - 20 minute storm highwater = 474.70

Overflow Structure:

Existing concrete structure with grate inlet top
Flowline of the two existing 72" CMP = 462.50
Flowline of low flow slot - (13.2" w x 30" h) = 467.75
Flowline of emergency overflow = 471.50

*Note: The 100 year - 20 minute storm was checked for safe passage through the basin in a worst case situation with the low flow opening blocked.

D= 2 Existing 72" CMP

TQ = 761.77 c.f.s.

$\frac{TQ}{2}$ = 380.89 c.f.s.

D= 72"

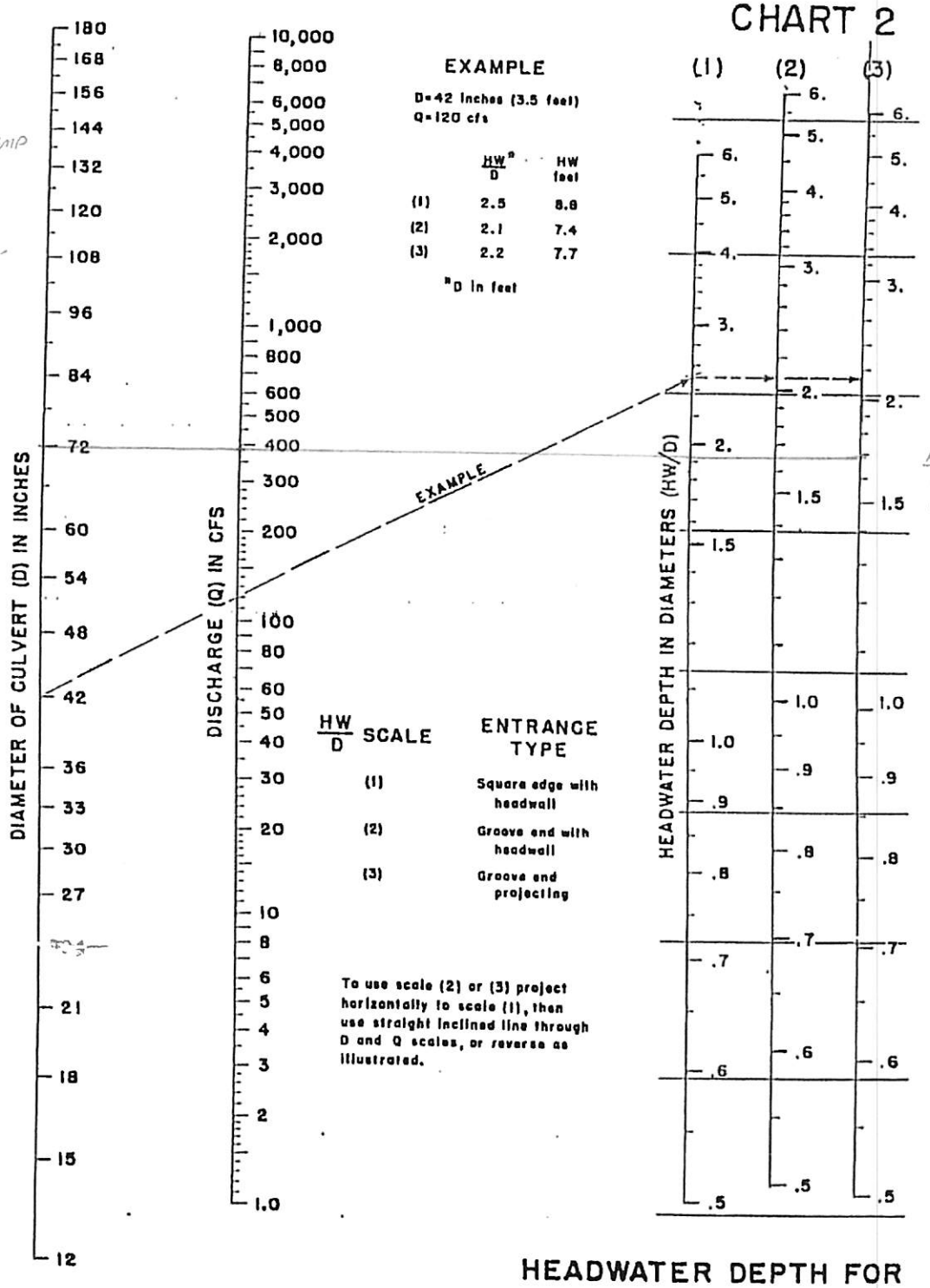
FL= 462.50

HW+FL= 472.50

$\frac{Hw}{D}$ = 1.7

Hw = 1.7(6) = 10.20

CHART 2



HEADWATER SCALES 2&3 REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

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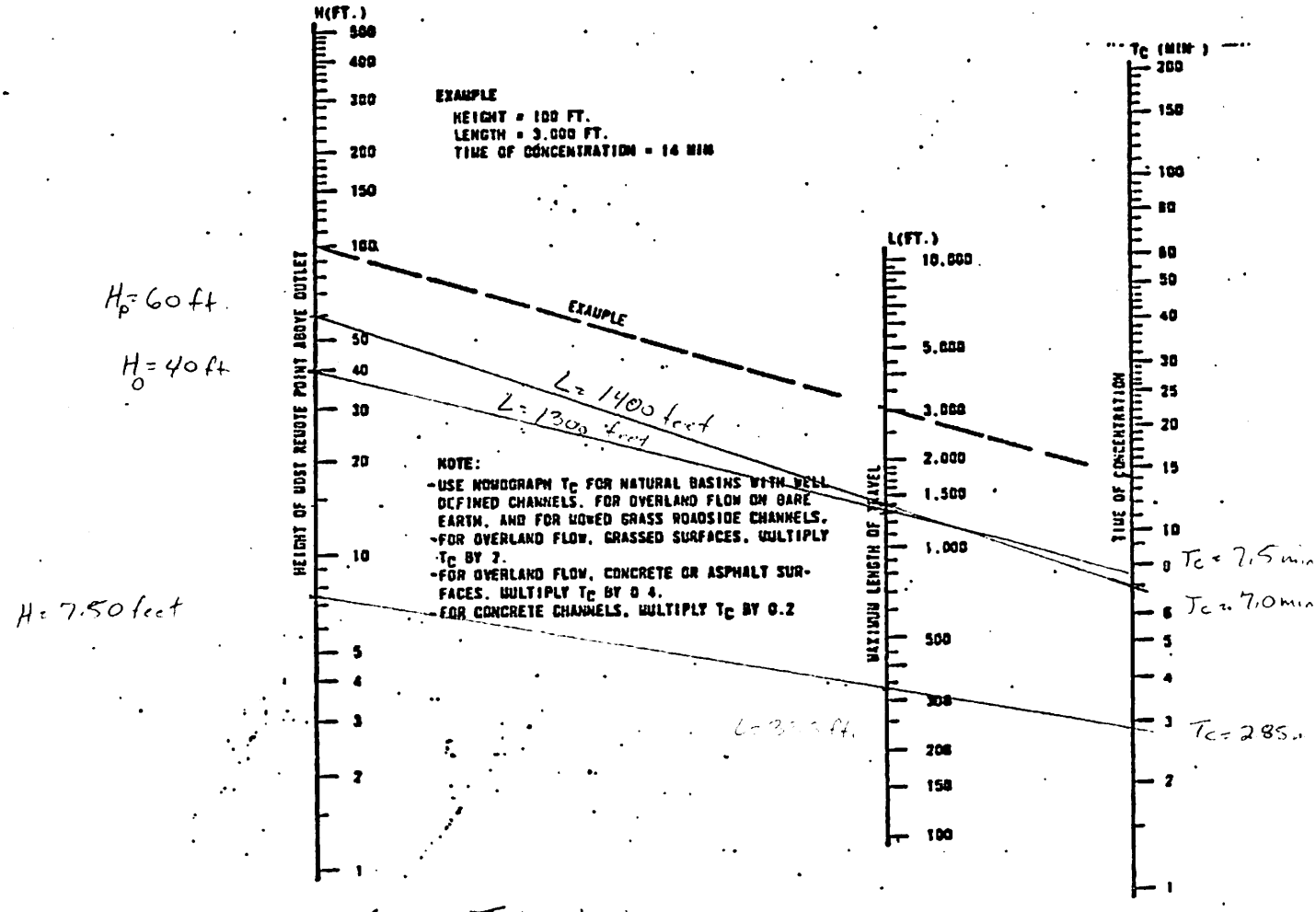
MANDERLEY ESTATES
96-8169



