X-SECTION A PARALLEL TO TRAMWAY - N. OF CEDAR HILL

MANNING'S N = .0250 SLOPE = .0286

POINT	DIST	ELEV	POINT	DIST	ELEV	POINT	DIST	ELEV
1	0.00	83.00	4	58.00	80.40	7	82.00	83.00
2	14.00	82.00	5	64.00	81.00			
3	38.00	81.00	6	69.00	82.00			

WSEL (FT)	DEPTH INC	FLOW AREA (SQ FT)	FLOW RATE (CFS)	WETTED PER (FT)	FLOW VEL (FPS)	TOP WID
80.5	0.1	0.2	0.3	4.3	1.4	4.3
80.6	0.2	0.9	1.9	8.7	2.2	8.7
80.7	0.3	2.0	5.5	13.0	2.8	13.0
80.8	0.4	3.5	11.9	17.4	3.4	17.3
80.9	0.5	5.4	21.6	21.7	4.0	21.7
81.0	0.6	7.8	35.1	26.0	4.5	26.0
81.1	0.7	10.5	54.1	29.0	5.1	28.9
81.2	0.8	13.6	77.3	31.9	5.7	31.8
81.3	0.9	16.9	105.1	34.8	6.2	34.7
81.4	1.0	20.5	137.5	37.7	6.7	37.6
81.5	1.1	24.4	175.0	40.6	7.2	40.5
81.6	1.2	28.6	217.6	43.5	7.6	43.4
81.7	1.3	33.1	265.6	46.4	8.0	46.3
81.8	1.4	37.9	319.3	49.3	8.4	49.2
81.9	1.5	42.9	378.8	52.2	8.8	52.1
82.0	1.6	48.3	444.4	55.2	9.2	55.0
82.1	1.7	53.9	517.3	57.9	9.6	57.7
82.2	1.8	59.8	596.7	60.6	10.0	60.4
82.3	1.9	66.0	682.6	63.3	10.3	63.1
82.4	2.0	72.5	775.3	66.0	10.7	65.8
82.5	2.1	79.2	874.9	68.7	11.1	68.5
82.6	2.2	86.2	981.7	71.4	11.4	71.2
82.7	2.3	93.4	1095.7	74.1	11.7	73.9
82.8	2.4	100.9	1217.3	76.8	12.1	76.6
82.9	2.5	108.7	1346.5	79.5	12.4	79.3
83.0	2.6	116.8	1483.6	82.2	12.7	82.0

X-SECTION B PARALLEL TO TRAMWAY - N. OF CEDAR HILL

MANNING'S N = .0250 SLOPE = .0388

POINT	DIST	ELEV	POINT	DIST	ELEV	POINT	DIST	ELEV
1	0.00	81.00	5	9.00	77.00	9	22.00	80.00
2	4.00	80.00	6	12.00	77.00	10	30.00	81.00
3	6.00	79.00	7	16.00	78.00			
4	6.50	78.00	8	19.00	79.00			

WSEL (FT)	DEPTH INC	FLOW AREA (SQ FT)	FLOW RATE (CFS)	WETTED PER (FT)	FLOW VEL (FPS)	TOP WID
77.1	0.1	0.3	0.8	3.7	2.4	3.7
77.2	0.2	0.7	2.6	4.4	3.6	4.3
77.3	0.3	1.2	5.3	5.0	4.5	5.0
77.4	0.4	1.7	9.0	5.7	5.3	5.6
77.5	0.5	2.3	13.7	6.4	5.9	6.3
77.6	0.6	3.0	19.5	7.1	6.6	6.9
77.7	0.7	3.7	26.3	7.8	7.1	7.6
77.8	0.8	4.5	34.4	8.5	7.7	8.2
77.9	0.9	5.3	43.6	9.1	8.2	8.9
78.0	1.0	6.3	54.2	9.8	8.7	9.5
78.1	1.1	7.2	66.9	10.2	9.3	9.9
78.2	1.2	8.2	80.9	10.7	9.8	10.2
78.3	1.3	9.3	96.0	11.1	10.4	10.6
78.4	1.4	10.3	112.4	11.5	10.9	10.9
78.5	1.5	11.4	130.0	12.0	11.4	11.3
78.6	1.6	12.6	148.8	12.4	11.8	11.6
78.7	1.7	13.8	168.9	12.8	12.3	12.0
78.8	1.8	15.0	190.2	13.2	12.7	12.3
78.9	1.9	16.2	212.8	13.7	13.1	12.7
79.0	2.0	17.5	236.7	14.1	13.5	13.0
79.1	2.1	18.8	260.7	14.6	13.8	13.5
79.2	2.2	20.2	286.2	15.2	14.2	14.0
79.3	2.3	21.6	313.2	15.7	14.5	14.5
79.4	2.4	23.1	341.9	16.3	14.8	15.0
79.5	2.5	24.6	372.1	16.8	15.1	15.5
79.6	2.6	26.2	404.0	17.3	15.4	16.0
79.7	2.7	27.8	437.6	17.9	15.7	16.5
79.8	2.8	29.5	472.9	18.4	16.0	17.0
79.9	2.9	31.2	509.9	19.0	16.3	17.5
80.0	3.0	33.0	548.8	19.5	16.6	18.0
80.1	3.1	34.9	577.5	20.7	16.6	19.2
80.2	3.2	36.8	609.5	21.9	16.5	20.4
80.3	3.3	38.9	644.8	23.1	16.6	21.6
80.4	3.4	41.2	683.5	24.4	16.6	22.8
80.5	3.5	43.5	725.5	25.6	16.7	24.0
80.6	3.6	46.0	770.9	26.8	16.8	25.2
80.7	3.7	48.5	819.7	28.0	16.9	26.4
80.8	3.8	51.2	872.0	29.2	17.0	27.6
80.9	3.9	54.1	927.8	30.5	17.2	28.8
81.0	4.0	57.0	987.3	31.7	17.3	30.0

X-SECTION C PARALLEL TO CEDAR HILL - E. SIDE OF TRAMWAY

MANNING'S N = .0350 SLOPE = .0455

POINT	DIST	ELEV	POINT	DIST	ELEV	POINT	DIST	ELEV
1	0.00	82.00	4	13.00	79.00	7	44.00	80.00
2	5.00	81.00	5	23.00	78.00	8	67.00	81.00
3	9.00	80.00	6	35.00	79.00	9	90.00	82.00

WSEL (FT)	DEPTH INC	FLOW AREA (SQ FT)	FLOW RATE (CFS)	WETTED PER (FT)	FLOW VEL (FPS)	TOP WID
78.1	0.1	0.1	0.1	2.2	1.2	2.2
78.2	0.2	0.4	0.9	4.4	1.9	4.4
78.3	0.3	1.0	2.5	6.6	2.5	6.6
78.4	0.4	1.8	5.4	8.8	3.1	8.8
78.5	0.5	2.8	9.9	11.0	3.6	11.0
78.6	0.6	4.0	16.0	13.3	4.0	13.2
78.7	0.7	5.4	24.2	15.5	4.5	15.4
78.8	0.8	7.0	34.5	17.7	4.9	17.6
78.9	0.9	8.9	47.3	19.9	5.3	19.8
79.0	1.0	11.0	62.6	22.1	5.7	22.0
79.1	1.1	13.3	82.3	23.4	6.2	23.3
79.2	1.2	15.7	104.6	24.7	6.7	24.6
79.3	1.3	18.2	129.6	26.0	7.1	25.9
79.4	1.4	20.8	157.4	27.4	7.6	27.2
79.5	1.5	23.6	188.0	28.7	8.0	28.5
79.6	1.6	26.5	221.5	30.0	8.3	29.8
79.7	1.7	29.6	258.0	31.3	8.7	31.1
79.8	1.8	32.8	297.4	32.6	9.1	32.4
79.9	1.9	36.1	340.0	34.0	9.4	33.7
80.0	2.0	39.5	385.8	35.3	9.8	35.0
80.1	2.1	43.1	425.2	38.0	9.9	37.7
80.2	2.2	47.0	469.2	40.7	10.0	40.4
80.3	2.3	51.2	517.8	43.4	10.1	43.1
80.4	2.4	55.7	571.3	46.1	10.3	45.8
80.5	2.5	60.4	629.8	48.8	10.4	48.5
80.6	2.6	65.4	693.3	51.6	10.6	51.2
80.7	2.7	70.6	762.2	54.3	10.8	53.9
80.8	2.8	76.1	836.5	57.0	11.0	56.6
80.9	2.9	81.9	916.4	59.7	11.2	59.3
81.0	3.0	88.0	1002.1	62.4	11.4	62.0
81.1	3.1	94.3	1092.7	65.2	11.6	64.8
81.2	3.2	101.0	1189.5	68.0	11.8	67.6
81.3	3.3	107.9	1292.7	70.9	12.0	70.4
81.4	3.4	115.0	1402.4	73.7	12.2	73.2
81.5	3.5	122.5	1518.8	76.5	12.4	76.0
81.6	3.6	130.2	1642.1	79.3	12.6	78.8
81.7	3.7	138.3	1772.4	82.1	12.8	81.6
81.8	3.8	146.6	1909.9	84.9	13.0	84.4
81.9	3.9	155.1	2054.7	87.7	13.2	87.2
82.0	4.0	164.0	2207.1	90.5	13.5	90.0

X-SECTION F PARALLEL TO CEDAR HILL - E. SIDE OF TRAMWAY

MANNING'S N = .0350 SLOPE = .0513

POINT	DIST	ELEV	POINT	DIST	ELEV	POINT	DIST	ELEV
1	0.00	102.20	4	37.00	100.00	7	70.00	102.00
2	10.00	102.00	5	44.00	100.00	8	73.00	102.20
3	19.00	101.00	6	61.00	101.00			

WSEL (FT)	DEPTH INC	FLOW AREA (SQ FT)	FLOW RATE (CFS)	WETTED PER (FT)	FLOW VEL (FPS)	TOP WID
100.1	0.1	0.9	1.6	10.5	1.8	10.5
100.2	0.2	2.1	5.7	14.0	2.7	14.0
100.3	0.3	3.7	12.5	17.5	3.4	17.5
100.4	0.4	5.6	22.3	21.0	4.0	21.0
100.5	0.5	7.9	35.5	24.5	4.5	24.5
100.6	0.6	10.5	52.5	28.0	5.0	28.0
100.7	0.7	13.5	73.5	31.5	5.5	31.5
100.8	0.8	16.8	99.0	35.0	5.9	35.0
100.9	0.9	20.5	129.1	38.6	6.3	38.5
101.0	1.0	24.5	164.3	42.1	6.7	42.0
101.1	1.1	28.8	209.1	43.9	7.3	43.8
101.2	1.2	33.3	258.9	45.7	7.8	45.6
101.3	1.3	37.9	313.7	47.5	8.3	47.4
101.4	1.4	42.7	373.7	49.3	8.7	49.2
101.5	1.5	47.8	438.8	51.1	9.2	51.0
101.6	1.6	52.9	509.2	52.9	9.6	52.8
101.7	1.7	58.3	584.9	54.7	10.0	54.6
101.8	1.8	63.9	666.0	56.5	10.4	56.4
101.9	1.9	69.6	752.5	58.4	10.8	58.2
102.0	2.0	75.5	844.7	60.2	11.2	60.0
102.1	2.1	81.8	902.0	66.7	11.0	66.5
102.2	2.2	88.8	971.5	73.2	10.9	73.0

ZELLER AND FULLERTON RELATIONSHIP

$$qs = 0.0064 \frac{n^{1.77} V^{4.32} G^{0.45}}{Y^{0.30} D_{50}^{0.61}}$$

n = Manning's Roughness

V = Velocity

G = Gradation Coefficient $= \frac{1}{2}\left[\frac{D_{84}}{D_{50}} + \frac{D_{50}}{D_{16}}\right]$

Y = Hydraulic Depth = $\frac{\text{Area}}{\text{Top Width}}$

D_{50} = 50% Passing Sediment Size

Q_s = Bed Load Discharge = qs * Top Width

Velocities and depths at each cross-section were determined from HEC-2 computer modeling.

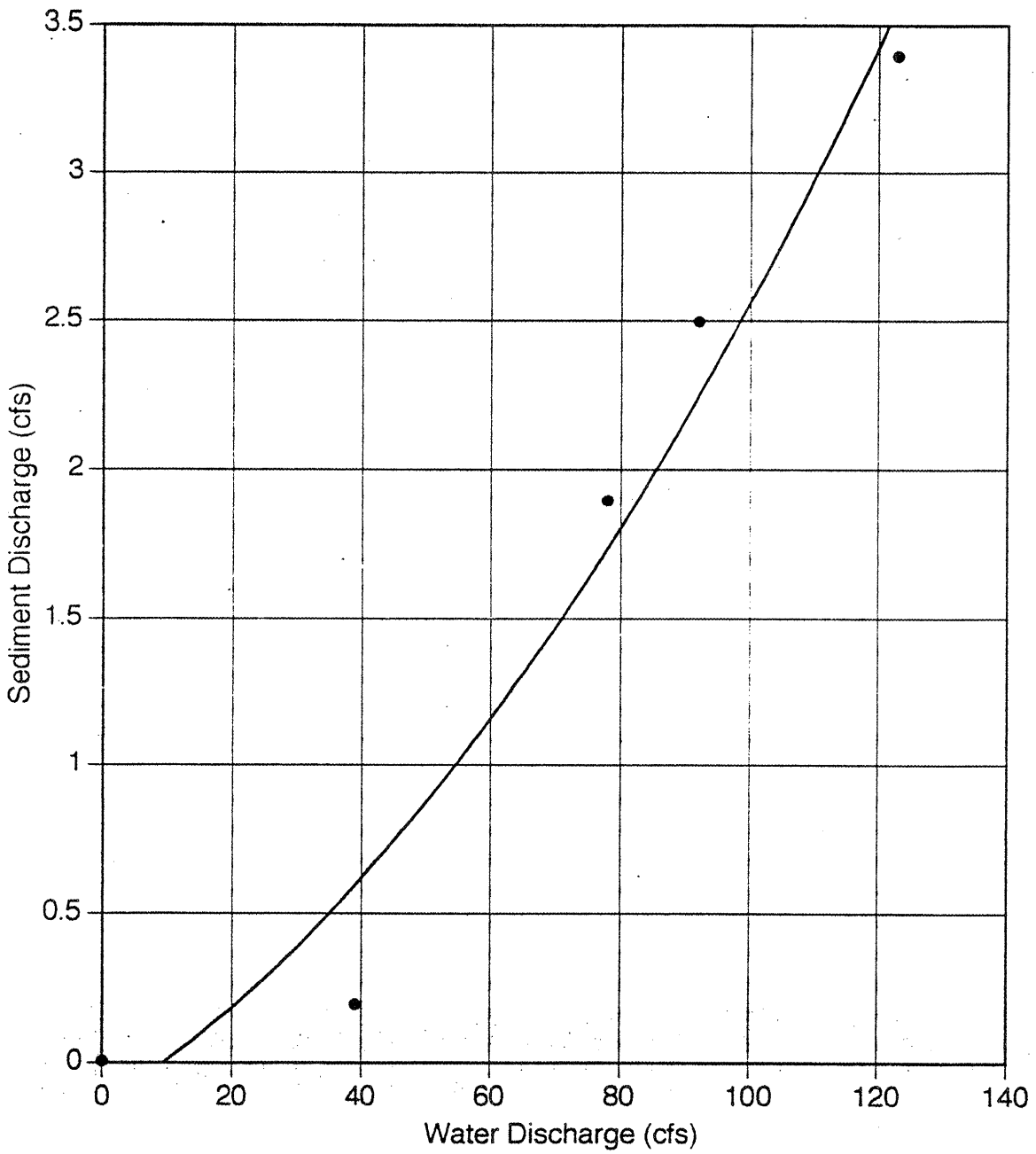
Bed Load Capacity at Tramway and Cedar Hills
Sandia Heights Units 27B and 27C

