

**BEAR ARROYO
DRAINAGE REPORT**

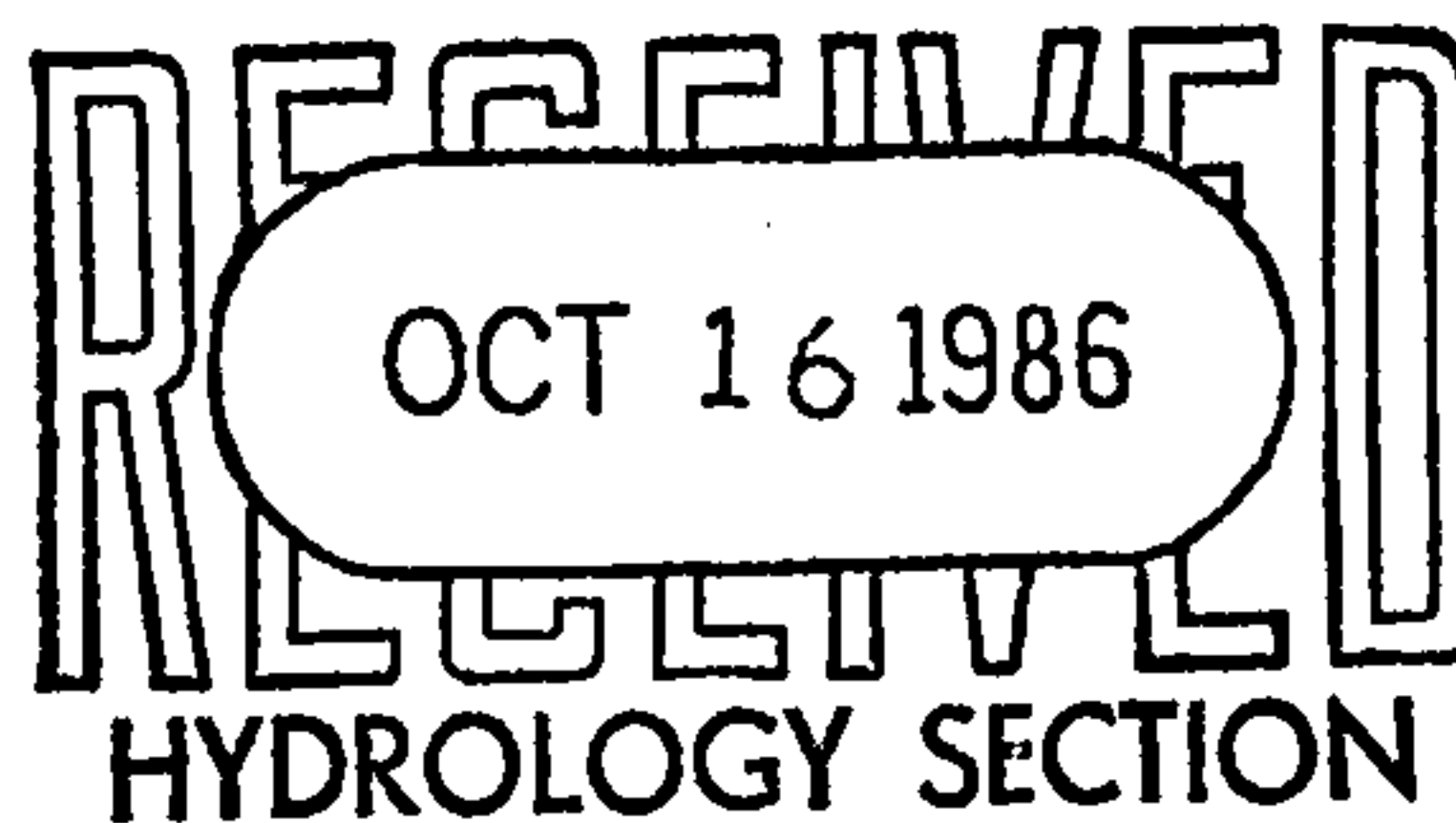
September 1986

Prepared for:

**Johnson Development
3001 Louisiana N.E.
Albuquerque, NM 87110**

Prepared by:

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INTRODUCTION

This report summarizes the drainage and design analysis for proposed improvements to the Bear Arroyo Channel between San Mateo Boulevard and the I-25 East Frontage Road. The project location is shown in Figure 1-A.

The purpose of the project is to alleviate problems caused by erosion and to allow properties to both the north and south to reclaim and utilize land for parking.

Drainage plans approved by the City of Albuquerque for the adjoining properties and the "Concept Design Report Bear Canyon Arroyo Channel Improvements", by Leedshill-Herkenhoff, Inc., May 1986, were utilized as reference materials.

EXISTING CONDITIONS

The Bear Arroyo is an unlined channel for approximately 900 feet that varies in width from 130 feet at I-25 to approximately 60 feet wide at San Mateo. Thirteen 10' X 4' concrete box culverts (CBC) carry arroyo flow across I-25. Due to extremely flat slopes there is a ponding area just upstream of the I-25 CBC. Four 10' X 4' CBC's carry the flows across San Mateo to the project site. Erosion has occurred in the vicinity of the outlet of the San Mateo CBC.

Inflows to the channel from the adjacent properties are as follows (please refer to the construction drawings for stationing):

1. An asphalt rundown enters from the north at about Station 5+68. Flow is 11 cfs.
2. Two concrete rundowns enter from the south at Stations 1+66 and 3+46, respectively. Flow is estimated at 5 cfs each.
3. A 24" RCP enters from the south at Station 3+02, contributing 12 cfs.
4. Inflow from the property to the south (Lotta Burger), flow is small, 1 cfs.
5. A 60" RCP enters at the south wing wall of the San Mateo CBC. Flow is 165 cfs.

The drainage upstream of the project area is comprised of the outflow from the Arroyo del Oso Dam and flows generated by the drainage area between the dam and San Mateo. Total design Q is 1800 cfs.

A limited soils investigation was done for the Leedshill-Herkenhoff report and yielded a classification of poorly graded sands with varying degrees of silt and clay fines. Construction of a site north of the arroyo has uncovered a 12" thick clay layer in the vicinity of the arroyo. It is therefore recommended that a complete soils investigation be undertaken before construction begins in order to determine correct overexcavation and fill quantities.

PROPOSED CONDITIONS

DPM - 6' min

must be
plunge pool type

The upper 624 feet of the channel will be enclosed in a CBC structure. The 4 - 10' x 4' CBC's at San Mateo will be transitioned into 2 - 10' x 5' CBC's. The transition structure will be 100' in length, at slopes of 8% and 4.07%. The 2 - 10' x 5' CBC's will be at a slope of 1.3% and end in a 3.5 foot drop to a riprap energy dissipation structure. The top of the riprap structure will be set at the same elevation as the existing arroyo bottom. Ending the box culvert above the existing arroyo bottom allows for a future extension to the culverts in I-25.

Two storm drain inlets will be constructed to allow off-site drainage to enter the CBC. The 60" RCP will penetrate the transition structure at a point where the inverts match. A 45° bend will be installed on the 60" RCP to maintain its existing slope and facilitate the connection to the transition structure. The asphalt rundown to the north will be extended to one of the storm drain inlets noted above. The remaining inflows from adjacent properties are either negligible or enter the arroyo west of the western terminus of the project.

The following assumptions were made regarding the design of the concrete box culverts:

- ✓ 1. Open channel flow must be maintained.
- ✓ 2. All local flow peaks will have passed through the CBC well before peak flows from upstream enter the structure.
- ✓ 3. 100-year storm event was used for design purposes.

The hydraulic calculations are contained in Appendix A. Appendix B contains the riprap sizing computations. Two HEC-2 runs are required because of the change from supercritical to subcritical after leaving the box. The first run is for Sta. 9+26.10 to 3+01.25. The second run is for Sta. 0+00.00 to 3+01.24. The HEC-2 output is in Appendix C.

ONGOING AND FUTURE DEVELOPMENT

The property to the north of the arroyo is under construction as this report is written. Several rundowns will discharge flows to the arroyo. They are located far enough to the west so as not to impact the box culvert. Any other new development should take into account the possible future extension of the concrete box structure.

The box culvert has been designed for highway traffic loads. Upon completion of this project, the amount of right-of-way required for drainage will be greatly reduced to the benefit of the adjoining landowners who are paying for this construction. Parking and/or access over the culvert is feasible.

PURPOSE: Determine size of concrete box culverts
for Bear Arroyo from San Mateo to
300 ft east of I-25.

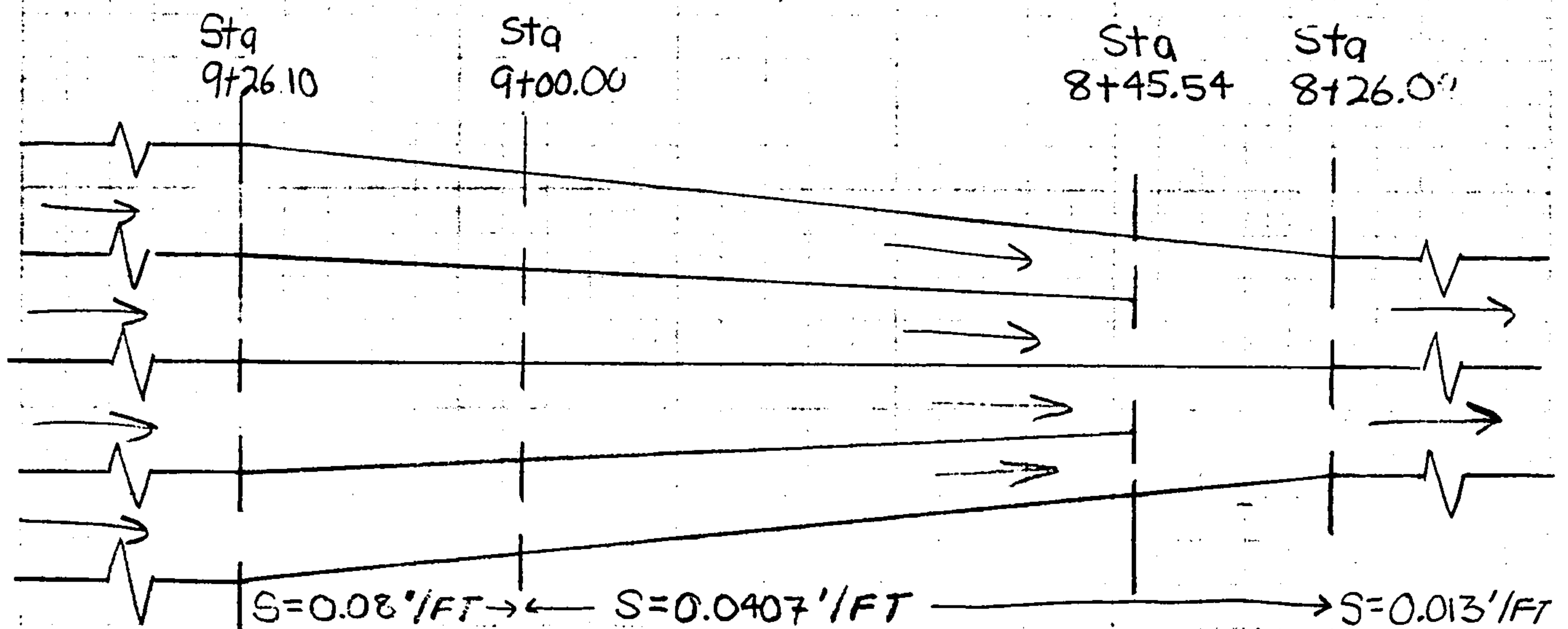
CONSTRAINTS:

1. Flow at existing San Mateo CBC
is supercritical.
2. $Fr = 2.2$ at San Mateo CBC*
3. Outlet conditions must not produce
hydraulic jump.

Given: $Q_{DESIGN} = 1800 \text{ CFS}^*$

10 Year Storm Flow = 1450 CFS
100 Year Storm Flow = 1800 CFS
Intermediate Flow = 900 CFS
Recurring Flow = 450 CFS

$n = 0.014$



* from Leedshill-Herkenhoff, "Concept Design Report Bear
Canyon Arroyo Channel Improvements"



PROJECT NAME Bear Arroyo Box Culv. SHEET 1 OF 6
PROJECT NO. 62631 BY KLS DATE
SUBJECT Hydraulic Calcs CH'D D/G DATE 2/22/26

FORMULAS*

$$Fr = \frac{V}{\sqrt{gy}}$$

$$V = \frac{Q}{y}$$

$$\therefore y = \sqrt[3]{\frac{Q^2}{Fr^2 g}}$$

$$y_c = \sqrt[3]{\frac{Q^2}{g}}$$

$$Q = \frac{1.50}{n} AR^{2/3} S_0^{1/2}$$

$$R = \frac{y - \text{xwidth}}{2y + \text{width}}$$

$$y_2 = \frac{y_1}{2} \left[-1 + \sqrt{1 + \frac{8Q^2}{gy_1^3}} \right]$$

$$z_1 + h_1 \cos \theta_1 + \frac{Q^2}{2gh_1^2} = z_2 + h_2 \cos \theta_2 + \frac{Q^2}{2gh_2^2} + \text{losses}$$

$$\cos \theta_1 \equiv \cos \theta_2 \equiv 1.00$$

* from Streeter and Wylie, "Fluid Mechanics"



PROJECT NAME Bear Arroyo Box Culvert SHEET 2 OF 6
PROJECT NO. 62631 BY KLS DATE
SUBJECT HYDRAULIC CALC CH'D DJG DATE 9/22/86

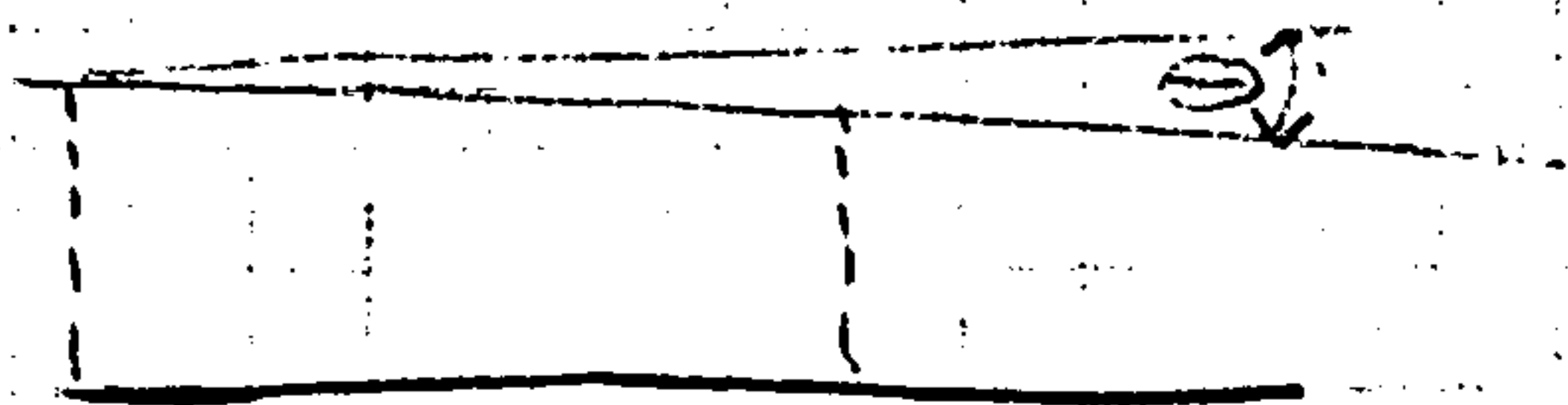
1) Depth of flow at Sta 9+26.10

$$Q = 40 \text{ cfs}$$

$$y = 3 \sqrt{\left[\frac{1800}{(2.2)(40)} \right]^2 \frac{1}{32.2}}$$

$$y = 2.35 \text{ ft}$$

2) Sta 9+00.00 Width = 8.7' per CBC



$$\theta = 2^\circ 50' 46''$$

Solving Chezy - Manning eqn.:

$$y = 1.56$$

3) Sta 8+45.54 Width = 6.0' per CBC

Solving Chezy Manning as above

$$y = 2.74$$



4) Sta 8+26.09

Width = 10' per CBC

$$S = 0.013 \text{ '}/\text{ft}$$

Solve Chezy Manning for y

$$y = 4.27$$

Assuming normal flow is reached at the end of the box culverts, the elevation at the cut-off will be 4.27 ft.



PROJECT NAME Bear Arroyo Box Culvert

PROJECT NO. 62631

SUBJECT HYDRAULIC CALC

SHEET 4

OF 6

BY KLS

DATE

CH'D DVG

DATE 7/22/86

$$Q = \frac{1.5}{n} A R^{2/3} S_0^{1/2}$$

$$\frac{Qn}{1.5 S_0^{1/2}} = 8.7y \left(\frac{8.7y}{2y + 2.7} \right)^{2/3} = 14.85$$

Solving by Trial & error:

$$y = 1.56$$

$$\text{and } y_c = 4.36$$

$$20.88 = 6y \left(\frac{6y}{2y + 5} \right)^{2/3}$$

Solving by Trial & error:

$$y = 2.74$$

$$73.67 = 10y \left(\frac{10y}{2y + 10} \right)^{2/3}$$

$$y = 4.27$$



SUPERELEVATION

$$S = \frac{V^2 b}{g r} *$$

$$V = \frac{Q}{A} = \frac{1800/2}{4.27(10)} = 21.1 \text{ fps}$$

$$b = 10'$$

$$g = 32.2 \text{ ft/sec}^2$$

$$r = 525'$$

$$S = 0.26'$$

*from City of Albuquerque "DPM" Sec. 22.3

PROJECT NAME BEAR ARROYO BOX CULVERT SHEET 6 OF 6
PROJECT NO. 62631 BY DJG DATE 9/22/86
SUBJECT HYDRAULIC CALC'S CH'D _____ DATE _____

APPENDIX B

1) Design Flow: $Q = 1850 \text{ cfs}$
 $V = 20.6 \text{ ft/s}$
 $R_h = 4.5 \text{ ft}$

Reference 2

254 mm / inch

2) Existing Bank/Bed

Banks = Average $D_{50} = 0.7 \text{ mm}$

Beds = Average $D_{50} = 2.2 \text{ mm}$

3) Bed $\frac{V^2}{R^{0.33}} = 257 \rightarrow \text{Type VH}$

Banks $\frac{VS^{0.17}}{(S_s - 1)^{0.66}} = 2.6 \rightarrow \text{Type VL} \rightarrow \text{use Type M}$

4) Bed $d_{50} = 24$

Banks $d_{50} = 12$

5) For Filter Use

$$\frac{D_{50}^{RR}}{D_{50}^F} > 12, < 58$$

$$\frac{D_{15}^{RR}}{D_{15}^F} > 12, < 40$$

$$D_{50}^{RR} = 24 \text{ in} = 610 \text{ mm}$$

$$D_{15} = 9 \text{ in} = 228.6 \text{ mm}$$

$$D_{50}^F = 50.8, 10.5$$

$$D_{15}^F = 2.9, 0.86$$

$$1 \text{ m} = 39.37 \text{ in}$$

$$1 \text{ mm} = 0.03937 \text{ in}$$



PROJECT NAME Bear Arroyo

PROJECT NO. 62630

SUBJECT Design Riprap / Filter

SHEET 1

OF 2

BY KLS

DATE 8/19/86

CH'D

DATE

Filter for Soil

Reference?

$$\frac{D_{50}^F}{D_{50}^S} > 12, < 58$$

$$\frac{D_{15}^F}{D_{15}^S} > 12, < 40$$

$$D_{50}^S = 2.2$$

$$D_{15}^S = 0.15$$

$$D_{50}^F = 26.4, 127.6$$

$$D_{15}^F = 1.8, 6.0$$

USE CLASS VI SB

Rip Rap Depth = 4'

Filter Depth = 2'

Width = 20' + 20'

length = 10'