$H_p = 60$ ft

$H_o = 40$ ft

$H = 7.50$ feet

$L = 1400$ feet

$L = 1300$ feet

$T_c = 7.5$ min

$T_c = 7.0$ min

$T_c = 2.85$ min

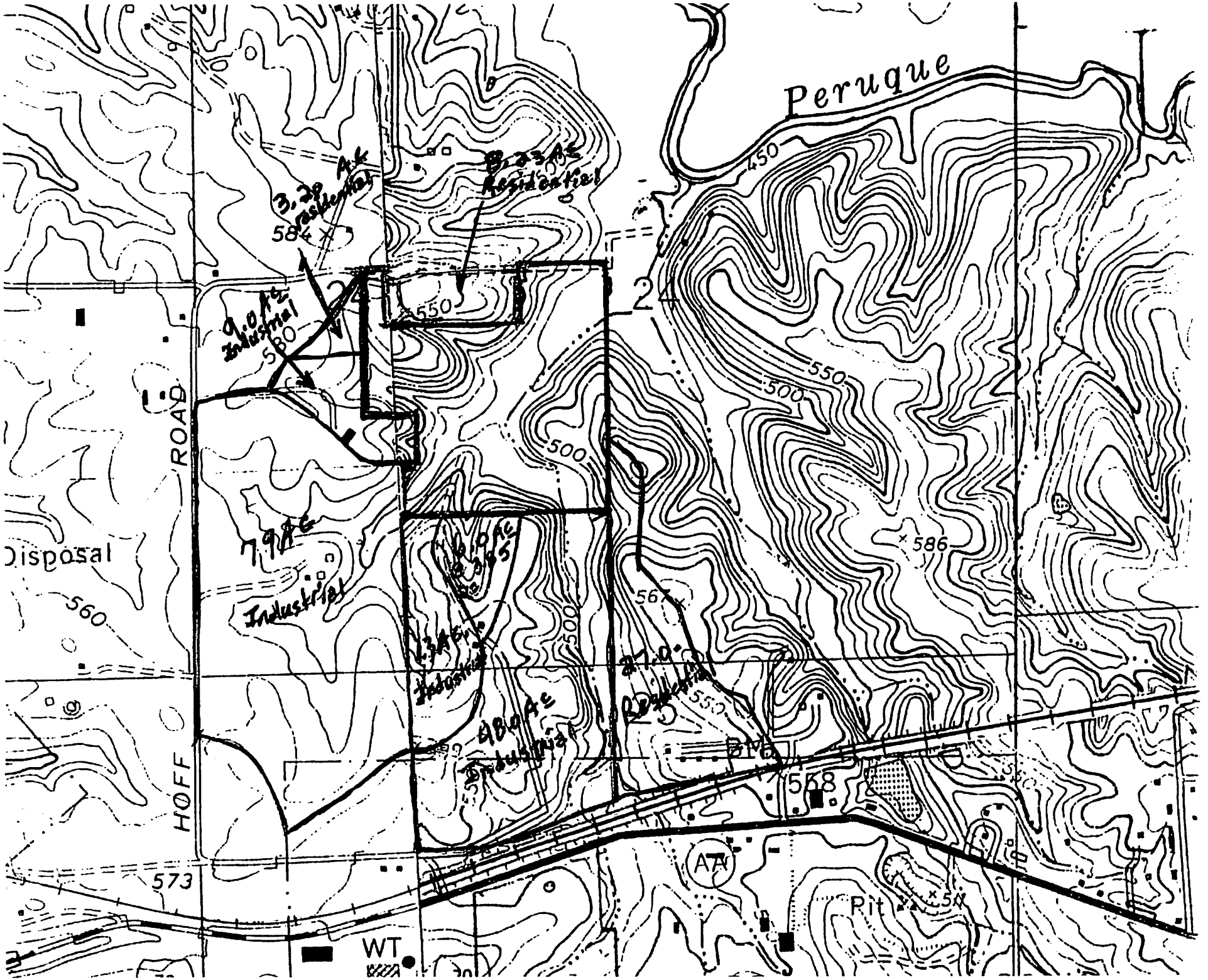
T_{c_1} (overland) = 7.5 minutes

T_c (pavement) = 7.0 min. $\times$ 0.4 = 2.80 minutes

T_{c_2} (overland) = 2.85 minutes

FIGURE 1

TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS


Perugue
450
550
500
586
584
580
560
573
ROAD
HOFF
Disposal
3.2 Ac Residential
9.0 Ac Industrial
7.9 Ac Industrial
1.3 Ac Industrial
4.8 Ac Industrial
2.7 Ac Residential
Bldg
568
AA
Pit
WT

POND-2 Version: 5.1[redacted]S/N:[redacted]

>>>>> HYDROGRAPH PRINTOUT <<<<<

02-06-1997 13:05:28

Hydrograph file: 8169-15 .HYD

HYDROGRAPH ORDINATES (cfs)
Time increment = 1.00 Minutes
Time on left represents time for first Q in each row.

Time Minutes							
0.00	0.00	37.09	74.17	111.26	148.35	185.44	222.52
7.00	259.61	296.70	333.78	370.87	407.96	445.04	482.13
14.00	482.13	482.13	482.13	482.13	482.13	482.13	482.13
21.00	445.04	407.96	370.87	333.78	296.70	259.61	222.52
28.00	185.44	148.35	111.26	74.17	37.09	0.00	

POND-2 Version: 5.17 S/N:

>>>>> HYDROGRAPH PRINTOUT <<<<<

02-06-1997 13:05:48

Hydrograph file: 8169-25 .HYD

HYDROGRAPH ORDINATES (cfs)
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Time on left represents time for first Q in each row.

Time Minutes							
0.00	0.00	45.76	91.52	137.28	183.04	228.80	274.56
7.00	320.33	366.09	411.85	457.59	503.37	549.13	594.90
14.00	594.90	594.90	594.90	594.90	594.90	594.90	594.90
21.00	549.13	503.37	457.59	411.85	366.09	320.33	274.56
28.00	228.80	183.04	137.28	91.52	45.76	0.00	

POND-2 Version: 5.17
S/N:

MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997

CALCULATED 02-06-1997 13:06:13
DISK FILE: 8169 .VOL

Planimeter scale: 1 inch = 50 ft.

Elevation (ft)	Planimeter (sq.in.)	Area (acres)	A1+A2+sqr(A1*A2) (acres)	* Volume (acre-ft)	Volume Sum (acre-ft)
467.75	69.76	4.00	0.00	0.00	0.00
470.00	76.82	4.41	12.61	9.46	9.46
472.00	88.33	5.07	14.21	9.47	18.93
474.00	101.97	5.85	16.37	10.91	29.84
476.00	117.36	6.74	18.87	12.58	42.42

* Incremental volume computed by the Conic Method for Reservoir Volumes.

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

***** COMPOSITE OUTFLOW SUMMARY ****

Elevation (ft)	Q (cfs)	Contributing Structures
467.75	0.0	1 +3
468.25	2.3	1 +3
468.75	6.6	1 +3
469.25	12.1	1 +3
469.75	18.7	1 +3
470.25	26.1	1 +3
470.75	34.3	1 +3
471.25	39.7	2 +4
471.75	61.2	2 +4 +5
472.25	137.4	2 +4 +5
472.75	244.1	2 +4 +5
473.25	374.1	2 +4 +5
473.75	523.5	2 +4 +5
474.25	690.0	2 +4 +5
474.75	872.0	2 +4 +5
475.25	1068.3	2 +4 +5
475.75	1277.9	2 +4 +5
476.00	0.0	

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

Outlet Structure File: 8169 .STR
Planimeter Input File: 8169 .VOL
Rating Table Output File: 8169 .POND