Vel. (fps)	Depth (Ft.)	Area (sf)	Top Width (Ft.)	Hydr Depth (Ft.)	D50 (mm)	Grad. Coeff G	Rough -ness n"	q(s) cfs/ft	Bed Load Qs (cfs)	Water Q (cfs)
				Section A		Sl = .0286				
3.5	0.7	11.0	29.5	0.373	1.4	13.4	0.025	0.0074	0.2	39
5.7	0.8	14.0	31.8	0.440	1.4	13.4	0.025	0.0594	1.9	78
6.1	0.9	15.0	33.3	0.451	1.4	13.4	0.025	0.0740	2.5	92
6.5	0.9	19.0	36.4	0.521	1.4	13.4	0.025	0.0941	3.4	123
				Section B		Slope = .0388				
5.7	1.1	7.0	9.7	0.719	1.4	13.4	0.025	0.0479	0.5	39
7.3	1.4	11.0	11.0	0.997	1.4	13.4	0.025	0.1283	1.4	78
6.3	1.8	15.0	12.2	1.230	1.4	13.4	0.025	0.0653	0.8	92
4.7	2.6	26.0	16.0	1.622	1.4	13.4	0.025	0.0166	0.3	123
				Section C		Slope = .0455				
3.6	0.5	2.8	11.0	0.255	1.4	13.4	0.025	0.0093	0.1	9.9
5.7	1.0	11.0	22.0	0.500	1.4	13.4	0.025	0.0555	1.2	63
8.3	1.6	26.5	29.8	0.889	1.4	13.4	0.025	0.2368	7.1	222
9.1	1.9	36.1	33.7	1.071	1.4	13.4	0.025	0.3332	11.2	340
				Section F		Slope = .0513				
4.5	0.5	7.9	24.5	0.322	1.4	13.4	0.025	0.0228	0.6	36
6.7	1.0	24.5	42.0	0.583	1.4	13.4	0.025	0.1065	4.5	164
8.3	1.3	37.9	47.4	0.800	1.4	13.4	0.025	0.2444	11.6	314

File Hydro:[c9025102.sandia]qsunit27b.wk3

Unit 27b & c, Arroyo 'A', Cross-Section A

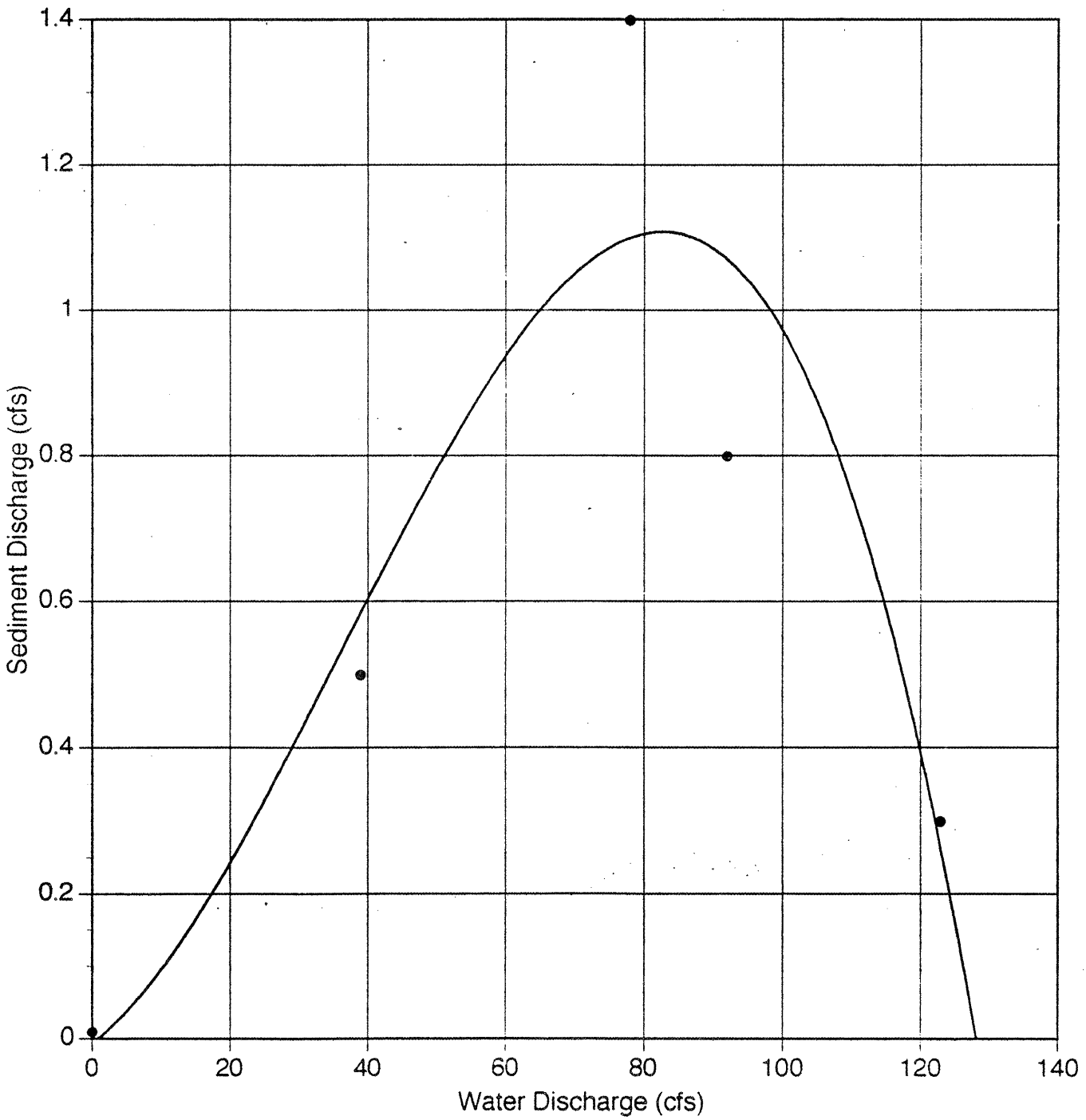
f(x) = 1.35E-4*x^2 + 1.35E-2*x + -1.36E-1
R2^2 = 9.49E-1,R1^2 = 9.39E-1,R0^2 = 9.66E-1



Unit 27b & c, Arroyo 'A', Cross-Section B

f(x) = -2.889E-6*x^3 + 3.134E-4*x^2 + 7.337E-3*x + -6.729E-3

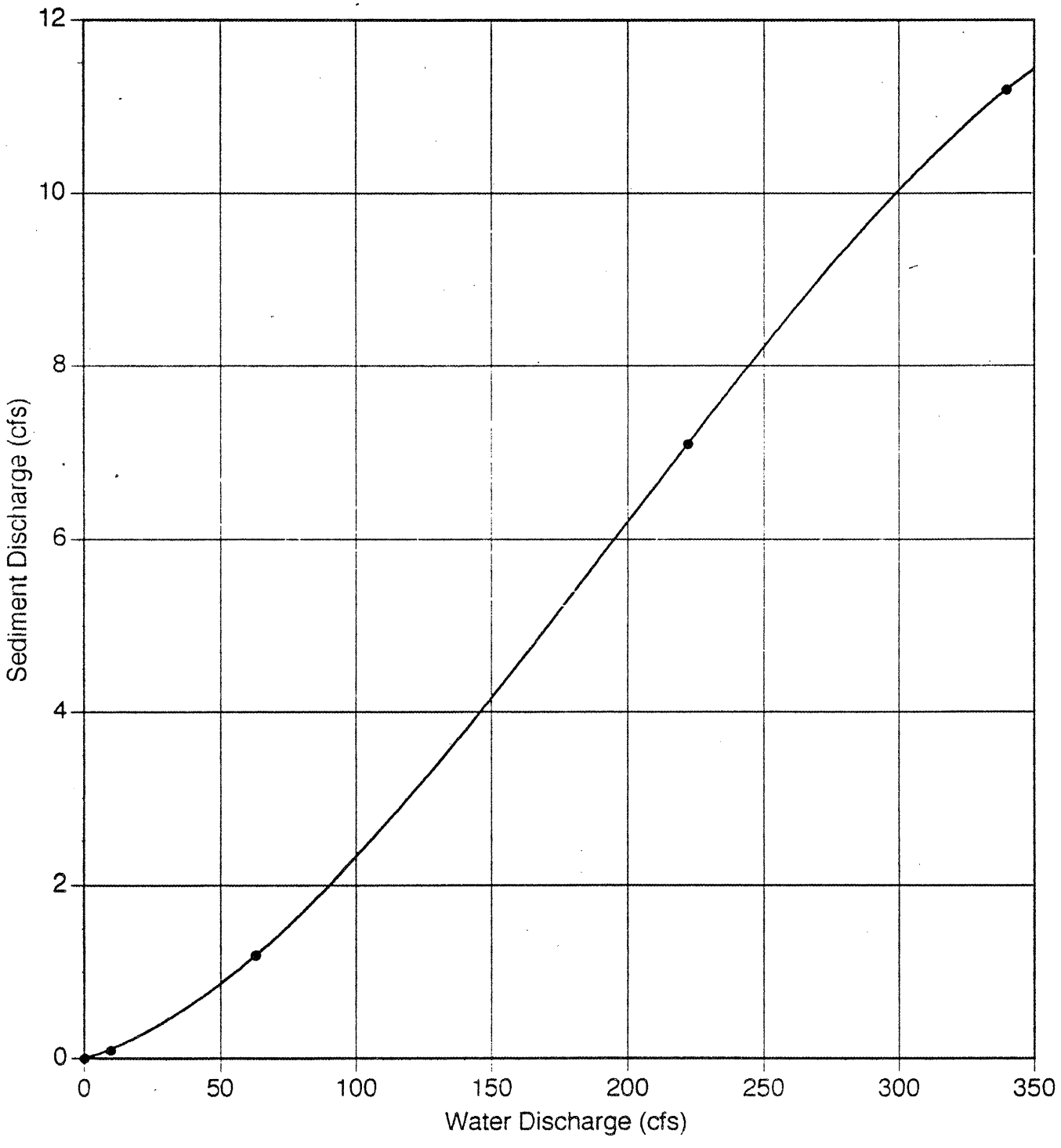
R3^2 = 4.798E-4,R2^2 = 1.993E-2,R1^2 = 1.498E-1,R0^2 = 8.477E-1



Unit 27b & c, Arroyo 'B', Cross-Section C

f(x) = -2.655E-7*x^3 + 1.573E-4*x^2 + 1.016E-2*x + -1.337E-3

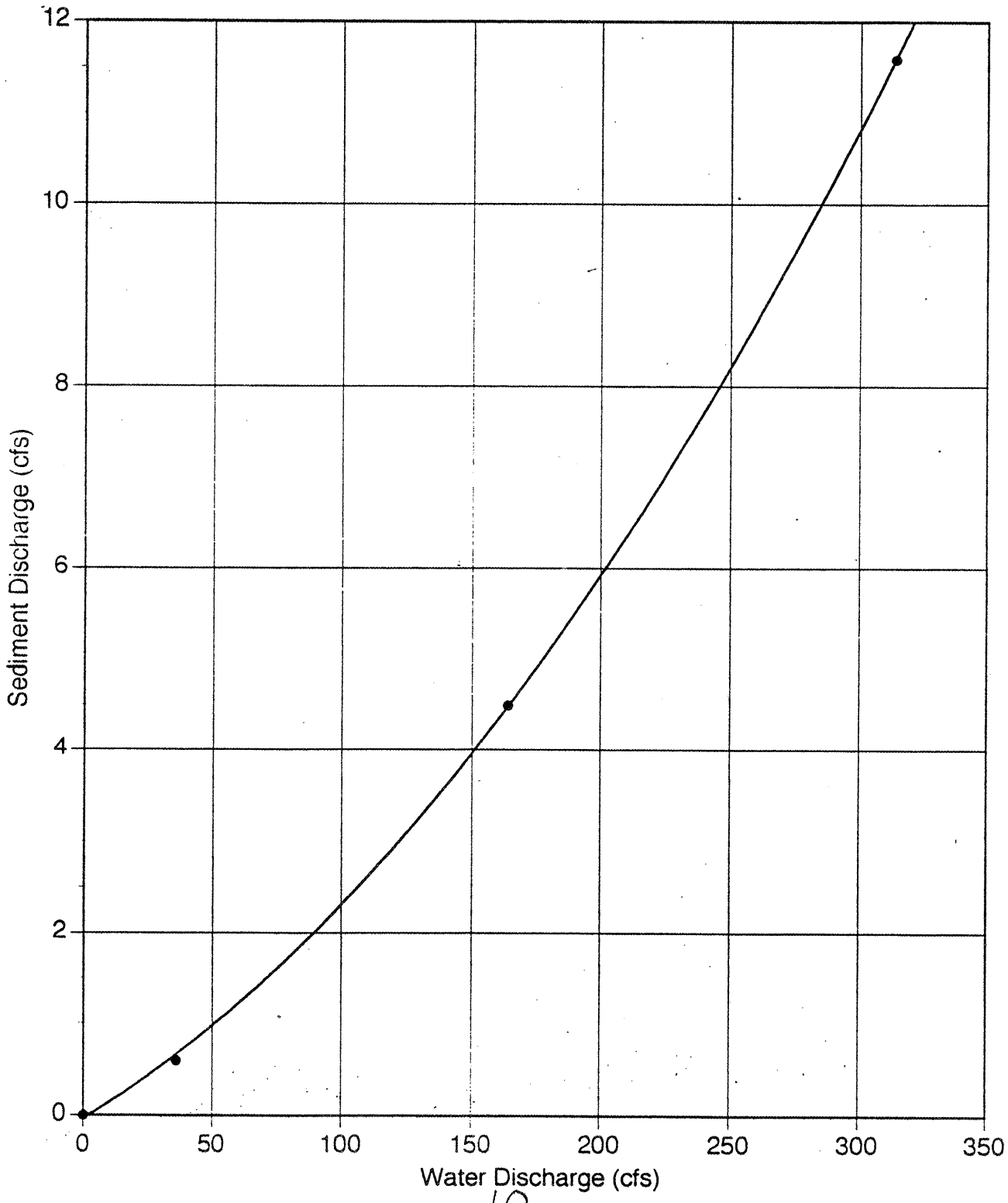
R3^2 = 8.842E-1,R2^2 = 9.604E-1,R1^2 = 9:952E-1,R0^2 = 10.000E-1



