RETURN TO:
Land Development
101 West Costilla, Suite 122
Colorado Springs, CO 80903

PRELIMINARY
MASTER DRAINAGE REPORT
FOR THE
NORTHERLY PARCEL OF THE HOUCK ESTATE

DREXEL, BARRELL & CO.

ENGINEERS — SURVEYORS

1700 38TH STREET BOULDER, COLORADO 80301 (303) 442-4338

RETURN TO:
Land Development
101 West Costilla, Suite 122
Colorado Springs, CO 80903

PRELIMINARY
MASTER DRAINAGE REPORT
FOR THE
NORTHERLY PARCEL OF THE HOUCK ESTATE

PREPARE FOR:

THE SPEER COMPANY
2735 RIGEL DRIVE
COLORADO SPRINGS, CO 80906

PREPARED BY:

DREXELL, BARRELL & CO.
1700 38TH STREET
BOULDER, COLORADO 80301

RECEIVED
PUBLIC WORKS/ENGINEERING
COLORADO SPRINGS, COLO.
SEP 28 1983
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CITY OF COLORADO SPRINGS
The "America the Beautiful" City
DEPARTMENT OF PUBLIC WORKS CITY ENGINEERING DIVISION (303) 578-6606
30 S. NEVADA SUITE 403 P.O. BOX 1575
COLORADO SPRINGS, COLORADO 80901

October 21, 1983

Mr. George Miners
Drexel, Barrel & Company
1700 38th Street
Boulder, CO 80301

Re: The Houck Estate Preliminary Master Drainage Reports

Dear Mr. Miners:

This office has reviewed your preliminary master drainage reports for the northerly parcel and the southerly parcel of the Houck Estates. We find that the reports are acceptable as preliminary reports and they are only conceptual in nature. Several details must be addressed in the final drainage reports and with the individual subdivision reports. Some of the details are, but not limited to, the following: adequate outfall facilities for all points of discharge from the master planned area; consideration of the potential erosion to natural channels downstream of this development; design of proper storm sewer facilities so that street capacities are not exceeded; all other items covered by the City of Colorado Springs Criteria Manual for Storm Runoff Determination.

It also should be brought to your attention that this office has been made aware of a serious underground water problem in the southerly portion of the Houck Estate in the vicinity of Templeton Gap Road. Although it is out of the scope of this Division's requirements, I am simply pointing this out so that you may take measures to reduce the impact of the underground water problem to the existing neighborhoods southwesterly of the Houck Estate's southern portion.

If you have any questions concerning this matter, please contact this office.

Sincerely,

Gary R. Haynes

Gary R. Haynes
City Engineer

GRH/ro

cc: DeWitt Miller, Director of Public Works
Bob Wolcott, City Planning
Chris Smith, Subdivision Development Administrator
Bev Dustin, Land Development Technician
Mark Norton, Civil Engineer II

PRELIMINARY MASTER DRAINAGE REPORT FOR THE SOUTHERLY PARCEL OF THE HOUCK ESTATE

I. INTRODUCTION

The northerly parcel of the Houck Estate is located in sections 17, 20, 21 and 28 of T13S, R66W of the 6th P.M., City of Colorado Springs, County of El Paso. More particularly, it is located west of Academy Boulevard, and east of Nevada Avenue, and is commonly referred to as the Autin Bluffs area. The parcel is approximately 711 acres and is being proposed primarily as a residential development of varying densities, with a small portion of the westerly central area proposed as commercial development.

II. PURPOSE OF STUDY

This drainage study was undertaken to analyze the run-off patterns for the site, and to determine a rough idea of the major facilities required to handle the drainage, given a conceptual land use plan. The kinds of development that may take place on the property has yet to be determined. The City of Colorado Springs is in the process of reviewing the proposed land use plan for zoning and development. Consequently this report does not attempt to address problems associated with any specific area, nor to develope the collection system which will be required.

III. STUDY METHODOLOGY

The modified S.C.S. methodology was used to develope basin flows. This methodology was taken from the Colorado Springs Storm Run-off Criteria Manual, March 1977. The design storm is the 5-year occurance the major central basin where the 100 year flow analysis exceeds the 500 c.f.s. limitation.

IV. OFFSITE RUN-OFF

Due to the site topography the only off-site run-off effecting the site is developed in the Erindale Subdivision to the northeast of the property. The drainage from Erindale outfalls in the northerly 40 acres of the Houck property via a 72" storm sewer, and is then carried in an open ditch. At the time of development it is proposed to pick up this flow in a conduit and carry it off-site.

V. MAJOR BASINS

All but the northerly 15% of the property is a portion of the Templeton Gap Drainage Basin and the proposed drainage facilities have been signed in accordance with the Basin Study. The majority of the property (380+ acres) drainas to the west towards Nevada Avenue along the proposed Montebello

Avenue right-of-way. The easterly portion of the property drains into existing subdivisions, or the proposed Union Boulevard extension right-of way with ultimate delivery of both area to the Templeton Gap Floodway.

The northerly 15% of the parcel drains into the Public Rock Basin westerly to Nevada Avenue and ultimately to Monument Creek. Additionally, the northerly most 40 acres of the property is responsible for carrying run-off generated by the Erindale Subdivision and the facilities in the area have been sized accordingly.

VI. BASIN FEES

As indicated above, approximately 103 acres, 15% of the parcel, is in the Pulpit Rock Drainage Basin. Fees for that basin are currently $2,054 per acre for a total of $211,562. The remaining 608 acres in the Templeton Gap Drainage Basin are subject to fees of $2,143 per acre (Basin fee = $2119, Bridge fee = $24) $1,302,944.00. Total drainage fees for the parcel are $1,514,506.00.

VII. FACILITY COST ESTIMATE

A cost estimate of the facilities on the attached Master Drainage Plan is $1,350,000. It should be emphasized that the plan is conceptual at the stage and does not include facilities required for collection, and/or appurtenant facilities.

VIII. CONCLUSIONS

Run-off from the site can be handled by facilities similar to those indicated in the Templeton Gap and Pulpit Rock Drainage Master Study. It is feasible to handle the run-off from the site in a satisfactory manner. However attention must be given to a collection system when zoning and development plans are finalized to insure street capacity is not exceeded and that erosion is minimized.

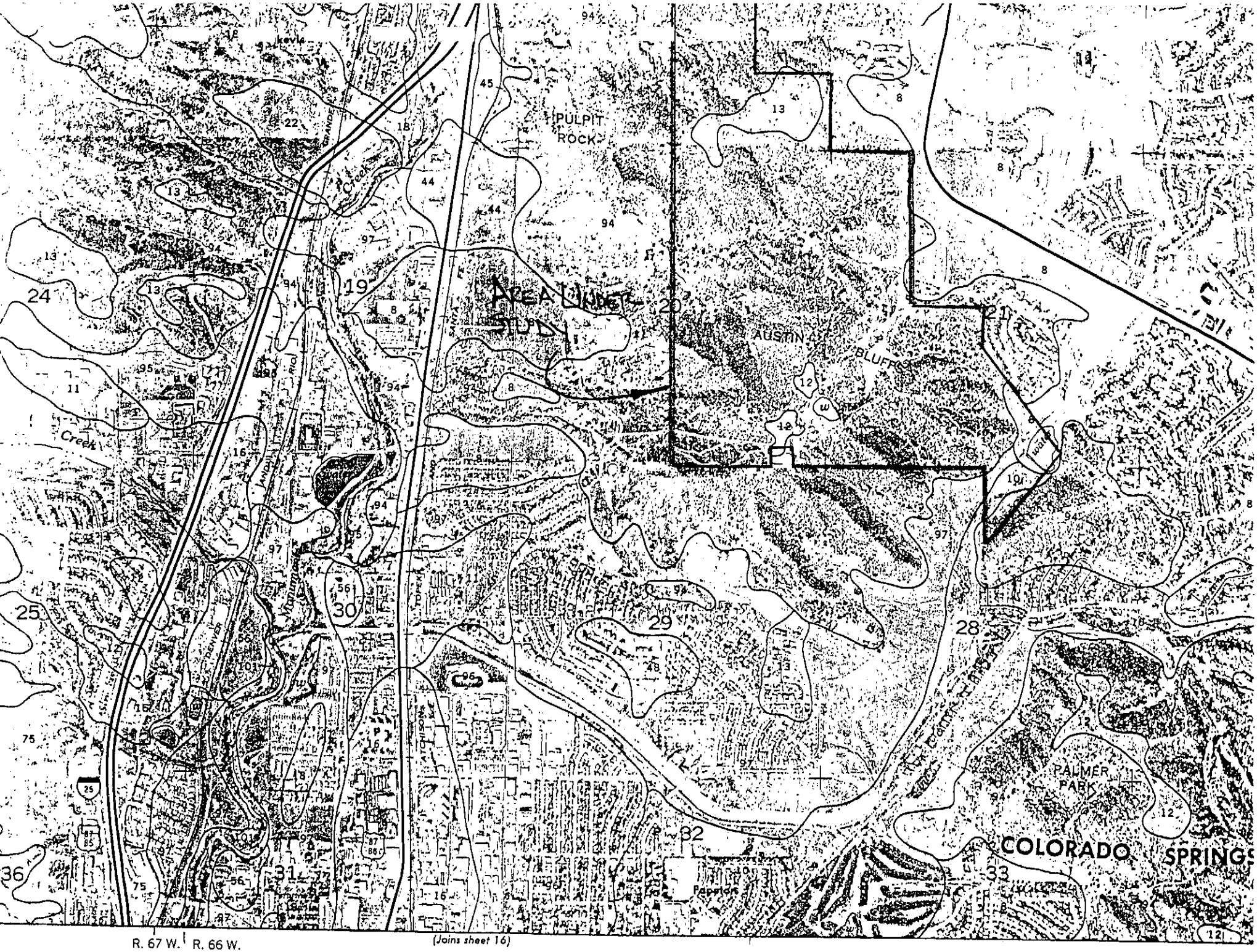
Due to the conceptual nature of this study no certification statements are included. The facilities indicated on the Master Drainage Plan are not under design at this time and are only approximations of the system ultimately required.

An estimated cost for the facilities shown on the attached Master Plan a vicinity map, and calculations are included for review.

Respectfully Submitted,

George Miners

GEORGE WALLACE MINERS
REGISTERED
18056
PROFESSIONAL ENGINEER
STATE OF COLORADO


PULPIT ROCK
AUSTIN BLUFFS
PALMER PARK
COLORADO SPRINGS
Peyton
Creek
19
20
21
24
25
28
29
30
31
32
33
36
R. 67 W.
R. 66 W.
(Joins sheet 16)

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job No
DRAINAGE STUDY & COST ESTIMATE	E 2714
Client	**By** / **Date**
SPELLR (HANCOCK ESTATE)	EWW 6/6/83

THE CONCEPTUAL DRAINAGE PLAN FOR THE NORTHERLY 111 ± ACRES INDICATES THE FOLLOWING FACILITIES WILL BE REQUIRED TO HANDLE STORM RUN-OFF.

→ ON-SITE

PIPE SIZE	LENGTH	COST/FOOT	TOTAL
18"	2500	27.00	67500
21"	800	31.50	25200
24"	2400	36.00	86400
30"	1400	45.00	63000
36"	1500	54.00	81000
42"	600	63.00	37800
48"	500	72.00	36000
54"	500	81.00	40500
72"	1300	108.00	140400
84"	1500	126.00	189000
90"	1000	135.00	135000
			901800
DRAINAGE STRUCTURES			135270
			1037070
CONTINGUENCIES @ 15%			155560
ENGINEERING @ 15%			155560
			$1348190

⇒ $1,350,000

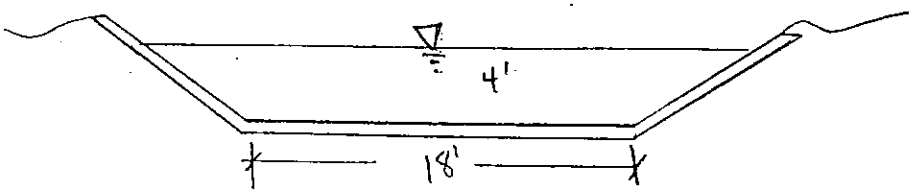
DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job Nº
DRAINAGE STUDY & COST ESTIMATE	E-2714
Client	**By** / **Date**
SPEER (CLOVER ESTATE)	GWH 6/6/83

— OFF-SITE

∴ FROM THE TEMPLETON GAP DRAINAGE STUDY

PROPOSED CHANNEL ALONG MONTEBELLO DR.



APPROXIMATELY 3800 L.F. OF CHANNEL @ $54 = 205200

CONTINGUENCIES @ 15% = 30780

ENGINEERING @ 15% = 30780

$266,760

OUTFALL FROM THE SOUTHWEST PORTION OF PROPERTY TO NEVADA.

600 L.F. 36" @ $48 = $28800

900 L.F. 48" @ 62[illegible] = 55800

1500 L.F. CHANNEL @ 54[illegible] = 81000

$165,600

CONTINGENCIES @ 15% 24840

ENGINEERING @ 15% 24840

$215,280.00

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/7/83

RUNOFF SUMMARY BY DRAINAGE BASIN

OUTFALL Pt.	BASIN	AREA/Ac	Tc/Hr.	CN	Sys. FLOW	OUTFALL PEAK
I	A	42.18	0.09	84	70	92
	B	23.622	0.14	82	30	
II	II	14.191	0.04	83	26	26
III	A	66.955	0.11	86	120	487
	B	31.147	0.08	85	56	
	C	50.399	0.11	82	70	
	D	51.739	0.14	86	89	
	E	45.192	0.15	84	67	
	F	79.616	0.20	84	110	
	G	55.486	0.14	85	90	
IV	IV	59.355	0.10	84	98	98
V	V	13.245	0.02	85	27	27
VI	VI	37.424	0.07	84	68	68
VII	VII	117.929	0.21	84	169	169
VIII	VIII	22.892	0.08	80	30	30

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job No
Master Drainage Study	E-2714
Client: Speer (Hoench Estate)	By: GWM Date: 2/3/83

Soil Groups Present within the Hoench Estate (SCS. Maps of El Paseo County #8)

Map Designation	Name	Hydrologic Soil Group
12	Bresser Sandy Loam	B
13	Bresser Sandy Loam	B
94	Travessilla Rock	D
10	Blendon Sandy Loam	B
8	Blakeland Loamy Sand	A
97	Truckton Sandy Loam	B

Curve Numbers By Land Use

Density	Soil Group	CN
1/8 Acre or less	B	85
	D	92
1/4 Acre	A	61
	B	75
	D	87
Open Space	A	49
	B	69
	D	84

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/83

-Basin IA = 42.8 Acres

	Soil Group	%	CN	Product
Residential ¼ Acre	D	28	87	2436
Residential ¼ Acre	B	14	75	1050
Open Space	D	58	84	4872
				8358

Weighted CN = 84 Q_5 = 0.82" Q_{100} = 1.94"

Basin IB = 23.622 Acres

R ¼	D	32	87	2784
R ¼	B	15	75	1125
R ⅛	B	4	85	340
O.S.	D	47	84	3948
				8197

Weighted CN = 82 Q_5 = 0.71" Q_{100} = 1.78"

Basin II = 14.191 Acres

R ¼	B	17	75	1275
R ¼	D	11	87	957
O.S.	D	72	84	6048
				8240

Weighted CN = 83 Q_5 = 0.77" Q_{100} = 1.86"

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/83

Basin III A = 66.955 Acres

Land Use	Soil Group	%	CN	Product
R 1/4	B	2	75	150
R 1/4	D	8	87	696
R 1/8	B	3	85	255
R 1/8	D	23	92	2116
Park	D	7	84	588
O.S.	D	57	84	4788
				8593

Weighted CN = 86 Q_5 = 0.92" Q_{100} = 2.10"

Basin III B = 31.147 Acres

R 1/8	B	4	85	340
R 1/8	D	7	92	644
R 1/4	D	13	87	1131
O.S.	D	76	84	6384
				8499

Weighted CN = 85 Q_5 = 0.87" Q_{100} = 2.02

Basin III C = 50.399

R 1/8	B	8	85	680
R 1/4	B	24	75	1800
R 1/4	D	9	87	783
O.S.	D	59	84	4956
				8219

Weighted CN = 82 Q_5 = 0.71" Q_{100} = 1.78

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/83

Basin III D = 51.739 Acres

Land Use	Soil Group	%	CN	Product
R 1/4	B	05	95	37.5
R 1/4	D	62.5	87	5437.5
O.S.	D	37	84	3108
				8583

Weighted CN = 86 Q_5 = 0.92 Q_{100} = 2.10

Basin III E = 45.192 Acres

R 1/4	A	6	61	366
R 1/8	D	1	92	92
R 1/4	D	59	87	5133
Park	D	4	84	336
O.S.	D	30	84	2520
				8447

Weighted CN = 84 Q_5 = 0.82 Q_{100} = 1.94

Basin III F = 79.616 Acres

R 1/4	B	11	75	825
R 1/4	D	43	87	3741
O.S.	D	46	84	3864
				8430

Weighted CN = 84 Q_5 = 0.82 Q_{100} = 1.94

Project: Master Drainage Study — Job No. E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/87