Min. Elev.(ft) = 467.75 Max. Elev.(ft) = 476 Incr.(ft) = .5

Additional elevations (ft) to be included in table:
* *

****
SYSTEM CONNECTIVITY
****

Structure	No.	Q Table		Q Table
WEIR-VR	1		->	1
ORIFICE	2	? 1	->	A
WEIR-VR	3		->	3
ORIFICE	4	? 3	->	B
WEIR-VR	5		->	5

Outflow rating table summary was stored in file:
8169 .POND

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

>>>>>> Structure No. 1 <<<<<<
(Input Data)

WEIR-VR
Weir - Vertical Rectangular

E1 elev.(ft)?	467.75
E2 elev.(ft)?	476.00
Weir coefficient?	3
Weir elev.(ft)?	467.75
Length (ft)?	1.10
Contracted/Suppressed (C/S)?	S

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
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FEBRUARY 06. 1997
****

>>>>>> Structure No. 2 <<<<<<
(Input Data)

ORIFICE
Orifice - Based on Area and Datum Elevation

E1 elev.(ft)?	469.00
E2 elev.(ft)?	476.00
Orifice coeff.?	.6
Invert elev.(ft)?	467.75
Datum elev.(ft) ?	469.00
Orifice area (sq ft)?	2.75

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

>>>>>> Structure No. 3 <<<<<<
(Input Data)

WEIR-VR
Weir - Vertical Rectangular

E1 elev.(ft)?	467.75
E2 elev.(ft)?	476.0
Weir coefficient?	3
Weir elev.(ft)?	467.75
Length (ft)?	1.10
Contracted/Suppressed (C/S)?	S

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

>>>>>> Structure No. 4 <<<<<<
(Input Data)

ORIFICE
Orifice - Based on Area and Datum Elevation

E1 elev.(ft)?	469.00
E2 elev.(ft)?	476.0
Orifice coeff.?	.6
Invert elev.(ft)?	467.75
Datum elev.(ft) ?	469.00
Orifice area (sq ft)?	2.75

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

>>>>>> Structure No. 5 <<<<<<
(Input Data)

WEIR-VR
Weir - Vertical Rectangular

E1 elev.(ft)?	471.50
E2 elev.(ft)?	476.00
Weir coefficient?	3
Weir elev.(ft)?	471.50
Length (ft)?	46.00
Contracted/Suppressed (C/S)?	S

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06, 1997
****

Outflow Rating Table for Structure #1
WEIR-VR Weir - Vertical Rectangular

***** INLET CONTROL ASSUMED *****

Elevation (ft)	Q (cfs)	Computation Messages
467.75	0.0	H =0.0
468.25	1.2	H =.5
468.75	3.3	H =1.0
469.25	6.1	H =1.5
469.75	9.3	H =2.0
470.25	13.0	H =2.5
470.75	17.1	H =3.0
471.25	21.6	H =3.5
471.75	26.4	H =4.0
472.25	31.5	H =4.5
472.75	36.9	H =5.0
473.25	42.6	H =5.5
473.75	48.5	H =6.0
474.25	54.7	H =6.5
474.75	61.1	H =7.0
475.25	67.8	H =7.5
475.75	74.7	H =8.0
476.00	0.0	E = or > E2=476.00

C = 3 L (ft) = 1.1
H (ft) = Table elev. - Invert elev. (467.75 ft)
Q (cfs) = C * L * (H**1.5) -- Suppressed Weir

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO.. INC.
FEBRUARY 06. 1997
****

Outflow Rating Table for Structure #2
ORIFICE Orifice - Based on Area and Datum Elevation

Elevation (ft)	Q (cfs)	Computation Messages
467.75	0.0	E < E1=469.00
468.25	0.0	E < E1=469.00
468.75	0.0	E < E1=469.00
469.25	6.6	H =.25
469.75	11.5	H =.750
470.25	14.8	H =1.25
470.75	17.5	H =1.75
471.25	19.9	H =2.25
471.75	22.0	H =2.75
472.25	23.9	H =3.25
472.75	25.6	H =3.75
473.25	27.3	H =4.25
473.75	28.9	H =4.75
474.25	30.3	H =5.25
474.75	31.8	H =5.75
475.25	33.1	H =6.25
475.75	34.4	H =6.75
476.00	0.0	E = or > E2=476.00

C = .6 A = 2.75 sq.ft.
H (ft) = Table elev. - Datum elev. (469 ft)
Q (cfs) = C * A * sqr(2g * H)

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

Outflow Rating Table for Structure #3
WEIR-VR Weir - Vertical Rectangular

***** INLET CONTROL ASSUMED *****

Elevation (ft)	Q (cfs)	Computation Messages
467.75	0.0	H =0.0
468.25	1.2	H =.5
468.75	3.3	H =1.0
469.25	6.1	H =1.5
469.75	9.3	H =2.0
470.25	13.0	H =2.5
470.75	17.1	H =3.0
471.25	21.6	H =3.5
471.75	26.4	H =4.0
472.25	31.5	H =4.5
472.75	36.9	H =5.0
473.25	42.6	H =5.5
473.75	48.5	H =6.0
474.25	54.7	H =6.5
474.75	61.1	H =7.0
475.25	67.8	H =7.5
475.75	74.7	H =8.0
476.00	0.0	E = or > E2=476.0

C = 3 L (ft) = 1.1
H (ft) = Table elev. - Invert elev. (467.75 ft)
Q (cfs) = C * L * (H**1.5) -- Suppressed Weir

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

Outflow Rating Table for Structure #4
ORIFICE Orifice - Based on Area and Datum Elevation

