VERTICAL ALIGNMENT CALCULATIONS

NORTHERN AVENUE BRIDGE OVER THE NEW RIVER

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CONTRACT NO. FCD 89-04

FLOOD CONTROL DISTRICT
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	FINANCE		FILE
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REMARKS

BRW

PLANNING
TRANSPORTATION
ENGINEERING
URBAN DESIGN

BRW, INC.
2700 NORTH CENTRAL AVENUE, SUITE 1000, PHOENIX, AZ 85004

FLOOD CONTROL DISTRICT of MARICOPA COUNTY

Vertical Alignment Calcs:

Design Ref: "A Policy on Geometric Design of Highways and Streets" AASHTO, 1984

Note: Design for 55 MPH. The existing road is posted @ 50 MPH. Design for 55 MPH

Misc. Design Conditions:

Match existing pavement before entering the 99th Ave. Intersec. The intersection is not to be reconstructed.
The curb returns end @ Sta: 53+80±.

Match the existing pavement @ the west end of project as soon as practical to reduce construction costs.

Stopping Sight Distance @ 55 MPH = 550 Ft. /

See table III-32, attached as sheet # 4 of 7 /.
(crest curves)
& table III-34, attached as sheet # 7 of 7 /
(sag curves)

Profile Drawing is attached herewith @ end of calcs. for reference.

Minimum K Values

crest curves = 220 (table III-32) /

sag curves = 130 (table III-34) /

BRW
MINNEAPOLIS PHOENIX

JOB MCFCD Northern Ave. SHEET NO. 1 of 7
MADE BY DRN DATE 10/4/89 JOB NO. 33-8960
CHECKED BY [illegible] DATE 11-5-89 SEC. SHT. NO.
CALCULATIONS FOR Vertical Alignment

Basic Design Formulas: Vertical Curve Lengths

Crest Vertical Curves: (See figure III-39 sh. 5 of 7)

where: S = Stopping Sight Distance, ft.
L = V.C. Length, ft.
A = Algebraic Grade Diff.

when: $S < L$

$$L = \frac{AS^2}{1329} \quad \text{(page 306)}$$

when: $S > L$

$$L = 2S - 1329/A$$

Sag Vertical Curves: (See figure III-40 sh. 6 of 7)

when: $S < L \Rightarrow L = \frac{AS^2}{400 + 3.5(S)}$

Headlight Distance Controll ($S = 550'$) when: $S > L \Rightarrow L = 2S - \frac{400 + 3.5(S)}{A}$

For Comfort $\Rightarrow$ use $L = AV^2/46.5$ @ $V = 55$ mph

Vertical Curve Design Criteria Check:

@ Sta: 38+70 to 41+30 $\quad -0.15\% \quad +1.50\%$

$A = 1.65$ @ $L = 260' \Rightarrow K = 158 > 130$ ✓ OK

Comfort $\Rightarrow L = 1.65(55^2)/46.5 = 107' << 260$ ✓ OK

Headlight $\Rightarrow$ ($S > L$) $\quad L = 2(550) - \frac{400 + 3.5(550)}{1.65} = (\cancel{309})$ N.A. ✓ OK

JOB MCFCD Northern Ave. SHEET NO. 2 of 7 (Rev. 10/5)
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CHECKED BY ____ DATE ____ SEC. SHT. NO. ____
CALCULATIONS FOR Vertical Alignment

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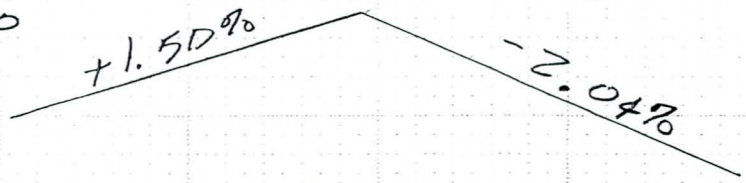
Sta: 42+30 to 50+30



$A = 3.54$

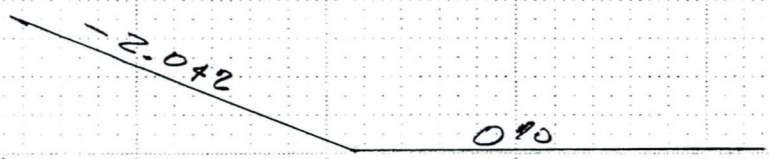
$CL = 800'$ $K = 226 > 220$ ✓ OK

$S = 550'$

$@\ S < L$ $L = AS^2/1329 = \frac{3.54(550^2)}{1329} = 806' < 800'$ ✓ OK

✓ Note: This is OK, 550' is on the "high end" of criteria.

