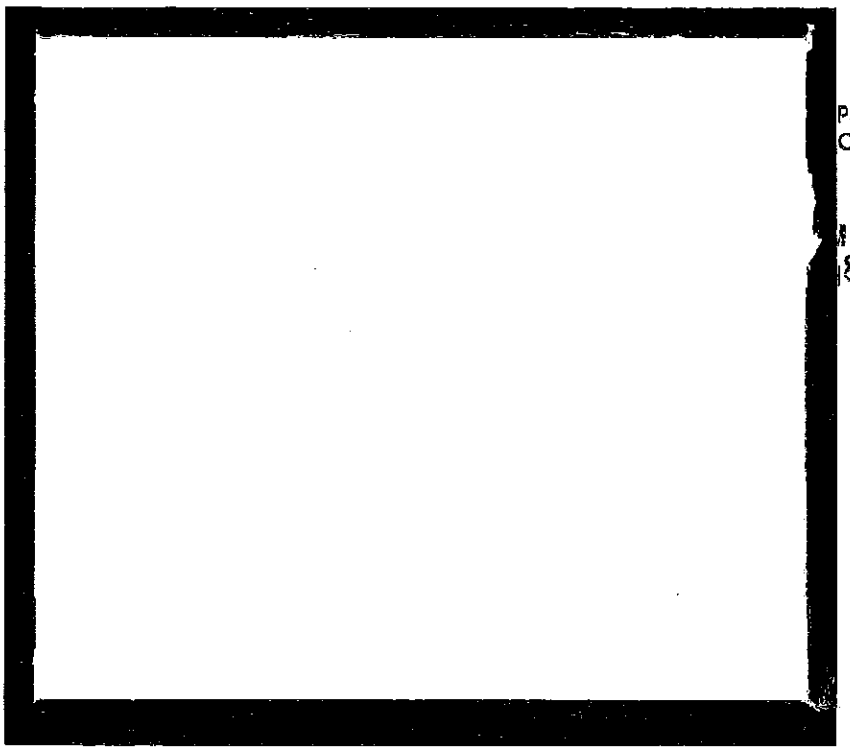
Broadmoor Bluffs Est.



NOT TO BE CHECKED OUT

COLORADO SPRINGS, CO
(719) 578-6212

DREXEL, BARRELL & CO.
ENGINEERS — SURVEYORS
1700 38TH STREET BOULDER, COLORADO 80301 (303) 442-4338

FINAL DRAINAGE REPORT FOR THE SINGLE-FAMILY PORTION OF BROADMOOR BLUFFS ESTATES COLORADO SPRINGS, COLORADO

PREPARED BY:

DREXEL, BARRELL & CO.
1700 38TH STREET
BOULDER, COLORADO 80301
(303) 442-4338

PREPARED FOR:

GATES LAND COMPANY
155 WEST LAKE AVENUE
COLORADO SPRINGS, CO 80906
(303) 829-5950

DECEMBER 12, 1984
E-3098
(0177R)

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APPENDICES

DRAWINGS (Back Insert)

CERTIFICATIONS

The attached drainage plan and report, "Final Drainage Report for the Single-Family portion of Broadmoor Bluffs Estates", were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City for drainage reports and said report is in conformity with the Master Plan of the drainage basin. I accept responsibility for any liability caused by the negligent acts, errors, or omissions on my part in preparing this report.

For: Drexel, Barrell & Co.

By: _____
John Common, P.E. #11958

JOHN COMMON
REGISTERED
11958
PROFESSIONAL ENGINEER
STATE OF COLORADO

The developer has read and will comply with all the requirements specified in this drainage report as approved by the City Engineer.

By: _____
Robert F. Svejkovsky
Title: Director of Engineering
Address: Gates Land Company
155 West Lake Avenue
Colorado Springs, CO 80906

City of Colorado Springs:

Filed in accordance with Section 15-3-906 of the Code of the City of Colorado Springs, 1980 as amended.

City Engineer: _____ Date: 1/9/85

Conditions:

FLOODPLAIN STATEMENT

The single-family portion of Broadmoor Bluffs Estates, as platted, does not lie in a designated special flood hazard area as indicated on the map index of the Flood Hazard Boundary Map H-01-35, for the City of Colorado Springs, prepared by the Department of Housing and Urban Development, Federal Insurance Administration (Community No. 080060A; latest revision 4/4/78).

FINAL DRAINAGE REPORT FOR THE SINGLE-FAMILY PORTION OF BROADMOOR BLUFFS ESTATES COLORADO SPRINGS, COLORADO

LOCATION

Broadmoor Bluffs Estates is a proposed sixty-lot single-family residential and park development. The Subdivision, approximately 59.22 acres, is located in the SE1/4 of the SE1/4 of Section 6, and in the NE1/4, the East 1/2 of the NW1/4 and the NE1/4 of the SW1/4 of Section 7, all in T15S, R66W of the 6th P.M., Colorado Springs, Colorado. More generally, the area lies west of Colorado State Highway No. 115, across from the Fort Carson Military Reservation. It is bounded on the north by Broadmoor Bluffs Park Filing No. 2 and 4; on the west by Broadmoor Bluffs Park Filing No. 8 and Neal Ranch Filing No. 2. The remaining surrounding properties are unplatted and owned by Gates Land Company.

INTENT

A previous report entitled "Final Drainage Report for Broadmoor Bluffs Drive and Farthing Drive and Preliminary Drainage Report for the Single-Family Portion of Broadmoor Bluffs Estates" was submitted to the City of Colorado Springs and approved on September 24, 1984. (Ref: Drexel, Barrell & Co. Drawing No. 3D 470 dated August 16, 1984 - Job No. E-3098).

The intent of this report is to finalize the study of the single-family area and establish the necessary drainage facilities required for the development of the subdivision.

Overall master drainage studies establishing guidelines for the preliminary and final reports on the single-family area, include the "Master Drainage Study for Cheynne Mountain Ranch" prepared by Hartzell-Pfeiffenberger and Associates, Inc. dated May 17, 1971, and the "Master Drainage Report for Basin IV, IV-A, IV-B and VII-B, Cheyenne Mountain Ranch" prepared by Drexel, Barrell & Co. dated July 18, 1983. Tributary flows from the west were taken from the "Drainage Study for Neal Ranch Filing 2, Broadmoor Bluffs Park Filing No. 8, and Farthing Drive" prepared by KKBNA, Inc. in June 1984. A drainage report for "Broadmoor Bluffs Park Filing No. 4", prepared by Guenther Polok on May 10, 1982 was referenced for consistancy of flows to the north.

Drainage patterns established in this final study are consistant with those established in the master reports and subsequent surrounding development analysis.

DESIGN REFERENCES

In addition to the previously mentioned drainage studies, the drainage design criteria was taken from the City of Colorado Springs "Determination of

Storm Runoff Criteria" manual. Flows were determined for the 6 hour initial 5 year, and major 100 year rainfalls. No flows over 500 cfs occur, so culverts were sized to pass the 5 year flows with no backwater and pass the 100 year flows with no overtopping of the curbs. Storm sewers were provided so as to not allow the initial rainfall to exceed 12 cfs within the 1/2 street flow and allow the major 100 year flows to be channelized within the rights-of-way.

Flows were analyzed using the modified SCS Method. Hydrologic soils groups were determined from maps published by the Soil Conservation Service.

The permissible drainage street capacities for 28 feet and 32 feet street widths, with 8" vertical curbs, are not listed in Table 5 of the Storm Runoff criteria; therefore, the method for determining theoretical and allowable curb flows is as described in the Denver Regional Council of Governments "Urban Storm Drainage Criteria Manual" as taken from the Bureau of Public Roads Publications. This method utilizes a nomograph for flow in triangular gutters to determine theoretical capacity then applies a reduction factor to arrive at an allowable capacity. The nomograph and reduction graph have been included with the calculations for your review.

EXISTING DRAINAGE CHARACTERISTICS

Two drainage swales carry flows easterly across the single-family area. Flow line grades vary from 5% to 25% and side slopes generally vary from 2:1 (2 horizontal to 1 vertical) to 5:1. The existing swales have naturally eroded to a rocky terrain and are mostly heavily vegetated with scrub oak and natural grasses. These swales define two major drainage basins in historical runoff.

As designed with the drainage report for Farthing and Broadmoor Bluffs Drives, the southerly swale parallels Farthing Drive and outfalls under Broadmoor Bluffs Drive through a 48" RCP; the northerly swale continues easterly to a 60" RCP under Broadmoor Bluffs Drive, north of the Academy interchange with Colorado State Highway No. 115. Some temporary swales have been constructed in the unplatted areas, east of the single-family platting, directing these swale flows to the previously mentioned outfalls under Broadmoor Bluffs Drive.

Existing site conditions in the single-family area are largely dense scrub oak on slopes ranging from 10 to 40% (10:1 to 2.5:1). The soils are predominantly of the Razor Series with some Jarre Tecolote Series existing along the steeper slopes of the western and northern portions of the platted lots.

At the present time, Farthing and Broadmoor Bluffs Drives are under construction with the proposed drainage structures as shown in that report partially in place.

DESIGN DRAINAGE CHARACTERISTICS

As previously mentioned, the two drainage swales across the single-family area define major runoff basins.

Approximately 39.9 offsite acres (Basins 1 and 2) are tributary to the two forks of the southern swale. Proposed grading along Cardiff Circle allows the runoff through major Basin "B" to be conveyed under the street. A 30" RCP is proposed to pass the 5 year flow of 15 cfs with a flow depth of 22-1/2". The 100 year flow of 48.9 cfs will require a headwater depth of 60". However this does not approach the street level nor encroach the proposed building envelope for Lot 43. Proposed runoff through minor Basin "C2" will be picked up by a storm sewer system and be directed into Basin "G". The storm sewer is designed to convey the 100 year flow of 44.2 cfs so as to not run over onto Gloucester Court. Again, grading along Cardiff Circle will allow for runoff in minor Basin "C3" to be passed through the storm sewer under the street.

The above two forks converge through major Basin "G" and will pass under Cardiff Circle again, through a 48" RCP. The 5 year flow of 37 cfs will require a headwater depth of 31" and a 62" headwater depth will be necessary for the 100 year flow of 107.8 cfs. These flows continue through minor Basin "J1" to a temporary swale section, east of the subdivision, provided with the drainage report for Farthing and Broadmoor Bluffs Drives.

Typical swale sections in Basins "B, C2 & G" shows Manning's flow depths for the 100 year runoff approximately 15" to 18" with velocities of 3 to 4 fps. All existing drainage swales are to remain natural except in areas where drainage structures are proposed.

Approximately 46.5 offsite acres (Basins 3, 4 & 5) are tributary to the northerly swale. The swale proceeds easterly through minor Basin E1 and does not cross any proposed streets. The 5 year flow of 42.9 cfs and 100 year flow of 127 cfs passes onto the unplatted land of Gates Land Company and eventually to the 60"-RCP under Broadmoor Bluffs Drive previously mentioned. A Manning's section at the end of Reginold Court shows 100 year flow depths of 36" with a velocity of 5.3 fps.

Access to residential lots at the ends of Cheshire and Reginold Courts will be across the northerly swale section and the means to cross this swale will be detailed with the respective lot development plan, as required by the City in hillside areas at the time of building permit application.

As shown on the drainage plan approximately 19 acres are tributary to the proposed street system and result in curb flow. The ultimate outfall along Cardiff Circle is the proposed sump inlets before Farthing Drive, and at the sump inlet at the end of Reginold Court. Intermediate inlets, on grade, at Cheshire Court and Cardiff Circle at minor Basin "C4" were designed to reduce the eventual down street peak flows at Reginold Court.

Theoretically, the southerly 1/2 of Cardiff Circle and Basins "F2/F3" are flowing to the sump condition in Cardiff Circle. Note: Cardiff Circle is on straight grade from the western intersection at Farthing Drive to the sump conditions before the eastern intersection with Farthing Drive. Gloucester, Cheshire, and Churchill Courts are uphill cul-de-sacs. Reginold Court is a downhill cul-de-sac. The northerly portion of Cardiff Circle, including Basins C1, C4, D1, D2, E2, E3 and E4, drain to the end of Reginold Court.

Calculations indicate the street flows in the north half of Cardiff Circle will spill into Reginold Court and not proceed southerly on Cardiff Circle.

The theoretical street capacities determined were reduced, significantly in some cases, using the recommended reduction factors. The allowable 1/2 street capacity was then determined to be adequate to contain even the 100 year flows. It is felt in this situation the reduction factors may not apply in all situations. The relative narrowness of the streets and expected lengths of driveways more likely generate a condition where on street parking will not occur and certainly not on both sides of a street. Therefore the applied reduction factors, accounting for flow obstruction primarily due to parked cars, probably act more as a safety factor than as a design reduction factor. Therefore, it could be assumed even the 100 year storm flows do not overtop the crown of the street; but for design analysis the reduction factors were applied.

Most of the curb inlets designed were upsized to the next inlet width to help alleviate runoff from the infrequent storms that seem common in the Colorado Springs area. This should help to even further reduce the 5 year storm flows. But this upsizing of inlets was not accounted for in the five year street flow analysis, a conservative approach.

Minimum 18" diameter rip-rap has been provided at culverts to protect against erosion and scouring. The 18" rock diameter should prevent mischevious displacement. Bedding details and bed sizes will be provided along with the street construction plans, as will culvert inverts and construction details.

CONCLUSION

This study generates the storm flows through the single-family area and the adequate drainage improvements necessary to convey the runoff.

Basin runoff and flow patterns are consistant with the applicable Master Drainage Studies, on file with the City of Colorado Springs, as well as the preliminary drainage plan for the area.

Copies of the calculations, with support material, are included for your review. The estimated drainage structure costs are included as Exhibit "G". By agreement with the City of Colorado Springs, no drainage basin fees are paid by Gates Land Company. The proposed drainage facilities will be built and paid for by Gates Land Company.

A copy of the Drainage Plan, Drexel, Barrell & Co. Drawing No. 3D 529-Sheet 1 of 1, has been included in the insert.

Respectfully submitted,

Douglas L. Mann
Drexel, Barrell & Co.

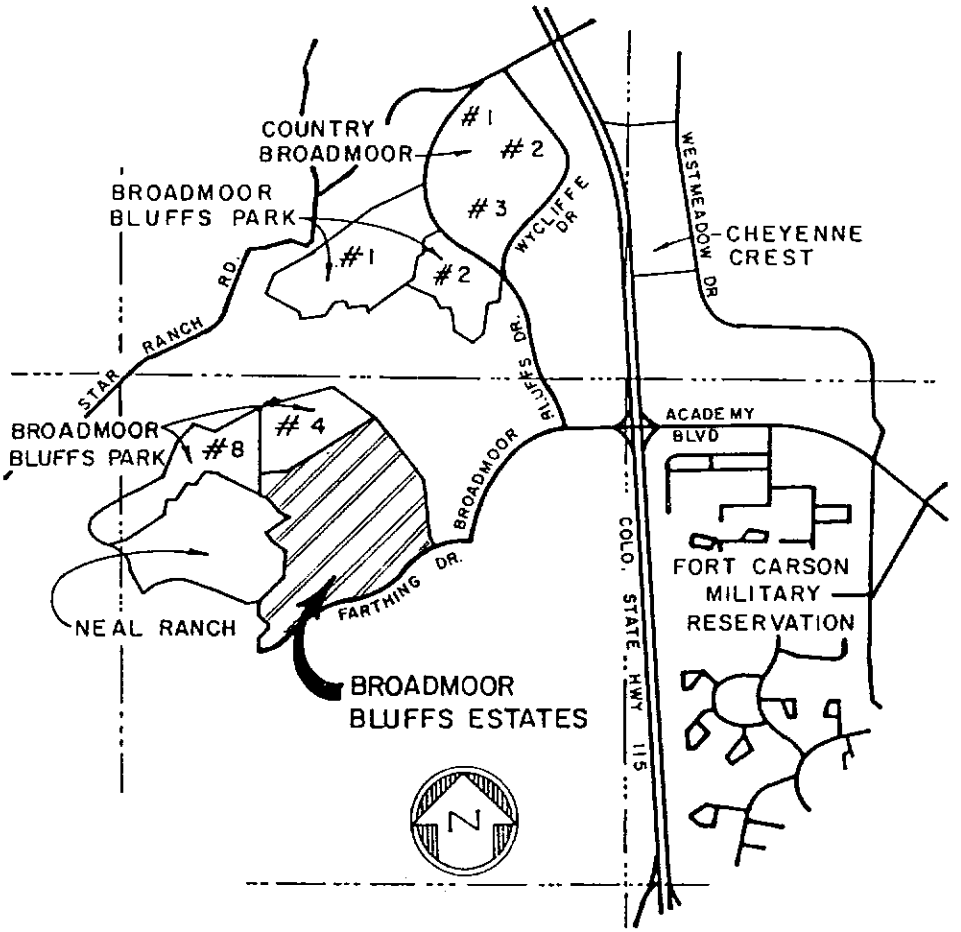
APPENDIX

SUBJECT	EXHIBIT
Vicinity Map	A
Vicinity Map (U.S.G.S.)	A1
Hydrologic Soils Map	B
Individual Basin Data Summary Sheet	C
Individual Basin Flow Calculations	C1 thru 8
Street Flow Data Summary Sheet	D
Street Flow Analysis Calculations	D1 thru 24
Combined Basin Flow Data Summary Sheet	E
Combined Basin Flow Calculations	E1 thru 8
Storm Sewer Sizing Calculations	F1 thru 8
Proposed Drainage Structures Cost Estimate	G

DRAWINGS (Back Insert)

Final Drainage Plan	Dwg No. 3D 529

EXHIBIT "A"



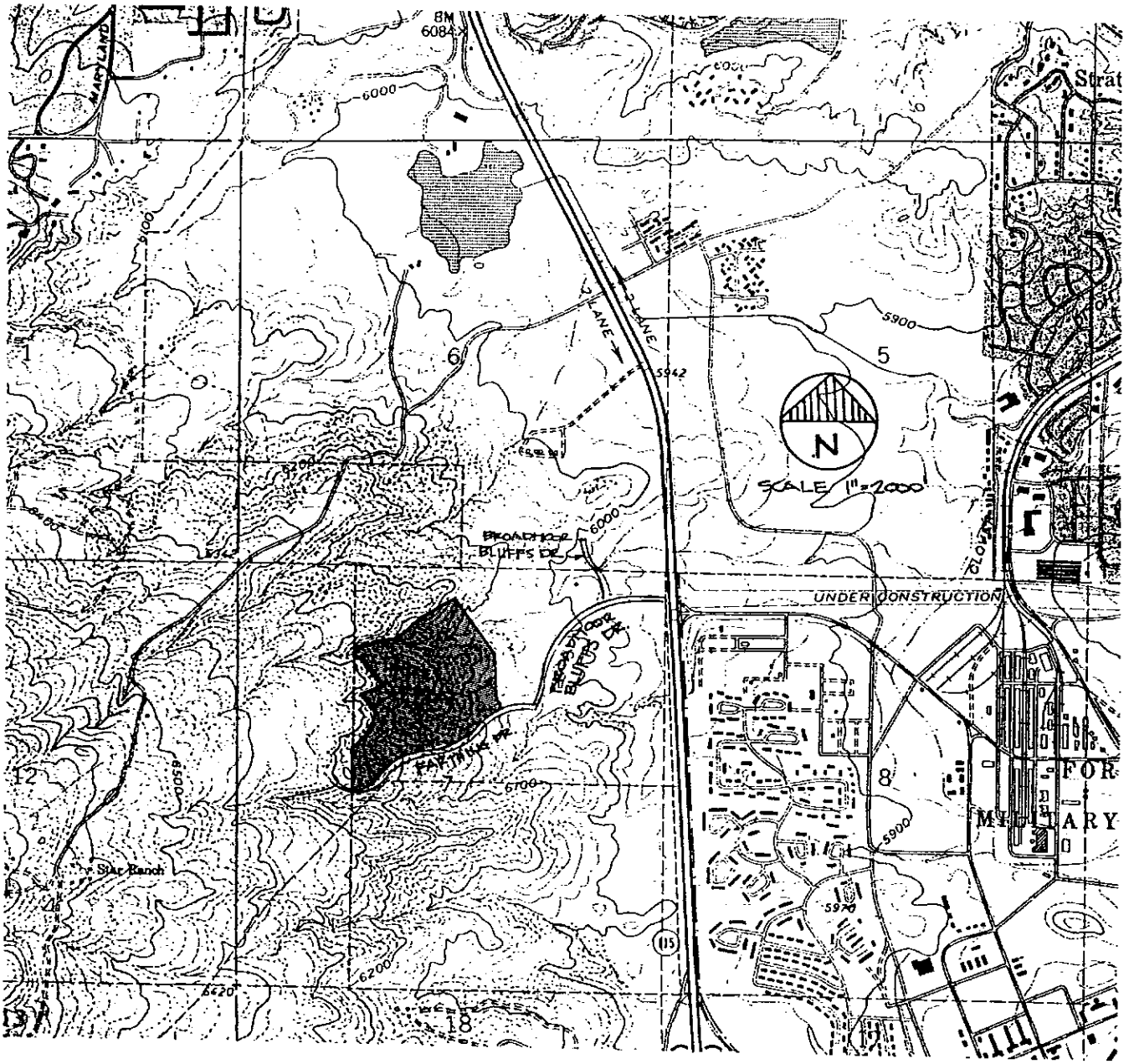
VICINITY MAP

SCALE - 1" = 2000'

BENCH MARKS

GATES GRID NO. 55,000 N
105,000 E
ELEVATION = 5959.26 (U.S.G.S.)