Elevation (ft)	Q (cfs)	Computation Messages
467.75	0.0	E < E1=469.00
468.25	0.0	E < E1=469.00
468.75	0.0	E < E1=469.00
469.25	6.6	H =.25
469.75	11.5	H =.750
470.25	14.8	H =1.25
470.75	17.5	H =1.75
471.25	19.9	H =2.25
471.75	22.0	H =2.75
472.25	23.9	H =3.25
472.75	25.6	H =3.75
473.25	27.3	H =4.25
473.75	28.9	H =4.75
474.25	30.3	H =5.25
474.75	31.8	H =5.75
475.25	33.1	H =6.25
475.75	34.4	H =6.75
476.00	0.0	E = or > E2=476.0

C = .6 A = 2.75 sq.ft.
H (ft) = Table elev. - Datum elev. (469 ft)
Q (cfs) = C * A * sqr(2g * H)

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

Outflow Rating Table for Structure #5
WEIR-VR Weir - Vertical Rectangular

***** INLET CONTROL ASSUMED *****

Elevation (ft)	Q (cfs)	Computation Messages
467.75	0.0	E < Inv.El.= 471.5
468.25	0.0	E < Inv.El.= 471.5
468.75	0.0	E < Inv.El.= 471.5
469.25	0.0	E < Inv.El.= 471.5
469.75	0.0	E < Inv.El.= 471.5
470.25	0.0	E < Inv.El.= 471.5
470.75	0.0	E < Inv.El.= 471.5
471.25	0.0	E < Inv.El.= 471.5
471.75	17.3	H =.25
472.25	89.6	H =.750
472.75	192.9	H =1.25
473.25	319.5	H =1.75
473.75	465.8	H =2.25
474.25	629.3	H =2.75
474.75	808.5	H =3.25
475.25	1002.1	H =3.75
475.75	1209.1	H =4.25
476.00	0.0	E = or > E2=476.00

C = 3 L (ft) = 46
H (ft) = Table elev. - Invert elev. (471.5 ft)
Q (cfs) = C * L * (H**1.5) -- Suppressed Weir

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

****
MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

Outflow Rating Table A
Table A = 1 ? 2

Elevation (ft)	Q (cfs)	Contributing Structures
467.75	0.0	1
468.25	1.2	1
468.75	3.3	1
469.25	6.1	1
469.75	9.3	1
470.25	13.0	1
470.75	17.1	1
471.25	19.9	2
471.75	22.0	2
472.25	23.9	2
472.75	25.6	2
473.25	27.3	2
473.75	28.9	2
474.25	30.3	2
474.75	31.8	2
475.25	33.1	2
475.75	34.4	2
476.00	0.0	-

Outlet Structure File: 8169 .STR

POND-2 Version: 5.17 S/N:
Date Executed: Time Executed:

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MANDERLEY ESTATES
DETENTION ANALYSIS
PREPARED BY: BAX ENGINEERING CO., INC.
FEBRUARY 06, 1997
****

Outflow Rating Table B
Table B = 3 ? 4

Elevation (ft)	Q (cfs)	Contributing Structures
467.75	0.0	3
468.25	1.2	3
468.75	3.3	3
469.25	6.1	3
469.75	9.3	3
470.25	13.0	3
470.75	17.1	3
471.25	19.9	4
471.75	22.0	4
472.25	23.9	4
472.75	25.6	4
473.25	27.3	4
473.75	28.9	4
474.25	30.3	4
474.75	31.8	4
475.25	33.1	4
475.75	34.4	4
476.00	0.0	-

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*********************************************
*                                           *
*              MANDERLEY ESTATES            *
*             DETENTION ANALYSIS            *
*  PREPARED BY: BAX ENGINEERING CO., INC.   *
*              FEBRUARY 06, 1997            *
*                                           *
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Inflow Hydrograph: 8169-15 .HYD
Rating Table file: 8169 .PND

----INITIAL CONDITIONS----
Elevation = 467.75 ft
Outflow = 0.00 cfs
Storage = 0.00 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
467.75	0.0	0.000
468.25	2.3	2.024
468.75	6.6	4.092
469.25	12.1	6.205
469.75	18.7	8.364
470.25	26.1	10.573
470.75	34.3	12.858
471.25	39.7	15.224
471.75	61.2	17.674
472.25	137.4	20.210
472.75	244.1	22.840
473.25	374.1	25.567
473.75	523.5	28.393
474.25	690.0	31.320
474.75	872.0	34.354
475.25	1068.3	37.497
475.75	1277.9	40.751

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
0.0	0.0
2938.7	2941.0
5941.8	5948.4
9010.2	9022.3
12144.5	12163.2
15351.5	15377.6
18669.1	18703.4
22105.7	22145.4
25663.1	25724.3
29345.2	29482.6
33164.0	33408.1
37123.6	37497.7
41226.5	41750.0
45476.3	46166.3
49881.3	50753.3
54445.1	55513.4
59170.7	60448.6

Time increment (t) = 1.0 min.