Rip Rap Volume = 30 CY x 130⁰⁰ → 3900⁰⁰

Filter Volume = 15 CY x 70⁰⁰ → 1050⁰⁰



PROJECT NAME _____

SHEET 2 OF 2

PROJECT NO. _____

BY _____ DATE _____

SUBJECT _____

CH'D _____ DATE _____

THIS RUN EXECUTED 12-NOV-86 10:22:23

 HEC2 RELEASE DATED NOV 76 UPDATED APR. 1980
 ERROR CORR - 01,02,03,04
 MODIFICATION - 50,51,52,53,54

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ARROYO BOX CULVERT

SUMMARY PRINTOUT

	SECNO	ELMIN	TOPWID	VCH	CWSEL	CRWS	QLOB	QCH	QROB	DEPTH	SSTA	ENDST	K*CHSL
	0.000	5182.50	146.07	5.20	5185.27	0.00	0.00	1800.00	0.00	2.77	53.77	199.84	0.00
	100.000	5181.80	158.56	3.67	5185.70	0.00	0.00	1800.00	0.00	3.90	31.84	190.40	-7.00
	200.000	5182.40	132.41	4.83	5185.76	0.00	0.00	1800.00	0.00	3.36	31.87	164.28	6.00
	244.490	5182.67	91.75	7.12	5185.61	0.00	0.00	1800.00	0.00	2.94	84.86	176.62	6.08
	245.490	5182.68	91.76	7.12	5185.62	0.00	0.00	1800.00	0.00	2.94	84.87	176.62	9.77
*	301.240	5182.92	20.00	14.32	5189.21	5189.21	0.00	1800.00	0.00	6.29	120.75	140.75	4.30
*	301.250	5186.38	20.50	0.00	5192.74	5192.74	0.00	0.00	1800.00	6.36	120.50	141.00346044.94	
*	350.000	5187.01	20.50	0.00	5193.35	5193.35	0.00	0.00	1800.00	6.34	120.50	141.00	12.92
*	400.000	5187.66	20.50	0.00	5194.01	5194.01	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	450.000	5188.31	20.50	0.00	5194.66	5194.66	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	500.000	5188.96	20.50	0.00	5195.31	5195.31	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	550.000	5189.61	20.50	0.00	5195.96	5195.96	0.00	0.00	1800.00	6.35	120.50	141.00	13.01
*	600.000	5190.26	20.50	0.00	5196.61	5196.61	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	650.000	5190.91	20.50	0.00	5197.26	5197.26	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	700.000	5191.56	20.50	0.00	5197.91	5197.91	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	750.000	5192.21	20.50	0.00	5198.56	5198.56	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	800.000	5192.86	20.50	0.00	5199.21	5199.21	0.00	0.00	1800.00	6.35	120.50	141.00	13.01

12-NOV-86 10:21:54

PAGE 11

	SECNO	ELMIN	TOPWID	VCH	CWSEL	CRINS	QLOB	QCH	QROB	DEPTH	SSTA	ENDST	K*CHSL
*	826.090	5193.20	20.50	14.19	5199.55	5199.55	0.00	1800.00	0.00	6.35	120.50	141.00	13.03
	845.530	5194.00	23.92	9.01	5202.57	0.00	0.00	1800.00	0.00	8.57	119.04	142.96	41.14
	845.540	5194.00	23.92	9.15	5202.56	0.00	0.00	1800.00	0.00	8.56	119.04	142.96	0.00
	900.000	5196.25	36.00	7.14	5203.45	0.00	0.00	1800.00	0.00	7.20	112.75	148.75	41.31
	926.100	5198.30	41.50	8.83	5203.39	0.00	0.00	1800.00	0.00	5.09	110.00	151.50	78.54

THIS RUN EXECUTED 12-NOV-86 14:12:52

 HEC2 RELEASE DATED NOV 76 UPDATED APR. 1980
 ERROR CORR - 01,02,03,04
 MODIFICATION - 50,51,52,53,54

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ARROYO BOX CULVERT

SUMMARY PRINTOUT

SECNO	ELMIN	TOPWID	VCH	CWSEL	CRWS	QLOB	QCH	QROB	DEPTH	SSTA	ENDST	K*CHSL
926.100	5198.30	39.97	19.09	5200.69	5202.35	0.00	1800.00	0.00	2.39	110.00	151.50	0.00
900.000	5196.25	34.49	21.21	5198.73	5200.69	0.00	1800.00	0.00	2.48	112.75	148.75	-78.54
845.540	5194.00	22.40	20.43	5197.96	5199.93	0.00	1800.00	0.00	3.96	119.04	142.96	-41.31
845.530	5194.00	23.41	20.76	5197.73	5199.73	0.00	1800.00	0.00	3.73	119.04	142.96	0.00
826.090	5193.20	20.00	20.42	5197.64	5199.54	0.00	1800.00	0.00	4.44	120.50	141.00	-41.14
800.000	5192.86	20.00	20.47	5197.30	5199.22	0.00	1800.00	0.00	4.44	120.50	141.00	-13.03
750.000	5192.21	20.00	20.58	5196.62	5198.57	0.00	1800.00	0.00	4.41	120.50	141.00	-13.00
700.000	5191.56	19.99	20.66	5195.95	5197.92	0.00	1800.00	0.00	4.39	120.50	141.00	-13.00
650.000	5190.91	19.99	20.71	5195.30	5197.27	0.00	1800.00	0.00	4.39	120.50	141.00	-13.00
600.000	5190.26	19.99	20.79	5194.63	5196.62	0.00	1800.00	0.00	4.37	120.50	141.00	-13.00
550.000	5189.61	19.99	20.82	5193.98	5195.97	0.00	1800.00	0.00	4.36	120.50	141.00	-13.00
500.000	5188.96	19.99	20.88	5193.31	5195.33	0.00	1800.00	0.00	4.35	120.50	141.00	-13.00
450.000	5188.31	19.99	20.90	5192.66	5194.68	0.00	1800.00	0.00	4.35	120.50	141.00	-13.00
400.000	5187.66	19.99	20.93	5192.00	5194.02	0.00	1800.00	0.00	4.34	120.50	141.00	-13.00
350.000	5187.01	19.99	20.95	5191.35	5193.37	0.00	1800.00	0.00	4.34	120.50	141.00	-13.00
301.250	5186.38	19.99	20.97	5190.72	5192.74	0.00	1800.00	0.00	4.33	120.50	141.00	-12.92
* 301.240	5182.92	20.00	14.42	5189.16	5189.22	0.00	1800.00	0.00	6.24	120.75	140.75	*****

12-NOV-86 14:11:29

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	SECNO	ELMIN	TOPWID	VCH	CWSEL	CRINS	QLOB	QCH	QROB	DEPTH	SSTA	ENDST	K*CHSL
	245.490	5182.68	82.51	17.36	5183.96	5185.15	0.00	1800.00	0.00	1.28	89.47	171.98	-4.30
*	244.490	5182.67	82.93	14.82	5184.16	5185.15	0.00	1800.00	0.00	1.49	89.26	172.19	-9.77
*	200.000	5182.40	124.66	7.79	5184.66	5184.66	0.00	1800.00	0.00	2.26	33.92	158.58	-6.08
*	100.000	5181.80	148.81	7.30	5184.11	5184.11	0.00	1800.00	0.00	2.31	35.47	184.28	-6.00
*	0.000	5182.50	140.97	7.47	5184.54	5184.54	0.00	1800.00	0.00	2.04	55.70	196.66	7.00

THIS RUN EXECUTED 24-SEP-86 11:46:41

 HFC2 RELEASE DATED NOV 76 UPDATED APR. 1980
 ERROR CORR - 01,02,03,04
 MODIFICATION - 50,51,52,53,54

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ARROYO BOX CULVERT

SUMMARY PRINTOUT

SECNO	ELMIN	TOPWID	VCH	CWSEL	CRIWS	QLOB	QCH	QROB	DEPTH	SSTA	ENDST	K*CHSL
926.100	5198.30	39.97	19.09	5200.69	5202.35	0.00	1800.00	0.00	2.39	110.00	151.50	0.00
900.000	5196.25	34.49	21.21	5198.73	5200.69	0.00	1800.00	0.00	2.48	112.75	148.75	-78.54
845.540	5194.00	22.40	20.43	5197.96	5199.93	0.00	1800.00	0.00	3.96	119.04	142.96	-41.31
845.530	5194.00	23.19	20.58	5197.86	5199.83	0.00	1800.00	0.00	3.86	119.04	142.74	0.00
826.090	5193.20	19.99	20.61	5197.60	5199.54	0.00	1800.00	0.00	4.40	120.50	141.00	-41.14
800.000	5192.86	19.99	20.66	5197.24	5199.22	0.00	1800.00	0.00	4.38	120.50	141.00	-13.03
750.000	5192.21	19.99	20.72	5196.59	5198.57	0.00	1800.00	0.00	4.38	120.50	141.00	-13.00
700.000	5191.56	19.99	20.76	5195.94	5197.92	0.00	1800.00	0.00	4.38	120.50	141.00	-13.00
650.000	5190.91	19.99	20.83	5195.27	5197.27	0.00	1800.00	0.00	4.36	120.50	141.00	-13.00
600.000	5190.26	19.99	20.86	5194.62	5196.62	0.00	1800.00	0.00	4.35	120.50	141.00	-13.00
550.000	5189.61	19.99	20.89	5193.96	5195.97	0.00	1800.00	0.00	4.35	120.50	141.00	-13.00
500.000	5188.96	19.99	20.94	5193.29	5195.33	0.00	1800.00	0.00	4.33	120.50	141.00	-13.00
450.000	5188.31	19.99	20.98	5192.63	5194.67	0.00	1800.00	0.00	4.32	120.50	141.00	-13.00
400.000	5187.66	19.99	20.98	5191.98	5194.02	0.00	1800.00	0.00	4.32	120.50	141.00	-13.00
350.000	5187.01	19.99	20.98	5191.34	5193.37	0.00	1800.00	0.00	4.33	120.50	141.00	-13.00
301.250	5186.38	19.99	21.00	5190.71	5192.74	0.00	1800.00	0.00	4.33	120.50	141.00	-12.92
* 301.240	5182.92	126.48	8.79	5188.94	5189.00	95.27	1676.35	28.38	6.02	44.03	170.51	*****

jump?

	SECHO	FLMIN	TOPWID	VCH	CWSEL	CRWS	QLOB	QCH	QROB	DEPTH	SSTA	ENDST	K*CHSL
*	276.240	5182.82	128.76	8.54	5188.91 =	5188.91	113.95	1653.38	32.67	6.09	43.13	171.89	-4.00
*	276.230	5182.82	124.51	9.04	5188.80 =	5188.80	66.72	1713.15	20.13	5.98	45.35	169.86	0.00
	200.000	5182.40	117.03	18.01	5183.58 =	5184.66	0.00	1800.00	0.00	1.18	35.93	152.97	-5.51
*	100.000	5181.80	148.74	7.35	5184.10 =	5184.10	0.00	1800.00	0.00	2.30	35.49	184.23	-6.00
*	0.000	5182.50	140.98	7.46	5184.54 =	5184.54	0.00	1800.00	0.00	2.04	55.69	196.67	7.00

THIS RUN EXECUTED 25-SEP-86 07:58:31

 HEC2 RELEASE DATED NOV 76 UPDATED APR. 1980
 ERROR CORR - 01,02,03,04
 MODIFICATION - 50,51,52,53,54

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ARROYO BOX CULVERT

SUMMARY PRINTOUT

	SECNO	ELMIN	TOPWID	VCH	CWSEL	CRIWS	QLOB	QCH	QROB	DEPTH	SSTA	ENDST	K*CHSL
	0.000	5182.50	146.07	5.20	5185.27	0.00	0.00	1800.00	0.00	2.77	53.77	199.84	0.00
	100.000	5181.80	158.56	3.67	5185.70	0.00	0.00	1800.00	0.00	3.90	31.84	190.40	-7.00
	200.000	5182.40	132.41	4.83	5185.76	0.00	0.00	1800.00	0.00	3.36	31.87	164.28	6.00
*	276.230	5182.82	92.34	10.16	5188.43	5188.43	21.91	1771.26	6.83	5.61	70.36	162.70	5.51
	276.240	5182.82	147.75	6.68	5189.51	0.00	270.65	1454.22	75.12	6.69	35.60	183.36	0.00
	301.240	5182.92	147.82	6.67	5189.61	0.00	271.13	1453.59	75.27	6.69	35.58	183.39	4.00
*	301.250	5186.38	20.50	0.00	5192.74	5192.74	0.00	0.00	1800.00	6.36	120.50	141.00346044.94	
*	350.000	5187.01	20.50	0.00	5193.35	5193.35	0.00	0.00	1800.00	6.34	120.50	141.00	12.92
*	400.000	5187.66	20.50	0.00	5194.01	5194.01	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	450.000	5188.31	20.50	0.00	5194.66	5194.66	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	500.000	5188.96	20.50	0.00	5195.31	5195.31	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	550.000	5189.61	20.50	0.00	5195.96	5195.96	0.00	0.00	1800.00	6.35	120.50	141.00	13.01
*	600.000	5190.26	20.50	0.00	5196.61	5196.61	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	650.000	5190.91	20.50	0.00	5197.26	5197.26	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	700.000	5191.56	20.50	0.00	5197.91	5197.91	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	750.000	5192.21	20.50	0.00	5198.56	5198.56	0.00	0.00	1800.00	6.35	120.50	141.00	13.00
*	800.000	5192.86	20.50	0.00	5199.21	5199.21	0.00	0.00	1800.00	6.35	120.50	141.00	13.01

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PAGE 10

	SECNO	ELMIN	TOPWID	VCH	CWSEL	CRWS	QLOB	QCH	QKOB	DFPTH	SSTA	FNDST	K*CHSL
*	826.090	5193.20	20.50	14.17	5199.55	5199.55	0.00	1800.00	0.00	6.35	120.50	141.00	13.03
	845.530	5194.00	23.92	11.44	5200.81	0.00	0.00	1800.00	0.00	6.81	119.04	142.96	41.14
	845.540	5194.00	23.92	11.81	5200.71	0.00	0.00	1800.00	0.00	6.71	119.04	142.96	0.00
	900.000	5196.25	36.00	9.45	5201.73	0.00	0.00	1800.00	0.00	5.48	112.75	148.75	41.31
*	926.100	5198.30	41.50	11.23	5202.34	5202.34	0.00	1800.00	0.00	4.04	110.00	151.50	78.54

ORIGINAL

_____, ("Grantor"), whose address is
700 Lomas NE, Suite 204, Albuquerque, NM 87102
 and the City of Albuquerque, a New Mexico municipal corporation
 ("City"), whose address is P. O. Box 1293, Albuquerque, New
 Mexico 87103, is made in Albuquerque, Bernalillo County, New
 Mexico and is entered into as of the date Grantor signs this
 Easement.

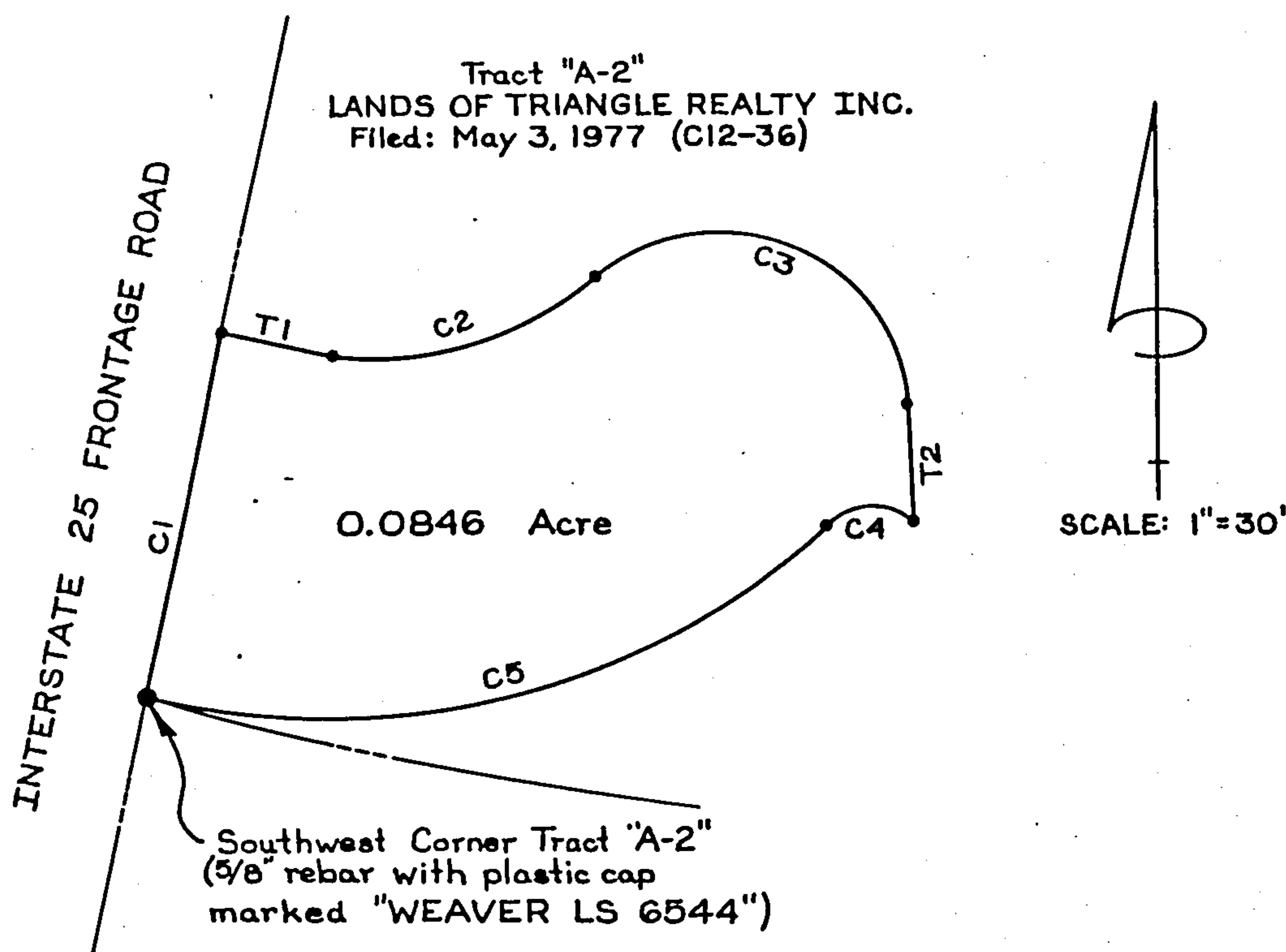
2. Grant of Easement. The Grantor grants to the City a permanent easement with warranty covenants ("Easement") in, over, upon and across the Property for [state the kind of easement, for example, "public street and highway purposes (including all utilities)," "water line," "sewer line," etc.:] Access for maintaining Arroyo Embankment Protection and Arroyo Facilities and no other purposes.

The grant of the Easement includes the right of the City to enter upon the Easement at any time for inspection, installation, maintenance, repair or modification and the right to remove trees, bushes, undergrowth and any other obstacles if the City determines they interfere with the appropriate use of the Easement. This grant includes the right of access to the easement across the Grantor's adjoining property.

This Easement is worded pursuant to the provisions of §§47-1-27 to 47-1-44, NMSA 1978 or successor statutes.

(Approved by Legal Dept.
as to form only-6/1/86)

EXHIBIT MAP



CURVE DATA					
NO.	ARC	RADIUS	DELTA	CHORD	TANGENT
C1	44.81	3984.52	00°38'40"	44.81	22.41
C2	34.13	40.36	48°27'23"	33.12	18.16
C3	50.48	22.50	128°32'26"	40.54	46.69
C4	10.96	7.47	84°01'28"	10.00	6.73
C5	88.46	86.00	58°56'16"	84.62	48.59

TANGENT DATA		
NO.	BEARING	DISTANCE
T1	S77°28'09"E	13.35
T2	S02°37'57"E	13.84

DESCRIPTION

A certain tract of land situate within the Elena Gallegos Grant, within the southeast 1/4 of Section 26, (as projected) T11N, R3E, N.M.P.M., Bernalillo County, Albuquerque, New Mexico and being a westerly portion of Tract "A-2" of LANDS OF TRIANGLE REALTY INCORPORATED as the same is shown and designated on the plat filed in the office of the County Clerk of Bernalillo County, New Mexico on May 3, 1977 in Volume C12, Folio 36 and being more particularly described by New Mexico State Plane Grid Bearings (Central Zone) and ground distances as follows:

BEGINNING at the southwest corner of the tract herein described, said corner being the southwest corner of said Tract "A-2" and also being a point on curve on the easterly right-of-way of Interstate 25 Frontage Road and from said point of beginning running thence along the westerly boundary of said Tract "A-2" and also along said right-of-way 44.81 feet along the arc of a curve to the left having a radius of 3984.52 feet and a chord bearing N12°12'23"E, 44.81 feet to the northwest corner of the tract herein described, thence leaving the westerly boundary of said Tract "A-2" and continuing along the northerly boundary of the tract herein described, S77°28'09"E, 13.35 feet to a point of curvature; thence, 34.13 feet along the arc of a curve to the left having a radius of 40.36 feet and a chord bearing N73°03'18"E, 33.12 feet to a point of reverse curvature; thence, 50.48 feet along the arc of a curve to the right having a radius of 22.50 feet and a chord bearing S66°54'10"E, 40.54 feet to a point of tangency; thence, S02°37'57"E, 13.84 feet to a point of curvature being the southeast corner of the tract herein described, thence continuing along the southerly boundary of the tract herein described, 10.96 feet along the arc of a curve to the left having a radius of 7.47 feet and a chord bearing S87°22'03"W, 10.00 feet to a point of reverse curvature; thence, 88.46 feet along the arc of a curve to the right having a radius of 86.00 feet and a chord bearing S76°04'05"W, 84.62 feet to the point and place of beginning.

