

**FOUR HILLS VILLAGE - 20TH INSTALLMENT
SUBDIVISION**

DRAINAGE REPORT

Prepared By:



RESOURCE TECHNOLOGY, INC.
2129 Osuna Road NE, Suite 200
Albuquerque, New Mexico 87113
(505) 345-3115

November, 1994

FOUR HILLS VILLAGE - 20TH INSTALLMENT SUBDIVISION

DRAINAGE REPORT

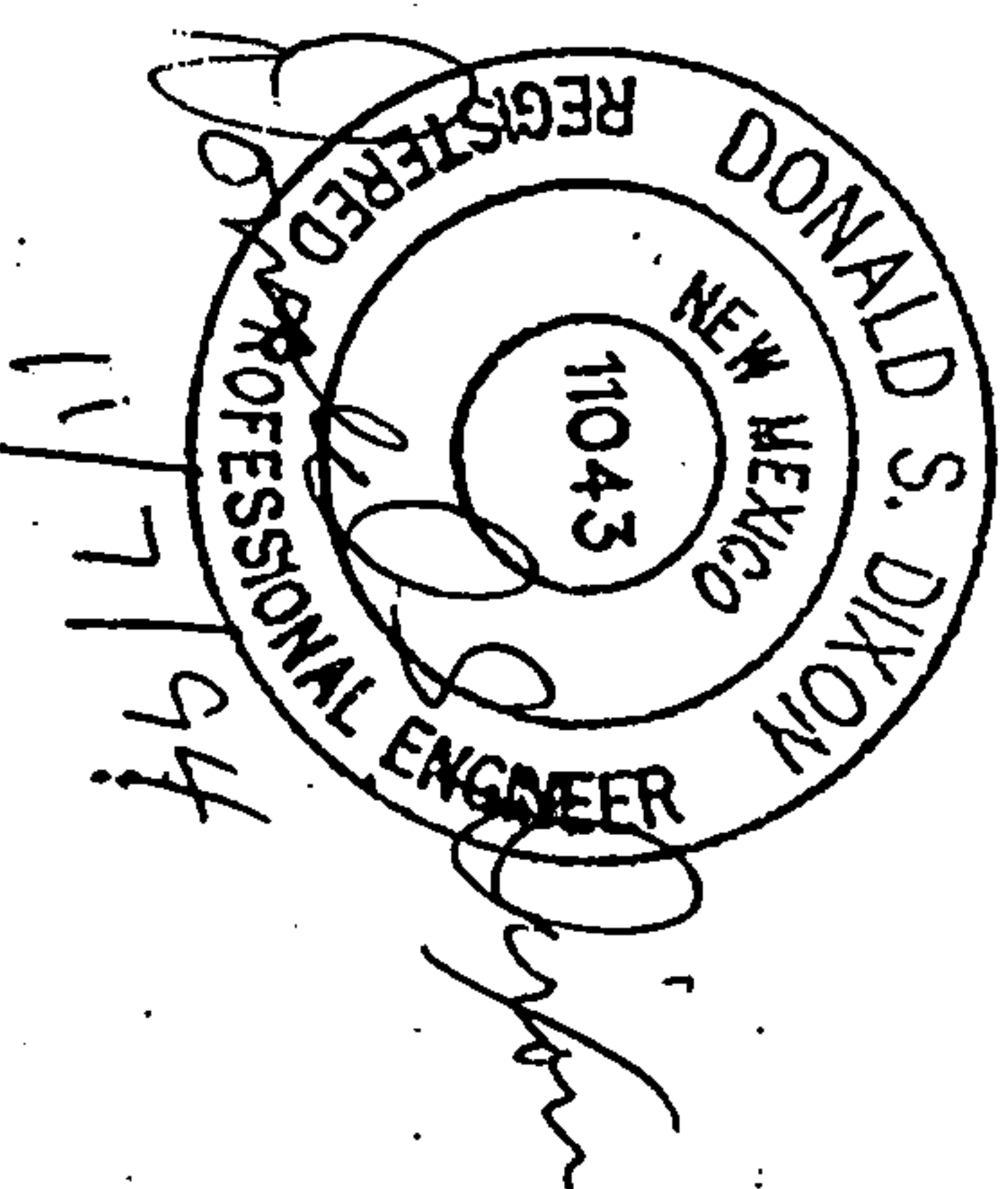
NOV - 91

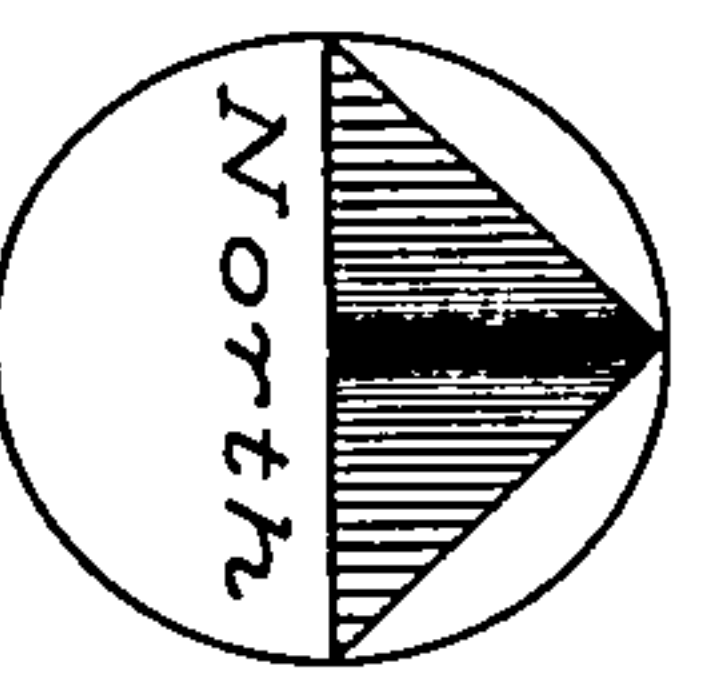
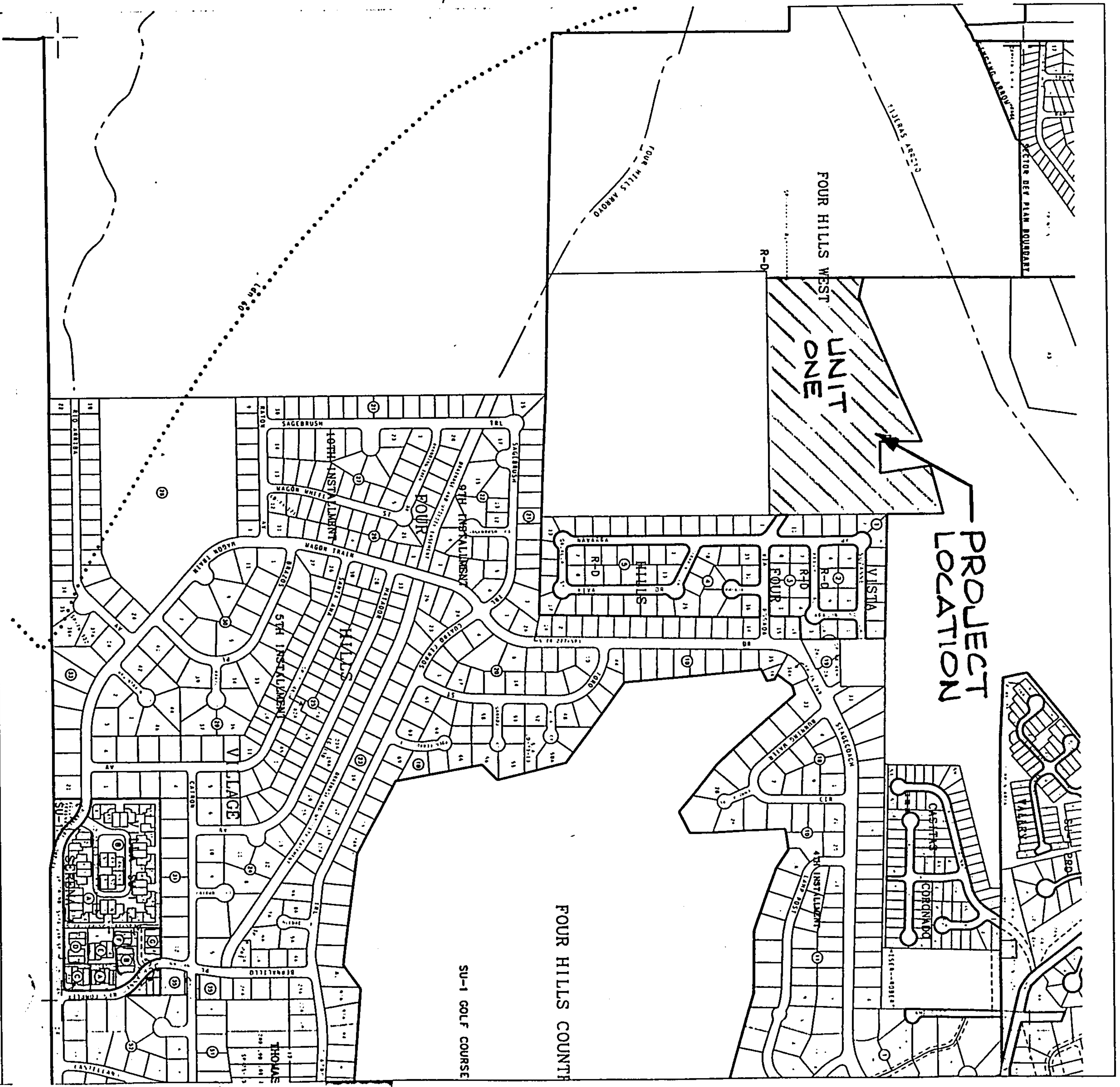
Prepared By:



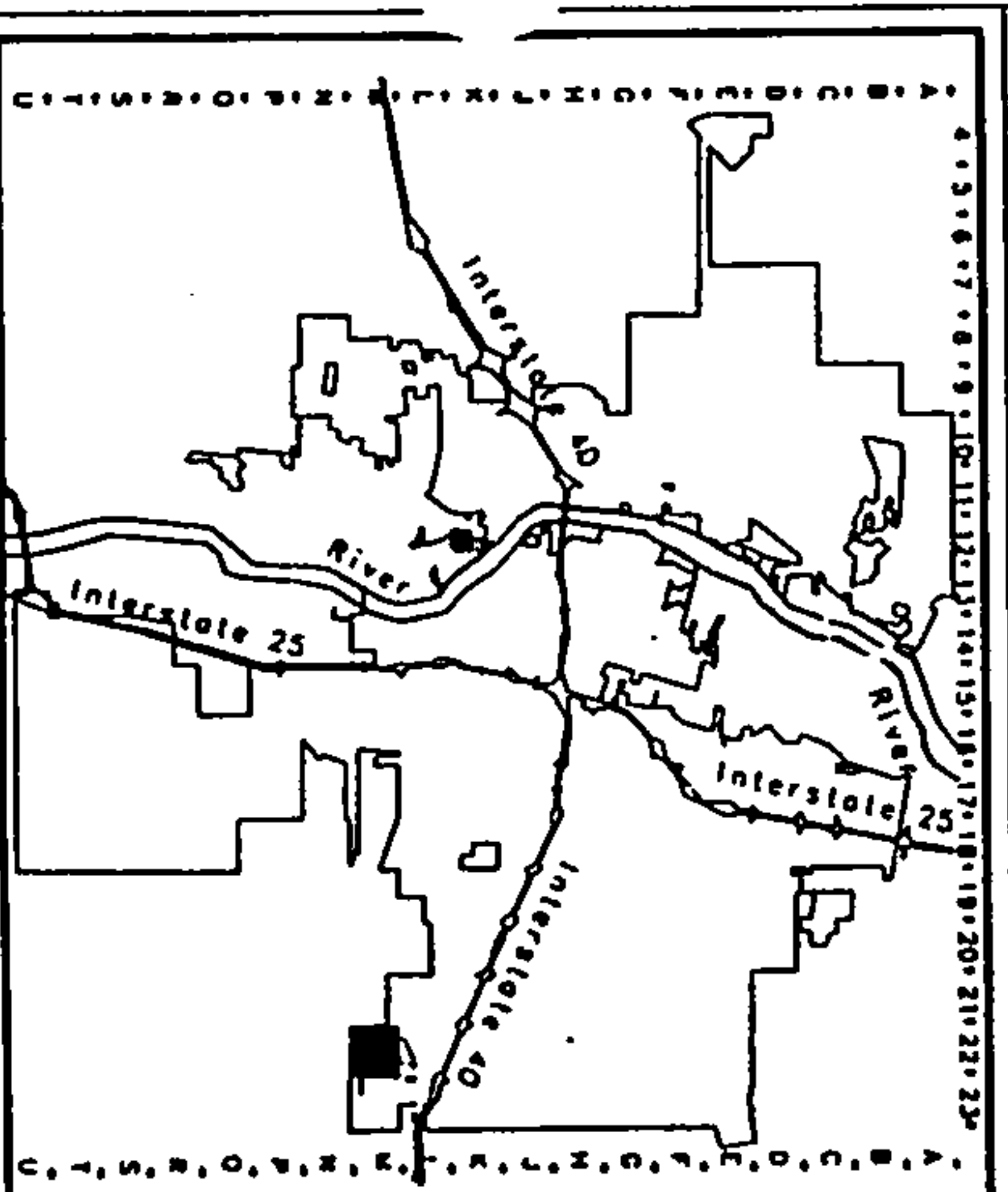
RESOURCE TECHNOLOGY, INC.
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VICINITY MAP



LEGAL DESCRIPTION

TION

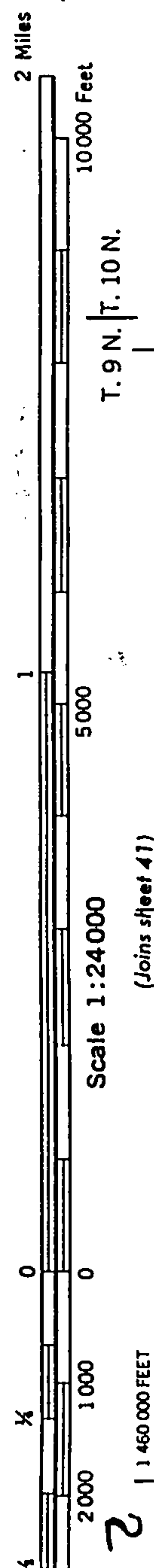
R4E

SEC 34

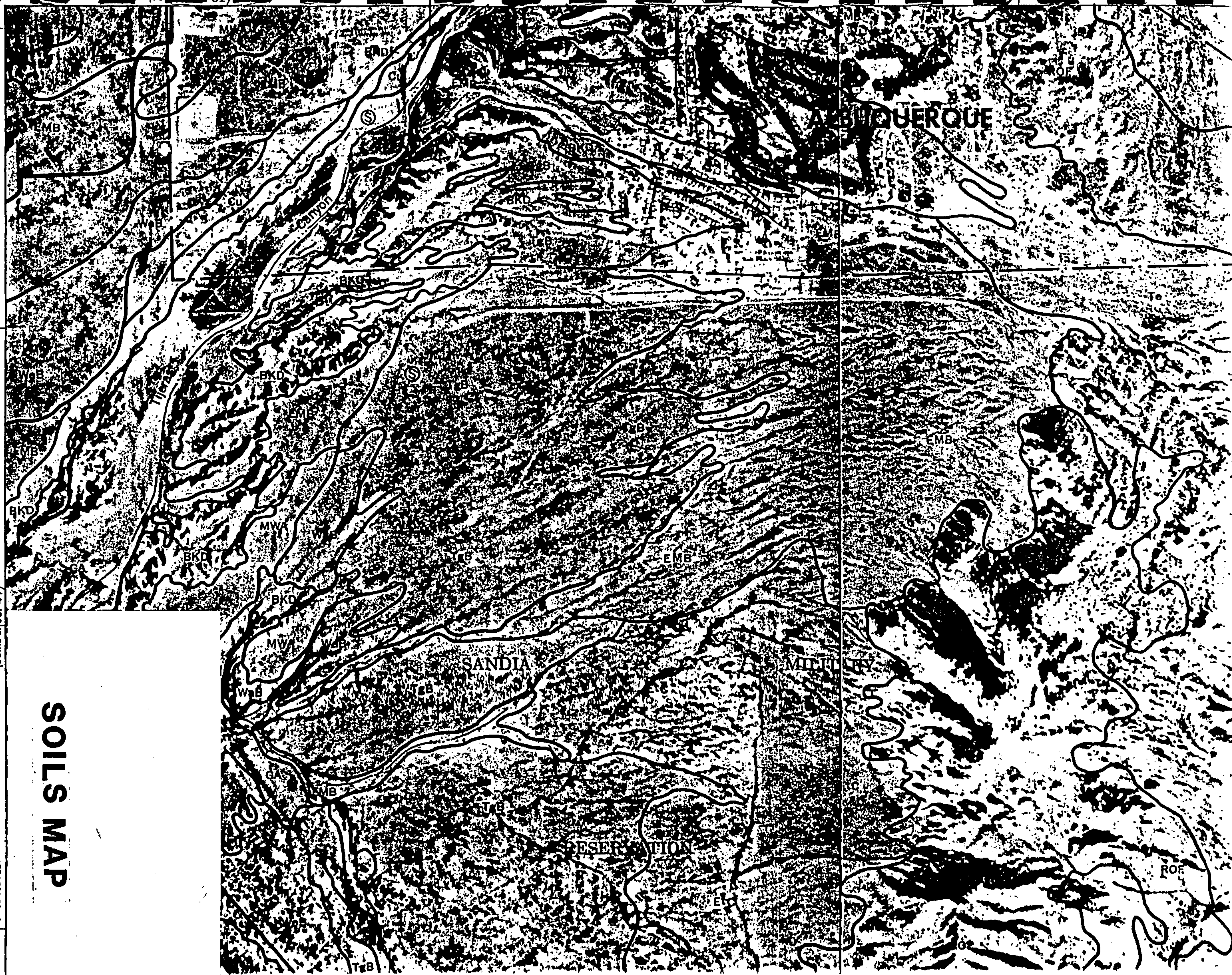
UNIFORM PROPERTY CODE

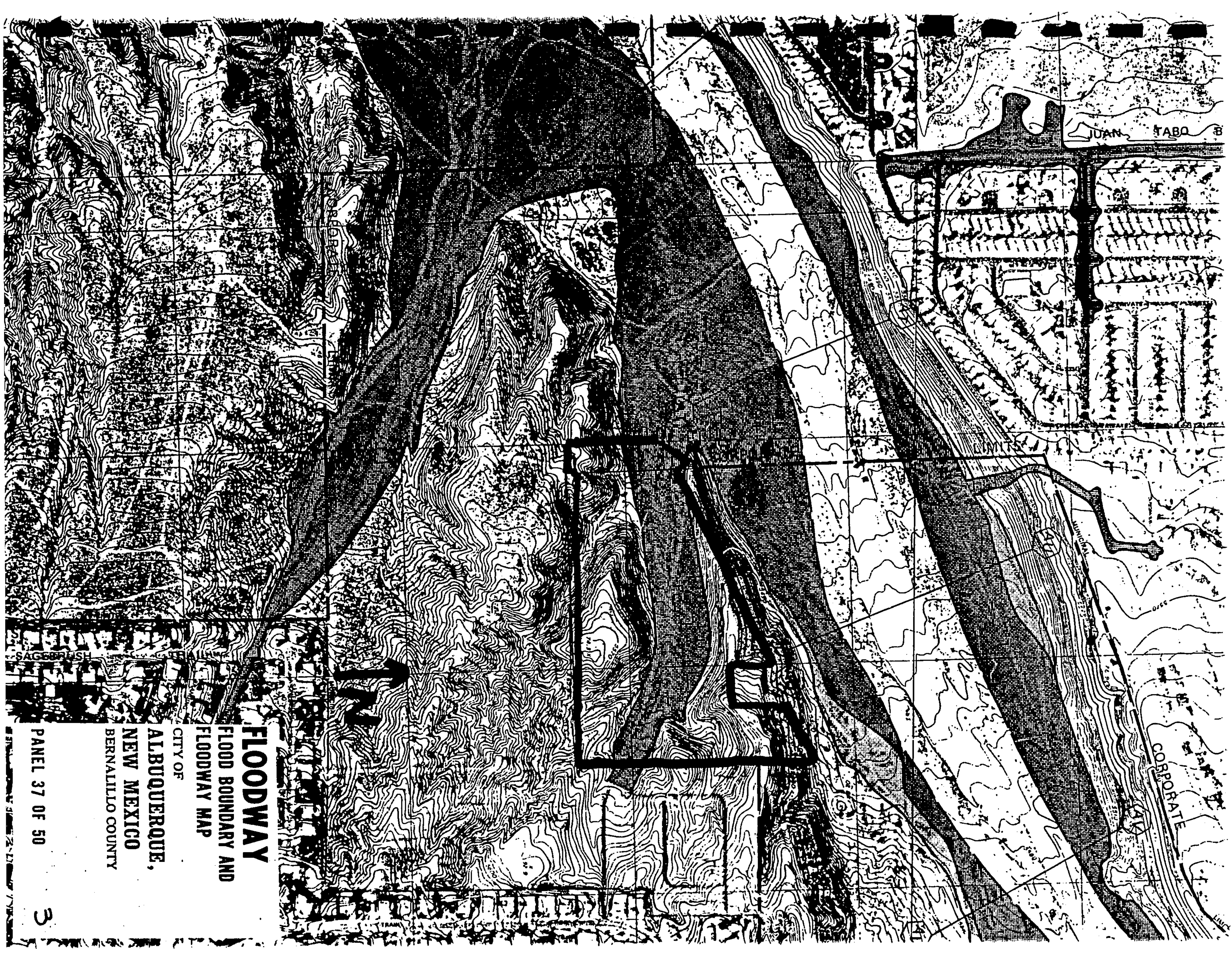
1-022-055

M-22-Z



SOILS MAP





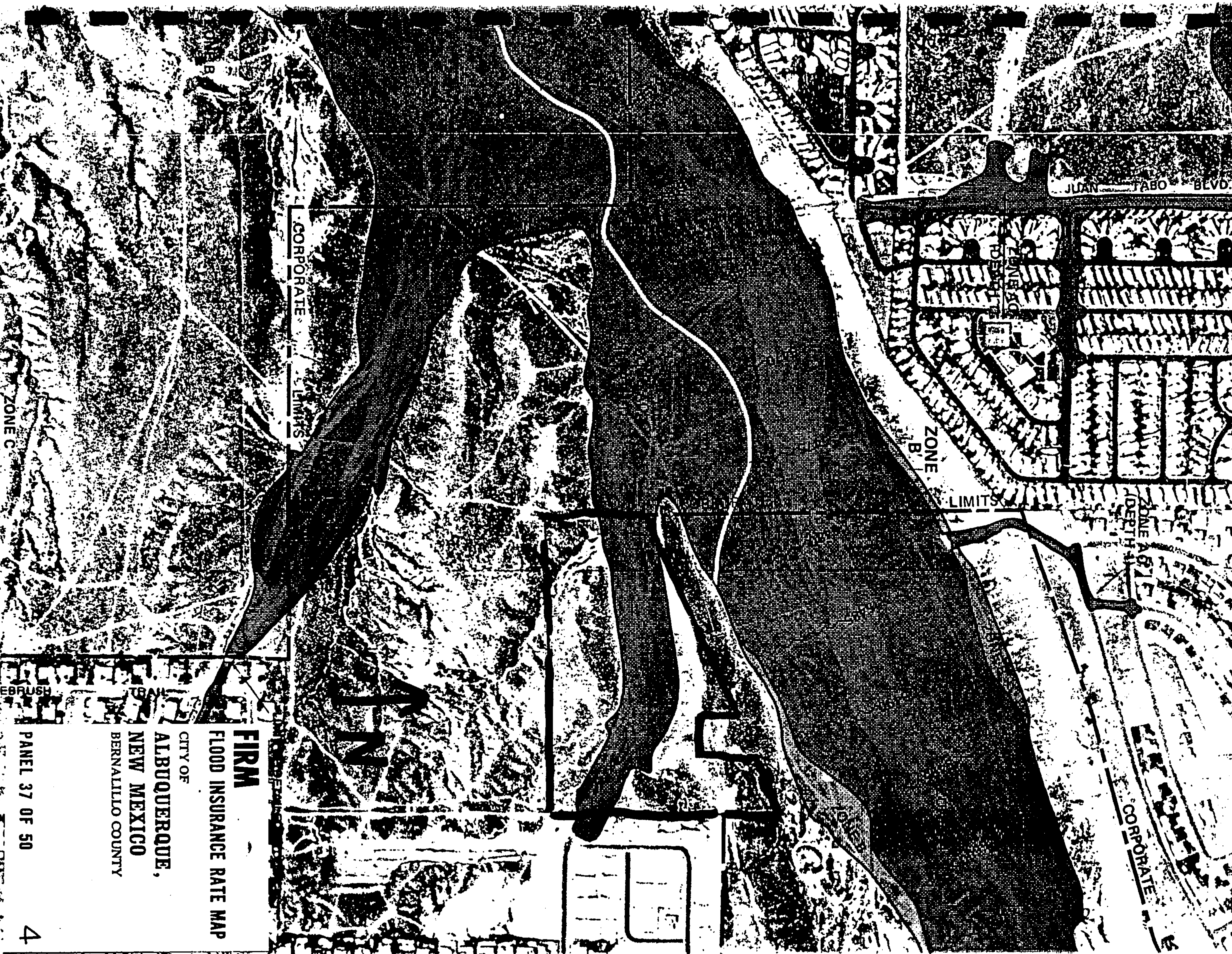
FLOODWAY

FLOOD BOUNDARY AND
FLOODWAY MAP

CITY OF

ALBUQUERQUE,
NEW MEXICO
BERNALILLO COUNTY

PANEL 37 OF 50



FIRM

FLOOD INSURANCE RATE MAP

CITY OF

ALBUQUERQUE,

NEW MEXICO

BERNALILLO COUNTY

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INTRODUCTION

The purpose of this drainage study is to address the drainage problems associated with the proposed Four Hills Village - 20th Installment Subdivision. This study and the associated recommendations incorporated into the grading and drainage plans for the subdivision are to serve as the basis for a Letter of Map Revision (LOMR) to be submitted to FEMA for modifications to existing floodplain designations in this area.

PROJECT LOCATION AND DESCRIPTION

Four Hill Village - 20th Installment consists of 21.5 acres of land located in the southeast section of the City of Albuquerque. It is bordered on the east by the Vista Four Hills subdivision, on the north and west by the Tijeras Arroyo, on the south by City owned open space (see Exhibit 1). The parcel consists of gravelly sand and decomposed granite covered by sparse amounts of native grasses and brush. The land slopes to the west at approximately 4-6%. The proposed development consists of 58 single dwelling unit lots to be developed by individual owners and/or builders.

METHODS

The hydrology used to develop the storm water flow rates is based on the January 1993 revisions to the City of Albuquerque Development Process manual, Vol. 2, Design Criteria, Section 22.2, Hydrology. Because of the substantial nature of the revisions compared to the former methodology used in previous drainage studies for adjacent areas impacting this site, all off-site flows entering the site were re-computed using the new hydrology.

Off-site flows in the Tijeras Arroyo do not enter the site and were not re-evaluated. However, the 1988 Leedshill-Herkenhoff study of the Tijeras Arroyo which used the former drainage criteria to determine the Prudent Line was evaluated (see Appendix). It was found that the Prudent Line, as shown in that study, was still valid for this reach of the arroyo.

EXISTING CONDITIONS

Via Posada Flows

Runoff from the east enters the Four Hills Village subdivision through an existing 36" storm drain and as street flows in Via Posada. These flows are combined at a concrete rundown and riprap lined energy dissipator at the end of this street before entering a natural arroyo that drains to the Tijeras Arroyo. This arroyo and its overbank areas are shown as zone AO on current floodplain maps. Table 1 compares the flow rates previously reported (Drainage Plan for Vista Four Hills, BHL, 1978) and those generated using the current hydrological standards.

Open Space Flows

Runoff from the south originates from City owned Open Space property. These flows enter the 4-Hills property in four natural swales or minor arroyos. Table 2 summarizes the calculated runoff rates and volumes.

Sediment generated by runoff from this area was of some concern as large volumes of silt could block swales and storm drain inlets. The largest of these basins, basin 940, was analyzed using procedures presented in the AMAFCA Erosion Design Guide and the 1/94 version of AHYMO. It was found that the average annual yield was only 2.7 tons (approximately 2 CY). If the remaining three open space generated sediment at the same rate, they would generate another .9 tons of sediment annually.

On-Site Flows

A ridge extending from east to west divides the northern quarter of the property from the remaining portion. This northern quarter drains by sheet flow directly to the Tijeras Arroyo. The remaining southern three-fourths drains to the natural arroyo that now starts at the western end of Via Posada and drains to the west before discharging to the Tijeras Arroyo. On-site flow rates are shown in Table 3.

TABLE 1

EXISTING (FULLY DEVELOPED) VIA POSADA FLOWS

Location / Basin	100-Year		BHI Q	10-Year	
	Q (cfs)	Vol (Ac-ft)		Q (cfs)	Vol (Ac-ft)
Via Posada Street Flow	67.3	5.71	54	3.2	.40
Via Posada Storm Drain	60.0	5.09	60	60.0	4.45
Total Off-Site at Via Posada	127.3	10.82	114	63.2	4.75

DEVELOPED CONDITIONS

The Four Hills Village - 20th Installment Grading Plan calls for the existing Via Posada storm drain to be extended through the proposed site following the existing 50-foot utility and drainage easement (see Sheet C2 and C9-C13). This storm drain will convey runoff from the east as well as site generated flows to a point west of the proposed site, thereby allowing the existing arroyo through the site to be filled and taken out of floodplain. An

impact basin energy dissipator and a short section of riprap lined channel will be constructed at the pipe outfall to reduce the 100-year velocity to approximately 5 ft/sec at normal depth. Velocity in the natural arroyo is 6 ft/sec.

The grades on Via Posada range from 3% to 5%. Since the gutter flow is super-critical inlets were spaced to keep the sequent depth within the limits allowed by the DPM. Calculations are in the appendix.

The two major drainages from the open space parcel (Basins 940 and 930) are to be intercepted by lined channels as shown on Sheet C3. These flows will then be conveyed to the proposed storm drain. The channels are wide and at a less than 1% grade so that they also serve as desilting basins. The horizontal curves meet or exceed the DPM requirements. Calculations are in the appendix. The minor drainages (Basins 920 and 950) will be incorporated into the lot drainage plan where they enter the site (at Lots 1, 2 and 20). Since flows from Basin 950 cross more than one lot before they reach the street, drainage easements have been provided. Because this is City owned open space, future development of this area is not anticipated. The minor amounts of sediment generated by these areas will not present any major problems for the proposed drainage improvements.

TABLE 2

EXISTING (UNDEVELOPED) OPEN SPACE OFF-SITE FLOWS

Basin / Location	100-Year			10-Year	
	Q (cfs)	Q (cfs)	Vol (Ac-ft)	Q (cfs)	Vol (Ac-ft)
	BHI	RTI		RTI	
950	.7	1.3	.04	.4	.01
940	14.1	26.7	.77	7.9	.22
930	3.5	6.7	.19	2.0	.06
920	.6	1.1	.03	.3	.01

There was some concern expressed about the possibility of ponding and possible damage to City owned property if the inlets to off-site interceptor channels for Basins 930 and 940 became blocked with sediment and debris. City Parks has agreed to grant storm drain maintenance construction and maintenance easements at these locations so that the inlets can be maintained. As a precautionary measure, these inlets were sized for the estimated 200-year event.