Unit 27b & c, Arroyo 'B', Cross-Section F

$f(x) = 6.387E\text{-}5*x^2 + 1.701E\text{-}2*x + -3.309E\text{-}2$

$R2^2 = 9.869E\text{-}1, R1^2 = 9.805E\text{-}1, R0^2 = 9.999E\text{-}1$



Reach 1 - Corresponds to X-Section A

100-year Storm Hydrograph

Qs=.000134*Q^2 + .0135*Q + -.136

Time in hrs.	Hyd 110S Inflow cfs	Inflow Vol cu. ft.	Bed Load cfs	Bed Load cubic ft.	Bed Load Tons
0.00	0.00	0	0.00	0.00	0.00
0.05	0.00	0	0.00	0.00	0.00
0.10	0.00	0	0.00	0.00	0.00
0.15	0.00	0	0.00	0.00	0.00
0.20	0.00	0	0.00	0.00	0.00
0.25	0.00	0	0.00	0.00	0.00
0.30	0.00	0	0.00	0.00	0.00
0.35	0.00	0	0.00	0.00	0.00
0.40	0.00	0	0.00	0.00	0.00
0.45	0.00	0	0.00	0.00	0.00
0.50	0.00	0	0.00	0.00	0.00
0.55	0.00	0	0.00	0.00	0.00
0.60	0.00	0	0.00	0.00	0.00
0.65	1.00	180	0.00	0.00	0.00
0.70	1.00	180	0.00	0.00	0.00
0.75	1.00	180	0.00	0.00	0.00
0.80	2.00	360	0.00	0.00	0.00
0.85	2.00	360	0.00	0.00	0.00
0.90	2.00	360	0.00	0.00	0.00
0.95	2.00	360	0.00	0.00	0.00
1.00	2.00	360	0.00	0.00	0.00
1.05	3.00	540	0.00	0.00	0.00
1.10	2.00	360	0.00	0.00	0.00
1.15	2.00	360	0.00	0.00	0.00
1.20	3.00	540	0.00	0.00	0.00
1.25	6.00	1080	0.00	0.00	0.00
1.30	13.00	2340	0.06	11.19	0.92
1.35	33.00	5940	0.46	81.98	6.78
1.40	69.00	12420	1.43	258.03	21.33
1.45	107.00	19260	2.84	511.68	42.31
1.50	123.00	22140	3.55	639.32	52.86
1.55	112.00	20160	3.06	550.24	45.49
1.60	91.00	16380	2.20	396.39	32.77
1.65	72.00	12960	1.53	275.52	22.78
1.70	56.00	10080	1.04	187.24	15.48
1.75	44.00	7920	0.72	129.14	10.68
1.80	35.00	6300	0.50	90.12	7.45
1.85	29.00	5220	0.37	66.27	5.48
1.90	24.00	4320	0.27	47.73	3.95
1.95	21.00	3780	0.21	37.19	3.07
2.00	19.00	3420	0.17	30.40	2.51
2.05	17.00	3060	0.13	23.80	1.97
2.10	14.00	2520	0.08	14.27	1.18
2.15	11.00	1980	0.03	5.17	0.43

2.20	9.00	1620	0.00	0.00	0.00
2.25	8.00	1440	0.00	0.00	0.00
2.30	7.00	1260	0.00	0.00	0.00
2.35	6.00	1080	0.00	0.00	0.00
2.40	5.00	900	0.00	0.00	0.00
2.45	5.00	900	0.00	0.00	0.00
2.50	4.00	720	0.00	0.00	0.00
2.55	4.00	720	0.00	0.00	0.00
2.60	3.00	540	0.00	0.00	0.00
2.65	3.00	540	0.00	0.00	0.00
2.70	3.00	540	0.00	0.00	0.00
2.75	3.00	540	0.00	0.00	0.00
2.80	2.00	360	0.00	0.00	0.00
2.85	2.00	360	0.00	0.00	0.00
2.90	2.00	360	0.00	0.00	0.00
2.95	2.00	360	0.00	0.00	0.00
3.00	2.00	360	0.00	0.00	0.00
3.05	2.00	360	0.00	0.00	0.00
3.10	1.00	180	0.00	0.00	0.00
3.15	1.00	180	0.00	0.00	0.00
3.20	1.00	180	0.00	0.00	0.00
3.25	1.00	180	0.00	0.00	0.00
3.30	1.00	180	0.00	0.00	0.00
3.35	1.00	180	0.00	0.00	0.00
3.40	1.00	180	0.00	0.00	0.00
3.45	1.00	180	0.00	0.00	0.00
3.50	1.00	180	0.00	0.00	0.00
3.55	1.00	180	0.00	0.00	0.00
3.60	1.00	180	0.00	0.00	0.00
3.65	1.00	180	0.00	0.00	0.00
3.70	1.00	180	0.00	0.00	0.00
3.75	1.00	180	0.00	0.00	0.00
3.80	1.00	180	0.00	0.00	0.00
3.85	1.00	180	0.00	0.00	0.00
3.90	1.00	180	0.00	0.00	0.00
3.95	1.00	180	0.00	0.00	0.00
4.00	1.00	180	0.00	0.00	0.00
4.05	1.00	180	0.00	0.00	0.00
4.10	1.00	180	0.00	0.00	0.00
4.15	1.00	180	0.00	0.00	0.00
4.20	1.00	180	0.00	0.00	0.00
4.25	1.00	180	0.00	0.00	0.00
4.30	1.00	180	0.00	0.00	0.00
4.35	1.00	180	0.00	0.00	0.00
4.40	1.00	180	0.00	0.00	0.00
4.45	1.00	180	0.00	0.00	0.00
4.50	1.00	180	0.00	0.00	0.00
4.55	1.00	180	0.00	0.00	0.00
4.60	1.00	180	0.00	0.00	0.00
4.65	1.00	180	0.00	0.00	0.00
4.70	1.00	180	0.00	0.00	0.00
4.75	1.00	180	0.00	0.00	0.00
4.80	1.00	180	0.00	0.00	0.00
4.85	1.00	180	0.00	0.00	0.00
4.90	1.00	180	0.00	0.00	0.00
4.95	1.00	180	0.00	0.00	0.00

	5.00	1.00	180	0.00	0.00	0.00
	5.05	1.00	180	0.00	0.00	0.00
	5.10	1.00	180	0.00	0.00	0.00
	5.15	1.00	180	0.00	0.00	0.00
	5.20	1.00	180	0.00	0.00	0.00
	5.25	1.00	180	0.00	0.00	0.00
	5.30	1.00	180	0.00	0.00	0.00
	5.35	1.00	180	0.00	0.00	0.00
	5.40	1.00	180	0.00	0.00	0.00
	5.45	1.00	180	0.00	0.00	0.00
	5.50	1.00	180	0.00	0.00	0.00
	5.55	1.00	180	0.00	0.00	0.00
	5.60	1.00	180	0.00	0.00	0.00
	5.65	1.00	180	0.00	0.00	0.00
	5.70	1.00	180	0.00	0.00	0.00
	5.75	1.00	180	0.00	0.00	0.00
	5.80	1.00	180	0.00	0.00	0.00
	5.85	1.00	180	0.00	0.00	0.00
	5.90	1.00	180	0.00	0.00	0.00
	5.95	1.00	180	0.00	0.00	0.00
	6.00	1.00	180	0.00	0.00	0.00
	6.05	1.00	180	0.00	0.00	0.00
	6.10	0.00	0	0.00	0.00	0.00
	6.15	0.00	0	0.00	0.00	0.00
	6.20	0.00	0	0.00	0.00	0.00
Total			189,180		3,356	277

File CDP:[c9029003.report]tona.wk1

Reach 2 - Corresponds to X-Section B

100-year Storm Hydrograph

$Qs = -.000002889*Q^3 + .0003134*Q^2 + .007337*Q - .006729$

Time in hrs.	Hyd 110S Inflow cfs	Inflow Vol cu. ft.	Bed Load cfs	Bed Load cubic ft.	Bed Load Tons
0.00	0.00	0	0.00	0.00	0.00
0.05	0.00	0	0.00	0.00	0.00
0.10	0.00	0	0.00	0.00	0.00
0.15	0.00	0	0.00	0.00	0.00
0.20	0.00	0	0.00	0.00	0.00
0.25	0.00	0	0.00	0.00	0.00
0.30	0.00	0	0.00	0.00	0.00
0.35	0.00	0	0.00	0.00	0.00
0.40	0.00	0	0.00	0.00	0.00
0.45	0.00	0	0.00	0.00	0.00
0.50	0.00	0	0.00	0.00	0.00
0.55	0.00	0	0.00	0.00	0.00
0.60	0.00	0	0.00	0.00	0.00
0.65	1.00	180	0.00	0.17	0.01
0.70	1.00	180	0.00	0.17	0.01
0.75	1.00	180	0.00	0.17	0.01
0.80	2.00	360	0.01	1.65	0.14
0.85	2.00	360	0.01	1.65	0.14
0.90	2.00	360	0.01	1.65	0.14
0.95	2.00	360	0.01	1.65	0.14
1.00	2.00	360	0.01	1.65	0.14
1.05	3.00	540	0.02	3.24	0.27
1.10	2.00	360	0.01	1.65	0.14
1.15	2.00	360	0.01	1.65	0.14
1.20	3.00	540	0.02	3.24	0.27
1.25	6.00	1080	0.05	8.63	0.71
1.30	13.00	2340	0.14	24.35	2.01
1.35	33.00	5940	0.47	85.12	7.04
1.40	69.00	12420	1.04	187.66	15.52
1.45	107.00	19260	0.83	148.91	12.31
1.50	123.00	22140	0.26	47.00	3.89
1.55	112.00	20160	0.69	123.74	10.23
1.60	91.00	16380	1.08	194.24	16.06
1.65	72.00	12960	1.07	192.22	15.89
1.70	56.00	10080	0.88	158.33	13.09
1.75	44.00	7920	0.68	121.81	10.07
1.80	35.00	6300	0.51	91.82	7.59
1.85	29.00	5220	0.40	71.85	5.94
1.90	24.00	4320	0.31	55.79	4.61
1.95	21.00	3780	0.26	46.58	3.85
2.00	19.00	3420	0.23	40.68	3.36
2.05	17.00	3060	0.19	34.99	2.89
2.10	14.00	2520	0.15	26.91	2.22
2.15	11.00	1980	0.11	19.45	1.61
2.20	9.00	1620	0.08	14.86	1.23
2.25	8.00	1440	0.07	12.70	1.05

2.30	7.00	1260	0.06	10.62	0.88
2.35	6.00	1080	0.05	8.63	0.71
2.40	5.00	900	0.04	6.74	0.56
2.45	5.00	900	0.04	6.74	0.56
2.50	4.00	720	0.03	4.94	0.41
2.55	4.00	720	0.03	4.94	0.41
2.60	3.00	540	0.02	3.24	0.27
2.65	3.00	540	0.02	3.24	0.27
2.70	3.00	540	0.02	3.24	0.27
2.75	3.00	540	0.02	3.24	0.27
2.80	2.00	360	0.01	1.65	0.14
2.85	2.00	360	0.01	1.65	0.14
2.90	2.00	360	0.01	1.65	0.14
2.95	2.00	360	0.01	1.65	0.14
3.00	2.00	360	0.01	1.65	0.14
3.05	2.00	360	0.01	1.65	0.14
3.10	1.00	180	0.00	0.17	0.01
3.15	1.00	180	0.00	0.17	0.01
3.20	1.00	180	0.00	0.17	0.01
3.25	1.00	180	0.00	0.17	0.01
3.30	1.00	180	0.00	0.17	0.01
3.35	1.00	180	0.00	0.17	0.01
3.40	1.00	180	0.00	0.17	0.01
3.45	1.00	180	0.00	0.17	0.01
3.50	1.00	180	0.00	0.17	0.01
3.55	1.00	180	0.00	0.17	0.01
3.60	1.00	180	0.00	0.17	0.01
3.65	1.00	180	0.00	0.17	0.01
3.70	1.00	180	0.00	0.17	0.01
3.75	1.00	180	0.00	0.17	0.01
3.80	1.00	180	0.00	0.17	0.01
3.85	1.00	180	0.00	0.17	0.01
3.90	1.00	180	0.00	0.17	0.01
3.95	1.00	180	0.00	0.17	0.01
4.00	1.00	180	0.00	0.17	0.01
4.05	1.00	180	0.00	0.17	0.01
4.10	1.00	180	0.00	0.17	0.01
4.15	1.00	180	0.00	0.17	0.01
4.20	1.00	180	0.00	0.17	0.01
4.25	1.00	180	0.00	0.17	0.01
4.30	1.00	180	0.00	0.17	0.01
4.35	1.00	180	0.00	0.17	0.01
4.40	1.00	180	0.00	0.17	0.01
4.45	1.00	180	0.00	0.17	0.01
4.50	1.00	180	0.00	0.17	0.01
4.55	1.00	180	0.00	0.17	0.01
4.60	1.00	180	0.00	0.17	0.01
4.65	1.00	180	0.00	0.17	0.01
4.70	1.00	180	0.00	0.17	0.01
4.75	1.00	180	0.00	0.17	0.01
4.80	1.00	180	0.00	0.17	0.01
4.85	1.00	180	0.00	0.17	0.01
4.90	1.00	180	0.00	0.17	0.01
4.95	1.00	180	0.00	0.17	0.01
5.00	1.00	180	0.00	0.17	0.01
5.05	1.00	180	0.00	0.17	0.01

	5.10	1.00	180	0.00	0.17	0.01
	5.15	1.00	180	0.00	0.17	0.01
	5.20	1.00	180	0.00	0.17	0.01
	5.25	1.00	180	0.00	0.17	0.01
	5.30	1.00	180	0.00	0.17	0.01
	5.35	1.00	180	0.00	0.17	0.01
	5.40	1.00	180	0.00	0.17	0.01
	5.45	1.00	180	0.00	0.17	0.01
	5.50	1.00	180	0.00	0.17	0.01
	5.55	1.00	180	0.00	0.17	0.01
	5.60	1.00	180	0.00	0.17	0.01
	5.65	1.00	180	0.00	0.17	0.01
	5.70	1.00	180	0.00	0.17	0.01
	5.75	1.00	180	0.00	0.17	0.01
	5.80	1.00	180	0.00	0.17	0.01
	5.85	1.00	180	0.00	0.17	0.01
	5.90	1.00	180	0.00	0.17	0.01
	5.95	1.00	180	0.00	0.17	0.01
	6.00	1.00	180	0.00	0.17	0.01
	6.05	1.00	180	0.00	0.17	0.01
	6.10	0.00	0	0.00	0.00	0.00
	6.15	0.00	0	0.00	0.00	0.00
	6.20	0.00	0	0.00	0.00	0.00
Total			189,180		1,802	149

File CDP:[c9029003.report]tonb.wk1

Reach 3 - Corresponds to X-Section C

100-year Storm Hydrograph

$Qs=-.0000002655*Q^3 + .0001573*Q^2 - .001337$

Time in hrs.	Hyd 110S Inflow cfs	Inflow Vol cu. ft.	Bed Load cfs	Bed Load cu. ft.	Bed Load Tons
0.00	0	0	0.00	0.00	0.00
0.05	0	0	0.00	0.00	0.00
0.10	0	0	0.00	0.00	0.00
0.15	0	0	0.00	0.00	0.00
0.20	0	0	0.00	0.00	0.00
0.25	0	0	0.00	0.00	0.00
0.30	0	0	0.00	0.00	0.00
0.35	0	0	0.00	0.00	0.00
0.40	0	0	0.00	0.00	0.00
0.45	0	0	0.00	0.00	0.00
0.50	0	0	0.00	0.00	0.00
0.55	0	0	0.00	0.00	0.00
0.60	0	0	0.00	0.00	0.00
0.65	1	180	0.00	0.00	0.00
0.70	2	360	0.00	0.00	0.00
0.75	2	360	0.00	0.00	0.00
0.80	3	540	0.00	0.02	0.00
0.85	3	540	0.00	0.02	0.00
0.90	4	720	0.00	0.22	0.02
0.95	4	720	0.00	0.22	0.02
1.00	4	720	0.00	0.22	0.02
1.05	5	900	0.00	0.47	0.04
1.10	4	720	0.00	0.22	0.02
1.15	4	720	0.00	0.22	0.02
1.20	4	720	0.00	0.22	0.02
1.25	7	1260	0.01	1.16	0.10
1.30	16	2880	0.04	7.20	0.60
1.35	41	7380	0.28	50.65	4.19
1.40	90	16200	1.47	263.94	21.82
1.45	152	27360	4.57	821.76	67.94
1.50	198	35640	8.23	1480.75	122.43
1.55	207	37260	9.09	1636.87	135.34
1.60	187	33660	7.24	1302.38	107.68
1.65	157	28260	4.90	882.61	72.97
1.70	127	22860	3.08	554.33	45.83
1.75	103	18540	1.96	352.36	29.13
1.80	84	15120	1.27	227.87	18.84
1.85	69	12420	0.83	150.26	12.42
1.90	57	10260	0.56	100.60	8.32
1.95	48	8640	0.39	70.28	5.81
2.00	41	7380	0.28	50.65	4.19
2.05	36	6480	0.21	38.68	3.20
2.10	31	5580	0.16	28.39	2.35
2.15	26	4680	0.11	19.74	1.63
2.20	22	3960	0.08	13.97	1.16
2.25	18	3240	0.05	9.21	0.76