POND-2 Version: 5.17 S/N:
EXECUTED: 02-06-1997 13:08:23

Pond File: 8169 .PND
Inflow Hydrograph: 8169-15 .HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH / ROUTING COMPUTATIONS

TIME (min)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
0.0	0.00	-----	0.0	0.0	0.00	467.75
1.0	37.09	37.1	37.0	37.1	0.03	467.76
2.0	74.17	111.3	148.1	148.3	0.12	467.78
3.0	111.26	185.4	333.0	333.5	0.26	467.81
4.0	148.35	259.6	591.7	592.6	0.46	467.85
5.0	185.44	333.8	924.0	925.4	0.72	467.91
6.0	222.52	408.0	1329.9	1332.0	1.04	467.98
7.0	259.61	482.1	1809.2	1812.0	1.42	468.06
8.0	296.70	556.3	2361.8	2365.5	1.85	468.15
9.0	333.78	630.5	2987.5	2992.3	2.37	468.26
10.0	370.87	704.7	3685.4	3692.2	3.37	468.37
11.0	407.96	778.8	4455.3	4464.2	4.48	468.50
12.0	445.04	853.0	5296.9	5308.3	5.68	468.64
13.0	482.13	927.2	6209.9	6224.1	7.09	468.79
14.0	482.13	964.3	7156.6	7174.2	8.79	468.95
15.0	482.13	964.3	8099.9	8120.8	10.49	469.10
16.0	482.13	964.3	9039.7	9064.1	12.19	469.26
17.0	482.13	964.3	9975.7	10004.0	14.16	469.41
18.0	482.13	964.3	10907.7	10939.9	16.13	469.56
19.0	482.13	964.3	11835.8	11871.9	18.09	469.70
20.0	482.13	964.3	12759.7	12800.0	20.17	469.85
21.0	445.04	927.2	13642.4	13686.9	22.21	469.99
22.0	407.96	853.0	14447.3	14495.4	24.07	470.11
23.0	370.87	778.8	15174.6	15226.1	25.75	470.23
24.0	333.78	704.7	15824.6	15879.3	27.34	470.33
25.0	296.70	630.5	16397.6	16455.1	28.76	470.41
26.0	259.61	556.3	16893.9	16953.9	29.99	470.49
27.0	222.52	482.1	17314.0	17376.0	31.03	470.55
28.0	185.44	408.0	17658.2	17721.9	31.88	470.60
29.0	148.35	333.8	17926.9	17992.0	32.55	470.64
30.0	111.26	259.6	18120.4	18186.5	33.03	470.67
31.0	74.17	185.4	18239.2	18305.9	33.32	470.69
32.0	37.09	111.3	18283.6	18350.5	33.43	470.70
33.0	0.00	37.1	18254.0	18320.7	33.36	470.69

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: 8169 .PND
Inflow Hydrograph: 8169-15 .HYD
Outflow Hydrograph: OUT .HYD

Starting Pond W.S. Elevation = 467.75 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow	=	482.13 cfs
Peak Outflow	=	33.43 cfs
Peak Elevation	=	470.70 ft

***** Summary of Approximate Peak Storage *****

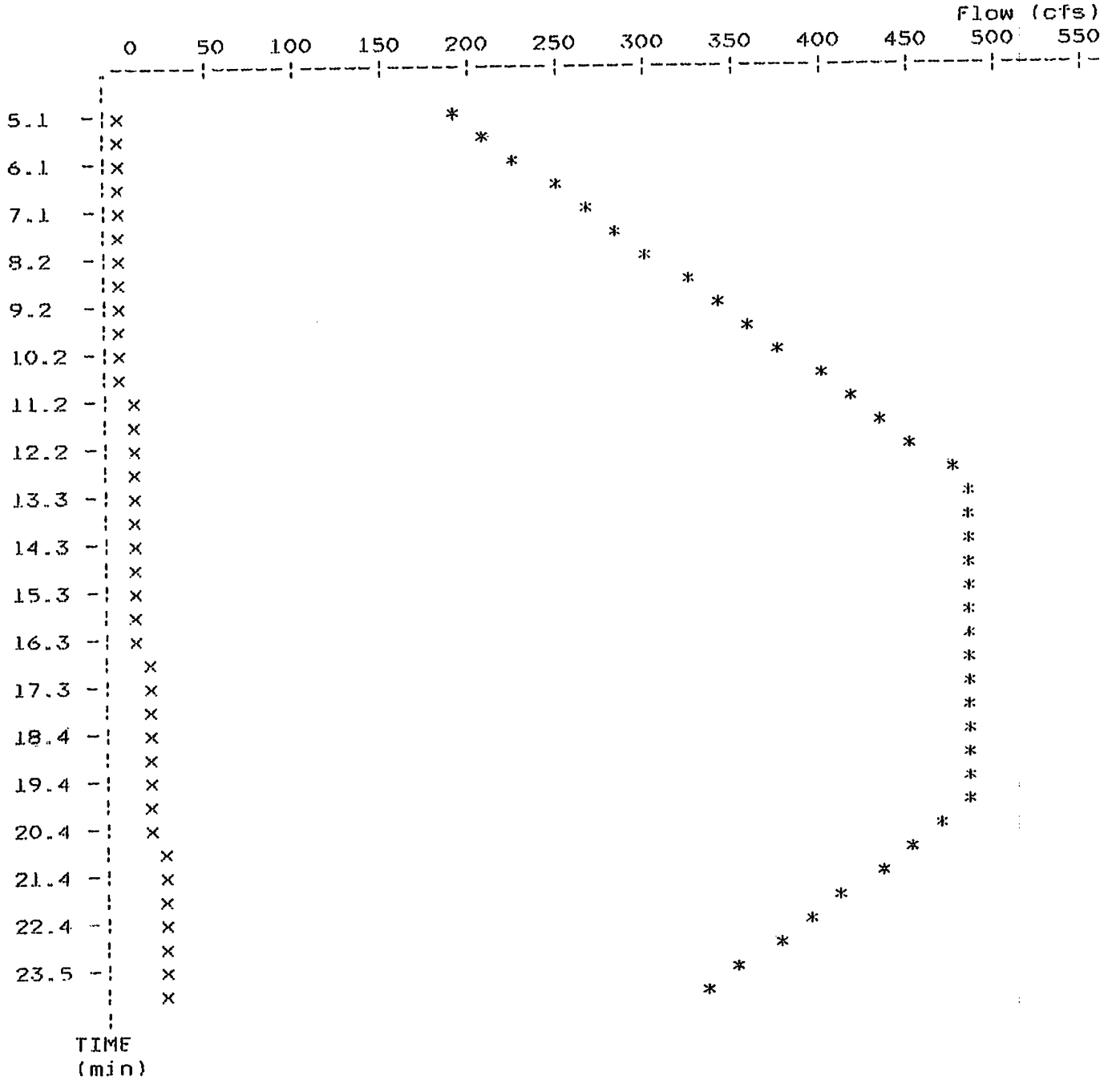
Initial Storage	=	0.00 ac-ft
Peak Storage From Storm	=	12.62 ac-ft
Total Storage in Pond	=	12.62 ac-ft