PROPOSED SITE GRADING

In addition to filling in the existing arroyo that bisects the site, the proposed grading plan calls for extensive use of split level building sites and retaining walls. The ridge on the south property line will be graded down at a 3:1 slope. A 2' flood wall and concrete lined swale will be constructed 5' from the property line to intercept off-site sheet flow and direct it to the nearest off-site interceptor channel. The northern ridge and the high ground on the east property line will be graded down at 3:1 slopes and the sheet flow incorporated into individual lot drainage plans. A fill area at the southwest end of the site will require a retaining wall behind Lots 4, 5 and 6. Additional retaining walls will be required between some individual lots due to the steep grade from east to west and between split level lots and flat pad lots. Wherever runoff is trapped behind these retaining walls it will be drained in lined swales and drainage easement to a point of safe discharge in Via Posada.

Sheet C3 shows the overview of the grading plan. Individual lot drainage plans are shown on sheets C-4 through C-8.

FLOODPLAIN MAPPING

The floodplain effecting this site is shown on Panel 37 of the FEMA floodway and insurance rate maps. Four Hills Village - 20th Installment is in Zone AO, depth 1.0 foot. The Tijeras Arroyo floodway is immediately downstream from the proposed subdivision, with cross-section AT's southern end only 200 feet from the west boundary of the subdivision. The 100-year water surface elevation for this cross-section was obtained from the 1983 FEMA Flood Insurance Study. This is reported to be 5472.4-feet. This is some 18-feet lower than the outlet for the proposed storm drain pipe, therefore, it was concluded that water surface elevations in the Tijeras Arroyo have no impact on this site.

Another concern is the potential of lateral migration of the Tijeras Arroyo. The subdivision site is separated on the north from the Tijeras Arroyo by a ridge rising 50 to 75 feet above the arrow flow line. Since the 100-year flow rate for the Tijeras Arroyo is reported as 14,300 cfs (FIS, 1983) with a velocity of 10.2 ft/sec, the potential exists for extensive lateral migration over time. However, the floodplain in this reach of the arroyo is over 1,000-feet wide and it appears that arroyo has confined its meander to this area in recent times. The Prudent Line, as identified by the 1988 Leedshill-Herkenhoff "Tijeras Arroyo Drainage Management Plan" abuts the north property line of this project. The closest building pad (for Lot 56) is some 80 feet from this point.

TABLE 3

ON-SITE FLOWS

Location / Basin	DEVELOPED		EXISTING			
	100-Year		10-Year		100-Year	
	Q (cfs)	Vol (Ac-ft)	Q (cfs)	Vol (Ac-ft)	Q (cfs)	Vol (Ac-ft)
400	12.9	.44	7.6	.23		
401	8.4	.29	5.0	.16		
402	7.4	.27	4.5	.15		
403	5.9	.21	3.6	.12		
404	4.9	.17	3.0	.10		
405	12.3	.44	7.5	.25		
406	3.6	.13	2.2	.07		
407	3.8	.13	2.2	.07		
TOTAL Site Runoff	59.2	2.08	35.6	1.15	34.2	1.02
					12.2	0.33

APPENDIX

CITY OF ALBUQUERQUE
PUBLIC WORKS DEPARTMENT
UTILITY DEVELOPMENT DIVISION/HYDROLOGY SECTION

PRE-DESIGN CONFERENCE

DRAINAGE FILE/ZONE ATLAS PAGE NO.: 11-22 DATE: 02-23-94

EPC NO.: _____ DRB NO.: _____ ZONE: _____

SUBJECT: Four Hills West, Unit One

STREET ADDRESS: Via Posada

LEGAL DESCRIPTION: Four Hills West, Unit One

APPROVAL REQUESTED: ☒ PRELIMINARY PLAT ☐ FINAL PLAT

☐ SITE DEVELOPMENT PLAN ☐ BUILDING PERMIT

☒ GRADING/PAVING PERMIT ☐ OTHER

ATTENDANCE: Don Dixon WHO REPRESENTING Resource Technology

GILBERT ADAMS CITY OF ALBUQ.

FINDINGS:

1. A SUBDIVISION PROPOSED, A DESIGNATED FOODPLAIN
RUNS THROUGH MIDDLE OF SITE

2. A LOMR required for FINAL RAT OF THE
REFERENCED SUBDIVISION. THE DEVELOPER MAY NOTE
"LOMR required prior to FINANCIAL GUARANTEE
RELEASE" ON THE INFRASTRUCTURE LIST. IF THE
WOULD LIKE TO PROCEED TO CONSTRUCTION PRIOR
TO SECURING THE CLONE FROM FEMA

3. IF THE DEVELOPER DOES NOT WANT TO GUARANTEE
THAT A CLONE SHOULD BE RECEIVED PRIOR TO PRELIMINARY
RAT AND BOND FOR LOMR ONLY

4. A DRAINAGE REPORT MEETING FEMA CRITERIA
REQUIRED FOR PRELIMINARY RAT.

The undersigned agrees that the above findings are summarized accurately and are only subject to change if further investigation reveals that they are not reasonable or that they are based on inaccurate information.

SIGNED: [Signature] SIGNED: [Signature]

TITLE: Project Eng. TITLE: ATT P.M.

DATE: 02-23-94 DATE: 2/23/94

NOTE PLEASE PROVIDE A COPY OF THIS PRE-DESIGN FORM WITH THE DRAINAGE SUBMITTAL.

TABLE A-1

DRAINAGE BASIN CHARACTERISTICS

BASIN ID	AREA (sq mi)	TP (hrs)	LAND TREATMENT			
			A (%)	B (%)	C (%)	D (%)
950 (E)	.0011	.133	100	0	0	0
940 (E)	.0220	.133	100	0	0	0
930 (E)	.0055	.133	100	0	0	0
920 (E)	.0009	.133	100	0	0	0
910 (E)*	.0397	.20	0	29	29	42
900 (E)*	.1502	.50	0	100	0	0
400 (F)	.0054	.133	0	20	50	30
401 (F)	.0034	.133	0	29	29	42
402 (F)	.0029	.133	0	24	26	50
403 (F)	.0023	.133	0	24	26	50
404 (F)	.0019	.133	0	24	26	50
405 (F)	.0048	.133	0	21	30	49
406 (F)	.0014	.133	0	21	30	49
407 (F)	.0016	.133	10	20	30	40

(E) Existing Conditions

(F) Future, Fully Developed Conditions

* Existing Conditions are Fully Developed

BASIN 900

Lot to be left vacant until
access to Juan Tabo is available

Emergency Exit

Well
Site

Wagon Train Drive

12'x2' CATTLE GUARD INLET

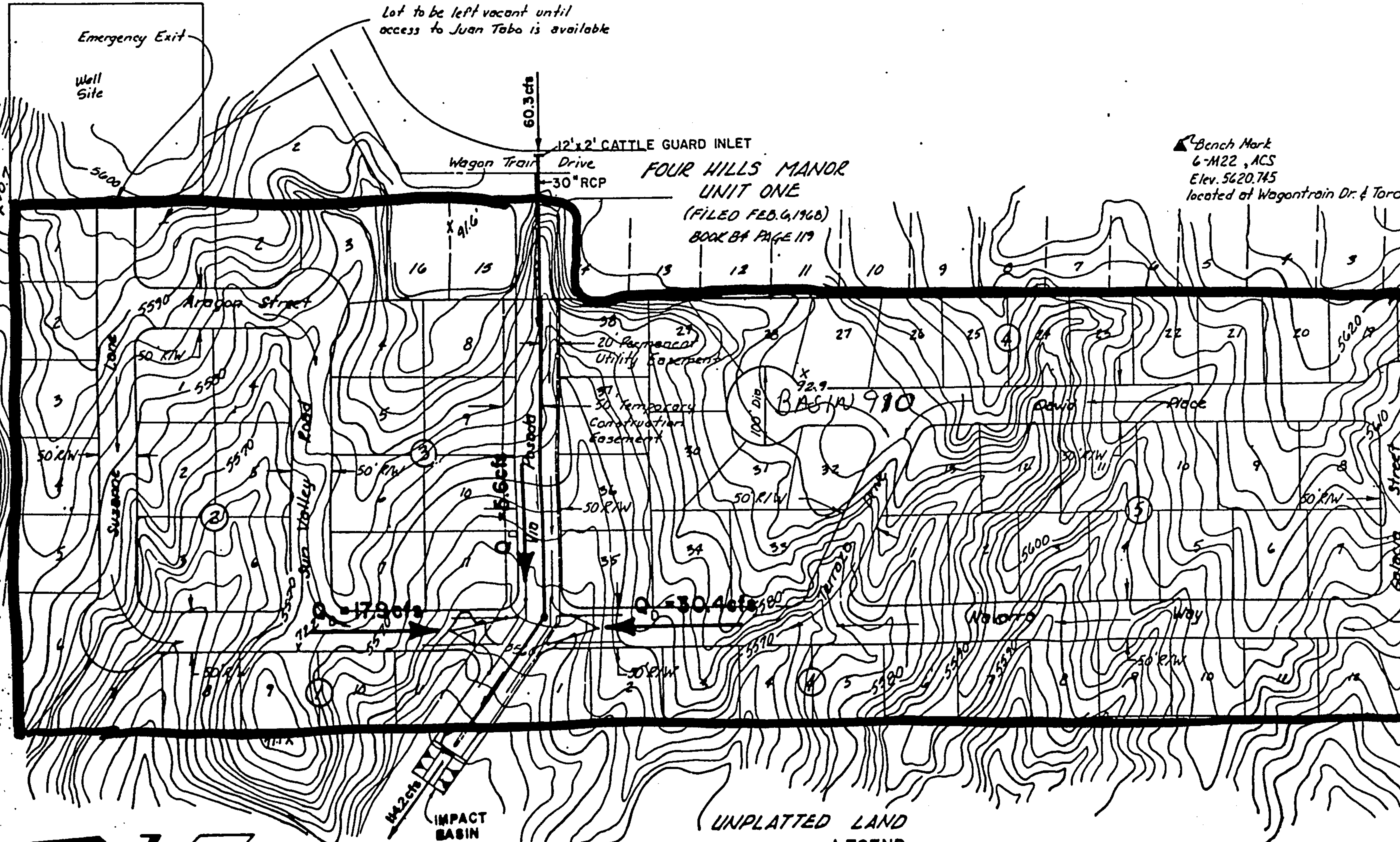
30" RCP

FOUR HILLS MANOR
UNIT ONE

(FILED FEB. 4, 1968)

BOOK 84 PAGE 119

Bench Mark
6-M22, ACS
Elev. 5620.745
located at Wagontrain Dr. & Toro S



UNPLATTED LAND LEGEND

- $Q_p = 30.4 cfs$
DEVELOPED FLOW RATE
AND DIRECTION
MANHOLE
- PIPE FLOW DIRECTION
- STREET FLOW DIRECTION

IMPACT
BASIN

RESOURCE TECHNOLOGY, INC.

ENGINEERS & ENVIRONMENTAL SCIENTISTS

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Phone: (505) 345-3115

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PROJECT NO. _____

SHEET _____ OF _____

CHECKED _____ DATE _____
APPROVED _____ DATE _____

TITLE Hydrology BY AKJ DATE 5/11/15

$$L = 4150 \text{ ft}$$

Basin 900

$$S = .047 \text{ ' / '}$$

$$K = .7$$

$$L_{ca} = 2000$$

$$K_n = .025$$

eqn 6-6

$$T_c = (12000 - L) / (72000 \times K \times S^{.5}) +$$

$$\left((L - 4000) \times K_n \times \left(\frac{L_{ca}}{L} \right)^{.33} \right) / (552.2 \times S^{.165})$$

$$T_c = \frac{7850}{10926} + \frac{2.95}{333.4}$$

$$.718 + .088 = .806 \text{ hr}$$

$$T_p = .67 T_c = .54 \text{ hr}$$

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SHEET _____ OF _____

CHECKED _____ DATE _____
APPROVED _____ DATE _____

TITLE Hydrology BY _____ DATE 5/23

Zone 3, UNDEVELOPED RUN OFF

16.89 Acres Basin 400' TOTAL

90% A 10% C

$$[.9(1.87) + .1(3.45)] \quad 16.89 = 34.2 \quad (100\text{yr})$$

$$[.9(.58) + .1(2)] \quad 16.89 = 12.2 \quad (10\text{yr})$$

No 1

$$[.9(.66) + .1(1.29)] \quad \frac{16.89}{12} = 1.02 \quad 100\text{yr}$$

$$[.9(.19) + .1(.62)] \quad \frac{16.89}{12} = .33 \quad 10\text{yr}$$

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ADD HYD	910.10	14 2	13	.18990	127.31 ✓	10.817	1.06808	1.716	1.047	
COMPUTE NM HYD	920.00	-	1	.00090	1.10	.031	.65617	1.518	1.911 PER IMP=	.00
ADD HYD	910.20	134 1	1	.19080	127.78 ✓	10.849	1.06613	1.716	1.046	
COMPUTE NM HYD	930.00	-	2	.00550	6.68 ✓	.192	.65617	1.518	1.899 PER IMP=	.00
COMPUTE NM HYD	940.00	-	3	.02200	26.71	.770	.65617	1.518	1.897 PER IMP=	.00
COMPUTE NM HYD	950.00	-	4	.00110	1.34	.038	.65617	1.518	1.908 PER IMP=	.00
COMPUTE NM HYD	400.00	-	5	.00540	12.92 ✓	.440	1.52706	1.518	3.738 PER IMP=	30.00
ADD HYD 2400	910.30	54 1	1	.19620	134.18 ✓	11.289	1.07882	1.650	1.069	
COMPUTE NM HYD	401.00	-	6	.00340	8.37	.294	1.62125	1.518	3.847 PER IMP=	42.00
ADD HYD 18400	910.40	14 6	1	.19960	138.97 ✓	11.583	1.08806	1.650	1.088	
COMPUTE NM HYD	402.00	-	7	.00290	7.45	.267	1.72614	1.518	4.012 PER IMP=	50.00
COMPUTE NM HYD	403.00	-	8	.00230	5.91	.212	1.72614	1.518	4.015 PER IMP=	50.00
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COMPUTE NM HYD	405.00	-	10	.00480	12.34	.442	1.72672	1.518	4.018 PER IMP=	49.00
ADD HYD	910.50	1410	1	.20440	146.79	12.025	1.10305	1.617	1.122	
ADD HYD	910.60	14 2	1	.20990	151.79	12.217	1.09134	1.617	1.130	
ADD HYD	910.70	14 7	1	.21280	157.00	12.484	1.09999	1.584	1.153	
ADD HYD	910.80	14 8	1	.21510	161.61	12.636	1.10669	1.584	1.174	
COMPUTE NM HYD	406.00	-	11	.00140	3.61	.129	1.72672	1.518	4.033 PER IMP=	49.00
ADD HYD	910.90	1411	1	.21650	164.42	12.825	1.11069	1.584	1.187	
ADD HYD	910.91	14 3	1	.23850	187.51	13.595	1.06877	1.584	1.228	
ADD HYD	910.92	14 9	1	.24040	191.84	13.770	1.07396	1.551	1.247	
ADD HYD	910.99	14 4	1	.24150	193.13	13.808	1.07206	1.551	1.250	
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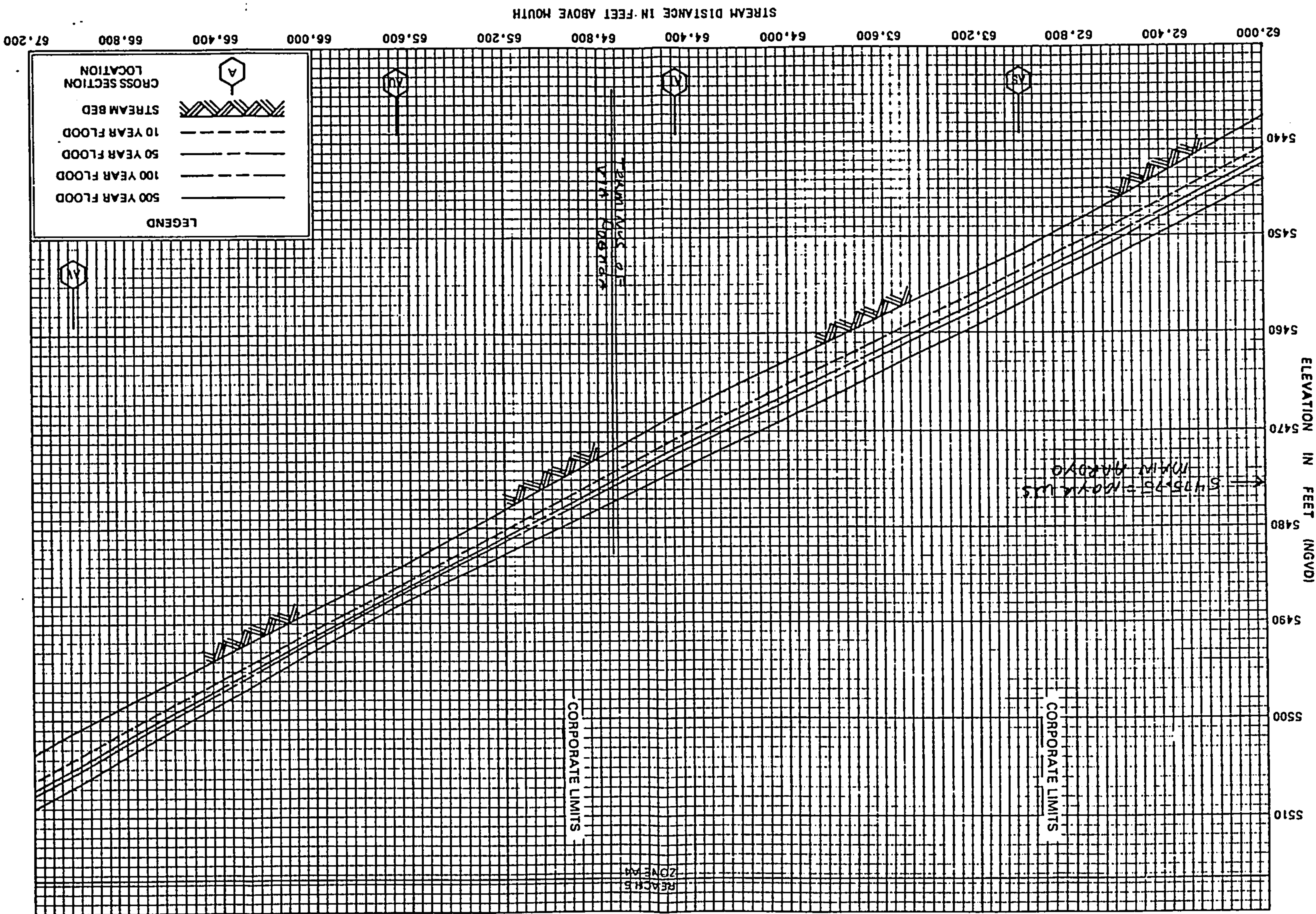
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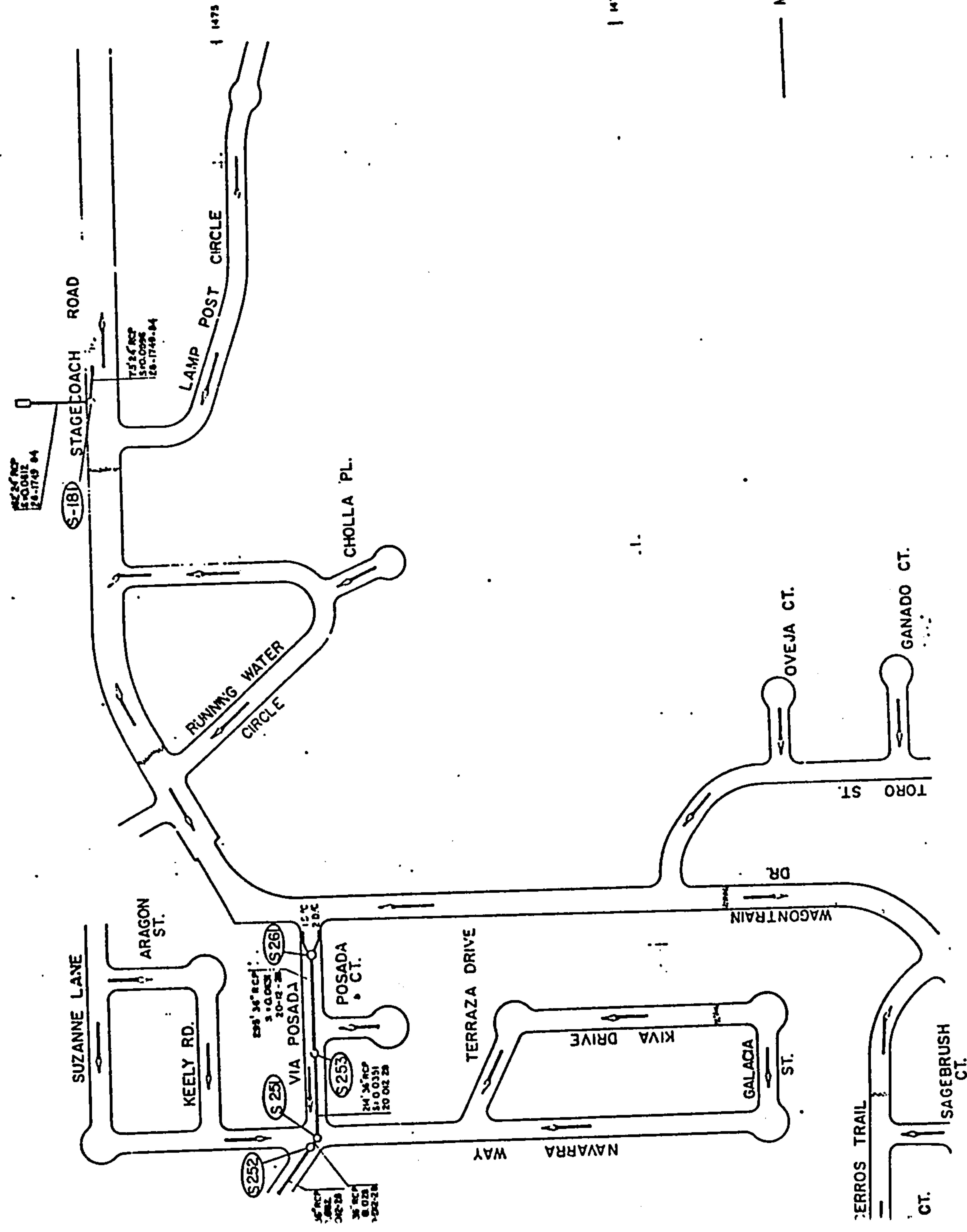
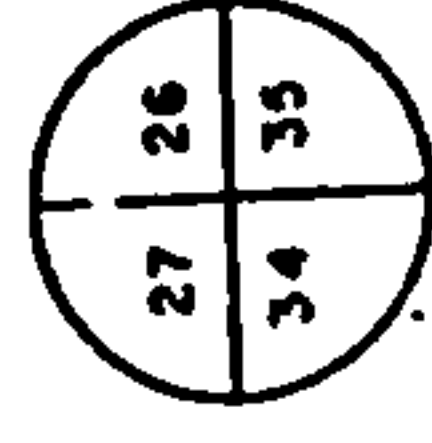
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RAINFALL TYPE=1

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[illegible]





DRAINAGE FACILITIES		MAP GRID	
		REVISIONS	
	DATE	REMARKS	
	10-2-84	SD 1614.4 / 170.4 - 11.5E 1" x 9"	

LEGEND		NOTES	
	STORM SEWER LINE	1. MANHOLE IDENTIFICATION REQUIRES BOTH THE MAP GRID & MANHOLE NO.	
	MANHOLE		

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PROJECT NO. _____

SHEET _____ OF _____

DATE 10/20/91

CHECKED _____ DATE _____

APPROVED _____ DATE _____

TITLE _____

#1 84+73 START V1+12 PCHCADA

Q = 67 cfs S = 3.9%

d = 1.55'

2-Type A + 2-Type C (double) Total Cap = 40 cfs

67-40 = 27 cfs in street
60+40 = 100 cfs in pipe

27 cfs 1/2 street = 13.5 cfs d =
S = 6.9%

d = 1.37 V = 6 1/3 F = $\frac{6}{\sqrt{32 \times 0.37}} = 1.73$

D₂ = 1.9 d₁ = 2.70' < 2.87' ok

?

#2 21+00 Basin 407

(27 cfs) in street + (7 cfs) off site + Basin 400 (13) + 12

Q_{TOTAL} = 47 cfs S = 3.9%

d = 1.48 V = 5.2 1/3 F = 1.32 D₂ = 2.18' < 2.87' ok

2 Type A + 2 Type double C C = 10 cfs at
A = 8 cfs at

47 cfs - 36 cfs = 11 cfs in street

100+36 cfs in pipe

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#4, 17+75

$$11 \text{ inst street} + 401 (8.4) + \frac{1}{2} 406 (8.75) + 405 (9.5) = 38 \text{ cfs in street}$$

$$S = 3\%$$

$$d = .45 \quad V = 5 \frac{1}{3} \quad F = 1.3 \quad D_2 = .59' < .87' \quad \checkmark$$

2 Type C double 10 cfs ea

$$18 \text{ cfs street} \quad 136 + 20 = 156 \text{ cfs storm drain}$$

#5 14+00

$$18 \text{ in street} + 402 (7.5) + 403 (6.7) = 31.4 \text{ cfs}$$

$$d = .43 \quad V = 4.8 \quad F = 1.3 \quad D_2 = .56' < .87' \quad \checkmark$$

2 Type double C 10 cfs ea

$$12 \text{ cfs street} \quad 156 + 20 = 176 \text{ cfs pipe}$$

#6 27 cfs from side channel to pipe

$$176 \text{ cfs} + 27 = 203 \text{ cfs in pipe at } \underline{12+00}$$

#7

$$16+00 \quad 12 \text{ cfs in street} + \frac{1}{2} 406 (8.75) + 404 (4.9) = 26 \text{ cfs}$$

✓

E. STREET HYDRAULICS

1. A secondary use of the street network is the conveyance of storm runoff. This secondary use must always be subsidiary to the primary function of streets which is the safe conveyance of people and vehicles. The goals of street hydraulic design are therefore:
 - a. To provide an economical means of transporting storm runoff.
 - b. To ensure that the safety and convenience of the public are preserved.
 - c. To prevent storm runoff, once collected by the street system, from leaving the street right-of-way except at specially designated locations.
2. Street hydraulic design criteria are as follows:
 - a. Manning's roughness coefficient is 0.017.
 - b. Flow depths in the event of the 100-year design discharge may not exceed 0.2 feet above curb height or 0.87 feet at any location.
 - c. Flow depths in the event of the 10-year design discharge may not exceed 0.5 feet in any collector or arterial street. One lane free of flowing or standing water in each traffic direction must be preserved on arterial streets.
 - d. The product of depth times velocity shall not exceed 6.5 in any location in any street in the event of a 10-year design storm (with velocity calculated as the average velocity measured in feet per second and depth measured at the gutter flowline in feet.)
3. For streets with more than two driving lanes in each direction:
 - a. The product of depth times velocity may not exceed 6.5 at any location in any street in the event of a 10-year design storm (with velocity calculated as the average velocity measured in feet per second and depth measured at the gutter flowline in feet).
 - b. Inverted crown streets are prohibited.
 - c. The assumption of equal flow distribution between gutters on undivided streets and between street sections on divided streets is only valid where its validity can be demonstrated.

4. Plates 22.3 D-1 through 22.3 D-4 may be used where applicable in the hydraulic design of streets. T-intersections, radical slope changes and intersections are potential locations for hydraulic jumps when upstream slopes are steeper than critical slope.

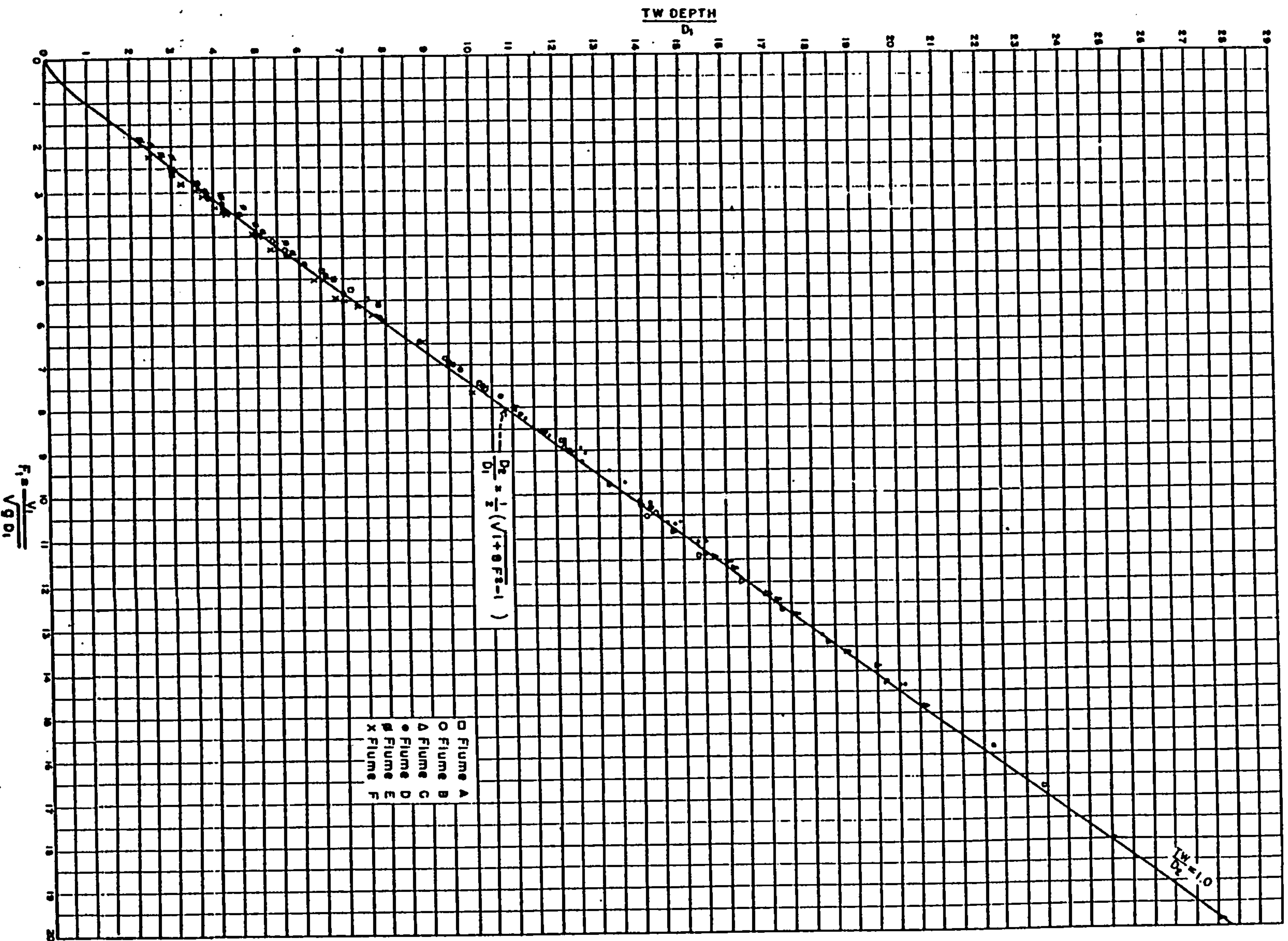
When conditions indicate that a hydraulic jump or that the effects of superelevation will allow runoff to exceed street hydraulic design criteria, provisions must be made to for treatment of the problem. The warping of street sections and the construction of deflector walls for these purposes is prohibited unless specifically authorized by the City Engineer.