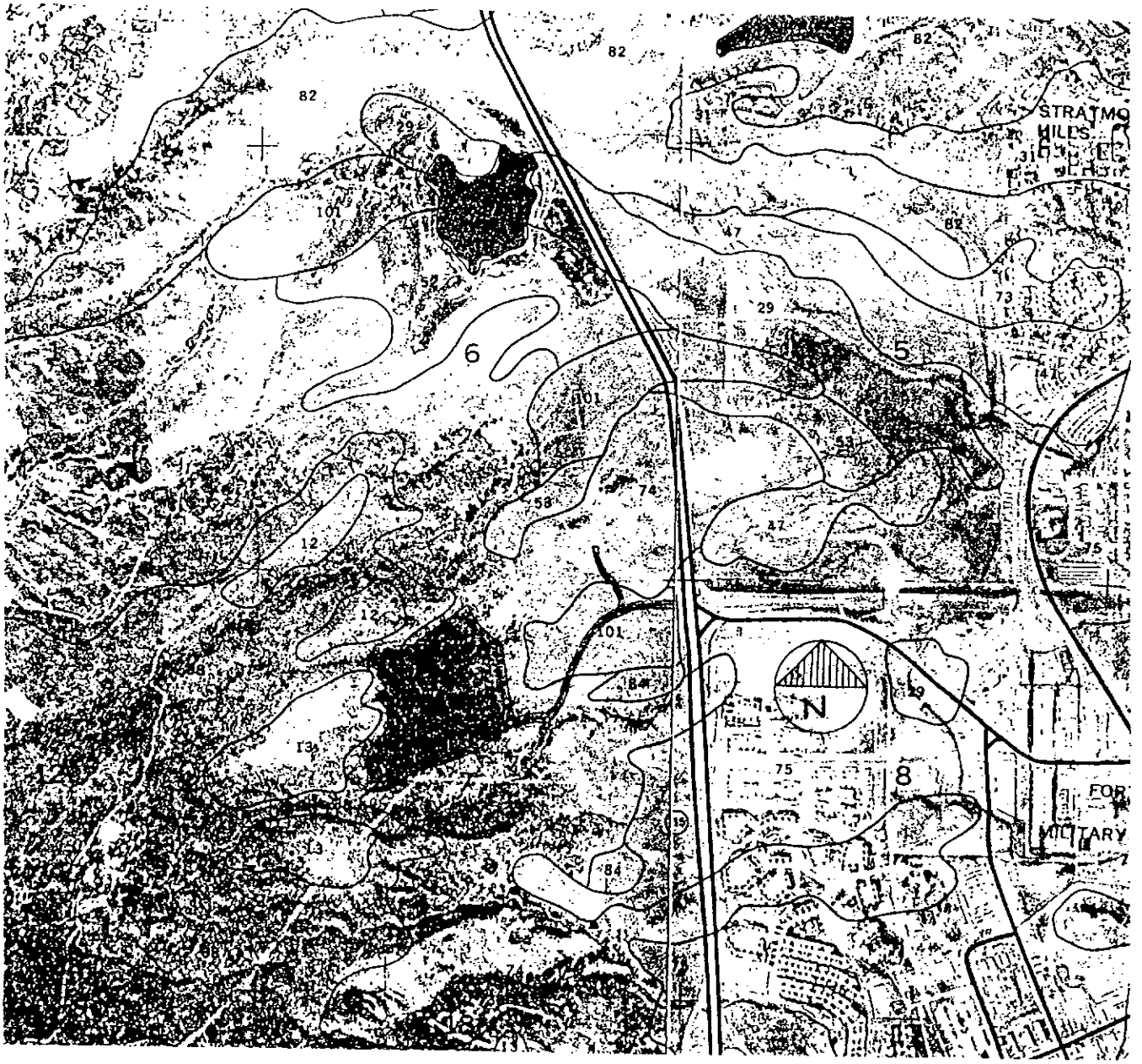
EXHIBIT "A1"



U.S.G.S.
VICINITY MAP

SCALE : 1" = 2000'

EXHIBIT "B"



SOILS MAP

SCALE : 1" = 2000'

SEE NEXT PAGE FOR DESCRIPTIONS.

EXHIBIT "B"

HYDROLOGIC SOILS GROUPS
FOR
BROADMOOR BLUFFS ESTATES STUDY

No.	Classification	Hydrologic Group
12	Bresser	B
13	Bresser	B
38	Jarre Tecolote Series	B
74	Razor	C
84	Stapleton	B
101	Ustic Torrifluvents	B

EXHIBIT "C"

INDIVIDUAL BASIN FLOW ANALYSIS

EXHIBIT "C"
INDIVIDUAL BASIN DATA SUMMARY SHEET

Basin Designation	Area (ac.)	CN	Tc (hr)	Q5 (in)	Q100 (in)	qp (csm/in)	q5 (cfs)	q100 (cfs)
B	4.86	74	0.10	0.40	1.24	1280	3.9	12.1
C1	3.84	75	0.10	0.44	1.30	1280	3.4	10.0
C2	1.50	72	0.10	0.34	1.12	1280	1.0	3.4
C3	1.12	80	0.10	0.62	1.64	1280	1.4	3.7
C4	0.36	98	0.10	1.87	3.27	1280	1.3	2.4
D1	1.93	80	0.12	0.62	1.64	1240	2.3	6.1
D2	4.30	76	0.16	0.47	1.36	1140	3.6	10.4
E1	12.87	76	0.12	0.47	1.36	1220	11.5	33.4
E2	0.56	98	0.10	1.87	3.27	1280	2.1	3.7
E3	3.06	80	0.10	0.62	1.64	1280	3.8	10.0
E4	0.49	98	0.10	1.87	3.27	1280	1.8	3.2
F1	1.35	92	0.11	1.33	2.64	1260	3.5	7.0
F2	3.21	80	0.10	0.62	1.64	1280	4.0	10.5
F3	0.40	98	0.10	1.87	3.27	1280	1.5	2.6
G	9.02	77	0.23	0.51	1.43	1020	7.3	20.6
J1	4.10	80	0.10	0.62	1.64	1280	5.1	13.5

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job Nº
BROADMOOR BLUFFS ESTATES EXHIBIT "C"	E 3098

Client	By	Date
GATES LAND CO.	dlm	DEC 10, 1984

CKD: ROOM 12-14-84

INDIVIDUAL BASIN FLOWS

BASIN A FLOWS TO FARTHING. IS PART OF DRAINAGE REPORT APPROVED FOR BROADMOOR BLUFFS & FARTHING DRIVES.
REF: $Q_5 = 4.7$ cfs $Q_{100} = 11.6$ cfs

BASIN B AREA = 4.86 AC.

SOIL GROUP	ACREAGE	USE	CN	%	%CN
38(B)	2.98	R½	70	61.3	42.9
74(C)	1.88	R½	80	38.7	30.9
	4.86			100	74

T_c: 125' OVERLAND AT 37% (12 fps) 1.0 MIN
520' NATURAL SWALE AT 10% (4 fps) 2.2 MIN
T_c 3.2 MIN. ≈ 0.1 h

q_p = 1280 CSM/IN
Q_5 = 0.4 IN Q_{100} = 1.24 IN

$q_5 = 1280 * 4.86/640 * 0.4 = 3.9$ cfs
$q_{100} = 1280 * 4.86/640 * 1.24 = 12.1$ cfs

	QA/640
5	.0030
100	.0094

BASIN C1 AREA = 3.84 AC.

SOIL GROUP	ACREAGE	USE	CN	%	%CN
38(B)	1.93	R½	70	50.3	35.2
74(C)	1.91	R½	80	49.7	39.8
	3.84			100	75

T_c: 200 LF OVERLAND AT 35% (2 fps) 1.7 MIN
120 LF OVERLAND AT 16% (1.4 fps) 1.4 MIN
250 LF CURB FLOW AT 2% (2.8 fps) 1.5 MIN
4.6 MIN ≈ 0.1 h

q_p = 1280 CSM/IN
Q_5 = 0.44 IN Q_{100} = 1.30 IN.

$q_5 = 1280 * 3.84/640 * 0.44 = 3.4$ cfs
$q_{100} = 1280 * 3.84/640 * 1.30 = 10.0$ cfs

	QA/640
5	.0026
100	.0078

Project: BROADMOOR BLUFFS ESTATES — EXHIBIT "C" | Job No. E 3098

Client: GATES LAUB CO. | By: dlm | Date: DEC. 10. 1984

CAO: ~~RODII~~ 12-14-84

BASIN C2 SEE pg. 7

BASIN C3 AREA = 1.12 Ac

SOIL GROUP 74(C) USE R1/2 CN 80

Tc: 300 LF OVERLAND AT 10% (1.6 fps) 3.1 MIN
120 LF SWALE AT 10% (4 fps) 0.5 MIN
3.6 MIN ± 0.1 h

q_{10} = 1280 CSM/IN

Q_5 = 0.62 IN : Q_{100} = 1.64 IN

q_5 = 1280 * 1.12/640 * 0.62 = 1.4 cfs

q_{100} = 1280 * 1.12/640 * 1.64 = 3.7 cfs

	QA / 640
5	.0011
100	.0029

BASIN C4 SEE pg. 8

BASIN D2 AREA = 4.30 Ac

SOIL GROUP	ACREAGE	USE	CN	%	%CN
38 (B)	1.93	R1/2	70	44.9	31.4
74 (C)	2.37	R1/2	80	55.1	44.1
	4.30			100	76

Tc: 280 LF OVERLAND AT 15% (1.4 fps) 3.3 MIN
320 LF OVERLAND AT 10% (1.1 fps) 4.8 MIN
150 LF CURB FLOW AT 2.5% (3.1 fps) 0.8 MIN
200 LF CURB FLOW AT 9.0% (6.0 fps) 0.6 MIN
9.5 MIN. ± 0.16h

q_{10} = 1140 CSM/IN

Q_5 = 0.47 IN Q_{100} = 1.36 IN.

q_5 = 1140 * 4.30/640 * 0.47 = 3.6 cfs

q_{100} = 1140 * 4.30/640 * 1.36 = 10.4 cfs

	QA/640
5	.0032
100	.0091

BASIN D1 SEE pg 8

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job No
BROADMOOR BLUFFS ESTATES EXHIBIT "C"	E 3098

Client	By	Date
GATES LAND CO	dln	DEC. 10, 1984

CAD: RAD III 12-17-84

BASIN E1 AREA = 12.87 AC

SOIL GROUP	ACREAGE	USE	CN	%	% CN
38 (B)	5.42	R 1/2	70	42.1	29.5
74 (C)	7.45	R 1/2	80	57.9	46.3
	12.87			100	76

Tc: 250 LF OVERLAND AT 30 % (2fps) 2.1 MIN.
1200 LF NAT. SWALE AT 12 % (4 fps) 5.0 MIN.
7.1 MIN ≈ 0.12h

q_p = 1220 CSM/IN

Q_5 = 0.47 IN Q_{100} = 1.36 IN

q_5 = 1220 * 12.87/640 * 0.47 = 11.5 cfs

q_{100} = 1220 * 12.87/640 * 1.36 = 33.4 cfs

QA/640
5 = .0095
100 = .0273

BASIN E2 AREA = 0.56 AC

SOIL GROUP 74(C) USE: STREET CN 98

Tc: 150 LF CURB FLOW AT 7.5% (5.5 fps) 0.5 MIN
150 LF " AT 2.5% (3.1 fps) 0.8 MIN
200 LF " AT 9.0% (6.0 fps) 0.6 MIN
75 LF " AT 6.0% (4.8 fps) 0.3 MIN
225 LF " AT 9.2% (6.0 fps) 0.6 MIN
75 LF " AT 6.0% (4.8 fps) 0.3 MIN
3.1 MIN ≈ 0.1h

q_p = 1280 CSM/IN

Q_5 = 1.87 IN Q_{100} = 3.27 IN

q_5 = 1280 * 0.56/640 * 1.87 = 2.1 cfs

q_{100} = 1280 * 0.56/640 * 3.27 = 3.7 cfs

QA/640
5 = .0016
100 = .0029

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job Nº
BROADMOOR BLUFFS ESTATES EXHIBIT "C"	E 3098

Client	By	Date
GATES LAND CO	dlm	DEC 10, 1984

CTO: KOO III 12-14-84

BASIN E3 AREA = 3.06 Ac

SOIL GROUP 74 (C) USE: R 1/2 CN 80

Tc: 200 LF OVERLAND AT 22% (1.7 fps) 2.0 MIN.
220 LF OVERLAND AT 9 % (1.0 fps) 3.7 MIN
5.7 MIN. ≈ 0.1h

q_p = 1280 CSM/IN

Q_5 = 0.62 IN Q_{100} = 1.64 IN

q_5 = 1280 * 3.06/640 * 0.62 = 3.8 cfs
q_{100} = 1280 * 3.06/640 * 1.64 = 10.0 cfs

	QA/640
5	.0030
100	.0078

BASIN E4 AREA = 0.49 Ac

SOIL GROUP 74 (C) USE: STREET CN 98

Tc: 100 LF CURB FLOW AT 2.0% (2.8 fps) 0.6 MIN
150 LF " AT 10.0% (6.3 fps) 0.4 MIN
700 LF " AT 1% (2.0 fps) 1.7 MIN
150 LF " AT 6.2% (4.8 fps) 0.5 MIN
150 LF " AT 1.0% (2.0 fps) 1.3 MIN
4.5 MIN ≈ 0.1h

q_p = 1280 CSM/IN

Q_5 = 1.87 IN Q_{100} = 3.27 IN

q_5 = 1280 * 0.49/640 * 1.87 = 1.8 cfs
q_{100} = 1280 * 0.49/640 * 3.27 = 3.2 cfs

	QA/640
5	.0014
100	.0025

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

3405 N. EL PASO STREET (303) 633-5029
COLORADO SPRINGS, COLORADO 80907

Project: BROADMOOR BLUFFS ESTATES EXHIBIT "C" | Job No. E 3098

Client: GATES LAND CO | By: dlm | Date: DEC 10, 1984

CRO: KOOIII 12-14-84

BASIN F1 SEE PAGE 7

BASIN F2 AREA = 3.21 Ac

SOIL GROUP 74(c) USE: R1/2 CN 80

Tc: 215 LF OVERLAND AT 16% (1.4 fps) 2.6 MIN
200 LF CURB FLOW AT 6% (5 fps) 0.7 MIN
200 LF CURB FLOW AT 9% (6 fps) 0.6 MIN
75 LF CURB FLOW AT 1% (2 fps) 0.6 MIN
4.5 MIN ≈ 0.1 h

q_p = 1280 CSM/IN

Q_5 = 0.62 IN Q_{100} = 1.64 IN

q_5 = 1280 * 3.21/640 * 0.62 = 4.0 cfs

q_{100} = 1280 * 3.21/640 * 1.64 = 10.5 cfs

	QA/640
5	.0031
100	.0082

BASIN F3 AREA = 0.40 Ac

SOIL GROUP 74(c) USE: STREET CN 98

Tc: 350 LF CURB FLOW AT 6.0% (5 fps) 1.0 MIN
200 LF CURB FLOW AT 9.0% (6 fps) 0.6 MIN
75 LF CURB FLOW AT 1.0% (2 fps) 0.6 MIN
2.2 MIN ≈ 0.1 h

q_p = 1280 CSM/IN

Q_5 = 1.87 IN Q_{100} = 3.27 IN

q_5 = 1280 * 0.4/640 * 1.87 = 1.5 cfs

q_{100} = 1280 * 0.4/640 * 3.27 = 2.6 cfs

	QA/640
5	.0012
100	.0020

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job Nº
BROADMOOR BLUFFS ESTATES EXHIBIT "C"	E 3098

Client	By	Date
GATES LAND CO.	dlm	DEC. 10. 1984

CAO: RODIII 12-14-84

BASIN G AREA = 9.02 Ac

SOIL GROUP	ACREAGE	USE	CN	%	% CN
74 (c)	4.38	PARK	74	48.6	35.6
74 (c)	4.64	R 1/2	80	51.4	41.2
	9.02			100	77

Tc: 270 LF OVERLAND AT 2.6 % (0.55 fps) 8.2 MIN
250 LF OVERLAND AT 16 % (1.4 fps) 3.0 MIN
575 LF NAT. SWALE AT 10 % (4 fps) 2.4 MIN
13.6 MIN ≈ 0.23h

q_{10} = 1020 CSM/IN

Q_5 = 0.51 IN Q_{100} = 1.43 IN

q_5 = 1020 * 9.02/640 * 0.51 = 7.3 cfs

q_{100} = 1020 * 9.02/640 * 1.43 = 20.6 cfs

	QA/640
5	.0072
100	.0202

BASIN J1 AREA = 4.10 Ac

SOIL GROUP 74(c) USE: R 1/2 CN 80

Tc: 380 LF OVERLAND AT 13% (1.2 fps) 5.3 MIN ≈ 0.1 h

q_P = 1280 CSM/IN

Q_5 = 0.62 IN Q_{100} = 1.64 IN

q_5 = 1280 * 4.1/640 * 0.62 = 5.1 cfs

q_{100} = 1280 * 4.1/640 * 1.64 = 13.5 cfs

	QA/640
5	.0040
100	.0105

Project: BROADMOOR BLUFFS ESTATES EXHIBIT "C" | Job No: E 3098

Client: GATES LAND Co. | By: dlm | Date: DEC 10. 1984

CHD: RDO III 12-14-84

BASIN C2 AREA 1.50 Ac.