POND-2 Version: 5.17 S/N:

Pond File: 8169 .PND
Inflow Hydrograph: 8169-15 .HYD
Outflow Hydrograph: OUT .HYD

EXECUTED: 02-06-1997
13:08:23

Peak Inflow = 482.13 cfs
Peak Outflow = 33.43 cfs
Peak Elevation = 470.70 ft



x File: 8169-15 .HYD Qmax = 33.4 cfs
* File: OUT .HYD Qmax = 482.1 cfs

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*********************************************
*                                           *
*              MANDERLEY ESTATES            *
*             DETENTION ANALYSIS            *
*  PREPARED BY: BAX ENGINEERING CO., INC.   *
*              FEBRUARY 06, 1997            *
*                                           *
*********************************************
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Inflow Hydrograph: 8169-25 .HYD
Rating Table file: 8169 .PND

----INITIAL CONDITIONS----
Elevation = 467.75 ft
Outflow = 0.00 cfs
Storage = 0.00 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
467.75	0.0	0.000
468.25	2.3	2.024
468.75	6.6	4.092
469.25	12.1	6.205
469.75	18.7	8.364
470.25	26.1	10.573
470.75	34.3	12.858
471.25	39.7	15.224
471.75	61.2	17.674
472.25	137.4	20.210
472.75	244.1	22.840
473.25	374.1	25.567
473.75	523.5	28.393
474.25	690.0	31.320
474.75	872.0	34.354
475.25	1068.3	37.497
475.75	1277.9	40.751

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
0.0	0.0
2938.7	2941.0
5941.8	5948.4
9010.2	9022.3
12144.5	12163.2
15351.5	15377.6
18669.1	18703.4
22105.7	22145.4
25663.1	25724.3
29345.2	29482.6
33164.0	33408.1
37123.6	37497.7
41226.5	41750.0
45476.3	46166.3
49881.3	50753.3
54445.1	55513.4
59170.7	60448.6

Time increment (t) = 1.0 min.

POND-2 Version: 5.17 S/N:
EXECUTED: 02-06-1997 13:09:06

Pond File: 8169 .PND
Inflow Hydrograph: 8169-25 .HYD
Outflow Hydrograph: OUT .HYD

INFLOW HYDROGRAPH

TIME (min)	INFLOW (cfs)
0.0	0.00
1.0	45.76
2.0	91.52
3.0	137.28
4.0	183.04
5.0	228.80
6.0	274.56
7.0	320.33
8.0	366.09
9.0	411.85
10.0	457.59
11.0	503.37
12.0	549.13
13.0	594.90
14.0	594.90
15.0	594.90
16.0	594.90
17.0	594.90
18.0	594.90
19.0	594.90
20.0	594.90
21.0	549.13
22.0	503.37
23.0	457.59
24.0	411.85
25.0	366.09
26.0	320.33
27.0	274.56
28.0	228.80
29.0	183.04
30.0	137.28
31.0	91.52
32.0	45.76
33.0	0.00

ROUTING COMPUTATIONS

I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
-----	0.0	0.0	0.00	467.75
45.8	45.7	45.8	0.04	467.76
137.3	182.7	183.0	0.14	467.78
228.8	410.8	411.5	0.32	467.82
320.3	730.0	731.2	0.57	467.87
411.8	1140.1	1141.9	0.89	467.94
503.4	1640.9	1643.4	1.29	468.03
594.9	2232.3	2235.7	1.75	468.13
686.4	2914.1	2918.7	2.28	468.25
777.9	3685.3	3692.0	3.37	468.37
869.4	4545.5	4554.7	4.61	468.52
961.0	5494.5	5506.5	5.97	468.68
1052.5	6531.7	6547.0	7.67	468.85
1144.0	7656.4	7675.7	9.69	469.03
1189.8	8822.6	8846.2	11.78	469.22
1189.8	9984.0	10012.4	14.18	469.41
1189.8	11140.6	11173.8	16.62	469.59
1189.8	12292.2	12330.4	19.08	469.78
1189.8	13438.5	13482.0	21.74	469.96
1189.8	14579.6	14628.3	24.38	470.13
1189.8	15715.3	15769.4	27.07	470.31
1144.0	16799.8	16859.3	29.75	470.47
1052.5	17787.9	17852.3	32.20	470.62
961.0	18680.1	18748.8	34.37	470.76
869.4	19478.3	19549.5	35.63	470.87
777.9	20182.7	20256.2	36.74	470.98
686.4	20793.8	20869.2	37.70	471.06
594.9	21311.6	21388.7	38.51	471.14
503.4	21736.6	21815.0	39.18	471.20
411.8	22069.0	22148.5	39.72	471.25
320.3	22307.0	22389.4	41.17	471.28
228.8	22451.7	22535.8	42.05	471.30
137.3	22504.3	22589.0	42.37	471.31
45.8	22465.8	22550.0	42.13	471.31

