

FINAL DRAINAGE REPORT FOR
BROADMOOR BLUFFS DRIVE AND FARTHING DRIVE AND
PRELIMINARY DRAINAGE REPORT FOR
SINGLE-FAMILY PORTION OF
BROADMOOR BLUFFS ESTATES
A PORTION OF
CHEYENNE MOUNTAIN RANCH
COLORADO SPRINGS, COLORADO

MICROFICHERD

Prepared for:

Gates Land Company
155 West Lake Avenue
Colorado Springs, Colorado 80906
(303) 829-5950

Prepared By:

Drexel, Barrell & Co.
1700 38th Street
Boulder, Colorado 80301
(303) 442-4338

Date Prepared: August 31, 1984

E-3098
(0139R)

CERTIFICATIONS

The attached drainage plan and report, "Final Drainage Report for Broadmoor Bluffs Drive and Farthing Drive and Preliminary 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 appearing in this report.

For:



By:

John Common, P.E. #11956

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

By :

Robert F. Svejksky

Title : Director of Engineering

Address: 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:

9/24/84

CONDITIONS:

- 1) All berms and swales (natural and temporary improved swales) to be privately maintained.
- 2) Subject to a letter from Gates Land Co. agreeing to accept and maintain flows onto their property from Broadmoor Bluffs Drive and Farthing Drive.

FLOODPLAIN STATEMENT
FOR
BROADMOOR BLUFFS ESTATES

Broadmoor Bluffs Estates is not in a designated Floodplain as shown on the Flood Insurance Rating Maps.

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

LOCATION

Broadmoor Bluffs Estates is a proposed single-family residential development. The subdivision is approximately 59.22 acres located in the SE1/4 of the SE1/4 of Section 6, and in the NE1/4 of 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 No. 2 and 4; on the west by Broadmoor Bluffs Filing No. 8 and Neal Ranch Filing No. 2. The remaining surrounding properties are unplatted and owned by Gates Land Company.

INTENT

The primary intent of this report is to determine the necessary drainage facilities for the construction of Broadmoor Bluffs and Farthing Drives. The proposed single-family development shown, is preliminary, and will be updated at a later time.

The report is a refined and updated portion of the "Master Drainage Study for Cheyenne Mountain Ranch" prepared by Hartell-Pfeiffenberger and Associates, Inc. dated May 17, 1971, and of 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, to 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. The proposed drainage patterns and points of outfall along Colorado State Highway No. 115 are consistent with the Master Drainage Reports.

DESIGN REFERENCES

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 all 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 designed so as to not allow curb and gutter flow to exceed 12 cfs with the initial rainfall and allow major rainfall to be channelized within the right-of-way. Hydrolic soil groups were determined from maps published by the soil conservation service.

EXISTING DRAINAGE CHARACTERISTICS

Two major drainage basins are established in this study. Each basin contains at least one existing drainage swale. The southerly basin, "I", outfalls runoff from approximately 84.7 acres to a swale which carries flows to a pair of existing 72" culverts under Colorado State Highway No. 115, located approximately 1250 feet south of the Academy Boulevard overpass. The northerly basin, "II", outfalls runoff from approximately 118.6 acres to a swale which carries flows to an existing 72" culvert under the same highway, located approximately 650 feet north of the Academy Boulevard overpass.

Existing site conditions range from grassy 6% slopes, in Basins K & L, to heavily vegetated slopes ranging from 8 + 30% in Basins A through E. The soils are predominantly of the razor series with some ustic torrifuvents existing around Basins K, L & the Academy overpass area. The existing drainage swales are generally heavily vegetated; ranging from natural grasses to scoub oak.

DESIGN DRAINAGE CHARACTERISTICS

Approximately 39.9 acres (offsite Basins 1 & 2) are tributary to major Basin I. Two forks from swale "A" extend westerly through the single-family area and eventually pick up these flows. Future culverts will be required beneath Cardiff Circle to pass these flows. The two forks merge within Basin G and continue easterly, paralleling the proposed Farthing Drive. This swale dissipates in Basin J and the storm runoff turns into sheet flow. To contain this sheet flow and effectively pass it under Broadmoor Bluffs Drive, a temporary swale section is proposed across Basin J. This swale will direct flows to a proposed 48" culvert at the intersection of Farthing and Broadmoor Bluffs Drives. These flows will then be directed to an existing major swale outfalling to the previously mentioned twin 72" culverts under Colorado State Highway No. 115.

The flows generated in Farthing Drive are to be picked up by a series of inlets at the intersection and directed to the same outfall. Basin J is proposed as a future commercial area. With the existing topography, and proposed street grades, it would be difficult to direct future design runoff from Basin J to the 48" culvert. Therefore a 36" culvert is proposed to release flows from this basin. In the event, prior to street construction, this area should be designated for another use, this culvert may be redesigned.

Approximately 46.5 acres (offsite Basins 3, 4 & 5) are tributary to major Basin II. These flows become concentrated at Swale "B" within Basin E. This swale continues easterly and crosses under the north-south extension of Broadmoor Bluffs Drive. Upon entering Basin K, a section of this swale will be displaced by Broadmoor Bluffs Drive, so a temporary swale is proposed here also to divert flows back to the natural swale.

With the specific development of Basins J and K, appropriate drainage improvements can be incorporated with the site plan to adequately convey the flows. Several possible sections have been presented in the calculations and an applicable design should be detailed along with the development of these basins.

Runoff from Swale "B" outfalls through a proposed 60" culvert under Broadmoor Bluffs Drive and then proceeds in a natural swale to the 72" culvert under Colorado State Highway No. 115.

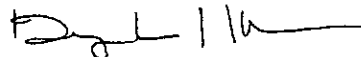
Swales "A" & "B", through the proposed single-family area, are to remain natural and privately maintained. Future culverts, in this area, have been preliminary sized and will be detailed with the final drainage report for the single-family area.

CONCLUSION

This study generated the flows to be passed along and under Broadmoor Bluffs Drive and Farthing Drive. The intent is to provide sufficient design criteria for the street construction at this time. The preliminary analysis of the proposed single-family area should serve as a master study for future development. The detailed design flows and drainage patterns, for the basins within the study affecting Broadmoor Bluffs Drive and Farthing Drive, will be provided to the City at the time of proposed development. Future design drainage flows and patterns within the minor basins should be consistent with this report.

Copies of the calculations, with support material, follow for your review and the estimated drainage structure costs are included as Exhibit "H". 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 has been included for your review.

Respectfully submitted,

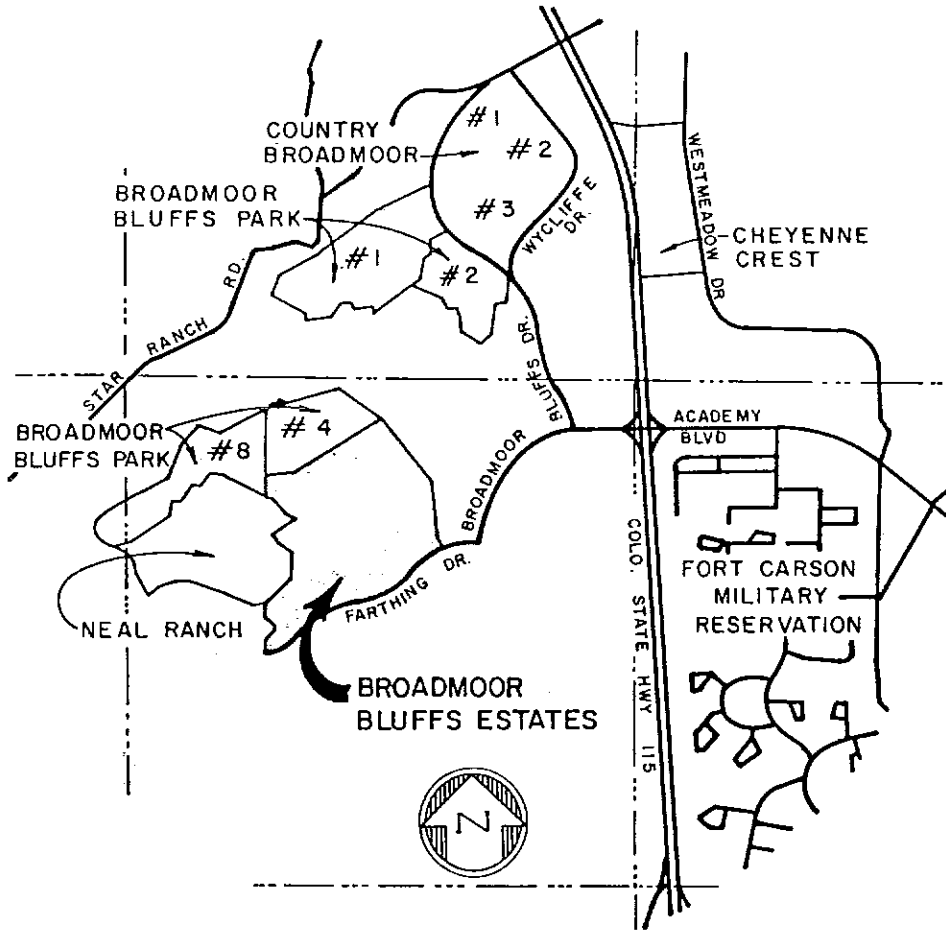


Douglas L. Mann
Drexel, Barrell & Co.

APPENDIX

<u>SUBJECT</u>	<u>EXHIBIT</u>
Vicinity Map	A
Vicinity Map (USGS)	A1
Hydrologic Soil Group	B
Individual Basin Data Summary Sheet	C
Individual Basin Flow Calculations	C 1 thru 7
Street Flow Data Summary Sheet	D
Street Flow Analysis Calculations	D 1 thru 6
Combined Basin Data Summary Sheet	E
Combined Basin Flow Calculations	E 1 thru 9
Storm Sewer Sizing Calculations	F 1 thru 3
Supportive Charts	F 1 thru 9
Rip Rap Sizing	G 1 thru 2
Estimated Drainage Structure Cost Estimates	H

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 "B"



SOILS MAP

SCALE : 1" = 2000'

SEE NEXT PAGE FOR
DESCRIPTIONS.

EXHIBIT "B"
HYDROLOGIC SOILS GROUPS
FOR
BROADMOOR BLUFFS ESTATES STUDY

<u>No.</u>	<u>Classification</u>	<u>Hydrologic Group</u>
12	Bresser	B
13	Bresser	B
38	Jarre Tecolote Series	B
74	Razor	C
84	Stapleton	B
101	Ustic Torrifuvents	B

EXHIBIT "C"
INDIVIDUAL BASIN FLOW CALCULATIONS

EXHIBIT "C"

INDIVIDUAL BASIN DATA SUMMARY SHEET

<u>Off-site Basin</u>	<u>Area(ac)</u>	<u>CN</u>	<u>TC(hr)</u>	<u>Q5(in)</u>	<u>Q100(in)</u>	<u>qp(csm/in)</u>	<u>q5(cfs)</u>	<u>q100(cfs)</u>
1*	21.5	72	0.17	0.34	1.12	1100	12.6	41.4
2*	18.4	76	0.20	0.48	1.36	1100	18.6	52.8
3*	1.2	72	0.17	0.35	1.14	1100	1.0	2.8
4*	44.0	72	0.21	0.35	1.14	1040	33.3	94.2
5*	1.3	72	0.17	0.35	1.14	1100	1.1	3.0
<u>Off-site Basin</u>								
A	4.06	78	0.12	0.54	1.50	1220	4.2	11.6
B	4.56	74	0.11	0.40	1.24	1250	3.6	11.0
C	6.52	76	0.10	0.47	1.36	1280	6.1	17.7
D	5.96	76	0.15	0.47	1.36	1160	5.1	14.7
E	19.54	76	0.10	0.47	1.36	1280	18.4	53.1
F	4.78	80	0.10	0.62	1.64	1280	5.9	15.7
G	8.34	80	0.15	0.62	1.64	1160	9.4	24.8
H	2.20	98	0.10	1.87	3.27	1280	8.2	14.4
I	1.16	98	0.10	1.87	3.27	1280	4.3	7.6
J	13.22	89	0.18	1.12	2.36	1100	25.4	53.6
K	28.84	88	0.21	0.92	2.10	1050	43.5	99.4
L	9.50	82	0.16	0.71	1.78	1140	12.0	30.1
M	3.70	86	0.10	0.92	2.10	1280	6.8	15.5
N	4.60	94	0.21	1.49	2.84	1050	11.2	21.4
<u>Off-site Basin</u>								
Off	3.87	90	0.11	1.18	2.45	1250	8.9	18.5

