Date 5/15/95
Made By [illegible]
Checked By
Client ROYAL OAKS
Job No. 7391
Subject DETENTION

GBA
GEORGE BUTLER ASSOCIATES, INC.

Remarks

ROYAL OAKS – TOTAL STORAGE REQUIRED – ALL PHASES 25yr.

= 40.90 ACRES x (3.26 CFS/AC – 2.31 CFS/AC) x 1800 SEC

= 69939 CF

STORAGE CURRENTLY PROVIDED => PHASE 2 BASIN = 30321 CF
PHASE 3 B BASIN = 20100 CF

DETERMINE REMAINING STORAGE TO BE PROVIDED:

69939 CF – (30321 CF + 20100 CF) = 19518 CF

FLOW TO BASIN => 38.00 CFS (15 yr EVENT)
x 1.18
44.84 CFS

ELEVATION VS STORAGE TABLE

ELEV	HEAD (FT)	AREA (SF)	(FT) (Δ)	(CF) INCR. VOL	(CF) ACCUM VOL
499.80	0	0			0
			0.20	29.21	
500.00	0.20	292.98			29.21
			2.0	1427.97	
502.00	2.20	1135.89			1457.18
			2.0	3469.07	
504.00	4.20	2333.18			4926.25
			2.0	6376.43	
506.00	6.20	4043.25			11302.68
			2.0	10261.77	
508.00	8.20	6218.52			21564.45
			2.0	14996.39	
510.00	10.20	8777.87			36560.84
			2.0	20327.54	
512.00	12.20	11549.67			56888.38
			2.0	26419.91	
514.00	14.20	14870.24			83308.29
			2.0	32772.01	
516.00	16.20	17901.77			

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ELEVATION VS OUTFLOW TABLE

ELEV	H (FT)	Q (CFS)
499.80	0	0
500.00	0.15	3.30
502.00	1.70	11.09
504.00	3.70	16.37
506.00	5.70	20.31
508.00	7.70	23.61
510.00	9.70	26.50
512.00	11.70	29.10
514.00	13.70	31.49

$(Q = 0.6(A)\sqrt{2gh})$ (18" RCP ORIFACE)

$$\frac{2S}{\Delta t} + O \Rightarrow \frac{2\,S(CF)}{120\,SEC} + O_{CFS} \Rightarrow 1.6\bar{6}\,S + O$$

2S/Δt + O VS OUTFLOW TABLE

ELEV	STORAGE	OUTFLOW	2S/Δt + O
499.80	0	0	0
500.00	29.21	3.30	3.79
502.00	1457.18	11.09	35.39
504.00	4926.25	16.37	98.47
506.00	11302.68	20.31	208.69
508.00	21564.45	23.61	383.02
510.00	36560.84	26.50	635.85
512.00	56888.38	29.10	977.24
514.00	83308.29	31.49	1419.96

Page 3 Of 7

Date

Made By

Checked By

Client

Job No.