Tract contains 0.0846 acre, more or less.

Bohannon-Huston, Inc.
Courtyard I
7500 Jefferson N.E.
Albuquerque, NM 87109

November 6, 1986
Job No. 6 160 9

A. Dwain Weaver
A. Dwain Weaver
N.M.P.L.S. No. 6544



EASEMENT

This grant of Easement, between [state the name of the present real property owner exactly as shown on the real estate document conveying title to the present owner and state the legal status of the owner, for example, "single person," "husband and wife," "corporation of the State of X," "partnership":] Sandia Foundation

700 Lomas N.E. Suite 204, Albuquerque, NM 87102 ("Grantor"), whose address is 700 Lomas N.E. Suite 204, Albuquerque, NM 87102 and the City of Albuquerque, a New Mexico municipal corporation ("City"), whose address is P. O. Box 1293, Albuquerque, New Mexico 87103, is made in Albuquerque, Bernalillo County, New Mexico and is entered into as of the date Grantor signs this Easement.

1. Recital. Grantor is the owner of certain real property located at [give general description, for instance, subdivision, lot and block or street address:] Tract A-1-A Triangle Realty Inc. in Bernalillo County, New Mexico (the "Property").

2. Grant of Easement. The Grantor grants to the City a permanent easement with warranty covenants ("Easement") in, over, upon and across the Property for [state the kind of easement, for example, "public street and highway purposes (including all utilities)," "water line," "sewer line," etc.:] Drainage for Arroyo Embankment Protection and no other purposes.

The Easement is more particularly described in the attached Exhibit A. [State on the exhibit either the metes and bounds description of the Easement or state the exact dimensions and location in a manner which would enable a surveyor to locate the Easement on the ground.]

The grant of the Easement includes the right of the City to enter upon the Easement at any time for inspection, installation, maintenance, repair or modification and the right to remove trees, bushes, undergrowth and any other obstacles if the City determines they interfere with the appropriate use of the Easement. This grant includes the right of access to the easement across the Grantor's adjoining property.

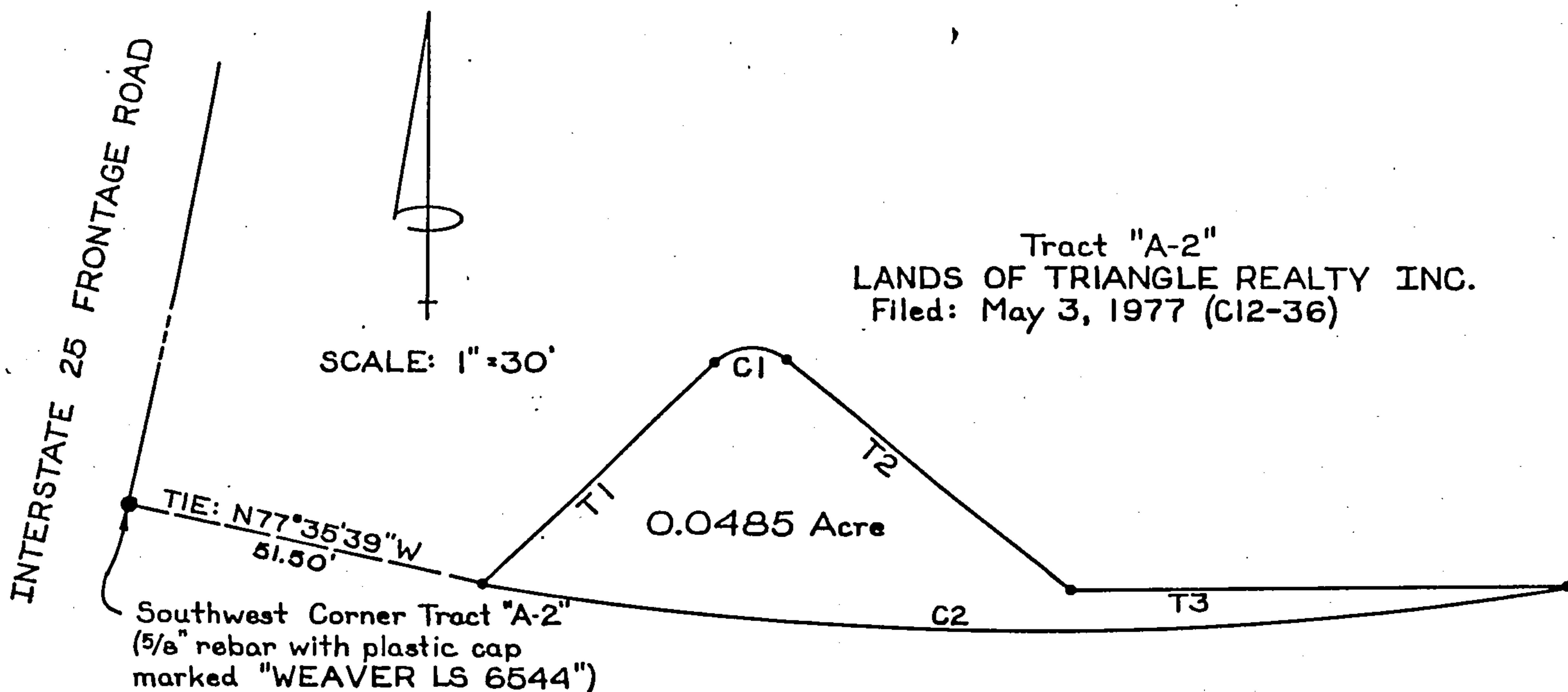
Grantor agrees for itself and its successors in interest that it has been paid in valuable consideration and that the grant of this Easement is not a gift or donation.

This Easement is worded pursuant to the provisions of §§47-1-27 to 47-1-44, NMSA 1978 or successor statutes.

3. Warranty. Grantor covenants and warrants that it is the owner in fee simple of the Property and that it has a good

(Approved by Legal Dept.
as to form only-6/1/86)

EXHIBIT MAP



CURVE DATA					
NO.	ARC	RADIUS	DELTA	CHORD	TANGENT
C1	10.96	7.47	84°01'28"	10.00	6.73
C2	152.45	425.00	20°33'10"	151.64	77.06

TANGENT DATA		
NO.	BEARING	DISTANCE
T1	N45°21'19"E	44.74
T2	S50°37'13"E	51.52
T3	N89°22'28"E	70.00

DESCRIPTION

A certain tract of land situate within the Elena Gallegos Grant, within the southeast 1/4 of Section 26, (as projected) T11N, R3E, N.M.P.M., Bernalillo County, Albuquerque, New Mexico and being a southerly portion of Tract "A-2" of LANDS OF TRIANGLE REALTY INCORPORATED as the same is shown and designated on the plat filed in the office of the County Clerk of Bernalillo County, New Mexico on May 3, 1977 in Volume C12, Folio 36 and being more particularly described by New Mexico State Plane Grid Bearings (Central Zone) and ground distances as follows:

BEGINNING at the southwest corner of the tract herein described, a point on curve on the southerly boundary of said Tract "A-2" whence the southwest corner of said Tract "A-2" bears N77°35'39"W, 51.50 feet and from said point of beginning running thence along the westerly boundary of the tract herein described, N45°21'19"E, 44.74 feet to a point of curvature; thence, 10.96 feet along the arc of a curve to the right having a radius of 7.47 feet and a chord bearing N87°22'03"E, 10.00 feet to a point of tangency; thence continuing along the northerly boundary of the tract herein described, S50°37'13"E, 51.52 feet to a point; thence, N89°22'28"E, 70.00 feet to the southeast corner of the tract herein described, a point on curve on the southerly boundary of said Tract "A-2", thence continuing along the southerly boundary of said Tract "A-2", 152.45 feet along the arc of a curve to the right having a radius of 425.00 feet and a chord bearing N89°59'22"W, 151.64 feet to the point and place of beginning.

Tract contains 0.0485 acre, more or less.

Bohannon-Huston, Inc.
Courtyard I
7500 Jefferson Street N.E.
Albuquerque, NM 87109

November 6, 1986
Job No. 6 160 9

A. Dwain Weaver
A. Dwain Weaver
N.M.P.L.S. No. 6544



EASEMENT

This grant of Easement, between [state the name of the present real property owner exactly as shown on the real estate document conveying title to the present owner and state the legal status of the owner, for example, "single person," "husband and wife," "corporation of the State of X," "partnership":] Sandia Foundation

700 Lomas NE, Suite 204, Albuquerque, NM 87102
and the City of Albuquerque, a New Mexico municipal corporation ("City"), whose address is P. O. Box 1293, Albuquerque, New Mexico 87103, is made in Albuquerque, Bernalillo County, New Mexico and is entered into as of the date Grantor signs this Easement.

1. Recital. Grantor is the owner of certain real property located at [give general description, for instance, subdivision, lot and block or street address:] _____ in Bernalillo County, New Mexico (the "Property").

2. Grant of Easement. The Grantor grants to the City a permanent easement with warranty covenants ("Easement") in, over, upon and across the Property for [state the kind of easement, for example, "public street and highway purposes (including all utilities)," "water line," "sewer line," etc.:] Access for maintaining Arroyo Embankment Protection and Arroyo Facilities and no other purposes.

The Easement is more particularly described in the attached Exhibit A. [State on the exhibit either the metes and bounds description of the Easement or state the exact dimensions and location in a manner which would enable a surveyor to locate the Easement on the ground.]

The grant of the Easement includes the right of the City to enter upon the Easement at any time for inspection, installation, maintenance, repair or modification and the right to remove trees, bushes, undergrowth and any other obstacles if the City determines they interfere with the appropriate use of the Easement. This grant includes the right of access to the easement across the Grantor's adjoining property.

Grantor agrees for itself and its successors in interest that it has been paid in valuable consideration and that the grant of this Easement is not a gift or donation.

This Easement is worded pursuant to the provisions of §§47-1-27 to 47-1-44, NMSA 1978 or successor statutes.

3. Warranty. Grantor covenants and warrants that it is the owner in fee simple of the Property and that it has a good

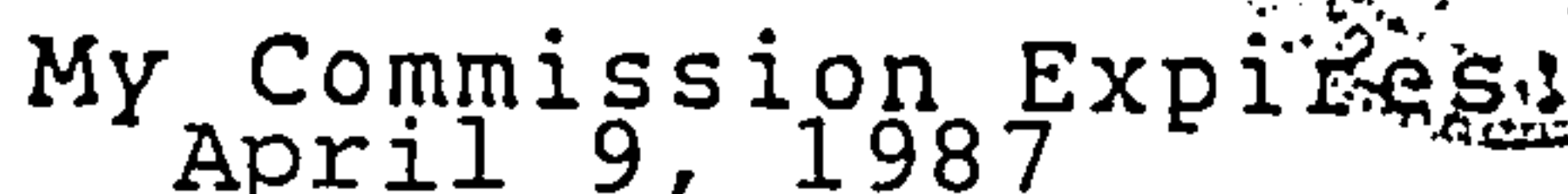
(Approved by Legal Dept.
as to form only-6/1/86)

4. Binding on Grantor's Property. The grant and other provisions of this Easement constitute covenants running with the land for the benefit of the City and its successors and assigns.

6. Form Not Changed. Grantor agrees that changes to the wording of this form are not binding upon the City unless initialed by the Grantor and approved and signed by the City Legal Department in writing on this form.

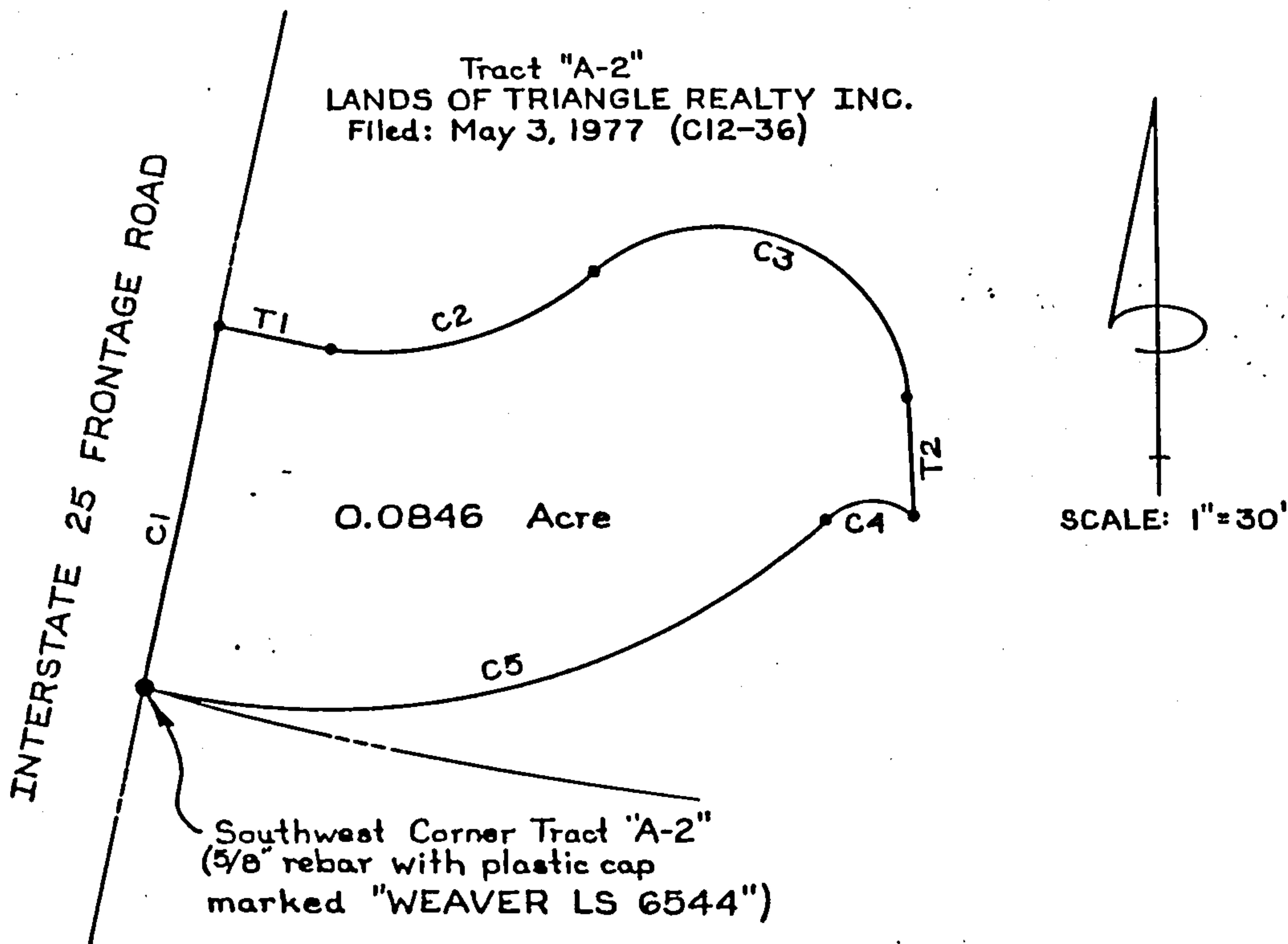
By: John Peracich
Its: President
Dated: December 2, 1986

The foregoing instrument was acknowledged before me this
2nd. day of December, 1986, by [name of person signing:]
John Perovich, [title or capacity, for instance,
"President" or "Owner":] President of [name of
the entity which owns the Property if other than the individual
signing, for instance, the name of the corporation, partnership,
or joint venture:] Sandia Foundation



(EXHIBIT "A" ATTACHED)

EXHIBIT MAP



CURVE DATA					
NO.	ARC	RADIUS	DELTA	CHORD	TANGENT
C1	44.81	3984.52	00°38'40"	44.81	22.41
C2	34.13	40.36	48°27'23"	33.12	18.16
C3	50.48	22.50	128°32'26"	40.54	46.69
C4	10.96	7.47	84°01'28"	10.00	6.73
C5	88.46	86.00	58°56'16"	84.62	48.59

TANGENT DATA		
NO.	BEARING	DISTANCE
T1	S77°28'09"E	13.35
T2	S02°37'57"E	13.84

DESCRIPTION

A certain tract of land situate within the Elena Gallegos Grant, within the southeast 1/4 of Section 26, (as projected) T11N, R3E, N.M.P.M., Bernalillo County, Albuquerque, New Mexico and being a westerly portion of Tract "A-2" of LANDS OF TRIANGLE REALTY INCORPORATED as the same is shown and designated on the plat filed in the office of the County Clerk of Bernalillo County, New Mexico on May 3, 1977 in Volume C12, Folio 36 and being more particularly described by New Mexico State Plane Grid Bearings (Central Zone) and ground distances as follows:

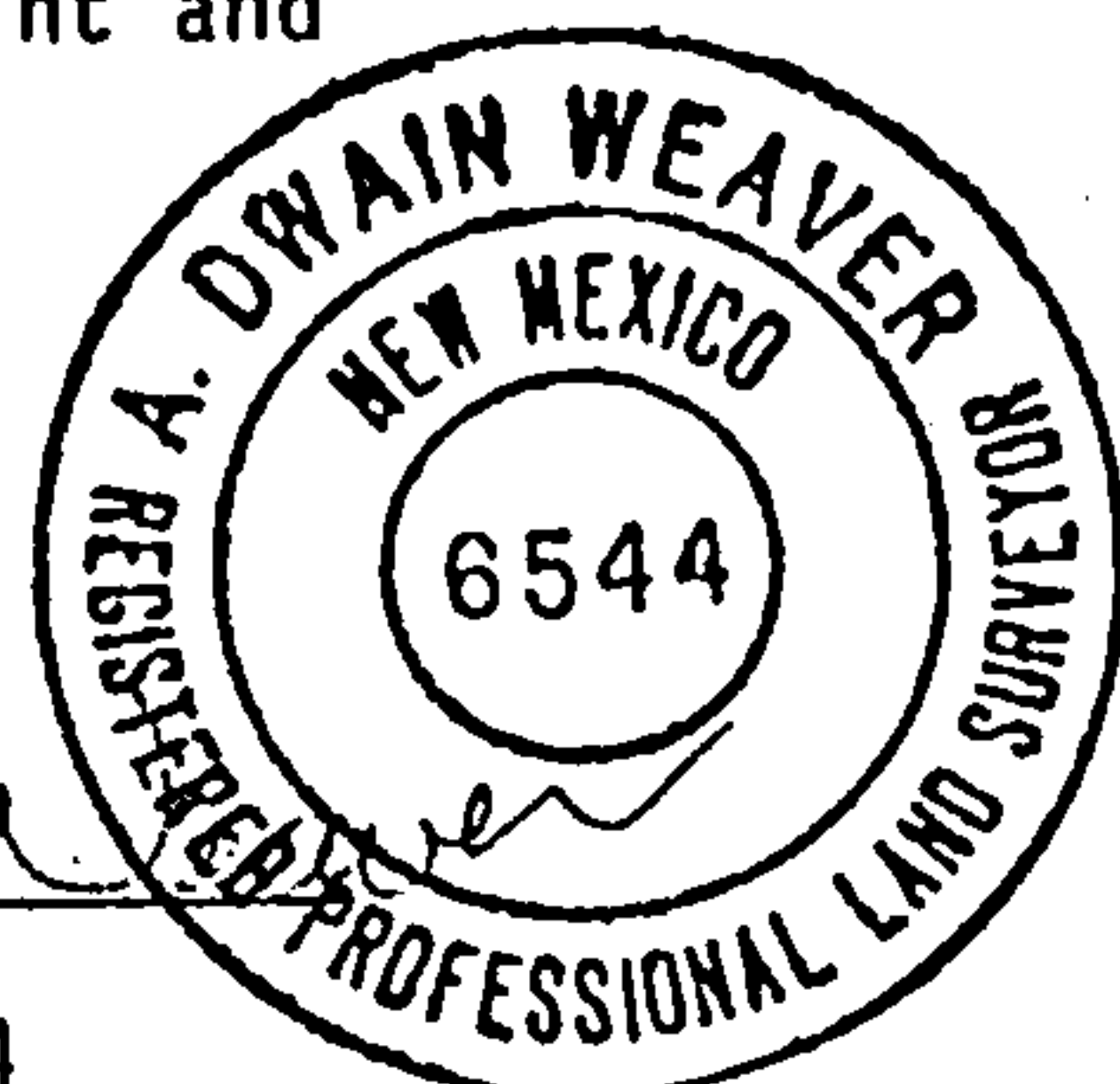
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Tract contains 0.0846 acre, more or less.