2.30	16	2880	0.04	7.20	0.60
2.35	14	2520	0.03	5.44	0.45
2.40	13	2340	0.03	4.65	0.38
2.45	12	2160	0.02	3.92	0.32
2.50	11	1980	0.02	3.25	0.27
2.55	10	1800	0.01	2.64	0.22
2.60	9	1620	0.01	2.09	0.17
2.65	8	1440	0.01	1.60	0.13
2.70	7	1260	0.01	1.16	0.10
2.75	7	1260	0.01	1.16	0.10
2.80	6	1080	0.00	0.79	0.07
2.85	6	1080	0.00	0.79	0.07
2.90	5	900	0.00	0.47	0.04
2.95	5	900	0.00	0.47	0.04
3.00	4	720	0.00	0.22	0.02
3.05	4	720	0.00	0.22	0.02
3.10	4	720	0.00	0.22	0.02
3.15	4	720	0.00	0.22	0.02
3.20	3	540	0.00	0.02	0.00
3.25	3	540	0.00	0.02	0.00
3.30	3	540	0.00	0.02	0.00
3.35	3	540	0.00	0.02	0.00
3.40	3	540	0.00	0.02	0.00
3.45	3	540	0.00	0.02	0.00
3.50	2	360	0.00	0.00	0.00
3.55	2	360	0.00	0.00	0.00
3.60	2	360	0.00	0.00	0.00
3.65	2	360	0.00	0.00	0.00
3.70	2	360	0.00	0.00	0.00
3.75	2	360	0.00	0.00	0.00
3.80	2	360	0.00	0.00	0.00
3.85	2	360	0.00	0.00	0.00
3.90	2	360	0.00	0.00	0.00
3.95	2	360	0.00	0.00	0.00
4.00	2	360	0.00	0.00	0.00
4.05	2	360	0.00	0.00	0.00
4.10	1	180	0.00	0.00	0.00
4.15	1	180	0.00	0.00	0.00
4.20	1	180	0.00	0.00	0.00
4.25	1	180	0.00	0.00	0.00
4.30	1	180	0.00	0.00	0.00
4.35	1	180	0.00	0.00	0.00
4.40	1	180	0.00	0.00	0.00
4.45	1	180	0.00	0.00	0.00
4.50	1	180	0.00	0.00	0.00
4.55	1	180	0.00	0.00	0.00
4.60	1	180	0.00	0.00	0.00
4.65	1	180	0.00	0.00	0.00
4.70	1	180	0.00	0.00	0.00
4.75	1	180	0.00	0.00	0.00
4.80	1	180	0.00	0.00	0.00
4.85	1	180	0.00	0.00	0.00
4.90	1	180	0.00	0.00	0.00
4.95	1	180	0.00	0.00	0.00
5.00	1	180	0.00	0.00	0.00
5.05	1	180	0.00	0.00	0.00

	5.10	1	180	0.00	0.00	0.00
	5.15	1	180	0.00	0.00	0.00
	5.20	1	180	0.00	0.00	0.00
	5.25	1	180	0.00	0.00	0.00
	5.30	1	180	0.00	0.00	0.00
	5.35	1	180	0.00	0.00	0.00
	5.40	1	180	0.00	0.00	0.00
	5.45	1	180	0.00	0.00	0.00
	5.50	1	180	0.00	0.00	0.00
	5.55	1	180	0.00	0.00	0.00
	5.60	1	180	0.00	0.00	0.00
	5.65	1	180	0.00	0.00	0.00
	5.70	1	180	0.00	0.00	0.00
	5.75	1	180	0.00	0.00	0.00
	5.80	1	180	0.00	0.00	0.00
	5.85	1	180	0.00	0.00	0.00
	5.90	1	180	0.00	0.00	0.00
	5.95	1	180	0.00	0.00	0.00
	6.00	1	180	0.00	0.00	0.00
	6.05	1	180	0.00	0.00	0.00
	6.10	1	180	0.00	0.00	0.00
	6.15	1	180	0.00	0.00	0.00
	6.20	0	0	0.00	0.00	0.00
Total			357,480		8,102	670

File CDP:[C9029003.report]tonc.wk1

Reach 4 - Corresponds to X-Section F

100-year Storm Hydrograph

$Qs = .00006387*Q^2 + .01701*Q - .03309$

Time in hrs.	Hyd 110S Inflow cfs	Inflow Vol cu. ft.	Bed Load cfs	Bed Load cu. ft.	Bed Load Tons
0.00	0	0	0.00	0.00	0.00
0.05	0	0	0.00	0.00	0.00
0.10	0	0	0.00	0.00	0.00
0.15	0	0	0.00	0.00	0.00
0.20	0	0	0.00	0.00	0.00
0.25	0	0	0.00	0.00	0.00
0.30	0	0	0.00	0.00	0.00
0.35	0	0	0.00	0.00	0.00
0.40	0	0	0.00	0.00	0.00
0.45	0	0	0.00	0.00	0.00
0.50	0	0	0.00	0.00	0.00
0.55	0	0	0.00	0.00	0.00
0.60	0	0	0.00	0.00	0.00
0.65	1	180	0.00	0.00	0.00
0.70	2	360	0.00	0.21	0.02
0.75	2	360	0.00	0.21	0.02
0.80	3	540	0.02	3.33	0.28
0.85	3	540	0.02	3.33	0.28
0.90	4	720	0.04	6.47	0.54
0.95	4	720	0.04	6.47	0.54
1.00	4	720	0.04	6.47	0.54
1.05	5	900	0.05	9.64	0.80
1.10	4	720	0.04	6.47	0.54
1.15	4	720	0.04	6.47	0.54
1.20	4	720	0.04	6.47	0.54
1.25	7	1260	0.09	16.04	1.33
1.30	16	2880	0.26	45.98	3.80
1.35	41	7380	0.77	138.90	11.48
1.40	90	16200	2.02	362.73	29.99
1.45	152	27360	4.03	725.05	59.95
1.50	198	35640	5.84	1050.99	86.90
1.55	207	37260	6.22	1120.45	92.64
1.60	187	33660	5.38	968.63	80.09
1.65	157	28260	4.21	758.13	62.68
1.70	127	22860	3.16	568.32	46.99
1.75	103	18540	2.40	431.38	35.67
1.80	84	15120	1.85	332.36	27.48
1.85	69	12420	1.44	260.04	21.50
1.90	57	10260	1.14	205.92	17.03
1.95	48	8640	0.93	167.50	13.85
2.00	41	7380	0.77	138.90	11.48
2.05	36	6480	0.66	119.17	9.85
2.10	31	5580	0.56	100.01	8.27
2.15	26	4680	0.45	81.42	6.73
2.20	22	3960	0.37	66.97	5.54
2.25	18	3240	0.29	52.88	4.37

2.30	16	2880	0.26	45.98	3.80
2.35	14	2520	0.22	39.16	3.24
2.40	13	2340	0.20	35.79	2.96
2.45	12	2160	0.18	32.44	2.68
2.50	11	1980	0.16	29.11	2.41
2.55	10	1800	0.14	25.81	2.13
2.60	9	1620	0.13	22.53	1.86
2.65	8	1440	0.11	19.27	1.59
2.70	7	1260	0.09	16.04	1.33
2.75	7	1260	0.09	16.04	1.33
2.80	6	1080	0.07	12.83	1.06
2.85	6	1080	0.07	12.83	1.06
2.90	5	900	0.05	9.64	0.80
2.95	5	900	0.05	9.64	0.80
3.00	4	720	0.04	6.47	0.54
3.05	4	720	0.04	6.47	0.54
3.10	4	720	0.04	6.47	0.54
3.15	4	720	0.04	6.47	0.54
3.20	3	540	0.02	3.33	0.28
3.25	3	540	0.02	3.33	0.28
3.30	3	540	0.02	3.33	0.28
3.35	3	540	0.02	3.33	0.28
3.40	3	540	0.02	3.33	0.28
3.45	3	540	0.02	3.33	0.28
3.50	2	360	0.00	0.21	0.02
3.55	2	360	0.00	0.21	0.02
3.60	2	360	0.00	0.21	0.02
3.65	2	360	0.00	0.21	0.02
3.70	2	360	0.00	0.21	0.02
3.75	2	360	0.00	0.21	0.02
3.80	2	360	0.00	0.21	0.02
3.85	2	360	0.00	0.21	0.02
3.90	2	360	0.00	0.21	0.02
3.95	2	360	0.00	0.21	0.02
4.00	2	360	0.00	0.21	0.02
4.05	2	360	0.00	0.21	0.02
4.10	1	180	0.00	0.00	0.00
4.15	1	180	0.00	0.00	0.00
4.20	1	180	0.00	0.00	0.00
4.25	1	180	0.00	0.00	0.00
4.30	1	180	0.00	0.00	0.00
4.35	1	180	0.00	0.00	0.00
4.40	1	180	0.00	0.00	0.00
4.45	1	180	0.00	0.00	0.00
4.50	1	180	0.00	0.00	0.00
4.55	1	180	0.00	0.00	0.00
4.60	1	180	0.00	0.00	0.00
4.65	1	180	0.00	0.00	0.00
4.70	1	180	0.00	0.00	0.00
4.75	1	180	0.00	0.00	0.00
4.80	1	180	0.00	0.00	0.00
4.85	1	180	0.00	0.00	0.00
4.90	1	180	0.00	0.00	0.00
4.95	1	180	0.00	0.00	0.00
5.00	1	180	0.00	0.00	0.00
5.05	1	180	0.00	0.00	0.00

	5.10	1	180	0.00	0.00	0.00
	5.15	1	180	0.00	0.00	0.00
	5.20	1	180	0.00	0.00	0.00
	5.25	1	180	0.00	0.00	0.00
	5.30	1	180	0.00	0.00	0.00
	5.35	1	180	0.00	0.00	0.00
	5.40	1	180	0.00	0.00	0.00
	5.45	1	180	0.00	0.00	0.00
	5.50	1	180	0.00	0.00	0.00
	5.55	1	180	0.00	0.00	0.00
	5.60	1	180	0.00	0.00	0.00
	5.65	1	180	0.00	0.00	0.00
	5.70	1	180	0.00	0.00	0.00
	5.75	1	180	0.00	0.00	0.00
	5.80	1	180	0.00	0.00	0.00
	5.85	1	180	0.00	0.00	0.00
	5.90	1	180	0.00	0.00	0.00
	5.95	1	180	0.00	0.00	0.00
	6.00	1	180	0.00	0.00	0.00
	6.05	1	180	0.00	0.00	0.00
	6.10	1	180	0.00	0.00	0.00
	6.15	1	180	0.00	0.00	0.00
	6.20	0	0	0.00	0.00	0.00
Total			357,480		8,143	673

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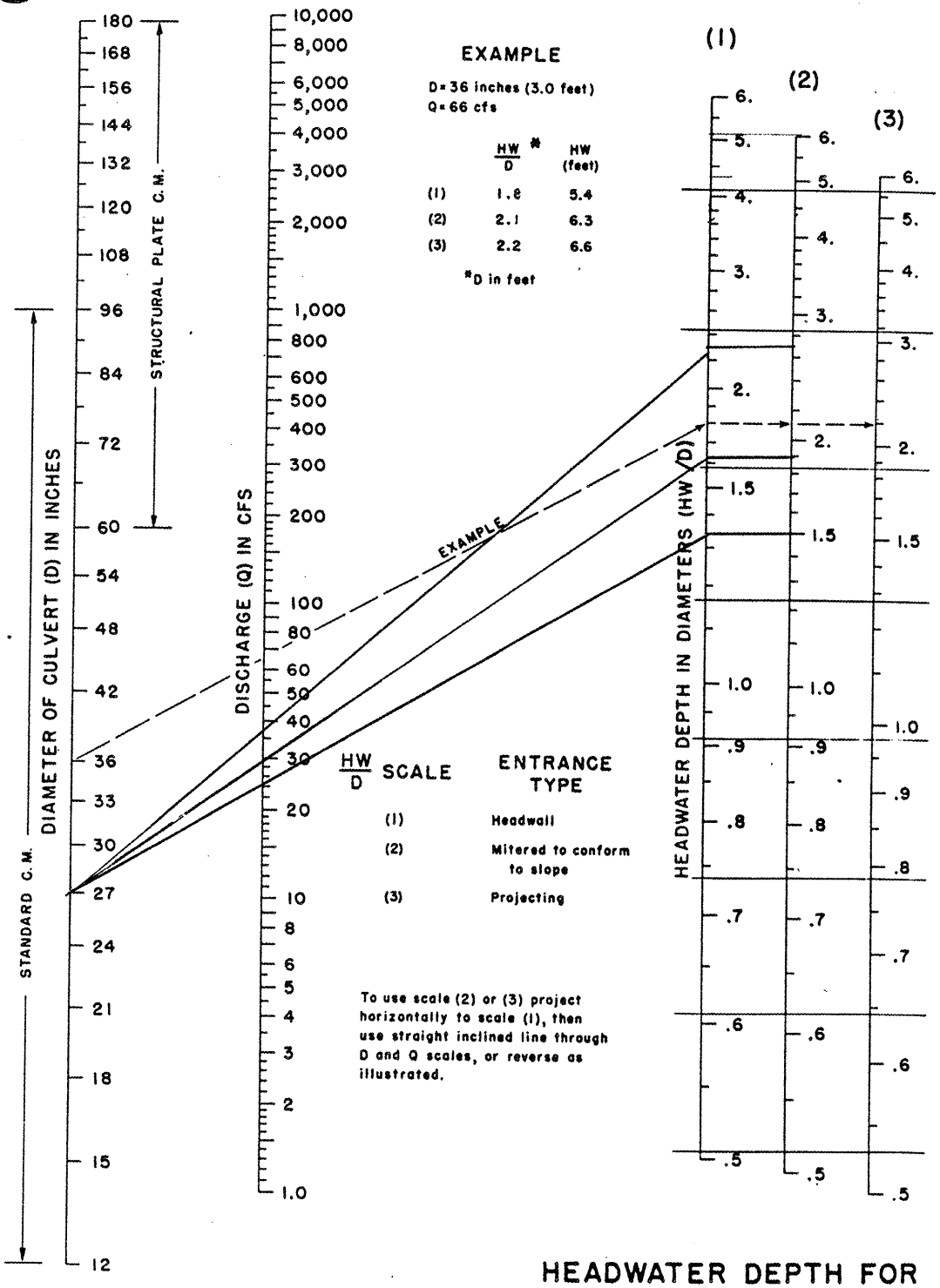
48" CMP - ½ Plugged