Subject

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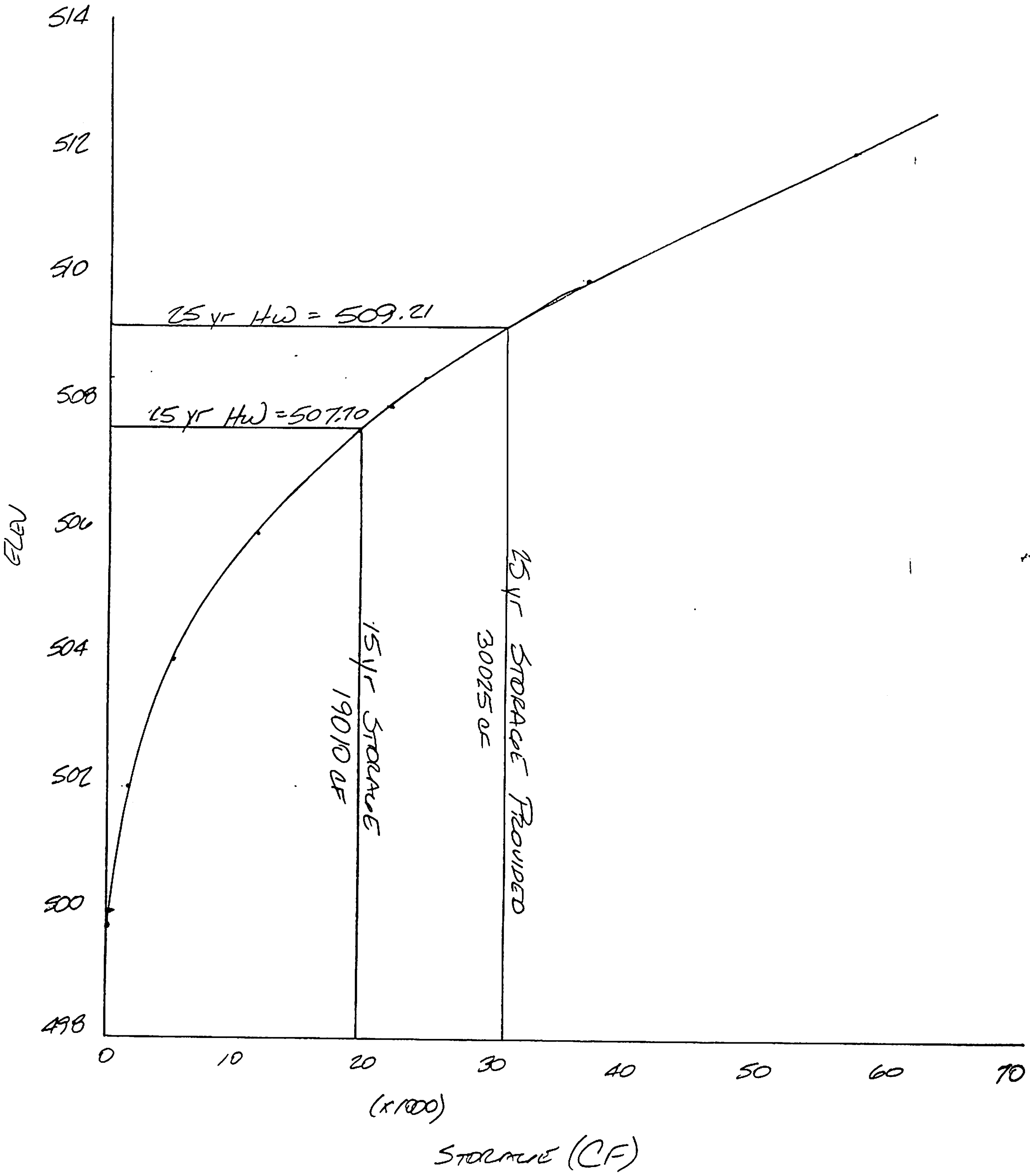
ELEV VS STORAGE
(FT) (CF)



Page 4 Of 7

Date

Made By

Checked By

Client

Job No.