Bohannon-Huston, Inc.
Courtyard I
7500 Jefferson N.E.
Albuquerque, NM 87109

November 6, 1986
Job No. 6 160 9

A. Dwain Weaver
A. Dwain Weaver
N.M.P.L.S. No. 6544



EASEMENT

This grant of Easement, between [state the name of the present real property owner exactly as shown on the real estate document conveying title to the present owner and state the legal status of the owner, for example, "single person,"

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"partnership":] Sandia Foundation

("Grantor"), whose address is

700 Lomas NE, Suite 204, Albuquerque, NM 87102

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2. Grant of Easement. The Grantor grants to the City a permanent easement with warranty covenants ("Easement") in, over, upon and across the Property for [state the kind of easement, for example, "public street and highway purposes (including all utilities)," "water line," "sewer line,"

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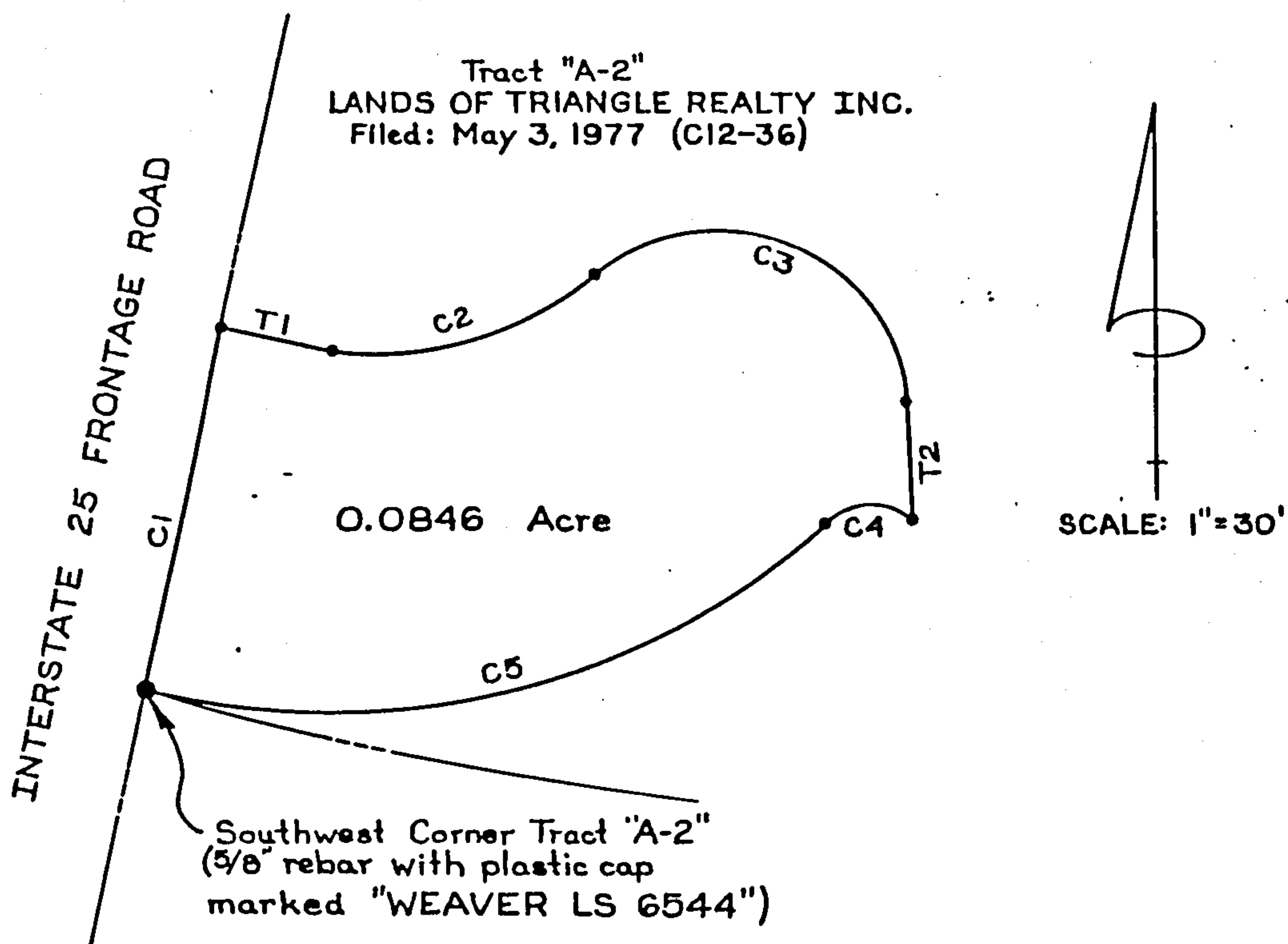
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(Approved by Legal Dept.
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EXHIBIT MAP



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DESCRIPTION

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Tract contains 0.0846 acre, more or less.

Bohannon-Huston, Inc.
Courtyard I
7500 Jefferson N.E.
Albuquerque, NM 87109

November 6, 1986
Job No. 6160 9

A. Dwain Weaver
A. Dwain Weaver
N.M.P.L.S. No. 6544



EASEMENT

This grant of Easement, between [state the name of the present real property owner exactly as shown on the real estate document conveying title to the present owner and state the legal status of the owner, for example, "single person," "husband and wife," "corporation of the State of X," "partnership":] Sandia Foundation

_____, ("Grantor"), whose address is
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and the City of Albuquerque, a New Mexico municipal corporation
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Easement.

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The grant of the Easement includes the right of the City to enter upon the Easement at any time for inspection, installation, maintenance, repair or modification and the right to remove trees, bushes, undergrowth and any other obstacles if the City determines they interfere with the appropriate use of the Easement. This grant includes the right of access to the easement across the Grantor's adjoining property.

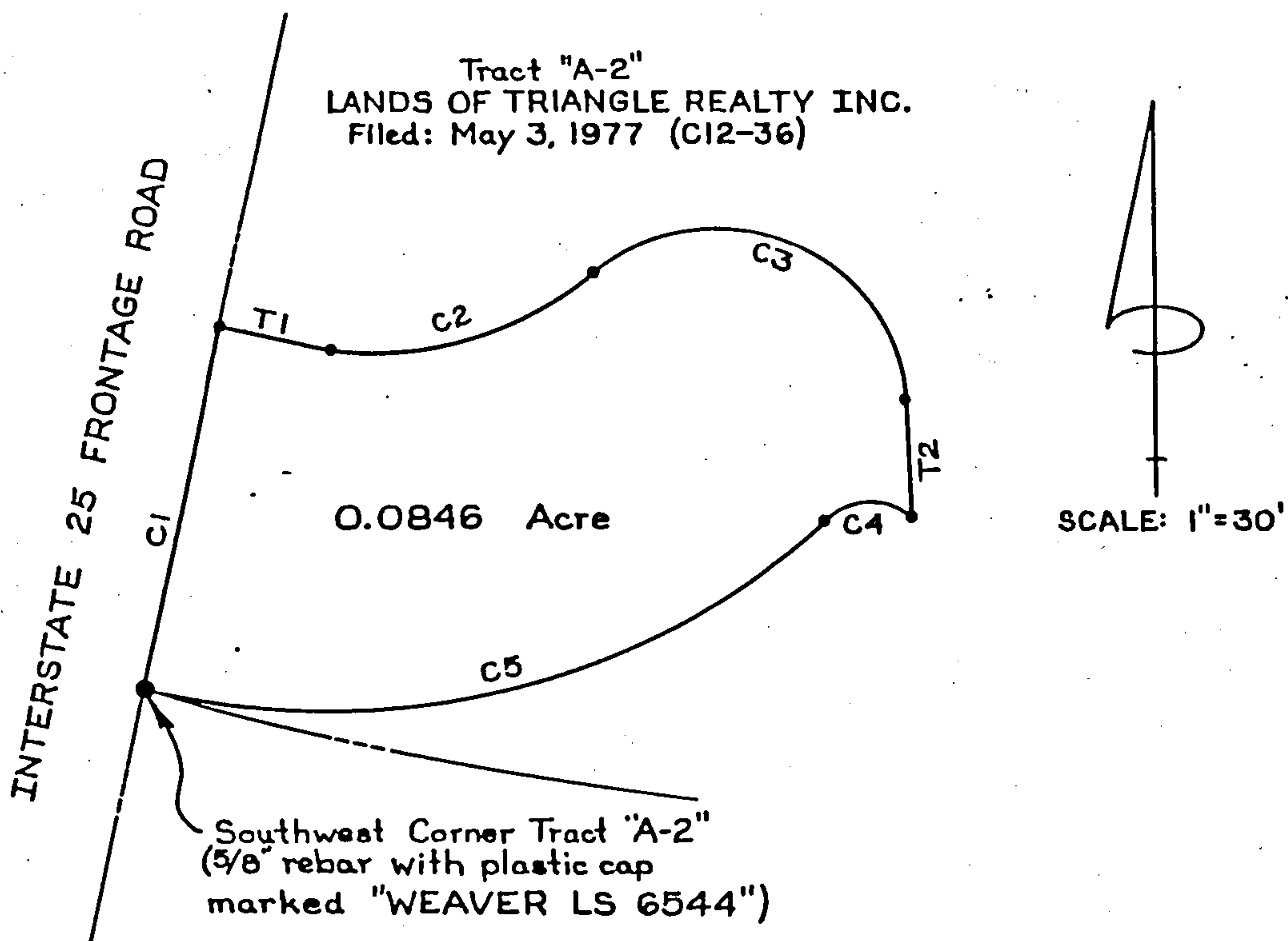
Grantor agrees for itself and its successors in interest that it has been paid in valuable consideration and that the grant of this Easement is not a gift or donation.

This Easement is worded pursuant to the provisions of §§47-1-27 to 47-1-44, NMSA 1978 or successor statutes.

3. Warranty. Grantor covenants and warrants that it is the owner in fee simple of the Property and that it has a good

(Approved by Legal Dept.
as to form only-6/1/86)

EXHIBIT MAP



CURVE DATA					
NO.	ARC	RADIUS	DELTA	CHORD	TANGENT
C1	44.81	3984.52	00°38'40"	44.81	22.41
C2	34.13	40.36	48°27'23"	33.12	18.16
C3	50.48	22.50	128°32'26"	40.54	46.69
C4	10.96	7.47	84°01'28"	10.00	6.73
C5	88.46	86.00	58°56'16"	84.62	48.59

TANGENT DATA		
NO.	BEARING	DISTANCE
T1	S77°28'09"E	13.35
T2	S02°37'57"E	13.84

DESCRIPTION

A certain tract of land situate within the Elena Gallegos Grant, within the southeast 1/4 of Section 26, (as projected) T11N, R3E, N.M.P.M., Bernalillo County, Albuquerque, New Mexico and being a westerly portion of Tract "A-2" of LANDS OF TRIANGLE REALTY INCORPORATED as the same is shown and designated on the plat filed in the office of the County Clerk of Bernalillo County, New Mexico on May 3, 1977 in Volume C12, Folio 36 and being more particularly described by New Mexico State Plane Grid Bearings (Central Zone) and ground distances as follows:

BEGINNING at the southwest corner of the tract herein described, said corner being the southwest corner of said Tract "A-2" and also being a point on curve on the easterly right-of-way of Interstate 25 Frontage Road and from said point of beginning running thence along the westerly boundary of said Tract "A-2" and also along said right-of-way 44.81 feet along the arc of a curve to the left having a radius of 3984.52 feet and a chord bearing N12°12'23"E, 44.81 feet to the northwest corner of the tract herein described, thence leaving the westerly boundary of said Tract "A-2" and continuing along the northerly boundary of the tract herein described, S77°28'09"E, 13.35 feet to a point of curvature; thence, 34.13 feet along the arc of a curve to the left having a radius of 40.36 feet and a chord bearing N73°03'18"E, 33.12 feet to a point of reverse curvature; thence, 50.48 feet along the arc of a curve to the right having a radius of 22.50 feet and a chord bearing S66°54'10"E, 40.54 feet to a point of tangency; thence, S02°37'57"E, 13.84 feet to a point of curvature being the southeast corner of the tract herein described, thence continuing along the southerly boundary of the tract herein described, 10.96 feet along the arc of a curve to the left having a radius of 7.47 feet and a chord bearing S87°22'03"W, 10.00 feet to a point of reverse curvature; thence, 88.46 feet along the arc of a curve to the right having a radius of 86.00 feet and a chord bearing S76°04'05"W, 84.62 feet to the point and place of beginning.

Tract contains 0.0846 acre, more or less.

Bohannon-Huston, Inc.
Courtyard I
7500 Jefferson N.E.
Albuquerque, NM 87109

November 6, 1986
Job No. 6544

A. Dwain Weaver
A. Dwain Weaver
N.M.P.L.S. No. 6544



EASEMENT

This grant of Easement, between [state the name of the present real property owner exactly as shown on the real estate document conveying title to the present owner and state the legal status of the owner, for example, "single person,"

"husband and wife," "corporation of the State of X,"

"partnership":] Sandia Foundation

("Grantor"), whose address is
700 Lomas N.E. Suite 204, Albuquerque, NM 87102

and the City of Albuquerque, a New Mexico municipal corporation ("City"), whose address is P. O. Box 1293, Albuquerque, New Mexico 87103, is made in Albuquerque, Bernalillo County, New Mexico and is entered into as of the date Grantor signs this Easement.

1. Recital. Grantor is the owner of certain real property located at [give general description, for instance, subdivision, lot and block or street address:] Tract A-1-A
Triangle Realty Inc. in Bernalillo County, New Mexico (the "Property").

2. Grant of Easement. The Grantor grants to the City a permanent easement with warranty covenants ("Easement") in, over, upon and across the Property for [state the kind of easement, for example, "public street and highway purposes (including all utilities)," "water line," "sewer line," etc.:] Drainage for Arroyo Embankment Protection and no other purposes.

The Easement is more particularly described in the attached Exhibit A. [State on the exhibit either the metes and bounds description of the Easement or state the exact dimensions and location in a manner which would enable a surveyor to locate the Easement on the ground.]

The grant of the Easement includes the right of the City to enter upon the Easement at any time for inspection, installation, maintenance, repair or modification and the right to remove trees, bushes, undergrowth and any other obstacles if the City determines they interfere with the appropriate use of the Easement. This grant includes the right of access to the easement across the Grantor's adjoining property.

Grantor agrees for itself and its successors in interest that it has been paid in valuable consideration and that the grant of this Easement is not a gift or donation.

This Easement is worded pursuant to the provisions of §§47-1-27 to 47-1-44, NMSA 1978 or successor statutes.

3. Warranty. Grantor covenants and warrants that it is the owner in fee simple of the Property and that it has a good

(Approved by Legal Dept.
as to form only-6/1/86)

lawful right to convey the Property or any part thereof, that the Property is free from all encumbrances except encumbrances of record and taxes due and owing the Treasurer of Bernalillo County, and that the Grantor will forever warrant and defend the title to the Property against all claims from all persons or entities.

4. Binding on Grantor's Property. The grant and other provisions of this Easement constitute covenants running with the land for the benefit of the City and its successors and assigns.

5. Indemnification. As a part of the consideration for this grant, subject to the provisions of the New Mexico Tort Claims Act and all other applicable New Mexico laws, the City agrees to save Grantor harmless from any and all liability arising from the City's negligent use of the Easement for the purposes set forth herein. The City does not agree to save Grantor harmless from any liability which may arise from Grantor's use of the Easement and the Property.

6. Form Not Changed. Grantor agrees that changes to the wording of this form are not binding upon the City unless initialed by the Grantor and approved and signed by the City Legal Department in writing on this form.

CITY OF ALBUQUERQUE

Approved:

GRANTOR:

By: John Peracich
Its: President
Dated: December 2, 1986

By: _____
Title: _____
Dated: _____

STATE OF New Mexico)
) ss
COUNTY OF Bernalillo)

The foregoing instrument was acknowledged before me this
2nd. day of December, 1986, by [name of person signing:]
John Perovich, [title or capacity, for instance,
"President" or "Owner":] President of [name of
the entity which owns the Property if other than the individual
signing, for instance, the name of the corporation, partnership,
or joint venture:] Sandia Foundation



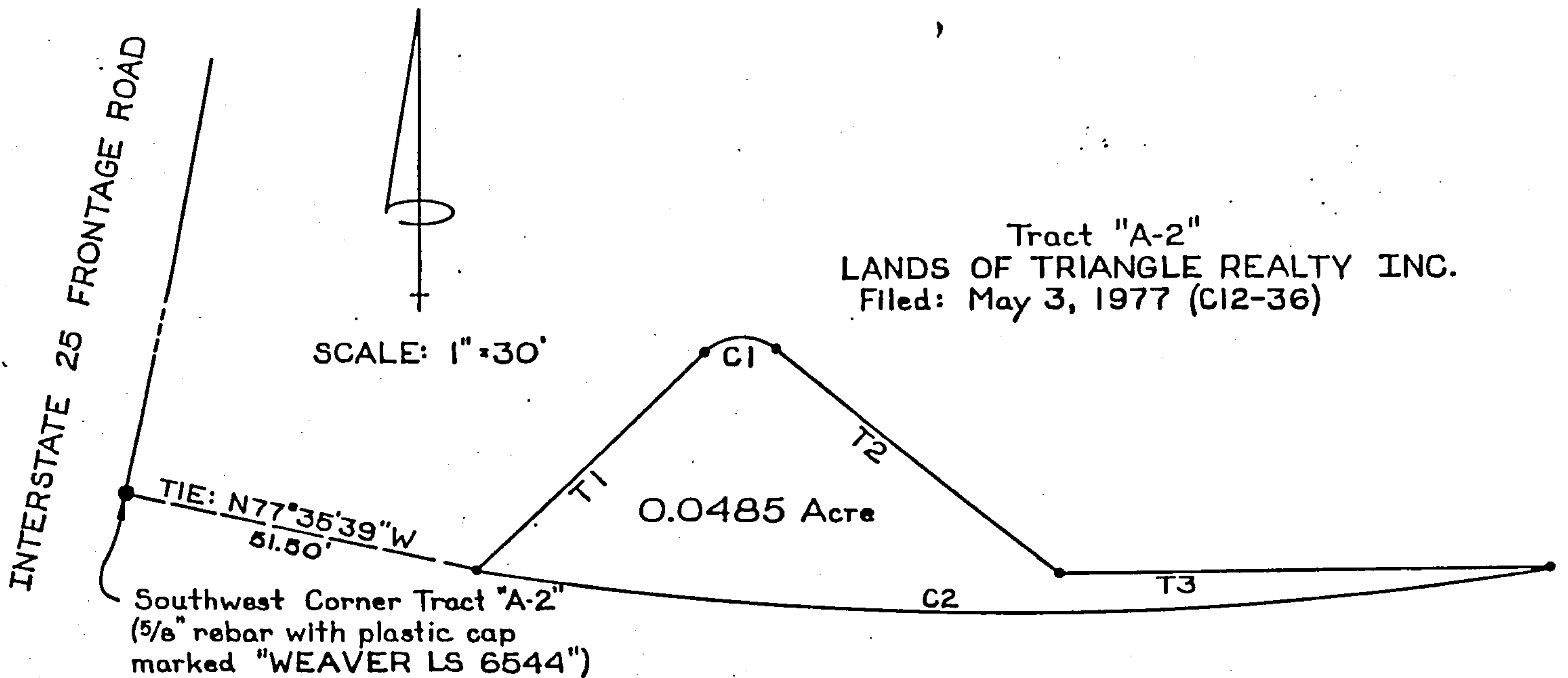
OFFICIAL SEAL *7-10-71*
NITA MAYHUGH Public
NOTARY PUBLIC-STATE OF NEW MEXICO
Notary Bond Filed with Secretary of State
My Commission Expires *4-9-87*

My Commission Expires
April 9, 1987

(Approved by Legal Dept.
as to form only-6/1/86)

(EXHIBIT "A" ATTACHED)

EXHIBIT MAP



CURVE DATA					
NO.	ARC	RADIUS	DELTA	CHORD	TANGENT
C1	10.96	7.47	84°01'28"	10.00	6.73
C2	152.45	425.00	20°33'10"	151.64	77.06

TANGENT DATA		
NO.	BEARING	DISTANCE
T1	N45°21'19"E	44.74
T2	S50°37'13"E	51.52
T3	N89°22'28"E	70.00

DESCRIPTION

A certain tract of land situate within the Elena Gallegos Grant, within the southeast 1/4 of Section 26, (as projected) T11N, R3E, N.M.P.M., Bernalillo County, Albuquerque, New Mexico and being a southerly portion of Tract "A-2" of LANDS OF TRIANGLE REALTY INCORPORATED as the same is shown and designated on the plat filed in the office of the County Clerk of Bernalillo County, New Mexico on May 3, 1977 in Volume C12, Folio 36 and being more particularly described by New Mexico State Plane Grid Bearings (Central Zone) and ground distances as follows:

BEGINNING at the southwest corner of the tract herein described, a point on curve on the southerly boundary of said Tract "A-2" whence the southwest corner of said Tract "A-2" bears N77°35'39"W, 51.50 feet and from said point of beginning running thence along the westerly boundary of the tract herein described, N45°21'19"E, 44.74 feet to a point of curvature; thence, 10.96 feet along the arc of a curve to the right having a radius of 7.47 feet and a chord bearing N87°22'03"E, 10.00 feet to a point of tangency; thence continuing along the northerly boundary of the tract herein described, S50°37'13"E, 51.52 feet to a point; thence, N89°22'28"E, 70.00 feet to the southeast corner of the tract herein described, a point on curve on the southerly boundary of said Tract "A-2", thence continuing along the southerly boundary of said Tract "A-2", 152.45 feet along the arc of a curve to the right having a radius of 425.00 feet and a chord bearing N89°59'22"W, 151.64 feet to the point and place of beginning.