* Taked from the KKBNA Study

Project: BROADMOOR BLUFFS ESTATES Job No: E 3098

Client: GATES LAND CO. By: [Signature] Date: AUGUST 2, 84

BASIN C AREA = 6.52 AC

SOIL GROUP	ACREAGE	USE	CN	%	% CN
38 (B)	2.32	R 1/2	70	35.6	24.9
74 (C)	4.20	R 1/2	80	64.4	51.5
	6.52			100	76

T_c: 320' OVERLAND AT 30% 3.8 MIN
 300' NAT SWALE AT 10% 0.8 MIN
 4.6 MIN = 0.1 h

$q_p = 1280 \text{ csm/in}$

$Q_5 = 0.47 \text{ in}$ $Q_{100} = 1.36 \text{ in}$

$q_B = 1280 * 6.52/640 * 0.47 = 6.1 \text{ cfs}$	QA/640 5 .0048 100 .0139
$q_{100} = 1280 * 6.52/640 * 1.36 = 17.7 \text{ cfs}$	

BASIN D AREA = 5.96 AC

SOIL GROUP	ACREAGE	USE	CN	%	% CN
38 (B)	2.12	R 1/2	70	35.6	24.9
74 (C)	3.84	R 1/2	80	64.4	51.5
	5.96			100.0	76

T_c: 500' OVERLAND AT 20% 7.6 MIN
 350' CURB FLOW AT 4% 1.6 MIN
 9.2 MIN = 0.15 h

$q_p = 1160 \text{ csm/in}$

$Q_5 = 0.47 \text{ in}$ $Q_{100} = 1.36 \text{ in}$

$q_B = 1160 * 5.96/640 * 0.47 = 5.1 \text{ cfs}$	QA/640 5 .0044 100 .0127
$q_{100} = 1160 * 5.96/640 * 1.36 = 14.7 \text{ cfs}$	

Project: BROADMOOR BLIFFS ESTATES Job No: E 3098

Client: GATES LAUB CO. By: JH Date: AUGUST 2, 84

BASIN E AREA = 19.54 AC

SOIL GROUP	ACREAGE	USE	CN	%	% CN
3B (B)	8.50	R ¹ / ₂	70	43.5	30.5
74 (C)	11.04	R ¹ / ₂	80	56.5	45.2
	19.54			100.0	76

Tc: 300' OVERLAND AT 30% 3.6 MIN
 400' NAT. SWALE AT 12% 1.7 MIN
 5.3 MIN = 0.1h

qp = 1280 csm/in

Q₅ = 0.47 IN Q₁₀₀ = 1.36 IN

Q₅ = 1280 * 19.54 / 640 * 0.47 = 184 cfs

Q₁₀₀ = 1280 * 19.54 / 640 * 1.36 = 53.1 cfs

QA/640
5 .0144
100 .0415

BASIN F AREA = 4.78 AC

SOIL GROUP 74(C) USE R¹/₂ CN = 80

Tc: 300' OVERLAND AT 16% 5 MIN
 500' CURB FLOW AT 8% 1.5 MIN
 6.5 MIN = 0.1h

qp = 1280 csm/in

Q₅ = 0.62 IN Q₁₀₀ = 1.64 IN

Q₅ = 1280 * 4.78 / 640 * 0.62 = 5.9 cfs

Q₁₀₀ = 1280 * 4.78 / 640 * 1.64 = 15.7 cfs

QA/640
5 .0046
100 .0122

Project: BEOAL MOON BLUFFS ESTATES Job No: E 3098

Client: GATES LAND CO. By: clm Date: AUGUST 2, 84

BASIN G AREA = 8.34 ac

SOIL GROUP 74(C) USE R¹/₂ CN = 80

Tc: 200' OVERLAND AT 6% 5.6 MIN
940' NAT SWALE 10% 3.2 MIN

Tc = 8.8 MIN = 0.15 h

qp = 1160 csm/in

Q5 = 0.62 in Q100 = 1.64 in

q5 = 1160 * 8.34 / 640 * 0.62 = 9.4 cfs

q100 = 1160 * 8.34 / 640 * 1.64 = 24.8 cfs

QA/640
5 .0081
100 .0214

BASIN H AREA = 2.20 ac

SOIL GROUP 74(C) USE STREET CN = 98

Tc: 200' CURB FLOW AT 7% 0.7 MIN
950' CURB FLOW AT 10% 2.6 MIN

3.3 MIN = 0.1 h

qp = 1280 csm/in

Q5 = 1.87 in Q100 = 3.27 in

q5 = 1280 * 2.2 / 640 * 1.87 = 8.2 cfs

q100 = 1280 * 2.2 / 640 * 3.27 = 14.4 cfs

QA/640
5 .0064
100 .0112

BASIN I AREA = 1.16 ac

SOIL GROUP 74(C) USE STREET CN = 98

Tc: 550' CURB FLOW AT 10% 1.5 MIN
150' CURB FLOW AT 4% 0.6 MIN

2.1 MIN = 0.1 h

qp = 1280 csm/in

Q5 = 1.87 in Q100 = 3.27 in

q5 = 1280 * 1.16 / 640 * 1.87 = 4.3 cfs

q100 = 1280 * 1.16 / 640 * 3.27 = 7.6 cfs

QA/640
5 .0034
100 .0059

Project: BROADMOOR BLUFFS ESTATES Job No: E 3098

Client: GATES LAND CO. By: cll Date: AUGUST 2.84

BASIN L AREA = 9.50 AC

SOIL GROUP	USE	ACREAGE	CN	%	% CN
74(C)	1/2	8.15	80	85.8	68.6
	COMM	1.35	94	14.2	13.4
		9.5		100.0	82

Tc: 250' OVERLAND AT 20% 2.8 MIN.
 300' OVERLAND AT 10% 5.0 MIN
 300' ASPH FLW AT 3% 1.8 MIN
9.6 MIN = 0.16 h

$q_p = 1140 \text{ csm/in}$

$\Phi_5 = 0.71 \text{ in}$ $\Phi_{100} = 1.78 \text{ in}$

$q_5 = 1140 * 9.5 / 640 * 0.71 = 12.0 \text{ cfs}$

$q_{100} = 1140 * 9.5 / 640 * 1.78 = 30.1 \text{ cfs}$

QA/CA
5 .10105
100 .0264

BASIN M AREA = 3.70 AC

SOIL GROUP	USE	ACREAGE	CN	%	% CN
74(C)	1/2	2.41	80	65.1	52
	STREET	1.29	98	34.9	34.2
		3.70		100	86

Tc: 150' OVERLAND AT 17% 1.8 MIN
 280' OVERLAND AT 14% 3.6 MIN
5.4 MIN = 0.1 h

$q_p = 1280 \text{ csm/in}$

$\Phi_5 = 0.92 \text{ in}$ $\Phi_{100} = 2.10 \text{ in}$

$q_5 = 1280 * 3.7 / 640 * 0.92 = 6.8 \text{ cfs}$

$q_{100} = 1280 * 3.7 / 640 * 2.10 = 15.5 \text{ cfs}$

QA/CA
5 .0053
100 .0121

Project BROADMOOR BLUFFS ESTATES	Job No E 3098
Client GATES LAND Co.	By CH
Date AUGUST 2, 84	

BASIN N AREA 4.6 AC

SOIL GROUP	ACREAGE	USE	CN	%	%CN
74 (c)	0.8	STREET	98	17.4	17.0
101 (B)	2.9	STREET	92	63.0	58.0
101 (B)	0.9	COMM	98	19.6	19.2
	4.6			100.0	94

Tc: 1100' CURB FLOW AT 1.5% 9.2 MIN
 450' CURB FLOW AT 5.6% 1.9 MIN
 250' CURB FLOW AT 3.6% 1.4 MIN
12.5 MIN = 0.21 h

$q_p = 1050 \text{ csm/in}$

$Q_5 = 1.49 \text{ in}$ $Q_{100} = 2.84 \text{ in}$

$q_5 = 1050 * 4.6/640 * 1.49 = 11.2 \text{ cfs}$	QA/640
$q_{100} = 1050 * 4.6/640 * 2.84 = 21.4 \text{ cfs}$	5 .0107
	100 .0204

OFFSITE BASIN (SOUTH OF PARTING C BROADMOOR BLUFFS)

AREA = 3.87 AC SOIL GROUP 74 (c)
 FUTURE SITE USE R5 CN = 90 (ASSUME 70% IMPERVIOUS)

Tc: 560 ASPH FLOW AT 5% 2.4 MIN
 100 OVERLAND AT 10% 2.4 MIN
 250 CURB FLOW AT 1.6% 2.1 MIN
6.5 MIN = 0.11 h

$Q_5 = 1.18 \text{ in}$ $Q_{100} = 2.45 \text{ in}$

$q_5 = 1250 * 3.87/640 * 1.18 = 8.9 \text{ cfs}$	QA/640
$q_{100} = 1250 * 3.87/640 * 2.45 = 18.5 \text{ cfs}$	5 .0071
	100 .0148

EXHIBIT "D"

STREET FLOW ANALYSIS CALCULATIONS

EXHIBIT "D"

STREET FLOW DATA SUMMARY SHEET

<u>DESIGN POINT</u>	<u>q5 (cfs)</u>	<u>q100 cfs</u>	<u>STD. CAP.(cfs)</u>	<u>INLET/SIZE (FT)</u>	<u>INLET CAPACITY (cfs)</u>	<u>INLET PICKUP/BY 5 (cfs)</u>	<u>INLET PICKUP/BY 100 (cf</u>
A (S. 1/2)	1.1	2.0	42.5	-			
A (N. 1/2)	4.1	11.1	42.5	-			
H (S. 1/2)	4.5	8.1	19.2	-			
H (N. 1/2)	7.1	16.0	19.2	-			
I (S. 1/2)	6.3	11.3	6.8	F/6	8.3	3.8/2.5	4.1/7.2
I (N. 1/2)	8.4	18.1	44.8	E/6	9.3	5.0/3.4	9.3/8.8
-	5.9	16.0	15.4	D/4	7.5	3.5/2.4	7.5/8.5
-	2.4	8.5	15.4	C/4	7.5	1.4/1.0	5.1/3.4
N (S. 1/2)	5.6	10.7	20.2	-			
N (N. 1/2)	5.6	10.7	20.2	-			
-	6.2	13.1	30.0	B/8	18.4	6.2/0 *	13.1/0 *
-	6.2	13.1	30.0	A/8	18.4	6.2/0 *	13.1/0 *

) * Sump condition inlet.

Project BROADMOOR BLUFFS ESTATES	EXHIBIT "D"	Job No E 3098
Client GATES LAND Co.	By djm	Date August 15, 84

STREET FLOW ANALYSIS & GULCH SIZING

FARTHING DRIVE. ASSUME NO INTERCEPTION OF PROPOSED FLOWS BY FUTURE CARDIFF CIRCLE.

ALLOW 1.0 cfs & 1.5 cfs (5 YR & 100 YR) RUN ON FROM FUTURE HOOKUP W/ NEAL RANCH 3RD PHASE.

BASIN "A" (STA 38+23 TO STA 28+66)

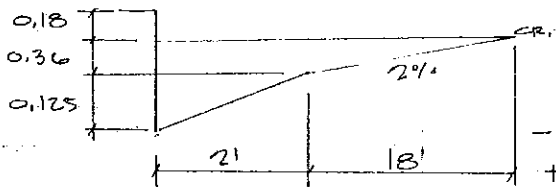
SUPERELEV. FLOWS TO N. H. EXCEPT FOR 0.3 AC 1/2 ST.