Basin III G = 55.486 Acres

Land Use	Soil Group	%	CN	Product
R 1/4	B	3	75	225
R 1/4	D	26	87	2262
O.S.	D	71	84	5964
				8451

Weighted CN = 85 Q_5 = 0.81" Q_{100} = 2.02"

Basin IV = 59.355 Acres

R 1/4	D	16	87	1392
O.S	D	84	84	7056
				8448

Weighted CN = 84 Q_5 = 0.82" Q_{100} = 1.94"

Basin V = 13.245 Acres

R 1/8	B	3	85	255
R 1/8	D	12	92	1104
O.S	D	85	84	7140
				8499

Weighted CN = 85 Q_5 = 0.81" Q_{100} = 2.02"

Basin VI = 37.424 Acres

R 1/8	D	1	92	92
R 1/4	D	9	87	783
O.S.	D	90	84	7560
				8435

Weighted CN = 84 Q_5 = 0.82" Q_{100} = 1.94"

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job No
Master Drainage Study	E-2714
Client: Speer (Hawk & State)	By: GWM Date: 2/3/82

Basin VII = 117.928 Acres

Land Use	Soil Group	%	CN	Product
R 1/8	B	1	85	85
R 1/8	D	7	92	644
R 1/4	A	5	61	305
R 1/4	D	36	87	3132
Park	D	3	84	252
O.S.	D	41	84	3444
				.7862

(Note approximated 7% (7 Acres) is Pond Area)

Weighted CN = 85 $Q_5 = 0.87"$ $Q_{100} = 2.02"$

Basin VIII = 22.882 Acres

R 1/8	B	29	85	2465
R 1/4	B	15	75	1125
R 1/4	D	25	87	2175
Park	B	22	69	1518
O.S.	B	5	69	345
O.S	D	4	84	336
				.7964

Weighted CN = 80 $Q_5 = 0.62"$ $Q_{100} = 1.64"$

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/83

$$A_{(\text{Basin Area})} \times Q_{(\text{Run-off})} = \frac{t_b}{2} \times q \quad \left(\text{Hydrograph Area}\right)$$

Solving for $t_b = \frac{2AQ}{q}$

$$Hr = 2\left(\frac{\text{Sq. Mix in} \times \text{Sec}}{Ft^3}\right)$$

$$= 2\left(\frac{43560 \frac{Ft^2}{Ac} \times 640 \frac{Ac}{Mi}}{12 \text{ in/ft} \times 3600 \text{ Sec/hr}}\right)$$

$$\Rightarrow t_b = \frac{1290\ AQ}{q}$$

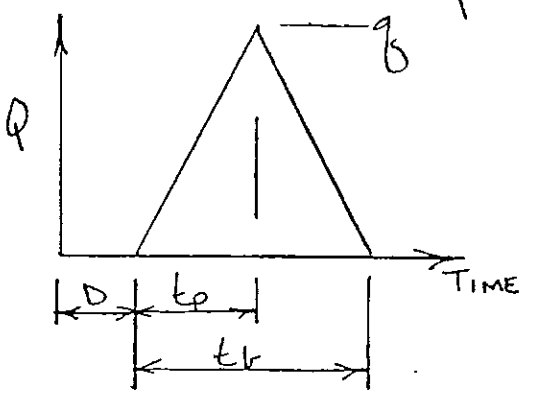
let $\Delta = .133\ t_c$

Project: Master Drainage Study — Job No. E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/83

— Determination of Hydrograph for Peak Flows in Colorado Springs

- *Total Precipitation:
  - 5yr 6 Hr Storm = 2.1 inches
  - 100yr 6 Hr. Storm = 3.5 inches
- Type IIA Storm - Figure I revision 7-13-77
- ** Q (Runoff in inches) over Basin = Area under Hydrograph
- $t_b = 2.67\ t_p$
- $q_{(Peak\ Flow)} = q_{p(CSM/in)} \times A_{(Area\ of\ Basin)} \times Q$
- Use recommended triangular Hydrograph



* Colorado Springs Determination of Storm Runoff Criteria - March 77
** S. Glade Wilkes - S.C.S., Denver

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWH — Date: 2/3/83

- Area I Basin A

A = 42.18 Acres
L = 1900'
H = 6560 - 6330 = 230'
CN = 84
Q_{5yr} = 0.82
Q_{100yr} = 1.92
T_c = 0.09 Hr. (TOTAL BASIN)
q_p = 1300 CSM/in

T_c: Reach ① 1500' H = 190' ⇒ T_c = 0.08
Reach ② 400' H = 40' ⇒ T_c = 0.03
$T_{c\,TOTAL}$ 0.11

q_p = 1250 q_s 67.55

$$q_5 = 1300\,(.82) \times \frac{42.18}{640} = 70.26 \text{ cfs}$$

$$q_{100} = q_5 \times \frac{1.92}{0.82} = 164.50 \text{ cfs}$$

$$t_{b5} = \frac{1290 \times 42.18 \times .82}{70.26 \times 640} = 0.99 \text{ Hr.}$$

$$t_{b100} = \frac{1290 \times 42.18 \times 1.92}{164.50 \times 640} = 0.99 \text{ Hr.}$$

t_p = 0.37 Hr.
D = 0.01 Hr.

↑ $Slope_5$ = 3.16 cfs/Min.
↓ $Slope_5$ = 1.89 cfs/Min.

↑ $Slope_{100}$ = 7.41 cfs/Min.
↓ $Slope_{100}$ = 4.42 cfs/Min.

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/83

- Area I Basin B

A = 23.622 Acres
L = 2300'
H = 6565 - 6350 = 215'
CN = 82
Q_{5yr} = 0.71
Q_{100yr} = 1.78
T_c = 0.14 Hr. (Total Basin - Avg.)
q_p = 1180 CSM/in.

n = 0.033
0.12

Distance to Outfall (A) = 600'
H_{BA} = 20' S = 3.33%
T_L = 0.075

$$q_5 = 1180\,(0.71) \times \frac{23.622}{640} = 30.92 \text{ cfs.}$$

$$q_{100} = q_5 \times \frac{1.78}{0.71} = 77.52 \text{ cfs}$$

$$tL_5 = \frac{1290 \times 0.71 \times 23.622}{640 \times 30.92} = 1.09 \text{ Hr.} \checkmark$$

$$tL_{100} = \frac{1290 \times 1.78 \times 23.622}{640 \times 77.52} = 1.09 \text{ Hr.} \checkmark$$

t_p = 0.41 Hr.
D = 0.02 Hr.
↑ Slope$_5$ = 1.26 cfs/min.
↓ Slope = 0.76 cfs/min.

T_c: Reach ① 850' H = 90' ⇒ T_c = 0.06
Reach ② 900' H = 110' ⇒ T_c = 0.055
Reach ③ 550' H = 25' ⇒ T_c = 0.055

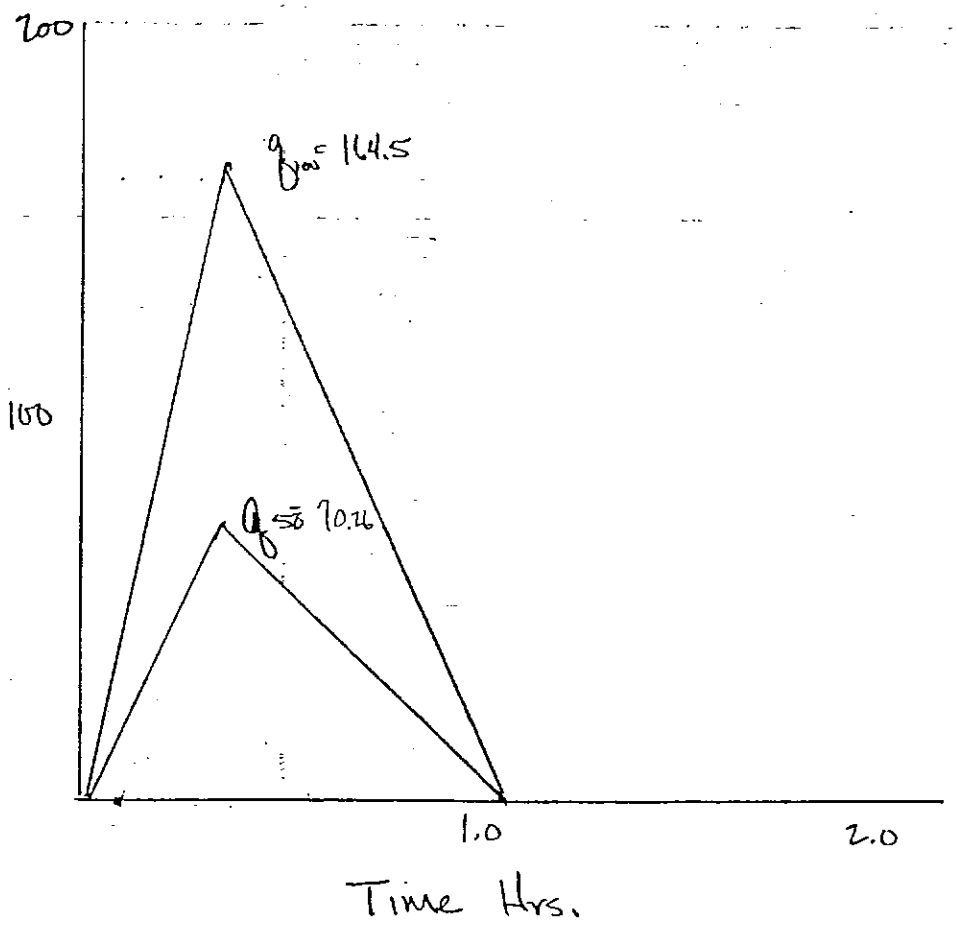
$T_{c\,TOTAL}$ = 0.17

q_p = 1120 q_5 = 29.35 cfs

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: [illegible] — Date: 2/3/83

Area I Basin A

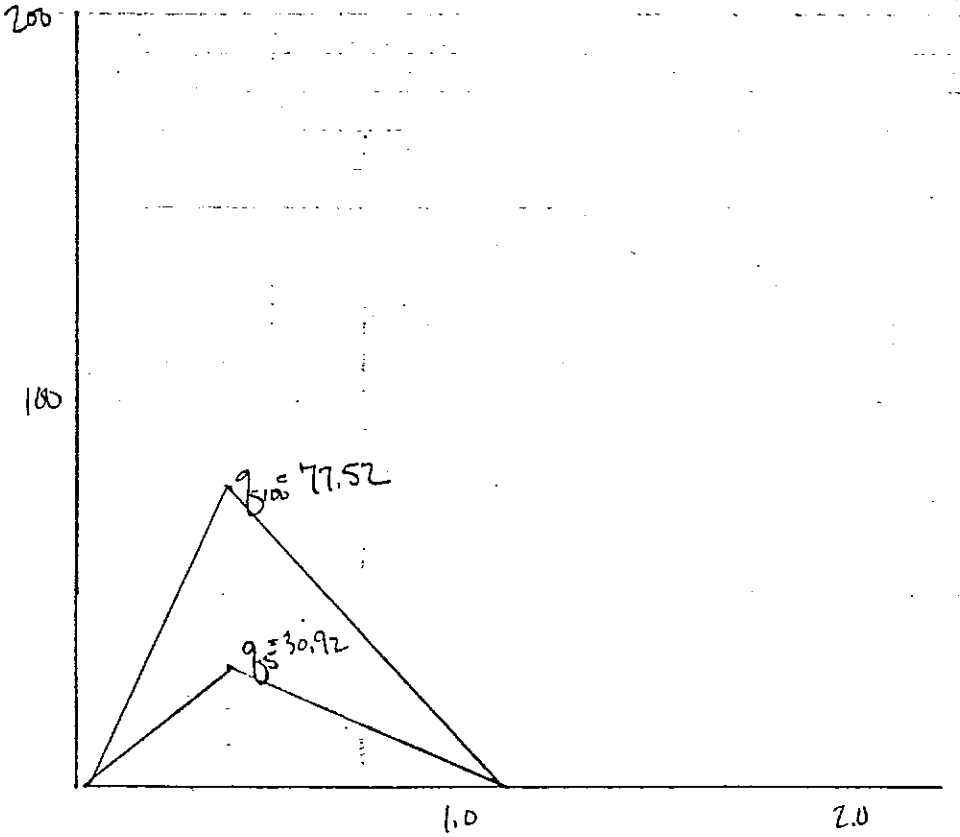


DREXEL, BARRELL & CO.

LAND SURVEYORS
CIVIL ENGINEERS

Project	Job No
Master Drainage Study	E-2714
Client	**By** / **Date**
Speer (Hauck Estate)	GWM 2/3/83

Area I Basin B



DEXCEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study | Job No: E-2714

Client: Speer (Houck Estate) | By: GWM | Date: 2/3/83

- Area II

A = 14.191 Acres

L = 850'

H = 6600 - 6370 = 230'

CN = 83

Q_{5yr} = 0.77

Q_{100yr} = 1.86

T_c = 0.04 Hr.

q_p = 1500 CSM/in

$$q_{5} = 1500 \times (0.77) \times \frac{14.191}{640} = 25.61 \text{ cfs}$$

$$q_{100} = q_{5} \times \frac{1.86}{0.77} = 61.86 \text{ cfs}$$

$$t_b = \frac{1290 \times 0.77 \times 14.191}{640 \times 25.61} = 0.86 \text{ Hr.}$$

t_p = 0.32 Hr.

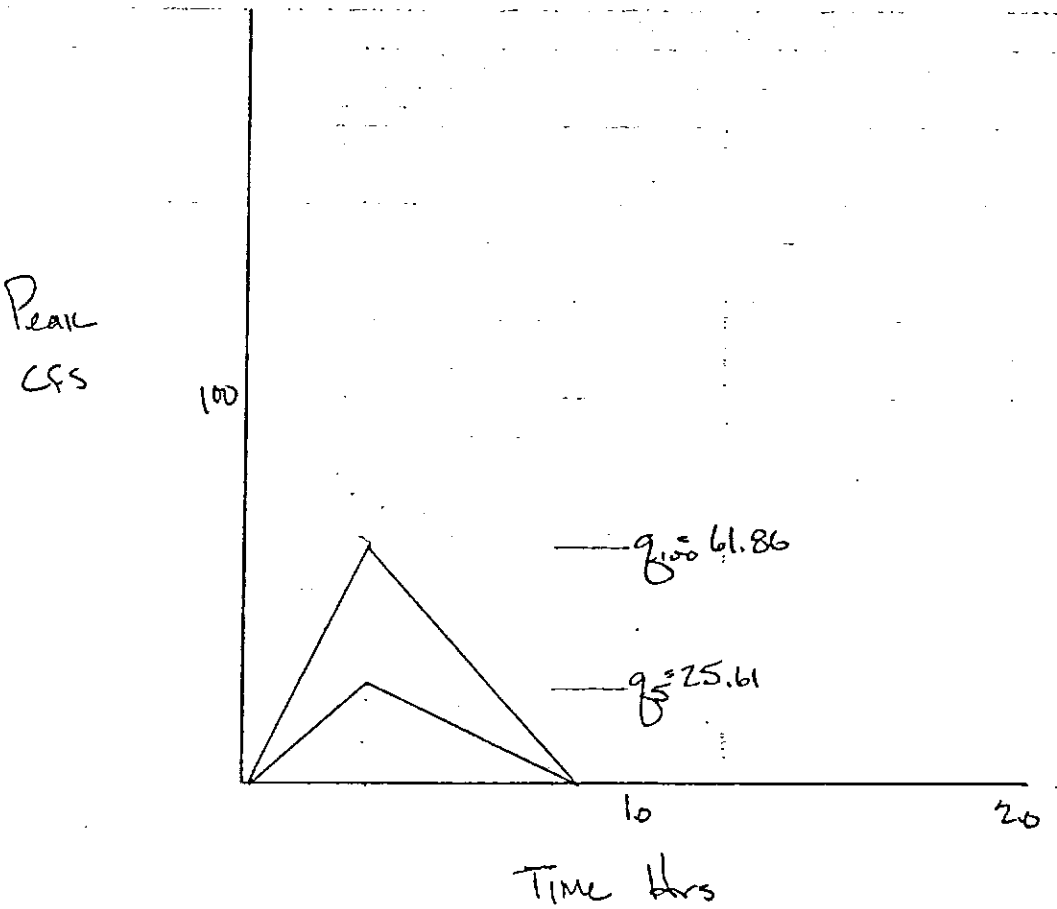
Δ = 0.01 Hr.

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Spear (Houck Estate) — By: GWM — Date: 2/3/83

Area II



DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: [illegible] — Date: 2/3/83

- Area III: Basin A

A = 66.955

L = 2100 ℓ

H = 6670 - 6330 = 340'

CN = 86

Q_{5yr} = 0.92

Q_{100yr} = 2.10

T_c = 0.11 Hr. (TOTAL BASIN - AVG.)

q_p = 1250 CSM/in

T_c: Reach ① 750' H = 24.6 ⇒ T_c = 0.03
Reach ② 1100' H = 80' ⇒ T_c = 0.08
Reach ③ 250' H = 20' ⇒ T_c = 0.03

$T_{c\,TOTAL}$ = 0.14

q_p = 1190 q_5 = 114.53

$$q_5 = 1250 \cdot (0.92) \times \frac{66.955}{640} = 120.31 \text{ cfs}$$

$$q_{100} = q_5 \times \frac{2.10}{0.92} = 274.62 \text{ cfs}$$

$$t_b = \frac{1290 \times 0.92 \times 66.955}{640 \times 120.31} = 1.03 \text{ Hr.}$$

t_p = 0.39

D = 0.01 Hr.