Sta: 50+30 to 53+70



$A = 2.04$

$CL = 340'$ $K = 167 > 130$ ✓ OK

Comfort $\Rightarrow L = 2.04(55^2)/46.5 = 133' < 340'$ ✓ OK

Headlight $@\ S > L$ $\Rightarrow L = 2(550) - \frac{400 + 3.5(550)}{2.04} = (40)$ N.A. ✓ OK

JOB MCFCD Northern Ave. SHEET NO. 3 of 7 (Rev. 10/5)

MADE BY DRN DATE 10/5/89 JOB NO. 33-8960

CHECKED BY _____ DATE _____ SEC. SHT. NO. _____

CALCULATIONS FOR Vertical Alignment

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ft and 6 in.,

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these lines, L line, the A, is a simple each design indicative of ns of K covers thus, A and L lation. The ed length of e in grades in mplified by

ths of vertical ht distances,

Design Speed (mph)	Assumed Speed for Condition (mph)	Coefficient of Friction, f	Stopping Sight Distance, Rounded for Design (ft)	Rate of Vertical Curvature, K[a] (length (ft) per percent of A)	
				Computed[b]	Rounded for Design
20	20-20	0.40	125-125	8.6- 8.6	10- 10
25	24-25	0.38	150-150	14.4- 16.1	20- 20
30	28-30	0.35	200-200	23.7- 28.8	30- 30
35	32-35	0.34	225-250	35.7- 46.4	40- 50
40	36-40	0.32	275-325	53.6- 73.9	60- 80
45	40-45	0.31	325-400	76.4-110.2	80-120
50	44-50	0.30	400-475	106.6-160.0	110-160
55	48-55	0.30	450-550	140.4-217.6	150-220
60	52-60	0.29	525-650	189.2-302.2	190-310
65	55-65	0.29	550-725	227.1-394.3	230-400
70	58-70	0.28	625-850	282.8-530.9	290-540

[a]Different K values for the same speed result from using unequal coefficients of friction.

[b]Using computed values of stopping sight distance.

Table III-32. Design controls for crest vertical curves based on stopping sight distance.