S, 1/2 ST. FLOWS $1280 \times \frac{0.3}{640} \times 1.87 = 1.1 \text{ cfs } 100 \text{ yr.}$
 $1280 \times \frac{0.3}{640} \times 3.27 = 2.0 \text{ cfs } 100 \text{ yr.}$

N, 1/2 ST FLOWS $4.2 + 1.0 - 1.1 = 4.1 \text{ cfs } 5 \text{ yr}$
 $11.6 + 1.5 - 2.0 = 11.1 \text{ cfs } 100 \text{ yr}$

STREET CAPACITY TABLE 5 NG > 6%

DRCGI NOMO FOR FLOW IN TRIANGULAR GUTTERS



$S = 0.072$
 $n = 0.016$
 $\frac{2}{n} = 1000 \quad d = 0.485 \quad Q = 27 \text{ cfs}$
 $\frac{1}{n} = 1000 \quad d = 0.36 \quad Q = 9.5 \text{ cfs}$
 $\frac{3}{n} = 3125 \quad d = 0.36 \quad Q = 30.0 \text{ cfs}$

1/2 ST CAP. = 42.5 cfs

$42.5 \times R.F. 0.32 = 13.6 \text{ cfs}$ ALLOW TO CROWN OK

PROPORATE "QA/640" PER ST. SIDE

$0.3/4.06 = X/.0034 \quad X = .0003 \quad 5 \text{ YR SOUTH}$

$0.3/4.06 = X/.0095 \quad X = .0007 \quad 100 \text{ YR SOUTH}$

$.0034 - .0003 = .0031 \quad 5 \text{ YR NORTH}$

$.0095 - .0007 = .0087 \quad 100 \text{ YR NORTH}$

Project BROADMOOR BLUFFS ESTATES		Job No E 3098	
Client GATES LAND CO.	By dlh	Date August 15, 84	

BASIN "H" (Flow to STA 17+00) 50/50 SPLIT FLOW

1/2 ST "QA/640" BASIN H 5YR .0032
100YR .0056

S. 1/2 STREET TOTAL "QA/640" 5YR 0.0032 + .0003 = .0035
100YR .0056 + .0007 = .0063

$T_c = 1.7 \text{ MIN "A"} + 3.3 \text{ MIN "H"} = 5 \text{ MIN OR } 0.1 \text{ h}$

$q_p = 1280 \quad q_5 = 1280 \times .0035 = 4.5 \text{ cfs}$

$q_{100} = 1280 \times .0063 = 8.1 \text{ cfs}$

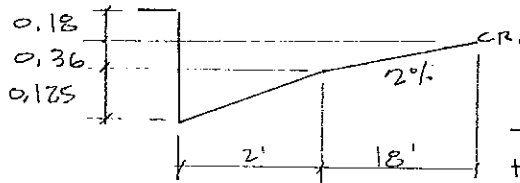
N. 1/2 STREET TOTAL "QA/640" 5YR .0032 + .0031 = .0063
100YR .0056 + .0087 = .0143

$T_c = 7.1 \text{ MIN "A"} + 3.3 \text{ MIN "H"} = 10.4 \text{ MIN OR } 0.17 \text{ h}$

$q_p = 1120 \quad q_5 = 1120 \times .0063 = 7.1 \text{ cfs}$

$q_{100} = 1120 \times .0143 = 16.0 \text{ cfs}$

CHECK ST. CAPACITY TABLE 6 NG > 6%



$S = 0.10$

$n = 0.016$

$z/n = 1000 \quad d = .485 \quad Q = 72 \text{ cfs}$

$-z/n = 1000 \quad d = .36 \quad Q = 26 \text{ cfs}$

$+z/n = 3125 \quad d = .36 \quad Q = 50 \text{ cfs}$

1/2 ST Q = 96 cfs

$96 \text{ cfs} \times \text{R.F. } 0.2 = 19.2 \text{ cfs to crown OK}$

Project <u>BROADMOOR BLUFFS ESTATES</u>	Job No <u>E 3098</u>
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Client <u>GATES LAND Co.</u>	By <u>djj</u>	Date <u>AUGUST 15 84</u>
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CHECK ST. CAPACITIES (CONT'D)

NORTH SIDE HAS TYP. SECTION
SLOPE AT BCR 4.9%

TABLE 5 INTERPOLATION $89.4 / 2 = 44.8$ cfs $\frac{1}{2}$ STREET ✓

SIZE INLETS

(STA 11+50)(S.) $Q_5 = 6.3$ $Q_{100} = 11.3$ ST CAP = 6.8 cfs
INLET F

TABLE 5 6' INLET CAP. 8.3 cfs

5 YR PICKUP $6.3 \times 0.6 = 3.8$ cfs w/ 2.5 cfs BY

100 YR PICKUP $6.8 \times 0.6 = 4.1$ cfs w/ 7.2 cfs BY

(STA 10+75)(N.) $Q_5 = 8.4$ $Q_{100} = 18.1$ ST. CAP = 44 cfs
INLET E

TABLE 5 6' INLET CAP. 9.3 cfs

5 YR PICKUP $8.4 \times 0.6 = 5.0$ cfs 3.4 cfs BY

100 YR PICKUP $18.1 \times 0.6 = 10.9$ cfs

↓
INLET CAPACITY 9.3 cfs 8.8 cfs BY

NOTE: FLOW BY INLETS IS TO BROADMOOR BLUFFS BCR 28+42

OFFSITE BASIN (FUTURE EXTENSION OF BROADMOOR BLUFFS TO SOUTH OF FARTHING TO HI-POINT)

$T_c = 12.5$ MIN APPROX. SAME AS FARTHING
ASSUME EQUIVALENT PEAK TIMES

$Q_5 = 8.9$ $Q_{100} = 18.5$

CHECK $\frac{1}{2}$ ST. CAPACITY

$30.8 / 2 = 15.4$ cfs

NOTE: ABOVE FLOWS ARE NOT DESIRABLE IN STREET,
SHOULD BE COLLECTED ONSITE & PIPED TO LEX.
SWALE TO SOUTH.

ACCOUNT ONLY FOR R.O.W. FUTURE FLOWS TO NORTH.

Project BROADMOOR BLIFFS ESTATES		Job No E 3098
Client GATES LAND CO.	By JH	Date AUGUST 15, 84

SUMMATION OF FLOW BY TO BCR (STA 28+42) AT Tc = 12.5 MIN.

5 YEAR 2.5 + 3.4 = 5.9 cfs
 100 YEAR 7.2 + 8.8 = 16.0 cfs

SIZE INLET

4' INLET CAP 7.5 cfs (INLET b)

5 YR 5.9 * 0.6 = 3.5 cfs 2.4 cfs BY
 100 YR 16.0 * 0.6 = 9.6 cfs

(INLET c) CAP = 7.5 8.5 cfs BY

4' INLET - 10' DOWNHILL IN SERIES TO LESSEN 100 YR FLOW

5 YR 2.4 * 0.6 = 1.4 1.0 cfs BY ✓
 100 YR 8.5 * 0.6 = 5.1 3.4 cfs BY ✓ OK

BASIN "N" (FLOW FROM STA 29+00 TO 11+50) 50/50 SPLIT

Q₅ = 11.2 cfs Q₁₀₀ = 21.4 cfs
1/2 ST FLOW Q₅ = 5.6 cfs
 Q₁₀₀ = 10.7 cfs

CHECK ST. CAPACITY

S = 0.036 TABLE 5 40.4 / 2 = 20.2 A SIDE ✓

SOUTH 1/2 ST. FLOWS

ALLOW TO FLOW ON TO BORROW DITCH ALONG INTERCHANGE & OUTFALL TO EXIST 24" CULVERT.

NORTH 1/2 ST FLOWS

ALLOW TO FLOW TO SUMP AT NORTH ON BROADMOOR BLIFFS

Project BROADMOOR BLUFFS ESTATES		Job No E 3098
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Client GATES LAND CO.	By d/h	Date AUGUST 15, 84
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Flows AT SUMP BROADMOOR BLUFFS STA. 17+00

5 YEAR 6.8 + 5.6 = 12.4 cfs
 100-YEAR 15.5 + 10.7 = 26.2 cfs

USE 8' SUMPS OVER CULVERT CAPAC. 18.4 cfs EACH,
(INLETS A & B)

CHECK ST CAPACITIES TABLE B

AT 6% 49 cfs

AT 1% 30 cfs OK

EXHIBIT "E"
COMBINED BASIN FLOW ANALYSIS

EXHIBIT "E"

COMBINED BASIN DATA SUMMARY SHEET

(TOTAL PEAK FLOW AT POINT)

<u>THROUGH BASIN</u>	<u>QA5</u>	<u>QA100</u>	<u>Tc (hr)</u>	<u>qp (csm/in)</u>	<u>q5 (cfs)</u>	<u>q 100 (cfs)</u>
B (B+1)	0.0143	0.0464	0.28	950	13.6	44.1
C (C+2)	0.0186	0.0530	0.28	950	17.7	50.4
G (C+B+1+2)	0.0410	0.1208	0.38	830	34.0	100.3
G *	0.0456	0.1130	0.38	830	37.8	110.4
J (F+G+C+B+1+2)	0.0456	0.1130	0.47	750	34.2	99.8
E (E+4+5)	0.0398	0.1243	0.30	920	36.6	114.4
E *	0.0442	0.1370	0.30	920	40.7	126.0
K (K+E+D+3+4+5)	0.0857	0.2316	0.43	780	66.8	180.6
K+L (Above K+L)	0.0962	0.2580	0.43	780	75.0	201.2

G* Just down stream of G to include Basin F at future street sump.

E* Just down stream of E to include Basin D+3 at future cul-de-sac inlet.

Project BROADMOOR BLUFFS ESTATES	EXHIBIT "E"	Job No E 3098
Client GATES LAND CO.	By JH	Date AUGUST 15 84

COMBINED BASIN FLOWS ALONG N. & S. NATURAL SWALES

OFFSITE TRIBUTARY FLOWS TAKEN FROM DRAINAGE REPORT PREPARED BY KKBNA FOR NEAL RANCH FILING NO. 2, BROADMOOR BLUFFS FILING NO. 8, & FARTHING DRIVE. SIGNED BY THE CITY OF COLO SPRG ON 7.5.84.

SWALE EVALUATION

SWALE "A" OUTFALLS TO PROPOSED CULVERT AT BROADMOOR BLUFFS & FARTHING INTERSECTION.

TRIB. BASINS: J.G.F.C.B	DREXEL BARRELL
4-1-6, 4-1-1, 4-1-2	KKBNA
4-1-4, 4-1-5, 4-1-7	
4-1-8, K-2-6	

SWALE "B" OUTFALLS TO CULVERT UNDER BROADMOOR BLUFFS AT STA 17+00

TRIB. BASINS: K.L.D.E	DREXEL BARRELL
K-1, K-2	MASTER PLAN BY KLH SHOWN ON KKBNA

NATURAL SWALE "A" TO REMAIN NATURAL & MAINTAINED

OFFSITE 4-1-6 $A = 21.5 \text{ ac}$ $Q_5 = 0.34$ $Q_{100} = 1.12$
 $T_c = 10.2 \text{ MIN}$

ET 4-1-7 $A = 18.4 \text{ ac}$ $Q_5 = 0.48$ $Q_{100} = 1.36$
 $T_c = 12.0 \text{ MIN}$

BASIN "B" (B + 4-1-6)
 "QA / 640" (4-1-6) $5 \text{ TR } .0114 + \text{"B"} .0029 = .0143$
 $100 \text{ TR } .0376 + \text{"B"} .0088 = .0464$

$T_c: 10.2 + 6.8 = 17 \text{ MIN OR } 0.28 \text{ h} \rightarrow$ HOLD TO MAINTENANCE

$Q_p = 950 \text{ IN/HR}$

$Q_5 = 950 * .0143 = 13.6 \text{ cfs}$

$Q_{100} = 950 * .0464 = 44.1 \text{ cfs}$

Project BROADHOCK BLUFFS ESTATES	Job No E 3098
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Client GATES LAND CO.	By JH	Date AUGUST 15, 84
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BASIN "C" (C + E U-1-7)