↑ $Slope_5$ = 5.14 cfs/Min.

↓ $Slope_5$ = 3.13 cfs/Min.

↑ $Slope_{100}$ = 11.74 cfs/Min.

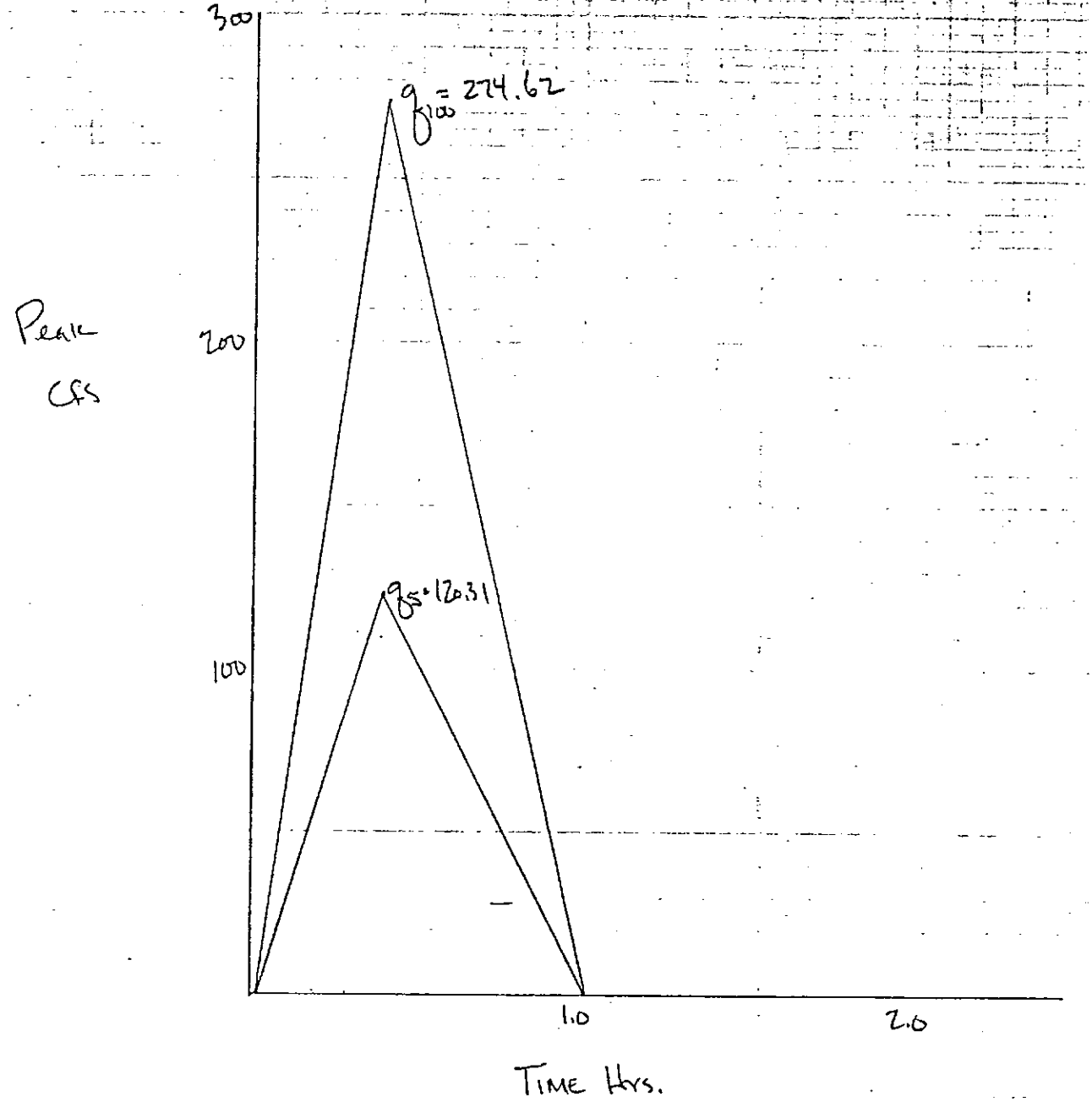
↓ $Slope_{100}$ = 7.15 cfs/Min

DIXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/83

Area III Basin A



DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/83

— Area III Basin B

A = 31.147 Acres
L = 1600'
H = 6590 - 6356 = 234'
CN = 85
Q_{5yr} = 0.87
Q_{100yr} = 2.02
T_c = 0.08 Hr. (TOTAL BASIN AVG)
q_p = 1320 csm/in.

$q_s = 1320 \times (0.87) \times \frac{31.147}{640} = 55.89$ cfs

$q_{100} = q_s \times \frac{2.02}{0.87} = 129.79$

$t_6 = \frac{1290 \times 0.87 \times 31.147}{640 \times 55.89} = 0.98$ Hr.

t_p = 0.37 Hr.
D = 0.01 Hr.

Distance to Outfall (A) = 850'
H_{B-A} = 26'
T_c = 0.09

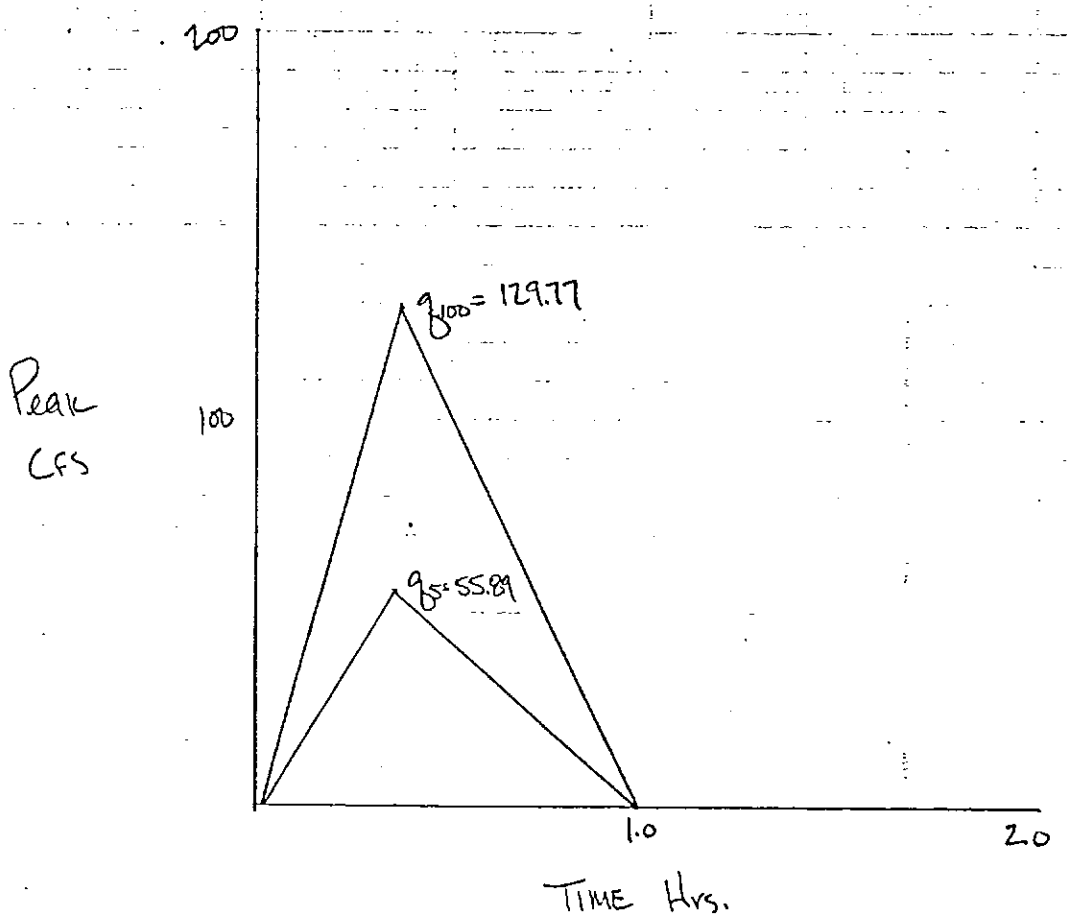
T_c: Reach (1) 1100' H = 220' $\Rightarrow T_c$ = 0.055
Reach (2) 500' H = 14' $\Rightarrow T_c$ = 0.06
$T_{c\,TOTAL}$ = 0.115

q_p = 1250 q_s = 52.93

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job No
Master Drainage Study	E-2714
Client: Speer (Houck Estate)	By: SWM / Date: 2/3/83

Area III Basin B



- Area III Basin C

$A = 50.399$

$L = 2100'$

$H = 6600 - 6380 = 220'$

$CN = 82$

$Q_{5yr} = 0.71$

$Q_{100yr} = 1.78$

$T_c = 0.11$ Hr. (TOTAL BASIN - AVG)

$q_p = 1250$ csm/in

$q_5 = 1250(0.71) \times \frac{50.399}{640} = 69.89$ cfs

$q_{100} = q_5 \times \frac{1.78}{0.71} = 175.22$ cfs

$t_b = \frac{1290 \times 0.71 \times 50.399}{640 \times 69.89} = 1.03$ Hr.

$t_p = 0.39$ Hr.

$D = 0.01$ Hr.

Distance to Outfall (B) = 900'

$H_{C-B} = 24'$

$T_c = 0.1$ Hr

T_c:

Reach ①	600'	H=90	⇒	$T_c = 0.04$
Reach ②	500'	H=80'	⇒	$T_c = 0.035$
Reach ③	500'	H=20'	⇒	$T_c = 0.055$
Reach ④	500'	H=30'	⇒	$T_c = 0.04$

$E_{TOTAL} = 0.17$ Hr.

$q_p = 1100$ $q_5 = 65.50$ cfs.

Project: Master Drainage Study

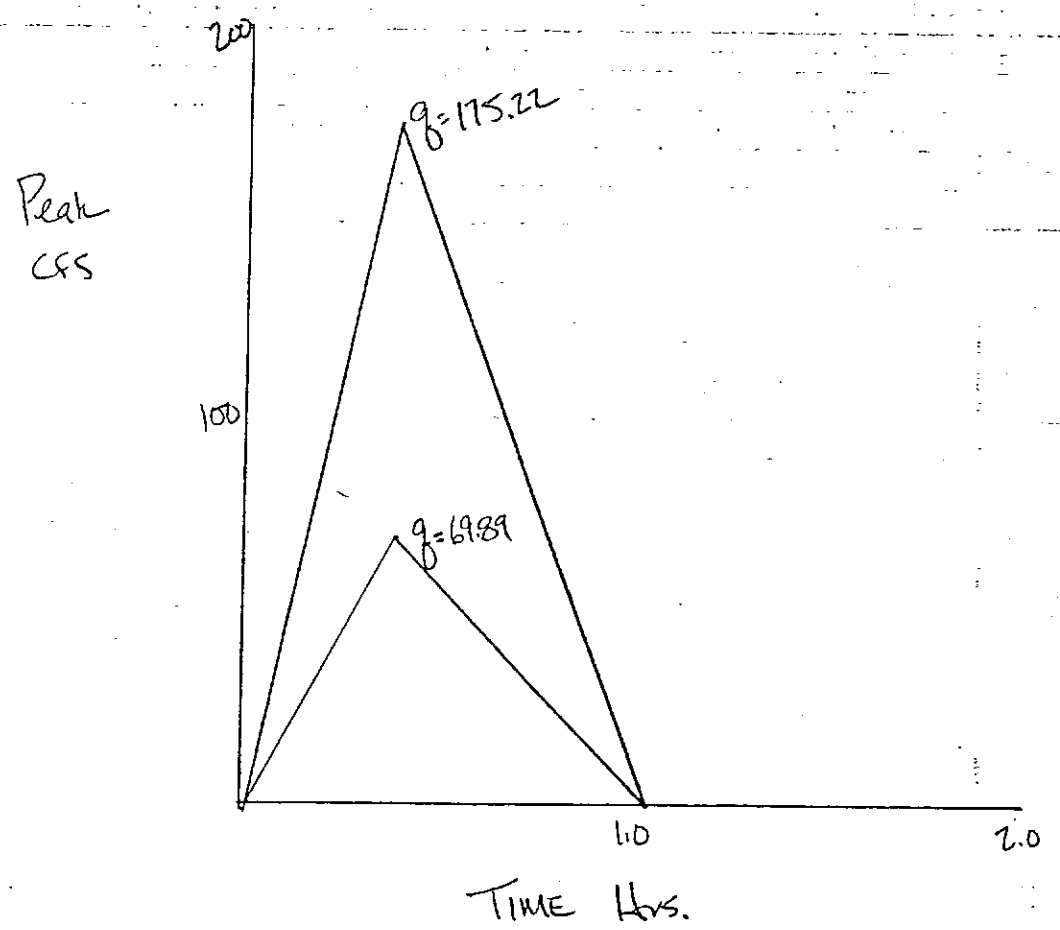
Job Nº: E-2714

Client: Speer (Houck Estate)

By: GWM

Date: 2/3/83

Area III Basin C



- Area III: Basin D

A = 51.739 Acres

L = 2050

H = 6550 - 6410 = 140'

CN = 86

Q_{5yr} = 0.92

Q_{100yr} = 2.10

T_c = 0.15 Hr. (Total Basin - Avg.)

q_p = 1190 csm/in.

$q_5 = 1190(0.92) \times \frac{51.739}{640} = 88.51$ cfs

$q_{100} = q_5 \times \frac{2.10}{0.92} = 202.02$ cfs

$t_b = \frac{1270 \times 0.92 \times 51.739}{640 \times 88.51} = 1.08$ Hr.

t_p = 0.40 Hr.

D = 0.02 Hr.

Distance to Outfall (C-F) = 950'

H_{D-CF} = 30'

T_c = 0.10 Hr.

T_c: Reach ① 800' @ 4% = 2.0 fps $\Rightarrow T_c$ = 0.11 Hr.

Reach ② 700' @ 14% = 3.5 fps $\Rightarrow T_c$ = 0.06 Hr.

Reach ③ 550' @ 4% = 2.0 fps. $\Rightarrow T_c$ = 0.08 Hr.

T_{TOTAL} = 0.25 Hr.

q_p = 1000 q_5 = 79.37 cfs

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Howck Estate) — By: BWM — Date: 2/3/83

- Area III Basin E

A = 45.192 Acres

L = 2500'

H = 6560 - 6410 = 150'

CN = 84

Q_{5yr} = 0.82

Q_{100yr} = 1.94

T_c = 0.15 Hr. ($L_{TOTAL\ BASIN}$ - Avg.)

Distance to Outfall (C-E) = 950'

H_{E-CF} = 30'

T_c = 0.10 Hr

q_p = 1150 csm/in.

$$q_5 = 1150 \times (.82) \times \frac{45.192}{640} = 66.59 \text{ cfs}$$

$$q_{100} = q_5 \times \frac{1.94}{0.82} = 157.54 \text{ cfs}$$

$$t_L = \frac{1290 \times 0.82 \times 45.192}{640 \times 66.59} = 1.12 \text{ Hr.}$$

t_p = 0.42 Hr.

D = 0.02 Hr.