Subject

GBA
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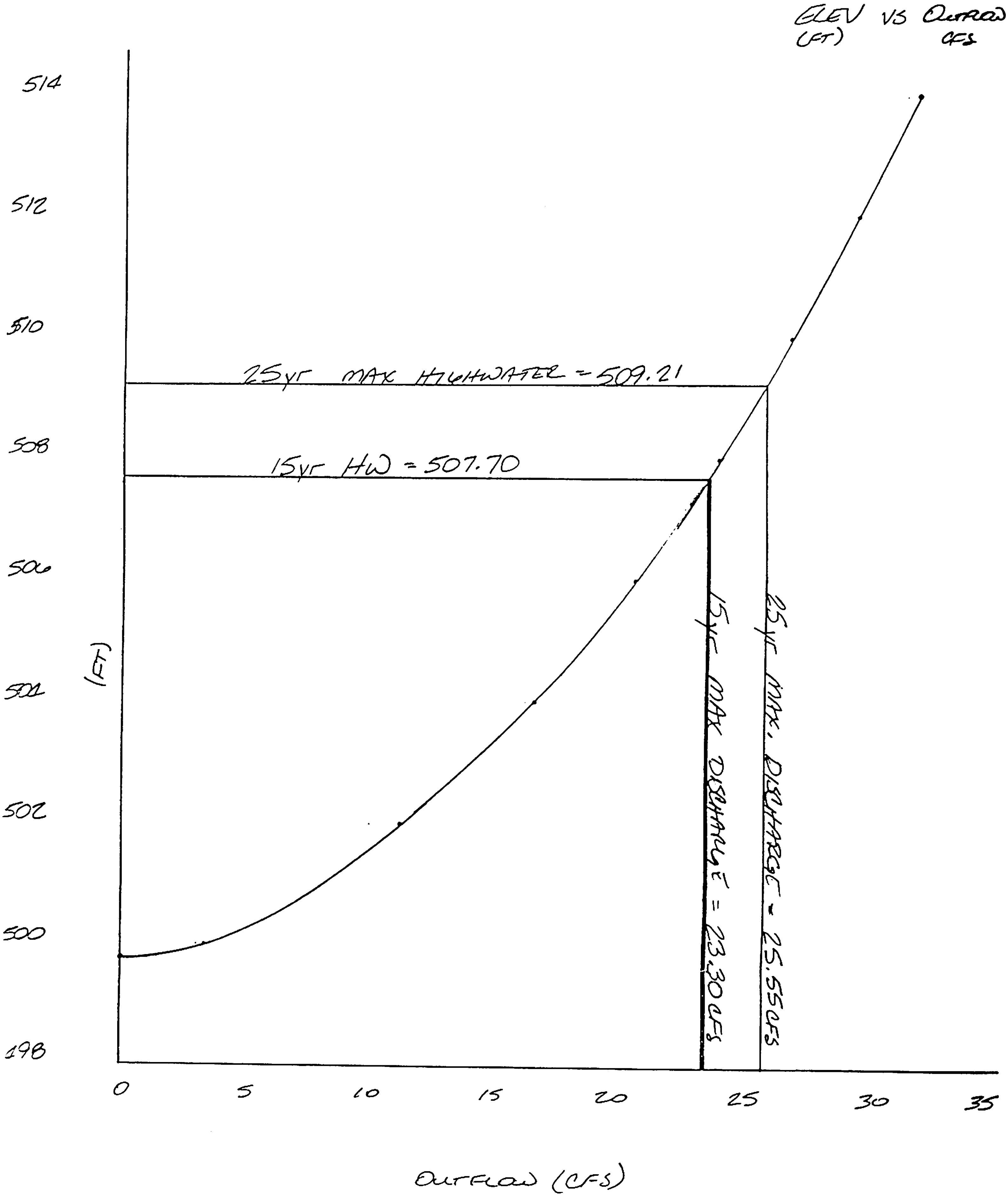
Remarks



GEORGE BUTLER ASSOCIATES, INC.