SOIL GROUP	ACREAGE	USE	CN	%	%·CN
38 (B)	1.20	R 1/2	70	80	56.0
74 (C)	0.30	R 1/2	80	20	16.0
	1.50			100	72

T_c: 380 LF SWALE AT 15% (6 fps) 1.1 MIN ≈ 0.1 h

q_p = 1280 CSM/IN

Q_5 = 0.34 IN Q_{100} = 1.12 IN

q_5 = 1280 * 1.5/640 * 0.34 = 1.0 cfs

q_{100} = 1280 * 1.5/640 * 1.12 = 3.4 csf

	QA/640
5	.0008
100	.0026

BASIN F1 AREA 1.35 Ac.

SOIL GROUP	ACREAGE	USE	CN	%	%·CN
74(C)	0.90	STREET	98	66.7	65.3
74(C)	0.45	R 1/2	80	33.3	26.7
	1.35			100	92

T_c: CURB FLOW

100' AT 4%	4 fps	0.4 MIN
150' AT 6.9%	5 fps	0.5
225' AT 1.9%	2.8 fps	1.3
400' AT 2.8%	3 fps	2.2
350' AT 6%	4.8 fps	1.2
225' AT 9.2%	5.5 fps	0.7
100' AT 6.0%	4.8 fps	0.3
		6.6 MIN ≈ 0.1 h

q_p = 1260 CSM/IN

Q_5 = 1.33 IN Q_{100} = 2.64 IN

q_5 = 1260 * 1.35/640 * 1.33 = 3.5 cfs

q_{100} = 1260 * 1.35/640 * 2.64 = 7.0 cfs

	QA/640
5	.0028
100	.0056

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: BROADMOOR BLUFFS ESTATES — Job No. E 3098

Client: GATES LAND CO — By: dlm — Date: DEC 10. 1984

CAO: RODII 12-14-84

BASIN C4 AREA = 0.36 Ac

SOIL GROUP 74(C) USE: STREET CN 98

Tc: 200' CURB FLOW AT 9.5% (5.5fps) 0.6 MIN
125' AT 12.0% (6.0 fps) 0.3
100' AT 6% (4.8 fps) 0.4
200' AT 2.8% (3 fps) 1.1
2.4 MIN ≈ 0.1 h

q_p = 1280 CSM/IN

Q_5 = 1.87 IN Q_{100} = 3.27 IN

q_5 = 1280 * 0.36/640 * 1.87 = 1.3 cfs

q_{100} = 1280 * 0.36/640 * 3.27 = 2.4 cfs

	QA/640
5	.0011
100	.0018

BASIN D1 AREA = 1.93 Ac

SOIL GROUP 74(C) USE: R1/2 CN = 80

Tc: 360' OVERLAND AT 10% (1 fps) 6 MIN
250' CURB AT 2.8% (3 fps) 1.4
7.4 MIN ≈ 0.12 h

q_p = 1240 CSM/IN

Q_5 = 0.62 IN Q_{100} = 1.64 IN

q_5 = 1240 * 1.93/640 * 0.62 = 2.3 cfs

q_{100} = 1240 * 1.93/640 * 1.64 = 6.1 cfs

	QA/640
5	.0019
100	.0049

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EXHIBIT "D"

STREET FLOW ANALYSIS CALCULATIONS

EXHIBIT "D"

STREET FLOW DATA SUMMARY SHEET

Design Point		q5/q100 (cfs)	1/2 Street Capacity To Top Crown (cfs)	1/2 Street Capacity To Top Curb (cfs)	Inlet Size (ft) Capacity (cfs)	Inlet Pickup/by 5 Year (cfs)	Inlet Pickup/by 100 Year (cfs)
Cardiff at Gloucester	W1/2	3.4/10.00	11.1	38.4			
	E1/2	1.1/ 1.9	11.1	38.4			
Cardiff at Inlet E	N1/2	4.7/12.3	11.1	38.4	6/13.2	2.8/1.9	5.4/6.9
Cheshire at Inlet D	S1/2	4.4/12.6	4.8	23.2	8/12.1	2.6/1.8	6.4/6.2
Cardiff at Cheshire	W1/2	5.4/17.1	9.5	35.2			
	E1/2	2.4/ 4.2	9.5	35.2			
Cardiff at Reginold	W1/2	3.5/ 7.0	9.5	35.2			
	E1/2	6.9/19.6	9.5	35.2			
Cardiff at Inlets A&B	W1/2	7.0/16.3	7.2	27.2	6/12.8	7.0/0	12.8/0
	E1/2	1.5/ 2.6	7.2	27.2	4/ 7.9	1.5/0	2.6/0
Reginold at Inlet C	W1/2	3.8/10.0		27.2			
	E1/2	7.5/19.8		27.2	8/18.4	10.2/0	18.4/8.6

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job No
BROADMOOR BLUFFS ESTATES — EXHIBIT "D"	E 3098

Client	By	Date
GATES LAND CO	dlm	DEC. 10. 1984

CHD: KDOT 12-14-84

SOUTHERLY 1/2 OF CARDIFF

AT GLOUCESTER AREA 0.29 Ac CURB GRADE 2.8%

CN 98 Q_5 = 1.87 IN Q_{100} = 3.27 IN

Tc: CURB FLOW 100' AT 4% 0.4 MIN
150 6.9% 0.5
225 1.9% 1.3
100 2.8% 0.6
2.8 MIN USE 0.1 h

q_p = 1280 CSM/IN

q_5 = 1280 * 0.29/640 * 1.87 = 1.1 cfs
q_{100} = 1280 * 0.29/640 * 1.87 = 1.9 cfs

ALLOW 1/2 ST TO TOP CROWN 11.1 cfs SEE pg. 10

AT CHESHIRE AREA = 0.65 Ac CURB GRADE 6.0%

CN 98 Q_5 = 1.87 IN Q_{100} = 3.27 IN

Tc: PREVIOUS 2.8 MIN
+ 300' AT 2.8% 2.8 MIN
+ 320 AT 6.0% 0.9 MIN
6.5 MIN ≈ 0.11 h

q_5 = 1260 CSM/IN

q_5 = 1260 * 0.65/640 * 1.87 = 2.4 cfs
q_{100} = 1260 * 0.65/640 * 3.27 = 4.2 cfs

ALLOW 1/2 STREET TO TOP CROWN 9.5 cfs see pg. 12

AT REGINOLD CURB GRADE 6%

INDIVIDUAL BASIN #1

q_5 = 3.5 cfs
q_{100} = 7.0 cfs

AT 6% ALLOW FLOW TO TOP CROWN (1/2 STREET) 9.5 cfs SEE pg 12
AT 9.2% " (1/2 STREET) 6.5 cfs SEE pg 14
AT 9.2% top curb (1/2 STREET) 26.4 cfs SEE pg 15

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job Nº
BROADMOOR BLUFFS ESTATES EXHIBIT "B"	E 3098

Client	By	Date
GATES LAND Co	HH	DEC. 10. 1984

CHD: RDOII 12-18-84

AT SUMP INLET OFF FARTHING

BASIN F1 + F2

QA/640 5 , 0031 + .0028 = .0059
100 . 0082 + .0056 = .0138

Tc: BASIN F1 6.6 MIN
ACROSS F2 200' CURBFLOW AT 6% 0.7 MIN
200' AT 9% 0.6
75' AT 1% 0.6
8.5 MIN x 0.14 h

q_p = 1180 CSM/IN
q_5 = 1180 x .0059 = 7.0 cfs
q_{100} = 1180 x .0138 = 16.3 cfs

AT 6% ALLOW FLOW TO	TOP CROWN (½ ST)	9.5 cfs	SEE pg 12
AT 6%	TOP CURB (½ ST)	39.9 cfs	SEE pg 13
AT 9%	TOP CURB (½ ST)	26.4 cfs	SEE pg 15
AT 1%	TOP CROWN (½ ST)	77.2 cfs	SEE pg 16
AT 1%	TOP CURB (½ ST)	27.2 cfs	SEE pg 17

6' SUMP INLET PICKUP 12.8 cfs

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project: BROADMOOR BLUFFS ESTATES — EXHIBIT "B" — Job No. E 3098

Client: GATES LAND CO. — By: dlm — Date: DEC. 10, 1984

CAD: RADIII 12-14-84

NORTHERLY 1/2 OF CARDIFF

TO GLOUCESTER — CURB GRADE 2.8%

BASIN C1 T_{c1} 4.6 MIN

q_5 = 3.4 cfs
q_{100} = 10.0 cfs

ALLOW 1/2 ST. FLOW TO CROWN 11.1 cfs SEE PG. 10

TO PROPOSED INLET ON 2.8% GRADE — C1 + C4

$QA/64.5$ .0026 + .0011 = .0037
$\quad\quad 100$ .0078 + .0018 = .0096

T_c: BASIN C1 4.6 MIN
FLOW ACROSS C4 200' AT 2.8% 1.1 MIN

T_c = 5.7 MIN OR 0.1h

q_5 = 1280 CSM/IN

q_5 = 1280 * .0037 = 4.7 cfs
q_{100} = 1280 * .0096 = 12.3 cfs

ALLOW 1/2 ST. AT 2.8% TO TOP CROWN 11.1 cfs SEE PG 10
TO TOP CURB 45.9 cfs SEE PG 11

4' INLET ON 2.8% ALLOW PICKUP 5.4 cfs

5YR PICKUP 4.7 * .6 = 2.8 cfs BY 1.9 cfs
100YR PICKUP 12.3 * .6 = ~~7.4~~ 5.4 cfs BY 6.9 cfs

TO PROPOSED INLET IN CHESHIRE — BASIN B2 + 3

T_c: 11.6 MIN
q_5 = 4.4 cfs
q_{100} = 12.6 cfs

1/2 ST. CAPACITY ALLOW 4.8 cfs
theoretical 20.2 cfs

6' CURB INLET ON 9% GRADE ALLOW 6.4 cfs

5-YEAR PICKUP 4.4 * 0.6 = 2.6 1.8 cfs by
100-YEAR PICKUP 12.6 * 0.6 = ~~7.6~~ 6.4 6.2 cfs by

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DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job Nº
BROADMOOR BLUFFS ESTATES EXHIBIT "D"	E 3098

Client	By	Date
GATES LAND CO	dlm	DEC. 10, 1984

CHO: KODIII 12-14-84

REDUCE THE AFFECTIVE QA/640's OF AREAS TRIBUTARY TO THE PROPOSED INLETS TO ACCOUNT FOR FLOW BY TO DOWNSTREAM POINTS.

INLET AT CARDIFF

QA/640	5	.0037	q	4.7	q by	1.9
	100	.0096	q	12.3	q by	6.9

$1.9/4.7 = X/.0037 \qquad X = .0015$

$6.9/12.3 = X/.0096 \qquad X = .0054$

INLET AT CHESHIRE

5	.0041	q	4.4	q by	1.8
100	.0117	q	12.6	q by	6.2

$1.8/4.4 = X/.0041 \qquad X = .0017$

$6.2/12.6 = X/.0117 \qquad X = .0058$

THE ABOVE EFFECTIVE QA/640 SHALL BE UTILIZED IN CALCULATIONS DOWNSTREAM TO ACCOUNT FOR INLET INTERCEPTION.

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Project: BROADMOOR BLUFFS ESTATES EXHIBIT "D" | Job No. E 3098

Client: GATES LAND CO. | By: dlH | Date: DEC. 10. 1984

CHD: 100 III 12-14-84

TO CHESHIRE CURB GRADE 6%

		CARDIFF ADJ.	D1	CHESH ADJ.	
QA/C40	5	.0015	+ .0019	+ .0017	= .0051
	100	.0054	+ .0049	+ .0058	= .0161

Tc: THRU C4 5.7 MIN + 1.2 MIN = 6.9 MIN > TO INTERSECTION
OR THRU D2 11.6 MIN + 0.4 MIN = 12.0 MIN

BACK THRU D2 TO AN EFFECTIVE AREA FOR TC = 6.9 MIN

LOSE 2.1 AC OF BASIN D2 ALL OF D3 MIN. OF D1

ADJUST QA/C40 5. .0017/4.3 * 2.2 = .0009
FOR BASIN D2 100. .0058/4.3 * 2.2 = .0030

CHECK BOTH FLOWS FOR THE LARGER PEAK

Tc = 12.0 ≈ 0.2 h q_p = 1060 CSM/IN ⇐ PEAK FLOW

q_5 = 1060 * .0051 = 5.4 cfs
q_{100} = 1060 * .0161 = 17.1 cfs

Tc = 6.9 MIN ≈ 0.12 h q_p = 1220 CSM/IN

q_5 = 1220 * .0043 = 5.2 cfs
q_{100} = 1220 * .0133 = 16.2 cfs

USE PEAK Tc AT 12 MIN

q_5 = 5.4 cfs
q_{100} = 17.1 cfs

½ ST ALLOW TO CROWN AT 6% 9.5 cfs
TO TOP CURB AT 6% 39.9 cfs

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project		Job Nº
BROADMOOR BLUFFS ESTATES	EXHIBIT "D"	E 3098

Client	By	Date
GATES LAND CO	dlm	DEC. 10, 1984

CAD: KOOIII 12-14-84

TO REGINOLD TO CHESHIRE + E2 CURB GRADE 6%

QA/640: 5 .0051 + .0016 = .0067
100 .0161 + .0029 = .0190

Tc: 12 MIN TO CHESHIRE
+ 75' CURB AT 6% .3 MIN
225 AT 9.2% .6 MIN
75' AT 6.0% .3 MIN
Tc 13.2 MIN OR 0.22 h

q_p = 1030 CFM/IN
q_5 = 1030 * .0067 = 6.9 cfs
q_{100} = 1030 * .0190 = 19.6 cfs

ALLOW 1/2 AT 6% TO CROWN 9.5 cfs
TO TOP CURB 39.9 cfs
ALLOW 1/2 AT 9.2% TO CROWN 6.5 cfs
TO TOP CURB 26.4 cfs

TO SUMP INLET AT PARTHING BASIN F3

q_5 = 1.5 4' SUMP INLET CAPACITY 7.9 cfs
q_{100} = 2.6

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job No
BROADMOOR BLUFFS ESTATES EXHIBIT "B"	E 3098

Client	By	Date
GATES LAND CO.	dlm	DEC. 10. 1984

CHO: 100III 12-14-84

SUMMARY OF FLOWS ALONG FARTHING

5 YR. SOUTHERLY 1/2 STREET FLOWS CONTAINED BETWEEN CROWN AND CURB ALL THE WAY.
NORTHERLY 1/2 STREET FLOWS CONTAINED BETWEEN CROWN AND CURB TO REGINOLD.

100 YR. SOUTHERLY 1/2 STREET CONTAINED BETWEEN CROWN & CURB TO PAST REGINOLD. SPILLS OVER CROWN BUT IS WITHIN CURBS.
NORTHERLY 1/2 STREET CONTAINED BETWEEN CROWN & CURB TO CHESHIRE THEN SPILLS OVER CROWN BUT IS WITHIN CURBS.

CHECK 100 YEAR FULL STREET FLOW AT REGINOLD.

$Q_{A/640}$ 100, .0190 + .0056 = .0246

T_c: 0.22 h See pg 6

q_{10} = 1030

q_{100} 1030 * .0246 = 25.4 cfs

STREET CAP AT TOP CURB = 35.2 * 2 = 70.4 cfs

100 YR. SPILL INTO REGINOLD = 12.7 cfs

CONTINUATION TO FARTHING 12.7 cfs

CHECK 100 YEAR FULL STREET FLOW AT SUMP INLETS IN CARPORT

$Q_{A/640}$ 100 .0246/2 + .0082 (F2) + .0020 (F3) = .0225

T_c = 13.2 MIN + 2.2 MIN = 15.4 MIN 0.26 h

q_p = 980 CSM/IN

q_{100} = 980 * .0225 = 22.1 cfs OR 11 cfs / SIDE

USE 4' INLET ON EAST CAP. 7.9
6' INLET ON WEST CAP. 12.8

Project: BROADMOOR BLUFFS ESTATES — EXHIBIT "D" — Job No. E-3098

Client: GATES LAND CO. — By: dln — Date: DEC 10, 1984

CAD: ROOM III 12-14-84

REGINOLD FLOWS

THEORETICAL 1/2 CARDIFF FLOW AT 9% 27.2 cfs

IF NO CARS OBSTRUCT FLOW 1/2 STREET WILL CARRY

SO ASSUME FULL 1/2 STREET DUMP INTO REGINOLD.

FLOWS FROM E2 WILL BE CROSS STREET TO BASIN E4

EAST END OF REGINOLD

		To Reginold	E4	
QA/64	5	.0067	+ .0014	= .0081
	100	.0190	+ .0025	= .0215

Tc: 13.2 MIN + 4.5 MIN = 17.7 MIN ≈ 0.30h

q_p = 920 GPM/IN

q_5 = 920 * .0081 = 7.5 cfs

q_{100} = 920 * .0215 = 19.8 cfs

ALLOW STREET CAPACITY AT CARDIFF INTERSECTION 26.6 cfs

1/2 STREET ALLOW TO TOP CURB AT 10% 20.2 cfs

AT 1% 27.2 cfs

WEST END OF REGINOLD

BASIN E3

Tc: 5.7 MIN

q_5 = 3.8 cfs

q_{100} = 10.0 cfs

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Project		Job Nº
BROADMOOR BLUFFS ESTATES	EXHIBIT "D"	E 3098