T_c: Reach ① 1400' H=90' $\Rightarrow T_c$ = 0.05
Reach ② 650' H=30' $\Rightarrow T_c$ = 0.06
Reach ③ 450' H=30' $\Rightarrow T_c$ = 0.04

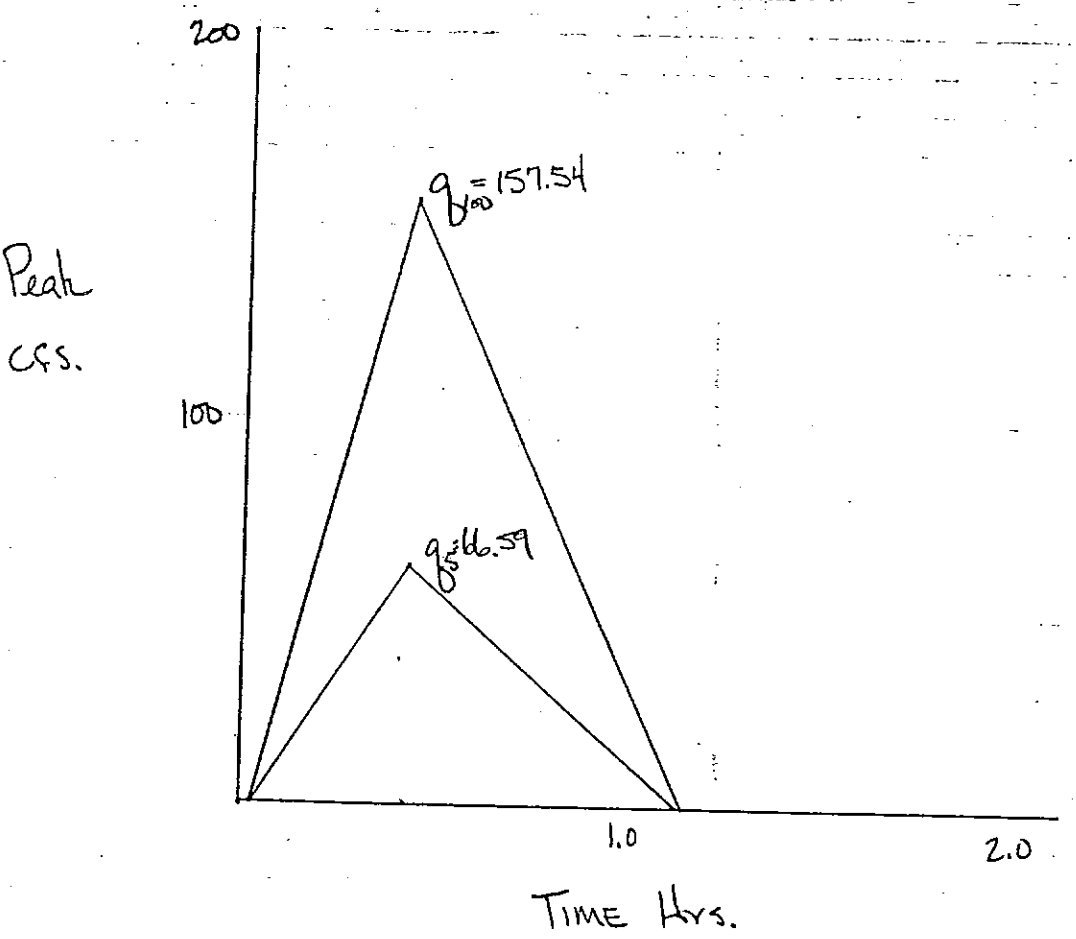
$T_{c\ TOTAL}$ = 0.15 ✓

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No. E-2714

Client: Speer (Howell) — By: GMM — Date: 2/3/83

Area III Basin E



DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No. E-2714

Client: Spuer (Hauck Estate) — By: GWM — Date: 2/3/83

Area III Basin F

A = 79.616 Acres

L = 3900'

H = 6676 − 6380 = 296'

CN = 84

Q_{5yr} = 0.82

Q_{100yr} = 1.94

T_c = 0.20 Hr. (TOTAL BASIN - AVG.)

q_p = 1080 csm/in.

$q_5 = 1080(0.82) \times \frac{79.616}{640} = 110.17$ cfs

$q_{100} = q_5 \times \frac{1.94}{0.82} = 260.64$ cfs

$t_5 = \frac{1290 \times 0.82 \times 79.616}{640 \times 110.17} = 1.19$ Hr.

t_p = 0.45 Hr.

D = 0.03 Hr.

Distance to Outfall (B-G) = 900'

H_{F-BG} = 24'

T_c = 0.10 Hr.

T_c:

Reach ①	1550'	H = 110'	$\Rightarrow T_c$ = 0.10
Reach ②	1000'	H = 90'	$\Rightarrow T_c$ = 0.07
Reach ③	800'	H = 60'	$\Rightarrow T_c$ = 0.07
Reach ④	550'	H = 30'	$\Rightarrow T_c$ = 0.05

$T_{c\,TOTAL}$ = 0.29 Hr.

q_p = 950 q_5 = 96.91 cfs.

DREXEL, BARRELL & CO.

LAND SURVEYORS
CIVIL ENGINEERS

Project: Master Drainage Study

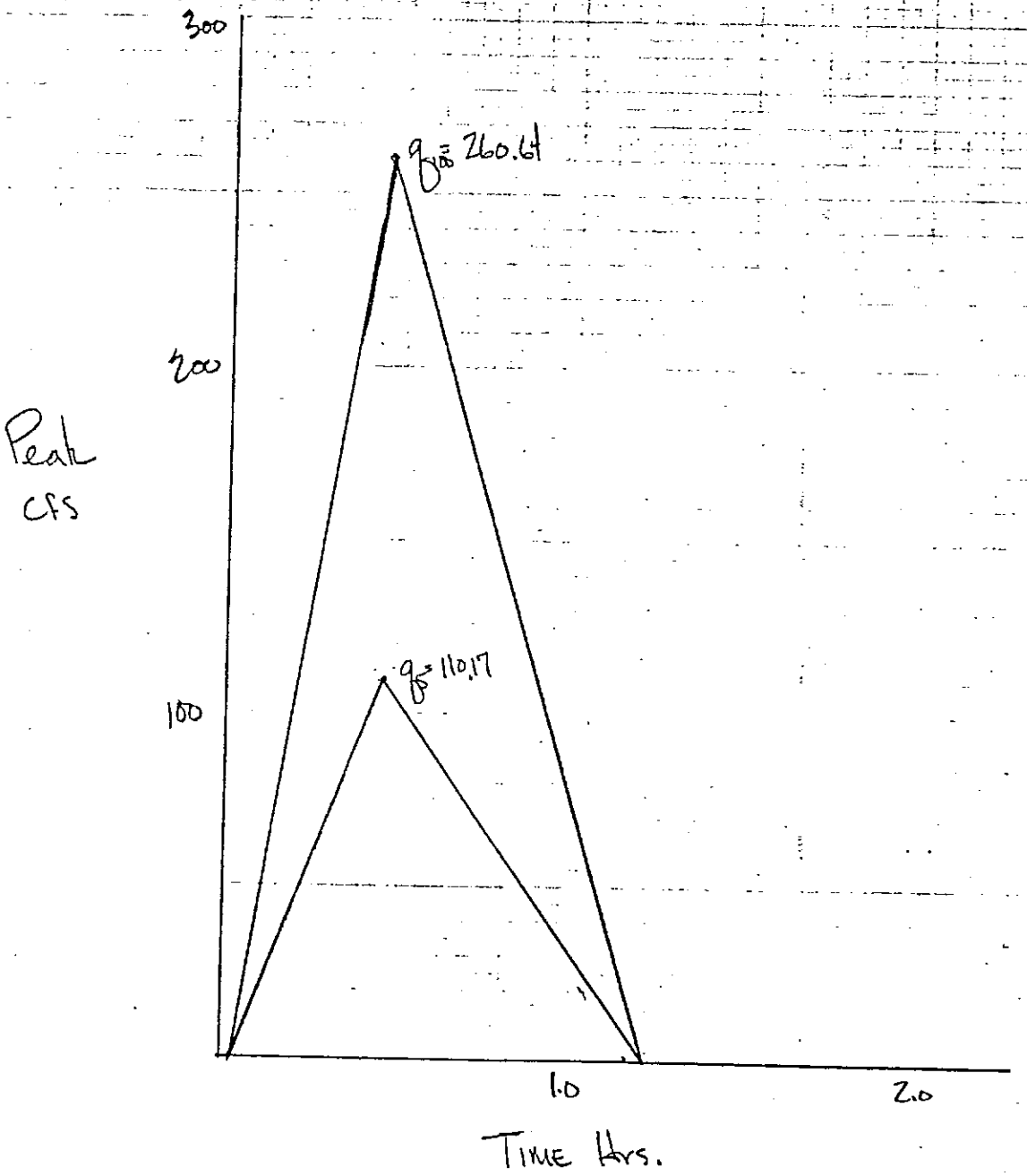
Job No: E-2714

Client: Speer (Houck Estate)

By: GWM

Date: 2/3/83

Area III Basin F



DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No. E-2714

Client: Speer (Houck Estate) — By: RWM — Date: 2/3/83

Area III Basin G

A = 55.486

L = 3000'

H = 6696 - 6356 = 346'

CN = 85

Q_{5yr} = 0.87

Q_{100yr} = 2.02

T_c = 0.14 Hr. (TOTAL BASIN - AVG)

q_p = 1190 CSM/in.

$q_5 = 1190(0.87) \times \frac{55.486}{640} = 89.76$ cfs

$q_{100} = q_5 \times \frac{2.02}{0.87} = 208.46$ cfs

$t_b = \frac{1290 \times 0.87 \times 55.486}{640 \times 89.76} = 1.08$ Hr.

t_p = 0.41 Hr.

D = 0.02 Hr.

Distance to Outfall (A) = 850'

H_{G-A} = 26'

T_c = 0.095 Hr.

T_c:
Reach (1) 250' H = 30' $\Rightarrow T_c$ = 0.02
Reach (2) 700' H = 180' $\Rightarrow T_c$ = 0.04
Reach (3) 1800' H = 110' $\Rightarrow T_c$ = 0.10
Reach (4) 250' H = 20' $\Rightarrow T_c$ = 0.02

T_c TOTAL = 0.18

q_p = 1100 q_5 = 82.97 cfs.

DREXEL, BARRELL & CO.

LAND SURVEYORS
CIVIL ENGINEERS

Project: Master Drainage

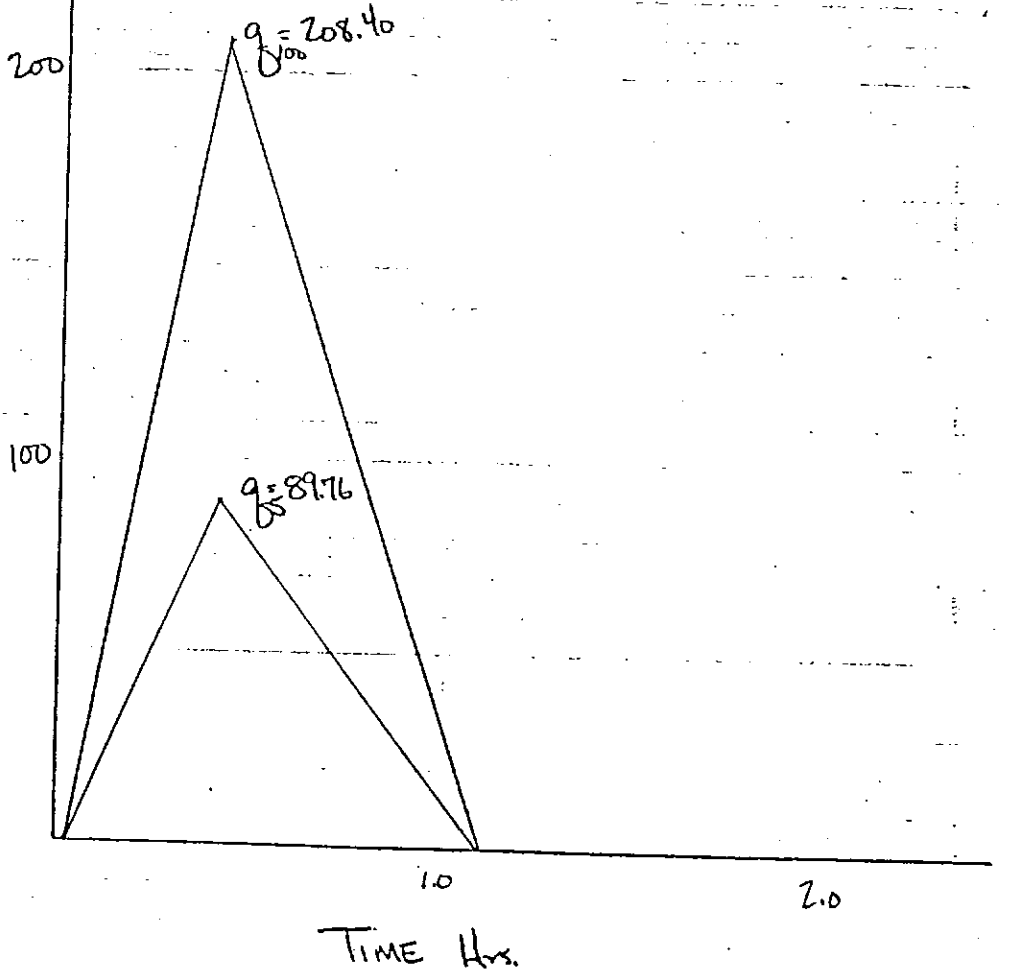
Job No: E-2714

Client: Speer (Houck Estate)

By: GROW

Date: 2/3/83

Area III Basin G



DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No. E-2714

Client: Speer (Howck Estate) — By: GMM — Date: 2/3/83

- Area IV

A = 59.355 Acres

L = 2050

H = 6680 - 6360 = 320'

CN = 84

Q_{5yr} = 0.82

Q_{100yr} = 1.94

T_c = 0.10 Hr.

q_p = 1280 csm/in.

$q_5 = 1280 \times 0.82 \times \frac{59.355}{640} = 97.34$ cfs

$q_{100} = q_5 \times \frac{1.94}{0.82} = 230.30$ cfs

$t_5 = \frac{1290 \times 0.82 \times 59.355}{640 \times 97.34} = 1.01$ Hr.

t_p = 0.38 Hr.

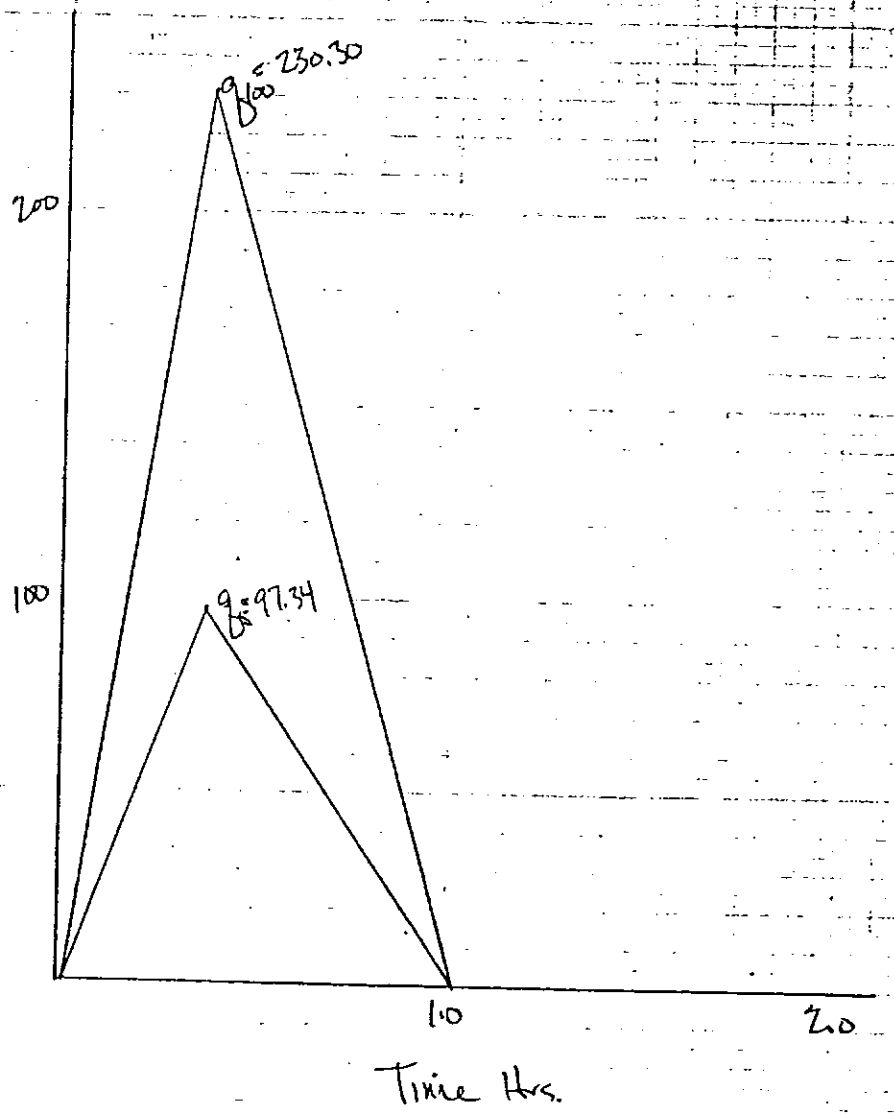
Δ = 0.01 Hr.

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/83

Area IV



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Project: Master Drainage Study — Job No. E-2714

Client: Speer (Howell Estate) — By: GWH — Date: 2/3/83

- Area V

A = 13.245 Acres

L = 500'

H = 6660 - 6470 = 190'

CN = 85

Q_{5yr} = 0.87

Q_{100yr} = 2.02

T_c = 0.02 Hr.

q_p = 1500 csm/in.

$q_5 = 1500(0.87) \times \frac{13.245}{640} = 27.01$ cfs

$q_{100} = q_5 \times \frac{2.02}{0.87} = 62.71$ cfs

$t_L = \frac{1290 \times 0.87 \times 13.245}{640 \times 27.01} = 0.86$ Hr.

t_p = 0.32 Hr.