Page 5 Of 7

Date

Made By

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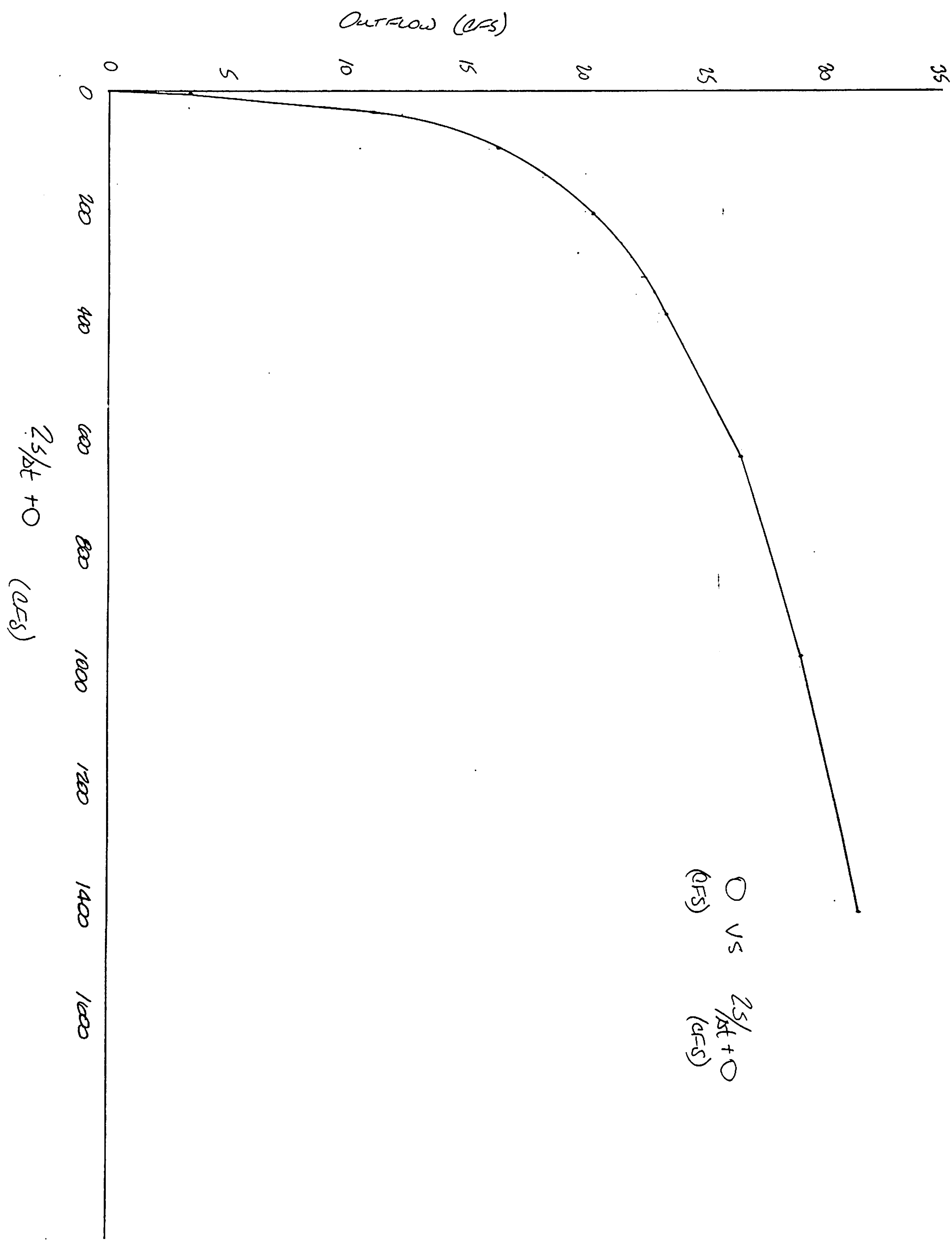
Remarks



GEORGE BUTLER ASSOCIATES, INC.

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Job No.

Subject

Remarks

25 yr ROUTING

TIME	I	I_{n+1}	2S/Δt − O	2S/Δt + O	STORAGE	ELEV	OUTFLOW
0	0	0	0	0	0	499.80	0
2	44.84	44.84	0	44.89			12.20
4	44.84	89.68	20.49	110.17			19.95
6	44.84	89.68	70.27	159.95			18.80
8	44.84	89.68	122.35	212.03			20.35
10	44.84	89.68	171.33	261.01			21.40
12	44.84	89.68	307.89	397.57			23.45
14	44.84	89.68	350.67	440.35			24.00
16	44.84	89.68	392.35	482.03			24.50
18	44.84	89.68	433.03	522.71			25.05
20	44.84	89.68	472.61	562.29	30025CF	509.21	25.55 ← PEAK
22	0	44.84	511.19	556.03			25.50
24	0						
26	0						