Tract contains 0.0485 acre, more or less.

Bohannon-Huston, Inc.
Courtyard I
7500 Jefferson Street N.E.
Albuquerque, NM 87109

November 6, 1986
Job No. 6 160 9

A. Dwain Weaver
A. Dwain Weaver
N.M.P.L.S. No. 6544



CBC Geometry

E-17/D65

From: Simons/Li

2-5'x10'

$$Q_{100} = 1800 \text{ CFS}$$

$$\text{Depth} = 4.33 \text{ FT}$$

Assuming no head loss:

$$V = 20.79 \text{ FPS}$$

$$\therefore Fr = \frac{20.79}{\sqrt{(32.2)(4.33)}} = 1.76 \text{ at top of drop.}$$

$$\text{drop height} = 3.5 \text{ FT}$$

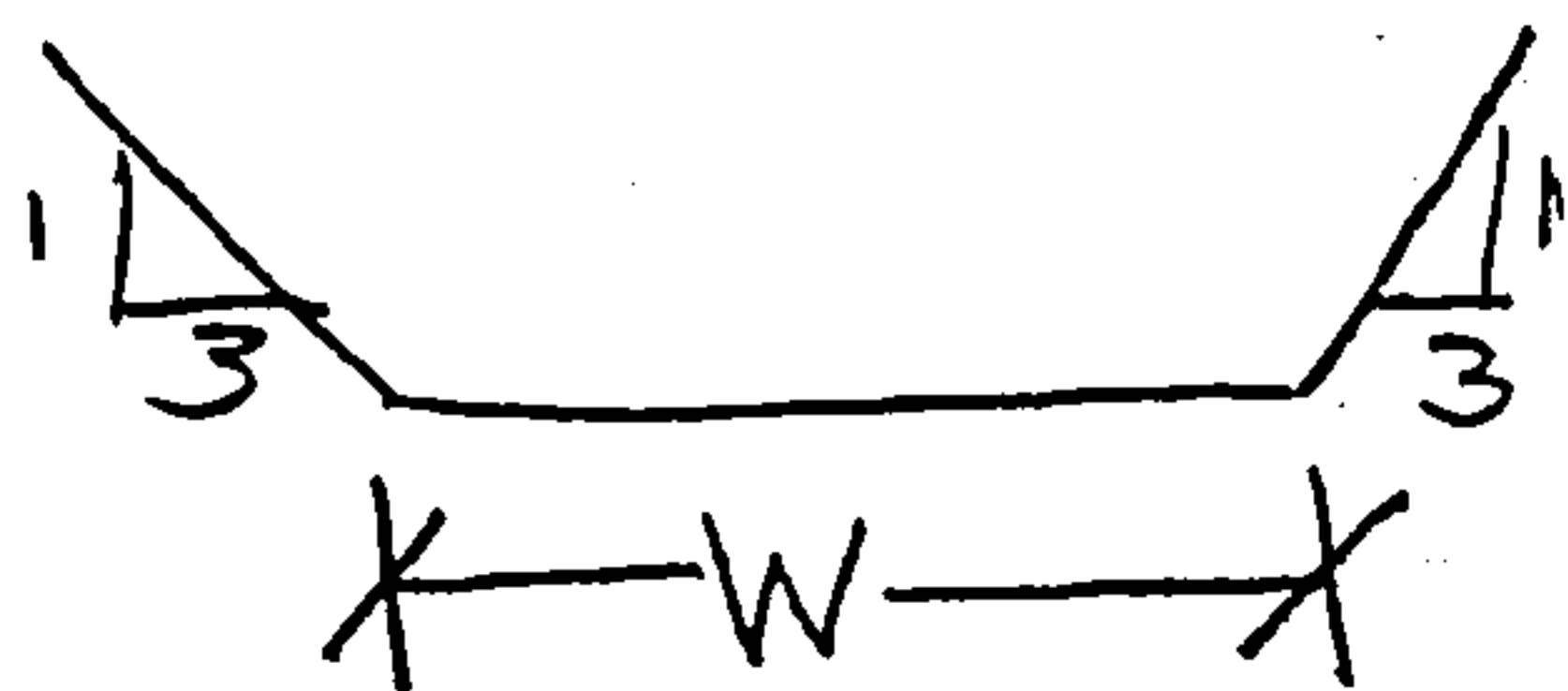
$$H = d_0 + \frac{V_0^2}{2g} = 11.04 \text{ FT}$$

$$\text{Available Head} = 11.04 + 3.5 = 14.54 \text{ FT}$$

* Since structure widens from 20 FT to 40 FT over the drop, uses an average width of 30 FT

Solving by trial & error:

$$W = 30 \quad d_1 = 1.78 \quad V_1 = 28.61$$

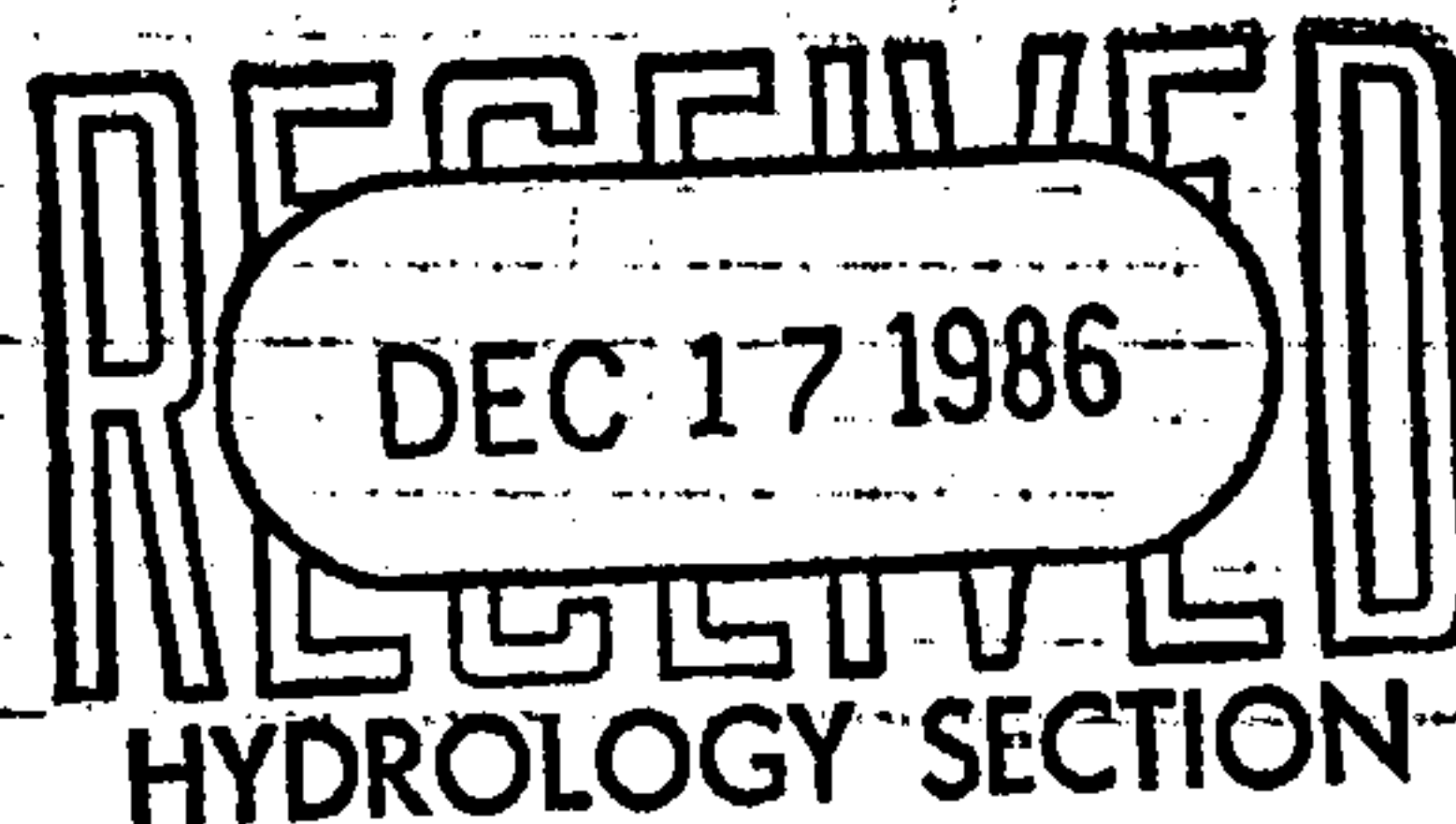


$$V = \frac{Q}{A} = \frac{1800}{d_1 W + 3d_1^2}$$

$$14.54 = d_1 + \frac{V_1^2}{2g}$$

$$Fr = 3.78$$

$$d_2 = d_1 \left(\frac{1}{2} (\sqrt{1 + 8Fr^2} - 1) \right) = 8.67$$

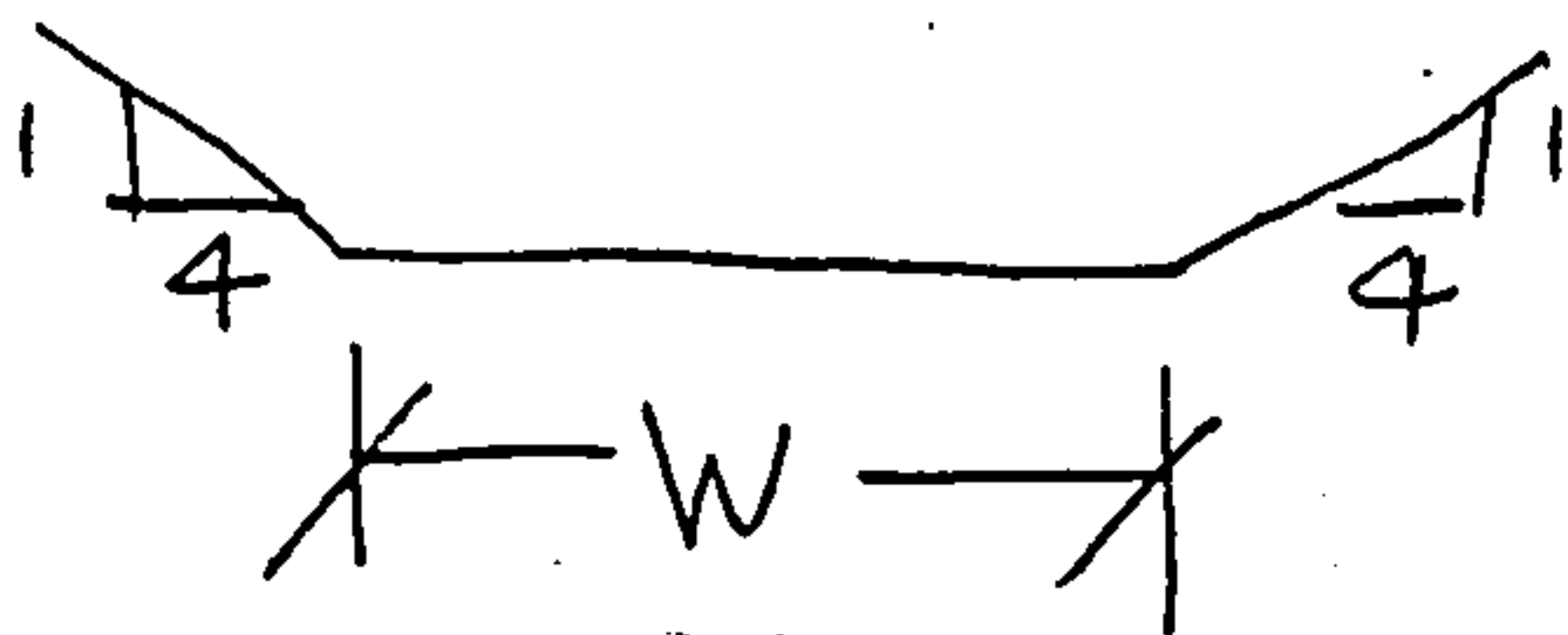


BOHANNAN-HUSTON INC.

PROJECT NAME Bear Arroyo Box Culvert SHEET 1 OF 2
 PROJECT NO. 62630 BY KLS DATE 12/86
 SUBJECT Energy Dissipation CH'D RLJ DATE 12/17/86

Structure widens from 40 FT to 80 FT over the pool area use an average width of 60 FT

Available head is: $14.54 = d_1 + \frac{V_1^2}{2g}$



$$V = \frac{Q}{A} = \frac{1800}{d_1 W + 4d_1^2}$$

$$W = 60 \quad d_1 = 0.95 \quad V = 29.70$$

$$Fr = 5.37$$

$$d_2 = d_1 \left(\frac{1}{2} (\sqrt{1 + 8Fr^2} - 1) \right) = 6.76$$

Using Figure 2-4 (From: Volume 2, Urban Storm Drainage Manual)

$$\frac{L_b}{d_2} = 6$$

$$L_b = 40.56 \text{ FT}$$

$$= 40 \text{ FT } 7 \text{ IN}$$

$$\text{Tailwater depth} = 3.0 \text{ FT}$$

$$\text{Set basin at } 6.76 - 3 = 3.76 \text{ FT}$$

below downstream depth,



BOHANNAN-HUSTON INC.

PROJECT NAME

SHEET

OF

PROJECT NO.

BY

DATE

SUBJECT

CH'D

DATE

2

2

KLS

12/86

RAQ

12/17/86

CBC Geometry

2 - 5'x10' Concrete Box Culverts

At Outlet of CBC's $d = 4.33$
 $V = 21.00$

$$Fr = \frac{V}{\sqrt{gd}}$$

$$Fr = 1.78$$

Using H.E.C. 14 Section XI as reference
(Example 2)

$$Q = 1800 \text{ CFS}$$

$$y_o = 4.33 \text{ FT}$$

$$TW = 3.0 \text{ FT}$$

$$\frac{TW}{y_o} = 0.69 < 0.75 \checkmark$$

$$2. V_o = \frac{Q}{A} = \frac{1800}{2(4.33)(10)} = 20.79 \text{ FPS}$$

$$1. y_o = y_e = 4.33 \text{ FT}$$

$$3. Fr = \frac{20.79}{\sqrt{g \cdot 4.33}} = 1.76$$

$$4. \frac{TW}{y_e} = \frac{3.0}{4.33} = 0.69 < 0.75 \text{ OK}$$

$$5. \text{Try } D_{50}/y_e = 0.46 \quad D_{50} = 2.00 \text{ FT}$$



BOHANNAN-HUSTON INC.

PROJECT NAME

Bear Arroyo Box Culvert

SHEET

1

OF

12/86

PROJECT NO.

62630

BY

DATE

SUBJECT

CH'D

DATE

From Figure XI-2

$$\frac{h_s}{y_e} = 0.95$$

$$h_s = (0.95)(4.33) = 4.11$$

$$\frac{h_s}{D_{50}} = \frac{4.11}{2.00} = 2.1$$

2 < 2.1 < 4 O.K.

6. $L_s = 10(h_s)$

$$L_s = 41.1 \text{ FT}$$

$$L_{smin} = (3)W_o = 60 \text{ FT} \text{ -- USE } 41.1 \text{ FT}$$

$$L_B = (\frac{5}{15})(4.11) = \cancel{61.65 \text{ FT}} \quad 20.55$$

$$L_{Bmin} = (\frac{4}{4})W_o = \cancel{80 \text{ FT}} \quad \text{USE } \cancel{61.65 \text{ FT}} \quad 20.55 \text{ FT}$$

Design riprap for downstream channel

Say depth = 3.0 FT side slopes 4:1

width = 80 FT

$$\therefore \text{Area} = (80)(3) + (3)(12) = 276 \text{ FT}^2$$

$$Q = 1800 \text{ CFS}$$

$$V = 6.52 \text{ FPS}$$

Compute equivalent circular diameter, D_e

$$A = \frac{\pi D_e^2}{4} = W_o y_o = 86.6$$

$$D_e = 10.5$$



BOHANNAN-HUSTON INC.

PROJECT NAME _____ SHEET 2 OF _____

PROJECT NO. _____ BY _____ DATE _____

SUBJECT _____ CH'D _____ DATE _____

BOHANNAN-HUSTON INC.