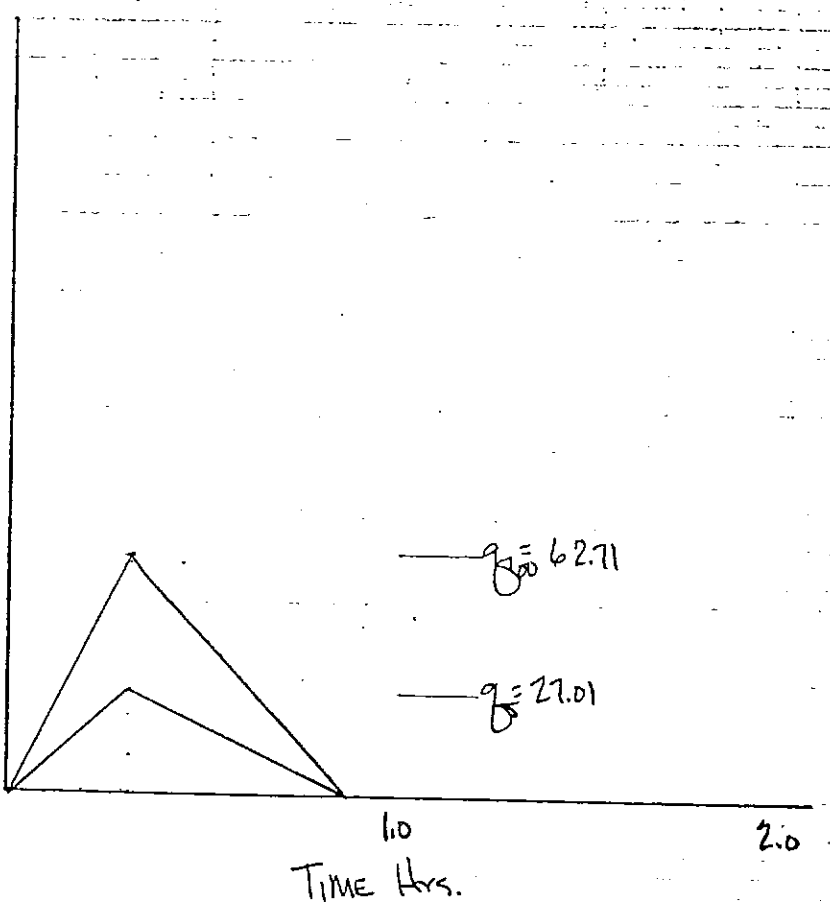
D = 0.003 Hr.

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/83

Area V



Project: Master Drainage Study — Job Nº E-2714

Client: Speer (Houck Estate) — By — Date 2/3/83

- Area VI

A = 37.424 Acres
L = 1450'

H = 6596 - 6354 = 236

CN = 84

Q_{Syr} = 0.82

Q_{100yr} = 1.94

T_c = 0.07 Hr.

q_p = 1400 CSM/in.

$$q_5 = 1400(0.82) \times \frac{37.424}{640} = 67.13 \text{ cfs}$$

$$q_{100} = q_5 \times \frac{1.94}{0.82} = 158.82 \text{ cfs}$$

$$t_5 = \frac{1290 \times 0.82 \times 37.424}{640 \times 67.13} = 0.92 \text{ Hr.}$$

t_p = 0.35 Hr.

D = 0.01 Hr.

Project: Master Drainage Study

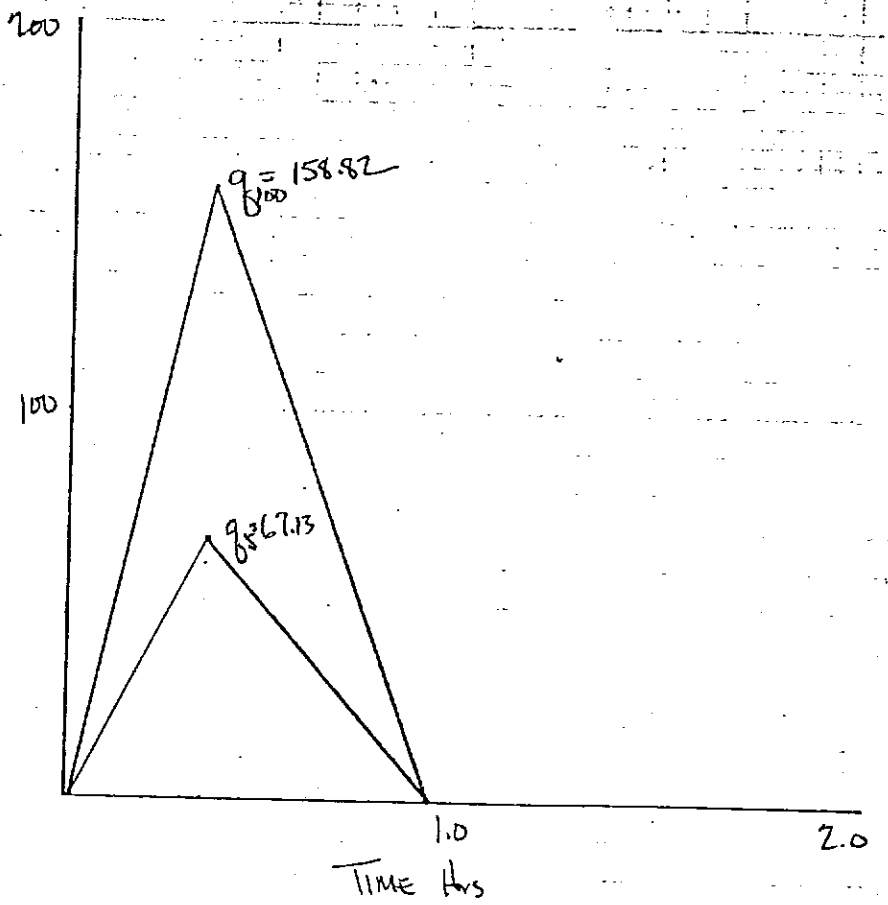
Job No: E-2714

Client: Speer (Houck Estate)

By: GNM

Date: 2/3/83

Area III



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Project: Master Drainage Study — Job No. E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/3/83

- Area VII

A = 117.928 Acres

L = 3950'

H = 6630 - 6360 = 270'

CN = 85

Q_{5yr} = 0.87

Q_{100yr} = 2.02

T_c = 0.21 Hr. (Total Basin - Avg.)

q_p = 1050 csm/in.

$$q_5 = 1050(0.87) \times \frac{117.928}{640} = 168.32 \text{ cfs.}$$

$$q_{100} = q_5 \times \frac{2.02}{0.87} = 390.82 \text{ cfs}$$

$$t_b = \frac{1290 \times 0.87 \times 117.928}{640 \times 168.32} = 1.23 \text{ Hr}$$

t_p = 0.46 Hr.

Δ = 0.03 Hr.

T_c:

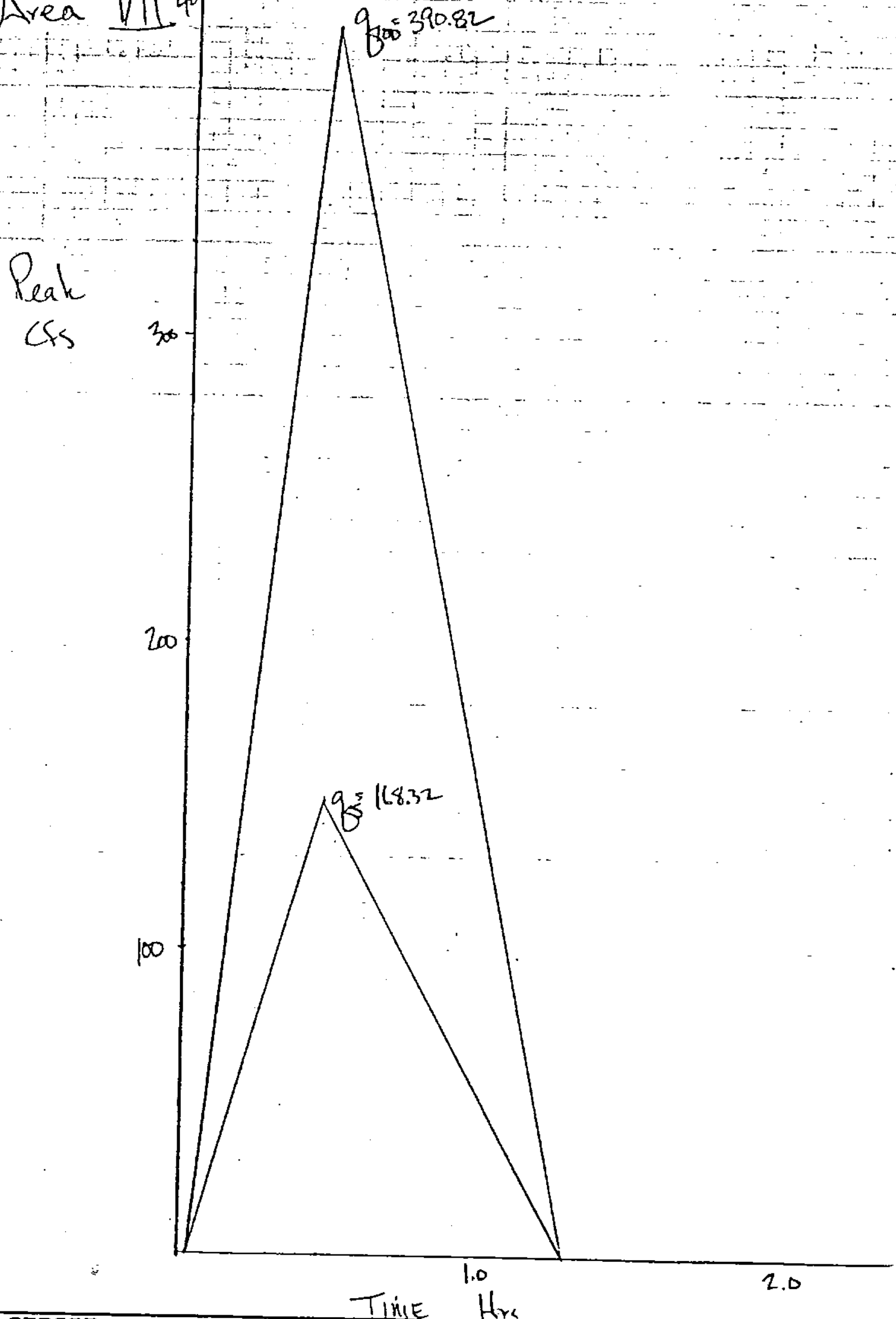
Reach ①	400'	H = 18'	$\Rightarrow T_c$ = 0.05
Reach ②	500'	H = 70'	$\Rightarrow T_c$ = 0.035
Reach ③	400'	H = 56'	$\Rightarrow T_c$ = 0.03
Reach ④	1000'	H = 60'	$\Rightarrow T_c$ = 0.09
Reach ⑤	800'	H = 38'	$\Rightarrow T_c$ = 0.09
Reach ⑥	850'	H = 36'	$\Rightarrow T_c$ = 0.09

q_p = 820 q_5 = 131.45 cfs $T_{c\,TOTAL}$ = 0.39

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study		Job Nº: E-2714
Client: Speer (Houck Estate)	By: GWM	Date: 2/3/83

Area VII 40



Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GMM — Date: 2/3/83

- Area VIII

A = 22.882 Acres
L = 1300'
H = 6556 - 6460 = 96'
CN = 80
Q_{5yr} = 0.62
Q_{100yr} = 1.64
T_c = 0.08 Hr.
q_p = 1320 CSM/in.

$$q_5 = 1320(0.62) \times \frac{22.882}{640} = 29.26 \text{ cfs}$$

$$q_{100} = q_5 \times \frac{1.64}{0.62} = 77.40 \text{ cfs}$$

$$t_b = \frac{1290 \times 0.62 \times 22.882}{640 \times 29.26} = 0.98 \text{ Hr.}$$

t_p = 0.37 Hr.
D = 0.01 Hr.

DREXEL, BARRELL & CO.

LAND SURVEYORS
CIVIL ENGINEERS

Project: Master Drainage Study

Job No: E-2714

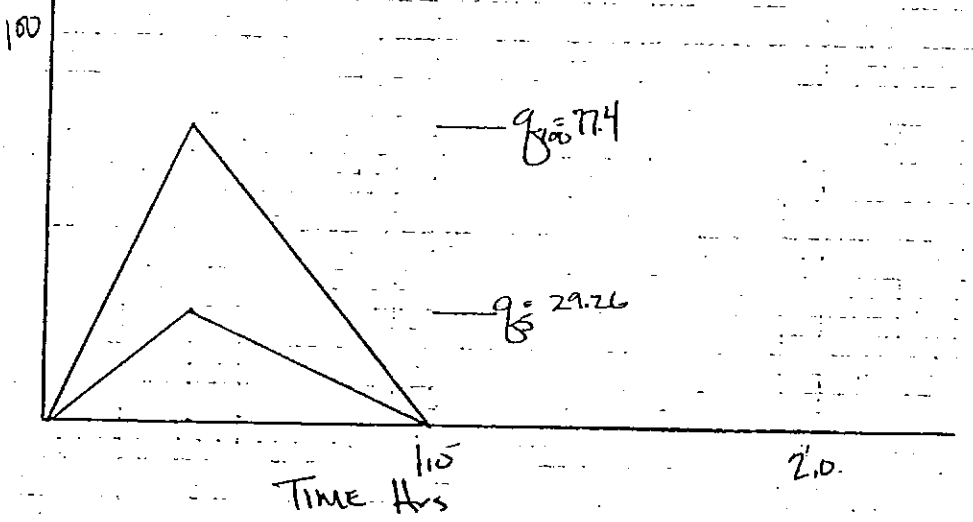
Client: Speer (Houck Estate)

By: GWM

Date: 4/3/83

Area VIII

Peak CFS



DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No. E-2714

Client: Speer (Houck Estate) — By: GMM — Date: 2/6/83

Development of Area I Basins A & B Composite Hydrograph (5yr.)

T_c B to A = 0.075 Hr.

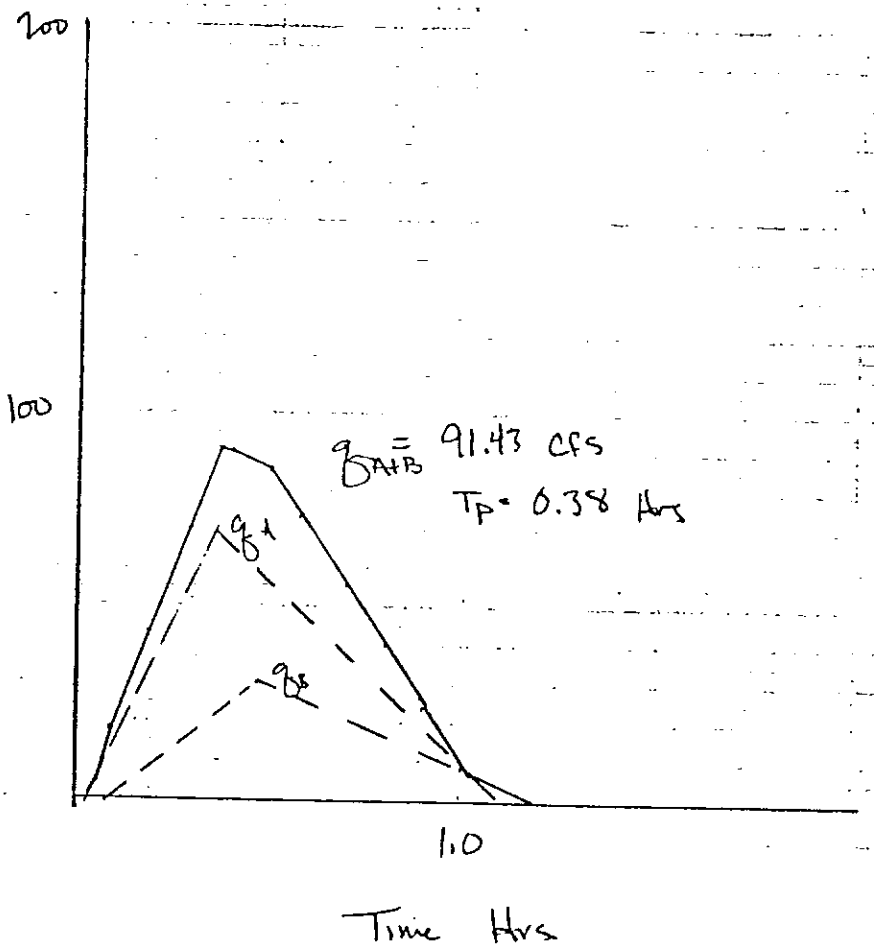
Time	A	B	Total
.10	17.06	0.01	17.07
.20	36.02	7.57	43.59
.30	54.98	15.13	70.11
.38	70.26	21.17	91.43
.40	67.99	22.69	90.68
.50	56.65	30.25	86.90
.51	56.54	30.32	86.86
.52	56.42	30.28	86.70
.60	45.31	26.63	71.94
.70	33.97	22.07	56.04
.80	22.63	17.51	40.14
.90	11.29	12.95	24.24
1.00	—	8.39	8.39

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Spear (Houck Estate) — By: GWM — Date: 2/6/83

Area I Basins A & B Composite Hydrograph 5 Yr.



DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Howell Estate) — By: GWM — Date: 2/4/83

- Development of D-E Composite Hydrograph (5yr.)

- Basin D

q_p = 88.51 cfs.
t_p = 0.40 Hr.
t_b = 1.08 Hr.
D = .02 Hr.
↑Slope = 3.69 cfs/Min.
↓Slope = 2.17 cfs/Min.