Vertical Curve Design Criteria

Northern Ave.
Road Design # 338960
Dev 10/4/89
Sh. 4 of 7

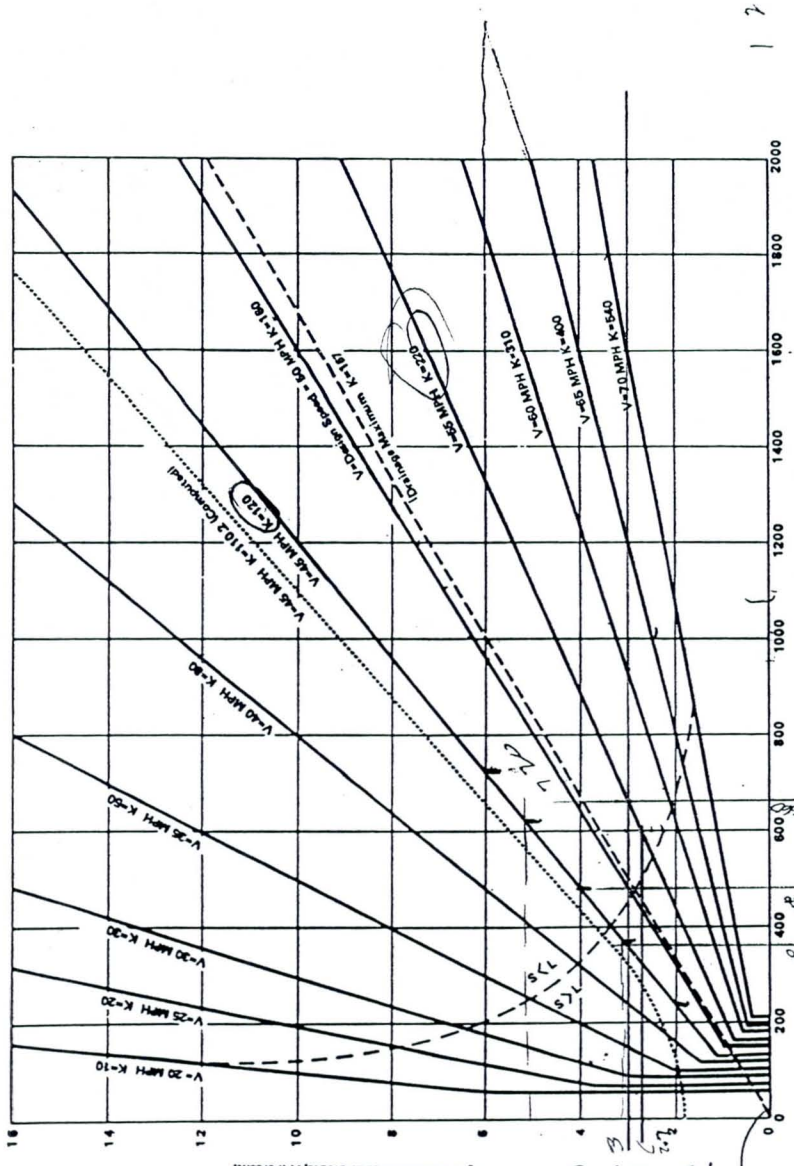

Figure III-39. Design controls for crest vertical curves, for stopping sight distance and open road conditions.

@ 45 MPH
6% - 720'
5% - 620'
4% - 500
3% - 375
2% - 250'

Vertical Alignment

Northern Ave
Road Design
#33-8960
DRN 10/4/89
sh. 5 of 7

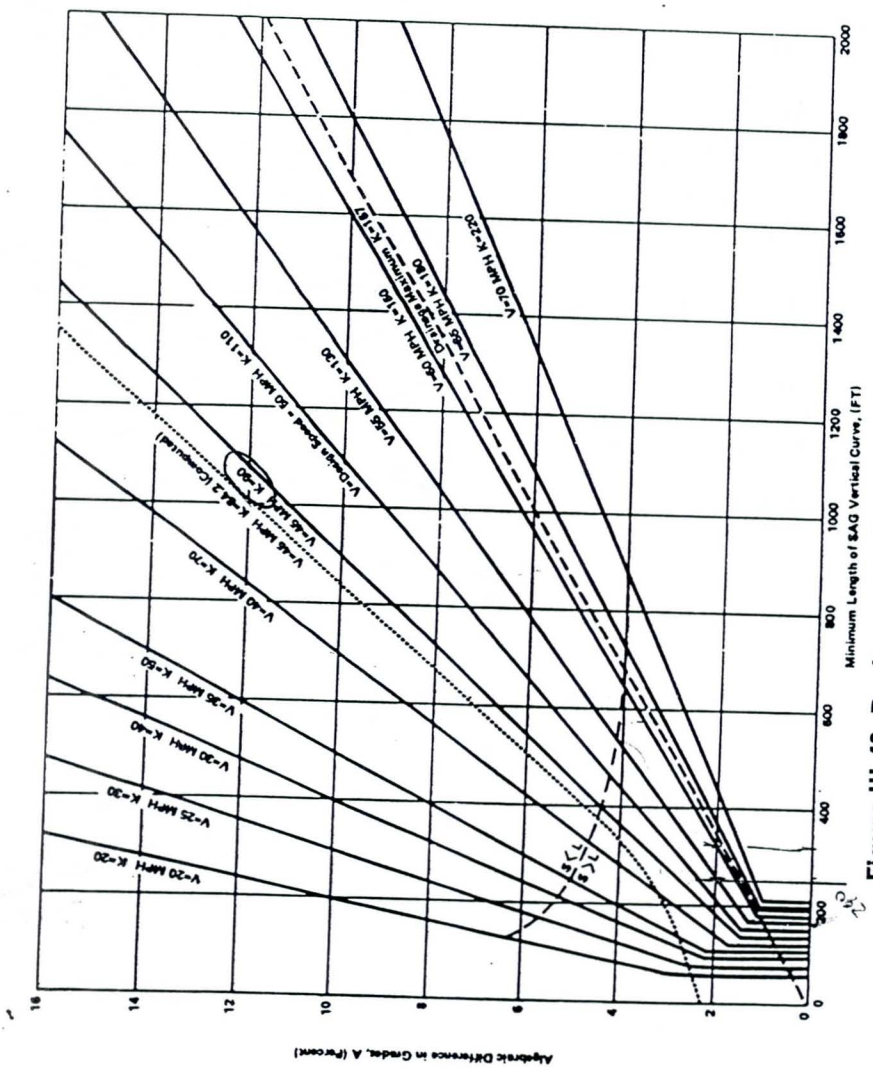

Figure III-40. Design controls for sag vertical curves, open road conditions.