Client	By	Date
GATES LAND CO.	DM	DEC. 10. 1984

C/O: KOZII 12-14-84

PEAK FLOWS AT REGINOLD INLET

$Q_A/640$ 5 .0081 + .0030 = .0111
100 .0215 + .0078 = .0293

T_c = 17.7 MIN = 0.3h
q_p = 920 CSM/IN

q_5 = 920 * .0111 = 10.2 cfs
q_{100} = 920 * .0293 = 27.0 cfs

SUMP INLET 6' ALLOW CAPACITY 12.8 cfs
8' 18.4 cfs

USE 8' INLET FOR INFREQUENT RAINFALL DRAINAGE

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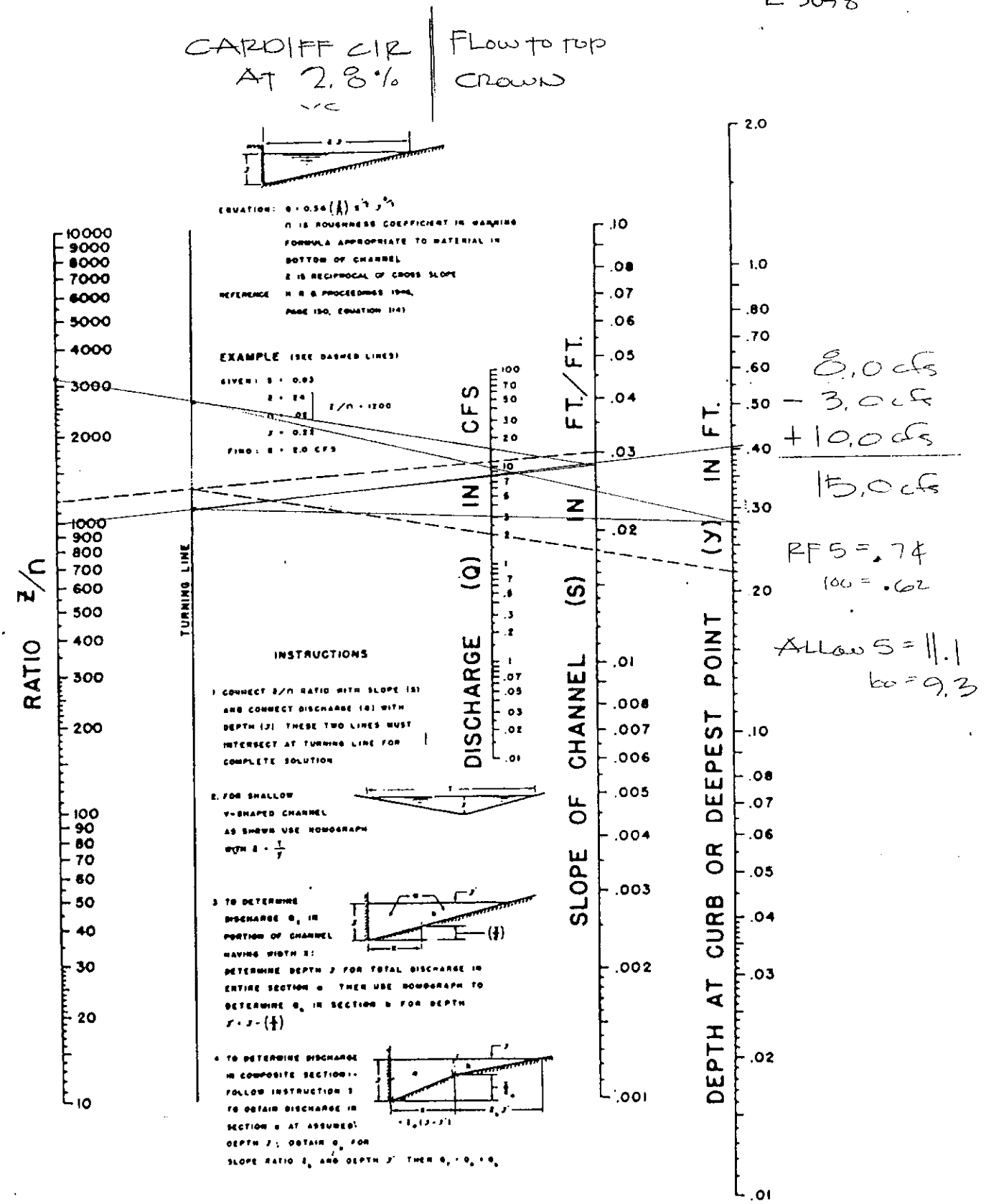
EXHIBIT "D" 10/24

E 3098

CAROLFF CIR AT 2.8% V/C

FLOW TO TOP CROWN



8.0 cfs
− 3.0 cfs
+ 10.0 cfs
15.0 cfs

RFS = .74
100 = .62

ALLOW S = 11.1
bo = 9.3

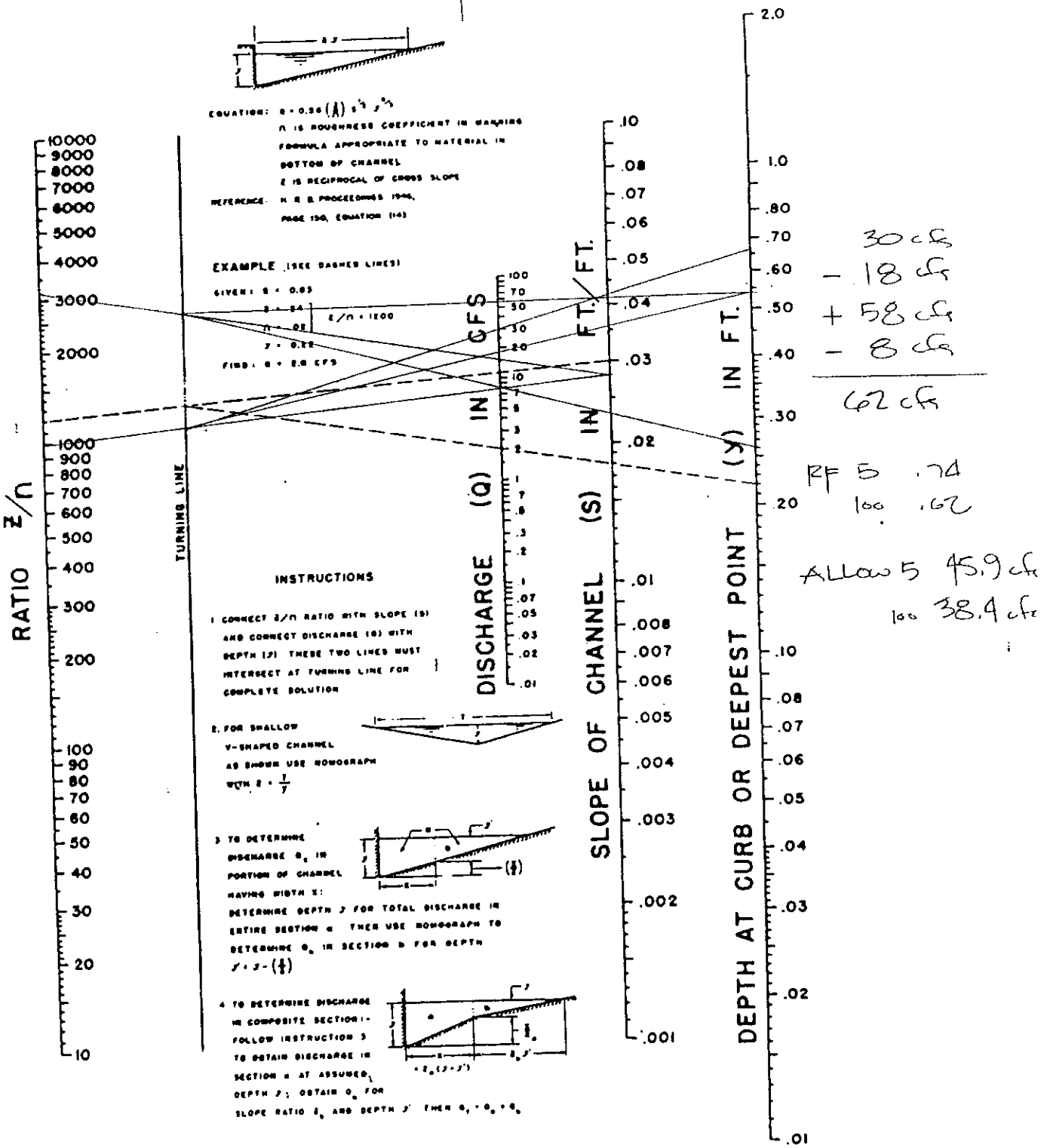
FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

EXHIBIT "D" 11/24

STREETS
E3098

CARDIFF CIR AT 2.8%

Flow To Top Curb



30 cfs
− 18 cfs
+ 58 cfs
− 8 cfs
62 cfs

RF 5 .74
100 .62

ALLOW 5 45.9 cfs
100 38.4 cfs

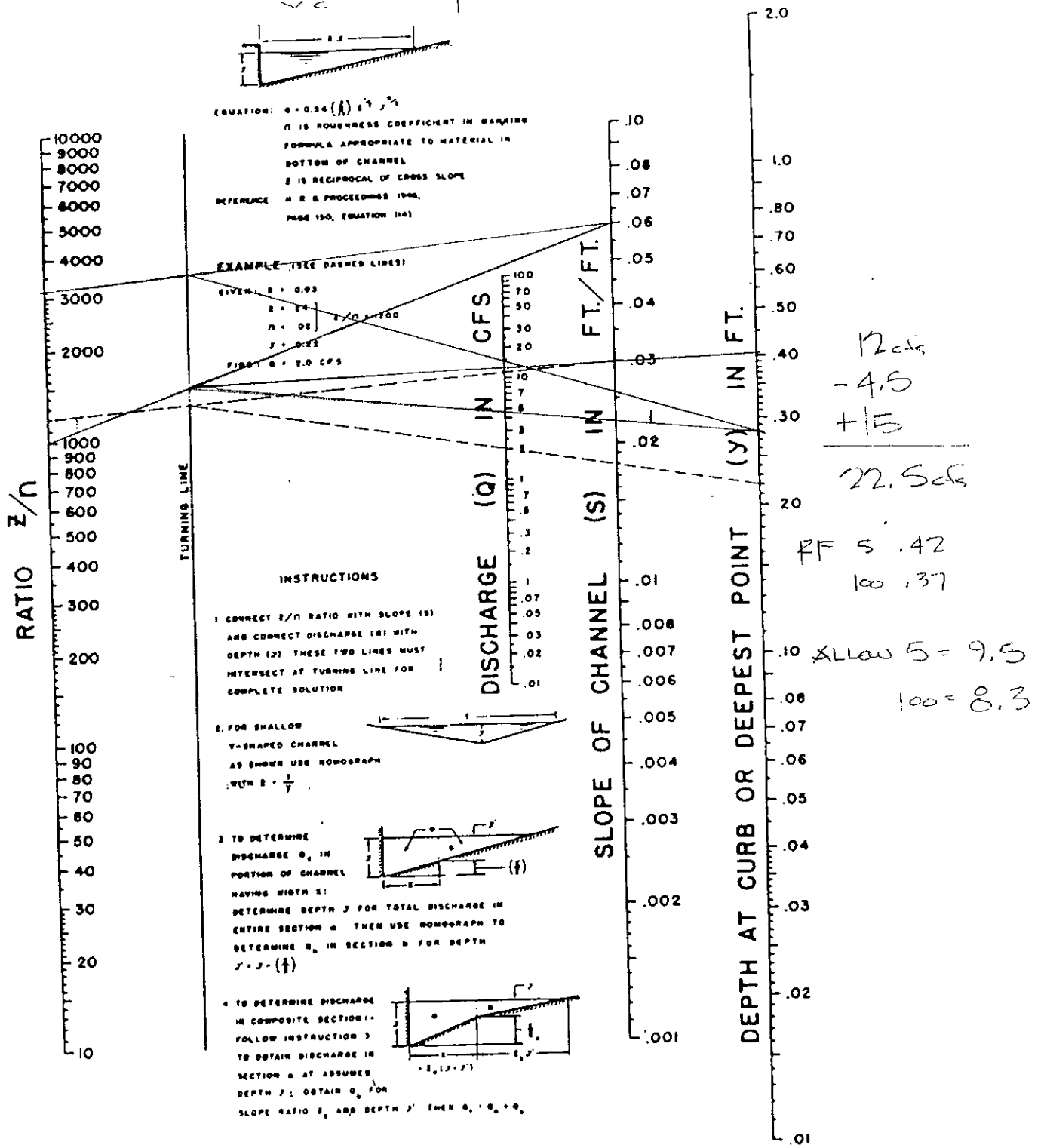
FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