- Basin E

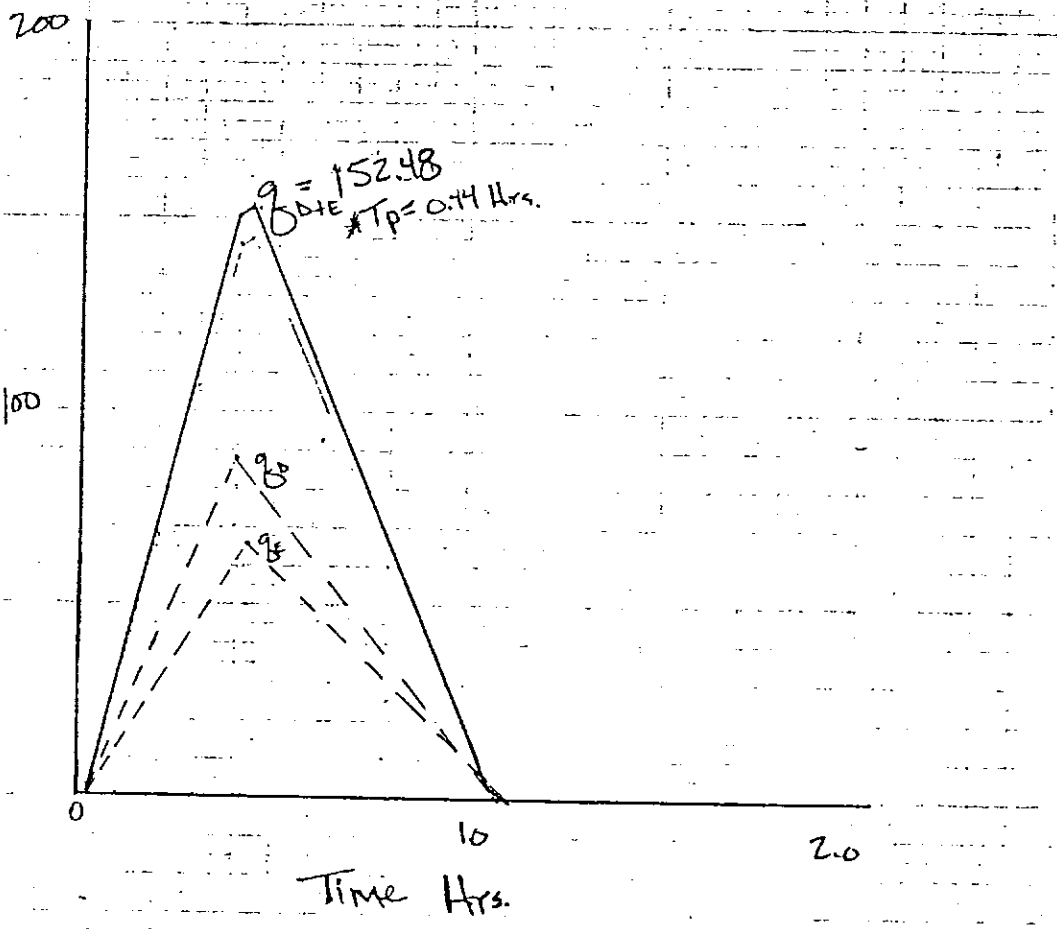
q_p = 66.59 cfs
t_p = 0.42 Hr.
t_b = 1.12 Hr.
D = 0.02 Hr.
↑Slope = 2.64 cfs/Min.
↓Slope = 1.85 cfs/Min

Time (Hrs.)	Flow (cfs.)
0.02	0
0.10	30.38
0.20	68.36
0.30	106.34
0.40	144.32
0.42	151.92
0.44	152.48 (Peak)
0.50	138.01
0.60	113.89
0.70	89.77
0.80	65.65
0.90	41.53
1.00	17.41

Project: Master Drainage Study | Job No: E-2714

Client: Speer (Houck Estate) | By: GNH | Date: 2/3/83

Area III Basins D-E Composite (5yr Analysis)



*Tp Measured from "0"

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/4/83

Development of C+F Composite Hydrograph (5yr.)

- Basin C
  - q_p = 69.89
  - t_p = 0.39 Hr.
  - t_b = 1.03 Hr.
  - Δ = 0.01 Hr.
  - ↑Slope = 2.99 cfs/Min.
  - ↓Slope = 1.82 cfs/Min.

- Basin F
  - q_p = 110.17
  - t_p = 0.45 Hr.
  - t_b = 1.19 Hr.
  - Δ = 0.03 Hr.
  - ↑Slope = 4.08 cfs/Min.
  - ↓Slope = 2.48 cfs/Min.

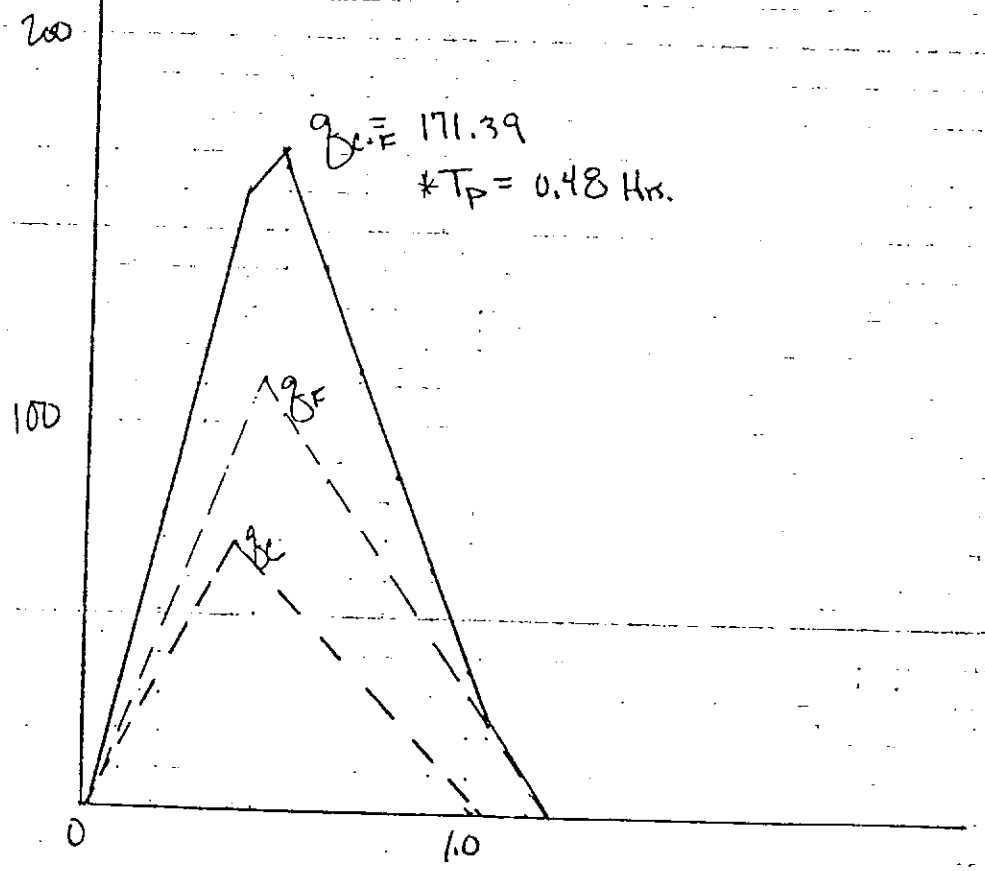
Time (Hr.)	Flow (cfs)
0.01	0
0.03	3.59
0.10	33.28
0.20	75.76
0.30	118.12
0.40	160.54
0.48	171.39 (Peak)
0.50	166.23
0.60	140.43
0.70	114.63
0.80	88.83
0.90	63.03
1.00	37.23

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study | Job No: E-2-714

Client: Speer (Houck Estate) | By: GWW | Date: 2/3/83

Area III Basins C-F Composite (5yr. Analysis)



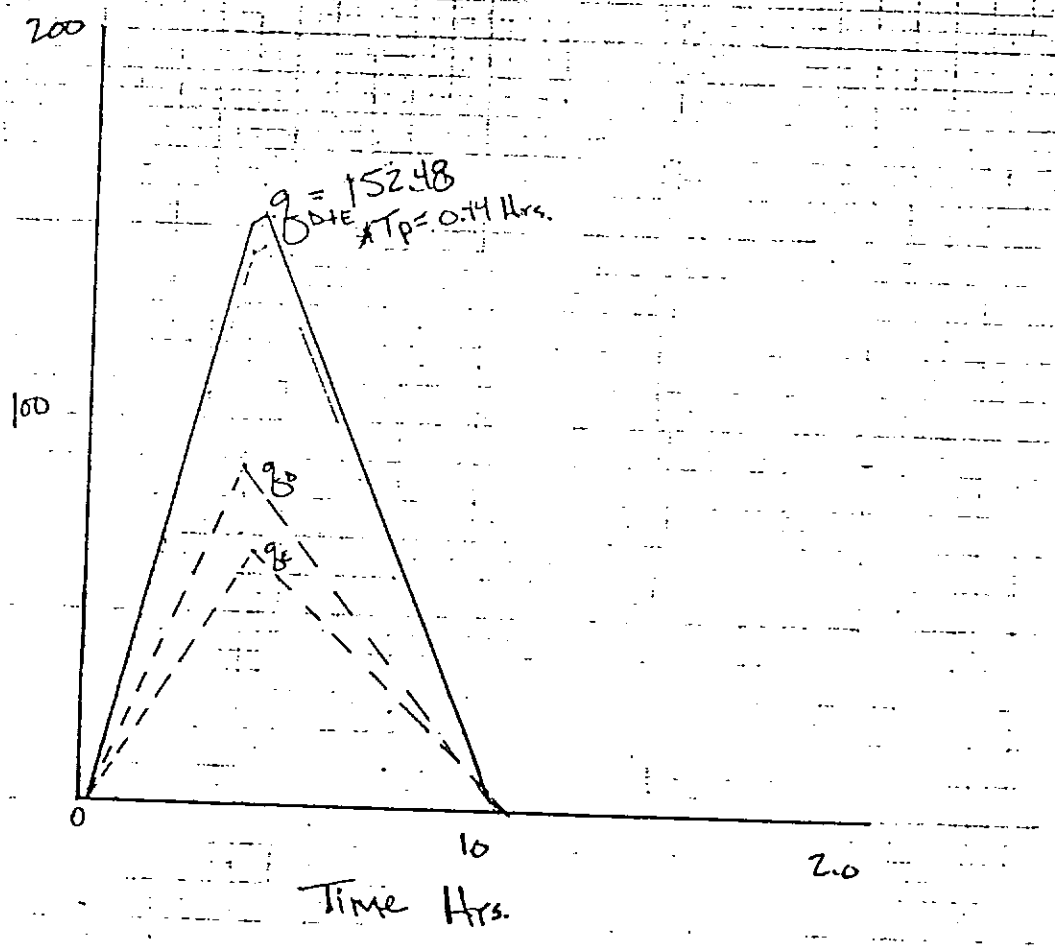
*T_p Measured From "0"

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Hauck Estate) — By: GAM — Date: 2/3/93

Area III - Basins D-E Composite (5yr Analysis)



*Tp Measured from "0"

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: SLOAN — Date: 2/3/84

Development of B-G Composite Hydrograph (5 yr.)

Basin B

q_p = 55.89 cfs
t_p = 0.37 Hr
t_G = 0.98 Hr
D = 0.01 Hr
↑Slope = 2.52 cfs/Min.
↓Slope = 1.53 cfs/Min.

Basin G

q_p = 89.76 cfs
t_p = 0.41 Hr.
t_G = 1.08 Hr.
D = 0.02 Hr.
↑Slope = 3.65 cfs/Min.
↓Slope = 2.23 cfs/Min.

Time (Hrs.)	Flow (cfs)
0.02	1.51
0.10	31.13
0.20	68.15
0.30	105.17
0.38	134.78
0.40	137.33
0.43	141.14 (Peak)
0.50	125.35
0.60	106.79
0.70	80.23
0.80	59.67
0.90	35.11
1.00	12.55

DREXEL, BARRELL & CO.

LAND SURVEYORS
CIVIL ENGINEERS

Project: Master Drainage Study

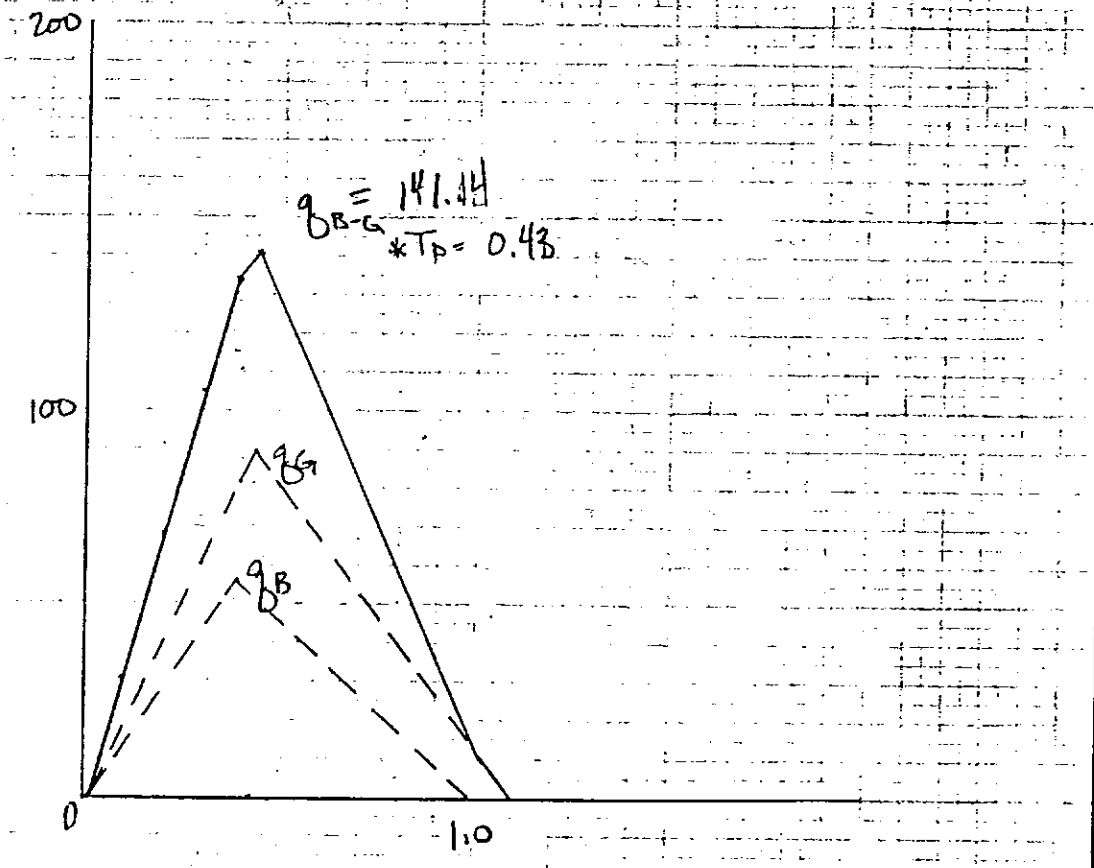
Job No: E-2714

Client: Speer (Houck Estate)

By: GWM

Date: 2/4/83

Area III Basins B-G Composite (5yr. Analysis)



*Tp Measured from "0"

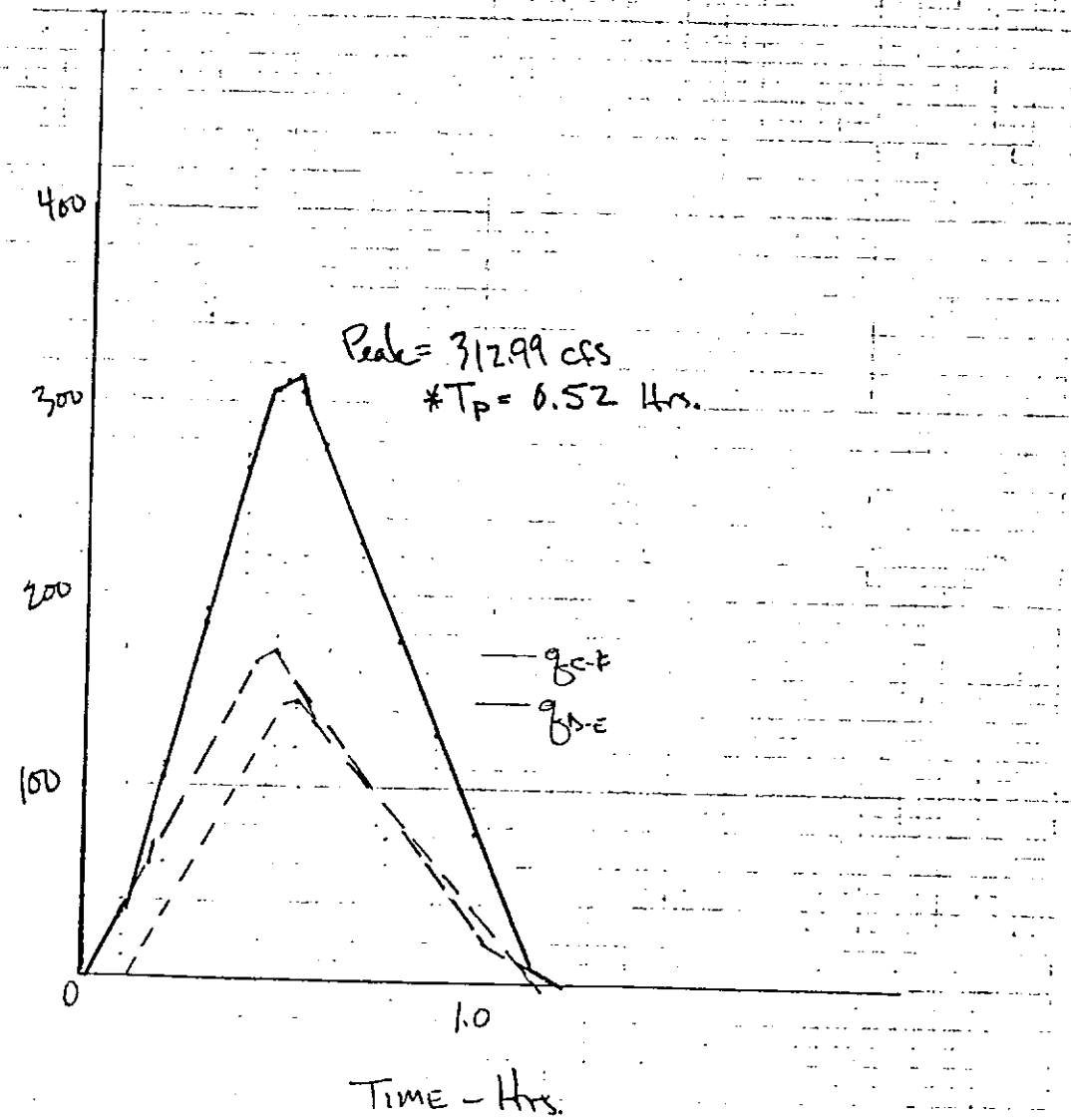
DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No. E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/4/83

Area III Basins CDEF Composite (5yr. Analysis)

T_c DE to CF = 0.10 Hr.