"QA/640" (E to U-1-7) 5 YR .0138 + "C".0048 = .0186

100 YR .0391 + "C".0139 = .053

Tc: 12 MIN + 4.6 = 16.6 MIN OR 0.28 h → ~~TR~~ / MANNING

q_p = 950 IN/HR

q₅ = 950 * .0186 = 17.7 cfs

q₁₀₀ = 950 * .053 = 50.4 cfs

BASIN "G" (B+C)

"QA/640" 5 YEAR .0186 + .0143 + .0081 = .0410

100 YEAR .053 + .0464 + .0214 = .1208

Tc: 17 MIN + 5.0 MIN = 23.0 MIN OR 0.38 h → ✓ MANNING OF PG. 6

q_p = 830 CS17/IN

q₅ = 830 * .041 = 34.0 cfs

q₁₀₀ = 830 * .1208 = 100.3 cfs

JUST DOWNSTREAM OF "G" TO INCLUDE ST. RELEASE OF F

"QA/640" 5 YR .0410 + .0046 = .0456

100 YR .1208 + .0122 = .1330

Tc = .38 h q_p = 830

q₅ = 830 * .0456 = 37.8 cfs

q₁₀₀ = 830 * .1330 = 110.4 cfs

Project: BROADMOOR BLUFFS ESTATES
Job No: E 3098

Client: GATES LAND CO. By: dlh Date: AUGUST 15, 84

BASIN "J" (OUTFALL AT BROADMOOR BLUFFS)

"QA/640" 5 YR .0456 + .0 = .0456
 100 YR .1330 + .0 = .1330
 $T_c: 23.0 \text{ MIN} + 4.9 \text{ MIN} = 27.9 \text{ MIN OR } 0.47 \text{ h}$
 $q_p = 750$
 $q_5 = 750 * .0456 = 34.2 \text{ cfs}$
 $q_{100} = 750 * .1330 = 99.8 \text{ cfs}$

NATURAL SWALE "B" TO REMAIN NATURAL & MAINTAINED

OFFSITE	AREA	K1 & K2	38.2 ac	
	#-7-2		5.2	
	U-1-3		0.6	$q_5 = 0.35$
	V-1-3		1.3	$q_{100} = 1.14$
	U-1-9		1.2	$T_c = 0.21 \text{ h}$
			<u>46.5 ac</u>	

"QA/640" 5 YR .0254
 100 YR .0828

BASIN "E"

"QA/640" 5 YR .0254 + .0144 = .0398
 100 YR .0828 + .0415 = .1243
 $T_c: 12.6 \text{ MIN} + 5.6 \text{ MIN} = 18.2 \text{ MIN OR } 0.30 \text{ h}$
 $q_p = 920 \text{ cfm/in}$
 $q_5 = 920 * .0398 = 36.6 \text{ cfs}$
 $q_{100} = 920 * .1243 = 114.4 \text{ cfs}$

Project BROADMOOR BLUFFS ESTATES		Job No E 3098
Client GATES LAND CO.	By dlj	Date August 15, 84

JUST DOWNSTREAM OF 'E' TO INCLUDE ST. RELEASE OF b

"QA/640" 5 YR .0398 + .0044 = .0442
100 YR .1243 + .0127 = .1370

$T_c = 0.3 \text{ h}$ $q_p = 920$

$q_5 = 920 * .0442 = 40.7 \text{ cfs}$

$q_{100} = 920 * .1370 = 126.0 \text{ cfs}$

BASIN "K" LESS BASIN L

"QA/640" 5 YR .0442 + .0415 = .0857
100 YR .1370 + .0946 = .2316

$T_c = 18.2 \text{ MIN} + 7.5 \text{ MIN} = 25.7 \text{ MIN}$ OR .43 h

$q_p = 780 \text{ csm/in}$

$q_5 = 780 * .0857 = 66.8 \text{ cfs}$

$q_{100} = 780 * .2316 = 180.6 \text{ cfs}$

BASIN "K+L"

"QA/640" 5 YR .0857 + .0105 = .0962
100 YR .2316 + .0264 = .2580

$T_c = .43 \text{ h}$ $q_p = 780 \text{ csm/in}$

$q_5 = 780 * .0962 = 75.0 \text{ cfs}$

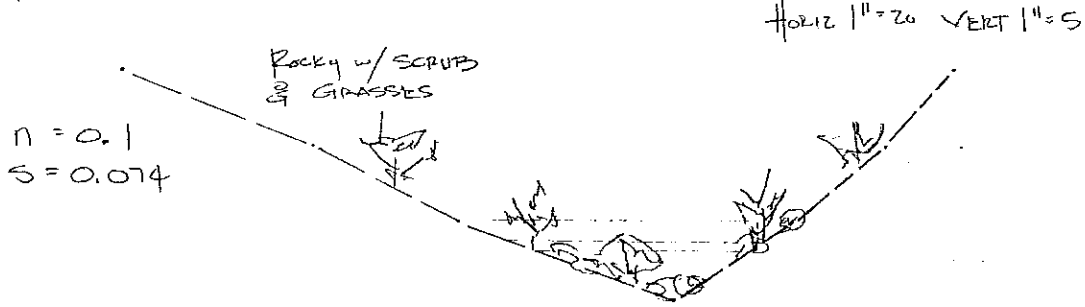
$q_{100} = 780 * .2580 = 201.2 \text{ cfs}$

Project BROADMOOR BLUFFS ESTATES		Job No E 3098
Client GATES LAND CO.	By djh	Date AUGUST 15.84

NATURAL SWALE FLOW CHECKS

SWALE "A"

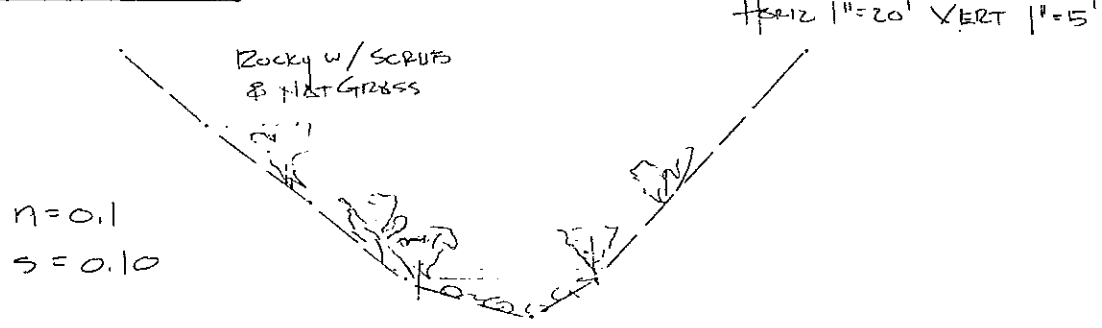
BASIN "B"



$n = 0.1$
 $s = 0.074$

$d = 2$	$d = 1.5$	$d = 1.25$	
$A = 38 \text{ SF}$	$A = 22.5 \text{ SF}$	$A = 16.4 \text{ SF}$	
$WP = 35$	$WP = 27$	$WP = 22$	
$R = 1.09$	$R = .833$	$R = .744$	
$Q = 163 \text{ HG.}$	$Q = 80.7 \text{ HG.}$	$Q = 54.6 \text{ cfs}$	$V = 3.3 \text{ cfs} \quad \underline{O.K.}$

BASIN "C"



$n = 0.1$
 $s = 0.10$

$d = 1'$	$d = 1.25$	
$A = 12 \text{ SF}$	$A = 17.3 \text{ SF}$	
$WP = 20$	$WP = 22$	
$R = 0.6$	$R = 0.79$	
$Q = 40.2 \text{ HG.}$	$Q = 69.6$	$V = 4 \text{ fps} \quad \underline{O.K.}$

Project BROADHURST BLUFFS ESTATES	Job No E 3098
Client GATES LAND CO.	By djh
Date August 15, 84	

BASIN "G"

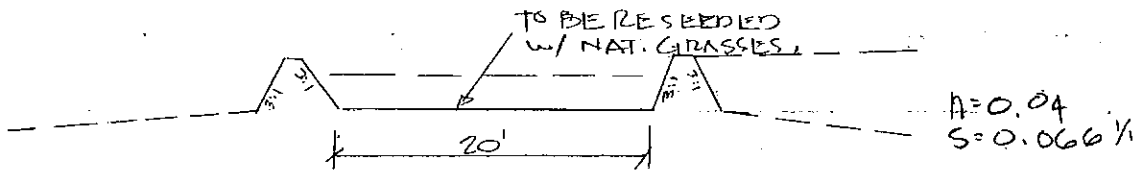


$n = 0.1$
 $s = 0.056$

<p>if d = 1' A = 22 SF WP = 40 R = .55 Q = 52.1 cfs <u>NG.</u></p>	<p>if d = 1.5' A = 43 SF WP = 44 R = .977 Q = 152 cfs <u>V = 3.6 fps OK</u></p>
--	---

BASIN "J" PROPOSE TEMPORARY BERTI TO ROUTE FLOWS TO CULVERT & DESIGN POSSIBLE FUTURE SWALE TO BE IMPLEMENTED W/ DEVELOPMENT OF PARCEL. (i.e. FUTURE COMMERCIAL SITE)

TYPICAL SECTION - TEMPORARY



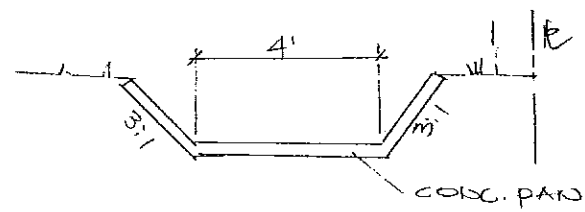
<p>if d = 0.7' A = 15.5 SF WP = 24.2 R = 0.639 Q = 110 cfs V = 7 fps</p>	<p>if d = 0.4' A = 8.5 SF WP = 22.4 R = 0.379 Q = 43 cfs V = 5 fps ✓</p>
--	--

BERTIS TO BE A MINIMUM 1' ABOVE LEVEL GRADED PAR.

Project 320ADMOOR BLUFFS ESTATES		Job No E 3098
Client GATES LAND CO.	By CHM	Date AUGUST 18, 84

BASIN "J" CONT'D

POSSIBLE FUTURE SECTION (w/ DEVELOPMENT OF PARCEL)



$S = 0.067$
 $n = 0.013$

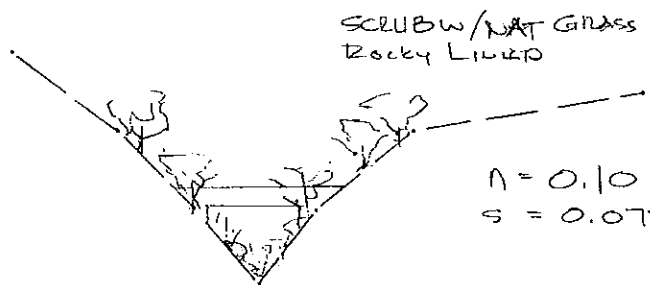
if $d = 0.8'$ $Q = 103 \text{ cfs}$ $v = 20 \text{ fps}$
if $d = 0.45'$ $Q = 35 \text{ cfs}$ $v = 14.5 \text{ fps}$

WITH THIS SECTION A CONC. TRANSITION SECTION WILL BE REQ'D TO MEET CULVERT,

SWALE "B"

BASIN "E" (JUST DOWNSTREAM)

VERT 1" = 20' VERT 1" = 5'



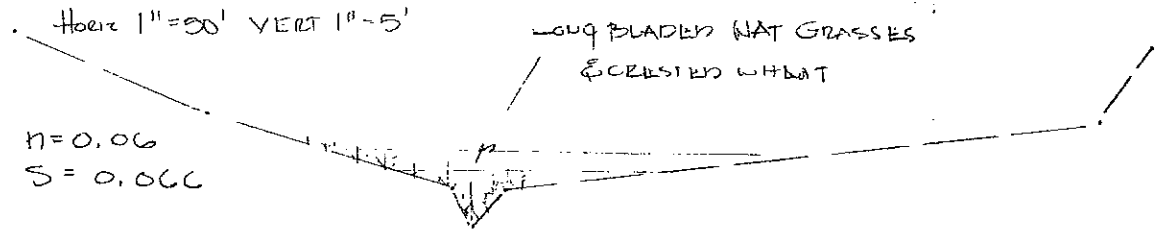
$n = 0.10$
 $s = 0.072$

if $d = 2$	if $d = 2.5$
$A = 13 \text{ SF}$	$A = 22.5 \text{ SF}$
$WP = 13.6$	$WP = 18.7 \text{ SF}$
$R = 0.956$	$R = 1.20$
$Q = 50.4 \text{ cfs}$ <u>N.G.</u>	$Q = 101.6 \text{ cfs}$ <u>OK</u> $v = 4.5 \text{ fps}$

Project BROADMOOR BLIFFS ESTATES		Job No E 3098	
Client GATES LAND CO.		By djm	Date AUGUST 18.84

SWALE "B" (Cont'd)

MID BASIN "K" Approx 300' No. of BROADMOOR BLIFFS FR.