STORAGE PROVIDED > STORAGE RQD. ∴ ✓
(30025CF > 19518CF)

SET SILL OF 100 yr OVERFLOW DEVICE @
ELEV = 509.21

$$Q_{100} = (38.00)(1.39) = 52.82\ \text{CFS}$$

ASSUME 18" RCP IS BLOCKED AND ALL STORMWATER MUST PASS THROUGH THE 100 yr OVERFLOW DEVICE (4 SIDED AREA INLET - ALL SIDES OPEN)

$$Q = CLH^{3/2}$$

$$52.82 = 2.8(2.67)(4)H^{3/2}$$

$$1.46' = H$$

$$100\text{HW ELEV} = 1.46 + 509.21 = 510.67'$$

Date

Made By

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Job No.

Subject

GEORGE BUTLER ASSOCIATES, INC.

Remarks

15 yr ROUTING

TIME	I	I_{N+1}	2S/Δt-O	2S/Δt+O	STORAGE	ELEV	OUTFLOW
0	0	0	0	0	0	499.80	0
2	38.00	38.00	0	38.00			6.30
4	38.00	76.00	25.40	101.40			16.50
6	38.00	76.00	68.40	144.40			18.35
8	38.00	76.00	107.70	183.70			19.50
10	38.00	76.00	144.70	220.70			20.50
12	38.00	76.00	179.70	255.70			21.30
14	38.00	76.00	213.10	289.10			21.85
16	38.00	76.00	245.40	321.40			22.40
18	38.00	76.00	276.60	352.60			22.80
20	38.00	76.00	307.00	383.00	19010 CF	507.70	23.30 ←
22	0	38.00	336.40	374.40			23.15
24	0	0					
26	0	0					

Page 1 Of 2

GBA
GEORGE BUTLER ASSOCIATES, INC.

Date

Made By

Checked By

Client ED KREUTZ

Job No. 7391

Subject ROYAL OAKS

Remarks

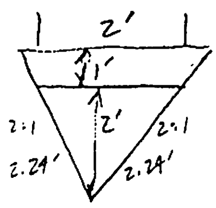
SIZE SWALE IN DETENTION BASIN

SLOPE = 6.54% USE GROUTED RIP-RAP – $n = 0.035$

Q = 38 cfs

FREEBOARD = 1'

ASSUME 3' DEEP V-DITCH



$$A = \tfrac{1}{2}\,2(2) = 2\ ft^2$$

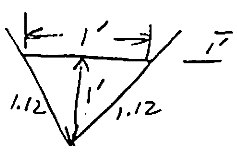
$$R = 2.24(2) = 4.48\ ft$$

$$V = \frac{1.486}{.035}(.0654)^{1/2}(4.48)^{2/3}$$

$$V = 29.51\ ft/s$$

$$Q = AV = 29.51(2) = 59.02 > 38$$ NO TOO BIG

ASSUME 2' DEEP V-DITCH



$$A = \tfrac{1}{2}(1)(1) = .5\ ft^2$$

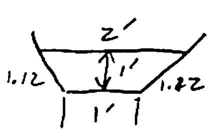
$$R = 2(1.12) = 2.24\ ft$$

$$V = \frac{1.486}{.035}(.0654)^{1/2}(2.24)^{2/3}$$

$$V = 18.59\ ft/s$$

$$Q = AV = 18.59\ ft/s\,(.5\ ft^2) = 9.30\ cfs < 38$$ NO TOO SMALL

ASSUME 2' DEEP FLAT-BOTTOM w/ 1' BOTTOM



$$A = \left(\frac{2+1}{2}\right)(1) = 1.5\ ft^2$$

$$R = 2(1.12)+1 = 3.24\ ft$$

$$V = \frac{1.486}{.035}(.0654)^{1/2}(3.24)^{2/3}$$

$$V = 23.77\ ft/s$$

$$Q = 23.77\ ft/s\,(1.5\ ft^2) = 35.66\ cfs < 38$$ TOO SMALL

GEORGE BUTLER ASSOCIATES, INC.