* T_p Measured From "0"

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/4/83

Development of BCDEFG Composite Hydrograph (5yr)

Tc. CDEF to BG = 0.10 Hr.

TIME (Hrs)	CDEF	BG	Total (cfs)
1.10	0	31.13	31.13
0.20	33.28	68.15	101.43
0.30	106.08	105.17	211.25
0.38	170.40	134.78	305.18
0.40	186.48	137.33	323.81
0.43	210.60	141.14	351.74
0.50	266.88	125.35	392.23
0.58	308.11	110.50	418.61 (Peak)
0.60	310.55	106.79	417.34
0.62	312.99	103.08	416.07
0.64	308.39	99.37	407.76
0.70	278.44	80.23	358.67
0.80	228.52	57.67	286.19
0.90	178.60	35.11	213.71
1.00	128.68	12.55	141.23

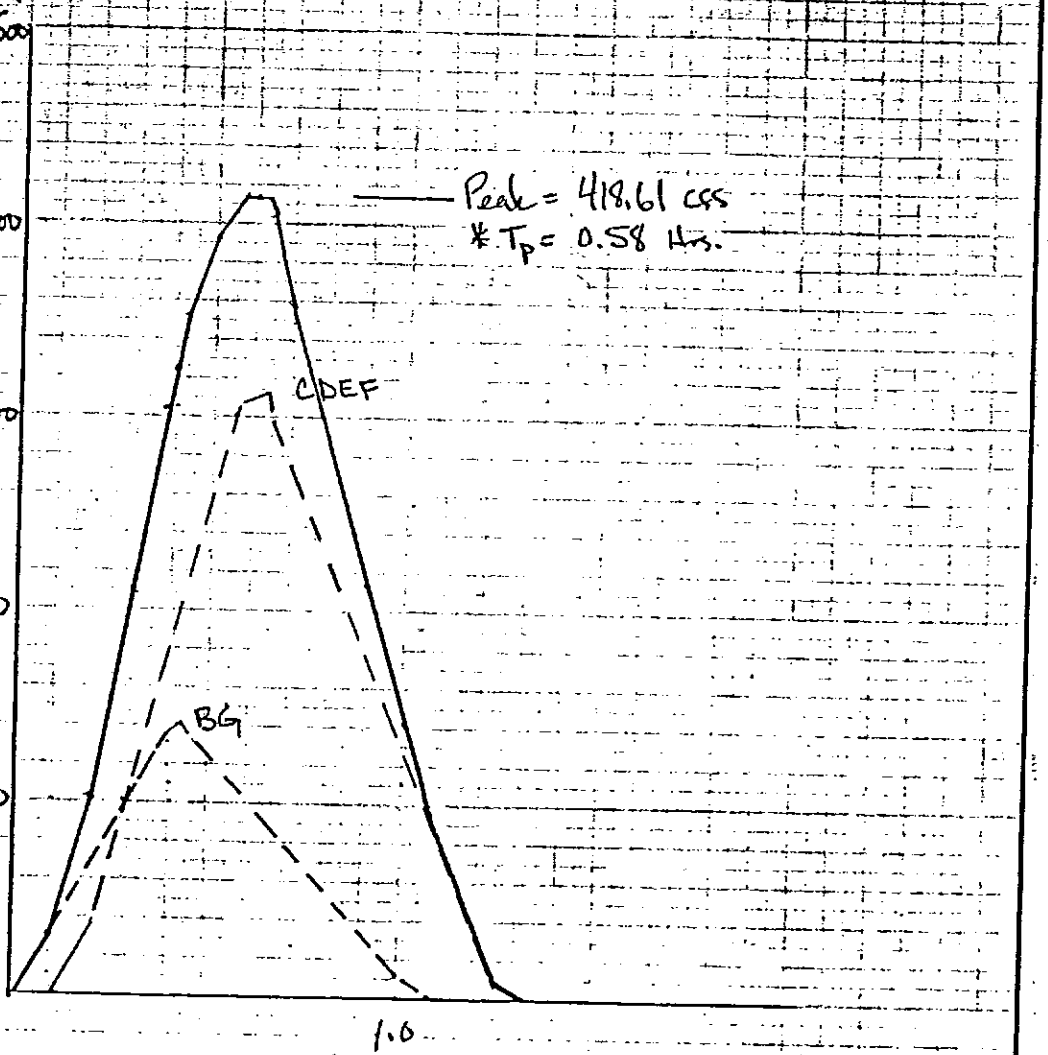
DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No. E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/4/83

Area III Basins BCDEFG Composite (5 yr. Analysis)

T_c CDEF to BG = 0.10 Hr.



* T_p Measured From "O"

DREXEL, BARRELL & CO.

LAND SURVEYORS
CIVIL ENGINEERS

Project: Master Drainage Study

Job No: E-2714

Client: Speer (Howell Estate

By: BWM

Date: 2/6/83

Development of ABCDEFG Composite Hydrograph (5 yr.)

T_L BCDEFG to A = 0.08 Hrs

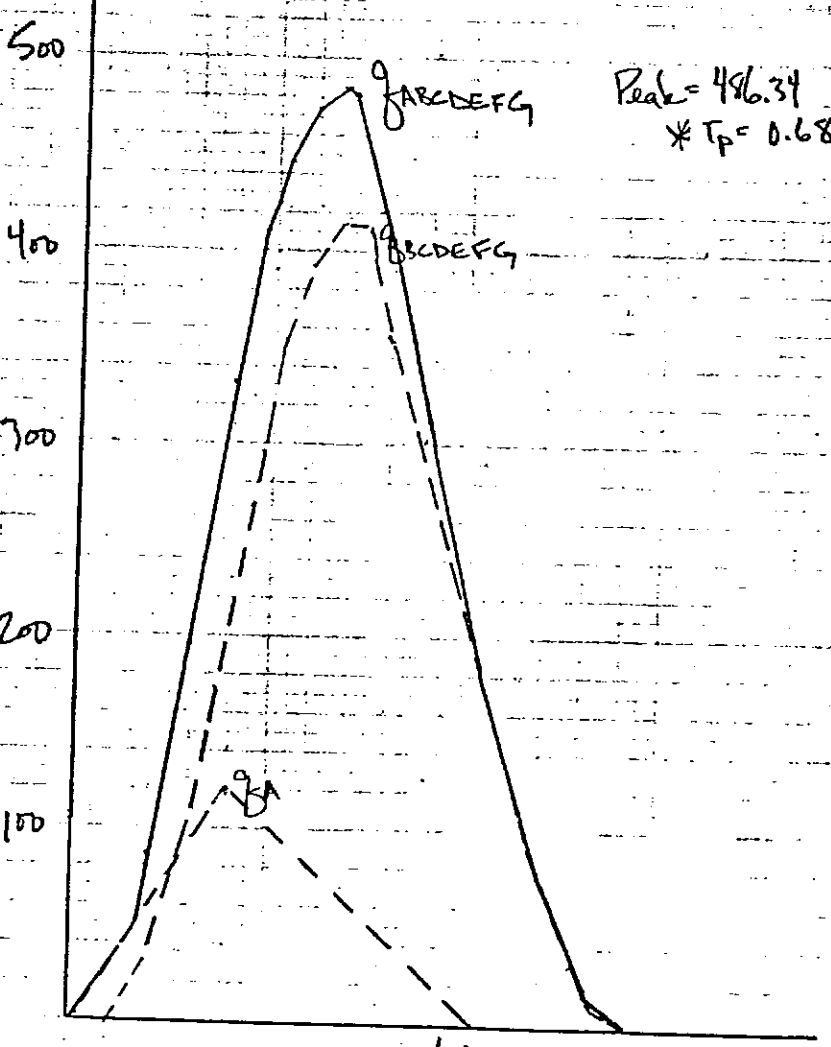
TIME	A	BCDEFG	Total CFS
.10	27.76	0	27.76
.20	58.60	31.13	89.73
.30	89.44	101.43	190.87
.40	120.31	211.25	331.56
.48	105.29	305.18	410.47
.50	101.53	323.81	425.34
.53	95.90	351.74	447.64
.60	82.75	392.23	474.98
.69	67.73	418.61	486.34
.70	63.97	417.34	481.31
.80	45.19	358.67	403.86
.90	26.41	286.19	312.60
1.00	7.63	213.71	221.34

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No. E-2714

Client: Speer (Houck Estate) — By: GWH — Date: 2/6/83

Area III - Basins ABCDEFG Composite Hydrograph (5 yr.)



*Tp Measured From "0"

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: SWM — Date: 2/4/83

- Development of D-E Composite Hydrograph (100 Yr.)

-Basin D

q_p = 202.02 cfs
t_p = 0.40 Hr.
t_b = 1.08 Hr.
Δ = 0.02 Hr.
↑Slope = 8.42 cfs/Min.
↓Slope = 4.95 cfs/Min.

-Basin E

q_p = 157.54
t_p = 0.42 Hr.
t_b = 1.12 Hr.
Δ = 0.02 Hr.
↑Slope = 6.25 cfs/Min.
↓Slope = 3.28 cfs/min

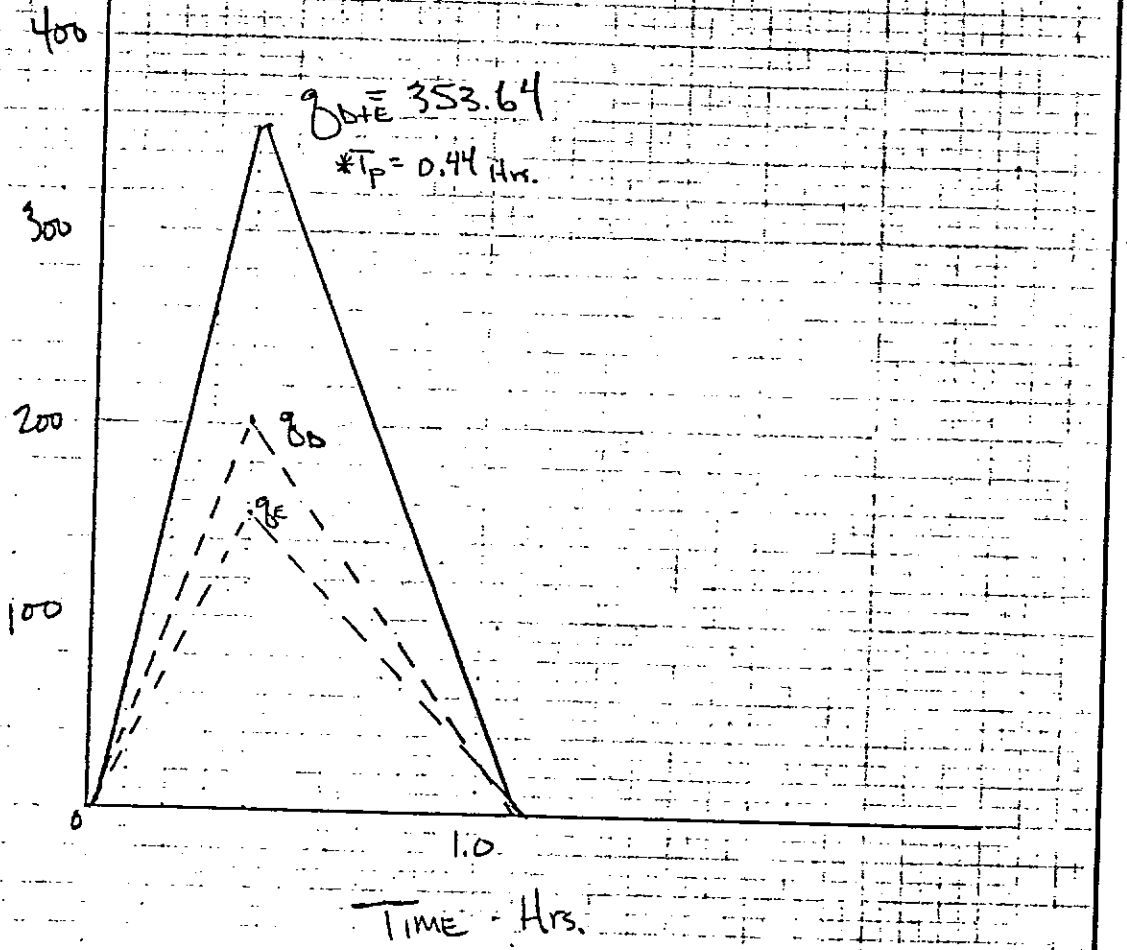
Time (Hrs.)	Flow (cfs)
0.02	0
0.10	70.42
0.20	158.44
0.30	246.46
0.40	334.48
0.42	352.08
0.44	353.64 (Peak)
0.50	324.01
0.60	274.63
0.70	225.25
0.80	175.87
0.90	126.49
1.00	77.11

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate — By: GWM — Date: 2/3/83

Area III Basins D-E Composite (100 Yr. Analysis)



*Tp Measured from "0"

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No. E-2714

Client: Speer (Houck Estate — By: GWM — Date: 2/4/83

Development of C.F. Composite Hydrograph (100 yr.)

- Basin C

$q_p = 175.22$ cfs
$t_p = 0.39$ Hr.
$t_b = 1.03$ Hr.
$D = 0.01$ Hr.
↑ Slope = 7.49 cfs/min.
↓ Slope = 4.56 cfs/min.

- Basin F

$q_p = 260.41$ cfs
$t_p = 0.45$ Hr.
$t_b = 1.19$ Hr.
$D = 0.03$ Hr.
↑ Slope = 9.65 cfs/min.
↓ Slope = 5.87 cfs/min.

Time (Hrs)	Flow (CFS)
0.01	0
0.03	8.99
0.10	80.98
0.20	183.82
0.30	296.66
0.40	389.50
0.48	413.93 (Peak)
0.50	401.41
0.60	338.83
0.70	276.25
0.80	213.67
0.90	151.09
1.00	88.51

DREXEL, BARRELL & CO.