EXHIBIT "D" 12/24

STREETS
E3098

CARDIFF CIR. AT 6% Vc

FLOW TO TOP CROWN



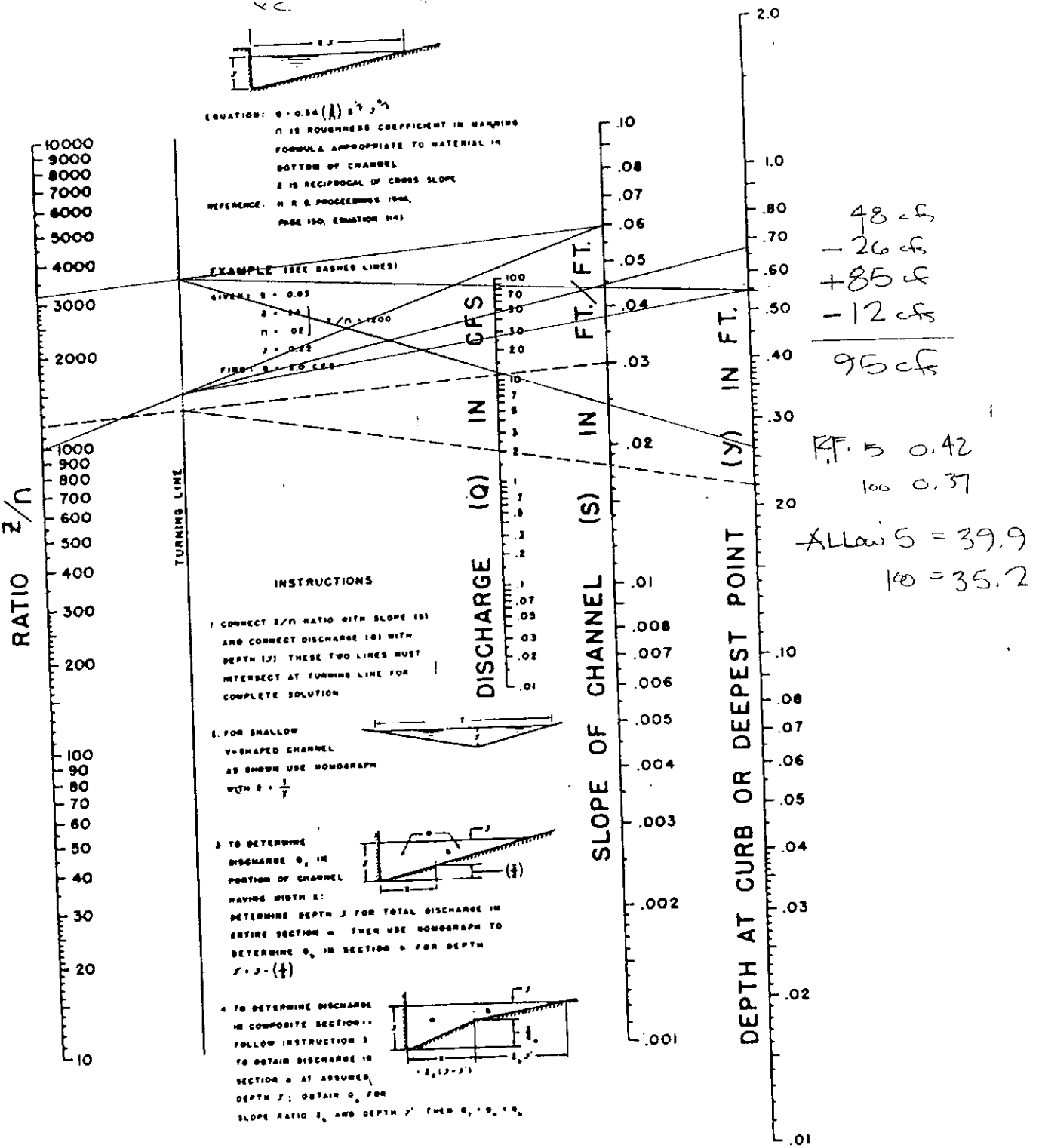
12 cfs
-4.5
+15
22.5 cfs

RF 5 .42
100 .37

ALLOW 5 = 9.5
100 = 8.3

FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

CARDIFF CIR AT 6% | FLOW TO TOP CURB



48 cfs
− 26 cfs
+85 cfs
− 12 cfs
95 cfs

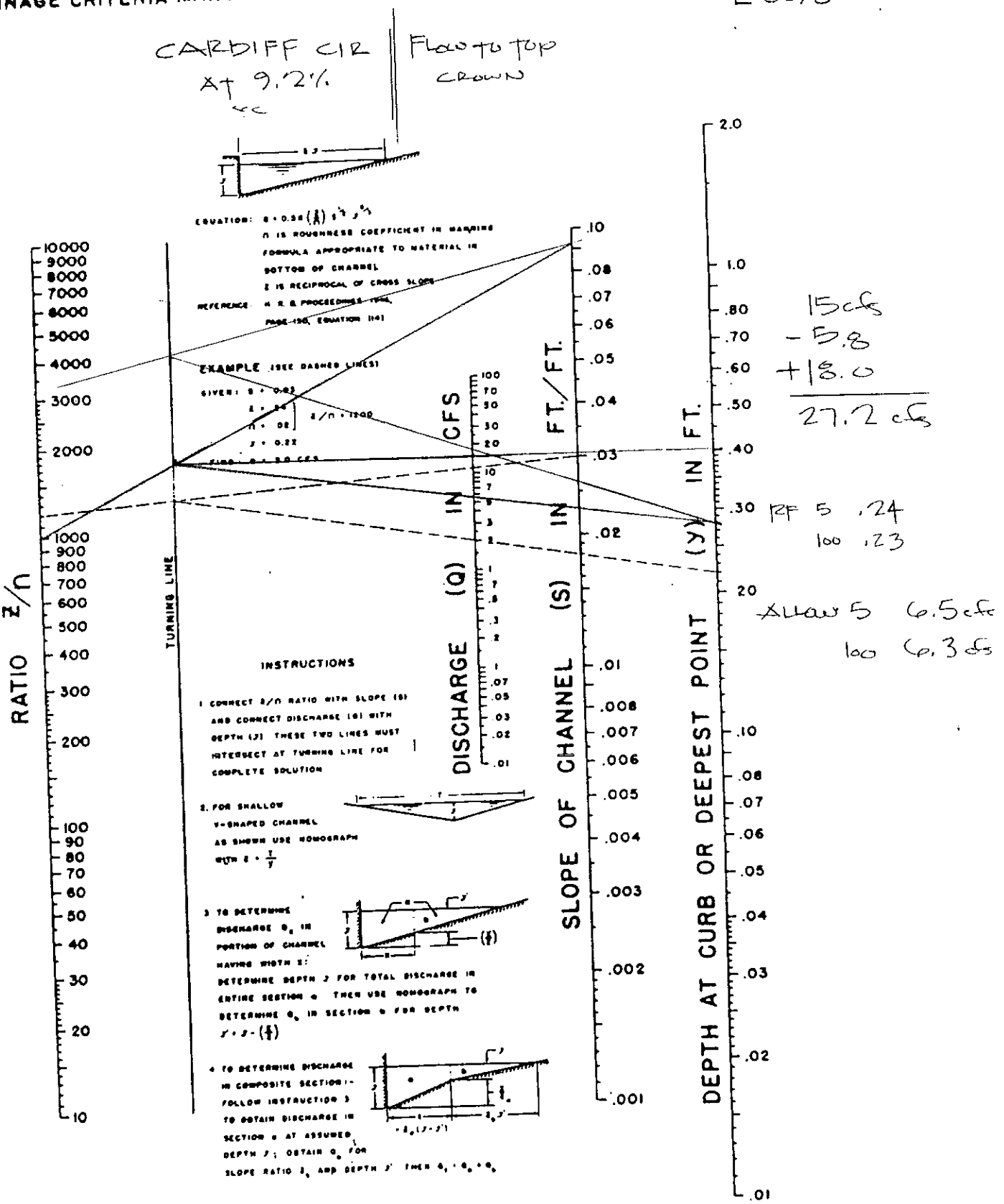
F.F. = 0.42
100 0.37

Allow Q = 39.9
100 = 35.2

FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

CARDIFF CIR AT 9.2% SC

FLOW TO TOP CROWN



15 cfs
- 5.8
+ 18.0
27.2 cfs

RF 5 .24
100 .23

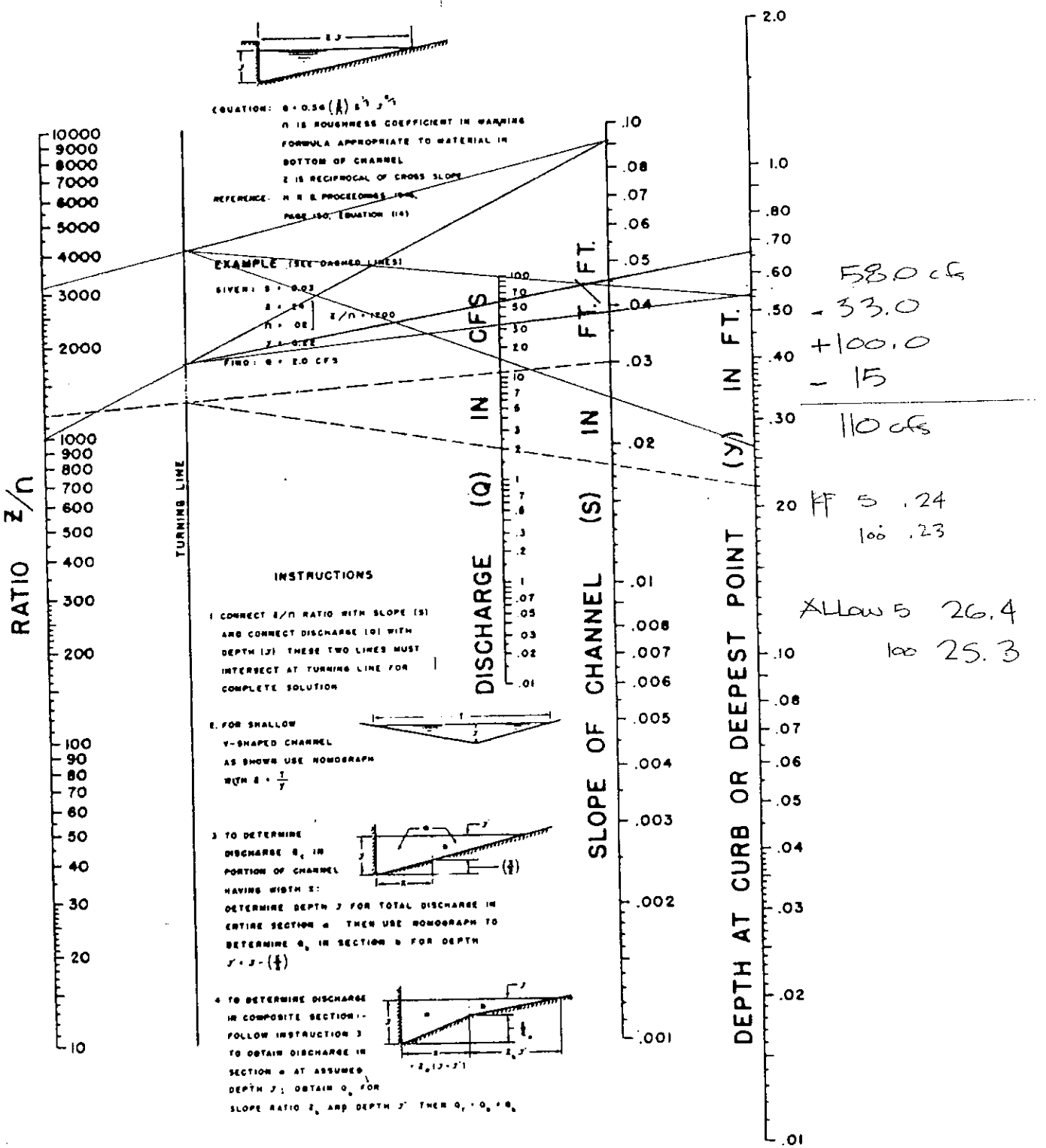
Allow 5 6.5 cfs
100 6.3 cfs

FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

EXHIBIT "D" 15/24

CARDIFF CIR AT 9.2% <c

FLOW TO TOP CURB



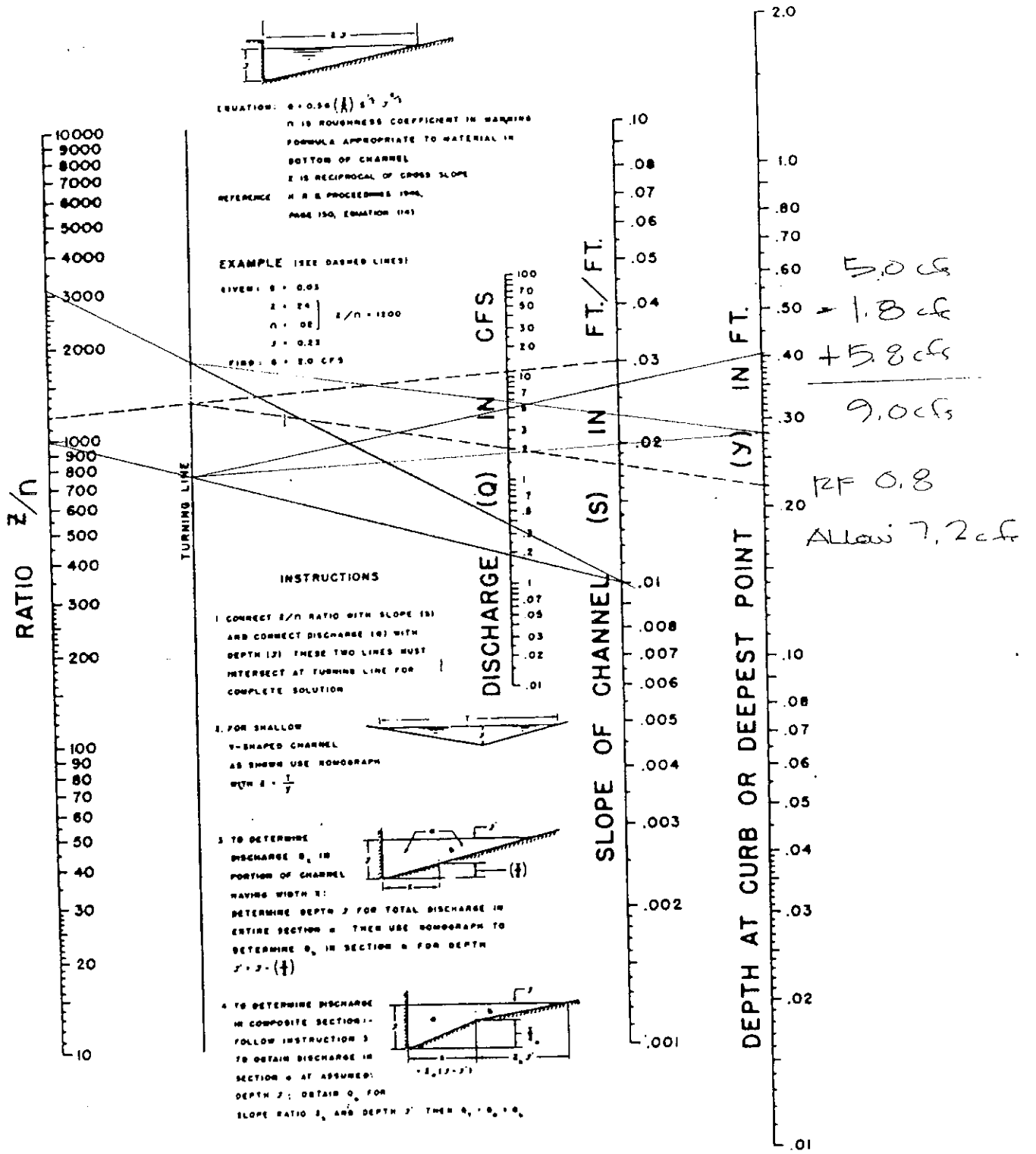
58.0 cfs
- 33.0
+100.0
- 15
110 cfs

FF S .24
100 .23

ALLOW S 26.4
100 25.3

FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

CARDIFF CIR AT 1% | FLOW TO TOP CROWN



5.0 cfs
- 1.8 cfs
+ 5.8 cfs
9.0 cfs

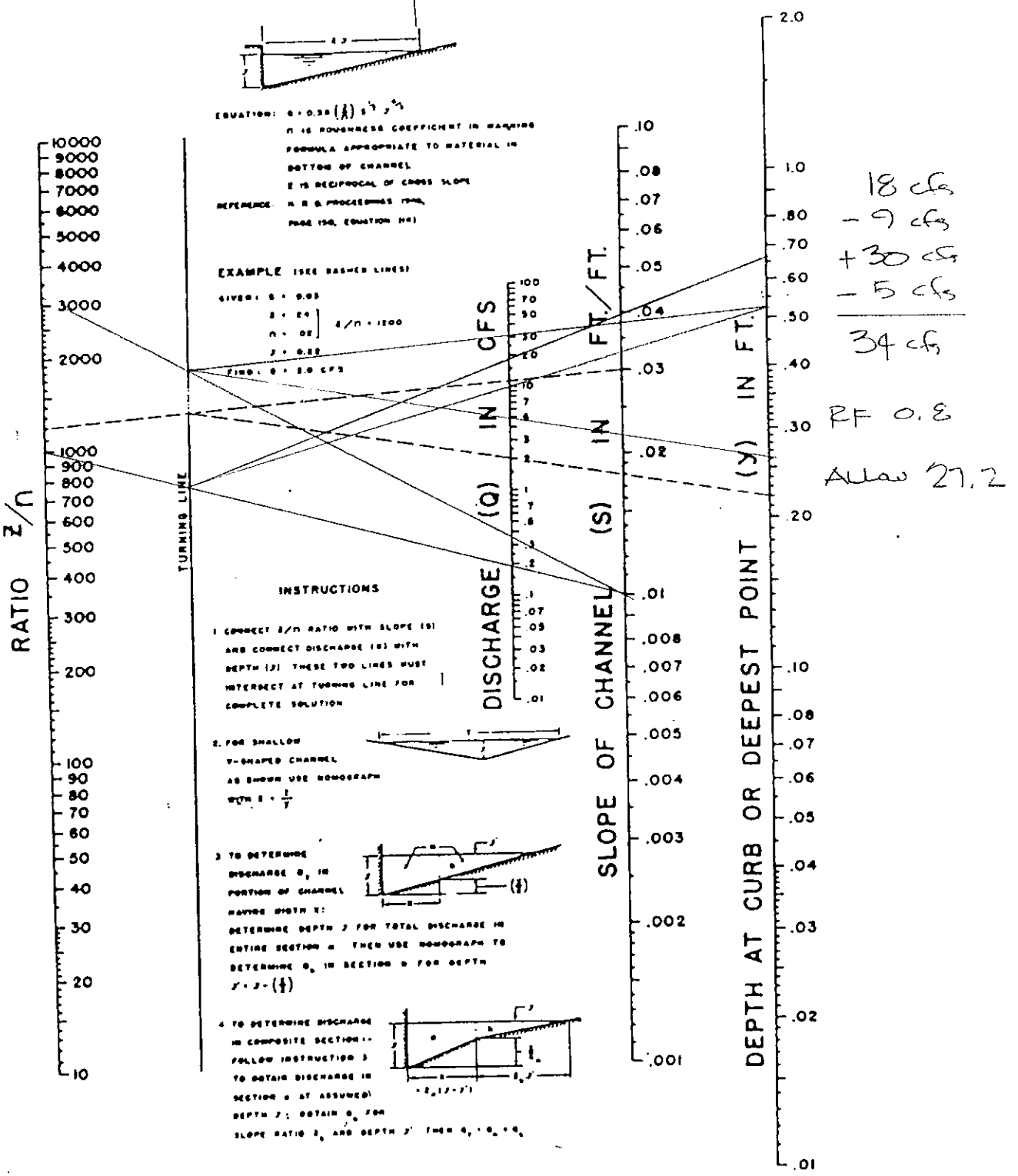
RF 0.8

Allow 7.2 cfs

FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

CARDIFF CIR AT 1%

Flow To Top Curb



18 cfs
− 9 cfs
+ 30 cfs
− 5 cfs
34 cfs

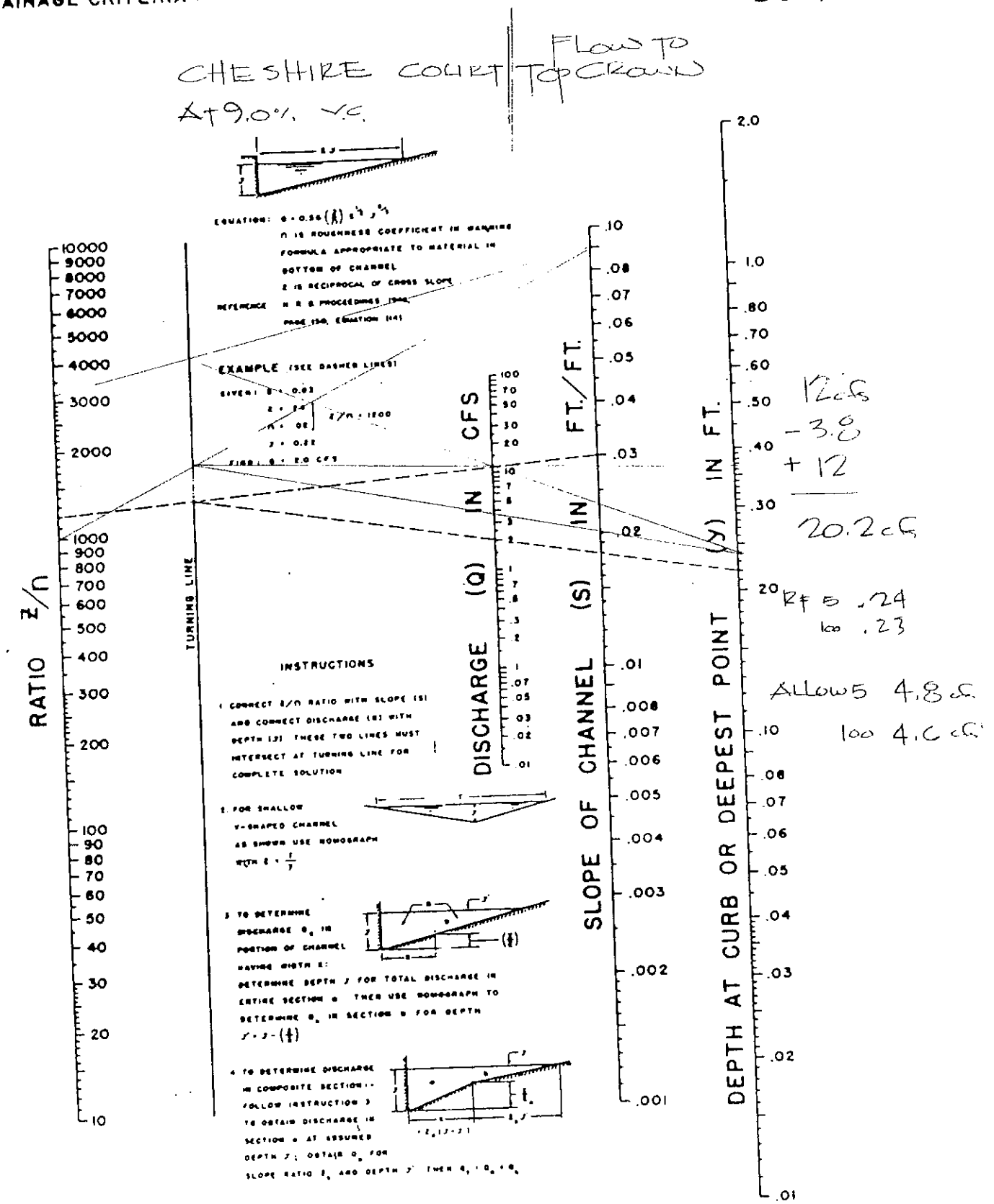
RF 0.8

Allow 27.2

FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

EXHIBIT "D" 18/24

CHESHIRE COURT Flow To Top Crown
At 9.0% V.C.