Flow characteristics ≈ 27" CMP

CHART 2



BUREAU OF PUBLIC ROADS JAN. 1963

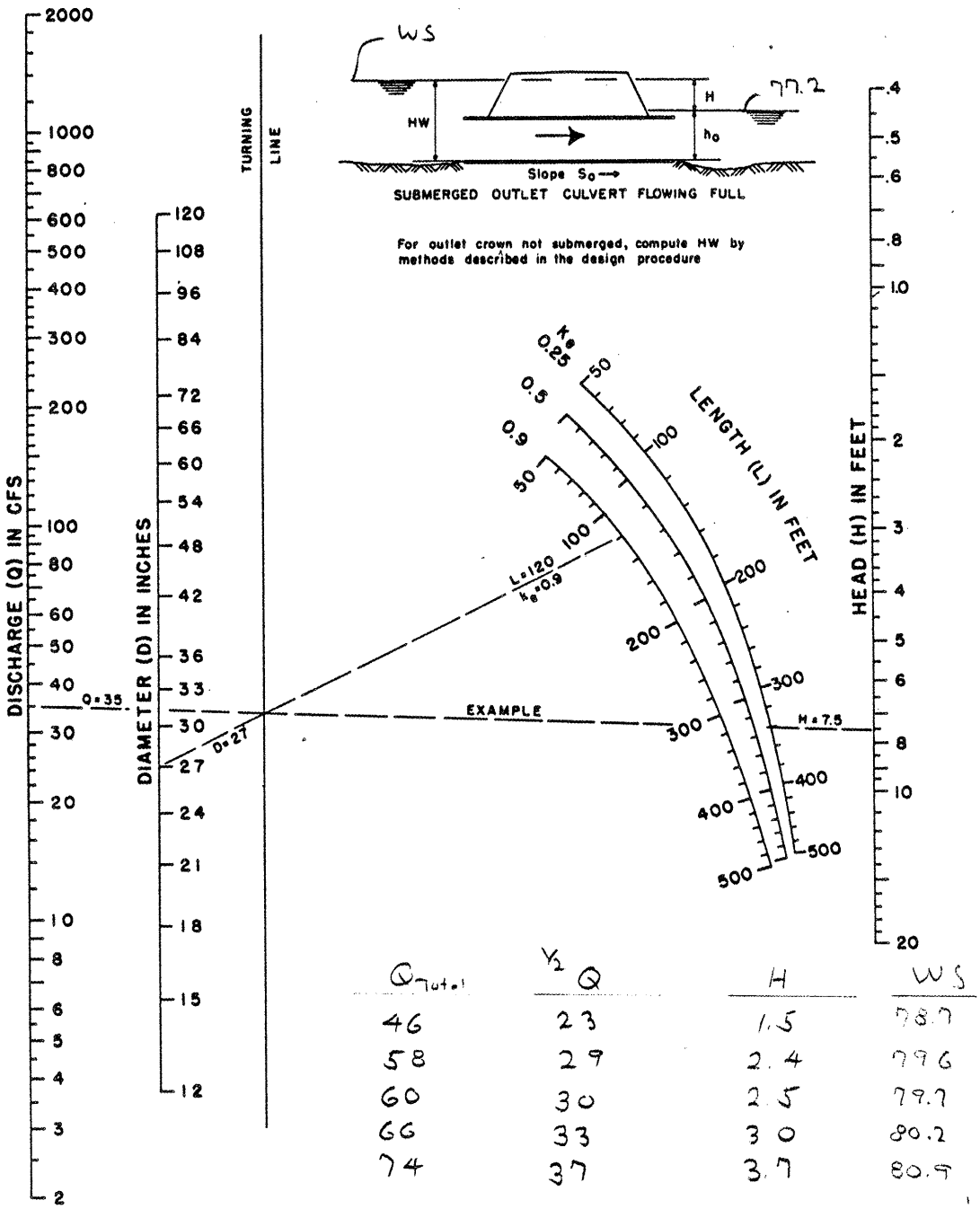
HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

Q	HW/D	HW
25	1.5	3.4
30	1.9	4.3
35	2.7	6.1

2 - 30" CMP's

Inflow Q = 123 cfs Outlet Elev. = 77.2

CHART 6



Q_{Total}	$\frac{1}{2}Q$	H	WS
46	23	1.5	78.7
58	29	2.4	79.6
60	30	2.5	79.7
66	33	3.0	80.2
74	37	3.7	80.9

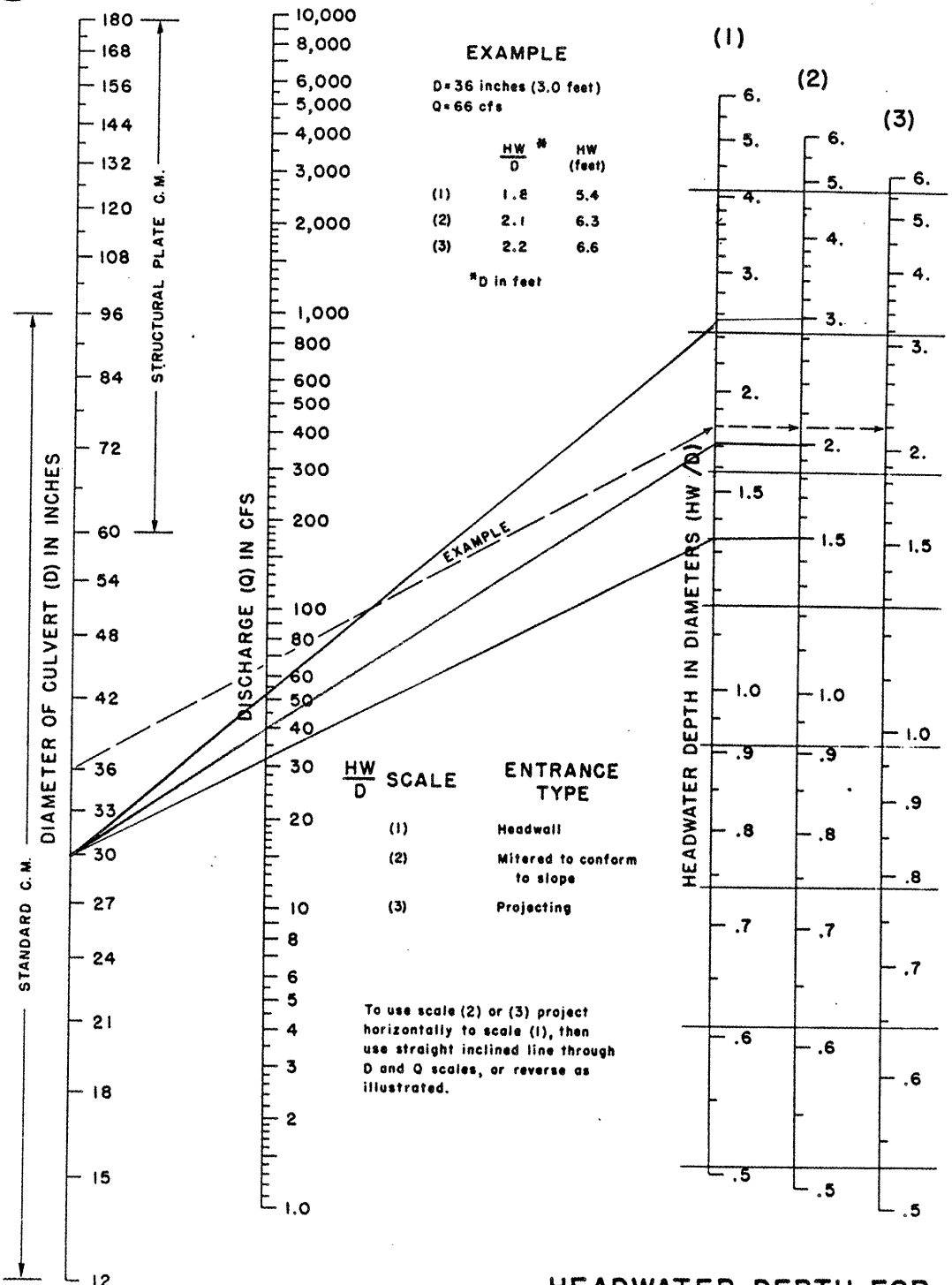
HEAD FOR STANDARD C. M. PIPE CULVERTS FLOWING FULL n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

2- 30" CMPs

Inflow Q = 123 cfs

CHART 2



BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

Since Inlet Control is > than Outlet Control Outlet Control Govern!

X-SECTION D PARALLEL TO CEDAR HILL - E. SIDE OF TRAMWAY

MANNING'S N = .0350 SLOPE = .0513

POINT	DIST	ELEV	POINT	DIST	ELEV	POINT	DIST	ELEV
1	0.00	91.00	4	20.00	90.00	7	52.00	89.20
2	4.00	91.30	5	22.00	89.30	8	60.00	90.00
3	17.00	91.00	6	40.00	90.00	9	76.00	90.40

WSEL (FT)	DEPTH INC	FLOW AREA (SQ FT)	FLOW RATE (CFS)	WETTED PER (FT)	FLOW VEL (FPS)	TOP WID
89.3	0.1	0.1	0.2	2.5	1.3	2.5
89.4	0.2	0.6	1.2	7.9	1.8	7.9
89.5	0.3	1.7	4.1	13.3	2.4	13.2
89.6	0.4	3.3	9.9	18.7	3.0	18.6
89.7	0.5	5.4	19.2	24.0	3.6	23.9
89.8	0.6	8.1	32.8	29.4	4.1	29.3
89.9	0.7	11.3	51.1	34.8	4.5	34.6
90.0	0.8	15.0	74.8	40.2	5.0	40.0
90.1	0.9	19.2	105.5	44.5	5.5	44.3
90.2	1.0	23.9	142.3	48.8	6.0	48.6
90.3	1.1	28.9	185.5	53.2	6.4	52.9
90.4	1.2	34.4	235.4	57.5	6.8	57.2

X-SECTION E FLOW SOUTH ON EAST SIDE OF TRAMWAY

WEIR COEFFICENT = 2.6000
CROSS SECTION DIVIDED INTO VERTICAL SLICES 0. FEET APART

POINT	DIST	ELEV	POINT	DIST	ELEV	POINT	DIST	ELEV
1	0.00	77.80	4	51.00	75.00	7	75.00	77.80
2	14.00	77.00	5	57.00	76.00			
3	40.00	76.00	6	60.00	77.00			

WSEL (FT)	DEPTH INC (FT)	FLOW AREA (SQ FT)	FLOW RATE (CFS)	FLOW VEL (FPS)	TOP WID PLUS OBSTRUCTIONS
75.10	0.10	0.09	0.06	0.66	1.70
75.20	0.20	0.34	0.32	0.93	3.40
75.30	0.30	0.77	0.87	1.14	5.10
75.40	0.40	1.36	1.79	1.32	6.80
75.50	0.50	2.13	3.13	1.47	8.50
75.60	0.60	3.06	4.93	1.61	10.20
75.70	0.70	4.17	7.25	1.74	11.90
75.80	0.80	5.44	10.12	1.86	13.60
75.90	0.90	6.89	13.59	1.97	15.30
76.00	1.00	8.50	17.68	2.08	17.00
76.10	1.10	10.35	22.48	2.17	19.90
76.20	1.20	12.48	28.11	2.25	22.80
76.30	1.30	14.91	34.68	2.33	25.70
76.40	1.40	17.62	42.26	2.40	28.60
76.50	1.50	20.63	50.93	2.47	31.50
76.60	1.60	23.92	60.73	2.54	34.40
76.70	1.70	27.51	71.74	2.61	37.30
76.80	1.80	31.38	84.00	2.68	40.20
76.90	1.90	35.55	97.57	2.74	43.10
77.00	2.00	40.00	112.49	2.81	46.00
77.10	2.10	44.78	128.85	2.88	49.62
77.20	2.20	49.92	146.74	2.94	53.25
77.30	2.30	55.43	166.26	3.00	56.87
77.40	2.40	61.30	187.47	3.06	60.50
77.50	2.50	67.53	210.44	3.12	64.12
77.60	2.60	74.12	235.23	3.17	67.75
77.70	2.70	81.08	261.90	3.23	71.37
77.80	2.80	88.40	290.51	3.29	75.00

HYDRO. E41780 TRAMWY. WEIR

TRAMWY.XSEC X - Section G

WEIR COEFFICENT = 3.0500
CROSS SECTION DIVIDED INTO VERTICAL SLICES 5. FEET APART

POINT	DIST	ELEV	POINT	DIST	ELEV	POINT	DIST	ELEV
1	0.00	83.00	4	81.00	80.00	7	259.00	81.00
2	23.00	82.00	5	128.00	79.40	8	319.00	82.00
3	46.00	81.00	6	206.00	80.00	9	409.00	83.00

WSEL (FT)	DEPTH INC (FT)	FLOW AREA (SQ FT)	FLOW RATE (CFS)	FLOW VEL (FPS)	TOP WID PLUS OBSTRUCTIONS
79.50	0.10	1.04	0.79	0.75	20.83
79.60	0.20	4.17	4.52	1.08	41.67
79.70	0.30	9.38	12.49	1.33	62.50
79.80	0.40	16.67	25.67	1.54	83.33
79.90	0.50	26.04	44.87	1.72	104.17
80.00	0.60	37.50	70.81	1.89	125.00
80.10	0.70	50.44	103.65	2.05	133.80
80.20	0.80	64.26	142.77	2.22	142.60
80.30	0.90	78.96	187.94	2.38	151.40
80.40	1.00	94.54	239.17	2.53	160.20
80.50	1.10	111.00	296.45	2.67	169.00
80.60	1.20	128.34	359.83	2.80	177.80
80.70	1.30	146.56	429.39	2.93	186.60
80.80	1.40	165.66	505.22	3.05	195.40
80.90	1.50	185.64	587.39	3.16	204.20
81.00	1.60	206.50	676.01	3.27	213.00
81.10	1.70	228.22	771.19	3.38	221.30
81.20	1.80	250.76	872.95	3.48	229.60
81.30	1.90	274.14	981.33	3.58	237.90
81.40	2.00	298.34	1096.46	3.68	246.20
81.50	2.10	323.38	1218.41	3.77	254.50
81.60	2.20	349.24	1347.26	3.86	262.80
81.70	2.30	375.94	1483.13	3.95	271.10
81.80	2.40	403.46	1626.06	4.03	279.40
81.90	2.50	431.82	1776.19	4.11	287.70
82.00	2.60	461.00	1933.54	4.19	296.00
82.10	2.70	491.17	2098.44	4.27	307.30
82.20	2.80	522.46	2271.18	4.35	318.60
82.30	2.90	554.89	2452.04	4.42	329.90
82.40	3.00	588.44	2641.27	4.49	341.20
82.50	3.10	623.13	2839.09	4.56	352.50
82.60	3.20	658.94	3045.66	4.62	363.80
82.70	3.30	695.89	3261.20	4.69	375.10
82.80	3.40	733.96	3485.82	4.75	386.40
82.90	3.50	773.17	3719.77	4.81	397.70
83.00	3.60	813.50	3963.11	4.87	409.00