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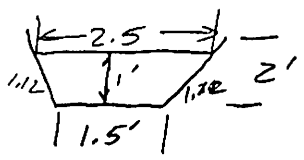
Job No.

Subject

Remarks

ASSUME 2' DEEP FLAT BOTTOM W/ 1.5' BOTTOM



$$A = \left(\frac{2.5+1.5}{2}\right)(1) = 2\ ft^2$$

$$R = 2(1.12)+1.5 = 3.74\ ft$$

$$V = \frac{1.486}{.035}(.0654)^{1/2}(3.74)^{2/3}$$

$$V = 26.16\ ft/s$$

$$Q = 26.16(2) = 52.32\ cfs$$ USE

GEORGE BUTLER ASSOCIATES, INC.

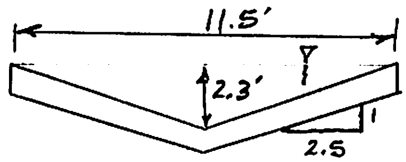
Page 1 Of 1
Date 5-15-92
Made By P. Lorton
Checked By
Client Ed Krentz
Job No. 6489
Subject Royal Oaks 3B

Remarks

SWALE IN DETENTION BASIN #2

From FHWA Hydraulic Circular No. 15 October 1975 ✓

For RipRap stone size of 0.75', Chart 27 (attached) indicates a maximum flow depth of 2.5 ft at the proposed swale slope of 2.4%.



N.T.S.

For triangular swale with depth, width, and sideslopes, as shown:

$Q = AV$

$Q = 115.3\ cfs$

$A = 13.2\ sq.ft$

$V = \frac{115.3\ cfs}{13.2\ sq.ft}$

$V = 8.7\ ft/sec$

Stable velocity for rip-rap lined swale.

n = .0377

$V = \frac{1.486}{.0377} \left(\frac{13.2_A}{12.4_{WP}}\right)^{2/3} (.024)^{1/2} = 6.36 \approx 6.4\ CFS$

(1.066)

1.043

$Q = VA = 84.4\ CFS \approx 85\ CFS$ 73% OF 15 YEAR STORM

OK
F.G.

Design of Stable Channels with Flexible Linings

Hydraulic Engineering Circular No. 15 October 1975

Reprinted March 1977

Prepared by the Hydraulics Branch, Bridge Division, Office of Engineering, Federal Highway Administration, Washington D.C. 20590

CONTENTS

U. S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

Reprinted December 1978

If the designer has no knowledge of the erodibility of the soil at a particular channel site, a reasonable estimate of d_{max} may be obtained by interpolating half-way between the "erosion resistant" and "erodible" lines of the maximum permissible depth charts (except Chart 27 for rock riprap, where no range is given because the underlying soil has no influence on the erosion resistance of the riprap lining).

Hydraulic Resistance

The flow velocity charts were developed to define the relationship between the hydraulic radius of the channel, R, longitudinal slope of the channel, S_o, and mean channel velocity, V, for a given channel lining. For some linings, such as rock riprap of a given size and fiber glass roving tacked with asphalt, the Manning equation may be used since the n value is essentially constant. For rock riprap, the Manning n value varies with mean stone size, as follows (6):

$$n = 0.0395\ D_{50}^{1/6}$$

Thus, the following n values apply for common stone sizes:

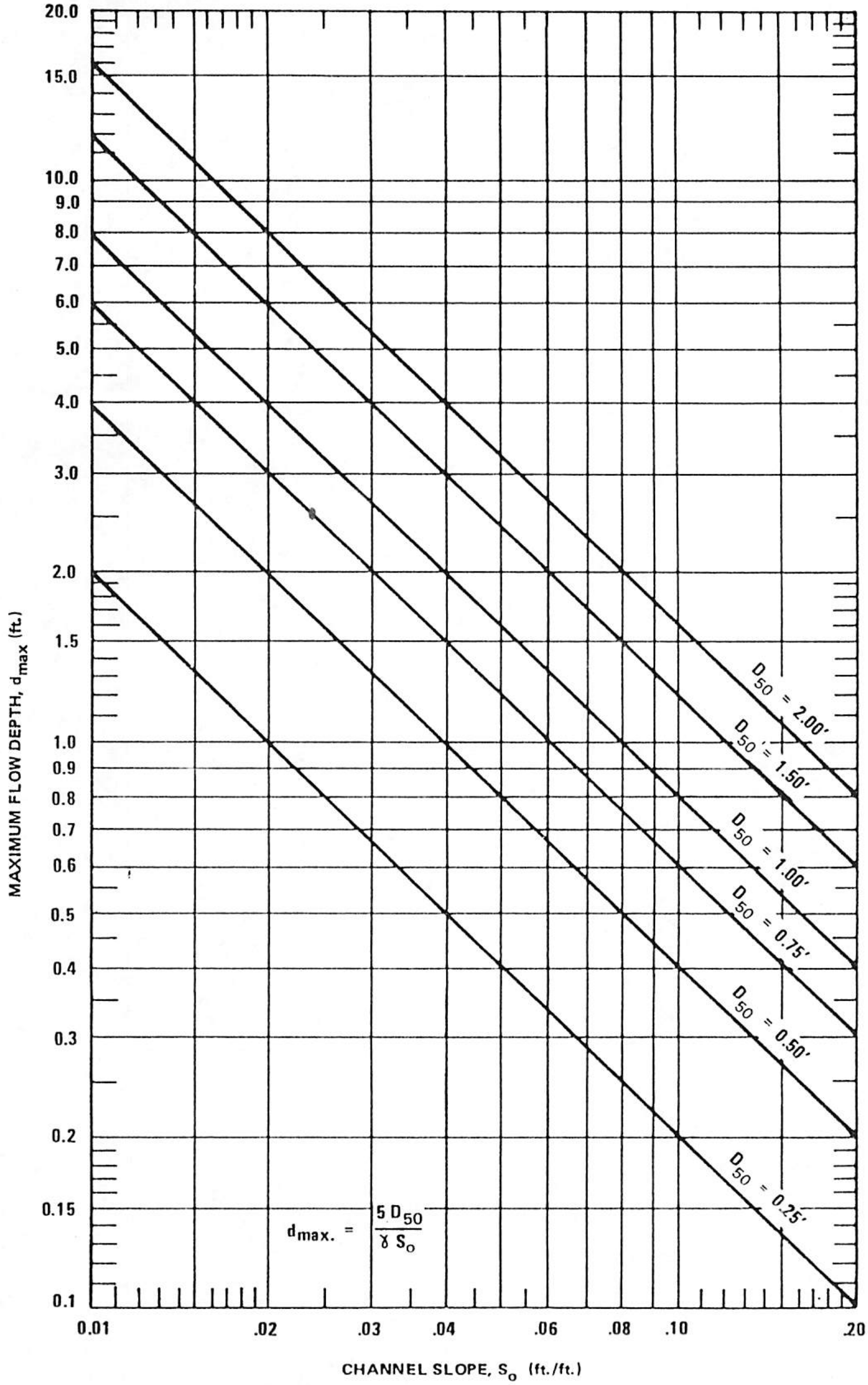
D_{50} (ft.)	n
0.25	0.0314
0.50	0.0352
0.75	0.0377
1.00	0.0395
1.50	0.0423

For fiber glass roving tacked with asphalt, Cox (4) found that the Manning n value was approximately a constant:

	Smooth Rolled Channels	Channels with Clods and Tracks
Single layer	0.030	0.035
Double layer	0.020	0.025

The higher values of n were used in the development of Charts 5 and 6, assuming that most highway channels will be rather rough after seeding and mulching.

Chart 27



MAXIMUM PERMISSIBLE DEPTH OF FLOW (d_{max})
FOR CHANNELS LINED WITH ROCK RIPRAP

16
14
12
10
VELOCITY, V (ft./sec.)