5. Intersections and other radical changes in street cross section and slope require special consideration whenever the flow depth/street slope relationship results in flows occurring in the supercritical flow regime. The critical slope line shown on the street rating curves is used to determine on which side of critical depth the flow occurs and if slope or cross section changes will allow the flow to cross through critical depth from supercritical.

If a flow is likely to cross into the subcritical flow range, then Plate 22.3 E-1, "Tail Water vs. Froude Number" is used to determine the height and Plate 22.3 E-2, "Length of Jump vs. Froude Number" figure is used to determine jump length. The height of jump should not exceed 0.87 feet and the jump should be contained within the street right-of-way.

TAIL WATER DEPTH VS. D₁

HYDRAULIC DESIGN OF STILLING BASINS AND ENERGY DISSIPATORS

FIGURE 5.—Ratio of tail water depth to D_1 (Basin I).

LENGTH OF JUMP IN TERMS OF D₁

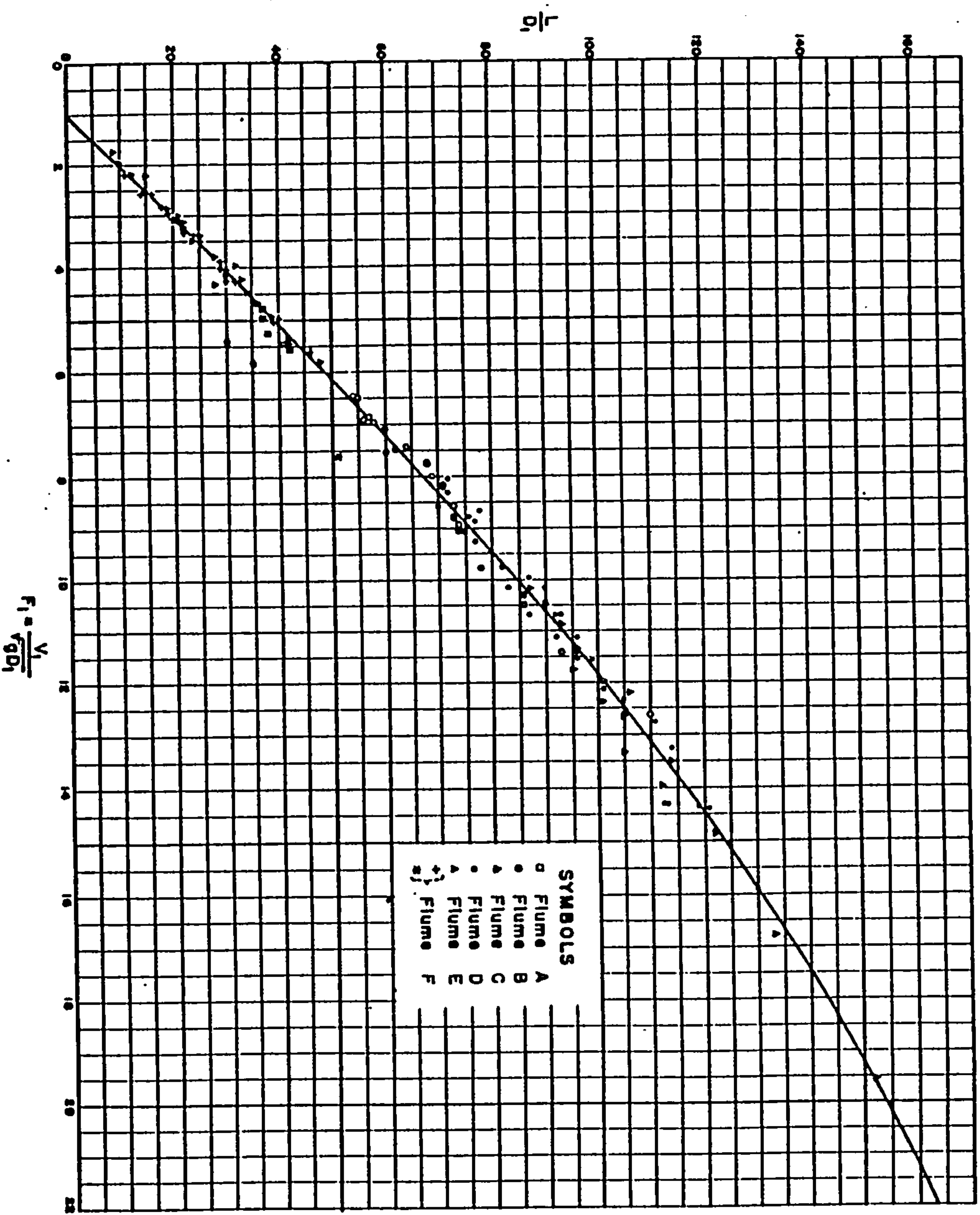


FIGURE 6.—Length of jump in terms of D_1 (Basin I).

4-82

RUN NO.	PIPE FLOW CFS	SLOPE '/	N	DIAMETER (FT)	PIPE CAPACITY CFS	D/D	VELOCITY '/S
1	136.00	.031	.013	3.50	177.25	0.66	20.32

RUN NO.	PIPE FLOW CFS	SLOPE '/	N	DIAMETER (FT)	PIPE CAPACITY CFS	D/D	VELOCITY '/S
1	156.00	.039	.013	3.50	199.13	0.67	22.93

RUN NO.	PIPE FLOW CFS	SLOPE '/	N	DIAMETER (FT)	PIPE CAPACITY CFS	D/D	VELOCITY '/S
1	176.00	.046	.013	3.50	216.27	0.68	25.06

STORM DRAIN

36"

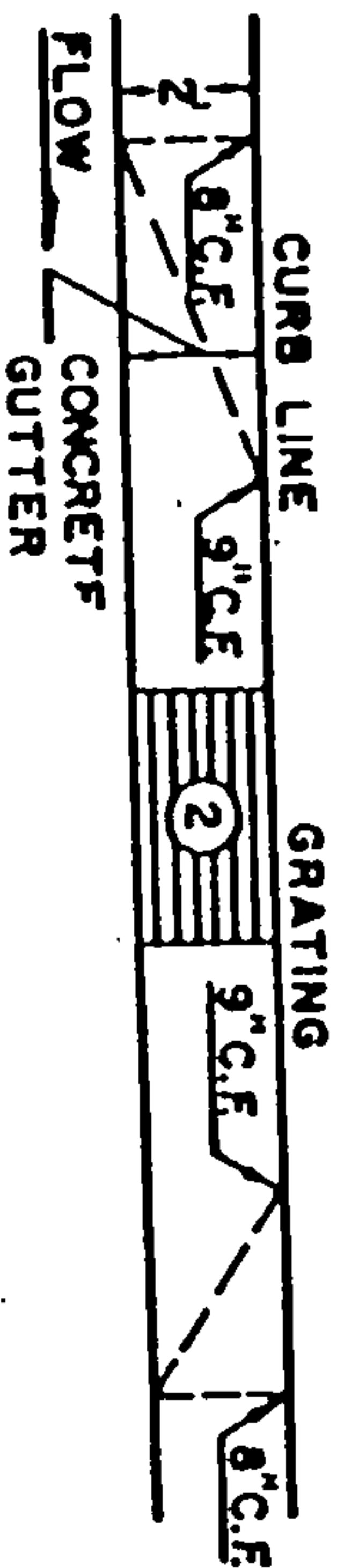
RUN NO.	PIPE FLOW CFS	SLOPE '/,	N	DIAMETER (FT)	PIPE CAPACITY CFS	D/D	VELOCITY '/S
1	60.00	.030	.013	3.00	115.73	0.51	16.55
2	80.00	.054	.013	3.00	155.26	0.51	22.07
3	100.00	.030	.013	3.00	115.73	0.72	18.47

570A W DRAIN

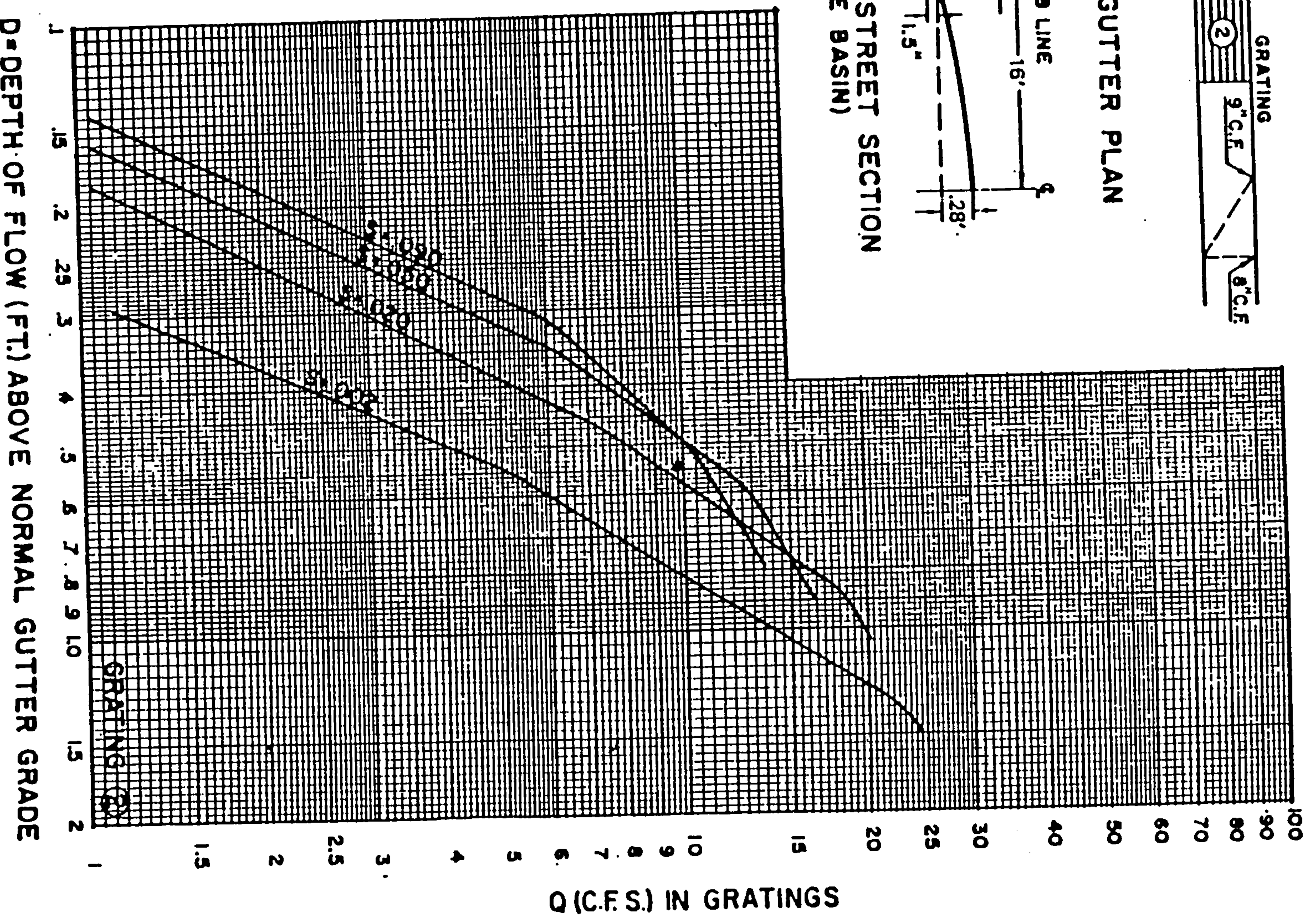
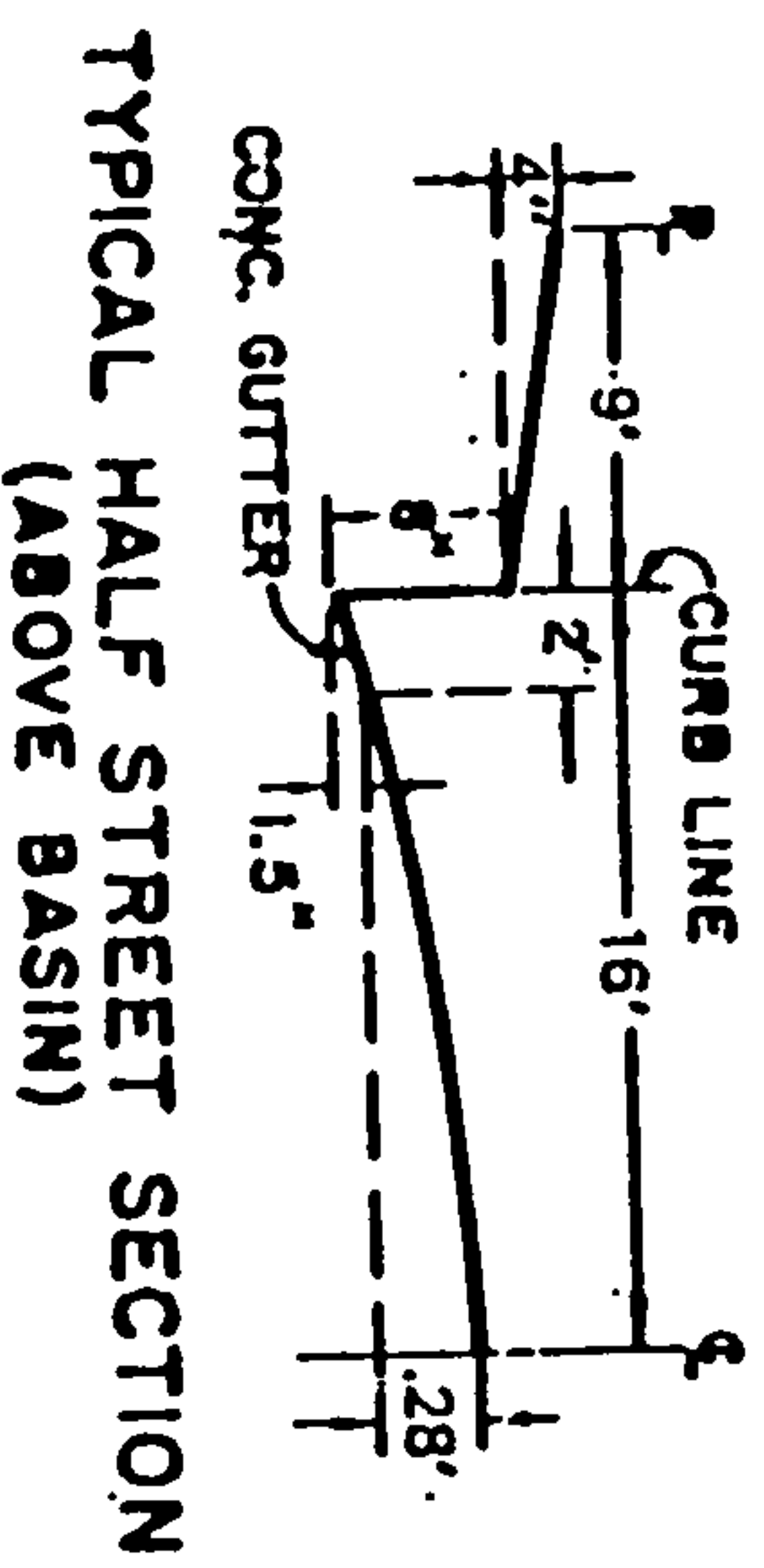
42"

RUN NO.	PIPE FLOW CFS	SLOPE '/,	N	DIAMETER (FT)	PIPE CAPACITY CFS	D/D	VELOCITY '/S
1	123.00	.038	.013	3.50	196.57	0.57	21.61
RUN NO.	PIPE FLOW CFS	SLOPE '/,	N	DIAMETER (FT)	PIPE CAPACITY CFS	D/D	VELOCITY '/S
2	139.00	.038	.013	3.50	196.57	0.62	22.19
RUN NO.	PIPE FLOW CFS	SLOPE '/,	N	DIAMETER (FT)	PIPE CAPACITY CFS	D/D	VELOCITY '/S
3	166.00	.036	.013	3.50	191.32	0.72	22.43

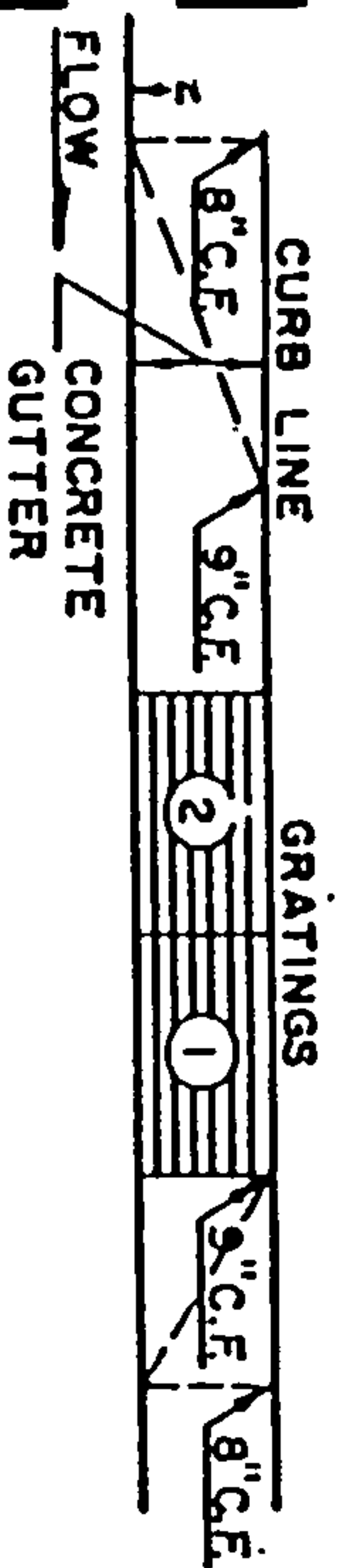
GRATING CAPACITIES FOR TYPE "A", "C" and "D"



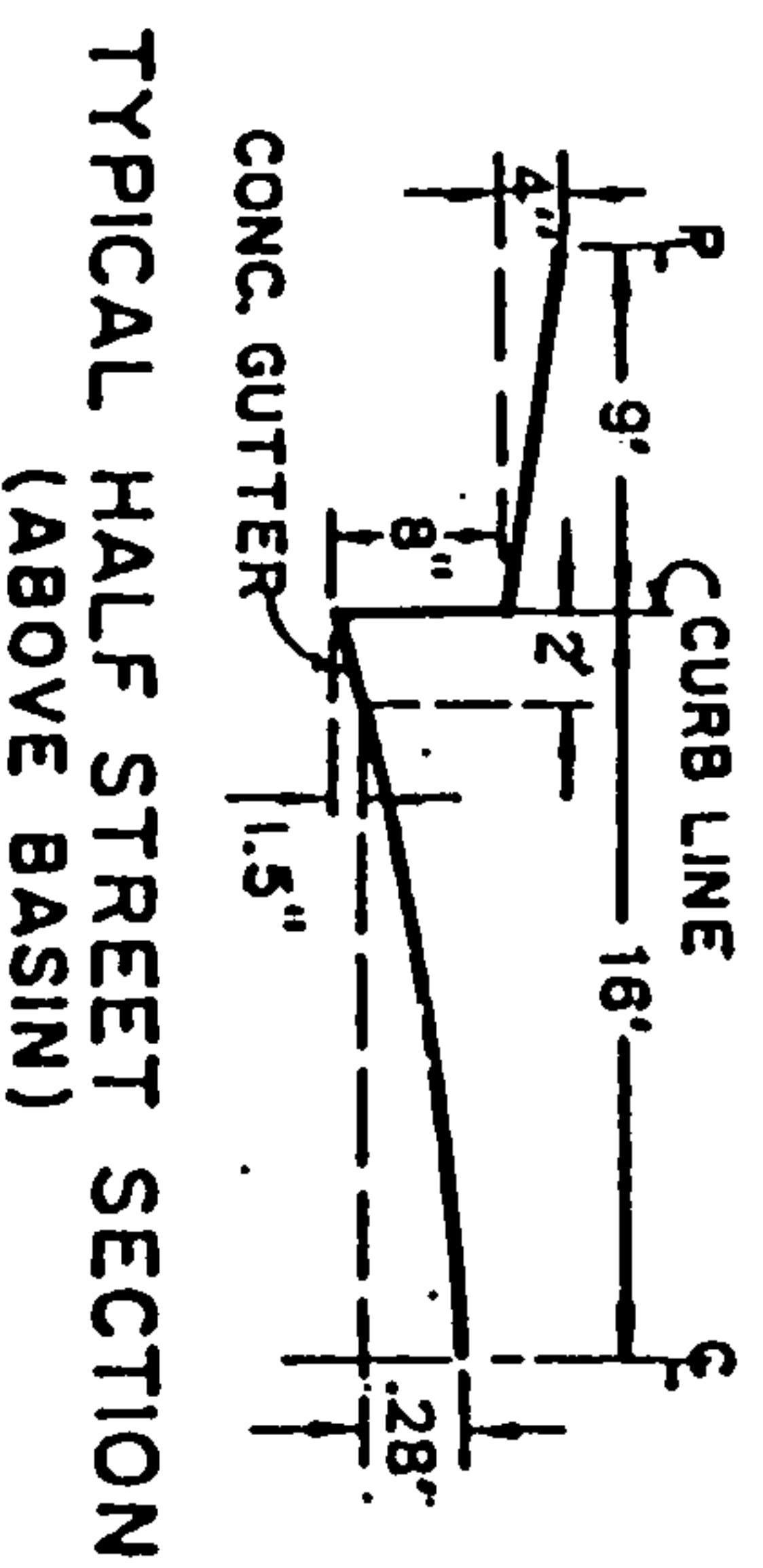
GRATING & GUTTER PLAN



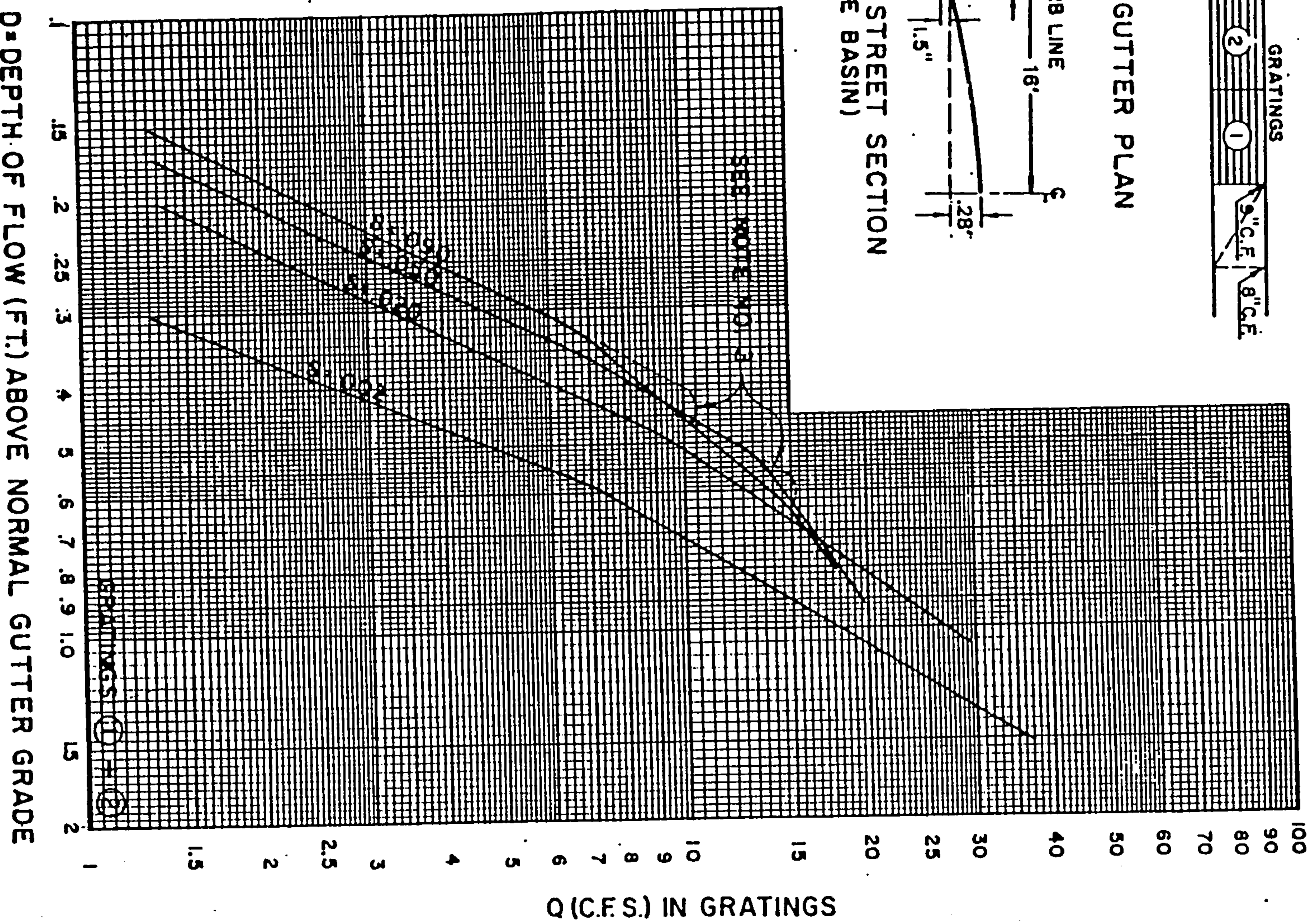
GRATING CAPACITIES FOR TYPE DOUBLE "C," AND "D"



GRATING & GUTTER PLAN



TYPICAL HALF STREET SECTION
(ABOVE BASIN)



D=DEPTH OF FLOW (FT.) ABOVE NORMAL GUTTER GRADE

RESOURCE TECHNOLOGY, INC.
ENGINEERS & ENVIRONMENTAL SCIENTISTS

2129 Osuna Road, NE Suite 200

Albuquerque, NM 87113

Phone: (505) 345-3115

Fax: (505) 345-4132

PROJECT NO. _____

SHEET _____ OF _____

BY _____ DATE _____

CHECKED _____ DATE _____

APPROVED _____ DATE _____

TITLE _____

1/2 Street 1

$D = 1.40$

$D = .60$

S

Q

V

Q

V

320

12

4.5' / s

46

7' / s

620

17

6.3' / s

65

10' / s

520

15

4.8' / s

60

9' / s

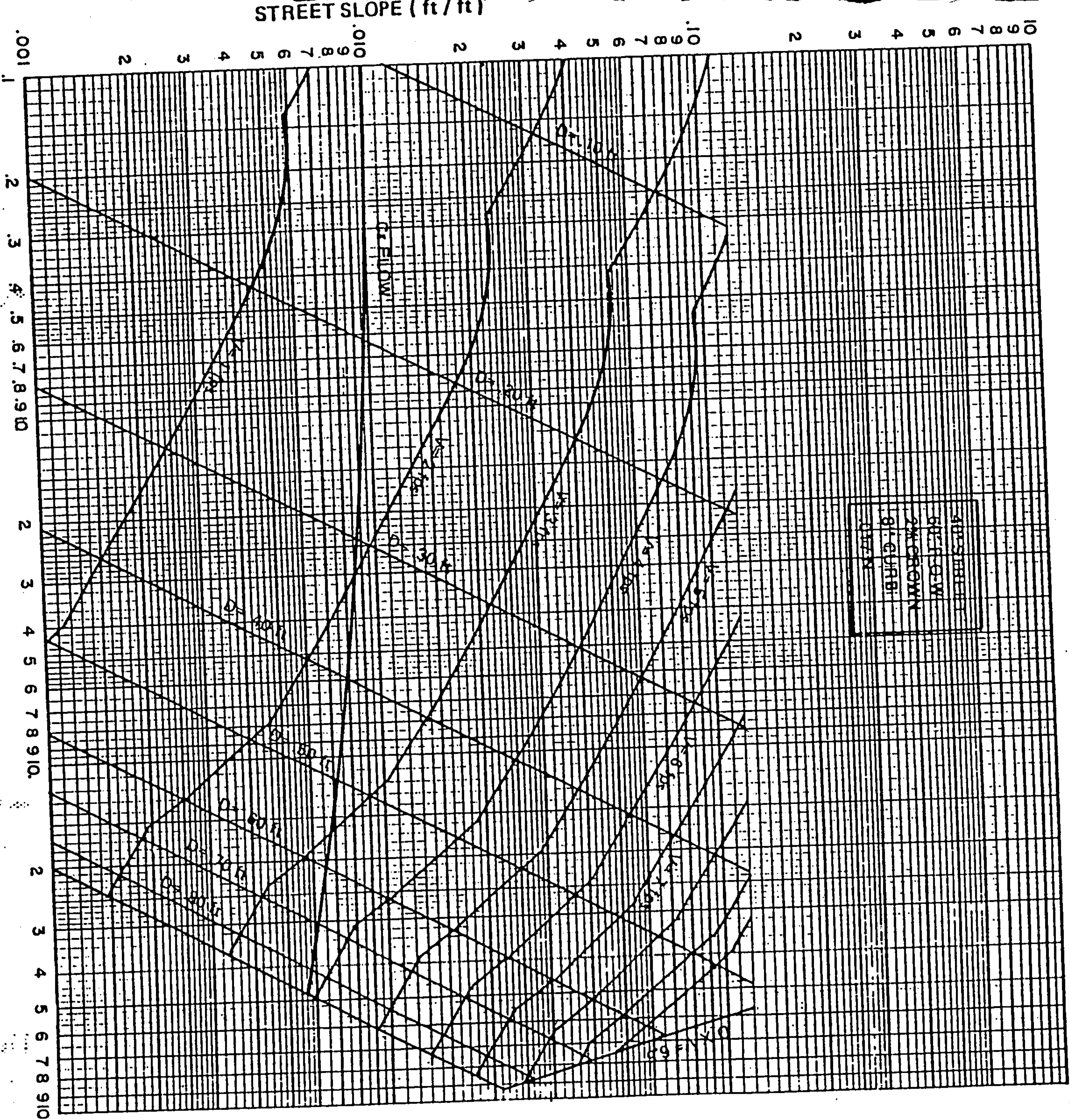
Via Posada at start of Project

$Q = 67 \text{ cfs}$

1/2 Street = 34 < 46

$d = .55'$ $V = 6.1' / s$

STREET. CAPACITY



ONE HALF STREET FLOWS (cfs)

Double C Inlets between ists 3+4

10/21/94

ID=2

CURB-SAG

CARRY-OVER TO

Q	CAPAC- ITY	FOND WIDTH	DEPTH ACTUAL	DEPTH MAX	CURB L	CURB H	DEPR W	DEPR A	Z1
37.000	14.827	%101.347	2.53	0.87	6.5	0.5	2.5	.10	40

ID=1

SAG

Q	CAPAC- ITY	POND WIDTH1	POND WIDTH2	DEPTH ACT	DEPTH MAX	W	L	Z1	Z2
27.000	21.910	40.00	0.00	1.000	0.870	2.50	6.50	40	0

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PROJECT NO. _____

SHEET _____ OF _____

BY _____ DATE 10/13

CHECKED _____ DATE _____

APPROVED _____ DATE _____

TITLE _____

$$r_{min} = \frac{4V^2 W}{g}$$

East Channel

$$Q = 9 \text{ cfs}$$

$$y = .29'$$

$$V = 3.01$$

$$W = 10$$

$$r = \frac{4(3.01)^2(10)}{32.2(.29)} = 38.8'$$

$$r_{actual} = 67.5'$$

West Channel

$$Q = 36$$

$$y = .7$$

$$V = 5.09$$

$$W = 10$$

$$r = 46.0'$$

$$r_{actual} = 57.5'$$

WEST END - $Q_{200} = 36$

CHANNEL LINING ANALYSIS

Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)
10.00	0.1	0.1	0.005
Lining			
Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient
Concrete 99.00	36.0	0.61	0.015
Normal			
Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)
0.70	7.07	5.09	0.21
			Stable

CHANNEL LINING ANALYSIS

Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)
10.00	0.1	0.1	0.005
Lining			
Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient
Concrete 99.00	30.0	0.55	0.015
Normal			
Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)
0.62	6.30	4.75	0.19
			Stable

East End Q200=9

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS					
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)		
10.00	0.1	0.1	0.005		
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient	
Concrete	99.00	9.0	0.28	0.015	
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks	
0.29	2.99	3.01	0.09	Stable	

Flood wall Swale - West

10/29/94

CHANNEL LINING ANALYSIS

Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)
0.10	3.0	3.0	<u>0.120</u>
Lining			
Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient
Concrete 99.00	<u>1.0</u>	0.10	0.015
Normal			
Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)
0.19	0.14	7.47	1.48
2.3 "			
Stable			

CHANNEL LINING ANALYSIS

Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)
0.10	3.0	3.0	<u>0.060</u>
Lining			
Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient
Concrete 99.00	<u>1.0</u>	0.11	0.015
Normal			
Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)
0.22	0.18	5.76	0.85
2.6 "			
Stable			

Flood wall side - EAST

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS					
Channel Bottom	Side Slope Lt.	Side Slope Rt.	Channel Slope		
Width (ft)	(Horz. to 1)	(Horz. to 1)	(ft/ft)		
0.10	3.0	3.0	<u>0.060</u>		
Lining					
Permissible	Discharge	Hydraulic	Manning		
Shear (lb/sf)	(cfs)	Radius (ft)	Coefficient		
Concrete	99.00	<u>0.6</u>	0.09	0.015	
Normal					
Area	Velocity	Calculated	Remarks		
Depth (ft)	(sf)	(ft/sec)	Shear (lb/sf)		
0.19	0.12	5.07	0.69	Stable	
2.2 "					

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS					
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)		
0.10	3.0	3.0	0.120		
Lining					
Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient		
Concrete 99.00	0.6	0.08	0.015		
Normal					
Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks		
0.16	0.09	6.58	1.20	Stable	
1.19"					

HOLMES & NARVER, INC.