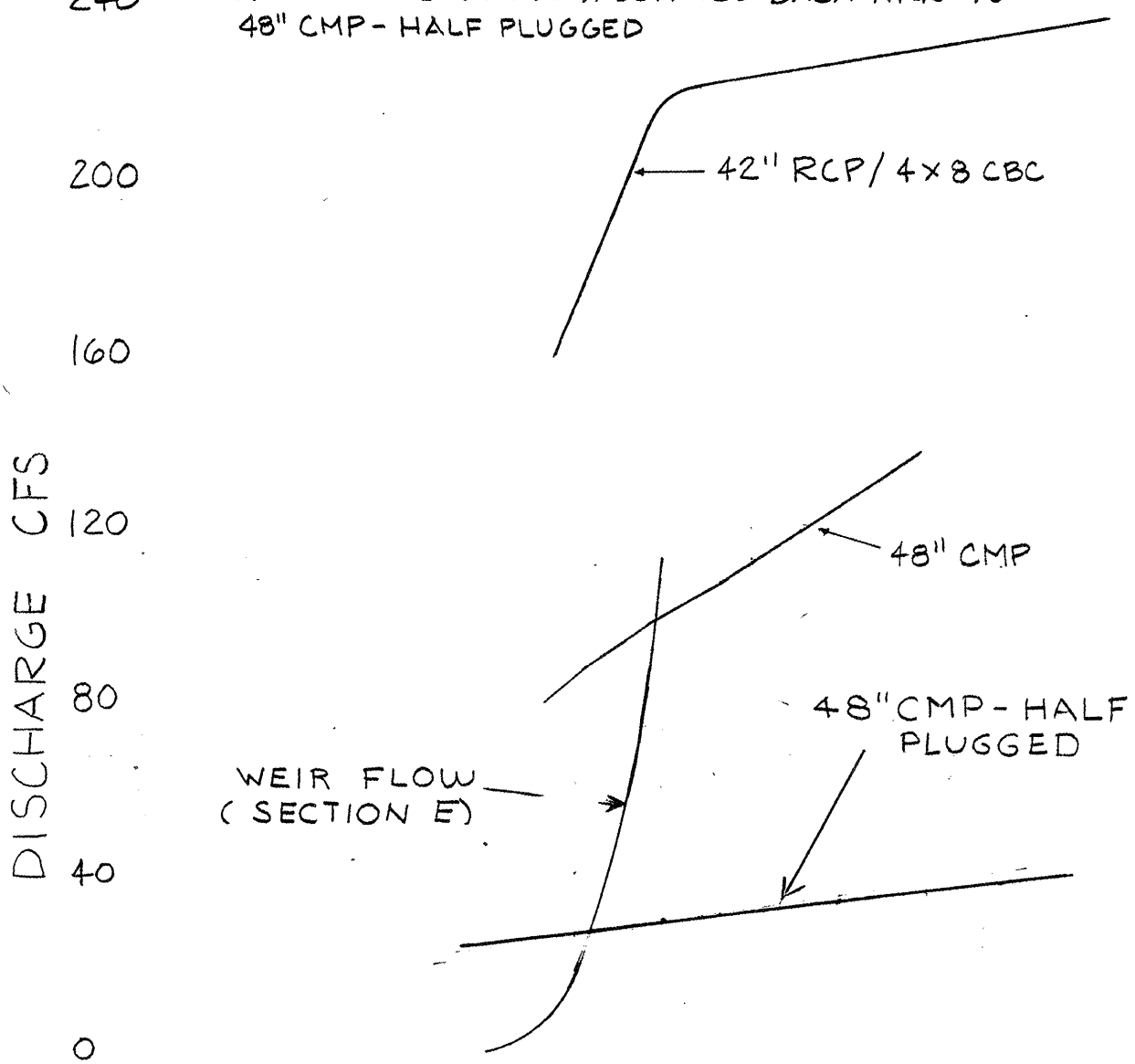
HYDRAULIC RATING CURVES

42" / 4×8 CBC

48" CMP

WEIR FLOW SOUTH TO N. DOMINGO BACA ARROYO

48" CMP - HALF PLUGGED



SCHANNAN-HUSTON INC.

PROJECT NAME UNIT 27 B&C SHEET 29

PROJECT NO 902690.03 BY HCS DATE 7-30-92

SUBJECT

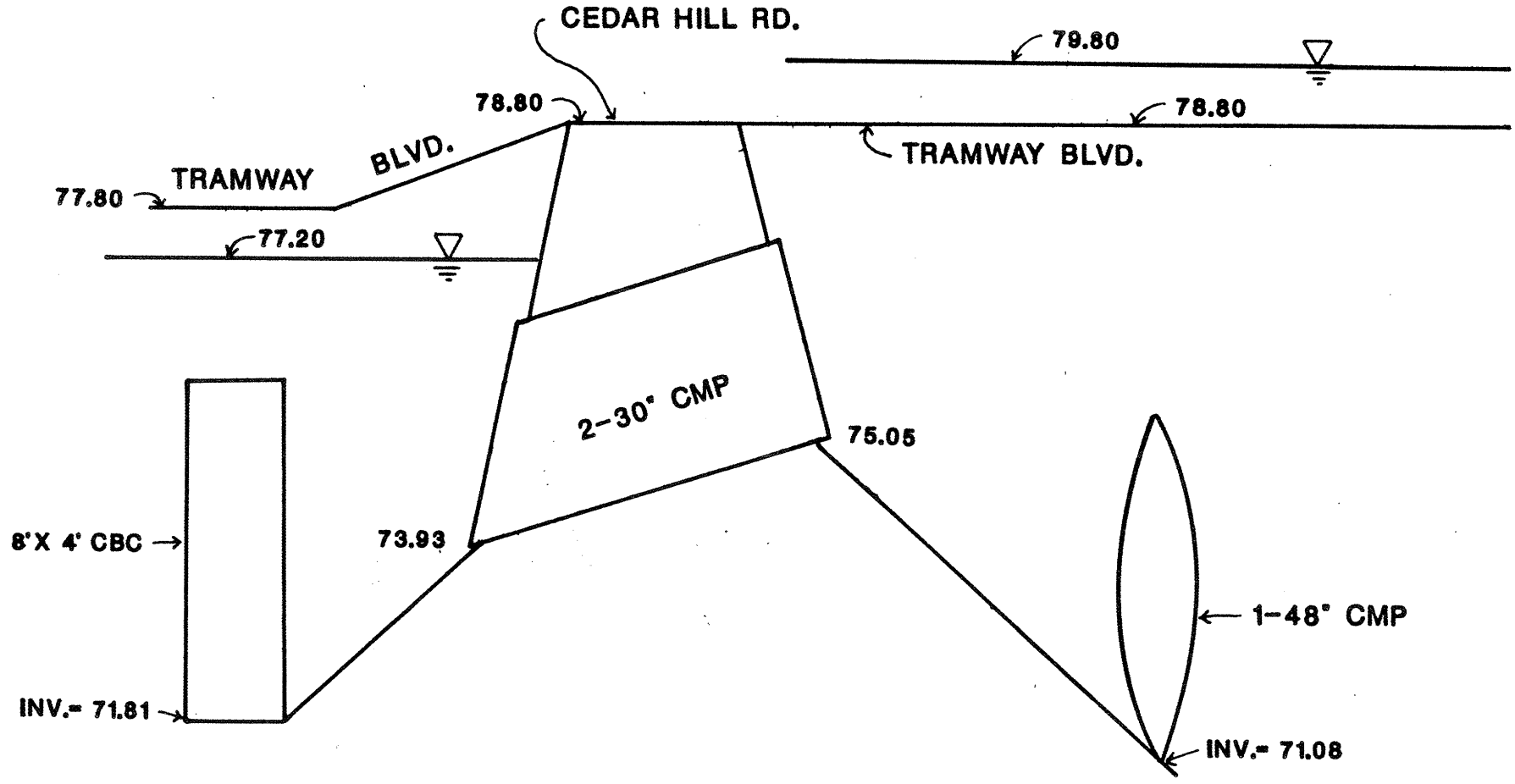
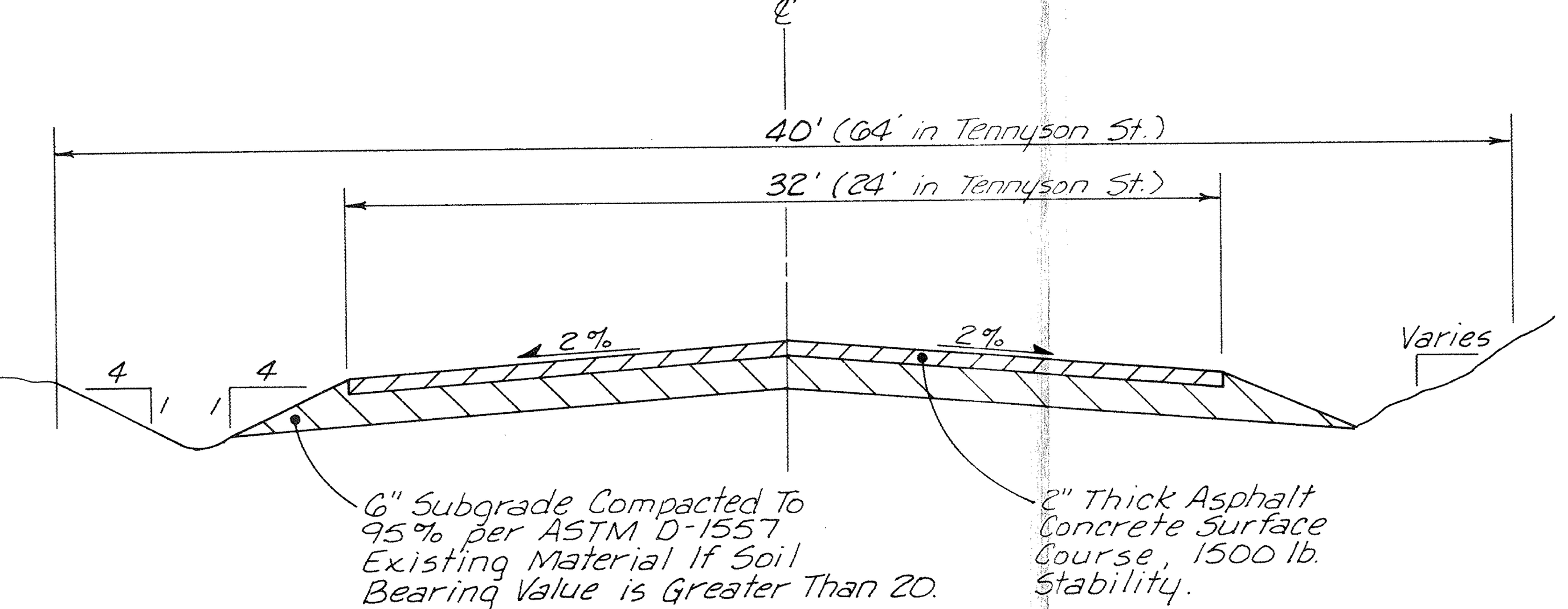


FIGURE 2
100-YR. ELEV.
WITH BULKING &
48" CMP HALF PLUGGED

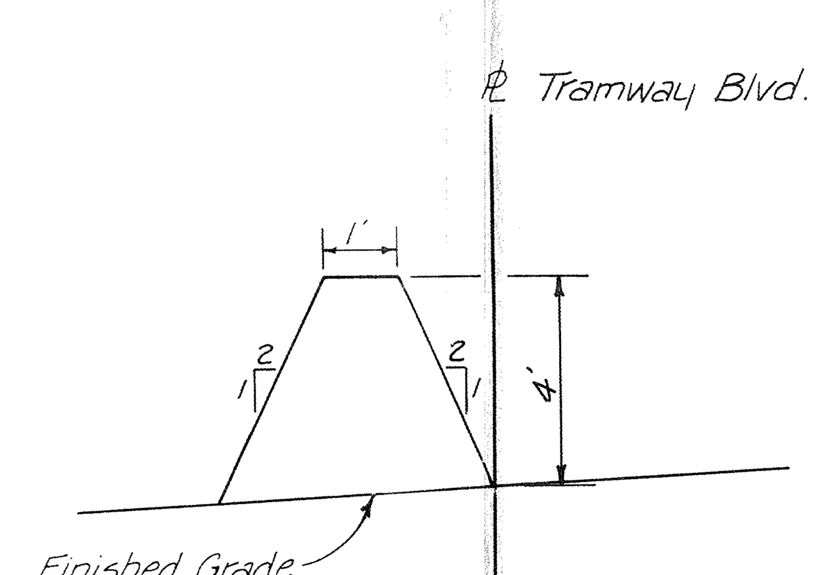
Note : See the Individual Street Plan and Profile Sheets For Final Street Grading and Paving.


CEDAR HILL ROAD
TRAMWAY BOULEVARD (200' R/W)
2-4'x10' BOX CULVERTS
8'x4' BOX CULVERT
48" CMP
See Sheet 9 For Pipe & Ditch Profile. See Sheet 11 For Section A-A.
See Sheet 9 For Channel Profile. See Sheet 11 For Channel Sections.
10' Sanitary Sewer Easement
Install Noise Control Berm See Detail Below
Constructed with Unit 28
SANDIA HEIGHTS SOUTH UNIT 28
CEDAR HILL ROAD (156' R/W)
CLIFFROSE DRIVE
WOLFBERRY PLACE
TRAMWAY CIRCLE
CORONA AVE.
TENNYSON STREET (64' R/W)
5' Drainage Easement
Install Catch Basin
Install 18" Storm Drain
Install 42" Storm Drain
Inv. 35.02
Inv. 34.03
Existing 42" CMP Culvert
Install Catch Basin Inv. = 46.00 Grate = 50.50 Connect Exist. 42" CMP to the Catch Basin
Install 42" CMP Parallel to 42" R.C.P.
NOTE: This Outlet Structure May Not Have to be Constructed if The Downstream Owners Agree That it is Not Required.
Construct 5'x5' Rip-Rap Erosion Control Pad at Pipe Outlet, Conform Pad Shape to Ditch. See Detail, Sheet 10
Construct 5'x5' Rip-Rap Erosion Control Pad at Pipe Outlet
NOTE: Approval of Downstream Owner Required Prior to Construction of Channel.
NEW LIMITS OF FLOOD
NEW LIMITS OF FLOOD (FROM HEC-2 RUN)
SIGNAL AVENUE
WILSHIRE AVENUE
CORONA AVENUE
ANAHEIM AVENUE
6030
6040
6050
6060
6070
2768-A 66.5
2767 64.6
2766 64.0
2765 62.0
2764 63.3
2763 61.8
2762 60.2
2761 58.7
2760 58.0
2759 57.5
2769 2770-A 64.0
2771-A 61.5
2772-A 59.0
2773 56.6
2774 53.9
2775 53.1
2776 50.3
2777 53.1
2754 56.9
2755 59.2
2756 57.2
2757 56.0
2758 55.7
2753 53.9
2752 50.7
2751 49.1
2750 47.9
2749 48.7
2744 57.0
2742-A 58.0
2741-A 55.5
2740-A 53.5
2738 57.1
2736-A 56.0
2735-A 56.0
2734-A 54.5
2739 55.1
2745 55.0
2746 52.9
2747 50.8
2748 48.7
2730 52.9
2731 51.1
2729 50.9
2728 48.9
2727 45.8
2726 46.8
2725 47.1
2724 48.5
2723 47.6
2722 46.8
2732 51.8
2733 48.7

NOTE: No basements will be constructed with this project.

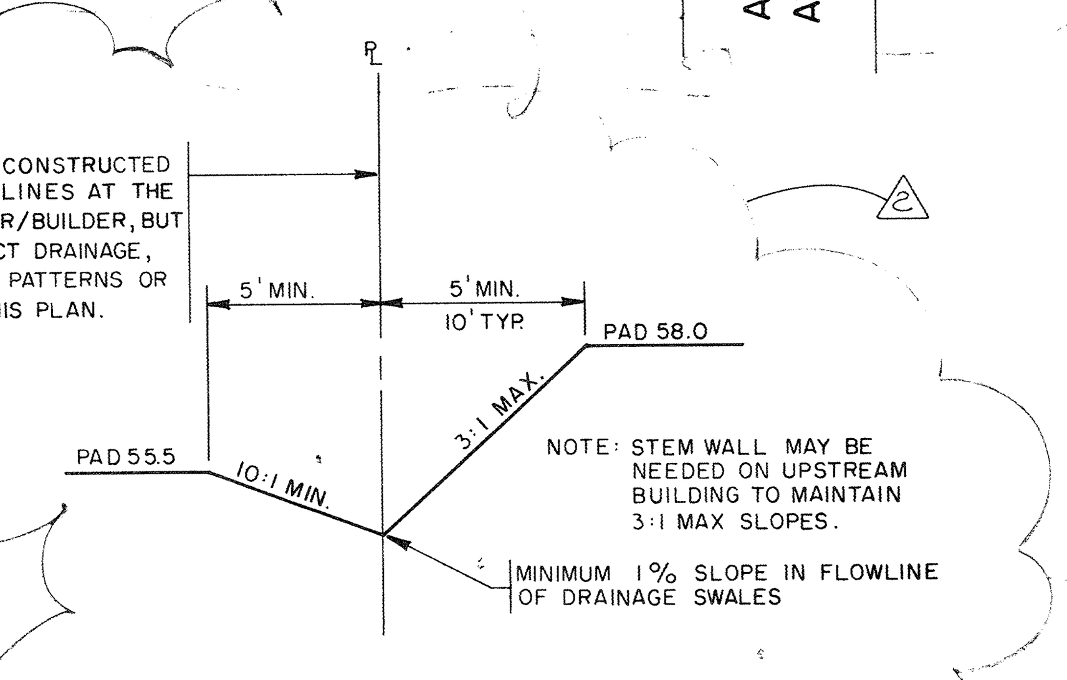


TYPICAL ROADWAY SECTION
NO SCALE



NOISE CONTROL BERM
NO SCALE

WALLS/FENCES MAY BE CONSTRUCTED ON SIDE YARD PROPERTY LINES AT THE DISCRETION OF THE OWNER/BUILDER, BUT THEY SHALL NOT OBSTRUCT DRAINAGE, NOR ALTER THE DRAINAGE PATTERNS OR GRADES IDENTIFIED ON THIS PLAN.