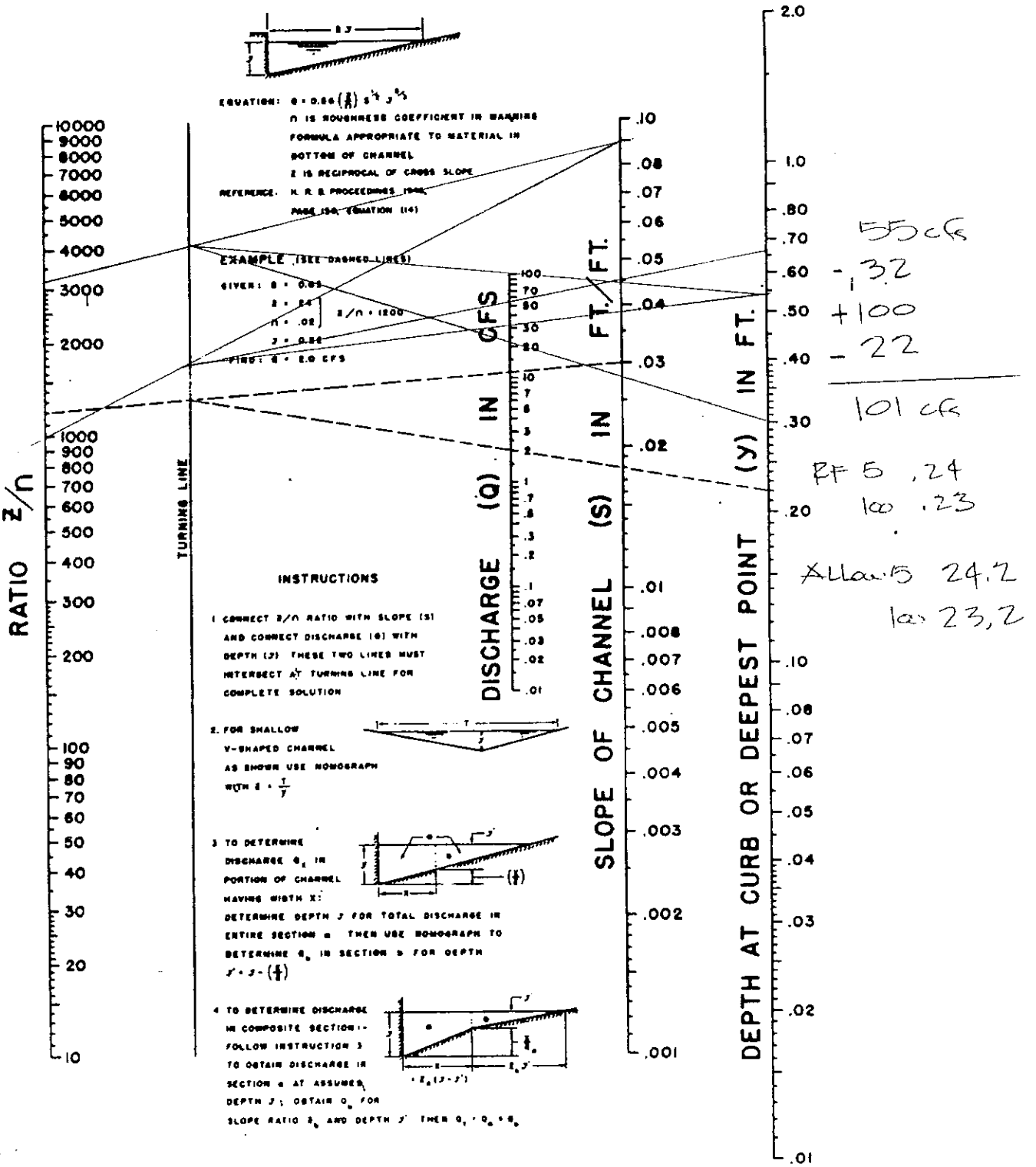
12cfs
-3.8
+12
20.2cfs

Rf = .24
100 .23

Allow 5 4.8cfs
100 4.6cfs

FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

CHESHIRE COURT AT 9% vc. | FLOW TO TOP CURB



55 cfs
- 32
+ 100
- 22
101 cfs

RF 5 .24
100 .23

Allan 5 24.2
100 23.2

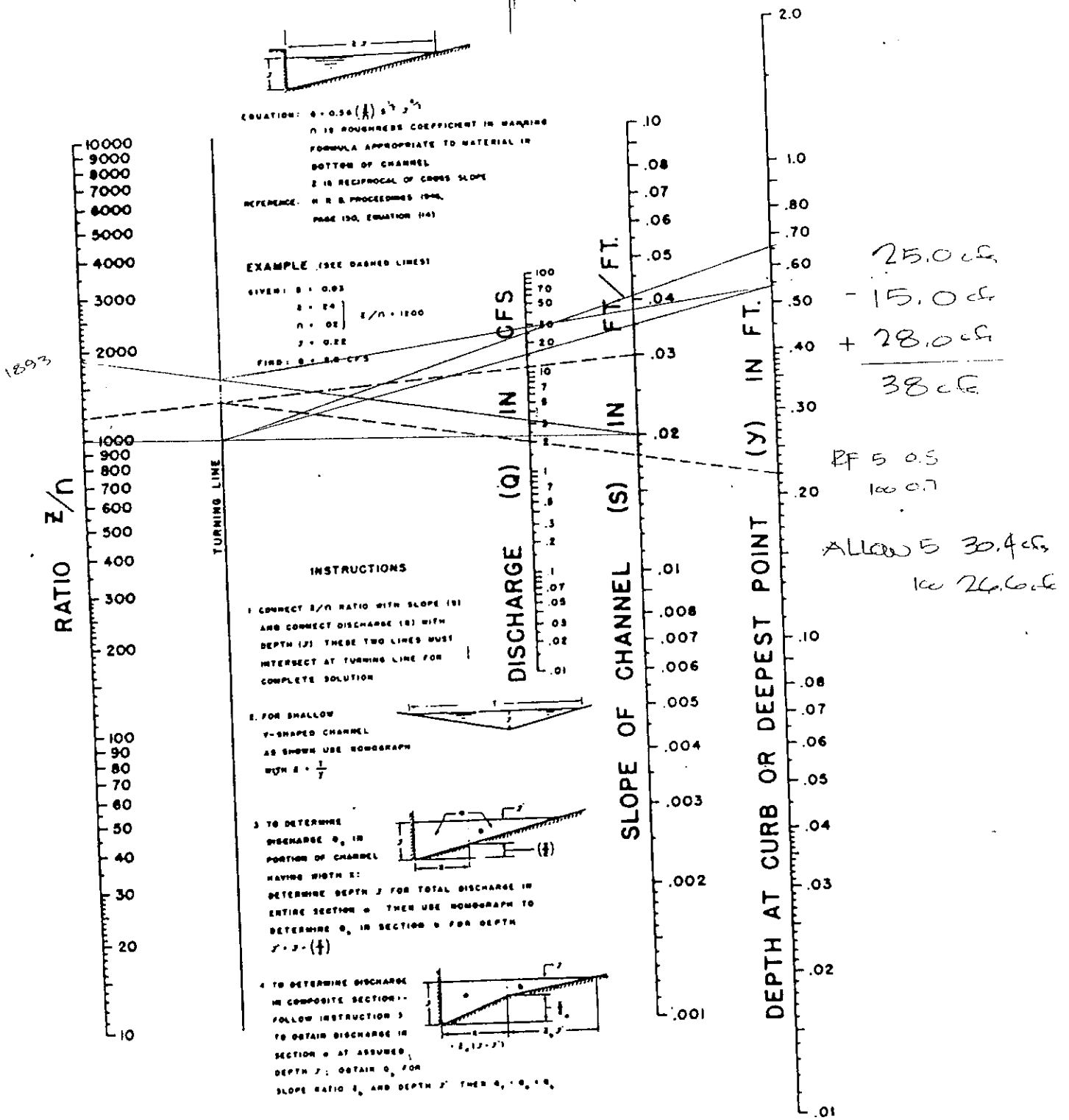
FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

EXHIBIT "D" 20/24

STREETS
E3098

REGILOLD CT AT INTERSECTION

3.3% CROSS FALL TO SOUTH
CURB TC GRADE 2%.
CAP TO TOP CURB.



1893

25.0 cfs
- 15.0 cfs
+ 28.0 cfs
38 cfs

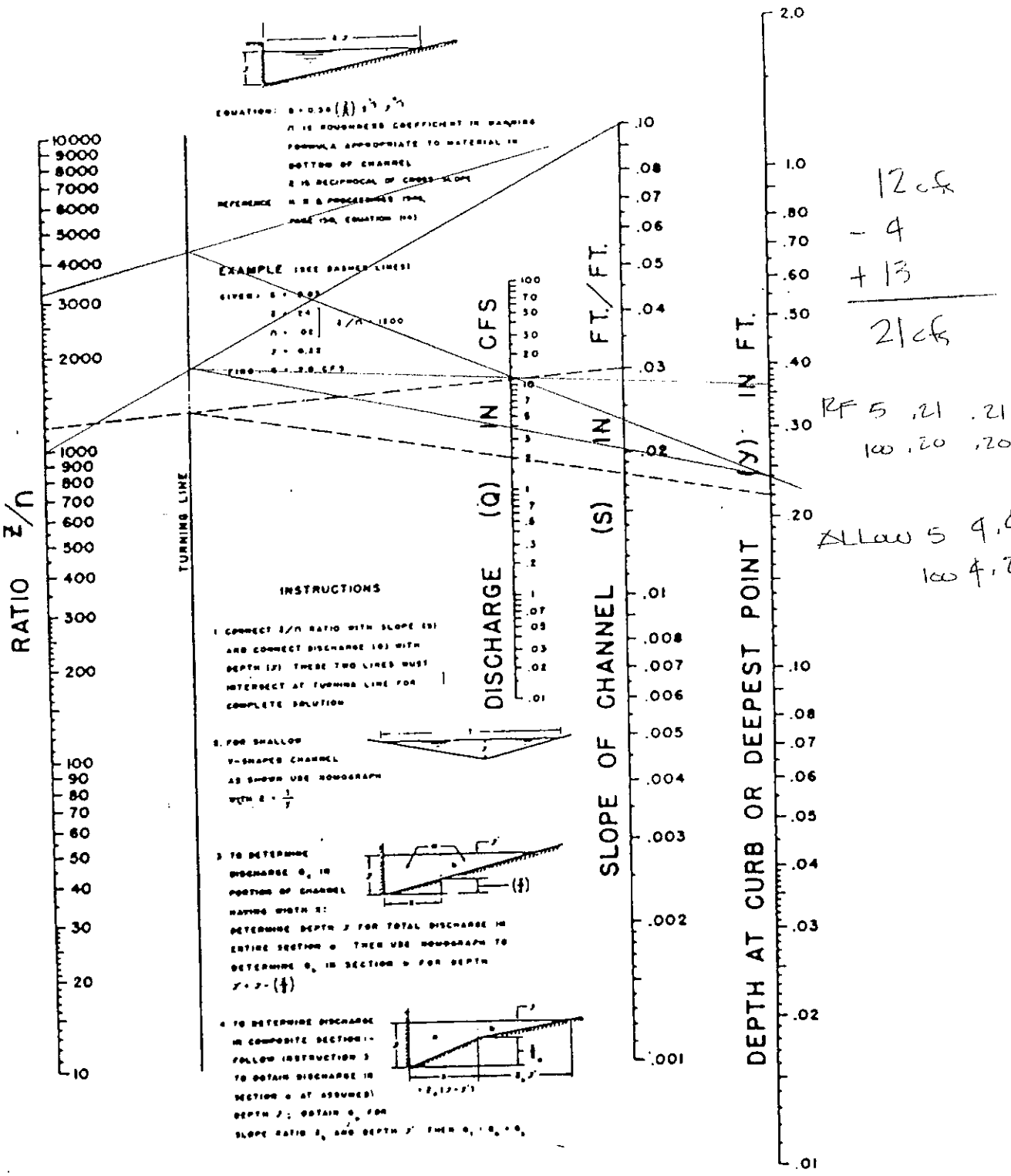
RF 5 0.5
100 0.7

ALLOWS 30.4 cfs
100 26.6 cfs

FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

EXHIBIT "D" 21/24

REGINOLD COURT AT 10% Vc || TO TOP CLOUD



12 cfs
- 4
+ 13
21 cfs

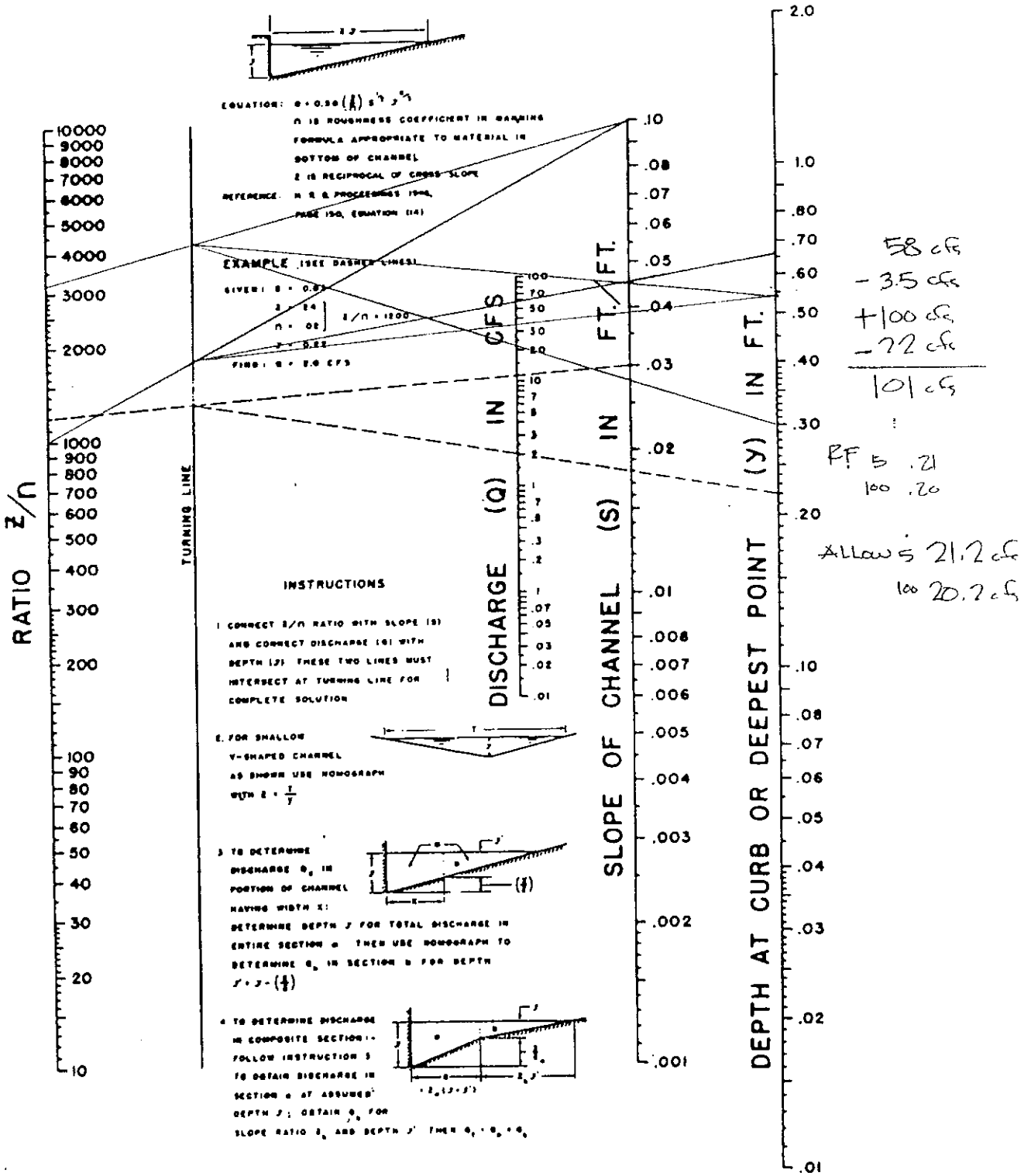
RF 5 .21 .21
100 .20 .20

Allow 5 9.4
100 4.2

FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

EXHIBIT 'D' 22/24

REYNOLDS G. AT 10% | FLOW TO TOP CURB



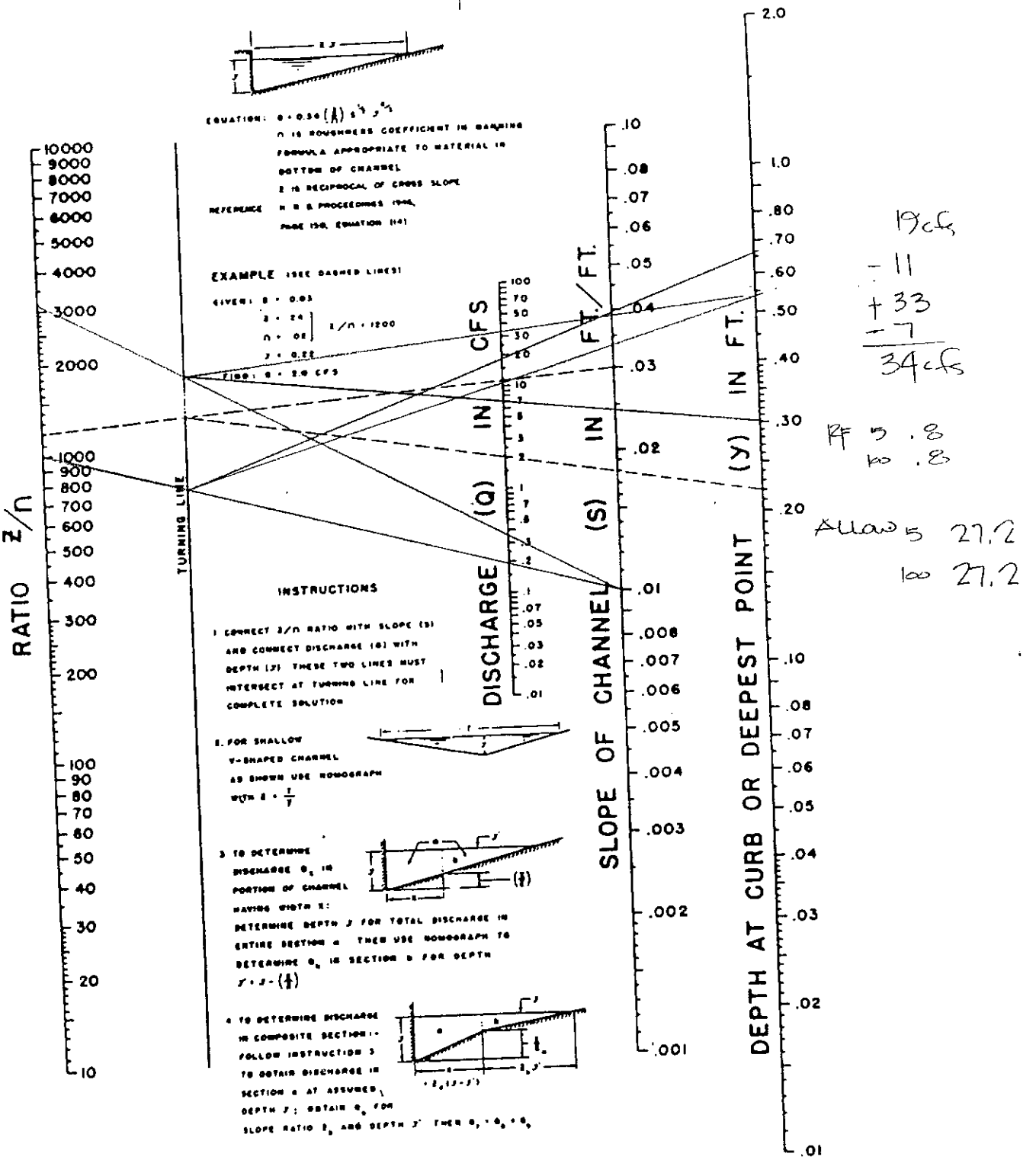
58 cfs
- 3.5 cfs
+ 100 cfs
- 22 cfs
101 cfs

FF = .21
100 .20

Allow = 21.2 cfs
100 20.2 cfs

FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

REGINOLD G AT 1.0% || FLOW TO TOP CURB



19 cfs
-11
+33
-7
34 cfs

RF 5 .8
to .8

Allow 5 27.2
100 27.2

FIGURE 6-1. NOMOGRAPH FOR FLOW IN TRIANGULAR GUTTERS.

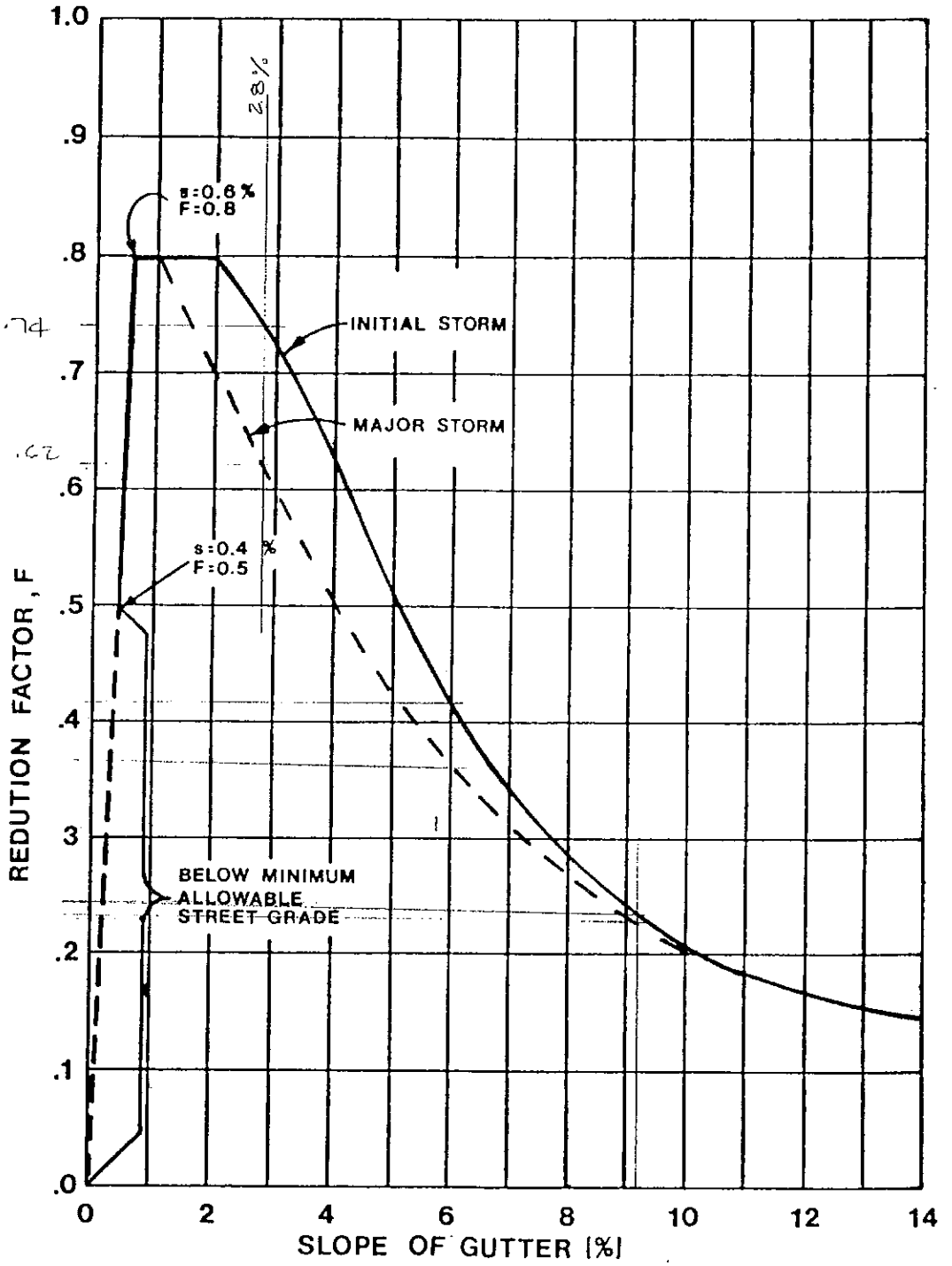


FIGURE 6-2 REDUCTION FACTOR FOR ALLOWABLE GUTTER CAPACITY LOCAL AND COLLECTOR STREETS

APPLY REDUCTION FACTOR FOR APPLICABLE SLOPE TO THE THEORETICAL GUTTER CAPACITY TO OBTAIN ALLOWABLE GUTTER CAPACITY APPROACHING ARTERIAL STREET