19.0	199.5	0.37	7.7
18.0	189.0	0.40	8.31
20.0	210.0	0.36	7.48
10.0	105.0	0.73	15.18

$$L/D_e = L \quad V_L/V_0 \quad V_L$$

$$V_{downstream} = 7.7 \text{ FPS} = V_L$$

$$V_0 = 20.79 \text{ FPS}$$

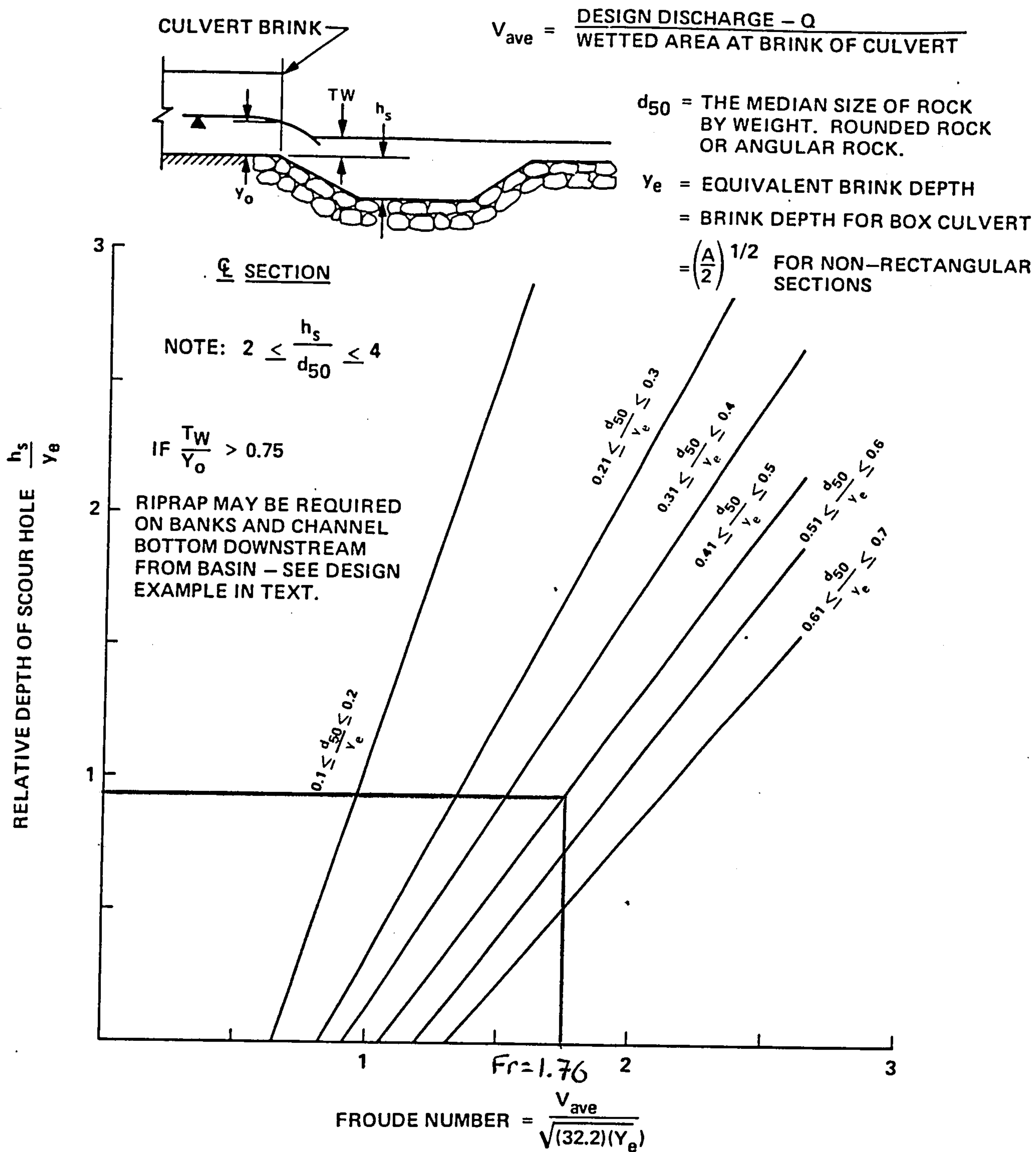


FIGURE X1-2. RELATIVE DEPTH OF SCOUR HOLE VERSUS FROUDE NUMBER AT BRINK OF CULVERT WITH RELATIVE SIZE OF RIPRAP AS A THIRD VARIABLE

CBC Geometry - 2- 4.33' x 10'

$$Q_{100} = 1800 \text{ cfs}$$

$$\text{Drop height} = 3.5'$$

$$\text{Downstream flow depth} = 3 \text{ ft}$$

rectangular drop

4:1 Slope at Drop

* Assuming no head loss

$$\text{Froude No at outlet} = 1.78$$

$$V = \frac{1800 \text{ cfs}}{2(4.33)(10 \text{ ft})} = 20.79 \text{ ft/s}$$

$$H = d_0 + \frac{V^2}{2g} = 4.33 + \frac{(20.79)^2}{2(32.2)}$$

$$= 11.04 \text{ ft}$$

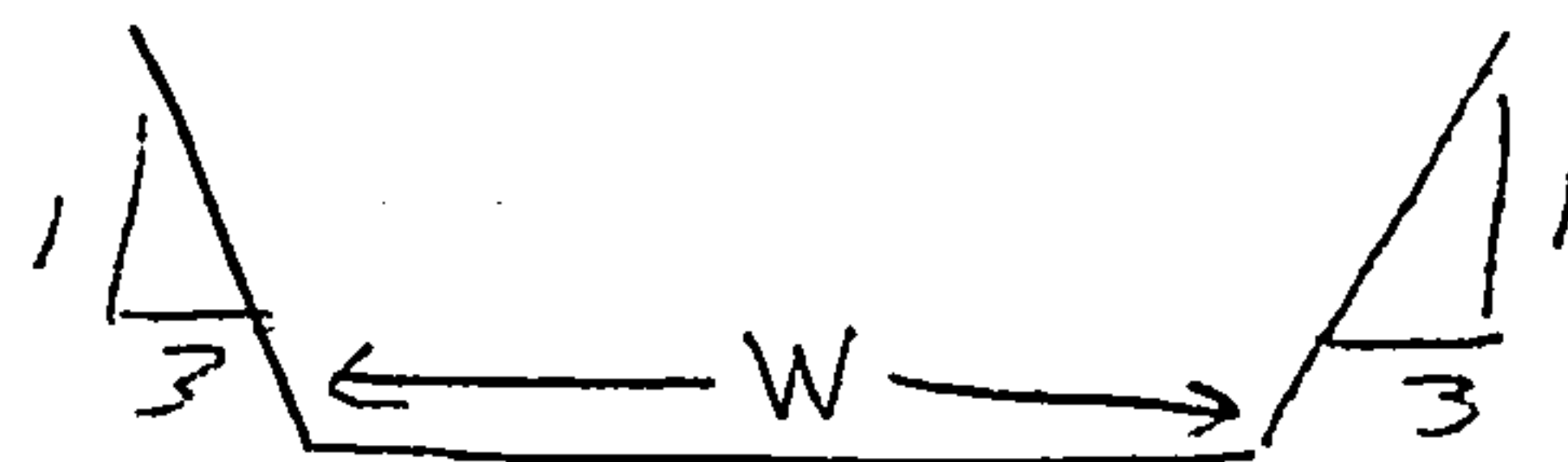
$$\text{Head available} = 14.54 \text{ ft} = d_1 + \frac{V_1^2}{2g}$$

Solving by trial / error:

$$W = 20 \quad d_1 = 2.37 \quad V = 28.02$$

$$W = 40 \quad d_1 = 1.40 \quad V = 29.09$$

$$W = 80 \quad d_1 = 0.73 \quad V = 30.00$$



$$V = \frac{Q}{A} = \frac{1800}{d_1 W + 3d_1^2}$$

$$Fr = \frac{V_1}{\sqrt{g d_1}} = 4.33$$

$$d_2 = d_1 \left(\frac{1}{2} (\sqrt{1 + 8 Fr^2} - 1) \right) = 7.9$$



BOHANNAN-HUSTON INC.

PROJECT NAME Bear Arroyo Box Culvert SHEET OF
PROJECT NO. BY KHS DATE 11/86
SUBJECT Energy Dissipation DTD DATE

$Q_{100} = 1800 \text{ cfs}$

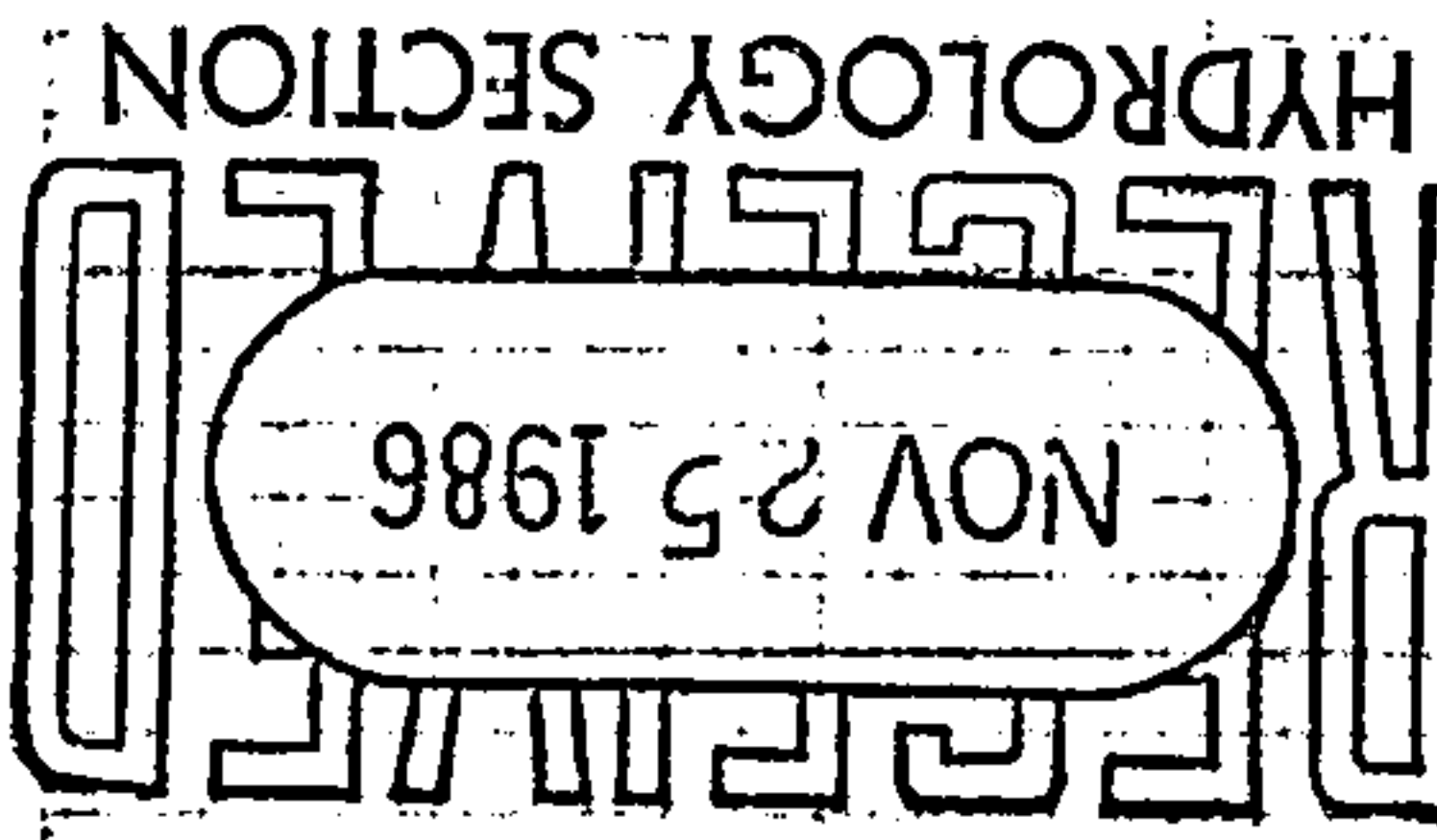
Drop height = 3.5'

rectangular drop 4:1 slope at drop

* Assuming no head loss

$$V = \frac{Q}{A} = \frac{1800 \text{ cfs}}{20.79 \text{ ft}^2/\text{s}} = 86.6 \text{ ft/s}$$

$$H = d_0 + \frac{V^2}{2g} = 4.33' + \frac{(20.79)^2}{2(32.2)} = 14.54'$$



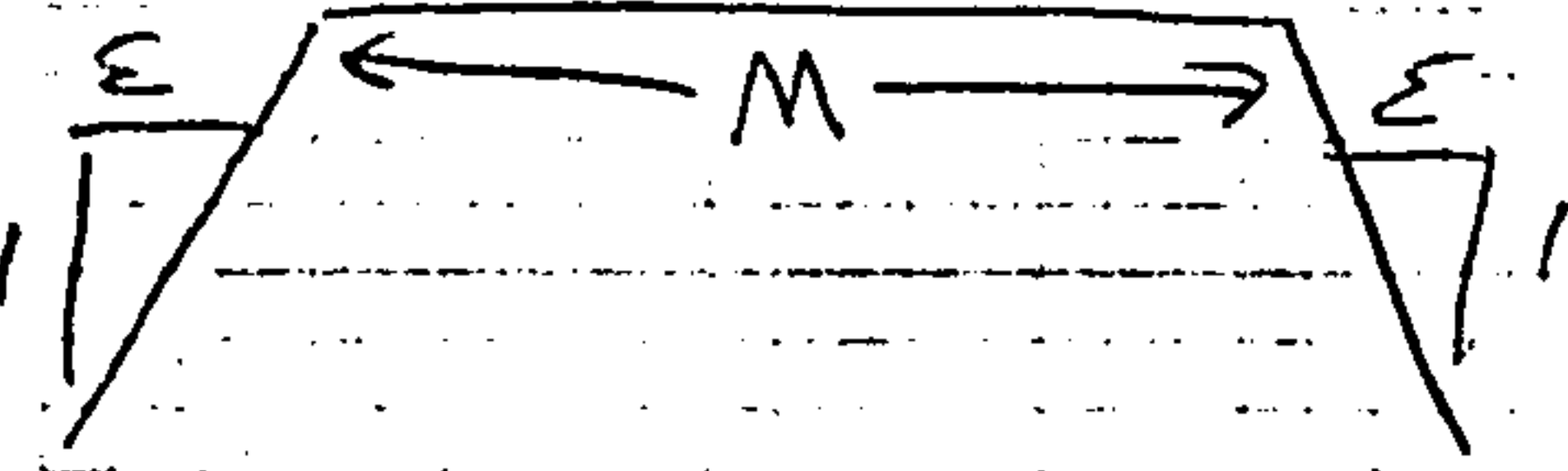
$$= 11.04 \text{ ft} + 3.5 = 14.54'$$

$$\text{Head available} = 14.54 \text{ ft} = d_1 + \frac{V_1^2}{2g}$$

Solving by trial & error:

$W=20 \quad d_1 = 2.37 \quad V = 28.02$

$W=40 \quad d_1 = 1.40 \quad V = 29.09$



$W=80 \quad d_1 = 0.73 \quad V = 30.00$

$V = \frac{Q}{A} = \frac{1800}{d_1 W + 3d_1^2}$

$$F_r = \frac{V}{\sqrt{gd_1}} = 4.33 \quad \text{--- recommended } (F_r = 8)$$

$$d_2 = d_1 \left(\frac{1}{2} (\sqrt{1 + 8F_r^2} - 1) \right) = 7.9' \quad (d_2 = 14 - 8 = 6)$$

$C_d = 1.0$



BOHANNAN-HOUSTON INC.

PROJECT NAME: Bear Armygo Box Culvert SHEET

PROJECT NO.

BY

KHS

DATE

11/86

CH/D

RHS

DATE

12/2/86

Energy Dissipation

SUBJECT

From Figure 2-4

$\frac{L_b}{d_2} = 5.9$

$d_2 = 7.9'$

$L_b = 5.9 \times 7.9 = 46.61' = 46' - 8"$

Set basin at $d_2 = 7.9' - 3.0' = 4.9' = 4' - 9"$

DPM jump length $L = (3.5)(1.4) = 4.9'$

Flow Depth

Solve for d_2 using Bernoulli Eqn.

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + d_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + d_2$$

$$\frac{(29.09)^2}{2(32.2)} + 1.4 = \frac{V_2^2}{2g} + d_2$$

$$14.54 = \frac{V_2^2}{2g} + d_2$$

$$\frac{1800}{V_2} = \frac{A}{Q} = \frac{d_2(80) + 3d_2^2}{1800}$$

Solving by Trial & Error

$$d_2 = 0.735 \text{ ft} \quad V_2 = 29.79 \text{ ft/s}$$

$$F_1 = \frac{V_2}{\sqrt{g d_2}} = \frac{29.79}{\sqrt{(32.2)(0.735)}} = 6.123$$

$$d_3 = d_2 \left(\frac{1}{2} \left(\sqrt{1 + 8 F_2^2} - 1 \right) \right)$$

$$= 0.735 \left(\frac{1}{2} \left(\sqrt{1 + 8(6.123)^2} - 1 \right) \right) = 6.10 \text{ feet}$$

$$\frac{L_b}{d_2} = 5.9$$

	d_i	V_i	$H_i = 14.54$
W=20	2.0	34.62	20.61
	2.5	26.18	13.14
	2.4	27.57	14.20
	2.35	28.32	14.80
	2.37	28.02	14.56
W=40	1.0	41.86	28.21
	1.5	26.97	12.79
	1.3	31.54	16.75
	1.4	29.09	14.54
W=80	1.0	21.69	8.31
	0.7	31.32	15.93
	0.71	30.87	15.51
	0.73	30.00	14.71
	0.74	29.58	14.33
	0.735	29.79	14.52