CHECKED _____ DATE _____

ENGINEERS-CONSTRUCTORS

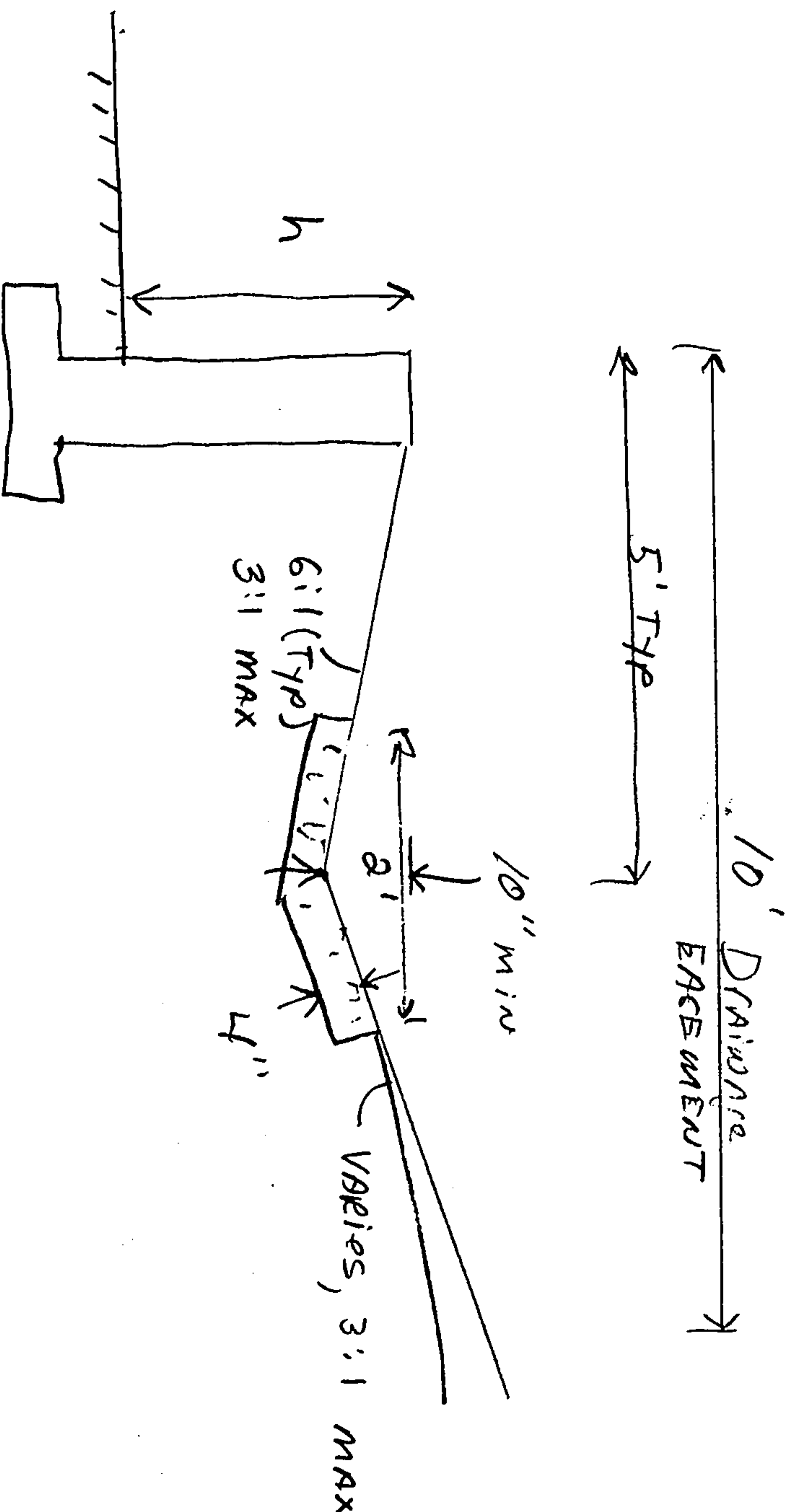
JOB NO. _____

APPROVED _____ DATE _____

Ameriwest Financial Center
6501 Americas Parkway, NE, Suite 700
Albuquerque, NM 87110

SHEET _____ OF _____

TITLE _____ BY _____ DATE _____



$h > 1.5'$ retaining wall
 $h < 1.5'$ garden wall

Back lot drainage easement, ~~sub~~ sale and wall detail

Typical Backyard Conc. Sewers

CHANNEL LINING ANALYSIS						
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)			
0.10	6.0	6.0	0.065			
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient		
Concrete	99.00	1.0	0.09	0.015		
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks		
0.17	0.20	5.08	0.71	Stable		

CHANNEL LINING ANALYSIS						
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)			
0.10	6.0	6.0	0.120			
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient		
Concrete	99.00	1.0	0.08	0.015		
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks		
0.15	0.16	6.40	1.16	Stable		

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS					
Channel Bottom	Side Slope Lt.	Side Slope Rt.	Channel Slope		
Width (ft)	(Horz. to 1)	(Horz. to 1)	(ft/ft)		
0.10	6.0	6.0	0.006		
Lining	Permissible	Discharge	Hydraulic	Manning	
	Shear (lb/sf)	(cfs)	Radius (ft)	Coefficient	
Concrete	99.00	1.0	0.14	0.015	
Normal	Area	Velocity	Calculated	Remarks	
Depth (ft)	(sf)	(ft/sec)	Shear (lb/sf)		
0.27	0.48	2.06	0.10	Stable	

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS					
Channel Bottom	Side Slope Lt.	Side Slope Rt.	Channel Slope		
Width (ft)	(Horz. to 1)	(Horz. to 1)	(ft/ft)		
0.10	6.0	6.0	0.006		
Lining	Permissible	Discharge	Hydraulic	Manning	
	Shear (lb/sf)	(cfs)	Radius (ft)	Coefficient	
Concrete	99.00	2.0	0.18	0.015	
Normal	Area	Velocity	Calculated	Remarks	
Depth (ft)	(sf)	(ft/sec)	Shear (lb/sf)		
0.35	0.81	2.45	0.13	Stable	

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS					
Channel Bottom	Side Slope Lt.	Side Slope Rt.	Channel Slope		
Width (ft)	(Horz. to 1)	(Horz. to 1)	(ft/ft)		
0.10	6.0	6.0	0.006		
Lining	Permissible	Discharge	Hydraulic	Manning	
	Shear (lb/sf)	(cfs)	Radius (ft)	Coefficient	
Concrete	99.00	3.0	0.21	0.015	
Normal	Area	Velocity	Calculated	Remarks	
Depth (ft)	(sf)	(ft/sec)	Shear (lb/sf)		
0.42	1.10	2.72	0.15	Stable	

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS						
Channel Bottom	Side Slope Lt.	Side Slope Rt.	Channel Slope			
Width (ft)	(Horz. to 1)	(Horz. to 1)	(ft/ft)			
0.10	6.0	6.0	0.010			
Lining	Permissible	Discharge	Hydraulic	Manning		
	Shear (lb/sf)	(cfs)	Radius (ft)	Coefficient		
Concrete	99.00	1.0	0.12	0.015		
Normal	Area	Velocity	Calculated	Remarks		
Depth (ft)	(sf)	(ft/sec)	Shear (lb/sf)			
0.24	0.40	2.50	0.15	Stable		

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS						
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)			
0.10	6.0	6.0	0.010			
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient		
Concrete	99.00	2.0	0.16	0.015		
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks		
0.32	0.67	2.97	0.20	Stable		

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS					
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)		
0.10	6.0	6.0	0.010		
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient	
Concrete	99.00	3.0	0.19	0.015	
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks	
0.38	0.91	3.29	0.23	Stable	

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS						
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)			
0.10	6.0	6.0	0.020			
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient		
Concrete	99.00	1.0	0.11	0.015		
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks		
0.21	0.31	3.24	0.27	Stable		

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS						
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)			
0.10	6.0	6.0	0.020			
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient		
Concrete	99.00	2.0	0.14	0.015		
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks		
0.28	0.52	3.86	0.35	Stable		

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS					
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)		
0.10	6.0	6.0	0.020		
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient	
Concrete	99.00	3.0	0.16	0.015	
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks	
0.33	0.70	4.27	0.41	Stable	

CHANNEL LINING ANALYSIS

Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)		
0.10	6.0	6.0	0.050		
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient	
Concrete	99.00	1.0	0.09	0.015	
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks	
0.18	0.22	4.57	0.56	Stable	

CHANNEL LINING ANALYSIS

Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)		
0.10	6.0	6.0	0.050		
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient	
Concrete	99.00	2.0	0.12	0.015	
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks	
0.23	0.37	5.44			

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS						
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)			
0.10	6.0	6.0	0.050			
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient		
Concrete	99.00	3.0	0.14	0.015		
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks		
0.27	0.50	6.02	0.87	Stable		

RESOURCE TECHNOLOGY, INC.

ENGINEERS & ENVIRONMENTAL SCIENTISTS

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Albuquerque, NM 87113

Phone: (505) 345-3115

Fax: (505) 345-4132

CHECKED _____ DATE _____

PROJECT NO. _____

APPROVED _____ DATE _____

SHEET _____ OF _____

TITLE 200-yr Calculations BY ASR DATE 10/21/9

Q

100-yr 29.6

50-yr 22.4

25-yr 15.8

10 yr 8

5 yr 3.2

$Q_{200} \sim 36 \text{ cfs}$ $Q_{200} = 1.22 Q_{100}$

$Q_{100} = 7$, $Q_{200} = 9 \text{ cfs}$

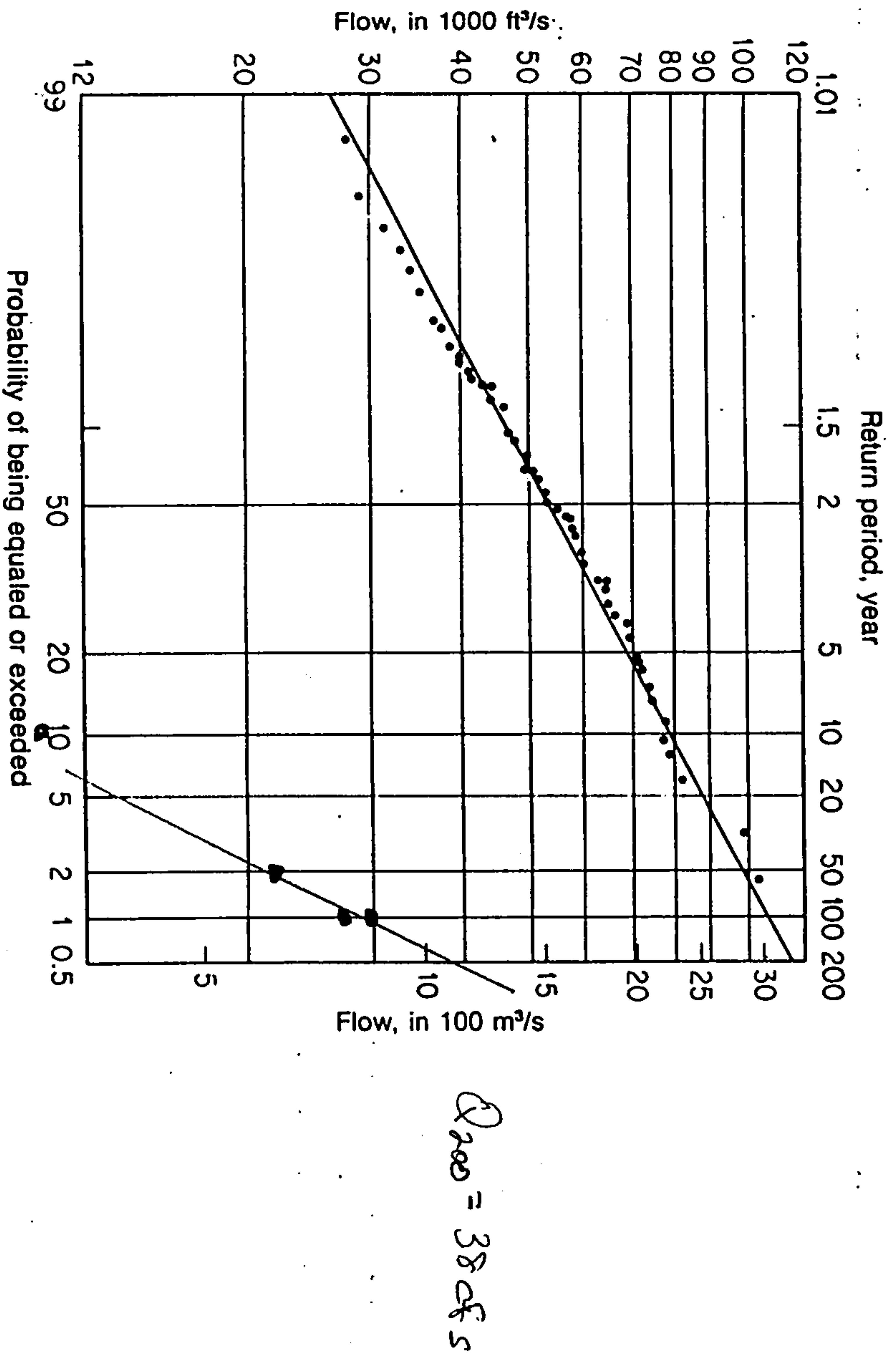


Figure 13-1 Flood-frequency curve for the Clearwater River at Kamiah, Idaho. The curve is plotted on log-normal probability paper and fitted by the log-Pearson Type III function. Points plotted with Eq. (13-2).

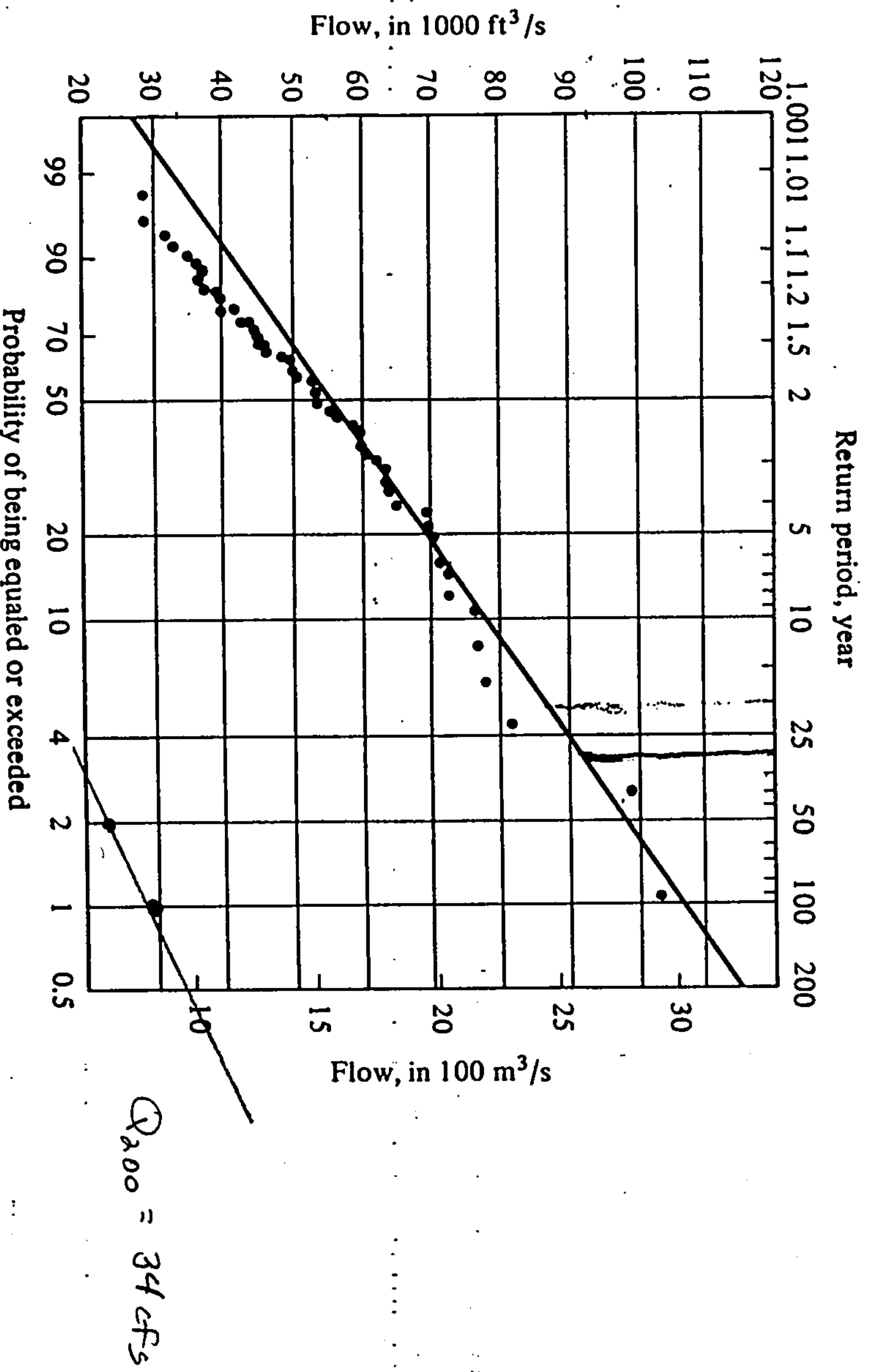


Figure 13-2 Flood-frequency curve for the Clearwater River at Kamiah, Idaho, plotted on extreme-value paper and fitted with the Type I (Gumbel) distribution. Points plotted with Eq. (13-3).

Natural Arroy at Point of Discharge

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS						
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)			
90.00	4.0	4.0	0.041			
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient		
Concrete	99.00	203.0	0.35	0.025		
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks		
0.36	33.40	6.07	0.93	Stable		

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS						
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)			
90.00	1.0	1.0	0.041			
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient		
Concrete	99.00	203.0	0.36	0.025		
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks		
0.36	33.11	6.13	0.93	Stable		

Sediment Calculations

RESOURCE TECHNOLOGY, INC.

ENGINEERS & ENVIRONMENTAL SCIENTISTS

2129 Osuna Road, NE Suite 200

Albuquerque, NM 87113

Phone: (505) 345-3115

Fax: (505) 345-4132

PROJECT NO. _____

SHEET _____ OF _____

CHECKED _____ DATE _____
APPROVED _____ DATE _____
TITLE Area 940 (B)

BY _____ DATE 5/21/94

P_{60} , P_{360} , P_{1440} for indicated return period.

2	5	70	25	50	100
0.93	1.21	1.43	1.71	1.93	2.14
1.13	1.47	1.73	2.08	2.34	2.60
1.34	1.76	2.07	2.48	2.79	3.10

See Table A-3

AY/YR) =05/20/1994

INPUT FILE = 4HILLALL.EXT

USER NO. = RSTECNWM,101

PHYMO SUMMARY TABLE (PHYMO0933) - AMAFCA VERSION OF HYMO - SEPTEMBER, 1993

PRINT DATE (MM/DD

COMMAND	IDENTIFICATION	HYDROGRAPH	FROM ID NO.	TO ID NO.	AREA (SQ MI)	PEAK DISCHARGE (CFS)	RUNOFF VOLUME (AC-FT)	RUNOFF (INCHES)	TIME TO PEAK (HOURS)	CFS PER ACRE	PAGE = 1
START											
RAINFALL TYPE= 1											
COMPUTE NM HYD			-	1	.02200	26.71	.770	.65617	1.518	1.897 PER IMP=	TIME= .00 RAINF= 2.600
SEDIMENT TRANSP			1		SED ID = 1	PEAK CONC. (PPM-W) =	30011	TOTAL SED. (TONS) =			.00
SEDIMENT TRANSP			1		SED ID = 1	PEAK CONC. (PPM-W) =	36806	TOTAL SED. (TONS) =			30.28
*SECTION 30											
SEDIMENT TRANSP			1		SED ID = 1	PEAK CONC. (PPM-W) =	28536	TOTAL SED. (TONS) =			33.15
RAINFALL TYPE= 1											
COMPUTE NM HYD			-	2	.02200	20.86	.589	.50193	1.519	1.481 PER IMP=	RAINF= 2.340
SEDIMENT TRANSP			2		SED ID = 1	PEAK CONC. (PPM-W) =	29139	TOTAL SED. (TONS) =			.00
SEDIMENT TRANSP			2		SED ID = 1	PEAK CONC. (PPM-W) =	34522	TOTAL SED. (TONS) =			22.66
*SECTION 30											
SEDIMENT TRANSP			2		SED ID = 1	PEAK CONC. (PPM-W) =	28138	TOTAL SED. (TONS) =			23.66
RAINFALL TYPE= 1											
COMPUTE NM HYD			-	3	.02200	15.17	.421	.35880	1.518	1.077 PER IMP=	RAINF= 2.080
SEDIMENT TRANSP			3		SED ID = 1	PEAK CONC. (PPM-W) =	29190	TOTAL SED. (TONS) =			22.38
SEDIMENT TRANSP			3		SED ID = 1	PEAK CONC. (PPM-W) =	31059	TOTAL SED. (TONS) =			16.09
*SECTION 30											
SEDIMENT TRANSP			3		SED ID = 1	PEAK CONC. (PPM-W) =	28012	TOTAL SED. (TONS) =			15.05
RAINFALL TYPE= 1											
COMPUTE NM HYD			-	4	.02200	7.94	.221	.18857	1.518	.564 PER IMP=	RAINF= 1.730
SEDIMENT TRANSP			4		SED ID = 1	PEAK CONC. (PPM-W) =	27549	TOTAL SED. (TONS) =			15.83
SEDIMENT TRANSP			4		SED ID = 1	PEAK CONC. (PPM-W) =	26474	TOTAL SED. (TONS) =			8.03
*SECTION 30											
SEDIMENT TRANSP			4		SED ID = 1	PEAK CONC. (PPM-W) =	27511	TOTAL SED. (TONS) =			7.43
RAINFALL TYPE= 1											
COMPUTE NM HYD			-	5	.02200	3.25	.092	.07830	1.518	.231 PER IMP=	RAINF= 1.470
SEDIMENT TRANSP			5		SED ID = 1	PEAK CONC. (PPM-W) =	25783	TOTAL SED. (TONS) =			8.04
SEDIMENT TRANSP			5		SED ID = 1	PEAK CONC. (PPM-W) =	25612	TOTAL SED. (TONS) =			3.15
*SECTION 30											
SEDIMENT TRANSP			5		SED ID = 1	PEAK CONC. (PPM-W) =	25879	TOTAL SED. (TONS) =			3.13
RAINFALL TYPE= 1											
COMPUTE NM HYD			-	6	.02200	.00	.000	.00000	-.033	.000 PER IMP=	RAINF= 3.17
SEDIMENT TRANSP			6		SED ID = 1	PEAK CONC. (PPM-W) =					1.130
FINISH											

Cross-Section
Locations "A" on
Arroyo "B" on
Basin 940

FOUR HILLS WEST
PROPERTY

CITY OF
P.R.

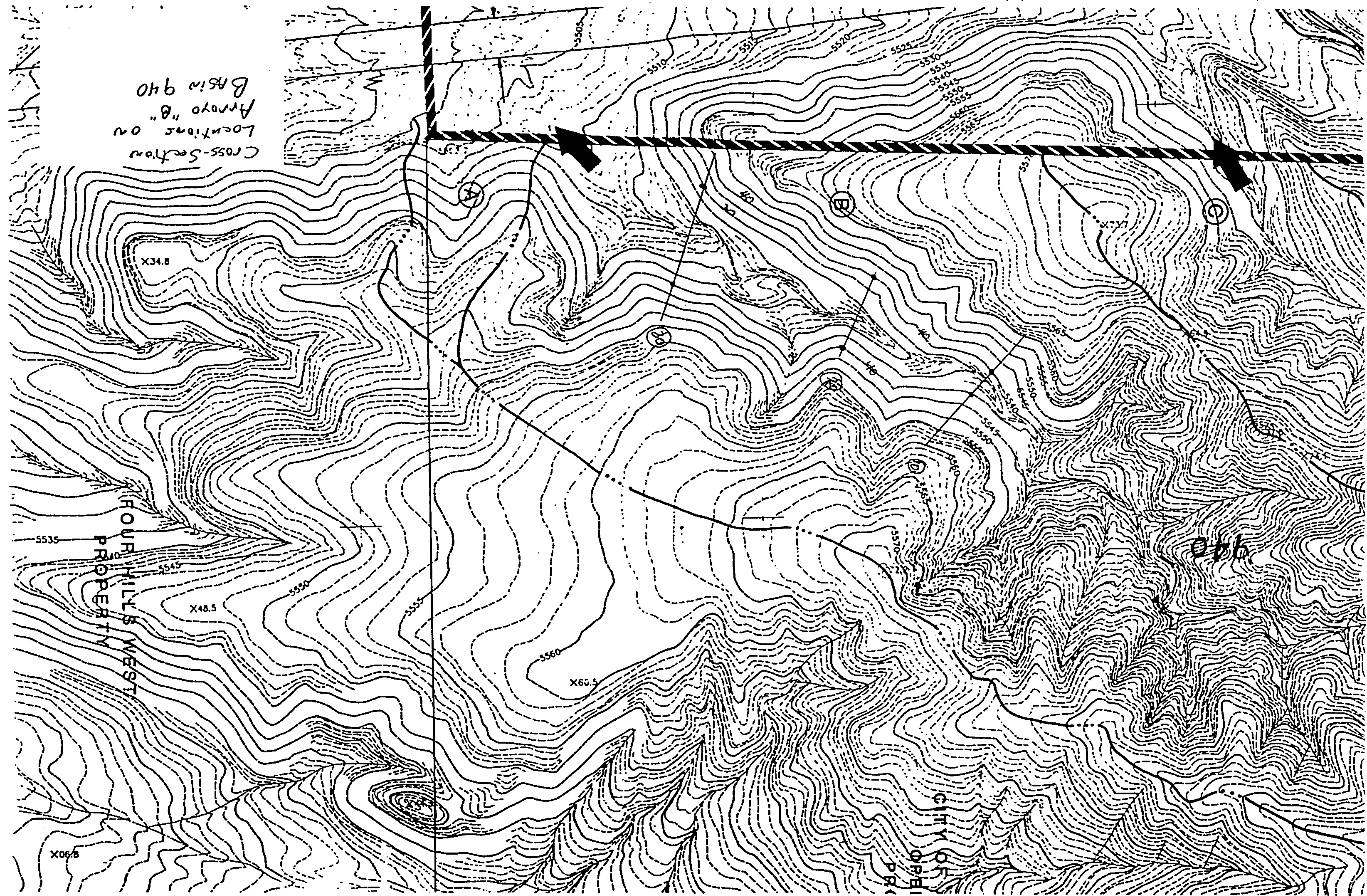
946

X06.8

X34.8

X48.5

X60.5



* WATER SURFACE PROFILES

* VERSION OF NOVEMBER 1976

* UPDATED MAY 1984

* IBM-PC-XT VERSION

* RUN DATE 06/20/94 TIME 21:19:19

* U.S. ARMY CORPS OF ENGINEERS
* THE HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET, SUITE D
* DAVIS, CALIFORNIA 95616
* (916) 440-2105 (FTS) 448-2105

*HEC-2 Input File used to develop channel rating curves for
Sediment Transport calculation using
Basin 940*

X	X	XXXXXX	XXXXX	XXXXX
X	X	X	X	X
X	X	X	X	X
XXXXXXX	XXXXX	X	XXXXX	XXXXX
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	XXXXXXX	XXXXX	XXXXXXX

06/20/94 21:19:20

PAGE 1

THIS RUN EXECUTED 06/20/94 21:19:20

HEC2 RELEASE DATED NOV 76 UPDATED MAY 1984

ERROR CORR - 01,02,03,04,05,06

MODIFICATION - 50,51,52,53,54,55,56

IBM-PC-XT VERSION 1.1

T1 FOUR HILLS

T2 HEC-2 RUN FOR SUPERCRITICAL FLOW
T3

J1	ICHECK	ING	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0.	0.	0.	1.	.000000	.00	.0	5.	534.500	.000
J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBM	CHNIM	ITRACE
	-1.000	.000	.000	.000	.000	.000	-1.000	.000	.000	.000

NC	.040	.040	.035	.100	.300	.000	.000	.000	.000	.000
	1.000	1.000	1.000	1.000	400.000	300.000	350.000	.000	.000	.000

06/20/94 21:19:20

SECNO	DEPTH	CHSEL	CRIMS	WSELK	EG	HV	HL	QLOSS	BANK ELEV
Q	QLODB	QCH	QROB	ALDB	ACH	AROB	VOL	TWA	LEFT/RIGHT
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CDRAR	TDFWID	ENDST

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

*SECOND 10.000

10.00	.49	533.49	533.49	534.50	533.61	.12	.00	.00	540.00
5.	0.	5.	0.	0.	2.	0.	0.	0.	540.00
.00	.00	2.83	.00	.040	.035	.040	.000	533.00	152.57
.023637	0.	0.	0.	0	16	0	.00	7.28	153.86

3685 20 TRIALS ATTEMPTED WSEL, CWSEL

3720 CRITICAL DEPTH ASSUMED

20.00	.43	523.93	523.93	.00	524.04	.11	10.55	6.10	530.00
5.	0.	5.	0.	0.	2.	0.	0.	0.	530.00
.04	.00	2.67	.00	.040	.035	.040	.000	523.50	200.27
.030652	400.	350.	300.	20	11	0	.00	8.66	208.93

3685 20 TRIALS ATTEMPTED WSEL, CWSEL

3720 CRITICAL DEPTH ASSUMED

30.00	.46	512.46	512.46	.00	512.57	.12	13.76	8.06	520.00
5.	0.	5.	0.	0.	2.	0.	0.	0.	520.00
.08	.00	2.75	.00	.040	.035	.040	.000	512.00	225.44
.030515	450.	450.	450.	20	8	0	.00	7.97	233.42

PAGE 3

THIS RUN EXECUTED 06/20/94 21:19:24

HEC2 RELEASE DATED NOV 76 UPDATED MAY 1984

ERROR CORR - 01,02,03,04,05,06

MODIFICATION - 50, 51, 52, 53, 54, 55, 56

IBM-PC-XT VERSION 1.1

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

SUMMARY PRINTOUT TABLE 150

	SECD	XLCH	ELTRD	ELLC	ELMIN	Ø	CMSEL	CRIMS	EG	10K*5	VCH	AREA	.01K
*	10.000	.00	.00	.00	533.00	5.00	533.49	533.49	533.61	296.37	2.83	1.77	.23
*	20.000	350.00	.00	.00	523.50	5.00	523.93	523.93	524.04	306.62	2.67	1.87	.23
*	30.000	450.00	.00	.00	512.00	5.00	512.46	512.46	512.57	305.15	2.75	1.82	.23

06/20/94 21:19:20

PAGE 4

SUMMARY PRINTOUT TABLE 150

	SECD	Ø	CMSEL	DIFWSP	DIFMSX	DIFKMS	TOPMID	XLCH
*	10.000	5.00	533.49	.00	.00	-1.01	7.28	.00
*	20.000	5.00	523.93	.00	-9.55	.00	8.66	350.00
*	30.000	5.00	512.46	.00	-11.48	.00	7.97	450.00

06/20/94 21:19:20

PAGE 5

SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION SECD= 10.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECD= 20.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECD= 20.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY

CAUTION SECD= 20.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECD= 30.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECD= 30.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY

CAUTION SECD= 30.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

06/20/94 21:19:24

PAGE 1

THIS RUN EXECUTED 06/20/94 21:19:24

HEC2 RELEASE DATED NOV 76 UPDATED MAY 1984

ERROR CORR - 01,02,03,04,05,06

MODIFICATION - 50,51,52,53,54,55,56

IBM-PC-XT VERSION 1.1

Sediment Calculations

RESOURCE TECHNOLOGY, INC.
ENGINEERS & ENVIRONMENTAL SCIENTISTS

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Albuquerque, NM 87113

Phone: (505) 345-3115

Fax: (505) 345-4132

CHECKED _____ DATE _____

APPROVED _____ DATE _____

TITLE X-Section Rating Curves

PROJECT NO. _____

SHEET _____ OF _____

BY _____ DATE _____

Q V T D

10
2.7
2.0
1.5
1.0
4.0
3.7
3.5
3.3
2.8
14
12
11
9
7
9.5
8.5
7.6
6.4
4.9

20
2.7
2.0
1.5
1.0
4.7
4.2
3.8
3.2
2.7
11
11
10
8
8.1
7.2
6.4
5.6
4.3

30
2.7
2.0
1.5
1.0
8.8
8.6
8.4
8.2
1.5
1.3
1.2
1.0
9.8
9.7
9.6
9.4

RESOURCE TECHNOLOGY, INC.