EXHIBIT "E"

OFFSITE AND ONSITE COMBINED BASIN FLOWS

EXHIBIT "E"
COMBINED BASIN DATA SUMMARY SHEET

(TOTAL PEAK FLOW AT A POINT)

Through Basin	QA/640 (5)	QA/640 (100)	Tc (hr)	qp (csm/in)	q5 (cfs)	q100 (cfs)
B (B+1)	0.0144	0.0470	0.21	1040	15.0	48.9
C2 (C2+2)	0.0154	0.0429	0.22	1030	15.9	44.2
C3 (pipe flow)	0.0165	0.0458	0.23	1010	16.7	46.2
G (thru C3 + thru B)	0.0403	0.1172	0.30	920	37.0	107.8
D2 (D2 + 3)	0.0041	0.0117	0.19	1080	4.4	12.6
E1 (E1+4+5+Inlet releases)	0.0488	0.1440	0.33	880	42.9	126.7
G (East of inlets)	0.0474	0.1330	0.30	920	43.6	122.4

Project: BROADMOOR BLUFFS ESTATES EXHIBIT "E" | Job No: E 3098

Client: GATES LAND CO. | By: dlm | Date: DEC 10, 1984

CHD: KDOT 12-17-84

OFFSITE BASINS 1-5 DERIVED FROM KKBNA STUDY

BASIN 1

KKBNA BASIN 4-1-6

AREA 21.5 Ac Tc 0.17h Q_5 = 0.34 in Q_{100} = 1.12 in
q_p = 1100 CSM/IN q_5 = 12.6 q_{100} = 41.4 cfs

"QA/640" 5 = .0114
100 = .03776

BASIN 2

KKBNA BASINS	AREA	Q_5	Q_{100}	"QA/640" 5	100
4-1-1	3.5	.48	1.36	.0026	.0074
4-1-2	4.1	.48	1.36	.0031	.0087
4-1-4	2.7	.48	1.36	.0020	.0057
K-2-6	2.3	.48	1.36	.0017	.0049
4-1-4A	0.2	1.87	3.27	.0004	.0010
4-1-5	2.1	.48	1.36	.0016	.0045
4-1-7	3.4	.48	1.36	.0026	.0072
4-1-8	0.3	.82	1.94	.0006	.0009
				.0146	.0403

Approx. Tc 0.20h q_p = 1080 CSM/IN

q_5 = .0146 * 1080 = 15.8 cfs vs. 18.6 / REPORT
q_{100} = .0403 * 1080 = 43.6 cfs vs. 152.8 / REPORT

BASIN 3

KKBNA BASIN 4-1-9

AREA = 1.2 Ac Tc = 0.17h Q_5 = 0.48 in Q_{100} = 1.36 in
q_p = 1100 CSM/IN q_5 = 1.0 cfs q_{100} = 2.8 cfs

"QA/640" 5 = .0009
100 = .0026

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job Nº
BROADMOOR BLUFFS ESTATES EXHIBIT "E"	E 3098

Client	By	Date
GATES LAND CO.	dlm	DEC 10, 1984

CAD: KOOIII 12-11-84

BASIN 4

KKBNA BASIN	AREA	Q_5	Q_{100}	"QA/640" 5	100
K1 & K2	38.2	.35	1.14	.0209	.0680
H-7-2	5.2	.48	1.36	.0039	.0111
				.0248	.0791

APPROX. Tc 0.21h q_p = 1040 CSM/IN

q_5 = 1040 * .0248 = 25.8 cfs vs. 33.3 / REPORT

q_{100} = 1040 * .0791 = 82.3 cfs vs. 94.2 / REPORT

BASIN 5

KKBNA BASIN V-1-3

AREA = 1.3 sq mi Tc = 0.17h Q_5 = 0.48 IN Q_{100} = 1.36 IN

q_p = 1100 CSM/IN q_5 = 1.1 cfs q_{100} = 3.0 cfs

"QA/640" 5. .0010 100. .0028

NOTE: FOR FURTHER COMBINED BASIN FLOW CALCULATED ONTO SITE, WILL CONTINUE TO SUMMATE "QA/640" & DERIVE A NEW Tc THRU EACH FLOW TO DETERMINE q_p.

THRU BASIN B (B+1)

"QA/640" 5 YR .0030 + .0114 = .0144

100 YR .0094 + .0376 = .0470

Tc: OFFSITE 10 MIN

ONSITE 250' SWALE AT 7% (3.2 fps) 1.3 MIN

370' SWALE AT 17% (5 fps) 1.2 MIN

12.5 MIN ≈ 0.21 h.

q_p = 1040 CSM/IN

q_5 = 1040 * 0.0144 = 15.0 cfs

q_{100} = 1040 * 0.0470 = 48.9 cfs

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Project	Job No.
BROADMOOR BLUFFS ESTATES EXHIDIT "E"	E 3098

Client	By	Date
GATES LAND CO	dlh	DEC 10, 1984

CHO: RODIII 12-14-84

THRU BASIN C2 (C2+2)

"QA/640" 5YR .0008 + .0146 = .0154
100YR .0026 + .0403 = .0429

Tc: OFFSITE 12 MIN
ONSITE 200' SWALE AT 10% (4 fps) 0.8 MIN
200' SWALE AT 20% (7 fps) 0.5 MIN
13.3 MIN ≈ 0.22 h

q_p = 1030 CSM/IN
q_5 = 1030 * 0.0154 = 15.9 cfs
q_{100} = 1030 * 0.0429 = 44.2 cfs

THRU BASIN C3 (PIPE FLOW) CALC PEAK FLOW AT MH TO UNDER CARDIFF

"QA/640" 5YR .0154 + .0011 = .0165
100YR .0429 + .0029 = .0458

Tc: UP TO BASIN 13.3 MIN 13.3
THRU BASIN: 250 LF PIPE FLOW
ASSUME 30" FULL ≈ 9 fps 0.5 MIN
13.8 MIN ≈ .23 h

q_p = 1010 CSM/IN
q_5 = 1010 * 0.0165 = 16.7 cfs
q_{100} = 1010 * 0.0458 = 46.2 cfs

PRORATE QA/640 TO ACCOUNT FOR INLET INTERCEPTION AT PIPE

5 "QA/640" AT INLET (see pg D-3) .0037 q_5 = 4.7 q_{inlet} 2.8
.0037 / 4.7 * 2.8 = .0022

100 "QA/640" AT INLET (SEE pg D-3) .0096 q_{100} = 12.3 q_{inlet} 5.4
.0096 / 12.3 * 5.4 = .0042

q_5 AT PIPE (.0165 + .0022) * 1010 = 18.9 cfs
q_{100} AT PIPE (.0458 + .0042) * 1010 = 50.5 cfs

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Project: BROADMOOR BLUFFS ESTATES EXHIBIT "E" | Job No: E 3098

Client: GATES LAND CO. | By: dlm | Date: DEC 10, 1984

CHO: RDO III 12-14-84

THRU BASIN "G" (THRU C 3 + THRU B)

"QA/640" 5YR .0144 + .0187 + .0072 = .0403
100YR .0470 + .0500 + .0202 = .1172

Tc: NORTH ROUTE FROM C2
TO BASIN 13.8 MIN
THRU BASIN 600' SWALE AT 10% (4fps) 2.5 MIN
250' SWALE AT 6% (3fps) 1.4 MIN
17.7 MIN x 0.30h

SOUTH ROUTE FROM B
TO BASIN 12.5 MIN
THRU BASIN 250' SWALE AT 6% (3 fps) 1.4 MIN
570' SWALE AT 10% (4 fps) 2.4 MIN
250' SWALE AT 6% (3 fps) 1.4 MIN
17.7 MIN x 0.30h

q_p = 920 CSM/IN (Tc=0.30h)
q_5 = 920 * 0.0403 = 37.0 cfs
q_{100} = 920 * 0.1172 = 107.8 cfs

THRU BASIN "D2" (D2+3)

"QA/640" 5YR .0032 + .0009 = .0041
100YR .0091 + .0026 = .0117

Tc: OFFSITE 55' OVERLAND AT 55% (2.4 fps) 0.4 MIN
100' OVERLAND AT 10% (1.0 fps) 1.7 MIN
2.1 MIN

ONSITE "D" 9.5 MIN

Tc = 11.6 MIN = 0.19 h

q_p = 1080 CSM/IN
q_5 = 1080 * 0.0041 = 4.4 cfs
q_{100} = 1080 * 0.0117 = 12.6 cfs

Project: BROADMOOR BLUFFS ESTATES EXHIBIT "E" | Job Nº E 3098

Client: GATES LAND CO | By: dlh | Date: DEC. 10, 1984

CMO: RODIII 12-14-84

PRORATE "QA/640" PICKED UP BY INLET AT CHESHIRE

5 YR .0041 q_5 = 4.4 q_{INLET} 2.6 (pg D3)

.0041 / 4.4 * 2.6 = .0024

100 YR .0117 q_{100} = 12.6 q_{INLET} 6.4 (pg D3)

.0117 / 12.6 * 6.4 = .0059

USE LATER FOR FLOWS TO E1

THRU BASIN "E1" E1 + 4 + 5 + CHESHIRE & REGINOLD RELEASES (SEE pg D9)

QA/640 5 YR .0095 + .0248 + .0010 + .0024 + .0111 = .0488

100 YR .0273 + .0791 + .0028 + .0059 + .0293 = .1440

T_c = .21 + .12 = 0.33 h

q_p = 880 CSM/IN

q_5 = 880 * .0488 = 42.9 cfs

q_{100} = 880 * .1440 = 126.7 cfs

FLOW AT END OF CHESHIRE COURT IN NATURAL SWALE

TRIBUTARY E1 = 2.8 ac QA/640 5 YR .47 * 2.8/640 = .0020

100 YR 1.36 * 2.8/640 = .0060

+ 4 + 5

QA/640 5 .0020 + .0248 + .0010 = .0278

100 .0060 + .0791 + .0028 = .0879

T_c = 0.21 h

q_p = 1050

q_5 = 1050 * .0278 = 29.2 cfs

q_{100} = 1050 * .0879 = 92.3 cfs

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job No
BROADMOOR BLUFFS ESTATES EXHIBIT "E"	E 3098

Client	By	Date
GATES LAND CO	dlH	DEC 10, 1984

CHD: ~~R00III~~ 12-14-84

FLOW AT END OF CULVERT (SUMP CONDITION ON CARROTT)

FLOW IN SWALE TO CULVERT + INLET RELEASE

Q A/640 5 YR .0403 + .0059 + .0012 = .0474
↑ FM E4 ↑ FM D2 ↑ FM C5

100 YR .1172 + .0138 + .0020 = .1330
↑ FM E4 ↑ FM D2 ↑ FM C5

Tc: .30 h

q_p = 920

q_5 = 920 * .0474 = 43.6 cfs

q_{100} = 920 * .1330 = 122.4 cfs

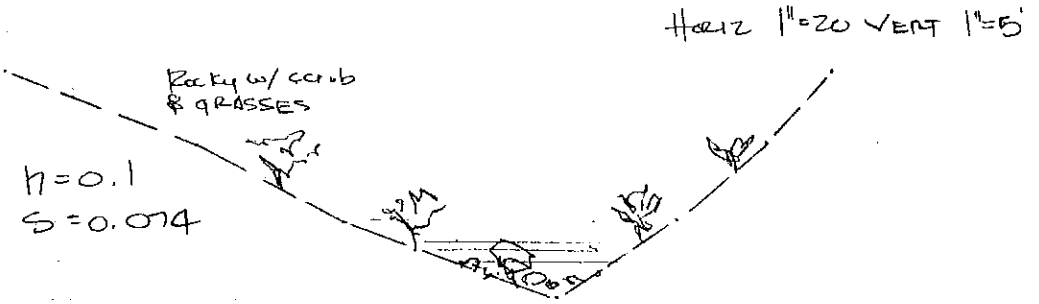
Project: BROADMOOR BLUFFS ESTATES — EXHIBIT "E" — Job No. E 3098

Client: GATES LAND CO. — By: dlm — Date: DEC. 10, 1984

CHO: KOOIII 12-14-84

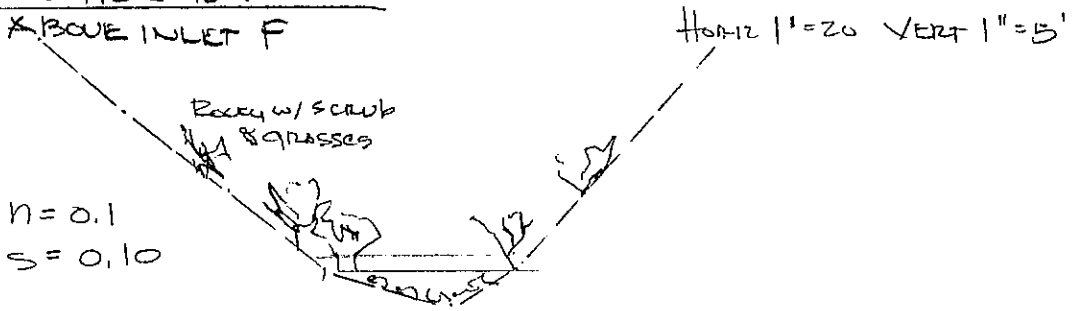
NATURAL SWALE FLOW CHECKS

TYPICAL SECTION BASIN "B" BEFORE CULVERT



if d = 2'	if d = 1.5'	if d = 1.25'	
A = 38sf	A = 22.5	A = 16.4	
WP 35	WP = 27	WP = 22	
R 1.09	R = .833	R = .744	
Q 163 NG.	Q = 80.7 NG	Q = 54.6	V = 3.3 fps OK

TYPICAL SECTION BASIN "C2" ABOVE INLET F



if d = 1'	if d = 1.25'	
A = 12 SF	A = 17.3	
WP = 20	WP = 22	
R = 0.6	R = 0.79	
Q = 40.2 NG	Q = 69.6	V = 4 fps OK

Project	Job Nº
BROADMOOR BLUFFS ESTATES EXHIBIT "E"	E 3098

Client	By	Date
GATES LAND Co	dlm	DEC. 10. 1984

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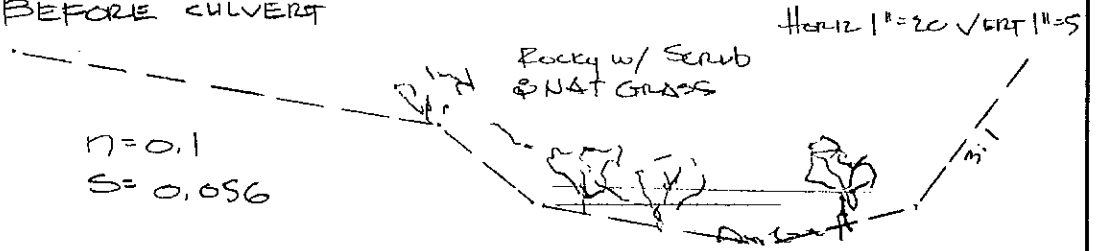
TYPICAL SECTION BASIN "G"

BEFORE CULVERT

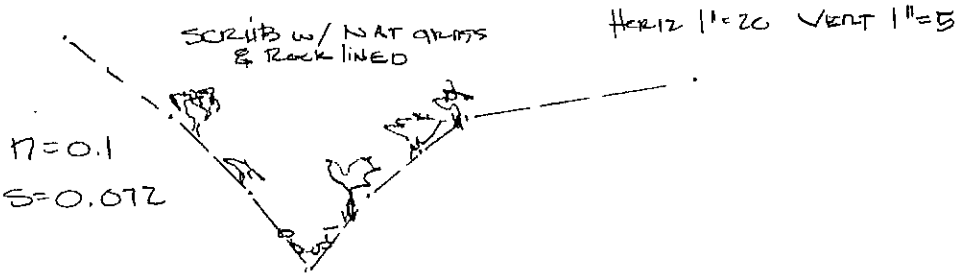


If d = 1'
A = 22 SF
wp = 40
R = 0.55
Q = 52.1 NG

If d = 1.5'
A = 43 SF
wp = 40
R = 0.977
Q = 152 cfs V = 3.6 fps OK

TYPICAL SECTION BASIN E1

AT REGINOLD CT



If d = 2'
A = 13 SF
WP = 13.6
R = 0.956
Q = 50.4 cfs NG

If d = 3'
A = 32.4 SF
WP = 21'
R = 1.544
Q = 173 cfs OK 5.3 fps

EXHIBIT "F"

STORM SEWER AND CULVERT CALCULATIONS

DREXEL, BARRELL & CO. LAND SURVEYORS CIVIL ENGINEERS

Project	Job Nº
BROADMOOR BLUFFS ESTATES EXHIBIT "F"	E 3098

Client	By	Date
GATES LAND CO.	dlm	DEC 10, 1984

CAD: RDOT 12-14-84

SIZE STORM PIPES

UNDER CARDIFF AT BASIN "B"

Q_5 = 15.0 cfs Q_{100} = 48.9 cfs

TRY 30" RCP (SEE following CHARTS)

INLET CONTROL Hw/d = 2.0 q = 50 cfs
Hw/d = 0.75 q = 15 cfs
Hw/d = 1.0 q = 24 cfs

GRAVITY FLOW AT 1.0% 40 cfs AT 9 fps full

UNDER CARDIFF AT BASIN "G"

Q_5 = 37.0 cfs Q_{100} = 107.8 cfs

TRY 48" RCP (SEE FOLLOWING CHARTS)

INLET CONTROL Hw/d = 1.28 q = 108 cfs
Hw/d = 0.64 q = 37 cfs
Hw/d = 1.0 q = 78 cfs

GRAVITY FLOW AT 1% 140 cfs AT 12 fps

INLET & PIPE SYSTEM AT GLOUCESTER

Q_5 = 15.9 cfs Q_{100} = 44.2 cfs

DESIGN INLET OPENING TO INTERCEPT 100YR WITH Hw = 2.5'

$44.2 = .83 A\sqrt{2 \times 32.2 \times 2.5}$ A = 4.2 SQ.FT.

ALLOW FOR TRASH PLUGGING 4.2 × 1.5 = 6.3 SF OPENING

INLET MUST BE APPROX. 15' DEEP TO CLEAR UTIL. IN GLOUCESTER.