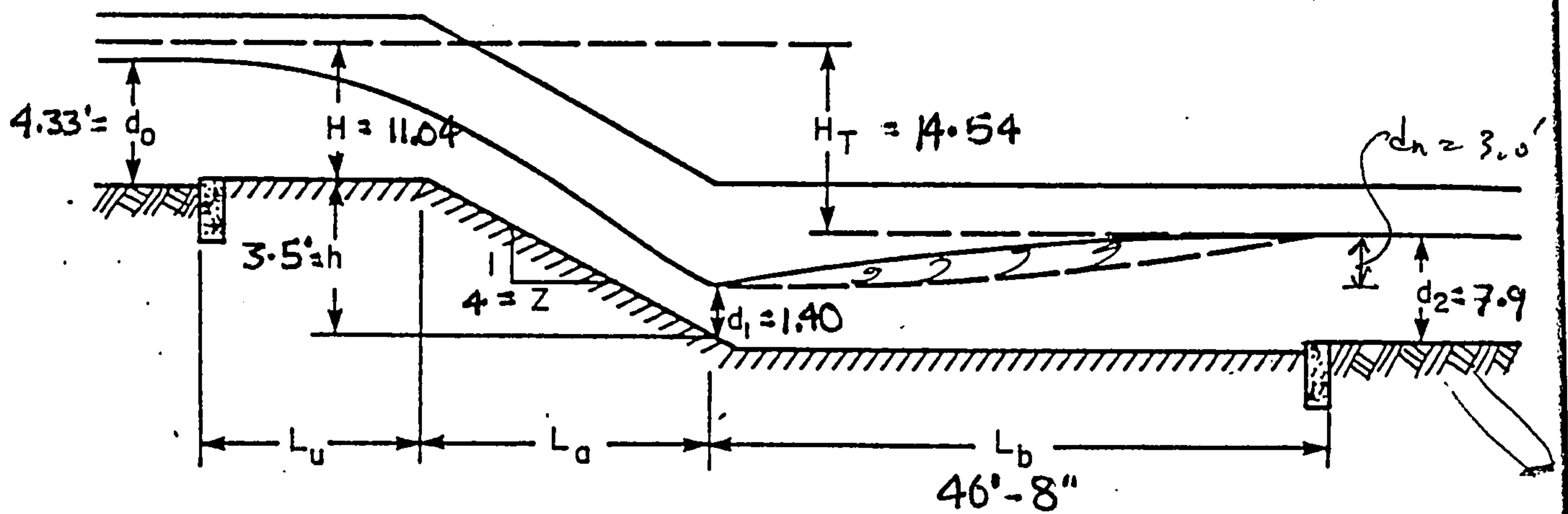
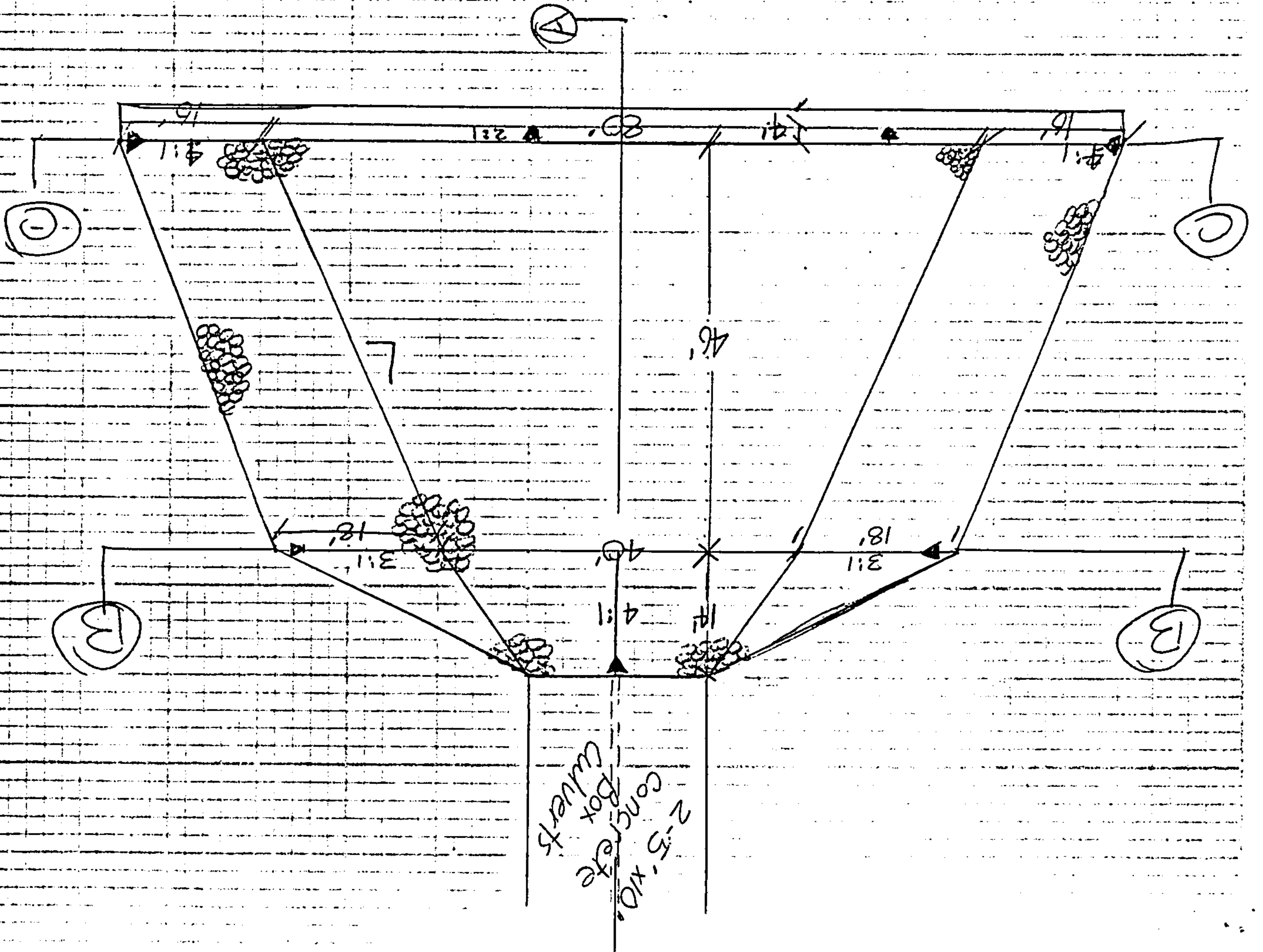
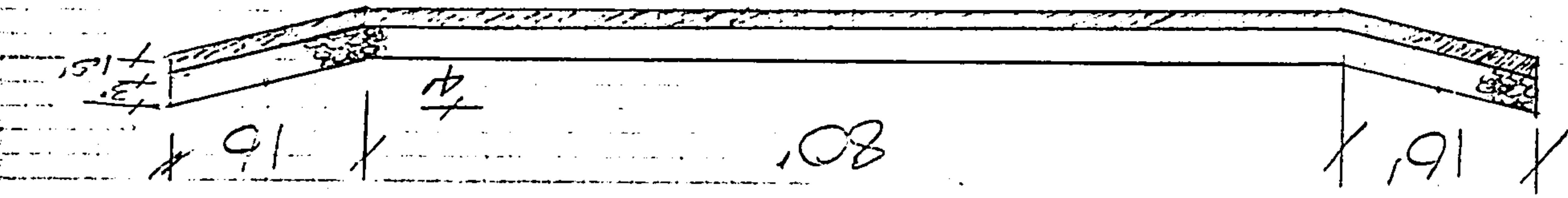


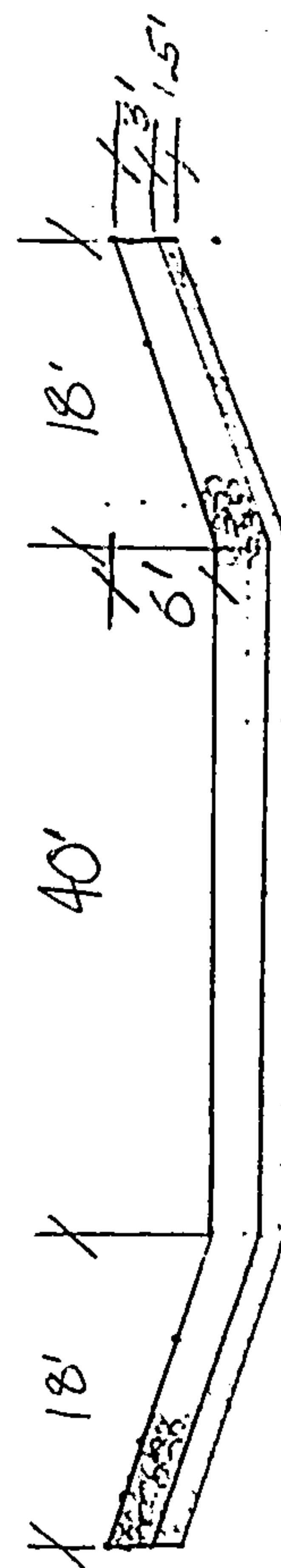
Figure 5-10. Definition sketch for a sloped drop structure.

BOHANNAN-HUSTON INC.



Section C-C





Section A-A

Section 17(b)



PROJECT NAME Bear Army o Box Culvert SHEET 2 OF 2
PROJECT NO. 62630 C BY _____ DATE _____
DRAWN BY Proprietary CHD _____ DATE _____

University of New Mexico
Department of Civil Engineering
University of New Mexico

Grain Size Distribution Curve

Test No. _____

Sample Riprap Filter Sizing for Bear Arroyo
Tested By _____ Party _____ Date _____

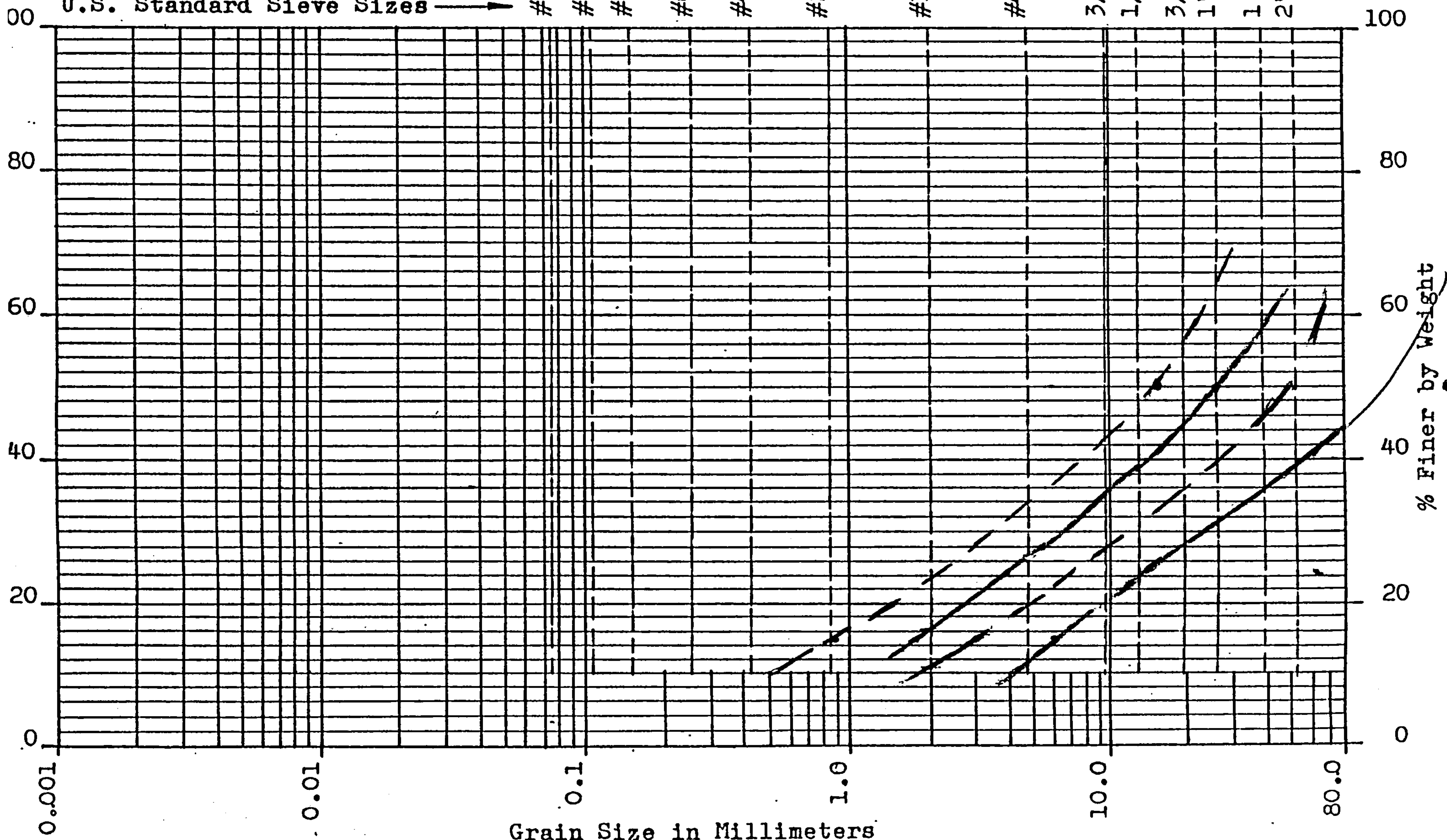
--- Filter for Riprap
— Filter for Soil

D_{10} _____ D_{60} _____ U_c _____

USE Class VI SB

U.S. Standard Sieve Sizes →

#200 #140 #100 #60 #40 #20 #10 #4 3/8" 1/2" 3/4" 1" 1.5" 2"



Simons & Li
FOR AMAFCA

bed only

Table 5-1. Riprap Requirements for Channel Bed Linings.

$V^2/R^{0.33}$	Riprap Required
< 60	Type VL *
60 - 90	Type L *
90 - 120	Type M *
120 - 180	Type H
> 180	Type VH

* It is recommended that these riprap classifications be buried with natural soils, after the riprap has been placed and accepted by the approving agency, to prevent damage by people.

For bank protection see Section 5.4.2 of "Major Drainage" in the Urban Storm Drainage Criteria Manual, Volume 2.

For side protection,
use Table 5-3 of Riprap subsidy.

Table 5-5
RIPRAP REQUIREMENTS FOR CHANNEL LININGS **

$V S^{0.17} / (S_s - 1)^{0.66*}$ (feet per second)	Rock Type ***
1.5 to 4.0	VL
4.0 to 5.0	L
5.0 to 5.8	M
5.8 to 7.1	H
7.1 to 8.2	VH

- * Use $S_s = 2.5$ unless the source of rock and its densities are known at the time of design.
- ** Table valid only for Froude number of 0.8 or less and side slopes no steeper than 2h:1v.
- *** Type VL and L riprap shall be buried after placement to reduce vandalism.
SM9 slope mattress with toe protection may be substituted for Type VL or L riprap.
G12 gabion with toe protection may be substituted for Type M and Type H riprap.

5.4.3 Toe Protection

Where only the channel sides are to be lined, additional riprap is needed to provide for long term stability of the lining. In this case, the riprap blanket should extend at least 3 feet below the existing channel bed and the thickness of the blanket below the existing channel bed increased to at least 3 times d_{50} to accommodate possible channel scour during floods (see Figure 5-4a). For sandy soils, consult specific criteria for channels on sandy soils. If wire enclosed rock lining is used, the toe must be protected by placing riprap at the toe. This is needed to protect against frequently occurring abrasion, (see Figure 5-4b and 5-4c).

Table 5-1

CLASSIFICATION AND GRADATION OF ORDINARY RIPRAP

<u>Riprap Designation</u>	<u>% Smaller Than Given Size By Weight</u>	<u>Intermediate Rock Dimension (Inches)</u>	<u>d₅₀[*] (Inches)</u>
Type VL	70-100	12	6**
	50-70	9	
	35-50	6	
	2-10	2	
Type L	70-100	15	9**
	50-70	12	
	35-50	9	
	2-10	3	
Type M	70-100	21	12
	50-70	18	
	35-50	12	
	2-10	4	
Type H	100	30	18
	50-70	24	
	35-50	18	
	2-10	6	
Type VH	100	42	24
	50-70	33	
	35-50	24	
	2-10	9	

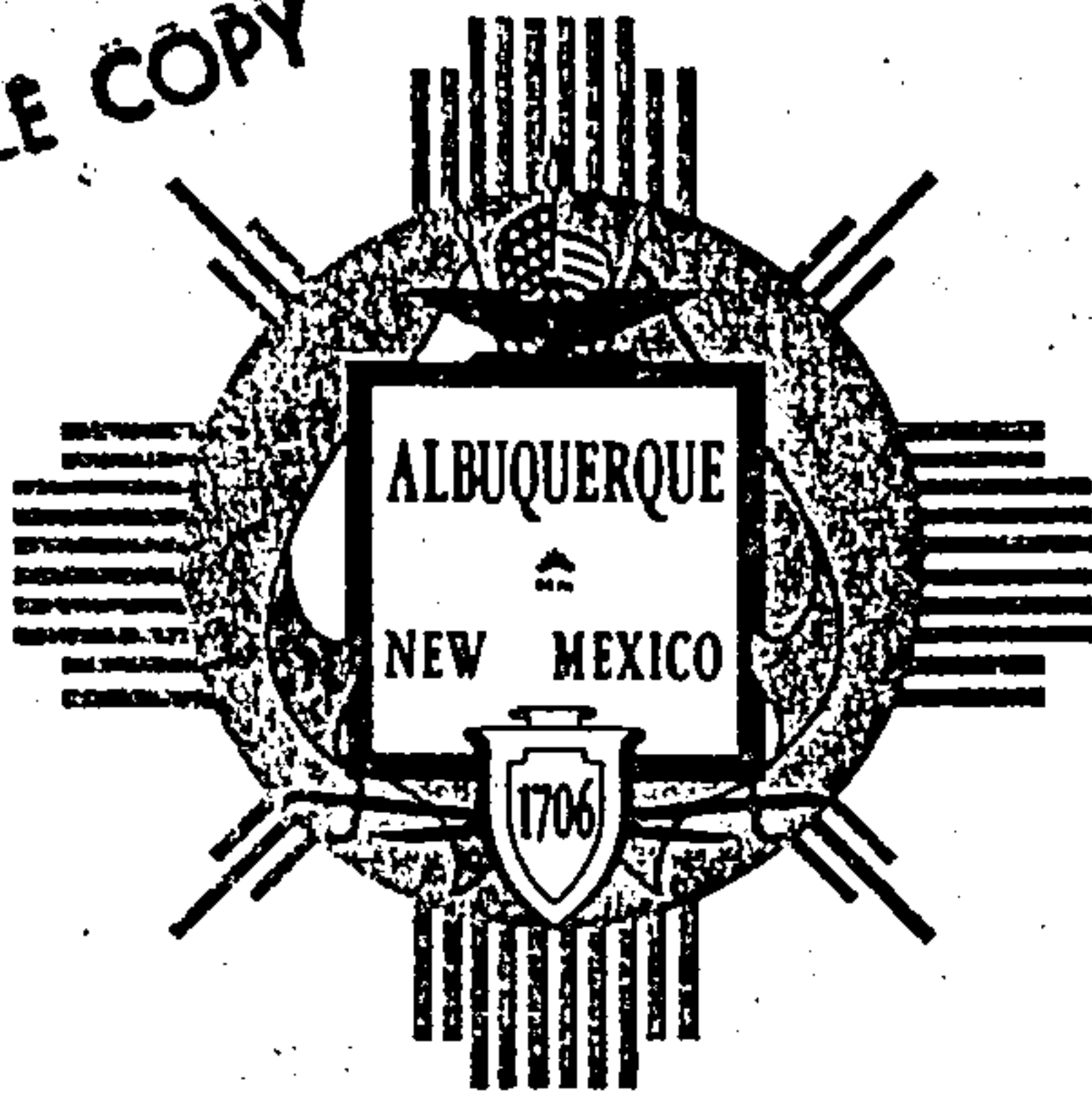
*d₅₀ = Mean particle size

** Bury types VL and L with native top soil and revegetate to protect from vandalism.

5.2 Wire Enclosed Rock

Wire enclosed rock refers to rocks that are bound together in a wire basket so that they act as a single unit. One of the major advantages of wire enclosed rock is that it provides an alternative in situations where available rock sizes are too small for ordinary riprap. Another advantage is the versatility that results from the regular geometric shapes of wire enclosed rock. The rectangular blocks and mats can be fashioned into almost any shape that can be

FILE COPY



City of Albuquerque

P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

HYDROLOGY SECTION
123 Central NW, Albuquerque, NM 87102
(505) 766-7644

December
~~November~~ 4, 1986

Daniel J. Grochowski, P.E.
Bohannon-Huston, Inc.
7500 Jefferson Street, NE
Albuquerque, New Mexico 87109

RE: BEAR ARROYO DRAINAGE REPORT SUBMITTAL FOR IMPROVEMENTS BETWEEN
SAN MATEO BOULEVARD AND I-25, RECEIVED NOVEMBER 25, 1986 FOR
FINAL PLAT AND WORK ORDER APPROVALS (E-17/D65) (PROJ. #3044)

Dear Dan:

After review of the above referenced submittal and discussions with Karen Scharf in my office today, I approved the Drainage Report and design of the plunge pool. In order to have complete documentation with the Drainage Report, please provide the following information at time of resubmittal of construction drawings to the DRC:

1. Design calculations for the plunge pool should include the Froude Number at the box culverts outlet.
2. A copy of Figure 2-4 from "structures" in the "Urban Storm Drainage Criteria Manual, Volume 2."
3. Completed plunge pool calculations for the basin length and depth for the 80 foot width, then determine the actual design length and depth to use. Consider using the procedures in Section XI of H.E.C. 14 to support dimensions used.
4. Provide the riprap and filter graphs left out of the original Drainage Report.

PUBLIC WORKS DEPARTMENT

Walter Nickerson, P.E., City Engineer

ENGINEERING GROUP

Telephone (505) 768-2500

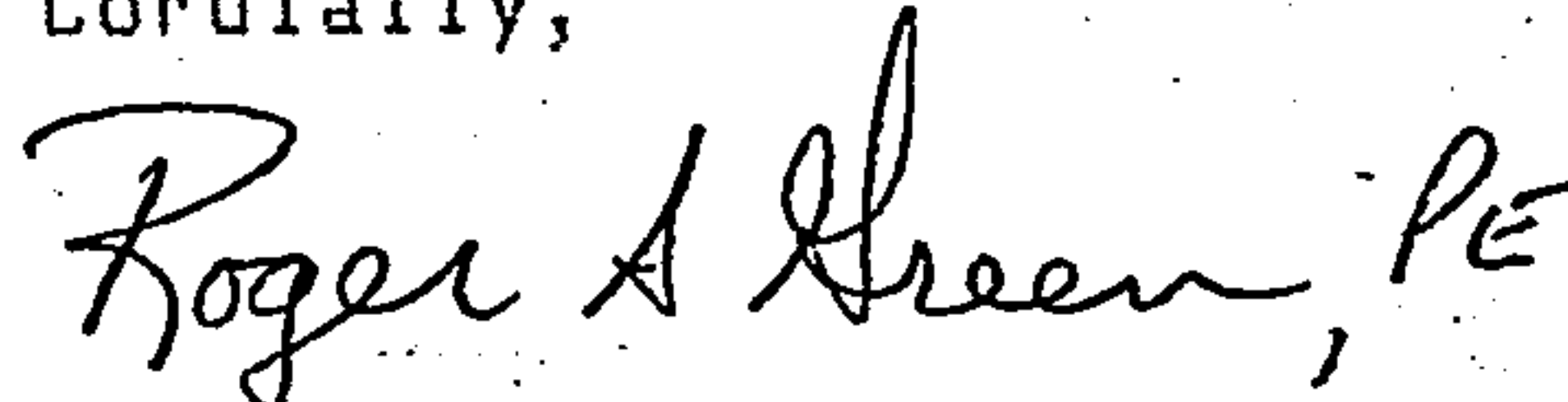
AN EQUAL OPPORTUNITY EMPLOYER

Daniel J. Grochowski, P.E.
December 4, 1986
Page 2

You also may want to check with Jim Fink in Hydrology Planning Section concerning the status of extending the box culverts to I-25. It appears the plunge pool at the box culverts outlet will be very expensive and may not be cost effective if it would soon be removed and the culverts extended.