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PROJECT NO. _____

CHECKED _____ DATE _____

APPROVED _____ DATE _____

TITLE Sed. Calc's

SHEET _____ OF _____

BY BJL DATE 5/22/94

$$Y_m = .015 Y_{100} + .015 Y_{50} + .04 Y_{25} + .08 Y_{10} + .2 Y_5 + .4 Y_2$$

$$Q_2 = 0$$

$$Y_m = .015(22.6) + .015(22.4) + .04(15.8) + .08(8) + .2(3.2)$$

$$Y_m = 2.69 \text{ Tons}$$

$$Y_{30yr} = 30 \times Y_m = 80.76 \text{ Tons}$$

$$\approx 2800 \text{ lb/cy}$$

30 year sed. Trans out of system

$$57.7 \text{ cy dog reduction,} =$$

Channel 1200' long $b \sim 10'$

.13' along bottom,

RESOURCE TECHNOLOGY, INC.

ENGINEERS & ENVIRONMENTAL SCIENTISTS

2129 Osuna Road, NE Suite 200

Albuquerque, NM 87113

Phone: (505) 345-3115

Fax: (505) 345-4132

PROJECT NO. _____

SHEET _____ OF _____

BY 5/20/94 DATE ASL

CHECKED _____ DATE _____

APPROVED _____ DATE _____

TITLE Sed Chls

Basin B, Area = .0220 sq mi
(940)

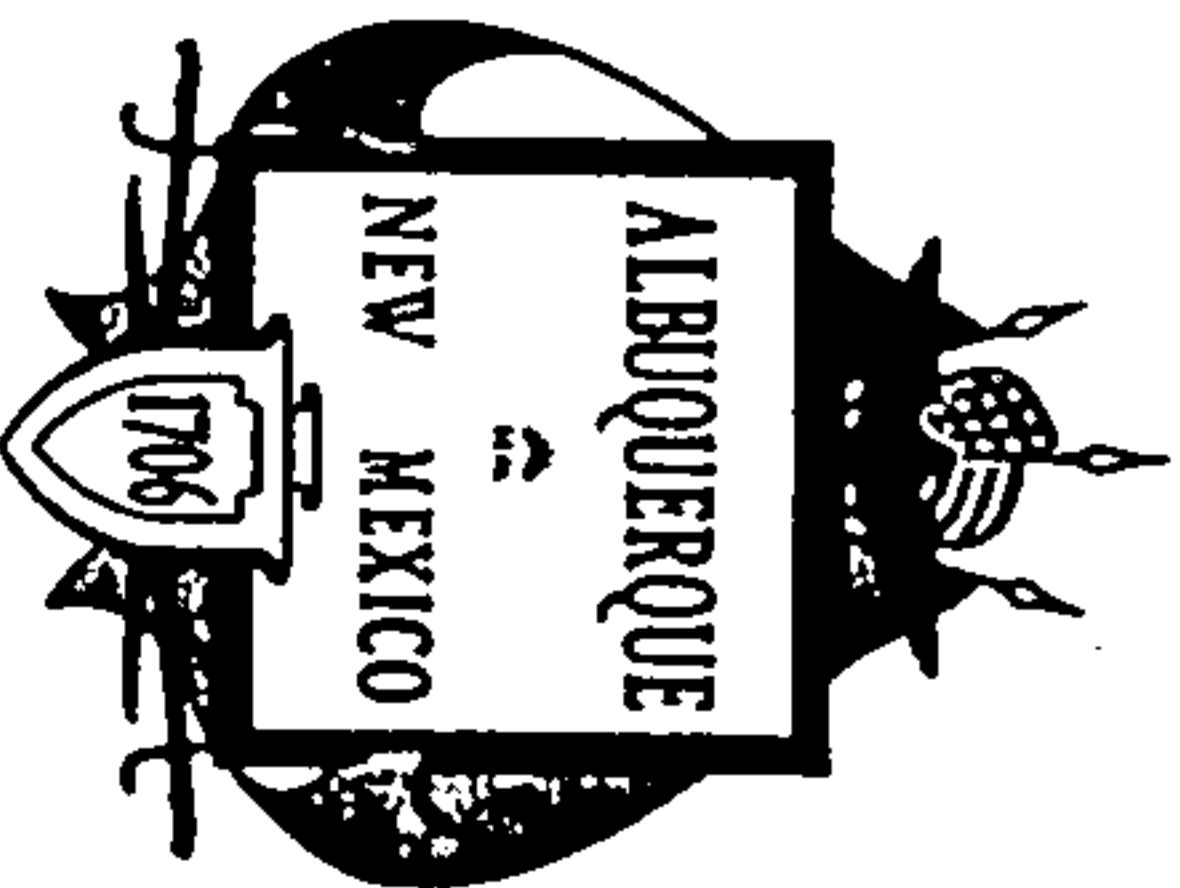
Basin C, Area = .0055 sq mi
(930)

Basin C sed. yield ~ 2590 Basin B

$Y_m = .25(2.69) \text{ tons} = .67 \text{ tons}$

$Y_{30} = 20.2 \text{ tons (14.4 cy)}$

RECEIVED OCT - 7 1994



City of Albuquerque

P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

October 4, 1994

Donald S. Dixon, P.E.
Resource Technology, Inc.
2129 Osuna Rd. NE, Suite 200
Albuquerque, NM 87113

RE: FOUR HILLS VILLAGE 20TH INSTALLMENT (M23/D11) SUBMITTED FOR
PRELIMINARY PLAT APPROVAL, ENGINEER'S STAMP DATED 6/24/94.

Dear Mr. Dixon:

AMAFCA has agreed to accept the floodplain easement for the Tijeras Arroyo adjacent to the above referenced development. Please note that this easement must be dedicated to AMAFCA prior to the plat action.

Typically, the limits of the floodplain easement for a natural arroyo are determined by the energy grade line (EGL) or the sequent depth as calculated by a HEC-2 analysis. Use the new hydrology when calculating the EGL for the arroyo. Also, erosion setback and scour calculations are required per the Sediment and Erosion Design Guide. If any construction is proposed within the limits of the erosion setback area, then a floodwall or floodproofing will be required.

Please plot the easement and the EGL on the drainage plan along with the erosion setback line, and include all calculations. Also, please include a copy of the plat showing the proposed easement with your resubmittal.

If you should have any questions, please feel free to call me at 768-2666.

Sincerely,

Susan M. Calongue, P.E.
City/County Floodplain Administrator

smc/WPHYD/495

c: Andrew Garcia
Terry Brown
Kurt Browning, AMAFCA
File



2129 OSUNA ROAD NE, SUITE 200
ALBUQUERQUE, NEW MEXICO 87113
(505) 345-3115
FAX (505) 345-4132

November 8, 1994

Ms. Susan Calongne, P.E.
City/County Floodplain Administrator
P.O. Box 1293
Albuquerque, New Mexico 87103

RE: PRUDENT LINE FOR FOUR HILLS 20TH INSTALLMENT (M23/D11)
RTI File No. 94-060

Dear Susan,

I had a telephone conversation with Fred Aguirre on 10/7/94 concerning the methodology for a prudent line analysis for the above referenced project, at which time we discussed several options. Given the fact that Leedshill-Herkenhoff, Inc. had conducted a similar study for the City of Albuquerque in 1988 as part of the Tijeras Arroyo Drainage Management Plan Phase II (DMP) we decided to use their results, if the following could be shown:

1. The 100-year flow rate used by Leedshill-Herkenhoff, Inc. (L-HI) 1988 for this reach of Tijeras Arroyo was equal to or greater than that proposed for the FEMA re-study (in progress) by Resource Technology, Inc. (RTI).
2. The methodology used for the determination of the prudent line for the L-HI analysis was comparable to or more conservative than that presented in the AMAFCA "Sediment and Erosion Design Guide" (SEDG), 1994. This would include sediment yield and transport analysis.

If both of the above two points could not be demonstrated or the L-HI study showed that this project was impacted by the prudent line, then a new study, utilizing the current version of AHYMO and the SEDG would be required.

We have conducted the necessary evaluation which is contained in Attachment 1, and these are our findings:

1. Table 1 in Attachment 1, shows the results of several hydrologic studies conducted on Tijeras Arroyo. RTI is proposing to use the USGS data because it is based on stream flow gage data for the longest period of record. As can be seen from the table, the L-HI study utilized a significantly higher flow rate.

2. The sediment transport analysis conducted by L-HI indicated a higher sediment yield and sediment transport capacity than would be found by using the SEDG for the watershed bed material gradations reported. An evaluation for Reach 3 (located along Four Hills 20th installment) results, as presented in the DMP, indicated a 14 to 49 percent greater sediment transport capacity for the L-HI results, than would be found by using the current methodology (SEDG). Therefore, even if an AHYMO analysis of the basin were to result in a 100-year flow rate substantially higher than that used by L-HI, the sediment transport capacity of the arroyo would still be expected to be lower using the current methodology (SEDG). See Attachment 1.
3. The prudent line based on the L-HI methodology is shown on Exhibit 1 (attached). As can be seen, it abuts the proposed subdivision but all proposed building pads and infrastructure improvements are well outside the indicated area.
4. An identical analysis was also completed for Reach 4 which is located upstream of Reach 3. The purpose for the Reach 4 analysis was to determine if the results would be similar to Reach 3. The analysis results for Reach 4 are very similar to Reach 3 and Attachment 2 contains this analysis.

In summary, the L-HI determination of the prudent line appears to be very comparable to that which would have been computed using the SEDG. Since that prudent line places this proposed project outside the impacted area, a more detailed analysis for this project is not warranted at this time.

RESOURCE TECHNOLOGY, INC.



Elvidio V. Diniz, P.E.
President

EVD/rjg

Attachments

ATTACHMENT 1

4-Hills 20th Installment

A1.1

RTI File No. 94-060

TABLE 1

Tijeras Arroyo Peak Discharge (cfs) Information

Return Period, Yrs.	COE 1974 (a)	RTI/USGS (b)	L-HI 1988 - DMP (c)	FEMA/USGS 1983
500		25,694		28,600
100	22,600 (IRF)	12,875	18,065	14,300
50		9,102		10,000
10		3,344	6,285	5,120

- (a) Floodplain Information Albuquerque Arroyos Part IV, Albuquerque, New Mexico. Department of the Army, Albuquerque, New Mexico; Corps of Engineers, Albuquerque, New Mexico. June 1974 (pg. 9-11).

Discussion with Army Corps of Engineers (10-21-94) indicate background information is unavailable and therefore we assume the peak discharge was developed with a HEC-1 model. IRF = Intermediate Regional Flood = 100-yr. flood. Drainage Area = 76 sq.mi.

- (b) RTI used USGS Stream Gage No. 08330500 data, 41 years of record, although 15 years of the peak flow data were below the gage base discharge of 250 cfs and were eliminated before the Log-Pearson Type III flood probability analysis was completed by the U.S. Geological Survey. The gage is located approximately 1 mile upstream of Four Hills Road. Discharges shown include Conditional Probability. Drainage Area = 75.30 sq.mi.

- (c) L-HI - DMP at Four Hills Road (approximately). Peak discharge was obtained from a HEC-1 model. Drainage Area = 78 sq.mi.

COMPARISON OF DMP SEDIMENT TRANSPORT EQUATION RESULTS
TO THE MPM-WOO EQUATION (SEDG) RESULTS

PURPOSE

Perform a brief comparison of the sediment transport equation results between the equations presented in the "Tijeras Arroyo Drainage Management Plan (DMP) Phase II" Report (Leedshill-Herkenhoff, Inc., February, 1988), and the MPM-Woo Equation presented in the "Sediment and Erosion Design Guide" (SEDG) (Resource Consultants and Engineers, Inc., March 1994).

PROCEDURE

Locate the 4-Hills 20th Installment Subdivision with respect to the DMP designated reaches and determine the applicable reach and its associated data and results as presented in the DMP. The Sheets and Tables referenced below are included at the end of this attachment.

LOCATION	-	Sheet M-22 in DMP
HEC-2 Sections	-	AT to AU (Sheet M-22 in DMP)
D_{50}	-	Average of all samples = 2.63mm (Table VIII-6 in DMP). As shown on Sheet M-22, Sample No.'s BG #5 and BG #6 are near the proposed subdivision. Table VIII-6 indicates BG #5 is a bed sample with D_{50} = 8.0mm and BG #6 is a bank sample with D_{50} = 0.6mm. Due to this range of extreme sizes compared to the other D_{50} values presented in Table VIII-6, the mean D_{50} of all samples was assumed which is 2.63mm (Table VIII-6).

Reach No. 3 - Table VIII-7 in DMP

V, Y, S_0 and D_{50} (Table VIII-2 in DMP) are all within range of values for which the MPM-Woo Equation is applicable (Table 3.6 in SEDG)

Therefore, based on D_{50} = 2.63mm, compute MPM-Woo Equation coefficient and exponents from Figure 3.10 in SEDG.

a	=	0.000002
b	=	5.67
c	=	-0.76
d	=	-1.6

Cf - assume 1 PPM and repeat for maximum concentration = 60,000 PPM because DMP did not present or consider Cf

Select 10-yr. and 100-yr. Q and Qs discharge values presented in DMP for Reach 3 (Appendix C, DMP), obtain V and Y for the 10-yr and 100-yr. Q's from Table VIII-2 (DMP), apply MPM-Woo Equation and compute Qs. Compare the results of the 10-yr. and 100-yr. Qs computations between DMP results and MPM-Woo Equation.

NOTE: This data is for one-time period at maximum discharge on the hydrograph.

Data Type	Return Period	
	10-yr.	100-yr.
Q (cfs)	6,285	18,065
V (ft/sec)	7.10	9.95
Y (ft)	2.24	3.54
TW (ft)	395	513

Hyd. Ord. Time Interval = 0.1 hrs. = 360 sec.

SEDIMENT TRANSPORT CAPACITY RESULTS (REACH 3)

Q	DMP		MPM-WOO *		Difference	
	Cf *	Qs	Qs	qs	Qs	% of DMP
(cfs)	(assumed)	(tons)	(cu ft)	(cfs/ft)	(cu ft)	
		(c)	(a)		(b)	
6,285	1 PPM	2,163	26,154	0.07269	10,337	—
6,285	60,000 PPM	2,163	26,154	0.08025	11,412	44
18,065	1 PPM	6,839	82,696	0.34789	62,248	—
18,065	60,000 PPM	6,839	82,696	0.38450	71,009	86

(a) assume specific weight of sediment = 165.4 lbs/cu.ft.
 $\text{tons} \frac{(2000 \text{ lbs})}{(1 \text{ cu ft})} = \text{cu ft}$
 $(\text{ ton })(165.4 \text{ lbs})$

(b) $Q_s = q_s (TW)(360)$
 $Q_s = \frac{\text{cu ft/sec}(\text{ft})(\text{sec})}{\text{ft}} = \text{cu ft}$

(c) tons in DMP is for Q lasting 360 (see Appendix C in DMP)

RESULTS SUMMARY FOR REACH 3 ONLY

The MPM-Woo Equation produces values of only 44% (10-yr.) to 86% (100-yr.) of the values computed in the DMP (if Cf = 60,000 PPM).

PRUDENT LINE ASSUMPTIONS IN DMP

Only the long term 25-yr. aggradation/degradation volume was used in the DMP to predict the aggradation/degradation in the reach and lateral bank movement. However, the current methodology states that the long term volume plus the 100-yr. volume is the total volume that should be used to develop the Prudent Line.

ROUGH ADJUSTMENT TO DMP PRUDENT LINE RESULTS

A rough adjustment and comparison of the DMP long term and 100-yr. sediment transport capacity results was completed to determine the increase (in percent) that would occur in the DMP results if the 100-yr. transport capacity volume were added to the long term sediment transport capacity volume. The following values were obtained from Table VIII-3 in the DMP for the total sediment transport capacity of the hydrograph.

100-yr. volume	= 34,603 CY
25-yr. long term volume	= <u>131,520 CY</u>
TOTAL	166,123 CY

Therefore $\frac{25\text{-yr. long term}}{\text{Total}} = \frac{131,520}{166,123} = 79\%$
(100-yr. + long term)

CONCLUSION

For Reach 3, the addition of the 100-yr. volume to the long term volume would increase the total such that the 25-yr. long term volume is 79% of the total volume. For simplicity this may be converted to a 21% increase in the prudent line if the total (100-yr. + 25-yr. long term) were used. Note that the previous comparison to the MPM-Woo Equation results indicated that the MPM-Woo Equation produced results 86% (100-yr.) of the DMP results. This may be converted to state that the DMP results are 14% greater than the MPM-Woo results. Also, the peak flow rates in the DMP are approximately 50% greater than those being considered at present.

Therefore, if the MPM-Woo Equation results were used to develop the Prudent Line based on the total 100-yr. and long term results, the result may be very similar to the Prudent Line determined in the DMP based on the analysis and comparison of results presented here for Reach 3.

COMPARISON OF DMP SEDIMENT TRANSPORT EQUATION RESULTS TO THE MPM-EINSTEIN EQUATION (SEDG) RESULTS

PURPOSE

Compare DMP 100-yr. results with the Meyer-Peter, Muller-Einstein Equation results.

MPM - Einstein Equation (see Sediment & Erosion Design Guide, March 1994 for more information, pg. 3-29)

$$q_b = \frac{12.85}{\sqrt{\rho \gamma_s}} (\tau_o - \tau_c)^{1.5}$$

PROCEDURE

Use hydraulic results for Reach 3 from Table VIII-2 (DMP) to compute τ_o and τ_{oc} . Compute τ_o from Shield's Method (copy of graph attached).

COMPUTATION

$$q_b = \frac{12.85}{\sqrt{1.94(165.4)}} (2.6 - 0.049)^{1.5}$$
$$q_b = 0.22726 \text{ cfs/ft}$$

Now convert to $Q_s = q_s \times TW \times 360$

$Q_s = 0.22726 \text{ cfs/ft}(513 \text{ ft})(360 \text{ sec})$
 $Q_s = 41,970 \text{ cu ft} = 100\text{-yr. result for one hydrograph ordinate at peak discharge.}$
Note that the DMP 100-yr. result for the hydrograph ordinate is 82,696 cu ft

RESULTS SUMMARY FOR REACH 3 ONLY

The MPM-Einstein Equation produces values of only 51% of the values computed in the DMP.

COMPARISON OF DMP, MPM-WOO AND MPM-EINSTEIN RESULTS

Source or Equation	Peak Q for 360 sec 100-yr. Results - Q_s (Sediment Transport Capacity)		
	(cu ft)	% of DMP	% by which the DMP is greater
DMP	82,696	—	—
MPM-Woo	71,009	86	14
MPM-Einstein	41,970	51	49

CONCLUSION

The purpose of this analysis was to determine if the Prudent Line as developed in the DMP is adequate as compared to results from two other equations and the Prudent Line methodology presented in the SEDG. Based on the comparison of the sediment transport capacity results presented in this analysis and the description of the procedure used to plot the Prudent Line as presented in the DMP, the following conclusion may be derived. Development of a Prudent Line based on the MPM-Woo and MPM-Einstein Equations using the methodology described in the SEDG would result in a Prudent Line very similar to the Prudent Line presented in the DMP.

**INCIPIENT MOTION ANALYSIS
USING SHIELD'S METHOD**

Computed by Resource Technology, Inc.

TABLE
ARROYO NAME / SUBREACH NAME TIERRE ARROYO / REACH 3
INCIPIENT MOTION USING SHIELD'S DIAGRAM

RETURN PERIOD (yr)	$\bar{Q}_p$ (cfs)	$\bar{V}$ (ft/sec)	$\bar{A}$ (ft ²)	$\bar{TW}$ (ft)	$\bar{Y}$ (ft)	$\bar{R}$ (ft)	$\bar{S}$ (ft/ft)	γ_o (lb/ft ²)	d_{50} (ft)	V^* (ft/sec)	Re^* g	F_s h	γ_c (lb/ft ²)	$\frac{\gamma_o}{\gamma_c}$ i	COMMENT
USE	HYDRAULIC RESULTS		FROM		DMP (TABLE VIII-2)		TO								
	COMPUTE HYDRAULIC		DATA		NEEDED										
100	18065	9.95	1816 (a)	513	3.54	3.5 (b)	0.012126	2.6 (c)	0.0086 (d)	1.16	830	0.056	0.049	$\frac{2.6}{0.049}$	ALL SED WILL MOVE
(a)	$\frac{18065}{9.95}$	= 1816	(b) $R = \frac{A}{P}$, ASSUME $P = TW + Y$		$2(Y) + TW$	(c) $\gamma = \gamma R S$		(d) $d_{50} = 2.63 \text{ mm}$							
			$R = \frac{1816}{2(3.54) + 513}$		= 3.47 = 3.5	= 62.4 (3.5) 0.012126		$2.63 \text{ mm} \left(\frac{-0.0328 \text{ ft}}{1 \text{ mm}} \right)$							
						$\gamma = 2.6$		= 0.0086 ft							

a) $Y = A / TW$ b) $R = A / P$, ASSUME $P = TW + Y \therefore R = A / (TW + Y)$
c) $S = \text{bed slope}$ d) $\gamma_o = \gamma R S$ e) $d_{50} = \text{sediment size analyzed (\% finer FROM GRAD CURVE)}$

f) $V^* = \sqrt{\frac{\gamma_o}{\rho_f}}$ g) $Re^* = \frac{V^* d_{50}}{\nu}$ h) $F_s = \text{OBTAINED FROM SHIELD'S DIAGRAM}$

i) $\gamma_c = F_s \gamma (S_s - 1) d_{50}$

NOTE:
FOR $d_{50} > \frac{1}{4}$ or 0.25' and $Re^* > 400$
CRITICAL STONE SIZE = $d_c = 11 R S$

CONSTANTS $\gamma = 62.4 \frac{\text{lb}}{\text{ft}^3}$, $\rho_f = 1.94 \frac{\text{lb-sec}^2}{\text{ft}^4}$, $\nu = 1.2 \times 10^{-5} \frac{\text{ft}^2}{\text{sec}}$

$\frac{\gamma_o}{\gamma} = RS$

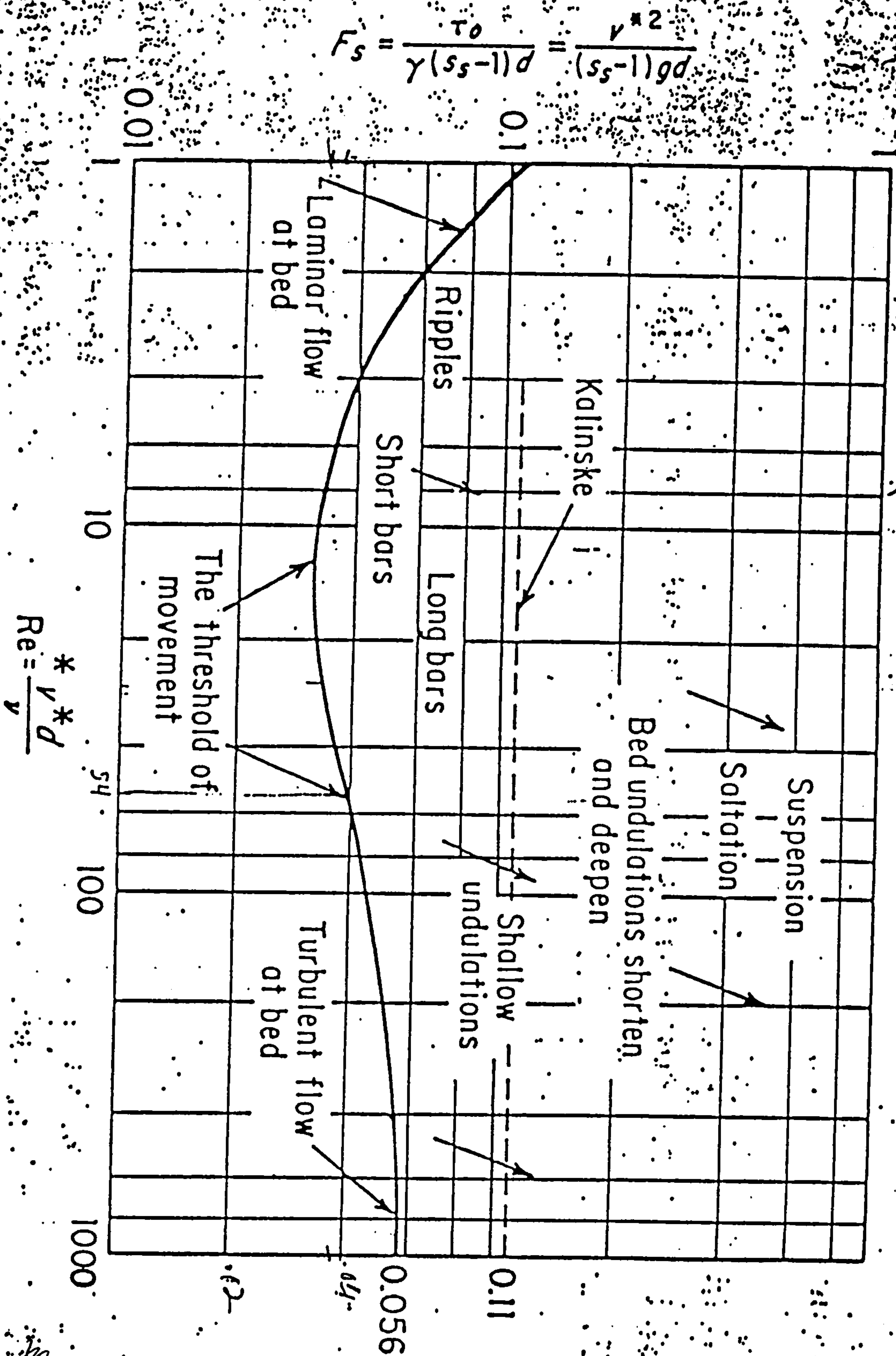


Figure 10-3. The Entrainment Function, after A. Shields [5]

of interest lies in the annotations in the region above the curve, representing a moving bed. These are known as "bed forms".