2% - 200'
3% - 300'
4% - 375'
5% - 500'

Northern Arc.
#33-8966
DRN 10/4/89
Sh. 6 of 7

Design Speed (mph)	Assumed Speed for Condition (mph)	Coefficient of Friction, f	Stopping Sight Distance, Rounded for Design (ft)	Rate of Vertical Curvature, K[a] (length (ft) per percent of A)	
				Computed[b]	Rounded for Design
20	20-20	0.40	125-125	14.7- 14.7	20- 20
25	24-25	0.38	150-150	21.7- 23.5	30- 30
30	28-30	0.35	200-200	30.8- 35.3	40- 40
35	32-35	0.34	225-250	40.8- 48.6	50- 50
40	36-40	0.32	275-325	53.4- 65.6	60- 70
45	40-45	0.31	325-400	67.0- 84.2	70- 90
50	44-50	0.30	400-475	82.5-105.6	90-110
55	48-55	0.30	450-550	97.6-126.7	100-130
60	52-60	0.29	525-650	116.7-153.4	120-160
65	55-65	0.29	550-725	129.9-178.6	130-180
70	58-70	0.28	625-850	147.7-211.3	150-220

[a]Different K values for the same speed result from using unequal coefficients of friction.

[b]Using computed values of stopping sight distance.

Table III-34. Design controls for sag vertical curves based on stopping sight distance.

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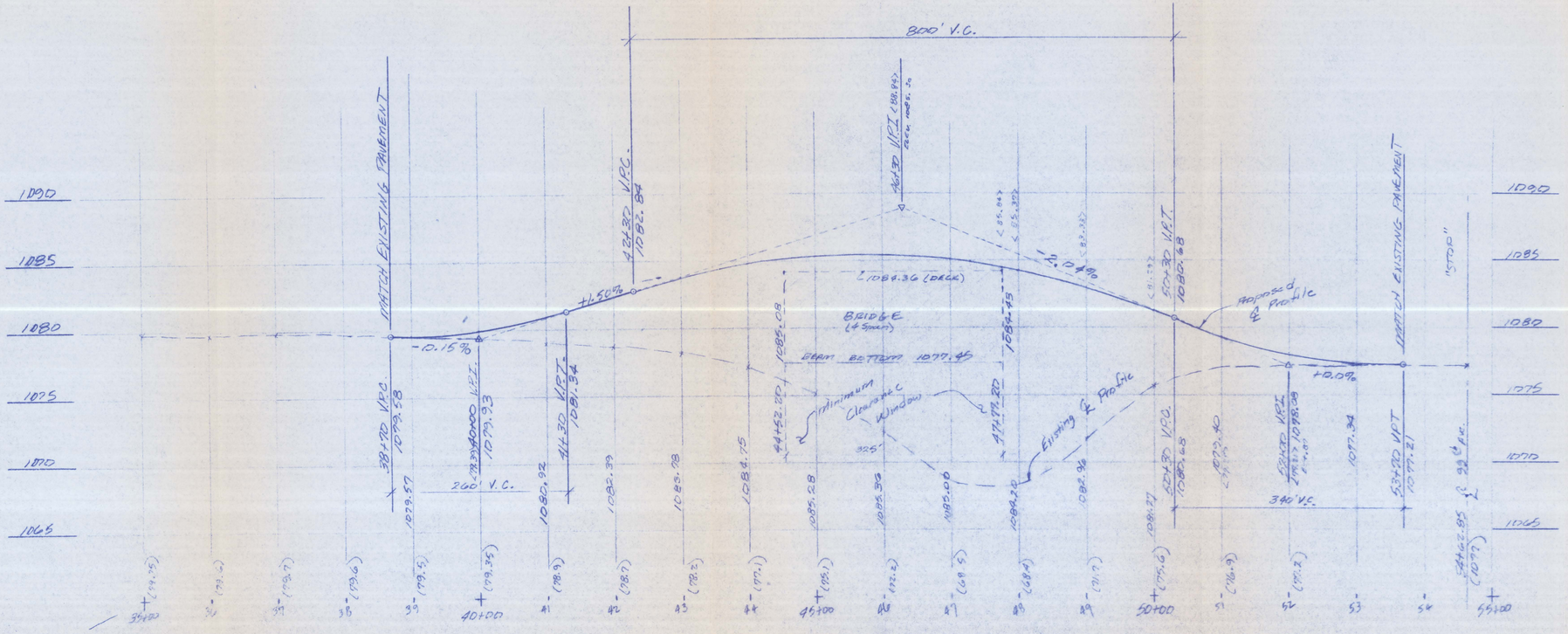
Northern Ave.
#33-8960
DEN 10/4/89
Sh. 7 of 7