TYPICAL SIDEYARD SWALE DETAIL
NOT TO SCALE

LEGEND

—42—	PROPOSED CONTOURS
— —	EXISTING CONTOURS
- - - -	NOISE CONTROL BERM
▓▓▓	PROPOSED RETAINING WALL
→	DIRECTION OF FLOW
→	DRAINAGE SWALE
54.2	LOT w/ PAD ELEVATION
• 39.0	PROPOSED SPOT ELEVATIONS
▒	NEW LIMITS OF 100 YEAR FLOOD

Date	Revision
11/20/85	1 Added Culverts
9/13/90	2 Replat Lots 2734-2737, Lots 2740-2743, Added Swale Detail
11/19/90	3 Replat Lots 2768-2772

10-1-90
11-20-90
For Revisions Only

Project No.

SANDIA HEIGHTS SOUTH
UNITS 27B & 27C

GRADING PLAN

RECEIVED JUL 18 1991 HYDROLOGY

DANIEL J. GROCHOWSKI NEW MEXICO 8766 REGISTERED PROFESSIONAL ENGINEER
2/12/86

Job No. 51424	Sheet 5 Of 11
Drawn By PE	Date 10/85
Checked By DJG	Scale 1" = 60'

Albuquerque
Metropolitan
Arroyo
Flood
Control
Authority

2600 PROSPECT N.E. - ALBUQUERQUE, N.M. 87107
TELEPHONE (505) 884-2215

Robert Mussetter, Ph.D., P.E.
Vice President
Resource Consultants, Inc.
PO Box 270460
Ft. Collins, Colorado 80522

October 7, 1992

RE: "Sediment Transport Analysis for Sandia Heights Unit 27 B and C" by Bohannan-Huston, Inc., dated July 31, 1992. Sixth Supplemental Agreement to "Prudent Limit and Sediment Transport Studies and Review" (Agreement dated October 1, 1990).

Dear Bob:

You are authorized to proceed with the review of the above-referenced project as described in your letter dated September 21, 1992. The work you will perform will be paid on a unit cost basis, with costs not to exceed $3,800 without prior written authorization. Any applicable gross receipts taxes may be billed in addition to this amount.

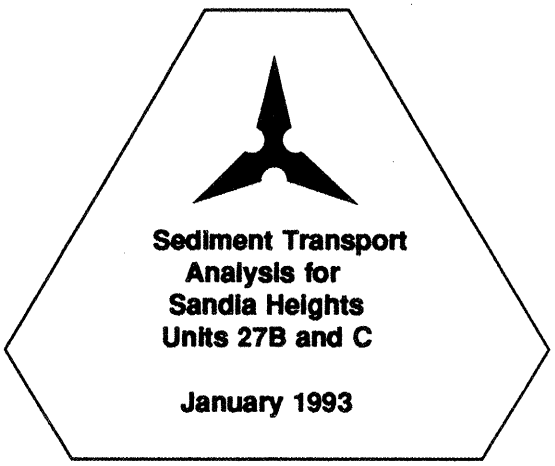
AMAFCA's contact on this project will be Cliff Anderson.

Sincerely,
AMAFCA

Larry A. Blair, P.E.
Executive Engineer

LAB:ij

copy: Gilbert Aldaz, City-County Floodplain Administrator
Robert Foglesong, Bernalillo Co. Surface Water Hydrologist



SEDIMENT TRANSPORT ANALYSIS FOR SANDIA HEIGHTS UNITS 27B AND C CASE NO. 6-91-177

Prepared for:

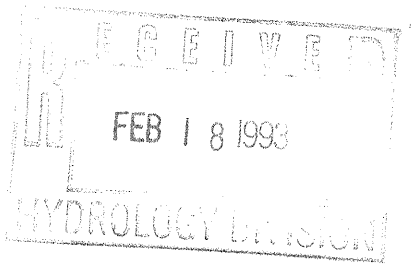
Sandia Peak Tram Company
No. 10 Tramway Loop, NE
Albuquerque, NM 87122

Prepared by:

BOHANNAN-HUSTON INC.
ENGINEERS ARCHITECTS PHOTOGRAMMETRISTS SURVEYORS
COURTYARD I, 7500 JEFFERSON NE ALBUQUERQUE, NM 87109 TEL (505) 823-1000 FAX (505) 821-0892

Sediment Transport
Analysis for
Sandia Heights
Units 27B and C

January 1993



I hereby certify that I am a registered professional engineer, registered in the State of New Mexico, and that the following report was prepared by me or under my supervision and is true and correct to the best of my knowledge and belief.

Howard C. Stone, P.E.
N.M.P.E. No. 9099

2/11/93
Date

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I. PURPOSE AND SCOPE

This report is submitted as an update to the "Floodplain Analysis for Sandia Heights Unit 27B & C" report presented in April 1991. The response letter from FEMA, by Mr. William Locke, asked for the following additional information:

> "Please provide an analyses of sediment transport through the project area, especially at the arroyo crossings under Tramway Boulevard, where the sediment load could drop due to reduced velocities. The analyses should estimate the volume of sediment deposited throughout the project area and the impact of this deposition on the hydraulic calculations."

Therefore, the scope of this report covers the movement of sediment upstream and through the 48" CMP and the 42", 4'x8' CBC.

II. SITE LOCATION AND DESCRIPTION

The property is located within the Sandia Heights Subdivision west of Tramway Boulevard between Cedar Hill Road on the north and Live Oak Road on the south (refer to the Location Map in Appendix 1). Tennyson Street forms the west boundary of the property, consisting of a 24' pavement section with utility and drainage improvements in place.

The property is bisected by two major arroyos which drain the property east of Tramway Boulevard. These include a minor tributary of the South La Cueva Arroyo which passes the property along the north boundary adjacent to Cedar Hill Road. An earthen channel was constructed within an easement granted to AMAFCA by the original subdivision plat. A concrete channel was constructed within the other arroyo, North Domingo Baca Arroyo, when the subdivision was originally developed.

III. HYDROLOGY

Figure 1 (Appendix 2) shows the 100-year flow rates that were presented in the previous report. The flows in parenthesis include a 10% bulking factor which is consistent with the previous report. The values in parentheses (accept for the basin flows) also assume that the 48" CMP is half plugged (see Sediment Analysis, Section E). These values are also listed in Table 1.

TABLE 1

100-YEAR FLOW RATES, CFS

	Unbulked	Bulked
Basin 1	112	123
Basin 2	188	207
Basins 3 and 4	82	90
48" CMP	110	35
42", 4'x8' CBC	208	218
Two 30" CMP	4	66
Flow south to North Domingo Baca	64	145
Street flow over Tramway	0	22

The following reports are referenced as using a similar bulking factor in the same area:

- "Conceptual Drainage Management Plan for High Desert Development," Technical Report, Bohannan-Huston, Inc., February 1992.

- "South Pino Arroyo Stabilization Study," Bohannan-Huston, Inc., February 1987.

Both of these reports were approved by the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA).

IV. HYDRAULICS

The previous report identified the hydraulics of the structures in the project area. The flows generated north of Cedar Hill Road flow into the 48" CMP. Since the CMP cannot carry the total flow (123 cfs versus 115 cfs capacity) the remaining flow passes downstream under Cedar Hill Road in the two 30" CMPs to the 42", 4'x8' CBC. The capacity of the 4'x8' CBC (the CBC transitions to a 42" RCP) is less than the total flow arriving. Therefore, the excess flows south on the east side of Tramway Boulevard to the North Domingo Baca Arroyo which, based on the previous drainage report, has the capacity to accommodate the flow.

V. SEDIMENT ANALYSIS

The drainage report previously submitted proposed a sediment bulking factor of 10%. This 10% bulking factor accounts for the wash load carried by the storm runoff. The wash load consists of the fine sediments not typically found in the bed that remain in suspension and are "washed" through the system. The wash load will only be considered in this analysis in terms of its effect of increasing the volume of fluid passing a particular point of interest (bulking factor).

This analysis addresses the movement of the bed material which consists of sediments typically found in the bed material, some of which will be transported as bed load (rolling or bouncing along the bed), and some of which will be transported as suspended load. This material is not considered to substantially add to the volume of the fluid, but is important to analyses of deposition and erosion.

A. Sediment Investigation

A field investigation was performed at the project site. During the site visit, four sediment grab samples were obtained at the locations shown in Figure 1. In addition, the condition of the drainage facilities and channels (vegetation, scour, obstructions, etc.) were determined.

A sieve analysis was performed on the four grab samples, the results of which can be found in Appendix 3, Sediment Investigations. The sediment in the arroyo beds can be described as medium to course sand.

B. Sediment Transport

A total of six cross-sections were selected in the project area in order to establish the hydraulics of the two arroyos. Table 2 describes the cross-section locations.

TABLE 2

CROSS-SECTION LOCATIONS

Cross-Section	Location	Reach Number
A	300' north of Cedar Hill east side of Tramway	1
B	150' north of Cedar Hill east side of Tramway	2
C	80' east of Tramway south side of Cedar Hill	3
D	300' east of Tramway south side of Cedar Hill	3
E	200' south of Cedar Hill east side of Tramway	
F	500' east of Tramway south side of Cedar Hill	4

Cross-sections A, B, C, and F were used in the sediment transport analysis. The sediment analysis was performed using the Zeller and Fullerton relationship to determine the bed material transport capacity of each reach. The Zeller and Fullerton relationship estimates the bed material load discharge, given the channel roughness, flow depth and velocity, and bed sediment grain-size distribution (see Appendix 4 for a full description). Sediment discharges (Qs) were determined for several flow discharges (Q) using Zeller and Fullerton.

Regression analysis was then applied to these data pairs to determine a Qs versus Q relationship for each reach (see curve fitting graphs in Appendix 4). The Qs versus Q relationships were then applied to the storm hydrograph (computed from AHYMO as described in the previous report) for each respective reach to determine the total sediment carrying capacity for each reach. The analysis calculations and results are described in Appendix 4, Sediment Transport Analysis.

Note from the curve fitting graph of cross-section B in Appendix 4 that the sediment discharge for Cross-Section B decreases after a peak of 1.1 cfs as the flow rate increases. This is because the headwater at the culvert backs up, and the flow velocity changes from supercritical to subcritical due to the backwater.

C. Sediment Results

The results of the sediment analysis are summarized in the following table:

TABLE 3

SEDIMENT ANALYSIS RESULTS

Reach No.	Bed Slope	Velocity fps	Peak Flow cfs	Total Bed Material tons	Mannings n
1	.0286	6.5	123	277	.025
2	.0388	4.7	123	149	.025
3	.0445	8.1	207	670	.035
4	.0513	7.8	207	673	.035

Reaches 3 and 4 have a much higher N value due to the fact that the arroyo has well established vegetation that consists of approximately three-foot high bushes. Reaches 1 and 2 mainly have native grasses as vegetative cover.

Reaches 1 and 3 were used to determine the amount of bed load that will be brought into the project area during the 100-year storm. Reaches 2 and 4 determine the amount of bed load that can be transported through the project area.

The following brief discussion addresses the sediment transport of the two arroyos in the project area.

Arroyo A - Paralleling Tramway: An examination of the sediment transport for this reach reveals that the reach directly in front of the 48" CMP (Reach 2) will transport a little more than one-half the sediment brought in by the upstream reach (Reach 1) during the 100-year storm. This is born out by the deposition in the 48" CMP which was approximately eight inches silted up at the time of the field inspection. A comparison of the culvert and approach velocities show a one-half plugged culvert velocity of 10.5 fps, a full culvert velocity of 9.2 fps, and an approach velocity of 6.5 fps. While this comparison indicates that the pipe would tend to scour clean, it is believed that the deposition in the approach reach will eventually plug part of the 48" CMP. Taking a conservative approach, it is assumed here that the 48" CMP will become one-half plugged during the 100-year storm because of the lesser carrying capacity of Reach 2.

Note that the two 30" CMPs crossing Cedar Hill Road have upstream inverts elevated four feet above the channel invert (Figure 2), thus, these structures are not expected to plug from sediment buildup.

Arroyo B - Paralleling Cedar Hill Road: The sediment transport capacities of Reach 3 and Reach 4 are almost identical--Reach 3 having a peak velocity of 8.1 fps and a 100-year storm transport of 670 tons, while Reach 4 values are 7.8 fps and 673 tons. The velocity in the 4'x8' CBC (6.8 cfs) is within 13% of the velocity in the upstream arroyo which leads to the conclusion that the CBC will not plug or be affected by sediment deposition during the 100-year storm. The site investigation also confirmed this since the CBC is clean and has shown no tendency to be affected by sedimentation.

Tables 4 and 5 provide a summary of the hydraulic analyses for the drainage structures accepting flow from Arroyos A and B, assuming a one-half plugged 48" CMP. Figure 1 (Appendix 2) also shows these flow rates (bulked flows with the 48" CMP one-half plugged in parentheses). With the 48" CMP one-half plugged, the water surface at the inlet to this pipe will be at elevation 79.8. At this elevation, 22 cfs from Arroyo A flows across

TABLE 4

FLOW ANALYSIS FOR ARROYO A THROUGH TWO 30" CMPS AND OVER TRAMWAY

Elevation ft	Depth Over Tramway ft	Two 30" CMP Flow cfs	48" CMP 1/2 Plug cfs	Weir Flow Over Tramway cfs	Total Flow cfs
77.5		8.0	31	---	39.0
78.0		46.0	32	---	78.0
78.5		36.0	33	---	69.0
79.0		58.0	34	0.0	92.0
79.5	0.1	64.0	35	0.8	99.8
79.8	0.4	66.0	35	26.0	127.0
79.9	0.5	68.0	36	45.0	149.0
80.0	0.6	70.0	37	71.0	178.0

NOTE:
1. Total inflow of 123 cfs causes a water surface elevation of 79.8.
2. From Table 4, water surface at outlet of 30" CMPs is at 77.2.
3. Low point in intersection is at 79.4.

TABLE 5

FLOW ANALYSIS FOR ARROYO B
48" CMP FLOWING ONE-HALF FULL

Elevation ft	42", 4'x8' CBC Flow cfs	Weir Flow cfs	Total Flow cfs
75.0	120.0	0.0	120.0
75.5	146.0	3.0	149.0
76.0	170.0	18.0	188.0
76.5	197.0	51.0	248.0
77.0	217.0	112.0	329.0
77.1	218.0	129.0	347.0
77.2	218.0	147.0	365.0
77.3	219.0	166.0	385.0
77.5	222.0	210.0	432.0

NOTE:
1. At total inflow of 363 cfs, water surface elevation is 77.2.
2. See Table 5 for 48" CMP flows due to pipe being one-half plugged.

Tramway to the west, then down Cedar Hill Road (confined in the street by the existing asphalt curb), and enters the arroyo at Tennyson Street (500' west of Tramway Boulevard). Approximately 66 cfs flows through the two 30" CMPs to the south side of Cedar Hills.