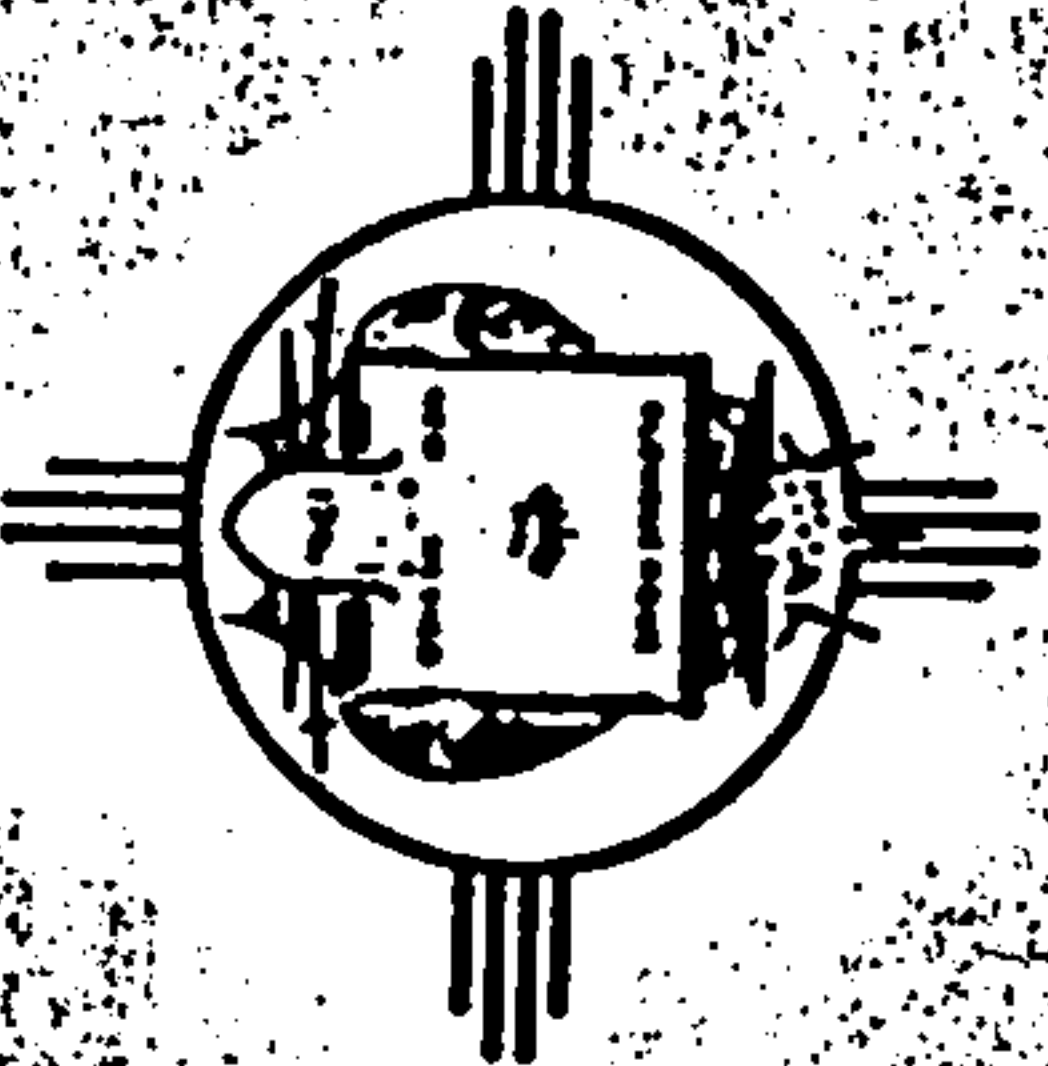
Debbie
Debra Dixon

6016.21

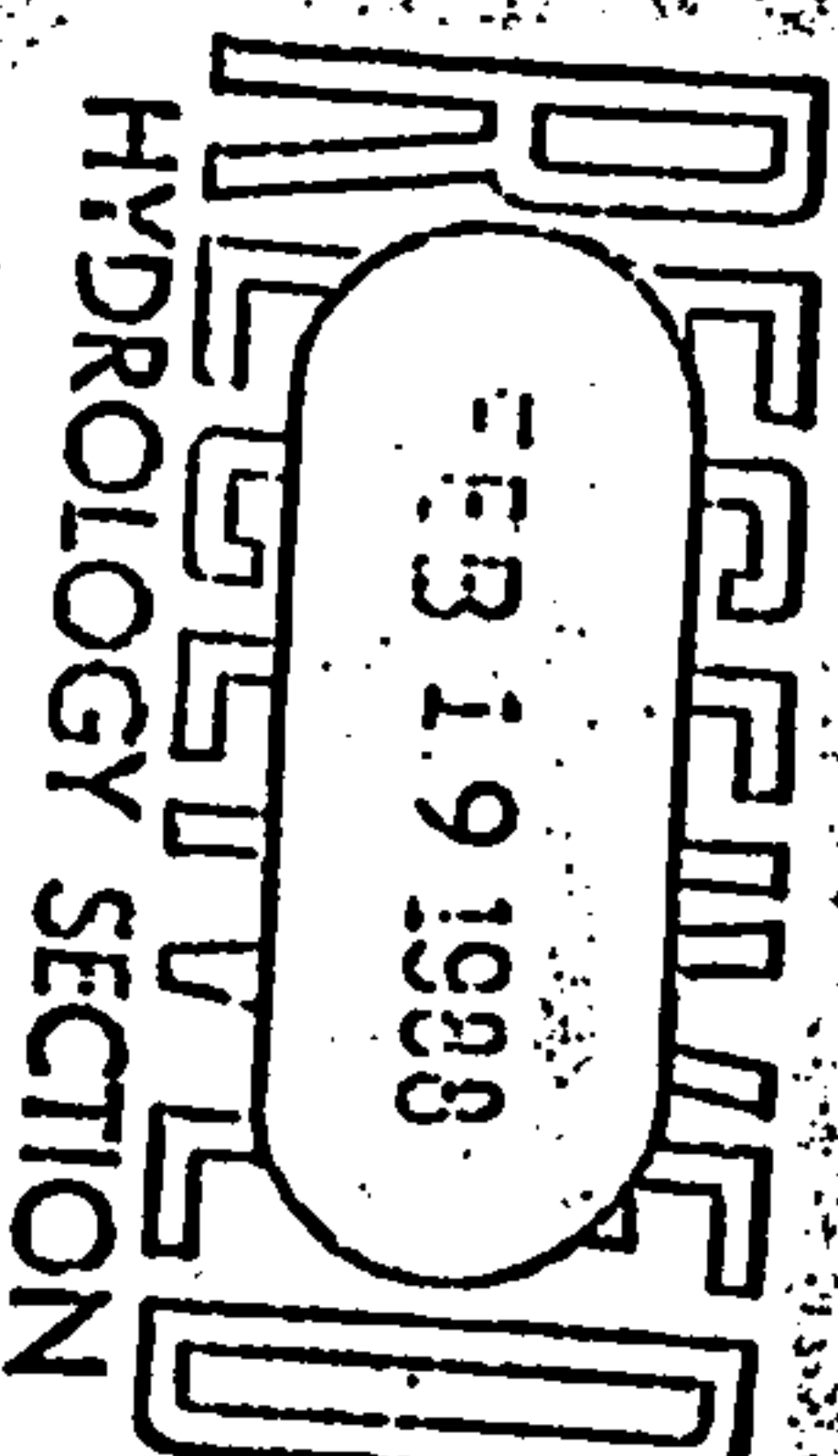
TIJERAS ARROYO DRAINAGE MANAGEMENT PLAN PHASE II

Prepared for
CITY OF ALBUQUERQUE

DRAFT



FEBRUARY 1988



LEEDSHILL-HERKENHOFF, INC.

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

ENGINEERS

ARCHITECTS



TABLE VIII-2
CHANNEL FLOW CHARACTERISTICS

Discharge (cfs)	Hydraulic Depth (Feet)	Velocity (fps)	Width (Feet)	Slope (Ft/Ft)	Sediment Transfer Qs (cfs)
Reach 1					
1560	2.61	8.19	73	.01232	11.46
3360	4.08	10.29	80	.01232	25.49
6285	5.88	11.88	90	.01232	49.36
11570	8.28	13.31	105	.01232	97.81
17210	9.95	15.04	115	.01232	152.78
18065	10.22	15.24	116	.01232	161.53
Reach 2					
1560	2.26	7.12	97	.01325	11.80
3360	3.41	8.01	123	.01325	26.53
6285	4.47	8.79	160	.01325	53.90
11570	5.50	10.36	203	.01325	105.82
17210	6.10	12.37	228	.01325	160.90
18065	6.20	12.56	232	.01325	169.75
Reach 3					
1560	1.37	4.65	245	.012126	9.29
3360	1.78	5.90	370	.012126	21.91
10- ~~11~~ 6285	2.24	7.10	395	.012126	43.61
11570	2.88	8.73	460	.012126	85.91
17210	3.47	9.82	505	.012126	131.83
100- ~~11~~ 18065	3.54	9.95	513	.012126	138.89
Reach 4					
1560	1.10	5.56	255	.01394	13.32
3360	1.76	6.89	277	.01394	28.10
10- ~~11~~ 6285	2.54	8.25	300	.01394	53.91
11570	3.62	9.77	327	.01394	104.47
17210	4.57	11.08	340	.01394	163.67
18065	4.70	11.30	340	.01394	173.05
Reach 5					
1560	2.85	7.82	70	.01520	14.16
3360	4.16	9.28	87	.01520	33.20
10- ~~11~~ 6285	5.64	10.72	104	.01520	68.19
11570	7.48	12.78	121	.01520	137.30
17210	9.00	14.38	133	.01520	217.38
18065	9.22	14.62	134	.01520	229.80

TABLE VIII-3

SEDIMENT TRANSPORT CAPACITY VOLUMES (CUYD)
FOR VARIOUS STORM EVENTS

<u>REACH</u>	<u>2-yr</u>	<u>5-yr</u>	<u>10-yr</u>	<u>25-yr</u>	<u>50-yr</u>	<u>100-yr</u>	<u>25-yr Accum.</u>
1	3,634	7,412	13,643	25,287	38,693	39,940	155,620
2	3,765	7,739	14,336	26,743	41,093	42,435	163,253
3	2,997	6,206	11,567	21,710	33,494	34,603	131,520
4	4,277	8,529	15,406	28,028	42,370	43,681	176,682
5	4,418	9,397	17,909	34,365	53,789	55,652	202,622

TABLE VIII-4

VOLUMES OF EROSION OR DEPOSITION (CUYD)

<u>REACH</u>	<u>2-yr</u>	<u>5-yr</u>	<u>10-yr</u>	<u>25-yr</u>	<u>50-yr</u>	<u>100-yr</u>	<u>25-yr Accum.</u>
1	+131	+327	+693	+1,456	+2,400	+2,495	+7,633
2	-768	-1,533	-2,769	-5,033	-7,599	-7,832	-31,733
3	+1,280	+2,323	+3,839	+6,318	+8,876	+9,078	+45,162
4	+141	+868	+2,503	+6,337	+11,419	+11,971	+25,940
5	NA	NA	NA	NA	NA	NA	NA

(-) Erosion
(+) Deposition
NA Not Applicable

TABLE VIII-6
SOIL SAMPLE SUMMARY

SAMPLE NO.	LOCATION		D-50% IN MM	D-90% IN MM
LH #1	Channel Bed	Approx. Sec. AS	4.0	12.0
LH #2	Floodplain	Approx. Sec. AS	2.0	15.0
LH #3	North Bank	Approx. Sec. AS	2.0	11.0
LH #4	Channel Bed	Between Sec. AQ & AR	1.7	5.4
LH #5	South Bank Low Flow Channel	Between Sec. AP & AQ	0.07	1.2
LH #6	350'± Below Four Hills Rd. Floodplain	Approx. Sec. AX	1.3	6.8
BG #2*	Sta. 575 Bed	Approx. Sec. BB	6.0	18.0
BG #3*	Sta. 575 Bank	Approx. Sec. BB	0.23	0.9
BG #4*	Sta. 575 Floodplain	Approx. Sec. BB	3.0	8.0
BG #5*	Sta. 644+30 Bed	Approx. Sec. AT	8.0	39.0
BG #6*	Sta. 644+30 Bank	Approx. Sec. AT	0.6	2.9
			<u>28.90</u>	<u>120.20</u>
		Mean	2.63	10.93

Note:

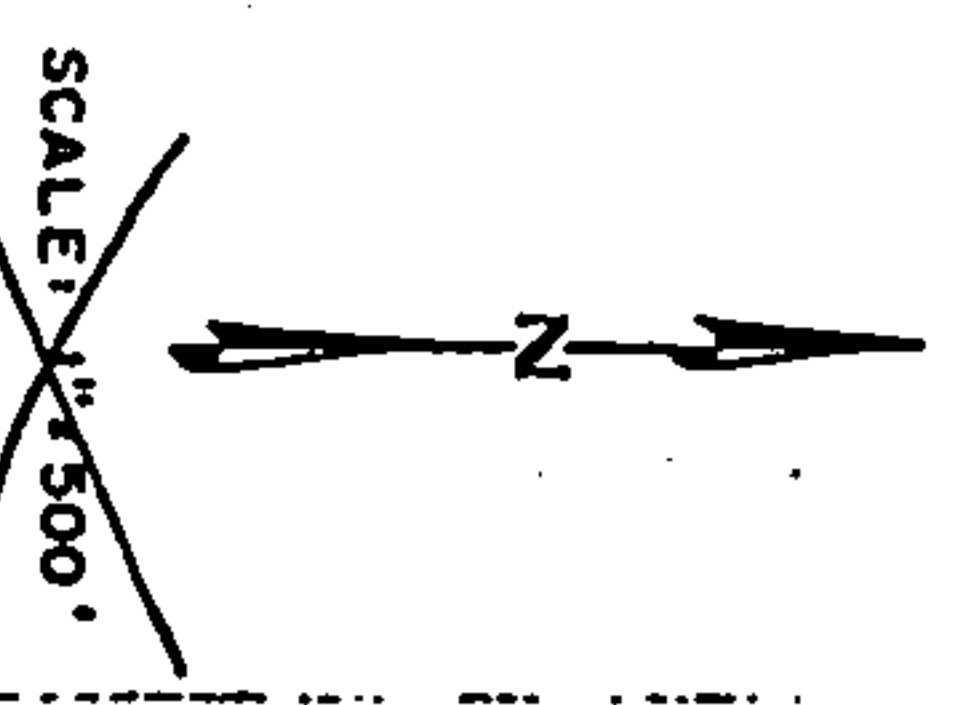
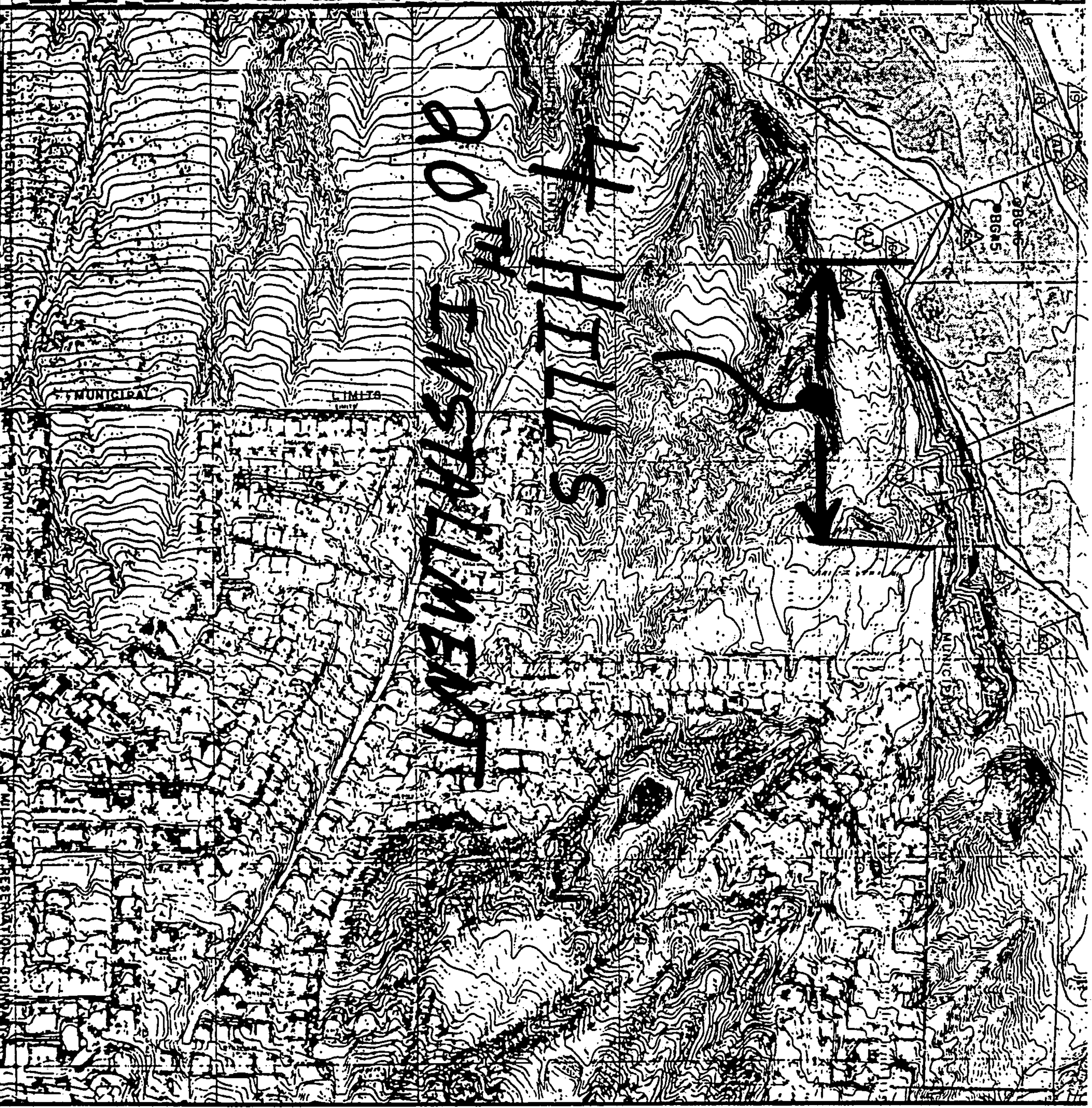
* Soil tests by Butch Gerbrandt, 1986.
Soil sample locations are plotted on sheets L-23, M-21, and M-22.

TABLE VIII-7

SUBREACH PHYSICAL CHARACTERISTICS

Subreach Number	From	To	Length (ft.)	Slope ft/ft
1	Sec KBU	500' below Sec A0	2070	.01232
2	500' below Sec. A0	Sec AR	2700	.01325
3	Sec. AR	500' below Sec. AW	6350	.012126
4	500' below Sec. AR K.V.U	Sec. F2	2367	.01394
5	Sec. F2	Sec. BE	5460	.01520

Note: Section locations are illustrated on Sheet Nos. L-22, L-23, M-21, M-22.



KEY TO MAP

- 100-YEAR FLOOD BOUNDARY — [Symbol: thick black line]
- CROSS SECTION LINE — [Symbol: line with cross-section symbols]
- OFFSET TANGENT LINES DELINEATING BOUNDARIES BEYOND WHICH DEVELOPMENT WOULD NOT BE PRUDENT. [Symbol: dashed line]
- SOIL SAMPLE LOCATION @ BG#5 [Symbol: circle with cross]

NOTES TO USER

BOUNDARIES OF THE FLOODPLAINS WERE COMPUTED AT CROSS SECTIONS AND INTERPOLATED BETWEEN CROSS SECTIONS.

THIS MAP WAS PREPARED TO FACILITATE FLOODPLAIN MANAGEMENT ACTIVITIES ONLY. IT MAY NOT SHOW ALL SPECIAL FLOOD HAZARD AREAS IN THE COMMUNITY OR ALL PLANIMETRIC FEATURES OUTSIDE OF THE FLOODPLAIN. REFER TO THE LATEST OFFICIAL FLOOD INSURANCE RATE MAP FOR ANY ADDITIONAL AREAS OF SPECIAL FLOOD HAZARD.

THIS MAP WAS PRODUCED BY PHOTOGRAMMETRIC METHODS USING PREVIOUSLY PREPARED (BY OTHERS) MATERIALS OBTAINED FROM THE CITY OF ALBUQUERQUE. DATE OF PHOTOGRAPHY 1982. 2-FOOT CONTOUR INTERVAL ESTABLISHED ON NATIONAL GEODETIC DATUM OF 1929. COORDINATES SHOWN ARE NEW MEXICO STATE PLAIN COORDINATES, CENTRAL ZONE. SHEET INDEX GRID EQUALS CITY ZONE ATLAS.

L	M	N	P	Q
14	15	16	17	18
19	20	21	22	23

SHEET INDEX

TIJERAS ARROYO DRAINAGE MANAGEMENT PLAN

PHASE II PRUDENT LIMITS

FEBRUARY 1988

LEEDSHILL-HERKENHOFF, INC. ENGINEERS & ARCHITECTS SHEET M-22

APPENDIX C

SEDIMENT TRANSPORT COMPUTER PRINTOUTS

Sediment Transport Calculation for Channel Reach 3

Peak

10-Year

Discharge

6284

cfs

Bedload Transport Factor

0.46641

Bedload Transport Exponent

1.10380

Time (hr:min)	Discharge (cfs)	Average Discharge (cfs)	Time Interval (min)	Bedload Transport (lbs/sec)	Sediment Transport (lbs)	Cumul. Transport (tons)
9.00	0	0	10.00	0.0	0	0
9.10	0	0	10.00	0.0	0	0
9.20	0	0	10.00	0.0	0	0
9.30	120	60	10.00	42.8	25683	12
9.40	484	305	10.00	237.1	124278	40
9.50	862	676	10.00	612.6	371757	276
1.00	1132	444	10.00	423.8	272268	562
1.10	1344	1567	10.00	1344.1	804332	967
1.20	2342	1471	10.00	2014.4	1211416	1573
1.30	3266	2804	10.00	2281.4	1788860	2467
1.40	4234	3723	10.00	4112.2	2423484	3701
1.50	5156	4688	10.00	5237.2	3154308	5278
2.00	5814	5475	10.00	6240.2	3744101	7150
2.10	6200	6007	10.00	6912.7	4147643	9224
2.20	6284	6242	10.00	7211.8	4227105	11387
2.30	6130	6207	10.00	7167.2	4300332	13538
2.40	5703	5917	10.00	6797.4	4078724	15577
2.50	5161	5432	10.00	6186.1	3711656	17433
3.00	4543	4852	10.00	5461.2	3276714	19071
3.10	3401	4222	10.00	4684.0	2810387	20476
3.20	3282	3592	10.00	3918.2	2350892	21652
3.30	2715	2999	10.00	3210.5	1926308	22615
3.40	2214	2465	10.00	2585.6	1551349	23391
3.50	1787	2001	10.00	2053.8	1232298	24007
4.00	1431	1604	10.00	1615.0	968982	24491
4.10	1132	1285	10.00	1260.0	756008	24869
4.20	904	1022	10.00	478.1	586836	25163
4.30	716	810	10.00	757.1	454280	25340
4.40	567	642	10.00	585.3	351158	25565
4.50	444	508	10.00	452.4	271426	25701
5.00	356	403	10.00	344.4	204423	25806
5.10	282	314	10.00	270.7	162406	25887
5.20	224	233	10.00	204.6	123742	25930
5.30	178	201	10.00	162.6	97341	25944
5.40	142	160	10.00	126.4	7828	26027
5.50	113	128	10.00	48.4	34018	26068
6.00	0	37	10.00	40.1	24062	26078

$$\Delta = 2163$$

7.17 ACFT
11387.24 LBS

Sediment Transport Calculation for Channel Reach 3

100-year Peak Discharge 18063 cfs	Time (HR:MM)	Discharge (cfs)	Average Discharge (cfs)	Time Interval (min)	Bedload Transport (lbs/sec)	Sediment Transport (lbs)	Cumul. Transport (tons)
	0.00	0	0	10.00	0.0	0	0
	0.10	0	0	10.00	0.2	130	0
	0.20	1	1	10.00	310.3	186164	93
	0.30	721	361	10.00	1354.5	812701	499
	0.40	2023	1372	10.00	2654.6	1592742	1296
	0.50	3025	2524	10.00	4026.1	2415640	2504
	1.00	4537	3681	10.00	6267.9	3760710	4384
	1.10	6657	5497	10.00	9731.1	5838672	7303
	1.20	9720	8189	10.00	13877.9	8326715	11467
	1.30	12869	11295	10.00	17876.5	10725915	16830
	1.40	15544	14207	10.00	21012.1	12607269	23133
	1.50	17349	16447	10.00	22793.2	13677114	29712
	2.00	18063	17706	10.00	23100.2	13860119	36902
	2.10	17778	17221	10.00	22154.4	13292662	43548
	2.20	16731	16235	10.00	20303.2	12181925	49639
	2.30	15155	15243	10.00	17890.4	10734249	55006
	2.40	13278	14217	10.00	15270.3	9162184	59387
	2.50	11355	12317	10.00	12726.9	7636168	63406
	3.00	9350	10443	10.00	8490.8	5040504	69050
	3.10	7886	8708	10.00	6695.9	4017512	71059
	3.20	6449	7168	10.00	5283.2	3169910	72644
	3.30	5223	5836	10.00	4155.3	2481278	73885
	3.40	4194	4709	10.00	3219.4	1931627	74850
	3.50	3349	3772	10.00	2496.6	1497935	75599
	4.00	2663	3006	10.00	1933.5	1160088	76179
	4.10	2112	2388	10.00	1497.9	898766	76629
	4.20	1676	1894	10.00	1160.8	696490	76977
	4.30	1330	1503	10.00	900.7	540406	77247
	4.40	1056	1193	10.00	700.6	420336	77457
	4.50	840	948	10.00	546.1	327669	77621
	5.00	670	755	10.00	425.9	255547	77749
	5.10	535	603	10.00	332.2	199298	77849
	5.20	427	481	10.00	259.0	153396	77926
	5.30	341	384	10.00	202.3	121361	77987
	5.40	272	307	10.00	162.7	9640	78012
	5.50	218	245	10.00			
	6.00	0	109	10.00			

$\Delta = 6839$

21.45 ACFT
54602.73 CUYD

25 YEAR SED. (LUMS) 296511
25 YEAR SED. (C.Y.) 151320

100 YR SED. (LUMS) /8012
100 YR SED. (C.Y.) 54602

SEDIMENT AND EROSION DESIGN GUIDE

Prepared for

Albuquerque Metropolitan Arroyo
Flood Control Authority
(AMAFCA)

Prepared by

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RCE Ref. No. 90-560

March 1994

RCE RESOURCE CONSULTANTS & ENGINEERS, INC.
A KLH Engineering Group Company

The conditions for which most of the available bed material transport relations were developed are significantly different from those encountered in most arroyos in the Albuquerque area, due to the combination of steep gradients and relatively small sediment sizes found in the typical arroyos. In spite of this shortcoming, various transport equations have been applied to specific projects in the area. Several of these relations are discussed in the following sections to provide a basis for understanding previous studies. These include the Meyer-Peter, Muller-Einstein (MPM-Einstein) method, the Colby method, Yang's equation, and an empirical power function relation developed by Zeller and Fullerton (1983).

In addition to the above, a power function relation developed by Resource Consultants & Engineers, Inc. (Mussetter, 1993, in-press) specifically for steep, sand-bed channels with high suspended sediment concentrations is presented. As discussed below, this relation overcomes many of the shortcomings of the other relations when applied to steep, sand-bed channels such as those found in the Albuquerque area and thus may provide more realistic results over the range of conditions encountered in these channels. It is recommended that this power function relation (Equation 3.41) be used in the Albuquerque area, unless there is analysis and calibration which demonstrates that other methods are more representative of actual conditions.

Meyer-Peter, Muller-Einstein Method

This method gives good results when both the bed-load and suspended load compose a significant portion of the total bed material load. The Meyer-Peter, Muller (MPM) formula, because of its formulation as an excess shear stress equation, is well suited to modeling the transport of sand as well as gravel- and cobble-sized material. The formula, rearranged by USBR (1960), is given by:

$$q_b = \frac{12.85}{\sqrt{\rho \gamma_s}} (\tau_0 - \tau_c)^{1.5} \quad (3.29)$$

where q_b = bed load transport capacity per unit width of channel (cfs/ft) for particle size i

ρ = density of water (1.94 slugs/cu ft)

γ_s = unit of weight of the sediment (pounds/cu ft)

τ_0 = bed shear stress in (lb/sq ft)

τ_c = critical shear stress (lb/sq ft)

The value of τ_c is computed from the Shields relation (Equation 3.25) with Shields dimensionless shear stress equal to 0.047. (Note that at critical conditions the bed shear and critical shear are equal, thus τ_c is obtained by substituting τ_c for τ_0 in Equation 3.25 and rearranging.) To apply Equation 3.29 by size fraction, divide the particle size distribution into discrete size ranges (usually 5 to 10 ranges is sufficient), compute the

geometric mean of each size range and compute the unit bed load, transport capacity is the sum of each transport capacity times the percentage of material in each size range given by:

$$Q_{\text{total}} = \sum Q_{\text{bi}} \Delta \%_i \quad (3.30)$$

$$\begin{aligned} \text{where } Q_{\text{total}} &= \text{transport capacity} \\ q_{\text{bi}} &= \text{transport capacity of the } i\text{-th size range} \\ \Delta \%_i &= \text{incremented percentage of material in the } i\text{-th size range} \end{aligned}$$

The suspended sediment-transport capacity is estimated using a solution developed by Einstein (1950). This method relies upon integration of the sediment concentration profile over the depth of flow assuming equilibrium conditions such that the rate at which sediment is transported upward due to turbulence is exactly equal to the rate at which the sediment is settling downward due to gravity. This equilibrium condition is described by the diffusion equation. The equations used in this method are quite complex and are beyond the scope of this Design Guide. They are discussed in detail in Vanoni (1977) and Simons, Li & Associates, Inc. (1982a). Additional discussion of the applicability of the method and computer code to solve the equations is presented in USGS (1989).

Yang's Bed Material Equation

Yang (1972) developed a relationship for the concentration of bed material discharge as a function of the rate of energy dissipation in the flow using dimensional analysis and the unit stream power concept. The basic form of Yang's equation is

$$\log C_s = M + N \log \frac{VS}{\omega} \quad (3.31)$$

$$\begin{aligned} \text{where } C_s &= \text{bed material concentration in ppm by weight} \\ V &= \text{flow velocity} \\ S &= \text{slope} \\ \omega &= \text{fall velocity of the sediment} \\ M \text{ and } N &= \text{dimensionless parameters related to the flow} \end{aligned}$$

The values of M and N were determined by regression analysis of laboratory data.

For suspended sediment concentrations less than about 4 percent by weight, the original derivation provides reasonable results for most conditions. Einstein and Chien (1955) however, found that the vertical distribution of sands in the water column deviates significantly from that predicted by the original Einstein method for suspended sediment concentrations above approximately 4 percent. The concentration profile becomes progressively more uniform with depth with increasing concentration. Based on their experimental results, they suggested a correction for the exponent on the concentration profile equation to partially compensate for the differences. Subsequent investigators (Chien and Wan, 1965; Ordonez, 1970; Lavelle and Thacker, 1978, van Rijn, 1984; Woo, 1985 and Woo et al., 1988) considered the effects of fall velocity reduction, fluid viscosity, and fluid density on the suspended sand concentration profile. The work of Woo (1985) and Woo et al. (1988) resulted in a complex differential equation that appears to account for the significant changes in fluid characteristics with increasing sediment concentration, and converges to essentially the same solution as obtained from Rouse's (1937) equation at low concentrations. Results obtained from the application of this relationship match the available measured data well.

Mussetter (1993, in-press) linked Woo's (1985) relationship for computing the suspended sediment concentration with the MPM bed-load equation to obtain a method for computing bed material load in streams carrying high concentrations of suspended sediment. Results obtained from this method were compared with the results from other available relations and, to the extent possible, measured sediment yield data. This comparison indicates that the new method may provide more realistic results over the range of flow and sediment transport conditions encountered in arroyos in the Albuquerque area.