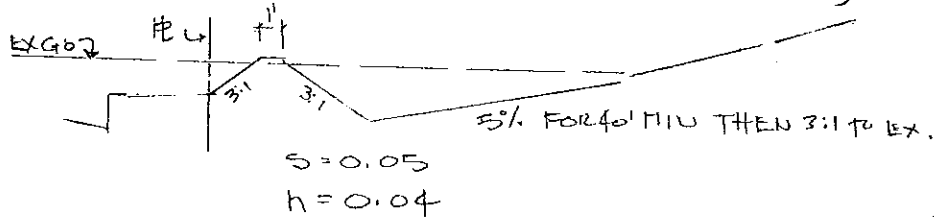


$1.5d = 7'$
 $A = 80 \text{ SF}$
 $WP = 125'$
 $R = 0.64$
 $Q = 378 \text{ cfs NG.}$

$1.5d = 1.5$
 $A = 27.5$
 $WP = 70$
 $R = 0.393$
 $Q = 94.1 \text{ cfs NG}$

$1.5d = 1.75$
 $A = 53.8$
 $WP = 100$
 $R = 0.538$
 $Q = 227 \text{ cfs OK}$
 $V = 4.2 \text{ fps. OK}$

PROVIDE TEMPORARY BERTM ALONG BROADMOOR BLIFFS TO DIVERT FLOWS TO CULVERT TILL SPECIFIC SITE DEVELOPMENT IS PROPOSED, (IE. FUTURE MULTIFAMILY, COMMERCIAL)



$1.5d = 1.5$
 $A = 27$
 $WP = 36$
 $R = 0.75$
 $Q = 185 \checkmark$
 $V = 4.8 \text{ fps}$

Project

BROADMOOR BLUFFS ESTATES

Job No

E
3098

Client

GATES LAND CO.

By

JH

Date

August 18, 84

BASIN K (CONT'D)

POSSIBLE FUTURE SECTION

$S = 0.05$
 $n = 0.013$



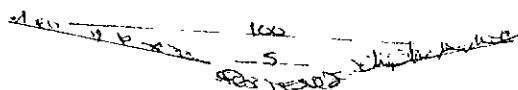
if $d = 1.15'$ $Q = 182 \text{ cfs}$ $v = 21.3 \text{ fps}$
if $d = 0.7'$ $Q = 69 \text{ cfs}$ $v = 16.2 \text{ fps}$

NOTE

FOR BOTH BASIN J & K TEMPORARY CHANNEL SECTIONS HAVE BEEN DESIGNED UNTIL SPECIFIC DEVELOPMENT PLANS ARE PROPOSED. CONC. PANS HAVE BEEN SHOWN AS A POSSIBLE IMPROVEMENT HOWEVER OTHER SECTIONS ARE WORKABLE & SHOULD BE ANALYZED WITH DETAILED SITE DEVELOPMENT

Eq.

A)

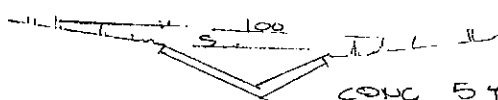


RIP RAP 5yr FLOW
GRASSED SWALE 100 YEAR OVERFLOW

B)

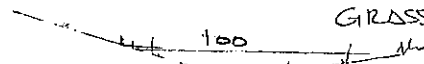
PIPED SYSTEMS

C)



CONC 5yr
GRASSED 100 YEAR

D)



PIPED 5yr
GRASSED 100 yr.

EXHIBIT "F"
STORM SEWER SIZING CALCULATIONS

Project BROADMOOR BLUFFS ESTATES		EXHIBIT "F"	Job No E 3098
Client GATES LAND CO.	By dlm	Date August 18, 54	

SIZE STORM SEWER

INLET "G" TO INLET "F" Q_5 (pickup) = 3.8 cfs Q_{100} (pickup) = 7.2 cfs
 18" RCP AT 6.4% GRAVITY FLOW $n = 0.013$
 $Q = 27$ cfs OK

INLET "F" TO SWALE $Q_5 = 3.8 + 5.0 = 8.8$ cfs
 $Q_{100} = 7.2 + 9.3 = 16.5$ cfs
 18" RCP AT 3% GRAVITY FLOW 18 cfs OK

FUTURE INLET TO INLET E

PICKUP 1/2 ST. FLOW BASIN 0.23 AC
 $q_p = 1280$ $Q_{100} = 3.27$

$q_{100} = 1280 * 0.23 / 40 * 3.27 = 1.50$ cfs
 4' INLET AT 1.6% CAP 7.5 cfs PICKUP = $1.5 * 0.6 = 0.9$
 4' WILL PICKUP 1.5 GUTTER TRICKLE
 18" RCP AT 1.6% 13.5 cfs OK

INLET "D" TO INLET "E" $Q_5 = 1.4$ $Q_{100} = 5.1$
 18" RCP AT 1% GRAVITY FLOW = 10.5 cfs OK

CULVERT AT STA. 28+35.15 2 BCR BROADMOOR BLUFFS DR.
 T_c : FORTHING = 12.5 MIN T_c : BASINS = 28 MIN. 48" RCP
 DESIGN PIPE FOR $Q_5 = 34.2$ cfs $Q_{100} = 99.8$ cfs

$H_w/D_{100TR} = 1.20$ $Q_{INLET ALLOW} = 99.8$ cfs
 (SEE CHART 11-1)
 $H_w/D_{5yr} = 0.62$ $Q_{INLET ALLOW} = 34.2$ cfs
 (SEE CHART 11-1)

OUTLET CONTROL DOES NOT PERTAIN.

48" GRAVITY FLOW @ 1% = 142 cfs $n = 0.013$

Project BROADMOOR BLUFFS ESTATES		Job No E 3098
Client GATES LAND CO.	By [Signature]	Date AUGUST 18 84

SIZE STORM SEWER (CONT'D)

INLET "C" ~~F~~ INLET "A" $Q_5 = 3.4 \text{ cfs}$ $Q_{100} = 6.4 \text{ cfs}$

18" RCP AT 4% GRAVITY FLOW = 22 cfs O.K.

SIZE CULVERT AT BROADMOOR BLUFFS ESTATES SUMP

T_c : BROADMOOR BLUFFS DR = 12.5 MIN

T_c : TERMINAL BASIN K = 25.7 MIN

SIZE CULVERT FOR $Q_5 = 75 \text{ cfs}$ | 60" RCP
 $Q_{100} = 210 \text{ cfs}$

H_w/d 100 yr = 1.42 $Q = 210 \text{ cfs}$ O.K.
(SEE CHART 11-1)

H_w/d 5 yr = 0.7 $Q = 75 \text{ cfs}$ O.K.
(SEE CHART 11-1)

GRAVITY FLOW AT 1%, 250 cfs O.K.

OUTLET CONTROL DOES NOT PERTAIN.

SIZE CULVERT AT BASIN "J" BROADMOOR BLUFFS DRIVE
STA 22+79.19

$Q_5 = 25.4 \text{ cfs}$ $H_w/d = .77$ | 36" RCP
 $Q_{100} = 53.6 \text{ cfs}$ $H_w/d = 1.3$

$Q_5 = 25.4 \text{ cfs}$ O.K. (SEE CHART 11-1)

$Q_{100} = 53.6 \text{ cfs}$ O.K. (SEE CHART 11-1)

OUTLET CONTROL DOES NOT PERTAIN

GRAVITY FLOW AT 1% 65 cfs $C_n = 0.013$

Project BROADMOOR BLUFFS ESTATES		Job No E 3098	
Client GATES LAND CO.	By dlr	Date August 22 84	

SIZE PIPES (CONT'D)

FUTURE CARDIFF CIRCLE (S. SWALE A)

$Q_5 = 13.6 \text{ cfs}$ $Q_{100} = 44.1 \text{ cfs}$

30" RCP $H_w/d = 0.74$ $Q = 14 \text{ cfs}$
 $H_w/d = 2.0$ $Q = 45 \text{ cfs}$

GRAVITY FLOW AT 2% 56 cfs OK.

FUTURE CARDIFF CIRCLE (N. SWALE A)

$Q_5 = 17.7 \text{ cfs}$ $Q_{100} = 50.4 \text{ cfs}$

30" RCP $H_w/d = 0.65$ $Q = 18 \text{ cfs}$
 $H_w/d = 1.5$ $Q = 55 \text{ cfs}$

GRAVITY FLOW AT 2% 90 cfs OK.

SWALE A (COMBINED FLOWS @ SWALE A) @ FUTURE CARDIFF CIR.

$Q_5 = 34 \text{ cfs}$ $Q_{100} = 100.3 \text{ cfs}$

42" RCP $H_w/d = 2.0$ $Q = 102 \text{ cfs}$
 $H_w/d = 0.78$ $Q = 35 \text{ cfs}$

GRAVITY FLOW @ 1% = 100 cfs. OK.

NORTHERLY CUL-DE-SAC (POSSIBLE FUTURE) OFF CARDIFF

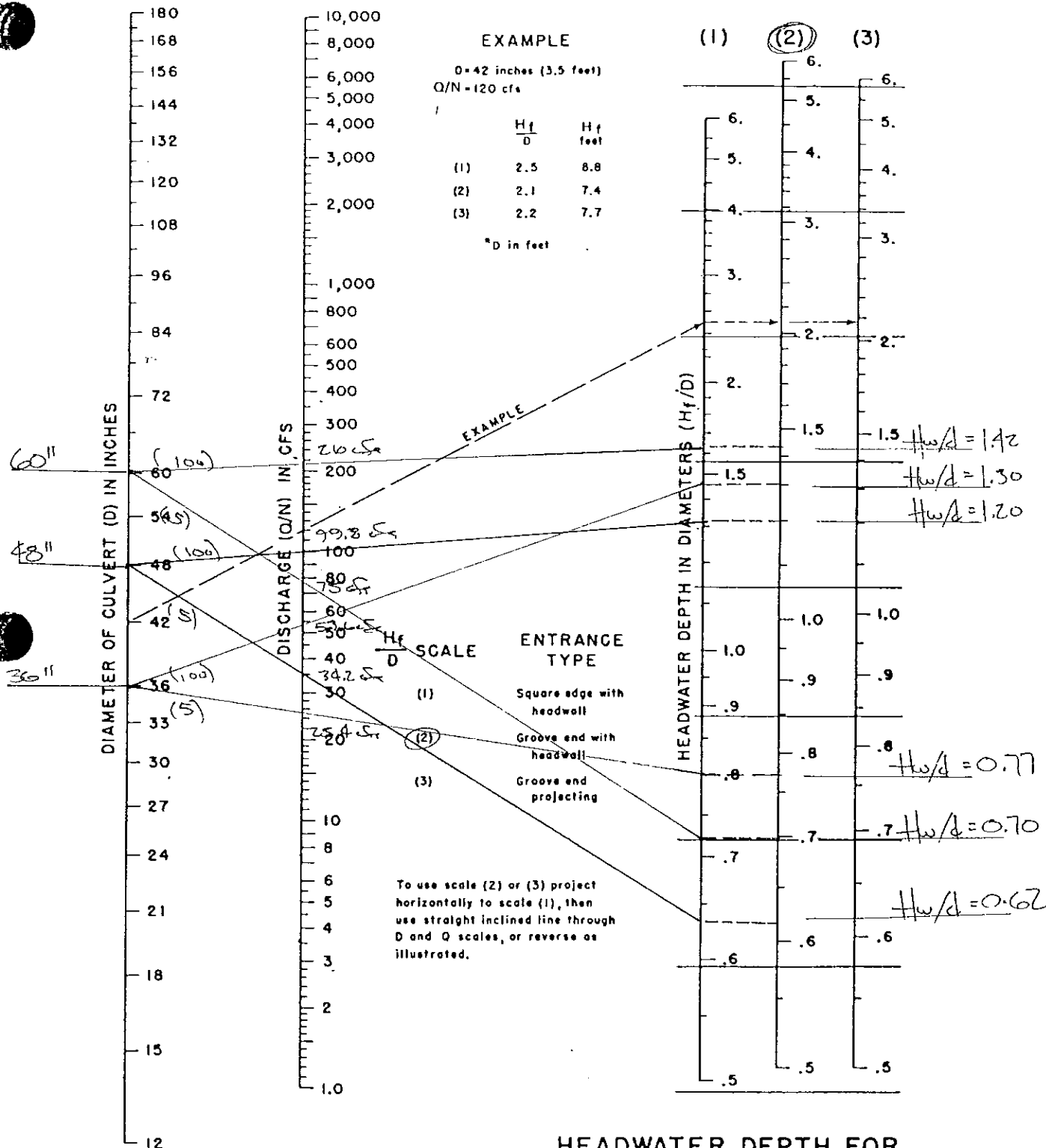
$Q_5 = 18.6 + \text{ cfs}$ $Q_{100} = 52.8 + \text{ cfs}$