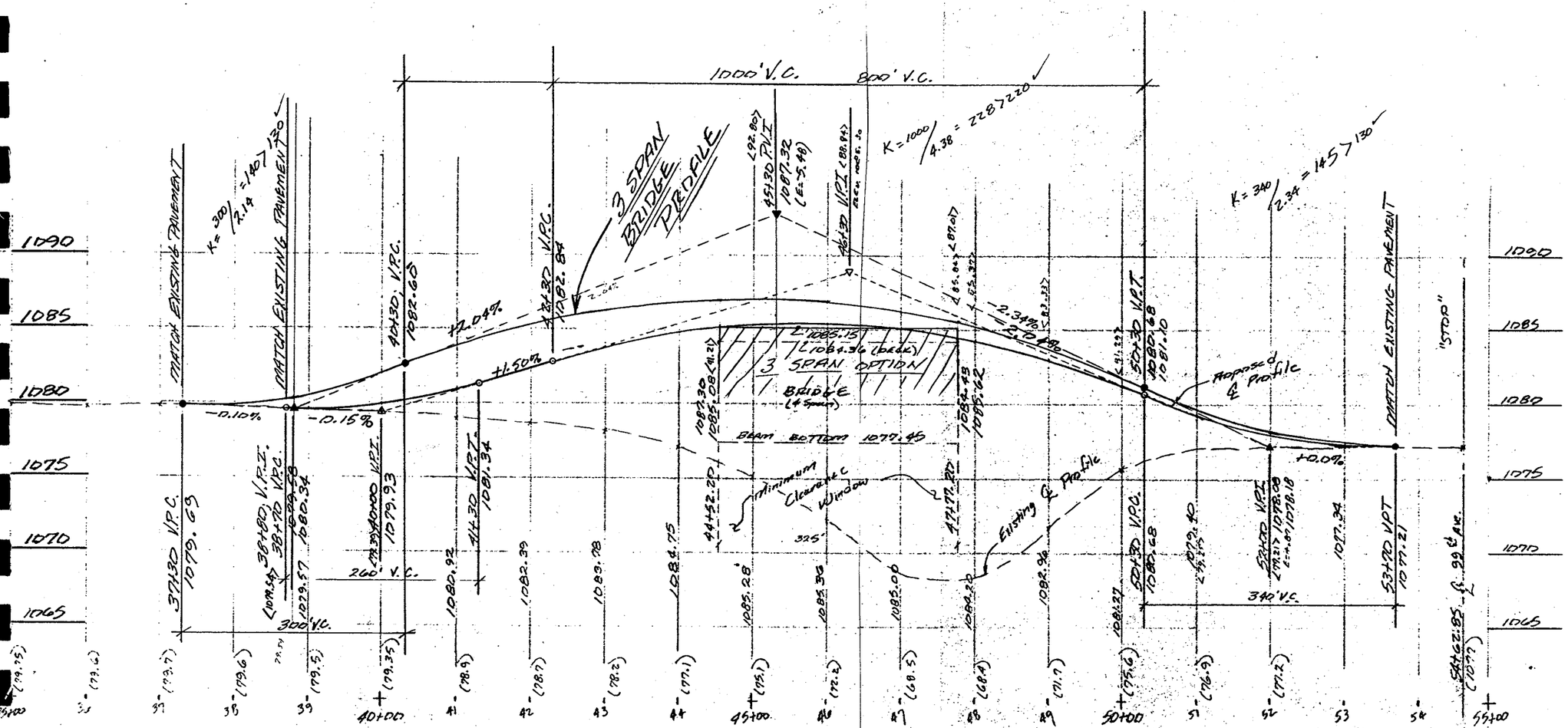
DESIGN SPEED
55 MPH

Profile Scales:
Hor. - 1" = 100'
Ver. - 1" = 5'

BRM# 33-8360
DRN 10/4/99

Northern Avenue
℄ Profile @ 55 MPH

Stopping Sight Distance = 550'



Revised for
3 Span Bridge Option
DRN 10/10/89

DESIGN SPEED
55 MPH

K sag @ 130 min
K crest @ 220 min

Profile Scales:
Hor. - 1" = 100'
Ver. - 1" = 5'

BRN# 33-8960
DEN 10/4/89

Northern Avenue
℄ Profile @ 55 MPH

Stopping Sight Distance = 550'