The MPM-Woo method was used to estimate bed material transport capacities for a broad range of hydraulic and bed material conditions (see Table 3.6) typical of the Albuquerque area. The results of these computations were then used to develop the following power function relation using multiple regression:

$$q_s = aV^b Y^c (1-C_r/10^6)^d \quad (3.41)$$

Table 3.6. Range of Conditions for which Equation 3.41 was Developed.

q (cfs)	V (fps)	Y (ft)	S _o	C _r (ppm)	D ₅₀ (mm)
1	1.9	0.3	0.005	0	0.2
80*	20.8*	7.2*	0.04*	60,000*	4.0*

* 3'

where

q_s	=	unit width bed material load in cfs/ft
V	=	average velocity in fps
Y	=	hydraulic depth in feet
C_f	=	fine sediment (silt and clay) concentration by weight.
S_o	=	channel slope

Values for the coefficient (a) and exponents (b, c, and d) are shown in Figure 3.10 as a function of the median bed material size. In applying Equation 3.41, the predicted bed material concentration (C_s) should not exceed the maximum concentration given by the equation:

$$C_{s_{max}} = 510,000 - 65,000 D_{50} \quad (3.42)$$

where D_{50} = medium bed material size in mm
 C_s = computed from the relation:

$$C_s = \frac{2.65 \times 10^6 Q_s}{(Q + 2.65 Q_s)} \quad (3.43)$$

and

$$Q_s = q_s W \quad (3.44)$$

When $C_{s_{max}}$ as given by Equation 3.42 is exceeded, non-Newtonian flow conditions are indicated and the assumptions upon which Equation 3.41 (and the other bed material transport equations presented in this Design Guide) is based are no longer valid. For these conditions, procedures applicable for non-Newtonian fluids (e.g., mudflows) should be considered.

Note that Equation 3.41 predicts bed material load only; the total sediment load is computed by adding the bed material and fine sediment loads, where the fine sediment load is computed from:

$$Q_f = \frac{C_f Q}{2.65 \times 10^6} \quad (3.45)$$

and the total sediment load is given by:

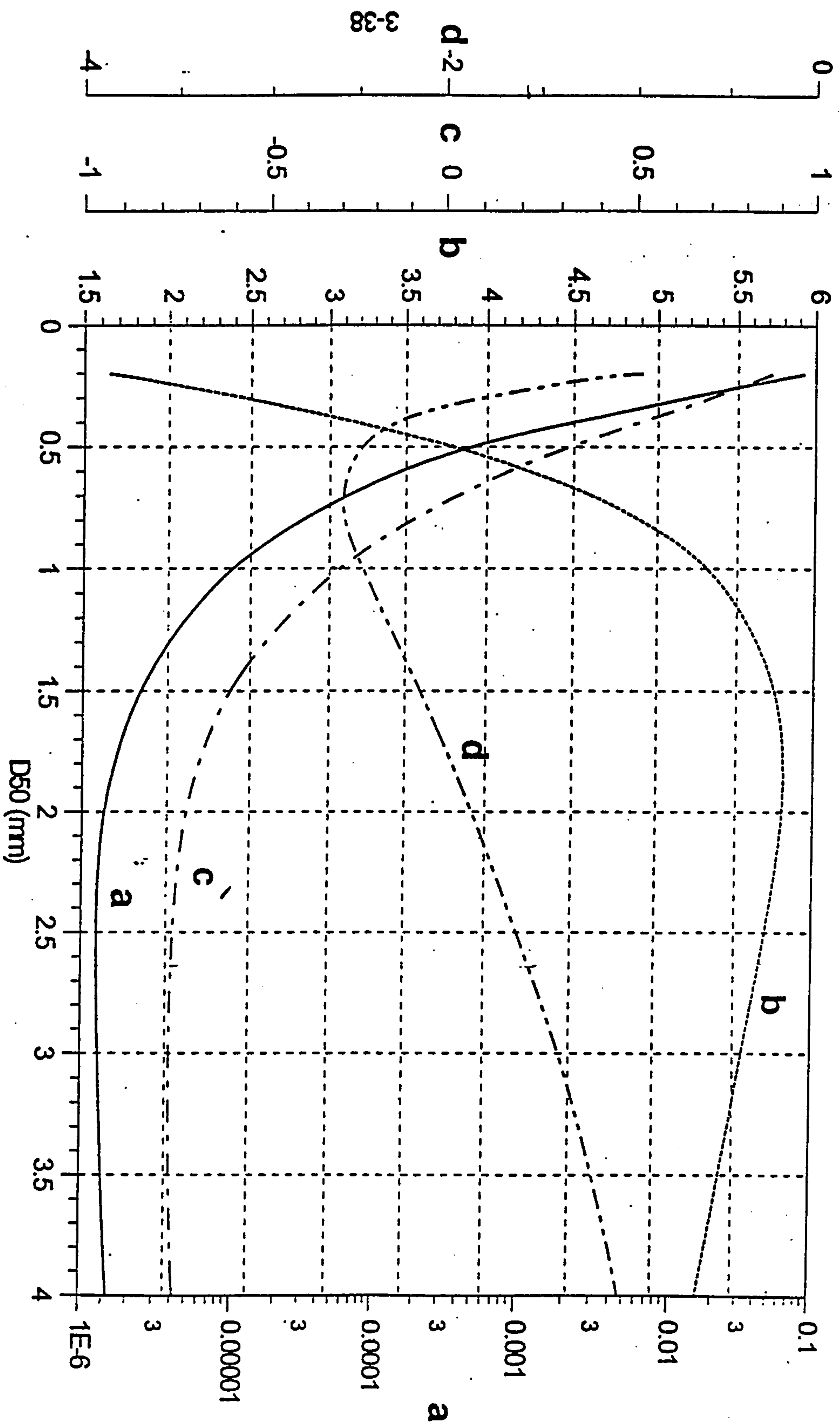


Figure 3.10. Coefficient and exponents for Equation 3.41, developed using MPM-Woo method.

ATTACHMENT 2

4-Hills 20th Installment

A2.1

RTI File No. 94-060

TABLE 1

Tijeras Arroyo Peak Discharge (cfs) Information				
Return Period, Yrs.	COE 1974 (a)	RTI/USGS (b)	L-HI 1988 - DMP (c)	FEMA/USGS 1983
500	22,600 (IRF)	25,694	18,065	28,600
100		12,875		14,300
50		9,102		10,000
10		3,344	6,285	5,120

(a) Floodplain Information Albuquerque Arroyos Part IV, Albuquerque, New Mexico. Department of the Army, Albuquerque, New Mexico; Corps of Engineers, Albuquerque, New Mexico. June 1974 (pg. 9-11).

Discussion with Army Corps of Engineers (10-21-94) indicate background information is unavailable and therefore we assume the peak discharge was developed with a HEC-1 model. IRF = Intermediate Regional Flood = 100-yr. flood. Drainage Area = 76 sq.mi.

(b) RTI used USGS Stream Gage No. 08330500 data, 41 years of record, although 15 years of the peak flow data were below the gage base discharge of 250 cfs and were eliminated before the Log-Pearson Type III flood probability analysis was completed by the U.S. Geological Survey. The gage is located approximately 1 mile upstream of Four Hills Road. Discharges shown include Conditional Probability. Drainage Area = 75.30 sq.mi.

(c) L-HI - DMP at Four Hills Road (approximately). Peak discharge was obtained from a HEC-1 model. Drainage Area = 78 sq.mi.

COMPARISON OF DMP SEDIMENT TRANSPORT EQUATION RESULTS TO THE MPM-WOO EQUATION (SEDG) RESULTS

PURPOSE

Perform a brief comparison of the sediment transport equation results between the equations presented in the "Tijeras Arroyo Drainage Management Plan (DMP) Phase II" Report (Leedshill-Herkenhoff, Inc., February, 1988), and the MPM-Woo Equation presented in the "Sediment and Erosion Design Guide" (SEDG) (Resource Consultants and Engineers, Inc., March 1994).

PROCEDURE

Locate the 4-Hills 20th Installment Subdivision with respect to the DMP designated reaches and determine the applicable reach and its associated data and results as presented in the DMP. The Sheets and Tables referenced below are included at the end of this attachment.

LOCATION - Sheet M-22 in DMP
HEC-2 Sections - AT to AU (Sheet M-22 in DMP)
 D_{50} - Average of all samples = 2.63mm (Table VIII-6 in DMP). As shown on Sheet M-22, Sample No.'s BG #5 and BG #6 are near the proposed subdivision. Table VIII-6 indicates BG #5 is a bed sample with D_{50} = 8.0mm and BG #6 is a bank sample with D_{50} = 0.6mm. Due to this range of extreme sizes compared to the other D_{50} values presented in Table VIII-6, the mean D_{50} of all samples was assumed which is 2.63mm (Table VIII-6).

Reach No. 4 - Table VIII-7 in DMP (Located upstream of Reach 3)
V, Y, S_0 and D_{50} (Table VIII-2 in DMP) are all within range of values for which the MPM-Woo Equation is applicable (Table 3.6 in SEDG)

Therefore, based on D_{50} = 2.63mm, compute MPM-Woo Equation coefficient and exponents from Figure 3.10 in SEDG.

a = 0.000002
b = 5.67
c = -0.76
d = -1.6
Cf - assume 1 PPM and repeat for maximum concentration = 60,000 PPM because DMP did not present or consider Cf

Select 10-yr. and 100-yr. Q and Qs discharge values presented in DMP for Reach 4 (Appendix C, DMP), obtain V and Y for the 10-yr and 100-yr. Q's from Table VIII-2 (DMP), apply MPM-Woo Equation and compute Qs. Compare the results of the 10-yr. and 100-yr. Qs computations between DMP results and MPM-Woo Equation.

NOTE: This data is for one-time period at maximum discharge on the hydrograph.

Data Type	Return Period	
	10-yr.	100-yr.
Q (cfs)	6,285	18,065
V (ft/sec)	8.25	11.30
Y (ft)	2.54	4.70
TW (ft)	300	340

Hyd. Ord. Time Interval = 0.1 hrs. = 360 sec.

SEDIMENT TRANSPORT CAPACITY RESULTS (REACH 4)

Q	DMP		MPM-WOO		Difference	
	Cf	Qs	Qs	qs	Qs	% of DMP
(cfs)	(assumed)	(tons)	(cu ft)	(cfs/ft)	(cu ft)	
6,285	1 PPM	2,773	33,531	0.15476	16,714	—
6,285	60,000 PPM	2,773	33,531	0.17086	18,453	55
18,065	1 PPM	8,305	100,423	0.57702	70,627	—
18,065	60,000 PPM	8,305	100,423	0.63707	77,977	77

(a) assume specific weight of sediment = 165.4 lbs/cu.ft.
 $\text{tons} \frac{(2000 \text{ lbs})}{(1 \text{ cu ft})} = \text{cu ft}$
 $(1 \text{ ton}) (165.4 \text{ lbs})$

(b) $Q_s = q_s (TW)(360)$
 $Q_s = \frac{\text{cu ft/sec}}{\text{ft}} (\text{sec}) = \text{cu ft}$

(c) tons in DMP is for Q lasting 360 sec (Appendix C in DMP)

RESULTS SUMMARY FOR REACH 4 ONLY

The MPM-Woo Equation produces values of only 55% (10-yr.) to 77% (100-yr.) of the values computed in the DMP (if Cf = 60,000 PPM).

PRUDENT LINE ASSUMPTIONS IN DMP

Only the long term 25-yr. aggradation/degradation volume was used in the DMP to predict the aggradation/degradation in the reach and lateral bank movement. However, the current methodology states that the long term volume plus the 100-yr. volume is the total volume that should be used to develop the Prudent Line.

ROUGH ADJUSTMENT TO DMP PRUDENT LINE RESULTS

A rough adjustment and comparison of the DMP long term and 100-yr. sediment transport capacity results was completed to determine the increase (in percent) that would occur in the DMP results if the 100-yr. transport capacity volume were added to the long term sediment transport capacity volume. The following values were obtained from Table VIII-3 in the DMP for the total sediment transport capacity of the hydrograph.

$$\begin{array}{rcl} \text{100-yr. volume} & = & 43,681 \text{ CY} \\ \text{25-yr. long term volume} & = & \frac{176,682 \text{ CY}}{220,363 \text{ CY}} \\ \text{TOTAL} & & \end{array}$$

$$\begin{array}{l} \text{Therefore } \frac{\text{25-yr. long term}}{\text{Total}} = \frac{176,682}{220,363} = 80\% \\ \text{(100-yr. + long term)} \end{array}$$

CONCLUSION

For Reach 4, the addition of the 100-yr. volume to the long term volume would increase the total such that the 25-yr. long term volume is 80% of the total volume. For simplicity this may be converted to a 20% increase in the prudent line if the total (100-yr. + 25-yr. long term) were used. Note that the previous comparison to the MPM-Woo Equation results indicated that the MPM-Woo Equation produced results 77% (100-yr.) of the DMP results. This may be converted to state that the DMP results are 23% greater than the MPM-Woo results. Also, the peak flow rates in the DMP are approximately 50% greater than those being considered at present.

Therefore, if the MPM-Woo Equation results were used to develop the Prudent Line based on the total 100-yr. and long term results, the result may be very similar to the Prudent Line determined in the DMP based on the analysis and comparison of results presented here for Reach 4.

COMPARISON OF DMP SEDIMENT TRANSPORT EQUATION RESULTS TO THE MPM-EINSTEIN EQUATION (SEDG) RESULTS

PURPOSE

Compare DMP 100-yr. results with the Meyer-Peter, Muller-Einstein Equation results.

MPM - Einstein Equation (see Sediment & Erosion Design Guide, March 1994 for more information, pg. 3-29)

$$q_b = \frac{12.85}{\sqrt{\rho \gamma_s}} (\tau_o - \tau_c)^{1.5}$$

PROCEDURE

Use hydraulic results for Reach 4 from Table VIII-2 (DMP) to compute τ_o and τ_{oc} .
Compute τ_o from Shield's Method (copy of graph attached).

COMPUTATION

$$q_b = \frac{12.85}{\sqrt{1.94(165.4)}} (4.4 - 0.049)^{1.5}$$
$$q_b = 0.5062 \text{ cfs/ft}$$

Now convert to $Q_s = q_s \times TW * 360$

$$Q_s = 0.5062 \text{ cfs/ft}(340 \text{ ft})(360 \text{ sec})$$

$$Q_s = 61,962 \text{ cu ft} = 100\text{-yr. result for one hydrograph ordinate at peak discharge.}$$

Note that the DMP 100-yr. result for the hydrograph ordinate is 100,423 cu ft.

RESULTS SUMMARY FOR REACH 4 ONLY

The MPM-Einstein Equation produces values of only 62% of the values computed in the DMP.

COMPARISON OF DMP, MPM-WOO AND MPM-EINSTEIN RESULTS

Source or Equation	Peak Q for 360 sec		
	100-yr. Results - Q_s (Sediment Transport Capacity)		
	(cu ft)	% of DMP	% increase in DMP
DMP	100,423	—	—
MPM-Woo	77,977	77	23
MPM-Einstein	61,962	62	38

**INCIPIENT MOTION ANALYSIS
USING SHIELD'S METHOD**

Computed by Resource Technology, Inc.

TABLE

ARROYO NAME / SUBREACH NAME TIJERAS ARROYO / REACH 4
INCIPIENT MOTION USING SHIELD'S DIAGRAM

RETURN PERIOD (yr)	$\bar{Q}_p$ (cfs)	$\bar{V}$ (ft/sec)	$\bar{A}$ (ft ²)	$\bar{TW}$ (ft)	$\bar{Y}$ (ft) a	$\bar{R}$ (ft) b	$\bar{S}$ (ft/ft) c	τ_0 (lb/ft ²) d	d_z d ₅₀ (ft) e	V^* (ft/sec) f	Re^* g	F_s h	τ_c (lb/ft ²) i	$\frac{\tau_0}{\tau_c}$	COMMENT
USE	HYDRAULIC RESULTS IN COMPUTE HYDRAULIC DATA				DMP (TABLE VIII-2) NEEDED.				TO						
100	18065	11.30	1599 (a)	340	4.70	4.6 (b)	0.01394	4.4 (c)	0.0086 (d)	1.5	1079	0.056	0.049	$\frac{4.4}{0.049}$	ALL SED. WILL MOVE
(a)	$\frac{18065}{11.30}$	= 1599	(b) $R = \frac{A}{P}$ assume $P = 2(Y) + TW$	$R = \frac{1599}{2(4.7) + 340} = 4.6$		(c) $\tau_0 = \gamma R S$	$\tau_0 = 62.4(4.6)(0.01394) = 4.4$		(d) need $d_{50} = 2.63 \text{ mm}$	$2.63 \text{ mm} (0.00328 \text{ ft}) = 0.0086 \text{ ft.}$					

a) $Y = A / TW$ b) $R = A / P$, ASSUME $P = TW + Y \therefore R = A / (TW + Y)$
c) $S = \text{bed slope}$ d) $\tau_0 = \gamma R S$ e) $d_z = \text{sediment size analyzed (\% finer FROM GRAD CURVE)}$

f) $V^* = \sqrt{\frac{\tau_0}{C_f}}$ g) $Re^* = \frac{V^* d_z}{\nu}$ h) $F_s = \text{OBTAINED FROM SHIELD'S DIAGRAM}$

i) $\tau_c = F_s \gamma (S_s - 1) d_z$

NOTE:
FOR $d_z > \frac{1}{4}$ or 0.25 and $Re^* > 400$
CRITICAL STONE SIZE $= d_c = 11 R S$

CONSTANTS $\gamma = 62.4 \frac{\text{lb}}{\text{ft}^3}$, $C_f = 1.94 \frac{\text{lb-sec}^2}{\text{ft}^4}$, $\nu = 1.2 \times 10^{-5} \frac{\text{ft}^2}{\text{sec}}$

$\frac{\tau_0}{\gamma} = RS$

THE THRESHOLD OF MOVEMENT

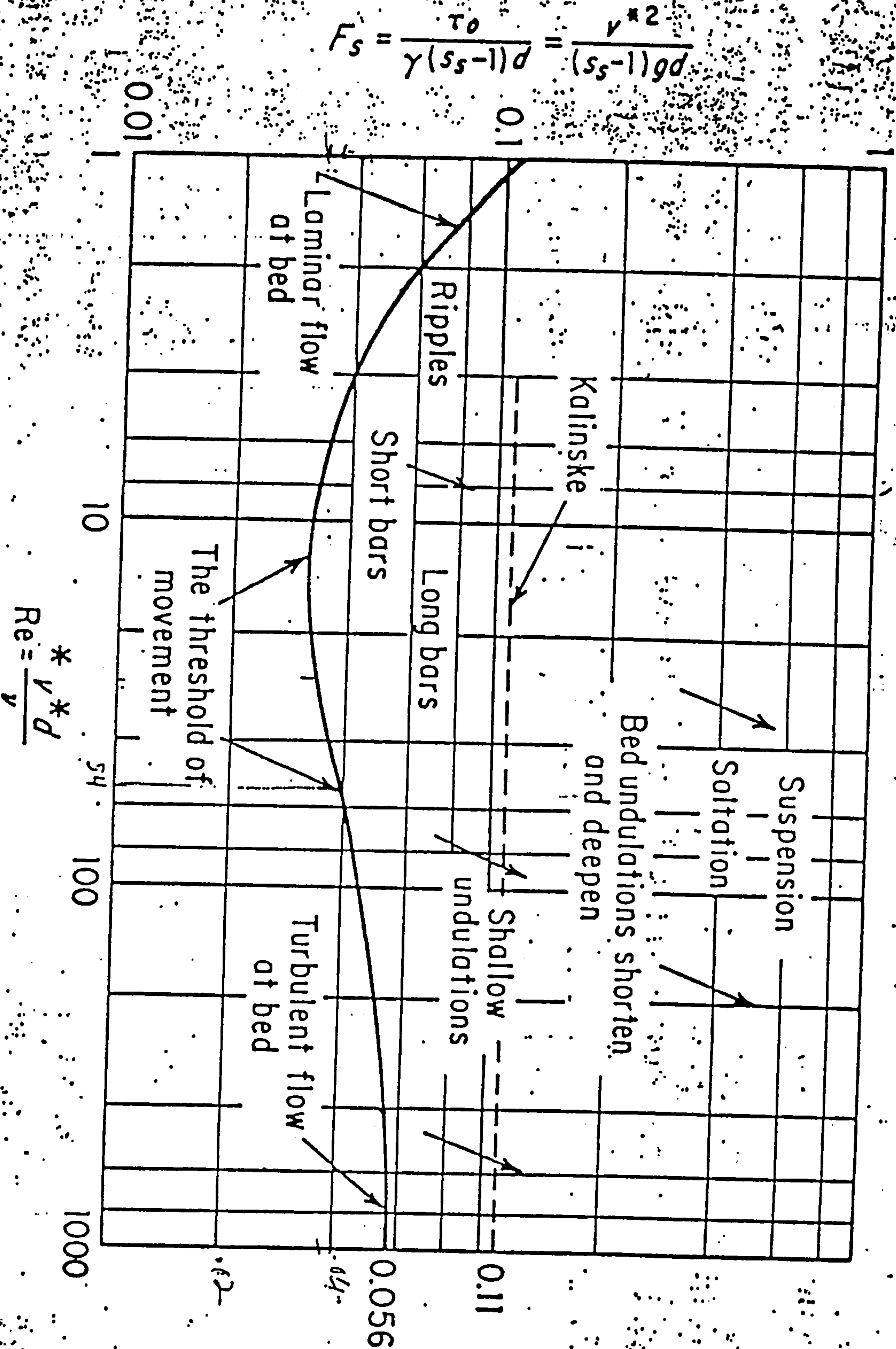


Figure 10-3. The Entrainment Function, after A. Shields [5]

of interest lies in the annotations in the region above the curve, representing

Sediment Transport Calculation for Channel Reach 4

10-year	Peak	Discharge	Bedload Transport Factor	Bedload Transport Exponent	0.93957	1.05206
		6284				
		cfs				
Time (HR.MN)	Discharge (cfs)	Average Discharge (cfs)	Time Interval (min)	Bedload Transport (lbs/sec)	Sediment Transport (lbs)	Cumul. Transport (tons)
0.00	0	0	10.00	0.0	0	0
0.10	0	0	10.00	0.0	0	0
0.20	0	0	10.00	0.0	0	0
0.30	120	60	10.00	69.8	41860	21
0.40	489	305	10.00	385.3	231187	137
0.50	862	676	10.00	891.0	534584	404
1.00	1135	999	10.00	1344.1	806445	807
1.10	1599	1367	10.00	1870.4	1122269	1368
1.20	2342	1971	10.00	2748.0	1648817	2193
1.30	3266	2804	10.00	3982.9	2389735	3387
1.40	4234	3753	10.00	5411.6	3246985	5011
1.50	5136	4688	10.00	6838.8	4103277	7063
2.00	5814	5475	10.00	8052.6	4831531	9478
2.10	6200	6007	10.00	8877.8	5326660	12142
2.20	6284	6242	10.00	9243.5	5561113	14915
2.30	6130	6207	10.00	9189.0	5513401	17671
2.40	5703	5917	10.00	8737.1	5242265	20293
2.50	5161	5432	10.00	7486.0	4741618	22686
3.00	4343	4852	10.00	7091.5	4254908	24816
3.10	3401	4222	10.00	6126.2	3675726	26654
3.20	3282	3592	10.00	5167.6	3100587	28204
3.30	2713	2999	10.00	4274.1	2564437	29486
3.40	2214	2465	10.00	3477.2	2086328	30529
3.50	1787	2001	10.00	2792.1	1675237	31367
4.00	1431	1609	10.00	2220.3	1332201	32033
4.10	1134	1285	10.00	1752.6	1051557	32559
4.20	904	1022	10.00	1376.7	825999	32972
4.30	716	810	10.00	1078.5	647115	33295
4.40	567	642	10.00	843.9	506314	33549
4.50	449	508	10.00	660.2	396106	33747
5.00	356	403	10.00	516.8	310063	33902
5.10	282	319	10.00	404.6	242783	34023
5.20	224	253	10.00	317.1	190242	34118
5.30	178	201	10.00	248.9	149342	34193
5.40	142	160	10.00	195.8	117475	34252
5.50	113	128	10.00	154.2	92513	34298
6.00	0	57	10.00	65.6	39739	34318

$$\Delta = 2773$$

9.55 Acft
15406.29 Cuyd

Sediment Transport Calculation for Channel Reach 4

Peak		100-Year		Bedload Transport Factor		0.93957	
Discharge		18063		Bedload Transport Exponent		1.02206	
cfs							
Time (HR:MM)	Discharge (cfs)	Average Discharge (cfs)	Time Interval (min)	Bedload Transport (lbs/sec)	Sediment Transport (lbs)	Cumul. Transport (tons)	
0.00	0	0	10.00	0.0	0	0	
0.10	0	1	10.00	0.3	272	0	
0.20	1	1	10.00	460.4	276523	138	
0.30	721	361	10.00	1877.6	1126388	702	
0.40	2023	1372	10.00	3565.6	2139353	1771	
0.50	3023	2324	10.00	5303.2	3181428	3362	
1.00	4337	3681	10.00	8086.6	4851958	5788	
1.10	6657	5447	10.00	12248.6	7379147	9478	
1.20	7720	8189	10.00	17250.0	10349484	14653	
1.30	12869	11295	10.00	21958.1	13174859	21240	
1.40	15544	14207	10.00	25614.8	15368896	28925	
1.50	17349	16447	10.00	27682.6	16609555	37230	
2.00	18063	17706	10.00	28035.5	16821314	45640	
2.10	17778	17921	10.00	26940.4	16164263	53722	
2.20	16731	17255	10.00	24790.5	14874290	61159	
2.30	15155	15943	10.00	21974.4	13184615	67752	
2.40	13278	14217	10.00	18895.9	11337531	73421	
2.50	11355	12317	10.00	15883.7	9530240	78186	
3.00	9530	10443	10.00	10640.7	6414437	85329	
3.10	7886	8708	10.00	8612.1	5167252	87913	
3.20	6449	7168	10.00	6871.0	4122619	89974	
3.30	5223	5836	10.00	5440.5	3264283	91606	
3.40	4194	4709	10.00	4285.3	2571186	92892	
3.50	3349	3772	10.00	2635.0	1581542	94691	
4.00	2663	3006	10.00	2066.7	1240024	95311	
4.10	2112	2388	10.00	1620.8	972503	96180	
4.20	1676	1894	10.00	1272.7	763572	96180	
4.30	1330	1503	10.00	1001.6	600971	96480	
4.40	1036	1193	10.00	740.0	473462	96717	
4.50	840	948	10.00	623.3	373488	96904	
5.00	670	733	10.00	491.8	295088	97052	
5.10	535	603	10.00	388.0	232785	97168	
5.20	427	481	10.00	306.3	183919	97260	
5.30	341	384	10.00	130.7	78447	97299	
5.40	272	307	10.00				
5.50	218	243	10.00				
6.00	0	109	10.00				
23 YEAR SED. (10MS)	353560						
25 YEAR SED. (C.Y.)	176682						
100 Yr Storm (10MS)	472299						
100 Yr Storm (C.Y.)	43681						

$$> \Delta = 8305$$

27.07 AcFt
43680.86 CuYd

M23/D11

METRIC
Corporation

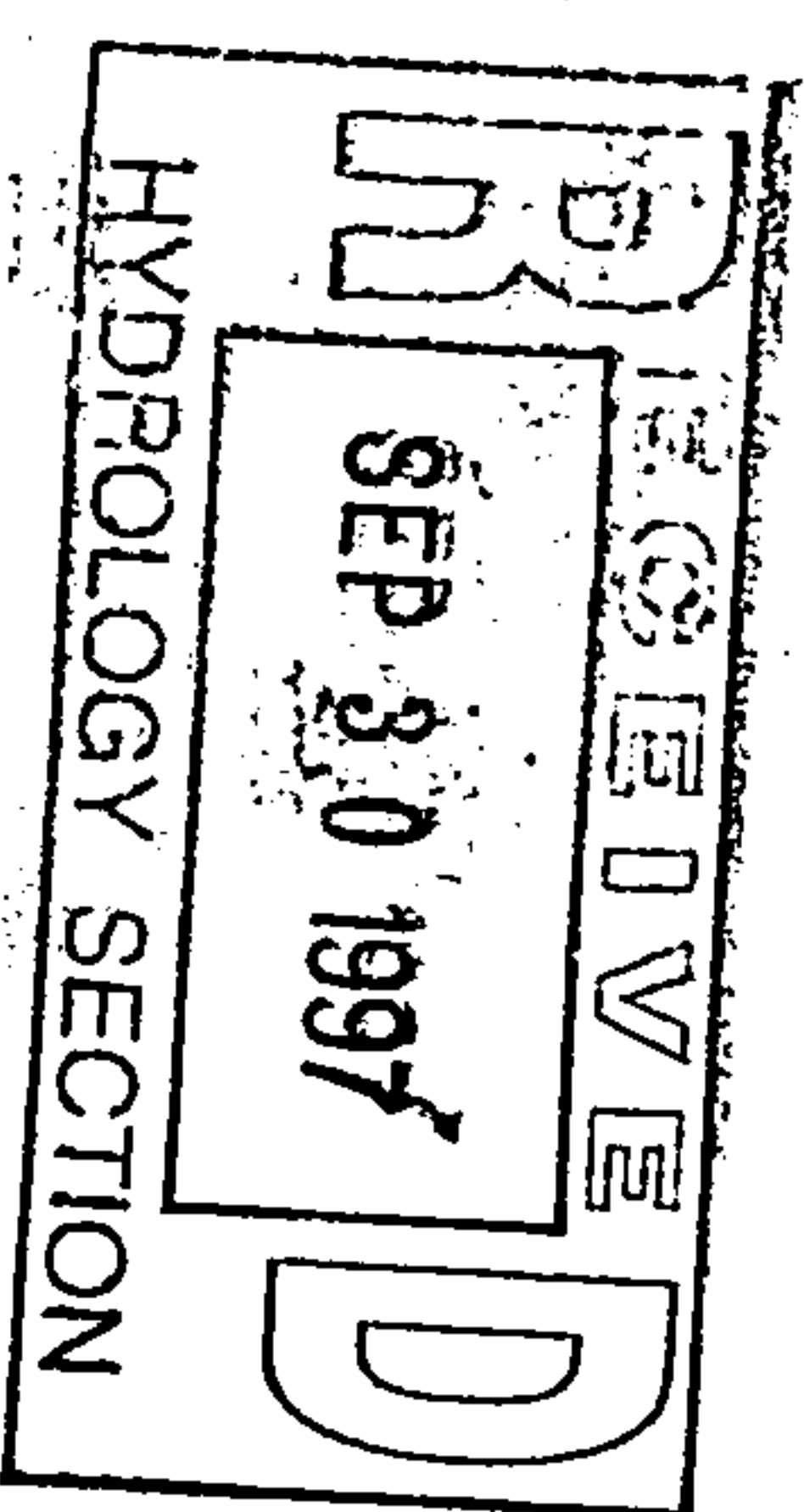
SCOUR INVESTIGATION FOR
PROPOSED 6-INCH GAS LINE CROSSING
OF TIJERAS ARROYO
AT SOUTH END OF JUAN TABO BLVD.
ALBUQUERQUE, NEW MEXICO

PREPARED FOR

PUBLIC SERVICE COMPANY OF NEW MEXICO
GAS SERVICES
ALBUQUERQUE, NEW MEXICO

PREPARED BY

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ALBUQUERQUE, NEW MEXICO



SEPTEMBER 1997

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SEPTEMBER 1997

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INTRODUCTION

Public Service Company of New Mexico (PNM) Gas Services has proposed crossing Tijeras Arroyo at the south end of Juan Tabo Blvd. in southeast Albuquerque, New Mexico with a 6 inch diameter polyethylene natural gas pipeline. The purpose of the proposed gas line is to provide a second gas feed to the Four Hills neighborhood to alleviate low gas pressure problems experienced in the past.