36" RCP $H_w/d = 0.7$ $Q = 20 \text{ cfs}$
 $H_w/d = 1.5$ $Q = 55 \text{ cfs}$

GRAVITY FLOW AT 1% 65 cfs. OK.

BROADMOOR BLUFFS CULVERTS

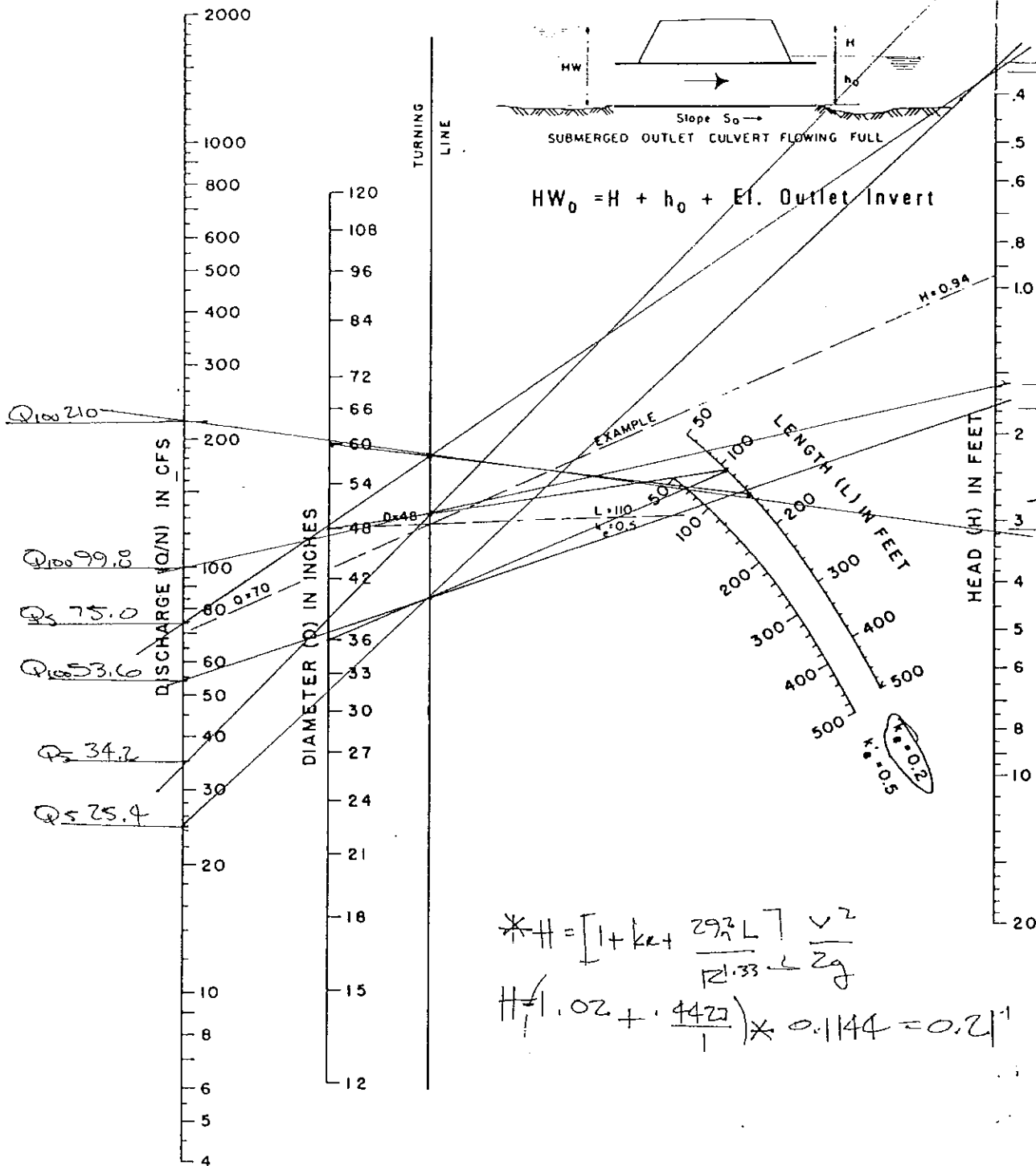
Chart 11 - 1



ROAD/BLUFFS CULVERTS

SEE BELOW *
(FULL FLOW)

Chart 2 - 1



$$*H = \left[1 + k_e + \frac{29.3 L}{12.33 L} \right] \frac{v^2}{2g}$$

$$H = \left(1.02 + \frac{.4423}{1} \right) * 0.1144 = 0.21'$$

HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

BROAD FLAT BLUFFS CULVERTS

FIGURE 7-

PROJECT: E. 3098

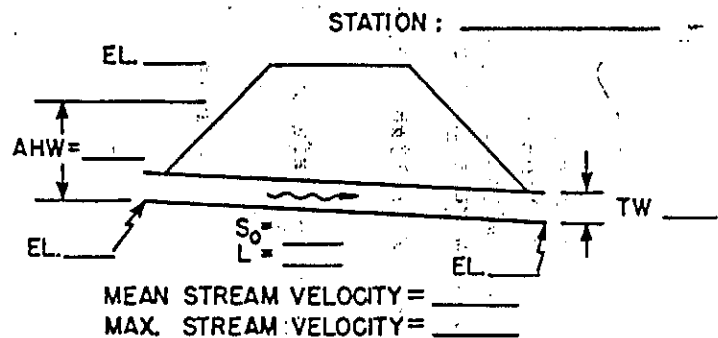
DESIGNER: dlw

DATE: August 22, 84

HYDROLOGIC AND CHANNEL INFORMATION

$Q_1 =$ _____
 $Q_2 =$ _____
 $TW_1 =$ _____
 $TW_2 =$ _____
 ($Q_1 =$ DESIGN DISCHARGE, SAY Q_{25}
 $Q_2 =$ CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH



5-18

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL					HW = H + h ₀ - LS ₀						
			HW/D	HW	K _e	H	d _c	$\frac{d_c + D}{2}$	TW	h ₀	LS ₀	HW				
36" Type 2	25.4	36"	0.77	2.31'	0.2	0.3	1.6	2.30	1.2	2.3	1.0	1.8	INLET	6.8		✓
48" Type 2	57.6	"	1.30	3.9'	0.2	1.75	2.3	2.65	1.7	2.65	1.0	3.3	INLET	7.6		✓
48" Type 2	34.2	48"	0.62	2.48'	0.2	0.21	1.75	2.88	0.4	2.88	1.0	2.09	INLET	5.3		✓
60" Type 2	99.8	"	1.20	4.80'	0.2	1.00	3.0	3.5	0.7	3.5	1.0	4.0	INLET	7.9		✓
60" Type 2	75.0	60"	0.70	3.5'	0.2	3.1	2.6	3.8	1.5	3.8	1.0	5.4	OUT	3.8		✓
60" Type 2	40.0	"	1.42	7.1'	0.2	0.32	3.85	4.42	2.0	4.42	1.4	3.8	INLET	10.7		✓

SUMMARY & RECOMMENDATIONS: SEE CHART

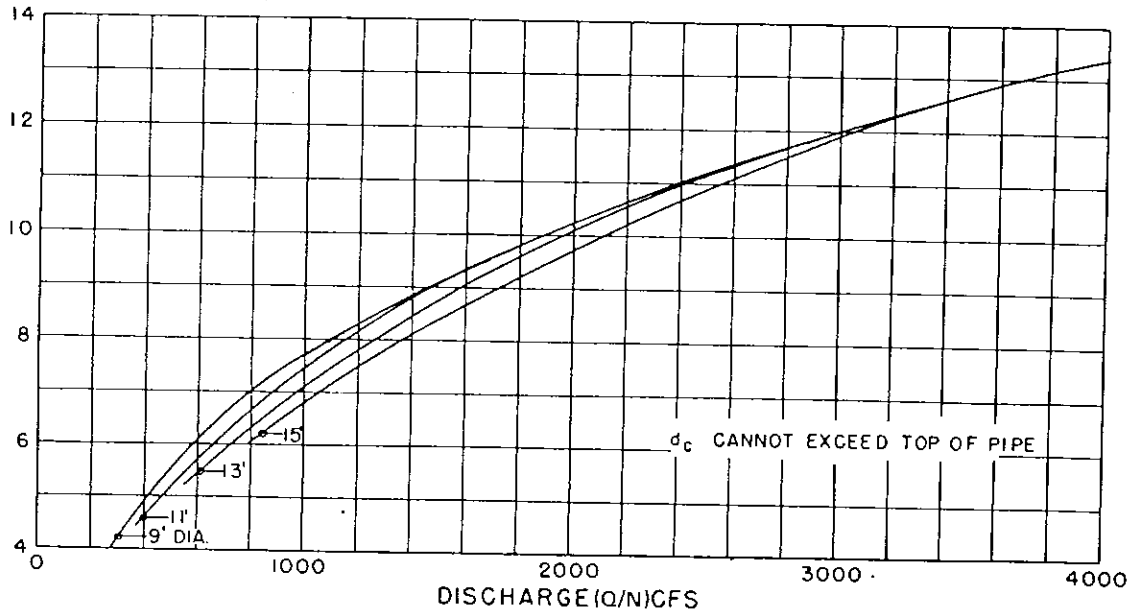
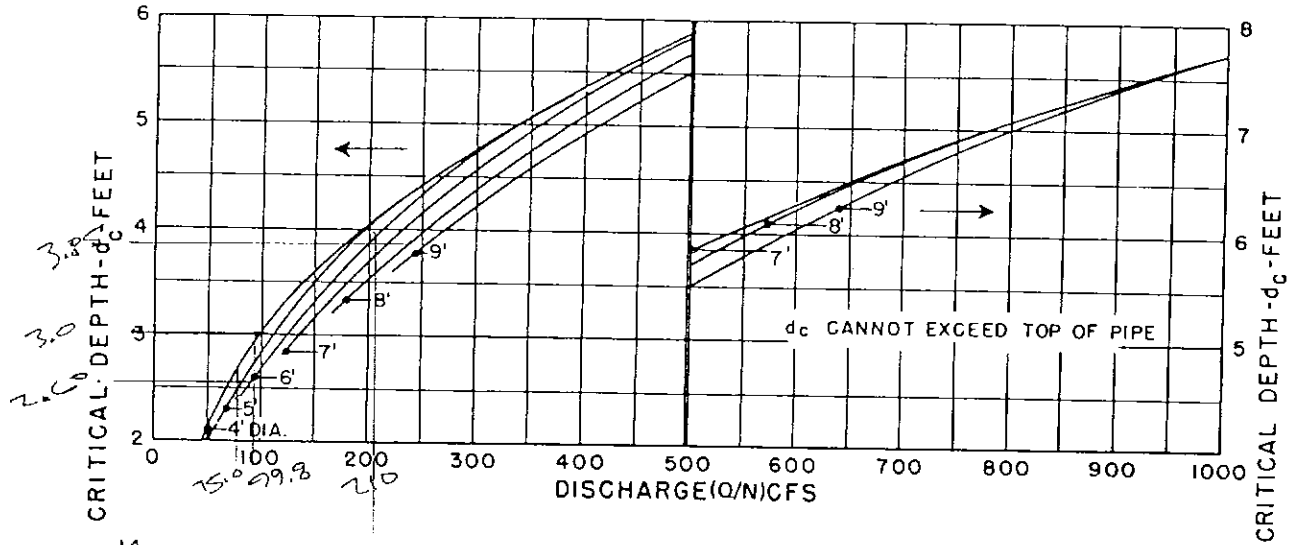
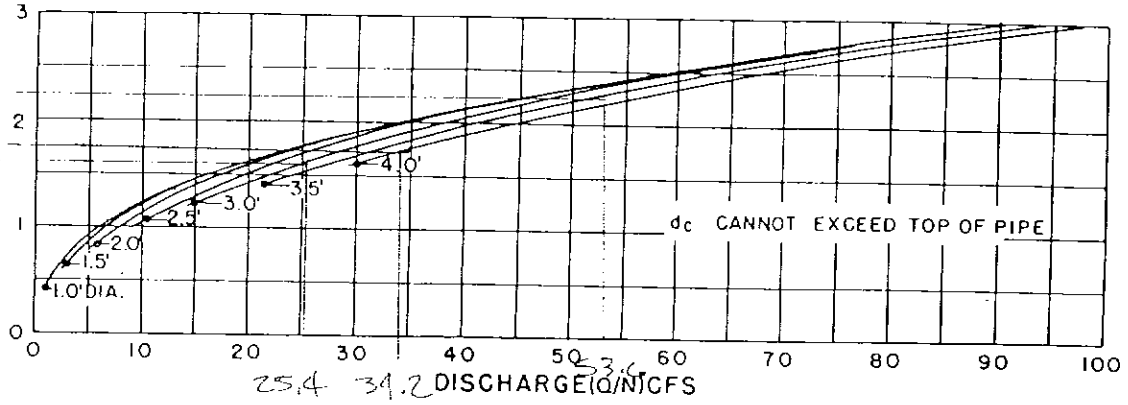
APPROX. HEADWATER NAT. SWALE FLOW TABLE No. 8