PIPE OUT TRY 30" RCP AT 1.2% GRAVITY FLOW = 45 cfs
FROM MH TO MH PIPE GRADE 4.5% GRAVITY FLOW = 85 cfs

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Project	Job No
BROADMOOR BLUFFS ESTATES EXHIBIT "F"	E 3098

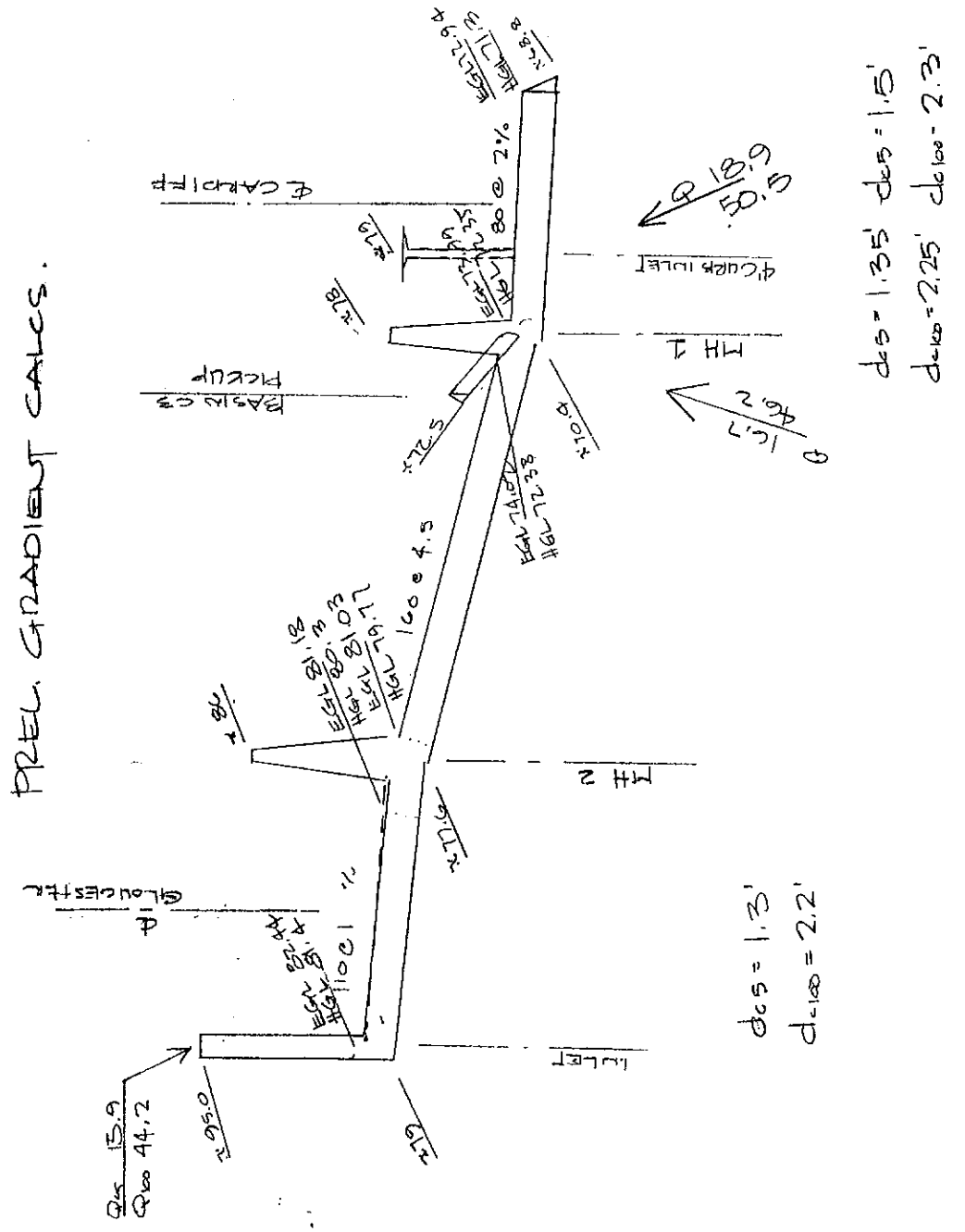
Client	By	Date
GATES LAND CO	dlH	DEC 10, 1984

CAD: A00III 12-14-84

9 AT PIPE CROSSING CARDIFF (SEE DR E3)

$q_5 = 18.9$ cfs $q_{100} = 50.5$ cfs

30" CROSS CULVERT AT 2% GRAVITY FLOW 58 cfs V = 14 fps



Project: BROADMOOR BLUFFS ESTATES — EXHIBIT "F" | Job No: E 3098

Client: GATES LAND CO | By: dlh | Date: DEC 10, 1984

CAD: ROOIII 12-14-84

PRELIMINARY RUN THRU STORM SEWER AT BASIN C3
(GRADES MAY CHANGE WHEN UTILITIES ELEV. ARE ALL ESTABLISHED)

OUTFALL AT BASIN G

DESIGN Q = 50.5 cfs n = 0.013
DIA PIPE = 30"
AREA PIPE (FULL) = 4.91 SF
$V = Q/A = 10.3$ fps $V^2/2g = 1.64' = H_V$

SET INV. AT 68.8

D = 2.5
71.3 HGL EGL 72.94

OUTFALL TO MH1

L = 80' D = 2.5' Q = 50.5 cfs A = 4.91
$H_f = f \frac{LV^2}{2gd} = 1.05'$ $S_F = 0.0131$
$S_o = 0.02$ OPEN CHANNEL FLOW BUT ASSUME FULL

MH 1 4' DIA MH

INV OUT = 80 * 0.02 + 68.8 = 70.4
$HGL_o = 71.3 + 1.05 = 72.35$
$EGL_o = 72.35 + 1.64 = 73.99$
$D_u/D_o = 2.5/2.5 = 1.0$ $A/d_u = 4/2.5 = 1.6$
From FIG 8.7 (DRCOG) $K_u = 0.02$ SET INV AT 70.5 Rounding AT outlet
$h_u = K_u V_o^2/2g = 0.2 * 10.3^2/64.4 = 0.3$
$HGL_u = 72.35 + 0.3 = 72.38$ $EGL_u = 74.02$

MH1 to MH 2

L = 160 D = 30" Q = 44.2 cfs A = 4.91 SF V = 9.6 fps
$S_F = .0100$ $S_o = 0.045$ OPEN CHANNEL FLOW

Project: BROADMOOR BLUFFS ESTATES · EXHIBIT "F" | Job No: E 3098

Client: GATES LAND CO | By: dlm | Date: DEC. 10, 1984

CHD: RDOTT 12-14-84

MH 2

OPEN CHANNEL FLOW THRU MH.

USE $H_L = .2 (H_{V_D} - H_{V_U})$

FIND H_{V_D} $d = 30"$ $S = 0.045$ $Q = 44.2$ cfs

FROM K & B TABLE 7-14

$Q = K'/n \, d^{8/3} S^{1/2}$ $K' = 0.235$

$D/d = .505$ & $d = 2.5 \Rightarrow D_n = 1.26'$

TABLE 7-4

$D/d = .505$ $C_a = 0.613$ $a = .613 * 2.5^2 = 3.83$ sf

V_D $44.2/3.83 = 11.5$ fps $H_{V_D} = V^2/2g = 2.07'$

FIND H_{V_U} SET $S_o \approx SF$ ASSUME FULL FLOW

$V_U = 44.2/4.90 = 9.0$ fps $H_{V_U} = 81/64.4 = 1.26$

$H_L = 0.2 (2.07 - 1.32) = 0.15$

CHECK UPSTREAM INV. BY EQUATING ENERGY GRADES

DS INV.	$70.5 + (160 * 0.045) = 77.7$
D_n	+ 1.26
DO H_V	+ 2.07
DS EGL	81.03
H_L	+ 0.15
US EGL	81.18
US H_V	- 1.26
US DIA	- 2.50
	77.42 ?

SET INV US AT 77.8

HGL$_U$ = 77.8 + 2.5 = 80.3

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Project		Job No
BROADMOOR BLUFFS ESTATES	EXHIBIT "F"	E 3098

Client	By	Date
GATES LAND CO	dlm	DEC 10, 1984

CKD: ROOIII 12-14-84

MH 2 TO INLET

L=110 D=30" Q=44.2 A=4.90 SF V=9.0 fps
$V^2/2g = 1.26'$
Sf = 0.01
SET So AT 0.01 ASSUME FULL FLOW

AT INLET

INV OUT 78.9
HGLo = 80.3 + (0.01×110) = 81.4
EGLo = 81.18 + 1.26 = 82.44

PREL. ROUGH RUN THRU SHOWN NO PROBLEMS.

RECOMMEND SET PIPE UNDER GLOUCESTER AT 1.2%
BETWEEN MH 1 & 2 USE 24" PIPE TO SAVE COST.

NOTE: WHEN RELATIONSHIPS WITH OTHER UTILITIY LINES IS CALCULATED GRADES MAY SLIGHTLY VARY & CALCULATIONS WILL BE FINALIZED & DETAILED.

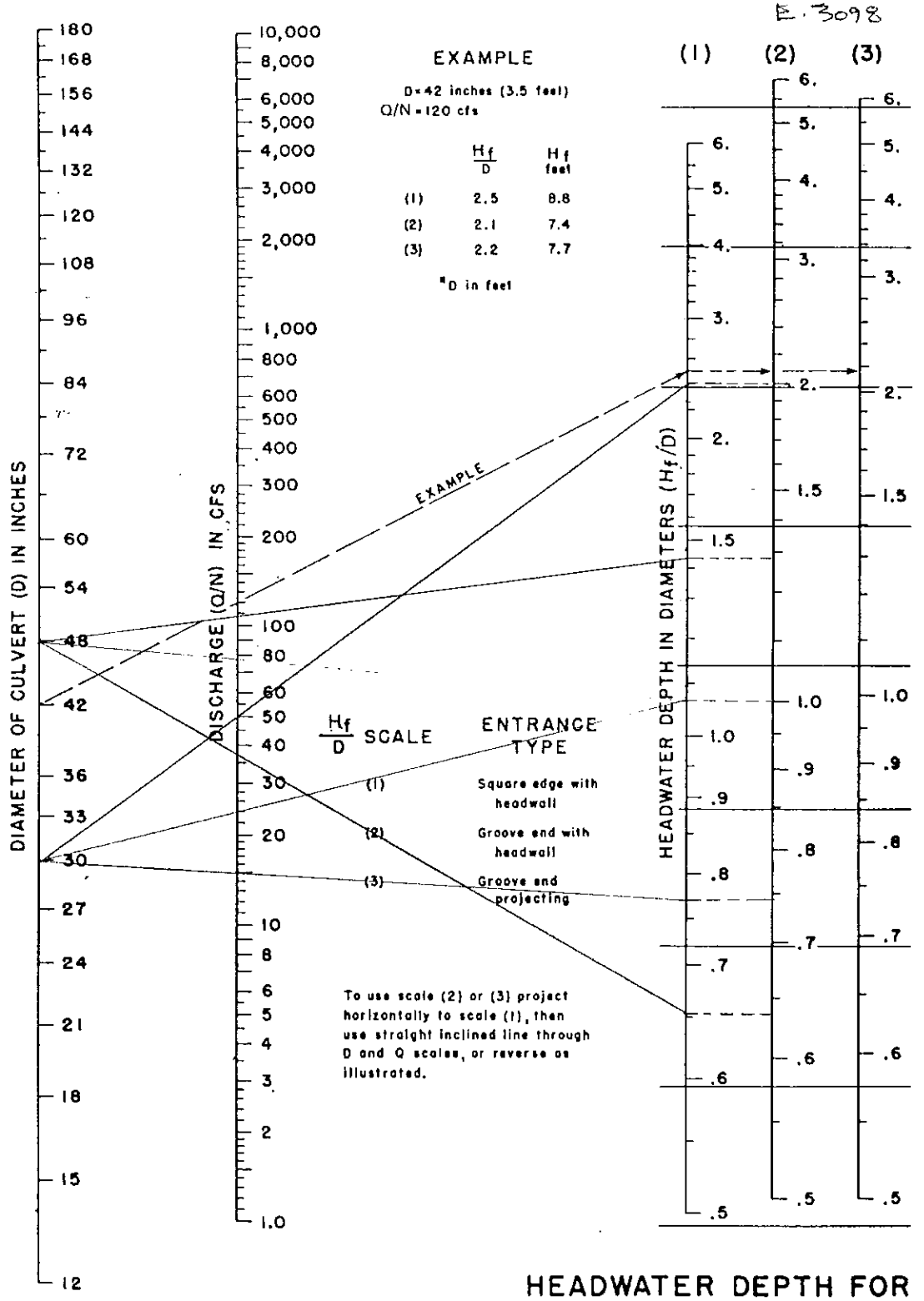
1700 38TH STREET (303) 442-4338
BOULDER, COLORADO 80301

3405 N. EL PASO STREET (303) 633-5029
COLORADO SPRINGS, COLORADO 80907

EXHIBIT 'F' 6/8

Chart 11

E-3098

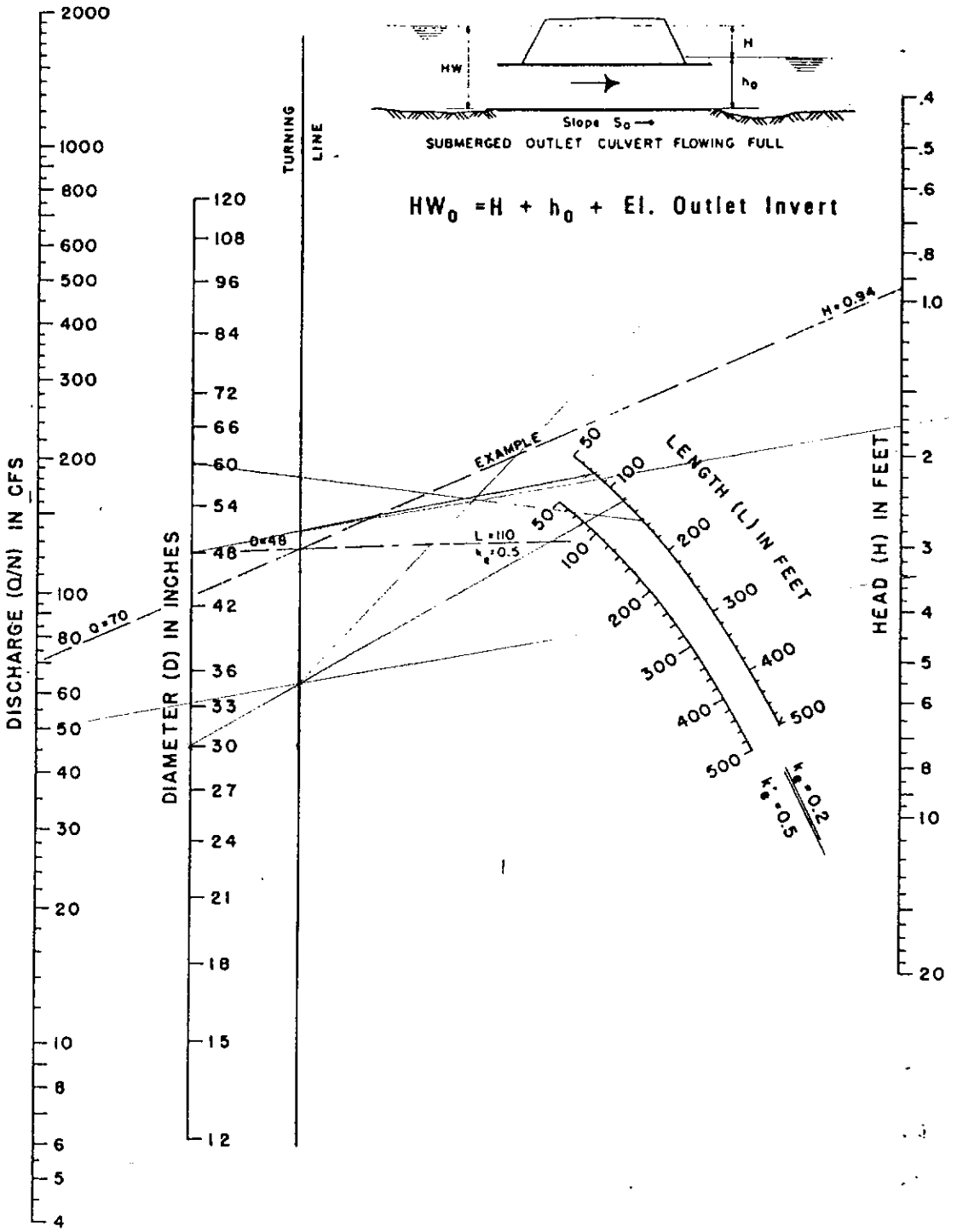


HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

EXHIBIT 'F' 7/8

E 3098

Chart 2



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

BUREAU OF PUBLIC ROADS JAN. 1963

PROJECT: E3098 Gutes

DESIGNER: dlm

DATE: DEC 7 84

HYDROLOGIC AND CHANNEL INFORMATION

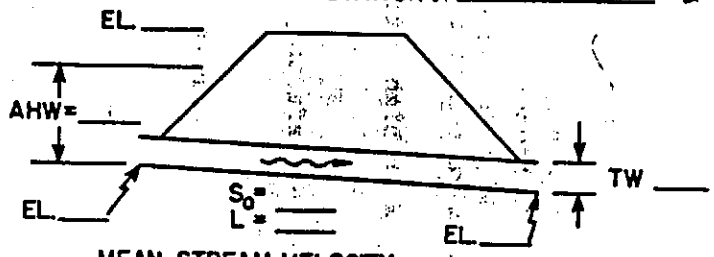
Q_1 = _____ TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: _____



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL HW=H+h_o−LS_o											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
WEST CARDIFF → RCP w/	48.9	30"	2.0	5.0	0.2	3.4	2.3	2.4	1.2	2.4	1.2	4.6	INLET			
FES	15.0	30"	.74	1.85	0.2	0.3	1.3	1.9		1.9	1.2	1.0	INLET			
EAST CARDIFF → RCP w/	107.8	48"	1.28	5.12	0.2	1.75	3.2	3.6		3.6	.74	4.6	INLET			
FES	37.0	48"	.64	2.56	0.2	.2	2.0	3.0		3.0	.74	2.46	INLET			

SUMMARY & RECOMMENDATIONS:

Figure 7

5-18

EXHIBIT "F"

E 3098

EXHIBIT "G"

DRAINAGE STRUCTURE COST ESTIMATE

EXHIBIT "G"

COST ESTIMATE
FOR THE
SINGLE-FAMILY PORTION
OF
BROADMOOR BLUFFS ESTATES

ITEM	UNIT	QUANTITY	UNIT COST	AMOUNT
18" RCP (C-76, Cl. III)	L.F.	374	$ 25.00	$ 9,350.00
24" RCP (C-76, Cl. III)	L.F.	160	35.00	5,600.00
30" RCP (C-76, Cl. III)	L.F.	310	50.00	15,500.00
48" RCP (C-76, Cl. III)	L.F.	74	75.00	5,550.00
18" RCP end section	Each	2	400.00	800.00
30" RCP end section	Each	3	650.00	1,950.00
48" RCP end section	Each	2	1,100.00	2,200.00
Std. 4' manholes	Each	2	1,500.00	3,000.00
Grated inlet (deep)	Each	1	4,000.00	4,000.00
Std. 4' D-10-R curb inlet	Each	1	1,500.00	1,500.00
Std. 6' D-10-R curb inlet	Each	2	2,000.00	4,000.00
Std. 8' D-10-R curb inlet	Each	2	3,000.00	6,000.00
18" dia. rip-rap	Cu Yd	400	50.00	20,000.00
			Total	$79,450.00