For Arroyo B, the water surface at the entrance to the 4'x8' CBC is at elevation 77.1. At this point, 218 cfs flows through the CBC with the remaining flow of 145 cfs flowing south to the North Domingo Arroyo in the swale on the east side of Tramway.

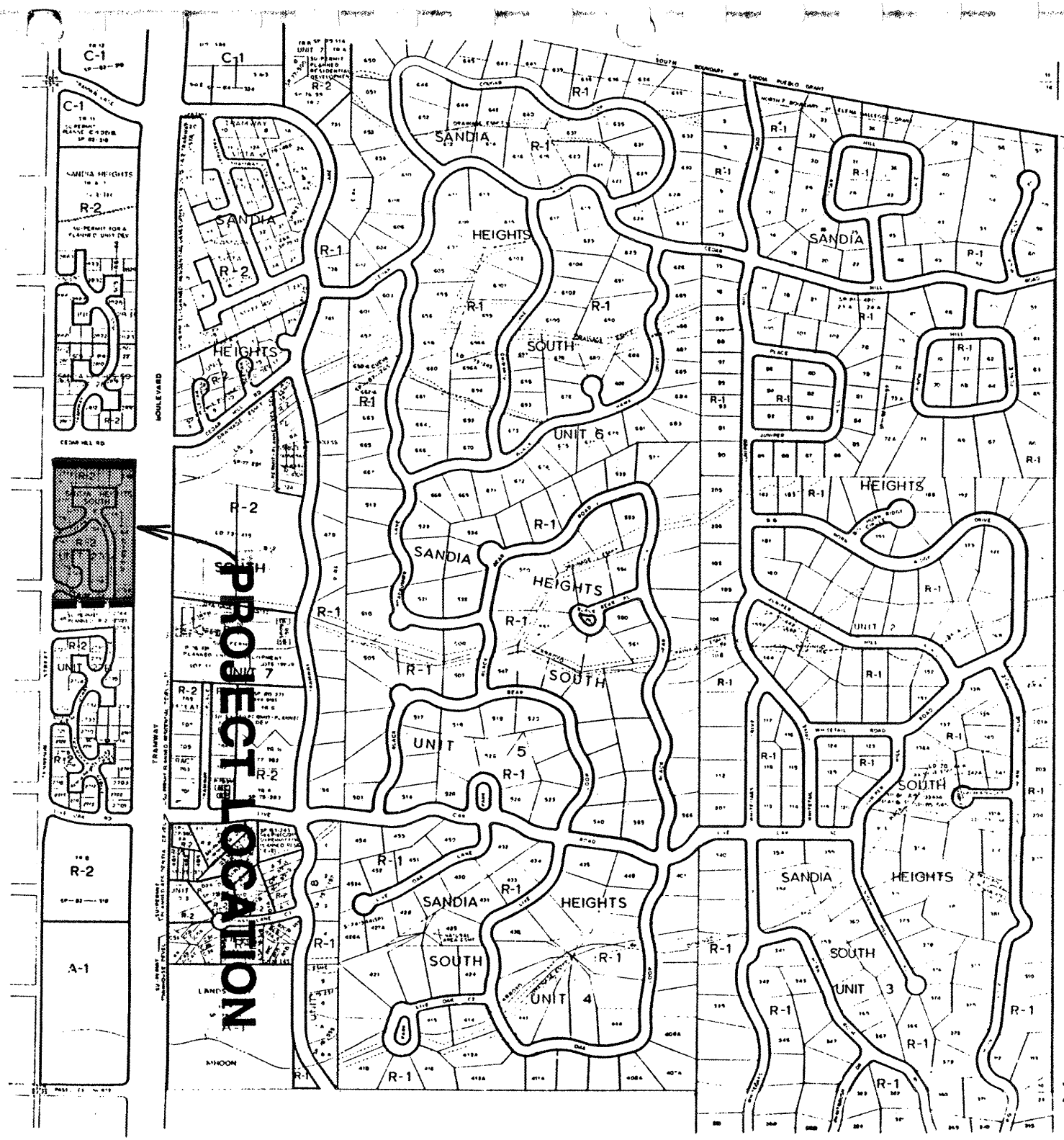
VI. CONCLUSION

This sediment and hydraulic analysis update to the previously submitted report dated April 1991 shows that with the 48" CMP one-half plugged, flow will overtop the intersection of Cedar Hill Road and Tramway Boulevard. The sheet flow over the road (.4' maximum depth), which is contained in Cedar Hill Road by the existing curb, will re-enter the arroyo at Tennyson Road. This additional study, requested by FEMA, should allow the LOMR submitted in April 1991 to move forward.

Figure 2. Show 1" =

APPENDIX 1

PROJECT LOCATION


PROJECT LOCATION
C-1
R-2
A-1
R-1
SANDIA HEIGHTS
SOUTH
UNIT 5
UNIT 6
UNIT 7
UNIT 4
UNIT 3
UNIT 2
TRAMWAY BOULEVARD
CEDAR HILL RD
WHITETAIL ROAD

C-23-Z

APPENDIX 3

SEDIMENT INVESTIGATION

Project: Cedar Hill Rd.

Client: Bohannan-Huston Inc.

Project Number: 92-2-248

Date Sampled: 07/22/92

Sample Location: Sample No. 1

SIEVE ANALYSIS TEST RESULTS

Sieve Size	Percent Passing
3/4"	100
3/8"	98.9
No. 4	92.5
No. 8	73.0
No. 16	42.5
No. 30	23.7
No. 50	13.5
No. 100	7.5
No. 200	5.3

V
Vinyard & Associates, Inc.
A

4415-D Hawkins, NE
Albuquerque, New Mexico 87109
(505) 345-1937

Geotechnical Engineering • Materials Testing • Environmental Engineering

July 24, 1992

Bohannan-Huston Inc.
7500 Jefferson NE
Albuquerque, NM 87109
Attn: Mr. Howard Stone

Subject: Cedar Hill Rd.
V & A Job No. 92-2-248

Dear Sir:

Attached are copies of the Laboratory Test Results for the subject project.

Should you have any questions regarding this data, please do not hesitate to call.

Sincerely,
Vinyard & Associates Inc.

Martin D. Vinyard, P.E.

MARTIN D. VINYARD
NEW MEXICO
8231
REGISTERED PROFESSIONAL ENGINEER

Attachment: Data Sheets (4)

cc: Addressee (2)

Project: Cedar Hill Rd.

Client: Bohannan-Huston Inc.

Project Number: 92-2-248

Date Sampled: 07/22/92

Sample Location: Sample #2

SIEVE ANALYSIS TEST RESULTS

Sieve Size	Percent Passing
- 3/8"	100
4.76mm - No. 4	96.8
- No. 8	72.1
- No. 16	39.4
- No. 30	19.6
- No. 50	8.9
- No. 100	3.8
- No. 200	1.9

Project: Cedar Hill Rd.

Client: Bohannan-Huston Inc.

Project Number: 92-2-248

Date Sampled: 07/22/92

Sample Location: Sample #3

SIEVE ANALYSIS TEST RESULTS

Sieve Size	Percent Passing
3/4"	100
3/8"	96.7
No. 4	81.7
No. 8	61.2
No. 16	45.9
No. 30	38.6
No. 50	34.4
No. 100	30.7
No. 200	23.9

Project: Cedar Hill Rd.

Client: Bohannan-Huston Inc.

Project Number: 92-2-248

Date Sampled: 07/22/92

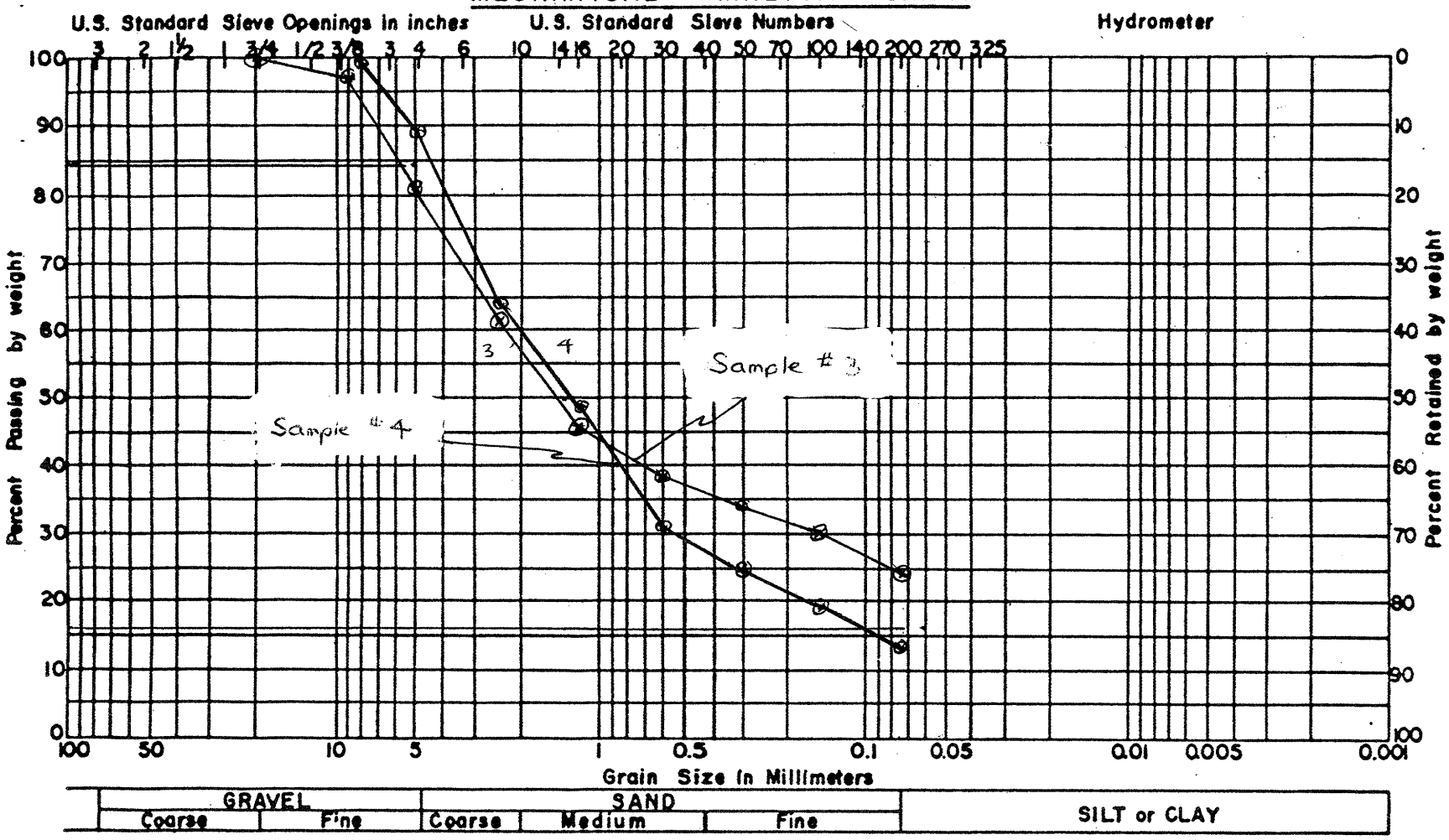
Sample Location: Sample #4

SIEVE ANALYSIS TEST RESULTS

Sieve Size	Percent Passing
3/4"	100
3/8"	98.8
No. 4	88.2
No. 8	64.6
No. 16	42.7
No. 30	32.4
No. 50	25.4
No. 100	19.5
No. 200	13.0

Form 116

MECHANICAL ANALYSIS CHART



D_{84} = 5.0 mm

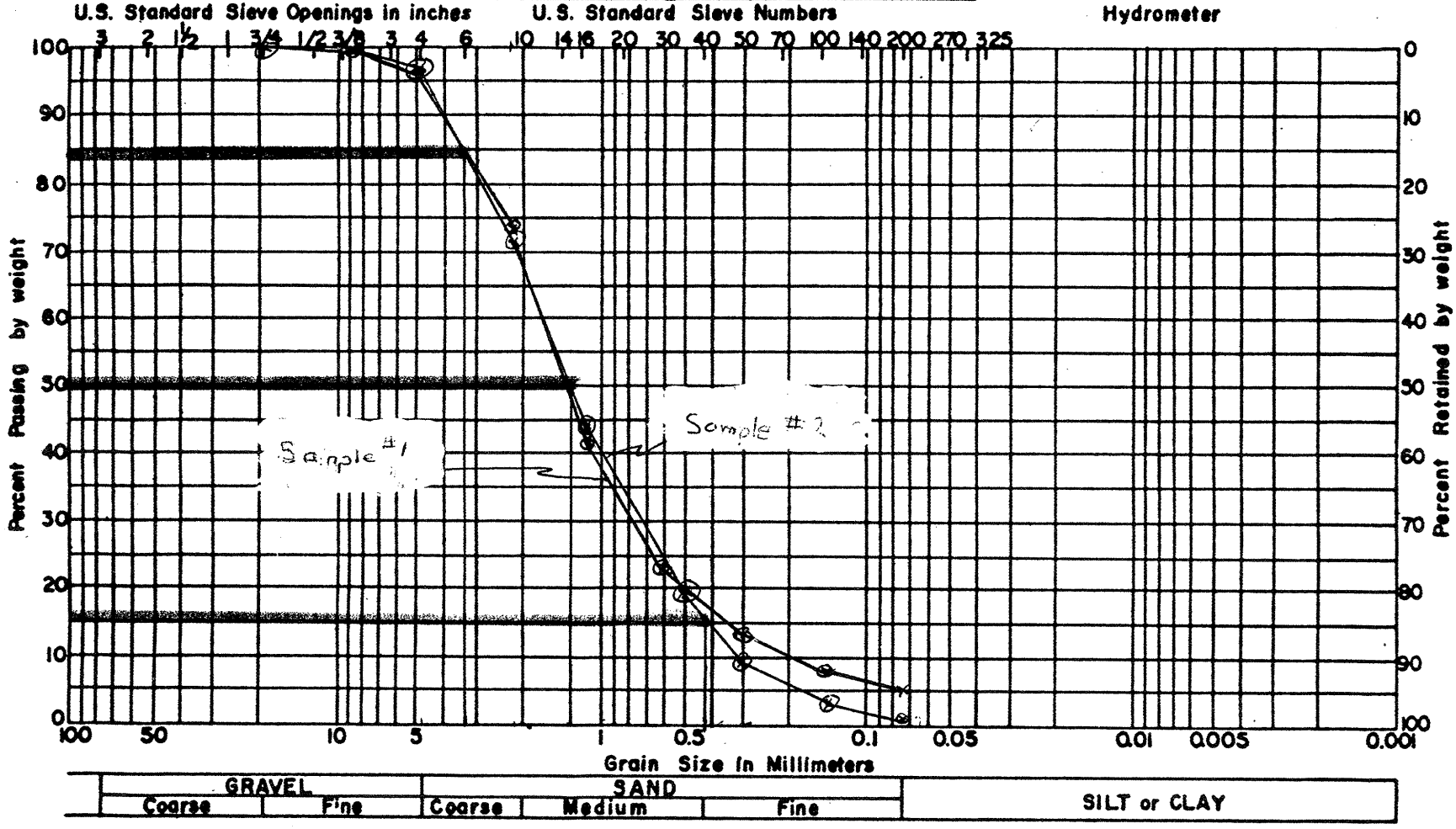
D_{50} = 1.4 mm

D_{16} = .06 mm

Samp # 3 + 4

Form. -116

MECHANICAL ANALYSIS CHART



D_{84} = 3.3 mm

D_{50} = 1.3 mm

D_{16} = .40 mm

Samples #1 & #2
Cedar Hills Rd.

APPENDIX 4

SEDIMENT TRANSPORT ANALYSIS

APPENDIX 4

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