Figure 7

6/3/84

Chart 6-1

2.3
1.75
.6



BUREAU OF PUBLIC ROADS

JAN. 1964

13-70

CRITICAL DEPTH
CIRCULAR PIPE

OUTLET VELOCITIES

TABLE NO. 8

Area of Flow Prism in
Partly Full Circular Conduit

Let $\frac{\text{Depth of Water}}{\text{Diameter of Conduit}} = \frac{y'}{D}$ and Tabulated Value = C_a . Then Area = $C_a D^2$

$\frac{y'}{D}$.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.0000	.0013	.0037	.0069	.0105	.0147	.0192	.0242	.0294	.0350
.1	.0409	.0470	.0534	.0600	.0668	.0739	.0811	.0885	.0961	.1039
.2	.1118	.1199	.1281	.1365	.1449	.1535	.1623	.1711	.1800	.1890
.3	.1982	.2074	.2167	.2260	.2355	.2450	.2546	.2642	.2739	.2836
.4	.2934	.3032	.3130	.3229	.3328	.3428	.3527	.3627	.3727	.3827
.5	.393	.403	.413	.423	.433	.443	.453	.462	.472	.482
.6	.492	.502	.512	.521	.531	.540	.550	.559	.569	.578
.7	.587	.596	.605	.614	.623	.632	.640	.649	.657	.666
.8	.674	.681	.689	.697	.704	.712	.719	.725	.732	.738
.9	.745	.750	.756	.761	.766	.771	.775	.779	.782	.784

Ref: Table 7-4, "Handbook of Hydraulics," King and Brater, 5th Edition.

$$36'' \left(\frac{5}{8} \right) \frac{y'}{D} = 0.52 \quad .413 \times 3^2 = 3.72 \text{ SF}$$