If you have any questions, call me at 768-2650.

Cordially,



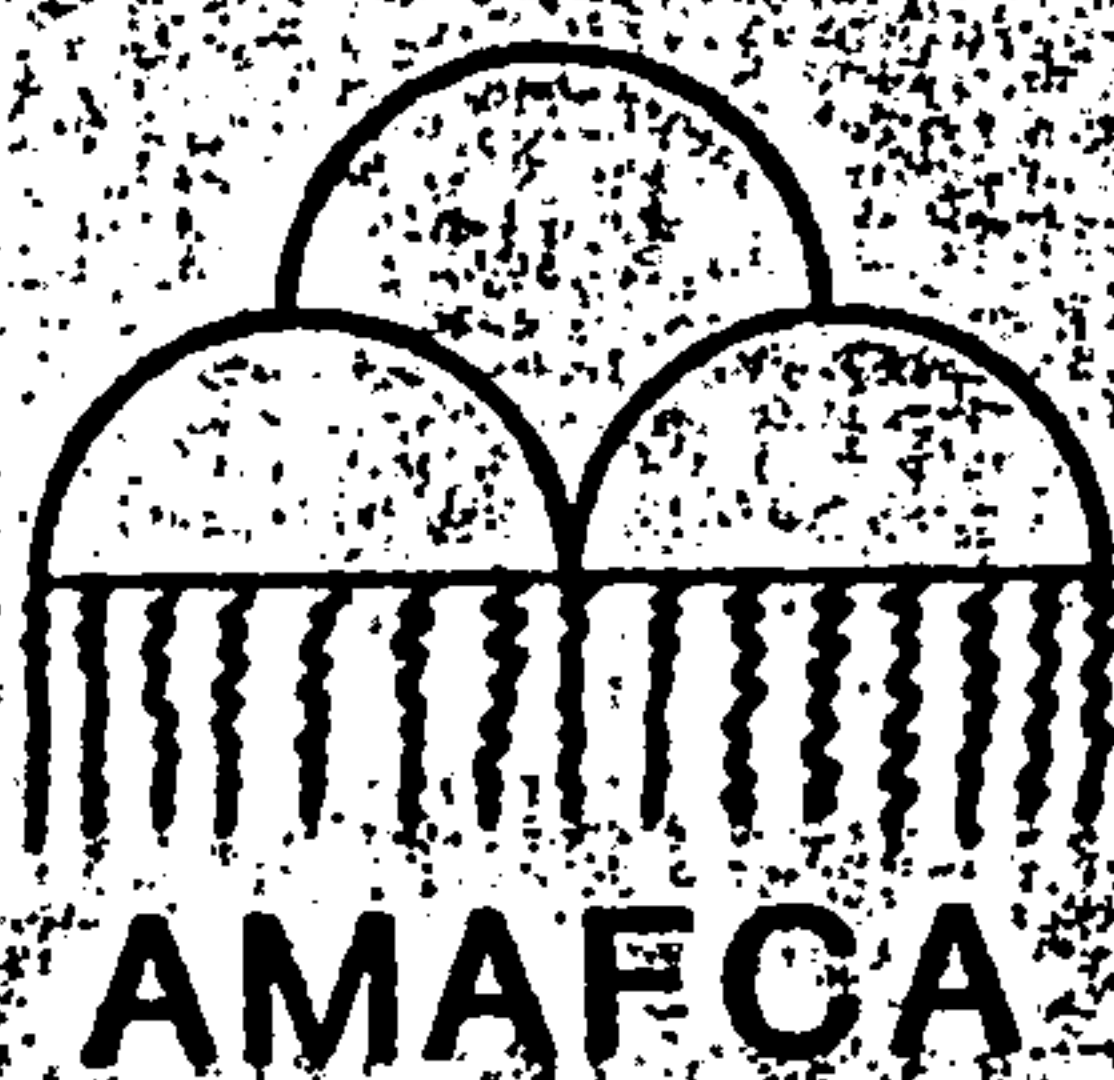
Roger A. Green, P.E.
C.E./Hydrology Section

cc: Andre Houle, DRC
Dan Sabo, AMAFCA

RAG/bsj

CONCEPT DESIGN REPORT BEAR CANYON ARROYO CHANNEL IMPROVEMENTS

Prepared for
ALBUQUERQUE METROPOLITAN ARROYO
FLOOD CONTROL AUTHORITY



APRIL 1987

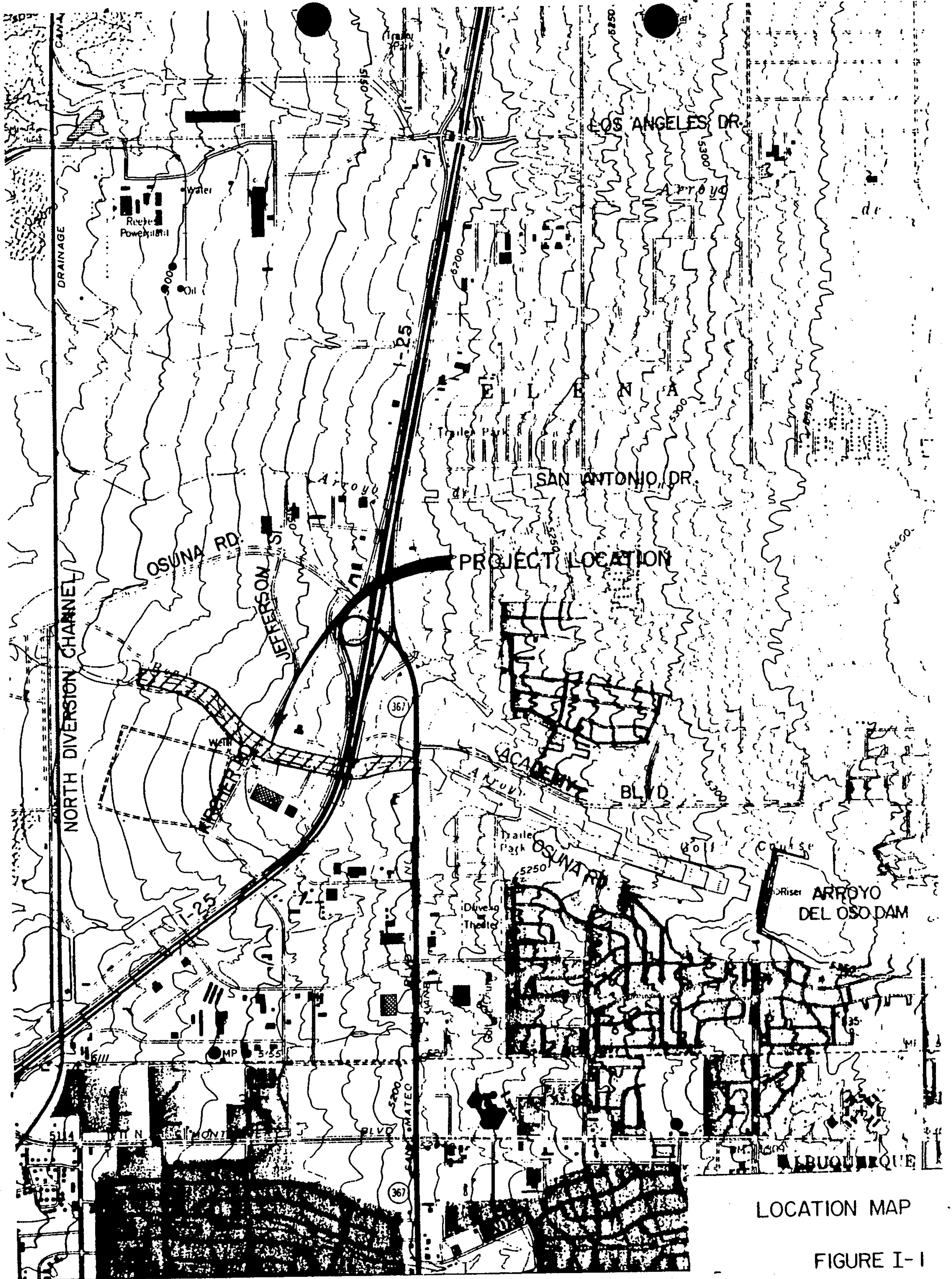


LEEDSHILL-HERKENHOFF, INC.

500 Copper Ave., N.W.
P.O. Box 1217 - Phone (505) 247-0294
Albuquerque, New Mexico 87103

ENGINEERS

ARCHITECTS



LOCATION MAP

FIGURE I-1

3. Reach 3 - I-25 to San Mateo Blvd:

This reach is more stable than the other two reaches of this project. The channel width varies from in excess of 130' just upstream of I-25 where a more or less permanent pond presently exists (possibly due to borrow taken from this area) to approximately 60' wide just below the San Mateo concrete box culvert (CBC).

Five inlets from adjacent properties exist in this reach:

a. Two concrete rundowns enter from the south at Stations 47+80 and 48+50 with approximately 9' and 3' of fall respectively from the end of the rundown to the channel bottom. These rundowns are relatively new and there is no apparent erosion.

b. A 24" RCP drain enters from the south approximately 4' above the channel. This line is new and has not been through a storm season.

c. An asphalt rundown enters from the north at about Station 52+80. Local erosion from inflows is apparent.

d. Inflow from property on the south at about station 55+00. No apparent problems since the flow is small.

e. A 60" RCP storm drain enters into the wing wall of the San Mateo CBC from the south. There are no apparent problems since the outlet is riprapped.

Local erosion has occurred and is occurring in the vicinity of the San Mateo CBC. The current channel gradient is approximately 1 percent with a gradient from the San Mateo CBC apron to the I-25 CBC east apron of 1.8%.

3. Reach 3:

Property bordering this reach is still being developed.

a. The Sunwest Bank, off of San Mateo Blvd. on the north side of the arroyo, had plans (letter dated 1/85) to extend its parking lot south and line the arroyo bank with riprap both on the north side and south side to protect Lota Burger. These plans have not yet been carried out.

b. The property on the north side of the arroyo between Sunwest Bank and the Frontage Rd. is presently being developed. Their plans include several rundowns into the arroyo from parking areas. In addition, the City is requiring them to riprap the arroyo bank as it is done on the south side of the arroyo. (The engineer is Bohannon-Huston.)

c. In addition, developers of properties on both sides of the arroyo are considering installing a box culvert the full length of Reach 3 in order to reclaim the land presently in a flood zone.

Development a. and b. above do not have much impact on our proposed solution. The construction of a box culvert, however, would considerably change the cost estimates and alternate comparisons of this study. We recommend that this study be re-evaluated if conditions in Reach 3 are modified to this extent.

TABLE III-2
REACH 2 - EVALUATION MATRIX

Alternate	Advantages	Disadvantages	Comparative Cost*
Lined Channel	Minimum maintenance	Imported fill	\$381,800
Soil Cement	Lowest cost		
Baffle Chute w/ full width vertical drop entry	Does not slow flow in I-25 culvert	Cost	\$451,200

* Note that these costs are not complete and are intended only to compare relative costs of alternates.

D. REACH 3:

1. Constraints:

a. Entry conditions into the I-25 box culvert will probably be supercritical if the upstream reach is lined and subcritical given an unlined upstream reach. In the lined condition stormwater can probably be contained in 3 of the 4'x 10' culverts. In the unlined condition and subcritical flow, eight boxes must remain open to maintain adequate free board for the 100 year flow.

b. Inlet flows enter from the properties on both sides.

c. Erosion just below the San Mateo culvert is 9' deep.

d. Net elevation difference between the San Mateo and I-25 culverts is 16', a net gradient of 1.8%.

e. The existing San Mateo CBC is about 42' wide consisting of 4 - 4'x 10' boxes. Flow in the culvert is supercritical with a Froude Number of 2.2. The flow in the San Mateo CBC enters the culvert approximately 900' upstream at the "Rutherford" box culvert. The parapet and headwalls at the entry into the "Rutherford" box are not adequate to allow subcritical entry conditions. Thus, any flow modifications at the outlet of the San Mateo CBC must not force a hydraulic jump into the box. The sequent depth of the flow in the box is greater than the box height and if a jump occurs, it will propagate up the box to the inlet.

It should be noted that the calculations for the entry conditions into the "Rutherford" box were not available from the drainage reports located. It is assumed that entry transition from the upstream lined channel into the box culvert is supercritical and wave heights are such that adequate freeboard is available. If the energy of the channel flow is not adequate to allow a supercritical entry, the depth necessary to get the flow into the culvert is approximately the same as the headwall elevation with no freeboard available.

2. Initial Investigation:

a. Lined Channel: The lined channel alternates are similar to Reach 1. Soil cement lining is the cheapest alternate at a comparison cost of \$375,800 of which \$163,000 is imported fill.

b. Meandering Channel: Due to the width of the channel for this reach, an alternate consisting of meandering flow was investigated. The concept is to force the flow path to take a sinusoidal longer route between the San Mateo structure and I-25 which will result in an effective gradient equal to the equilibrium slope. The proposed means of forcing this flow path is the use of riprap structures placed perpendicular to the channel centerline with openings at alternate sides of the channel. To force the 100 year flow to meander, the structure height would have to be about 13' which would be prohibitively expensive. An alternate allowing major flow events to flow over the structures while recurring flows would meander was considered. While the cost for this alternate is approximately the same as for a lined

with a 2:1 contraction ratio. The channel is stabilized with riprap up to the bottom of the baffle chute. The arroyo floor requires lining only in the transition section and 100'± upstream. The riprap bank stabilization is on a 2H:1V slope. Note that the bank protection also serves to keep the arroyo within the available right-of-way in the upstream part of the channel (for 160'±) where the depth is such that at a 3H:1V slope the available right-of-way would be exceeded.

Cost figures shown in the estimate assume that all the earth excavated to place the riprap bank protection will be disposed of off site. Some of this fill could possibly be used in the downstream reach.

3. Inlet Flows: Inlet flows will be controlled with wire enclosed riprap rundowns as described for Reach 1.

4. Maintenance and Access Road: We propose to locate the maintenance and access road on the south side of the arroyo with entrance from the frontage road and a ramp down at the west end of the reach (See Figure IV-8). To accommodate the maintenance on the south side of the arroyo the channel centerline will be shifted approximately 15' north of the right-of-way centerline.

D. REACH 3:

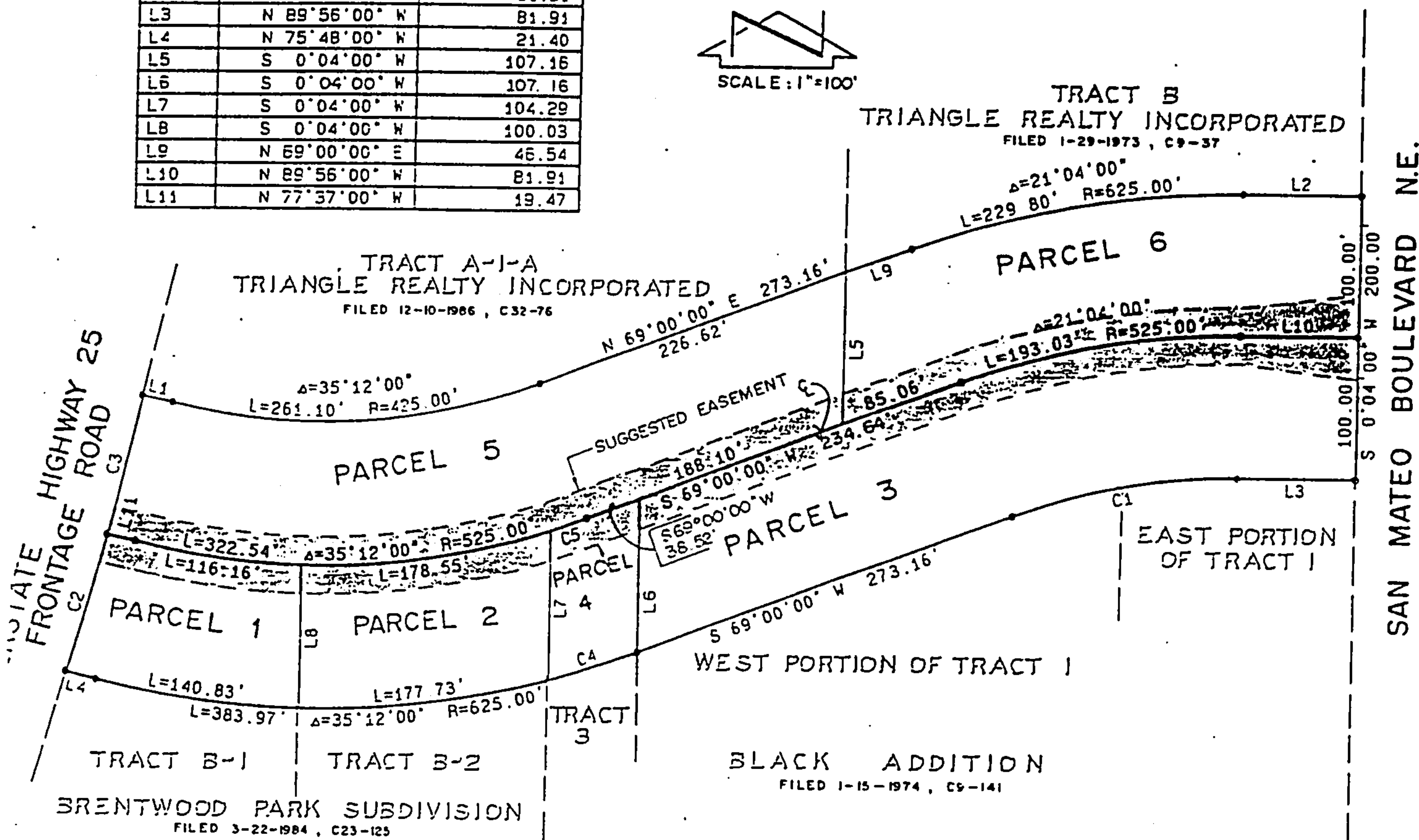
Reach 3 improvements consist of 1 drop structure and 125'± of riprap bank protection just downstream of the structure.

1. San Mateo Baffle Chute: The design of the San Mateo structure is complicated by the flow conditions in the existing culverts. Presently the storm water exits the culverts at supercritical flow; however, the baffle chute requires a subcritical entry. Given the entry conditions on the Rutherford Box discussed in Section III, a hydraulic jump backing up into the box must be avoided. The proposed solution is to obtain the subcritical flow conditions by forcing a hydraulic jump after the water exits the culverts. To avoid any contraction transition structures the new structures are designed to the same width as the existing culverts (42'±).

LINE	BEARING	DISTANCE
L1	S 77°37'00" E	21.39
L2	S 89°56'00" E	81.91
L3	N 89°56'00" W	81.91
L4	N 75°48'00" W	21.40
L5	S 0°04'00" W	107.16
L6	S 0°04'00" W	107.16
L7	S 0°04'00" W	104.29
L8	S 0°04'00" W	100.03
L9	N 69°00'00" E	46.54
L10	N 89°56'00" W	81.91
L11	N 77°37'00" W	19.47



SCALE: 1"=100'



CURVE	ARC	DELTA	RADIUS	CHORD LENGTH	CHORD BEARING	TAN LENGTH
C1	156.27	21°04'00"	425.00	155.39	S 79°32'00" W	79.02
C2	99.41	1°52'47"	3029.79	99.40	N 15°18'55" E	49.71
C3	99.95	1°26'15"	3984.52	99.95	N 13°06'10" E	49.98
C4	55.41	5°53'48"	525.00	55.39	S 71°59'54" W	32.74
C5	27.82	3°02'10"	525.00	27.82	N 70°31'05" E	13.91

EXHIBIT "A"
TO
AGREEMENT AND GRANT OF EASEMENT



811 DALLAS ST. - DALLAS, TEXAS 75201
ENGINEERS

JOB NO. 880401

[---] = Closed Conduit Easement