LAND SURVEYORS
CIVIL ENGINEERS

Project: Master Drainage Study

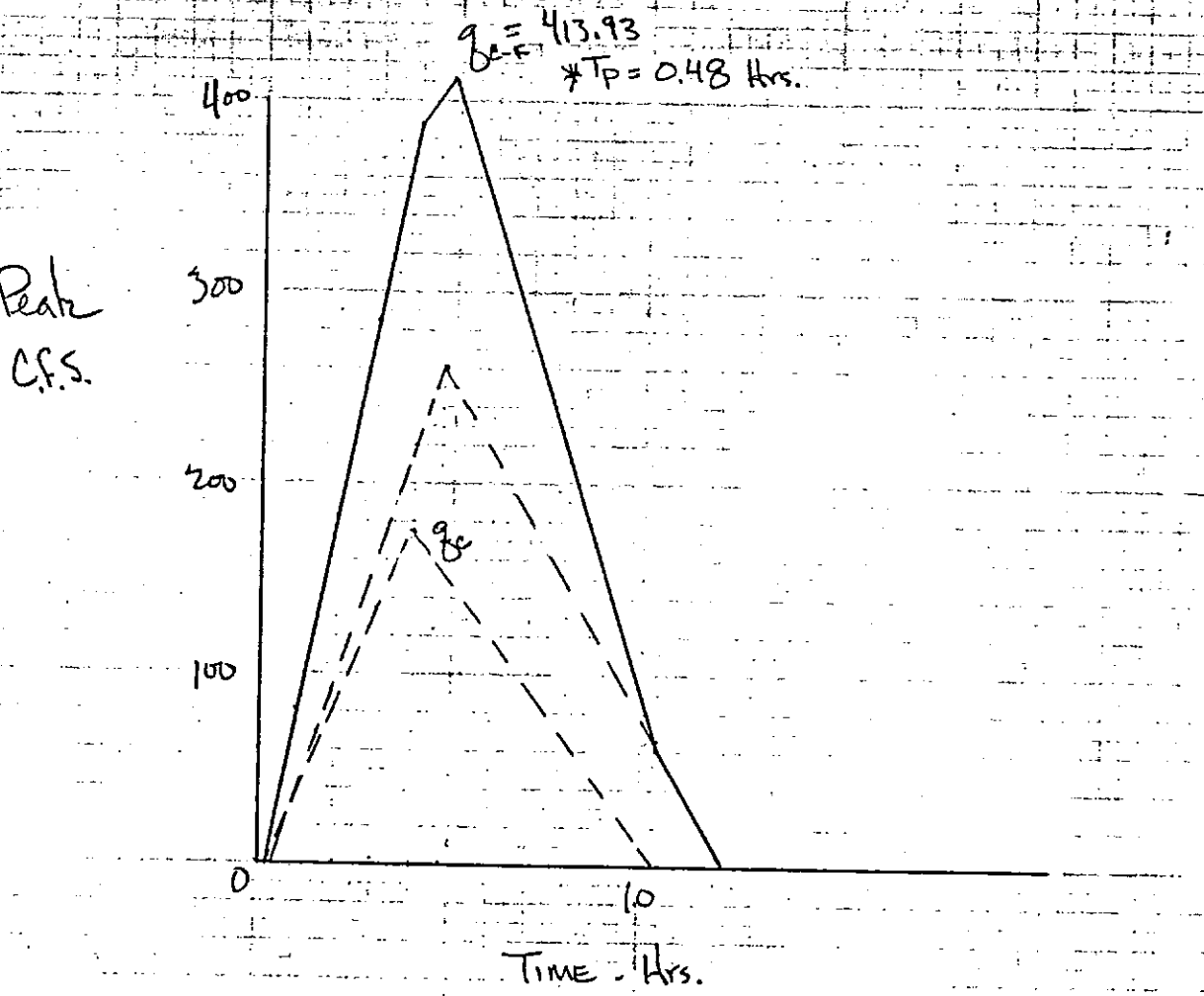
Job Nº: E-7714

Client: Speer (Houck Estate)

By: GWM

Date: 2/4/83

Area III Basins C-F Composite (100yr. Analysis)



*Tp Measured From "0"

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/4/83

Development of B-G Composite Hydrograph (100 yr.)

- Basin B

q_p = 129.17 cfs
t_p = 0.37 Hrs
t_b = 0.98 Hrs
D = 0.01 Hrs
↑ Slope = 5.85 cfs/Min.
↓ Slope = 3.55 cfs/Min.

- Basin G

q_p = 208.40 cfs
t_p = 0.41 Hrs
t_b = 1.08 Hrs.
D = 0.02 Hrs.
↑ Slope = 8.47 cfs/Min.
↓ Slope = 5.18 cfs/Min.

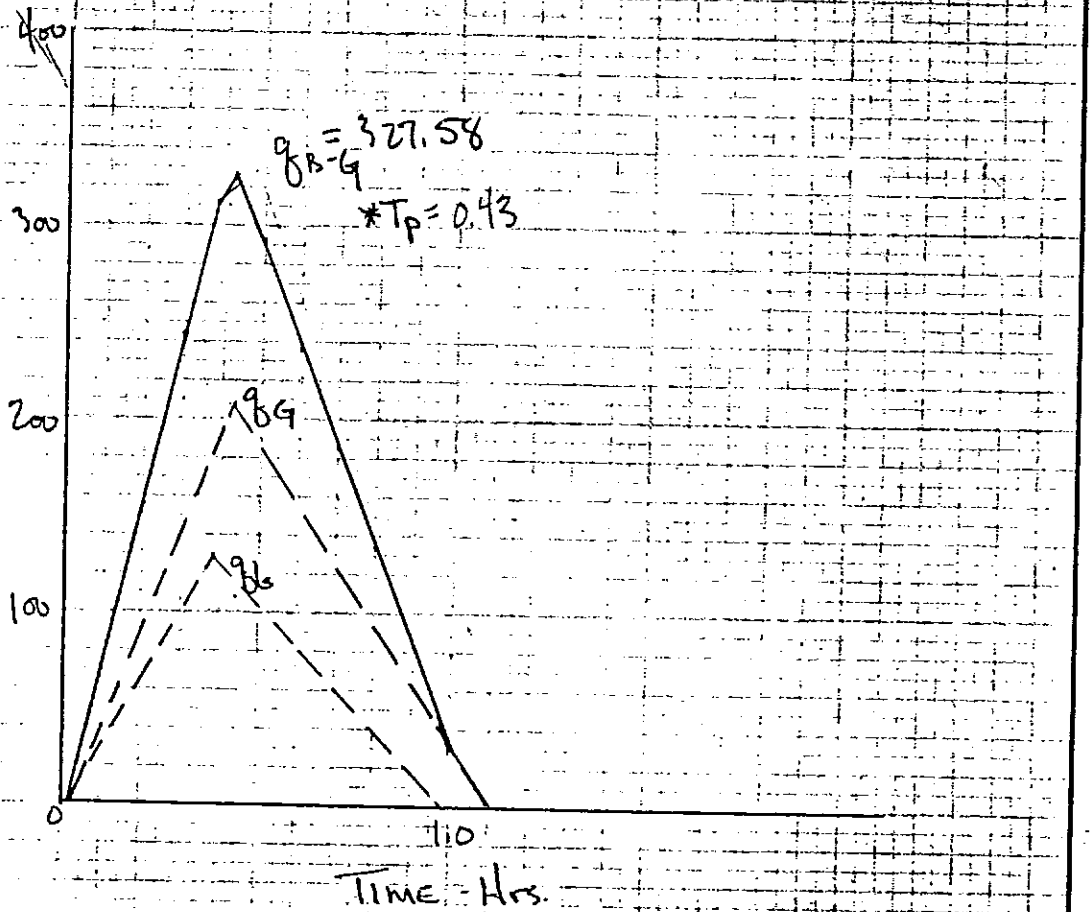
Time (Hrs)	Flow (cfs)	
0.02	3.51	
0.10	72.25	
0.20	158.17	
0.30	244.09	
0.38	312.82	
0.40	318.73	
0.43	321.58	(Peak)
0.50	290.92	
0.60	238.54	
0.70	186.16	
0.90	133.78	
0.90	81.41	
1.00	29.03	

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/4/83

Area III Basins B-G Composite (100 Yr. Analysis)



*Tp Measured from "0"

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: F-2714

Client: Speer (Houck Estate) — By: GWM — Date: 2/4/83

Development of CDEF Composite Hydrograph (100 yr.)

T_c DE to CF = 0.10 Hr.

TIME-Hrs	DE	CF	Total (cfs)
0.10	0	80.89	80.89
0.20	70.42	183.82	254.24
0.30	158.44	286.66	445.10
0.40	246.46	389.50	635.96
0.48	316.88	413.93	730.81
0.50	334.48	401.41	735.89
0.52	352.08	388.89	740.97 (Peak)
0.54	353.64	376.38	730.02
0.60	324.01	338.83	662.84
0.70	274.63	276.25	550.88
0.80	225.25	213.67	438.92
0.90	175.87	151.09	326.96
1.00	126.49	88.51	215.00

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

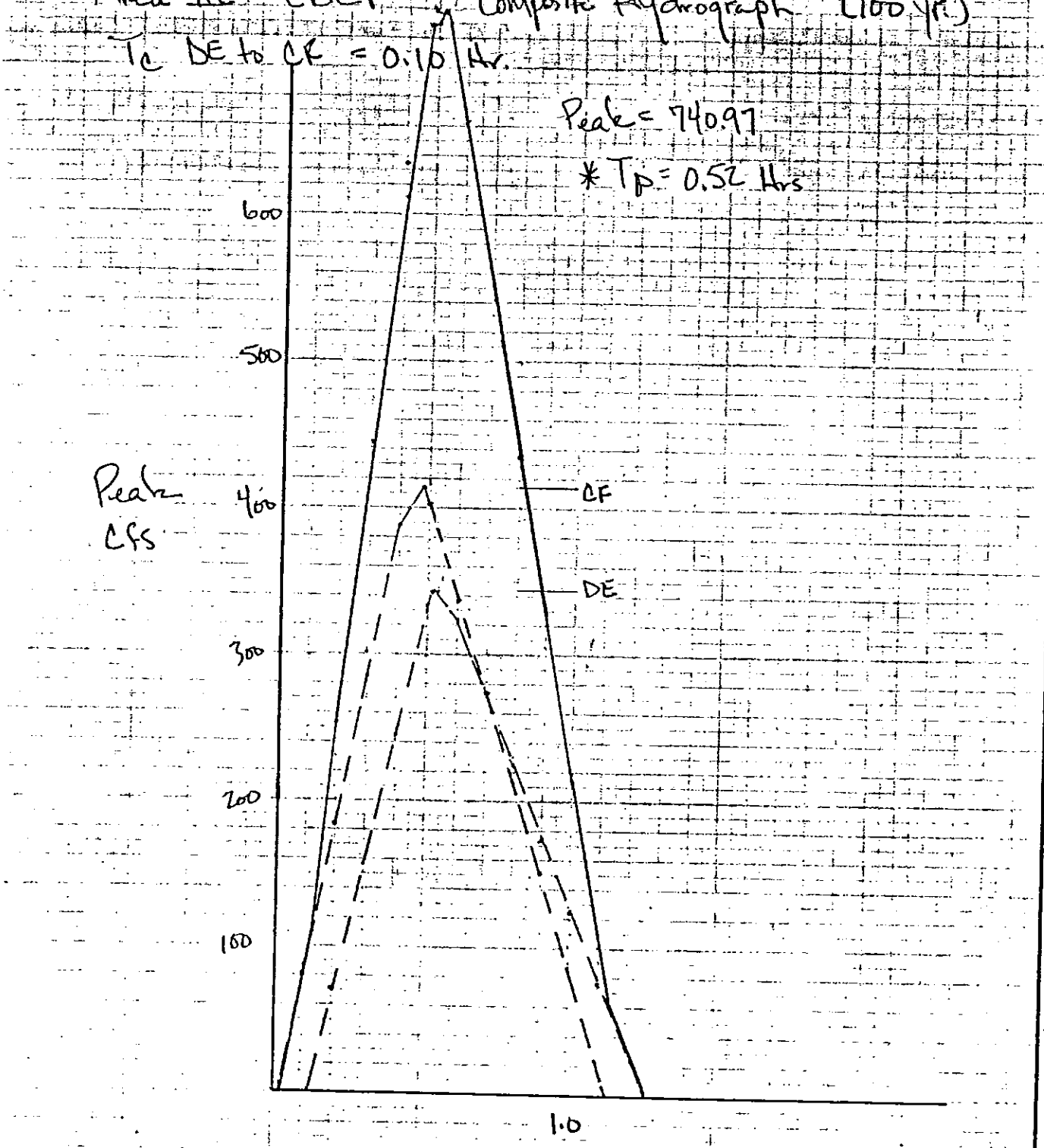
Client: Speer (Houck Estate) — By: GWM — Date: 2/4/83

Area III CDEF — Composite Hydrograph (100 yr.)

Tc DE to CF = 0.10 Hr.

Peak = 740.97

* Tp = 0.52 Hrs



* Tp Measured From "0"

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Water Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWW — Date: 2/4/83

Development of BCDEFG Composite Hydrograph (100yr)

T_c CDEF to BG = 0.10 Hr.

Time (Hrs.)	CDEF	BG	Total
0.10	0	72.25	72.25
0.20	80.89	158.17	239.06
0.30	254.24	244.09	498.53
0.38	406.94	312.82	719.76
0.40	445.10	318.73	763.83
0.43	502.36	327.58	829.94
0.50	635.96	290.92	926.88
0.58	730.81	249.02	979.83 (Peak)
0.60	735.89	238.51	974.43
0.62	740.97	228.06	969.03
0.64	730.02	217.59	947.61
0.70	662.84	186.16	849.00
0.80	550.88	133.78	684.66
0.90	438.92	81.41	520.33
1.00	326.96	29.03	355.99

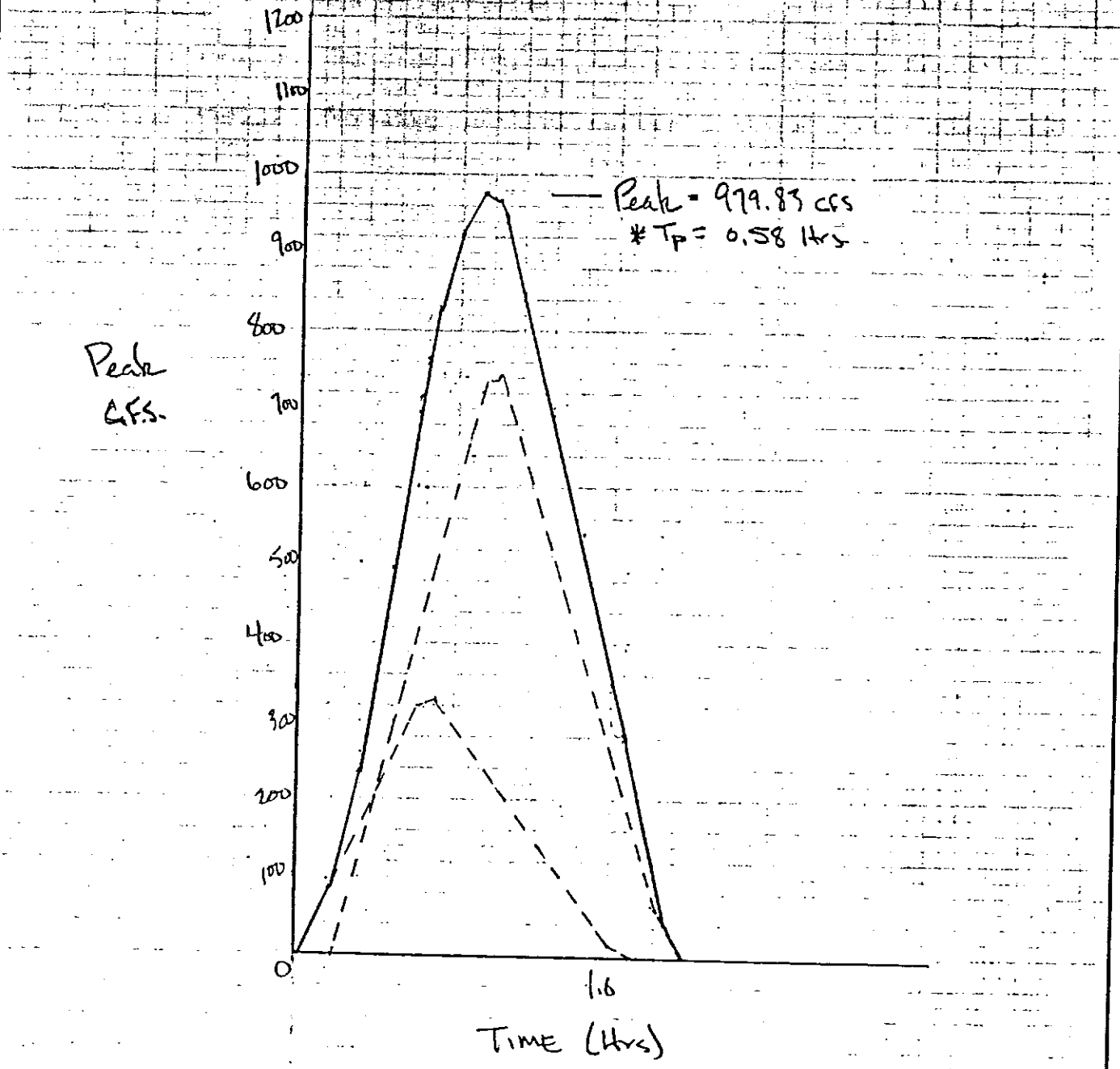
DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Spear (Houck Estate — By: GMM — Date: 2/4/83

Area III BCDEFG Composite Hydrograph (100 yr.)

Tc CDEF to BG = 0.10 Hr.



* Tp Measured From "0"

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: Master Drainage Study — Job No: E-2714

Client: Speer (Houck Estate) — By: GWW — Date: 2/6/83

Development of ABCDEFG Composite Hydrograph (100)

T BCDEFG to A = 0.08 Hrs.

Time (Hrs)	A	BCDEFG	Total
.10	63.40	-	63.40
.20	133.84	72.25	206.09
.30	204.28	239.06	443.34
.40	274.62	498.53	773.15
.48	240.30	719.76	960.06
.50	231.72	763.83	995.55
.53	218.85	829.94	1048.79
.60	188.82	926.88	1115.70
.68	154.50	979.83	1134.33
.70	145.92	974.43	1120.35
.80	103.02	849.00	952.02
.90	60.12	684.66	744.78
1.00	17.22	520.33	537.55