$$25.4 / 3.72 = 6.8 \text{ fps}$$

$$36'' \left(\frac{100}{100} \right) \frac{y'}{D} = 1.0 = 7.07 \text{ SF}$$

$$53.0 / 7.07 = 7.6 \text{ fps}$$

$$48'' \left(\frac{5}{8} \right) \frac{y'}{D} = .508 = .402 \times 4^2 = 6.43$$

$$34.2 / 6.43 = 5.3 \text{ fps}$$

$$48'' \left(\frac{100}{100} \right) \frac{y'}{D} = 1.0 = 2.56 \text{ SF}$$

$$99.8 / 2.56 = 7.9 \text{ fps}$$

$$60'' \left(\frac{5}{8} \right) \frac{y'}{D} = 1.0 = 19.6 \text{ SF}$$

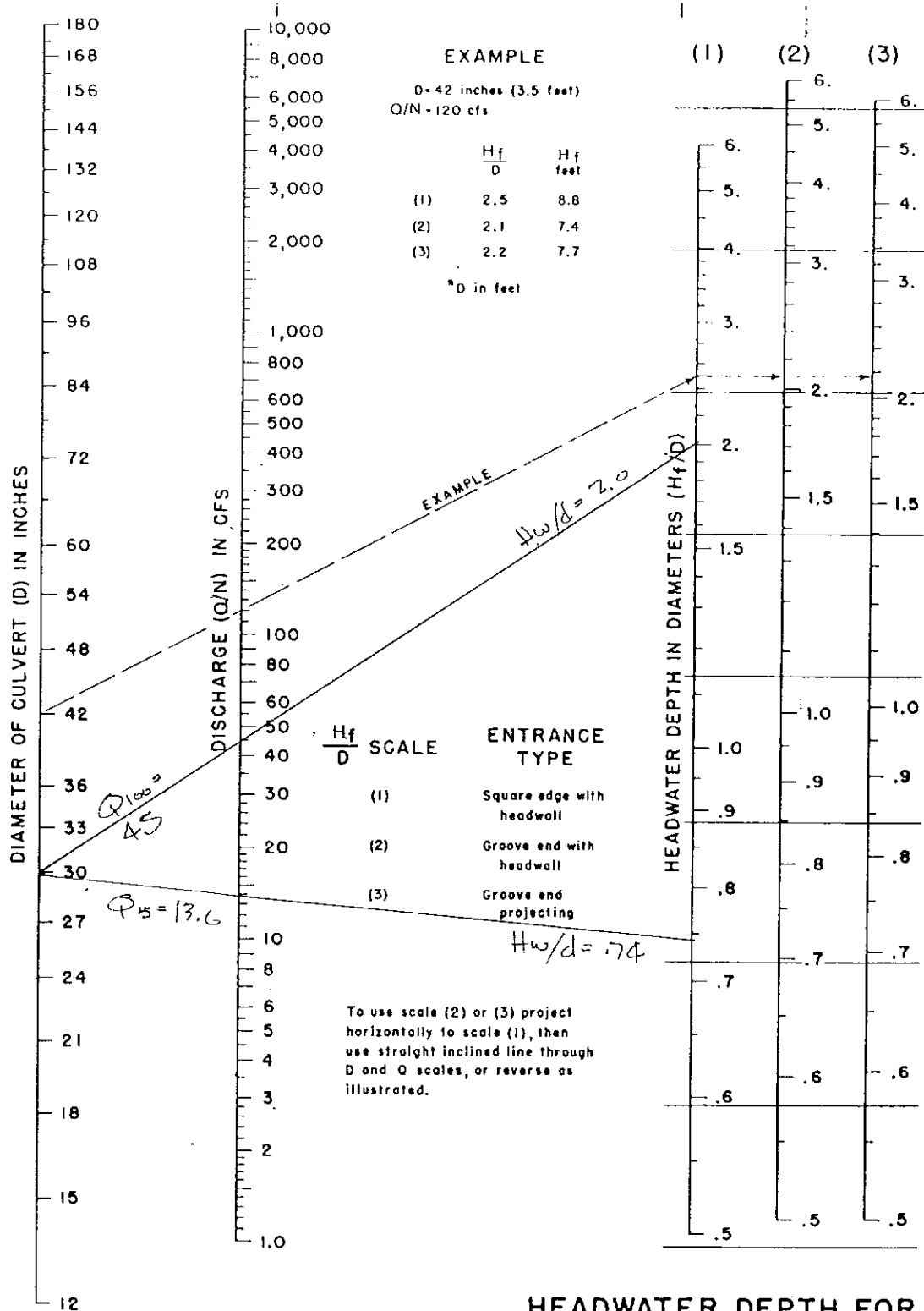
$$78 / 19.6 = 3.9 \text{ fps}$$

$$60'' \left(\frac{100}{100} \right) \frac{y'}{D} = 1.0 = 19.6 \text{ SF}$$

$$210 / 19.6 = 10.7 \text{ fps}$$

EWALE "A" SOUTH E
FUTURE CARDIFF CIRCLE

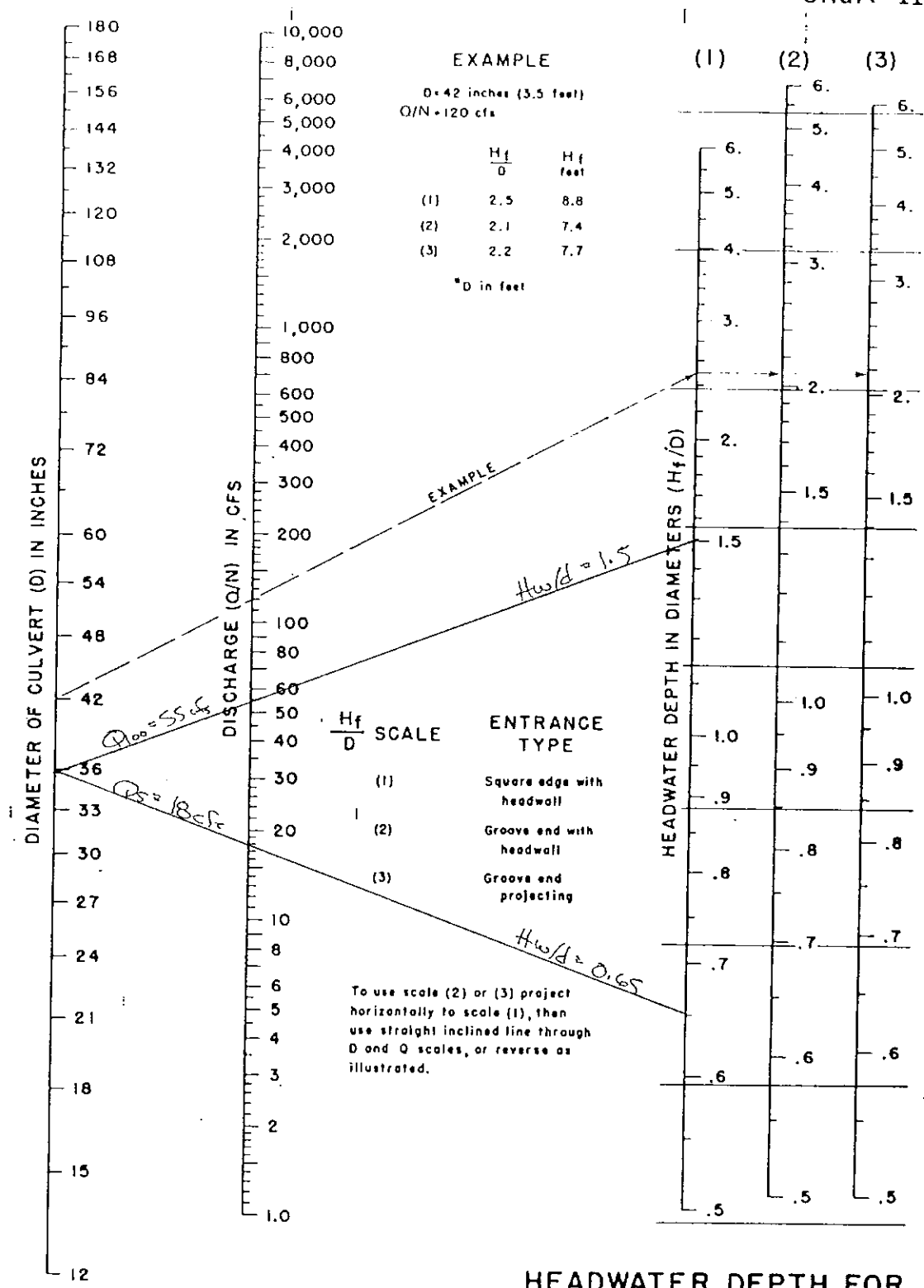
Chart 11-2



HEADWATER DEPTH FOR
CONCRETE PIPE CULVERTS
WITH INLET CONTROL

SWALE "A" NORTH
FUTURE GARBIFF CIRCLE

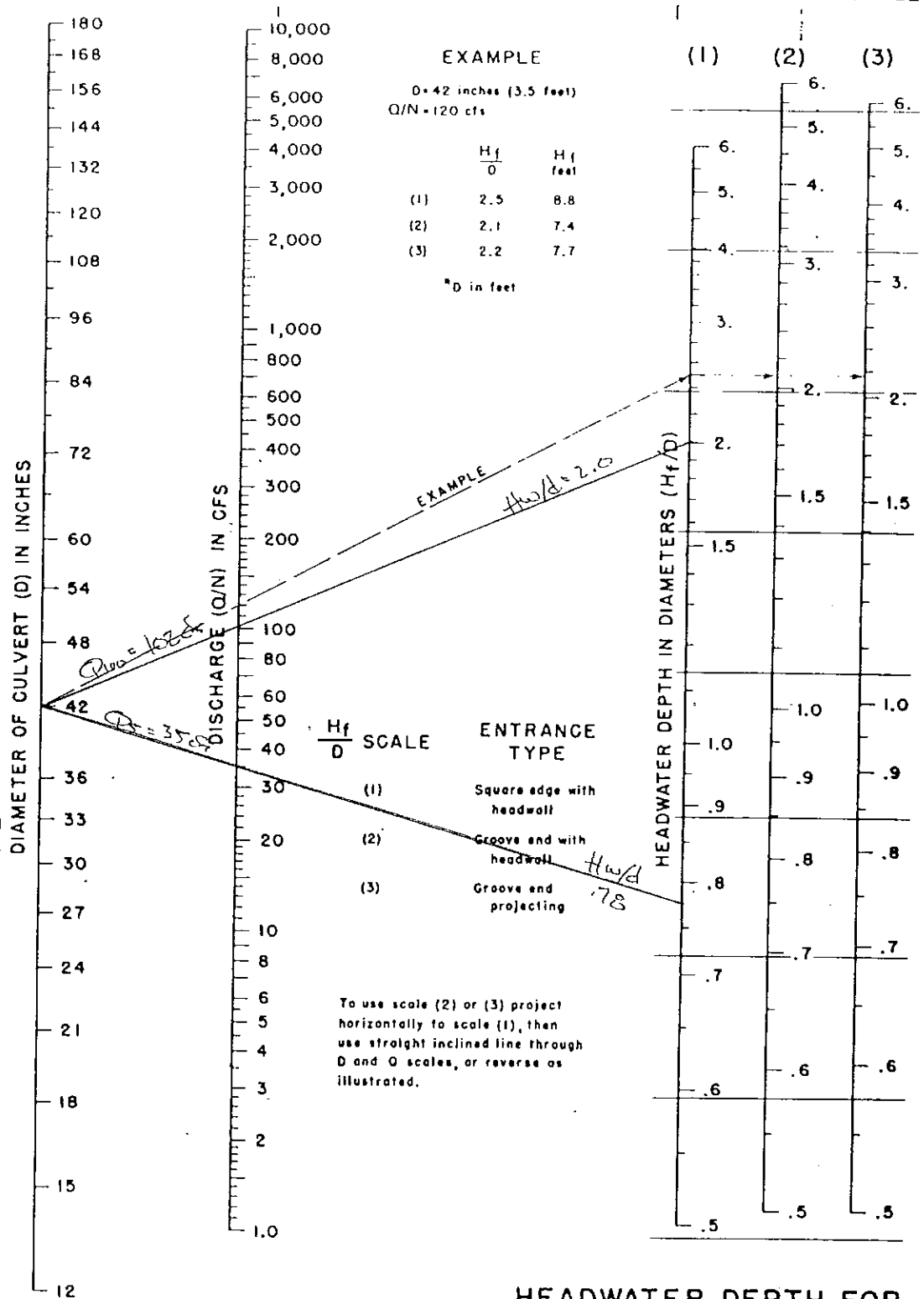
Chart 11-3



HEADWATER DEPTH FOR
CONCRETE PIPE CULVERTS
WITH INLET CONTROL

SWALE "A" @
FUTURE GARDIIF CIR.

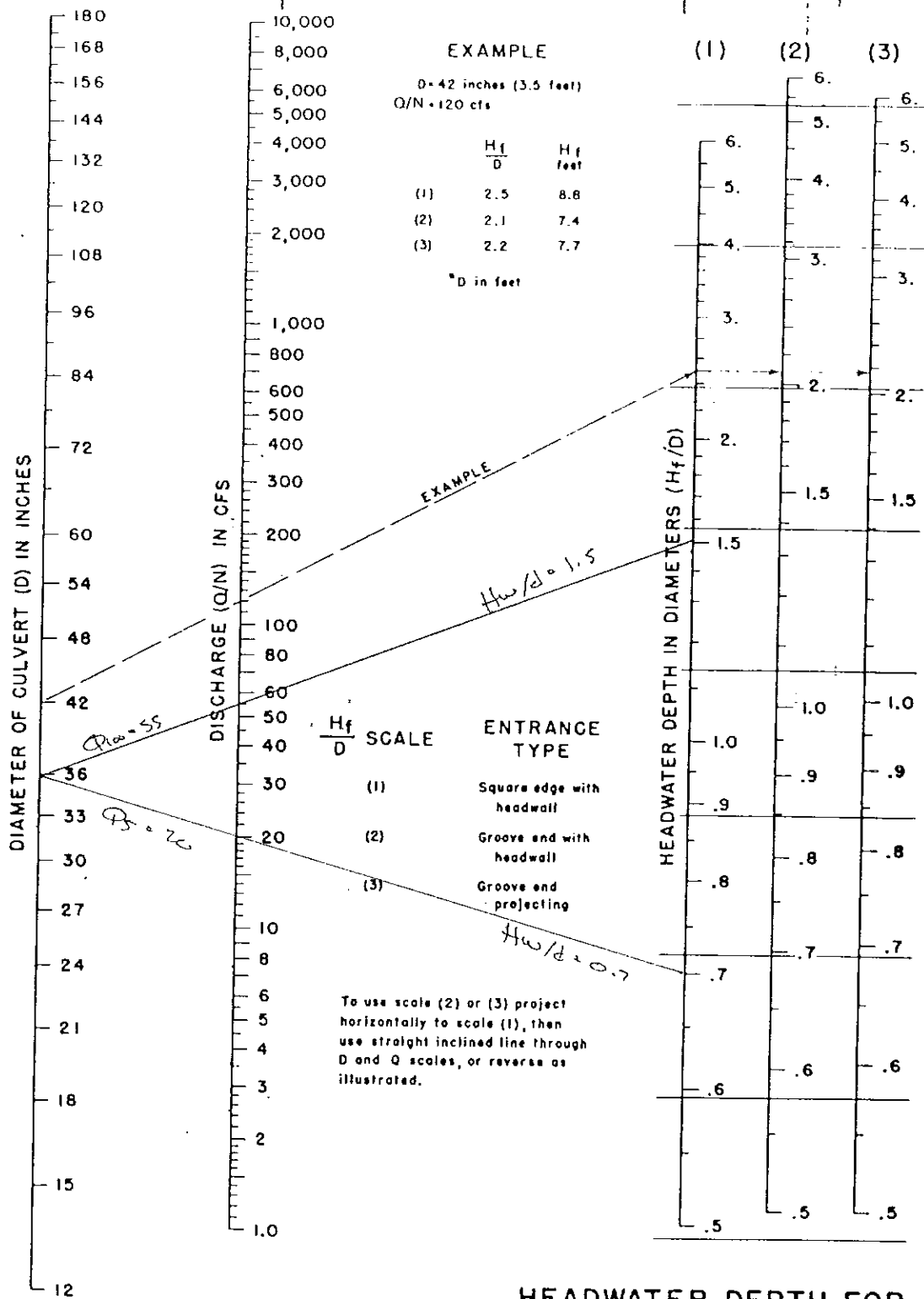
Chart 11-4



HEADWATER DEPTH FOR
CONCRETE PIPE CULVERTS
WITH INLET CONTROL

FUTURE
 GILDE. SAC OFF
 GARDIFF CIRCLE

Chart 11-5



HEADWATER DEPTH FOR
 CONCRETE PIPE CULVERTS
 WITH INLET CONTROL

EXHIBIT "G"
RIP RAP SIZING

Project BLAHOOK BLUFFS STAIRS		EXHIBIT "G"	Job No E 3078
Client GATES LAND CO.		By C.H.H.	Date August 21, 24

48" RCP

OUTLET 100 YR VEL = 7.6 fps
 USE 9" DIA RIP RAP
 INLET USE 9" DIA RIP RAP

36" RCP

OUTLET 100 YR VEL = 7.9 fps
 USE 9" DIA RIP RAP
 INLET USE 9" DIA RIP RAP

60" RCP

OUTLET 100 YR VEL = 10.7 fps
 USE 12" DIA RIP RAP
 INLET USE 12" DIA RIP RAP

NOTE: RIP RAP BED SIZING & BEDDING REQUIRES
 SHALL BE CALCULATED WITH THE STREET CONSTRUCTION
 PLANS

Project BROADMOOR BLUFFS ESTATES	Job No E 3098
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Client GATES LAND CO.	By JH	Date August 21, 84
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EROSION PROTECTION (CONT'D)

TRANSITION OF SWALE "B" TO TEMPORARY BERM & SWALE
AT BROADMOOR BLUFFS DR.

VELOCITY = 7 fps

USE 9" DIAMETER RAP

OUTFALL OF TEMPORARY SWALE TO EXIST SWALE
EAST OF BROADMOOR BLUFFS DR.

VELOCITY 10 fps

USE 12" DIAMETER RAP 18" DEEP MIN.

EXHIBIT "H"
ESTIMATED DRAINAGE STRUCTURE
COST ESTIMATES

EXHIBIT "H"

BROADMOOR BLUFFS ESTATES
COST ESTIMATE
FOR
DRAINAGE STRUCTURE IMPROVEMENTS ALONG
BROADMOOR BLUFFS DRIVES & FARTHING DRIVE

ITEM	UNIT	QUANTITY	UNIT COST	COST
18" RCP (c-76,CI.III)	L.F.	248	25	\$ 6,200.00
36" RCP (c-76,CI.III)	L.F.	88	48	4,224.00
48" RCP (c-76,CI.III)	L.F.	86	75	6,450.00
60" RCP (c-76,CI.III)	L.F.	130	100	13,000.00
18" RCP end sections	Ea.	1	400	400.00
36" RCP end sections	Ea.	2	700	1,400.00
48" RCP end sections	Ea.	2	1100	2,200.00
60" RCP end sections	Ea.	2	1500	3,000.00
9" Rip-rap	Cu. Yd.	400	50	20,000.00
12" Rip-rap	Cu. Yd.	300	50	15,000.00
Std 4' inlets	Ea.	1	1500	1,500.00
Std 6' inlets	Ea.	2	2000	4,000.00
Std. 8' sump curb inlets	Ea.	2	3000	6,000.00
4' inlet built over pipe	Ea.	1	1500	<u>1,500.00</u>
			Total	\$ 84,874.00