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: 8169 .PND
Inflow Hydrograph: 8169-25 .HYD
Outflow Hydrograph: OUT .HYD

Starting Pond W.S. Elevation = 467.75 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow	=	594.90 cfs
Peak Outflow	=	42.37 cfs
Peak Elevation	=	471.31 ft

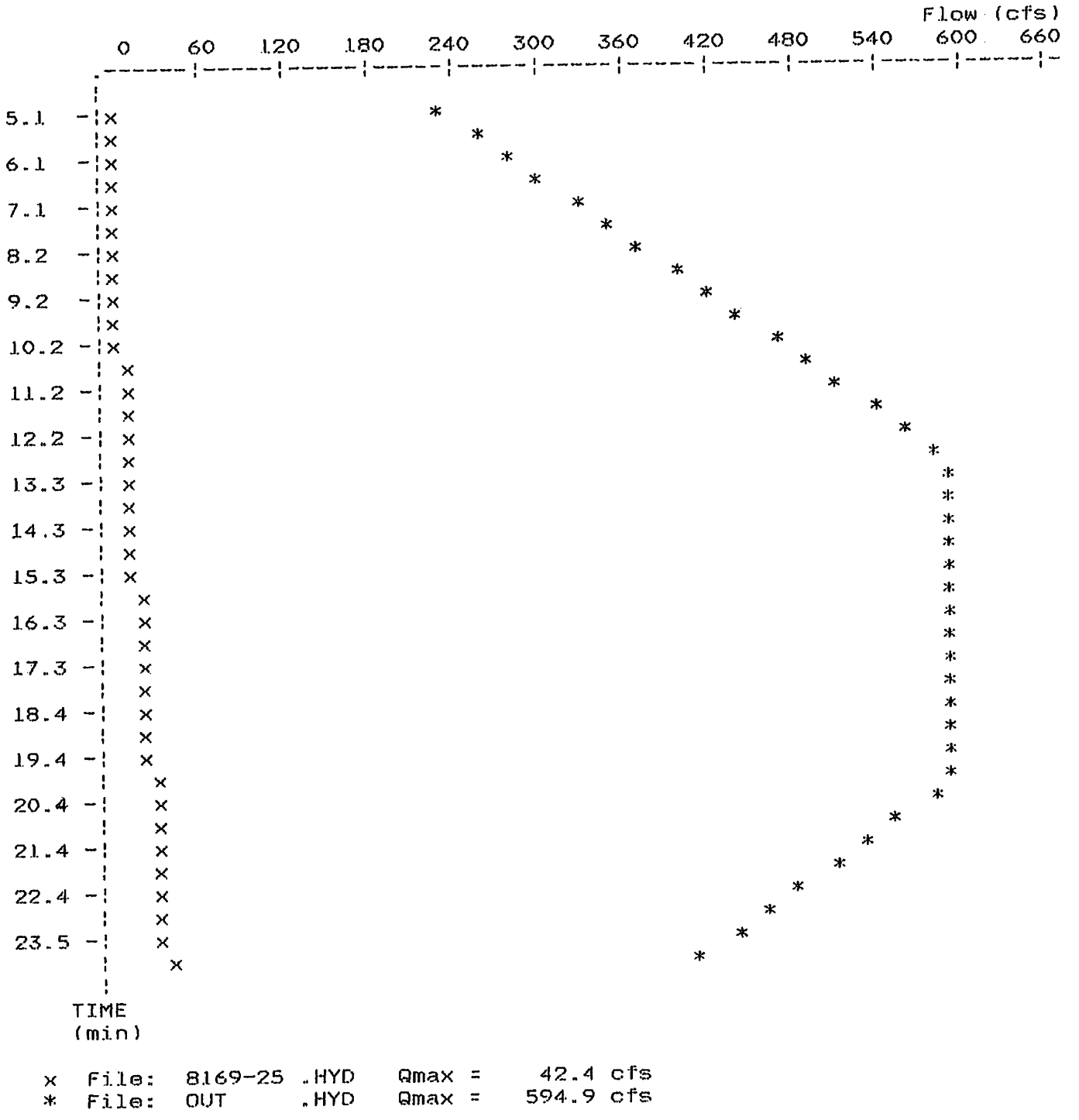
***** Summary of Approximate Peak Storage *****

Initial Storage	=	0.00 ac-ft
Peak Storage From Storm	=	15.53 ac-ft
Total Storage in Pond	=	15.53 ac-ft

Pond File: 8169 .PND
Inflow Hydrograph: 8169-25 .HYD
Outflow Hydrograph: OUT .HYD

EXECUTED: 02-06-1997
13:09:06

Peak Inflow = 594.90 cfs
Peak Outflow = 42.37 cfs
Peak Elevation = 471.31 ft



× File: 8169-25 .HYD Qmax = 42.4 cfs
* File: OUT .HYD Qmax = 594.9 cfs