The proposed gas line would be installed in a City of Albuquerque drainage and utility easement extending from the south end of Juan Tabo Blvd. to the west end of Via Posada in Four Hills (see FIGURE 1). The gas line would be installed along the west and south edge of the easement.

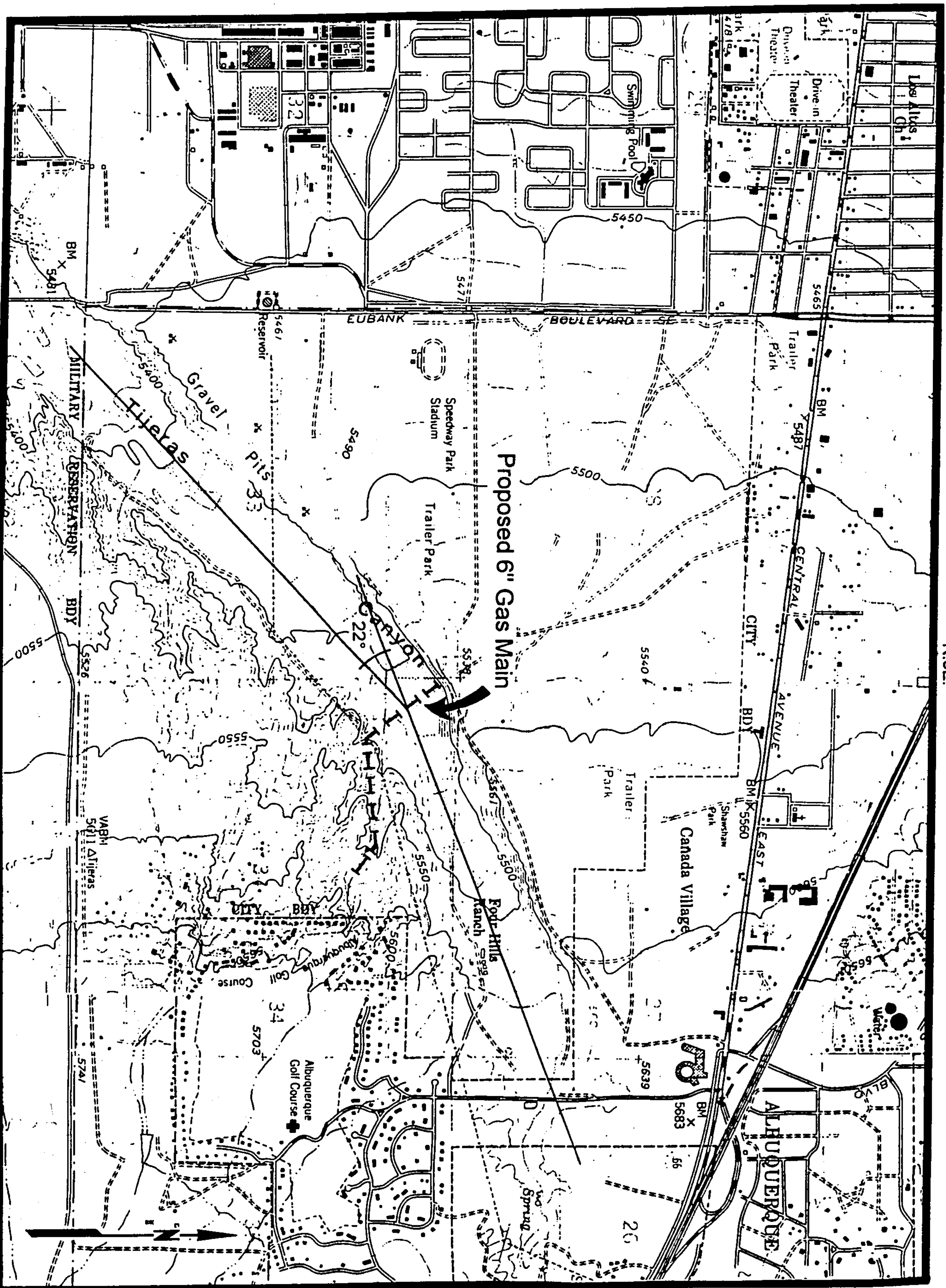
PNM Gas Services has contracted with METRIC Corporation to conduct a scour analysis to estimate the depth to which the gas line should be buried to avoid being damaged by erosional scour in Tijeras Arroyo.

At the proposed gas line crossing location, Tijeras Arroyo is an unlined natural channel with a drainage area exceeding 100 square miles.

The proposed gas line crossing does not cross any formal Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) right-of-way. However, it does cross a FEMA designated flood plain, and as a result, City of Albuquerque approval will probably be required. It is likely the City of Albuquerque will request AMAFCA review of the gas line crossing design.

ANALYSIS CRITERIA

Since it is likely that AMAFCA review will be sought, AMAFCA criteria were used for the scour analysis.



T.10N.
T.9N.

FIGURE 1
LOCATION MAP OF PROPOSED TIJERAS ARROYO
GAS LINE CROSSING

The Leeds Hill-Herkenhoff, Inc. report dated January 1994 entitled "Tijeras Arroyo Bank Stabilization at South Eubank Landfill Final Report", contains a detailed discussion of expected 100 year peak flows. The South Eubank Landfill Stabilization project is located just downstream from the proposed gas line crossing, and as a result, the peak flow used for the Landfill Stabilization is applicable to the gas line crossing. For this analysis, a 100 year peak flow of 24,860 CFS was used. This flow includes 10% sediment bulking.

The AMAFCA "Design and Policy Guide for Utility Crossings of Flood Control Channels" dated May 1983 indicates the preferred clearance (bury depth) between unlined channel bottom and the top of a buried conduit is 5 feet. The procedures presented in the AMAFCA "Sediment and Erosion Design Guide" dated November 1994 were used for the scour analysis.

HYDRAULIC ANALYSIS

As shown in FIGURE 1, the slope and cross section of Tijeras Arroyo are quite uniform throughout the reach where the gas line crossing is contemplated. As a result, uniform flow was assumed for the reach and Manning's equation was used to generate a stage discharge curve.

A cross section of Tijeras Arroyo at the gas line crossing location was generated using a local datum and an engineering level survey (see FIGURE 2). The average channel slope was measured as 1% from the Albuquerque East 7 ½ minute USGS Quadrangle Map. Based on visual observation, Manning's n was chosen as 0.032. The Manning's calculations are presented in APPENDIX A, and the resulting stage discharge curve is presented as FIGURE 3. The maximum depth of flow during passage of the 10-year peak flow is 6.8 feet at Point A on FIGURE 3.

South

North

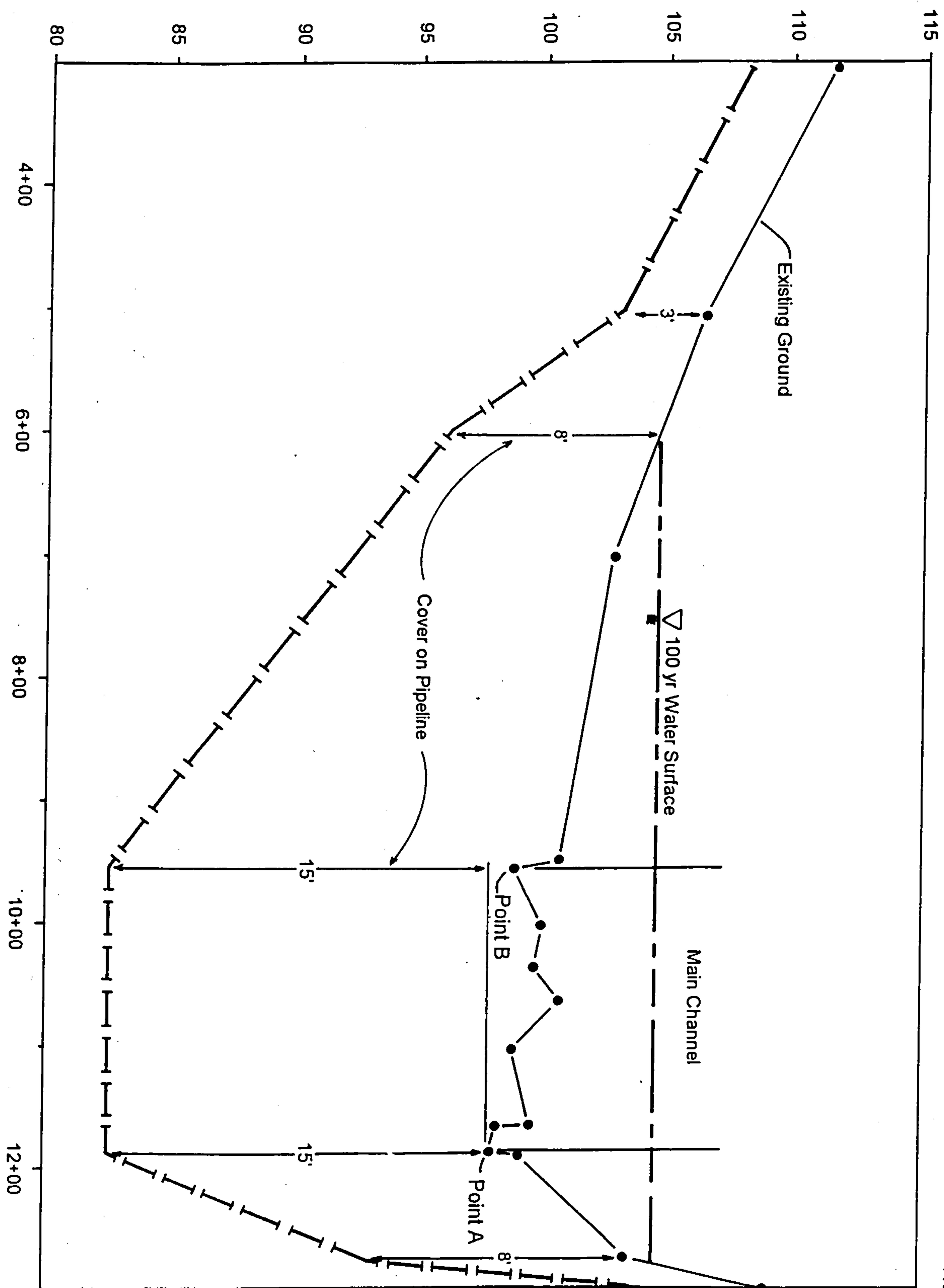


FIGURE 2

CROSS SECTION OF TIJERAS ARROYO
AT GAS LINE CROSSING

The average Froude number for the 100 year peak is:

$$Y_1 = \frac{A}{P_w} = \frac{2340.56}{677.26} = 3.46 \text{ ft.}$$

$$F_r = \frac{V}{\sqrt{gY_1}} = \frac{10.64}{\sqrt{32.2 \times 3.46}} = 1.01$$

The Froude number along the north bank of the arroyo at Point A (FIGURE 2) can be calculated using the depth of flow at that point of 6.8 ft.

$$V = \frac{1.49}{n} R^{2/3} S^{1/2} = \frac{1.49}{0.032} (6.8)^{2/3} (0.010)^{1/2} = 16.7 \text{ fps}$$

$$F_r = \frac{16.7}{\sqrt{32.2 \times 6.8}} = 1.13$$

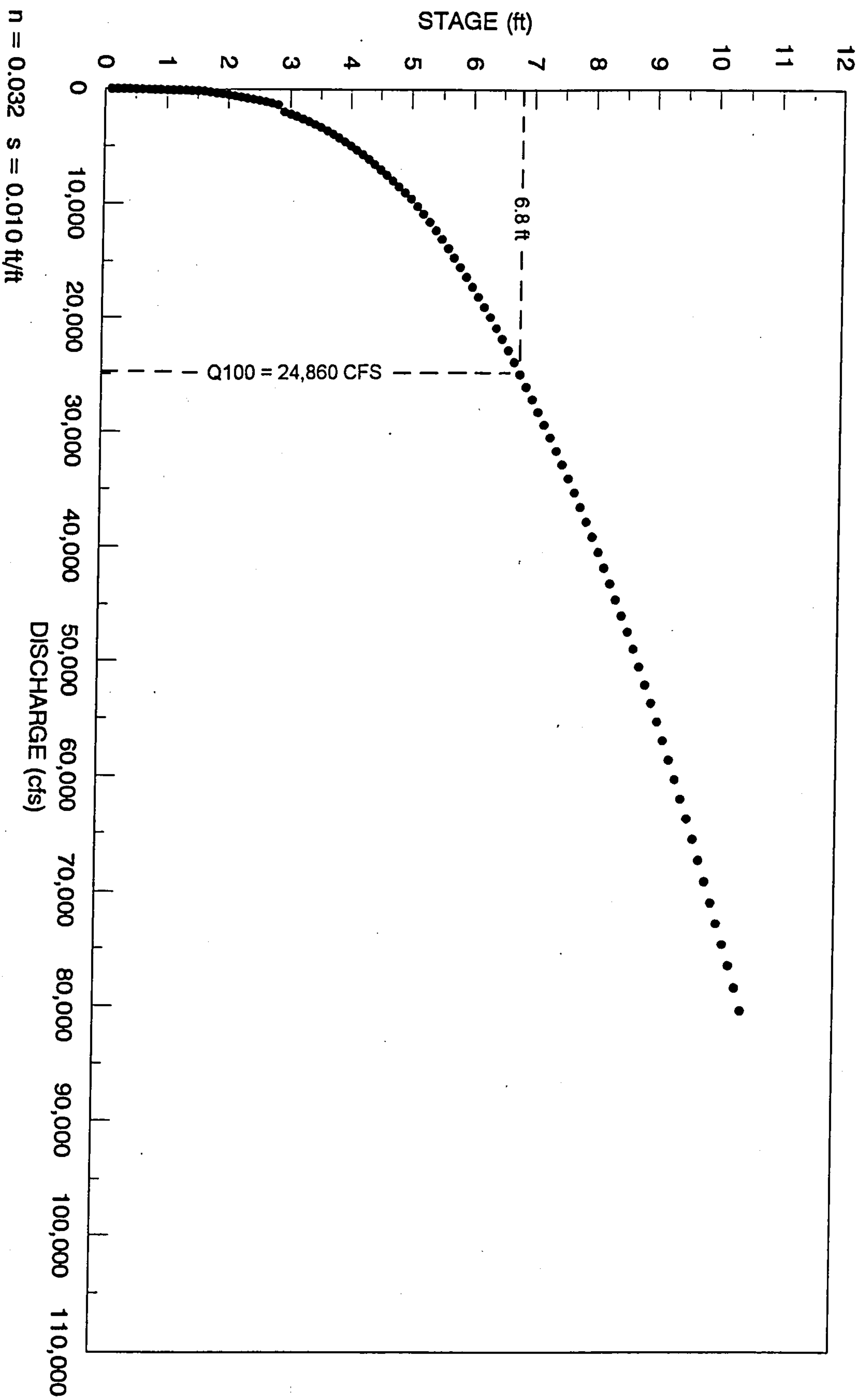
Thus, the average flow is near critical flow and near the north bank the flow is in the supercritical range.

SCOUR ANALYSIS

An evaluation of the scour potential at the gas line crossing location suggests that long term changes in the channel profile are not anticipated since large scale development in the watershed is not anticipated. Likewise, contraction scour caused by constriction of the flood plain is not anticipated since bridges or other constrictions are not planned in the vicinity of the gas line crossing. The effects of the channel bend (see FIGURE 1) are considered in the impingement term as described below.

The effects of local scour can be evaluated using equation 3.90 from the AMAFCA Sediment Erosion and Design Guide, November 1994.

FIGURE 3
 PNM GAS COMPANY
 TIJERAS ARROYO CROSSING AT JUAN TABO
 STAGE/DISCHARGE GRAPH



Equation 3.90 considers scour effects resulting from acceleration of flow caused by reduced roughness along a flood wall, antidune scour, and impingement of flow on the bank as follows:

$$\frac{Y_s}{Y_1} = \underbrace{\text{acceleration along flood wall}}_{0.73 \cos \theta} + \underbrace{\text{antidune}}_{0.14\pi F_r^2 \cos \theta} + \underbrace{\text{impingement}}_{4 F_r^{0.33} \sin \theta}$$

Since a flood wall or other bank armoring is not anticipated, the first term can be eliminated as follows:

$$Y_s = 0.14\pi F_r^2 \cos \theta + 4 F_r^{0.33} \sin \theta$$

Using a maximum depth of flow of 6.8 ft at Point A (FIGURE 2), a maximum Froude Number at 1.13, and an impingement angle of 22° yields:

$$\frac{Y_s}{Y_1} = 0.14\pi(1.13)^2 \cos 22^\circ + 4(1.13)^{0.33} \sin 22^\circ = 0.52 + 1.56 = 2.08$$

$$Y_s = 2.08 Y_1 = 2.08(6.8) = 14.15 \text{ ft.}$$

Thus the maximum anticipated scour at the gas line crossing is 14.15 ft. at Point A (FIGURE 2) along the north bank of the arroyo. Since the pilot channel presently at Point A could move anywhere within main channel, similar antidune scour and somewhat reduced impingement scour could occur at Point B (FIGURE 2).

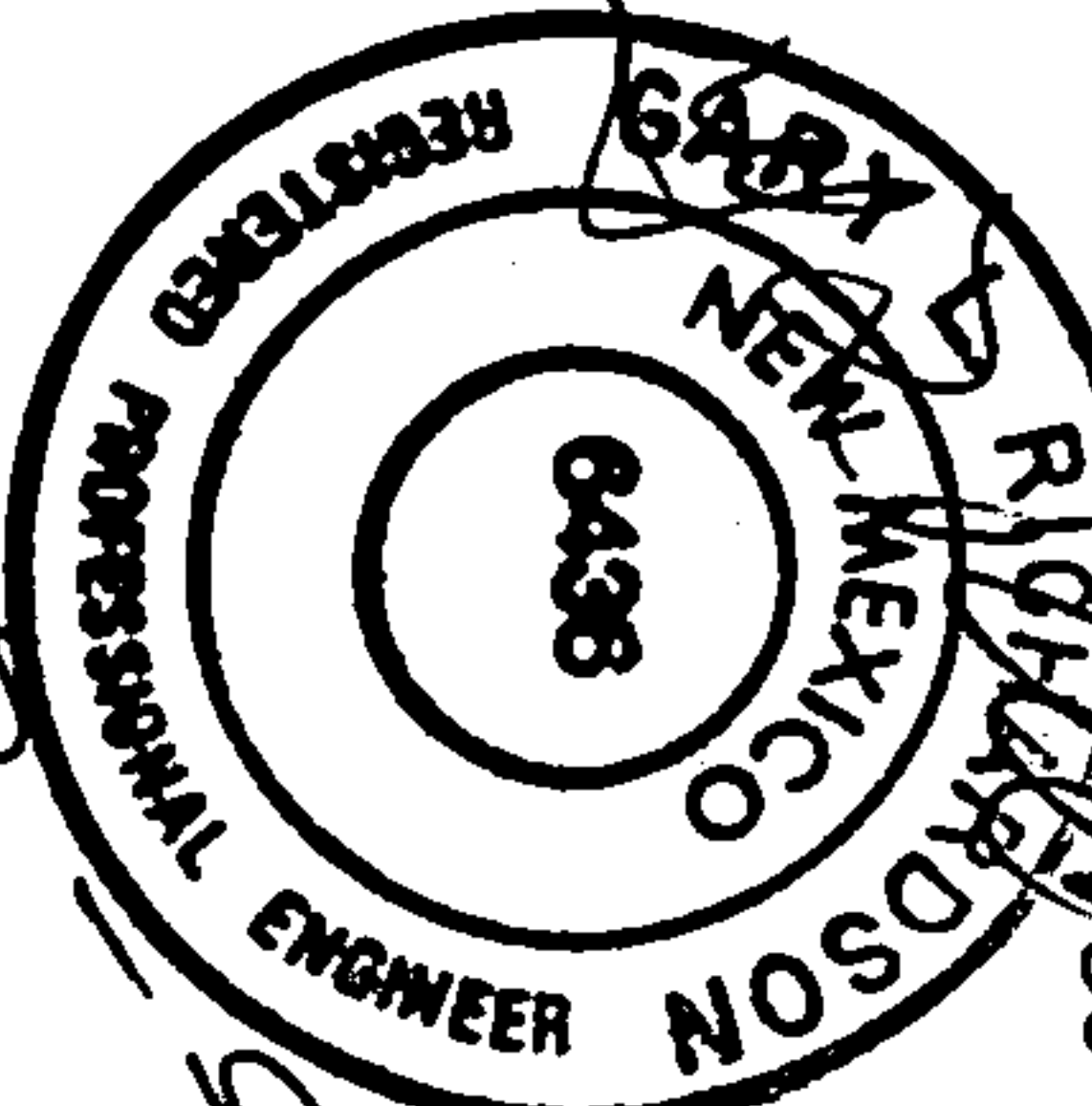
RECOMMENDATIONS

Based on the scour analysis discussed above, it is recommended that the gas line be

buried with a minimum of 15 feet of cover at Point A and Point B under the main channel, as shown on FIGURE 2. Within the 100-year flood plain the minimum cover should be 8 feet reducing to 3 feet of cover beyond the flood plain.

ENGINEER'S CERTIFICATION

I hereby certify that the work contained herein was conducted by me or under my supervision in accordance with standard engineering practices.

Richard N. Osborn

9-27-97

APPENDIX A

STAGE/DISCHARGE CURVE
PNM GAS COMPANY
TIJERAS ARROYO

STAGE/DISCHARGE CURVE
PNM GAS COMPANY
TIJERAS ARROYO

PREDICTION POINT CROSSING AT JUAN TABO

DATE 07-25-1997
MANNINGS N = .032
CHANNEL SLOPE= .01

ELEVATION (ft)	STAGE (ft)	DISCHARGE (cfs)	WP ft	AREA ft ²	VELOCITY (fps)	CRIT Q (cfs)
98.00	0.10	0.34	10.77	0.54	0.63	0.68
98.10	0.20	2.15	21.54	2.15	1.00	3.86
98.20	0.30	6.80	21.93	4.32	1.58	10.89
98.30	0.40	13.34	22.32	6.51	2.05	20.04
98.40	0.50	21.55	22.72	8.74	2.46	30.95
98.50	0.60	31.26	23.11	11.01	2.84	43.39
98.60	0.70	42.38	23.50	13.30	3.19	57.24
98.70	0.80	54.83	23.89	15.63	3.51	72.40
98.80	0.90	68.56	24.28	17.99	3.81	88.79
98.90	1.00	83.52	24.68	20.38	4.10	106.35
99.00	1.10	99.67	25.07	22.80	4.37	125.04
99.10	1.20	116.97	25.46	25.26	4.63	144.83
99.20	1.30	130.62	27.49	27.83	4.69	161.16
99.30	1.40	145.88	29.53	30.60	4.77	179.27
99.40	1.50	162.81	31.56	33.56	4.85	199.20
99.50	1.60	181.48	33.59	36.72	4.94	221.00
99.60	1.70	262.63	115.21	75.05	3.50	345.10
99.70	1.80	326.15	119.33	86.68	3.76	420.81
99.80	1.90	396.03	123.45	98.72	4.01	502.79
99.90	2.00	472.27	127.57	111.17	4.25	590.99
100.00	2.10	554.92	131.70	124.03	4.47	685.41
100.10	2.20	644.02	135.82	137.31	4.69	786.05
100.20	2.30	739.63	139.94	151.00	4.90	892.92
100.30	2.40	841.82	144.06	165.09	5.10	1006.05
100.40	2.50	950.66	148.18	179.60	5.29	1125.47
100.50	2.60	1066.22	152.31	194.52	5.48	1251.21
100.60	2.70	1188.59	156.43	209.86	5.66	1383.33
100.70	2.80	1317.85	160.55	225.60	5.84	1521.86
100.80	2.90	1952.92	270.05	351.69	5.55	2283.47
100.90	3.00	2141.24	284.00	379.23	5.65	2492.90
101.00	3.10	2344.20	297.96	408.17	5.74	2717.24
101.10	3.20	2562.25	311.92	438.50	5.84	2956.84
101.20	3.30	2795.80	325.87	470.22	5.95	3212.02
101.30	3.40	3045.31	339.83	503.34	6.05	3483.13
101.40	3.50	3311.20	353.79	537.86	6.16	3770.47
101.50	3.60	3593.89	367.75	573.77	6.26	4074.37
101.60	3.70	3893.82	381.70	611.07	6.37	4395.16
101.70	3.80	4211.41	395.66	649.78	6.48	4733.13
101.80	3.90	4547.08	409.62	689.87	6.59	5088.62
101.90	4.00	4901.25	423.58	731.37	6.70	5461.91

PREDICTION POINT CROSSING AT JUAN TABO CONTINUED

ELEVATION (ft)	STAGE (ft)	DISCHARGE (cfs)	WP ft	AREA ft ²	VELOCITY (fps)	CRIT Q (cfs)
102.00	4.10	5274.34	437.53	774.25	6.81	5853.32
102.10	4.20	5666.77	451.49	818.54	6.92	6263.13
102.20	4.30	6078.92	465.45	864.22	7.03	6691.65
102.30	4.40	6511.23	479.41	911.29	7.15	7139.17
102.40	4.50	6964.08	493.36	959.76	7.26	7605.97
102.50	4.60	7437.88	507.32	1009.63	7.37	8092.34
102.60	4.70	7933.02	521.28	1060.89	7.48	8598.55
102.70	4.80	8449.90	535.23	1113.54	7.59	9124.88
102.80	4.90	8988.90	549.19	1167.59	7.70	9671.60
102.90	5.00	9550.41	563.15	1223.04	7.81	10238.98
103.00	5.10	10209.05	570.45	1279.55	7.98	10886.20
103.10	5.20	10888.81	577.75	1336.79	8.15	11550.94
103.20	5.30	11589.70	585.05	1394.76	8.31	12233.15
103.30	5.40	12311.77	592.35	1453.46	8.47	12932.84
103.40	5.50	13055.12	599.65	1512.89	8.63	13650.04
103.50	5.60	13839.04	605.62	1572.98	8.80	14399.72
103.60	5.70	14644.23	611.59	1633.66	8.96	15166.38
103.70	5.80	15470.69	617.56	1694.95	9.13	15949.97
103.80	5.90	16318.45	623.53	1756.83	9.29	16750.49
103.90	6.00	17187.51	629.50	1819.30	9.45	17567.89
104.00	6.10	18077.91	635.47	1882.37	9.60	18402.16
104.10	6.20	18989.70	641.44	1946.04	9.76	19253.31
104.20	6.30	19922.88	647.41	2010.30	9.91	20121.29
104.30	6.40	20877.51	653.38	2075.16	10.06	21006.14
104.40	6.50	21853.63	659.35	2140.62	10.21	21907.83
104.50	6.60	22851.30	665.32	2206.67	10.36	22826.39
104.60	6.70	23870.54	671.29	2273.32	10.50	23761.79
104.70	6.80	24911.42	677.26	2340.56	10.64	24714.06
104.80	6.90	25974.00	683.23	2408.40	10.78	25683.22
104.90	7.00	27058.32	689.20	2476.83	10.92	26669.26
105.00	7.10	28164.44	695.17	2545.86	11.06	27672.21
105.10	7.20	29292.45	701.14	2615.49	11.20	28692.10
105.20	7.30	30442.37	707.11	2685.72	11.33	29728.92
105.30	7.40	31614.29	713.08	2756.53	11.47	30782.70
105.40	7.50	32808.27	719.05	2827.95	11.60	31853.48
105.50	7.60	34024.39	725.02	2899.96	11.73	32941.27
105.60	7.70	35262.70	730.99	2972.57	11.86	34046.10
105.70	7.80	36523.28	736.96	3045.77	11.99	35168.00
105.80	7.90	37806.20	742.93	3119.57	12.12	36306.98
105.90	8.00	39111.55	748.90	3193.97	12.25	37463.11
106.00	8.10	40439.36	754.87	3268.96	12.37	38636.36
106.10	8.20	41789.76	760.84	3344.55	12.49	39826.82
106.20	8.30	43162.79	766.81	3420.73	12.62	41034.50
106.30	8.40	44558.54	772.78	3497.51	12.74	42259.43
106.40	8.50	45977.11	778.75	3574.88	12.86	43501.66
106.50	8.60	47418.53	784.72	3652.85	12.98	44761.19
106.60	8.70	48944.81	789.15	3731.34	13.12	46081.70
106.70	8.80	50493.89	793.57	3810.28	13.25	47418.74
106.80	8.90	52065.65	798.00	3889.65	13.39	48772.22
106.90	9.00	53660.16	802.43	3969.47	13.52	50142.16

Q₁₀₀

PREDICTION POINT CROSSING AT JUAN TABO CONTINUED

ELEVATION (ft)	STAGE (ft)	DISCHARGE (cfs)	WP ft	AREA ft^2	VELOCITY (fps)	CRIT Q (cfs)
107.00	9.10	55277.41	806.86	4049.72	13.65	51528.54
107.10	9.20	56917.42	811.28	4130.42	13.78	52931.34
107.20	9.30	58580.20	815.71	4211.56	13.91	54350.55
107.30	9.40	60265.77	820.14	4293.15	14.04	55786.18
107.40	9.50	61974.19	824.57	4375.17	14.16	57238.23
107.50	9.60	63705.45	828.99	4457.64	14.29	58706.68
107.60	9.70	65459.56	833.42	4540.55	14.42	60191.54
107.70	9.80	67236.59	837.85	4623.90	14.54	61692.80
107.80	9.90	69036.54	842.28	4707.69	14.66	63210.47
107.90	10.00	70859.45	846.70	4791.92	14.79	64744.56
108.00	10.10	72705.34	851.13	4876.60	14.91	66295.06
108.10	10.20	74574.22	855.56	4961.71	15.03	67861.95
108.20	10.30	76466.18	859.99	5047.27	15.15	69445.30
108.30	10.40	78381.19	864.41	5133.27	15.27	71045.03
108.40	10.50	80319.33	868.84	5219.71	15.39	72661.23
108.50	10.60	82280.63	873.27	5306.60	15.51	74293.87
108.60	10.70	84265.06	877.70	5393.92	15.62	75942.91
108.70	10.80	86272.76	882.12	5481.69	15.74	77608.44
108.80	10.90	88303.69	886.55	5569.90	15.85	79290.43

FOUR HILLS WEST - UNIT ONE SUBDIVISION

DRAINAGE REPORT

Prepared By:



RESOURCE TECHNOLOGY, INC.

2129 Osuna Road NE, Suite 200
Albuquerque, New Mexico 87113
(505) 345-3115

June 24, 1994

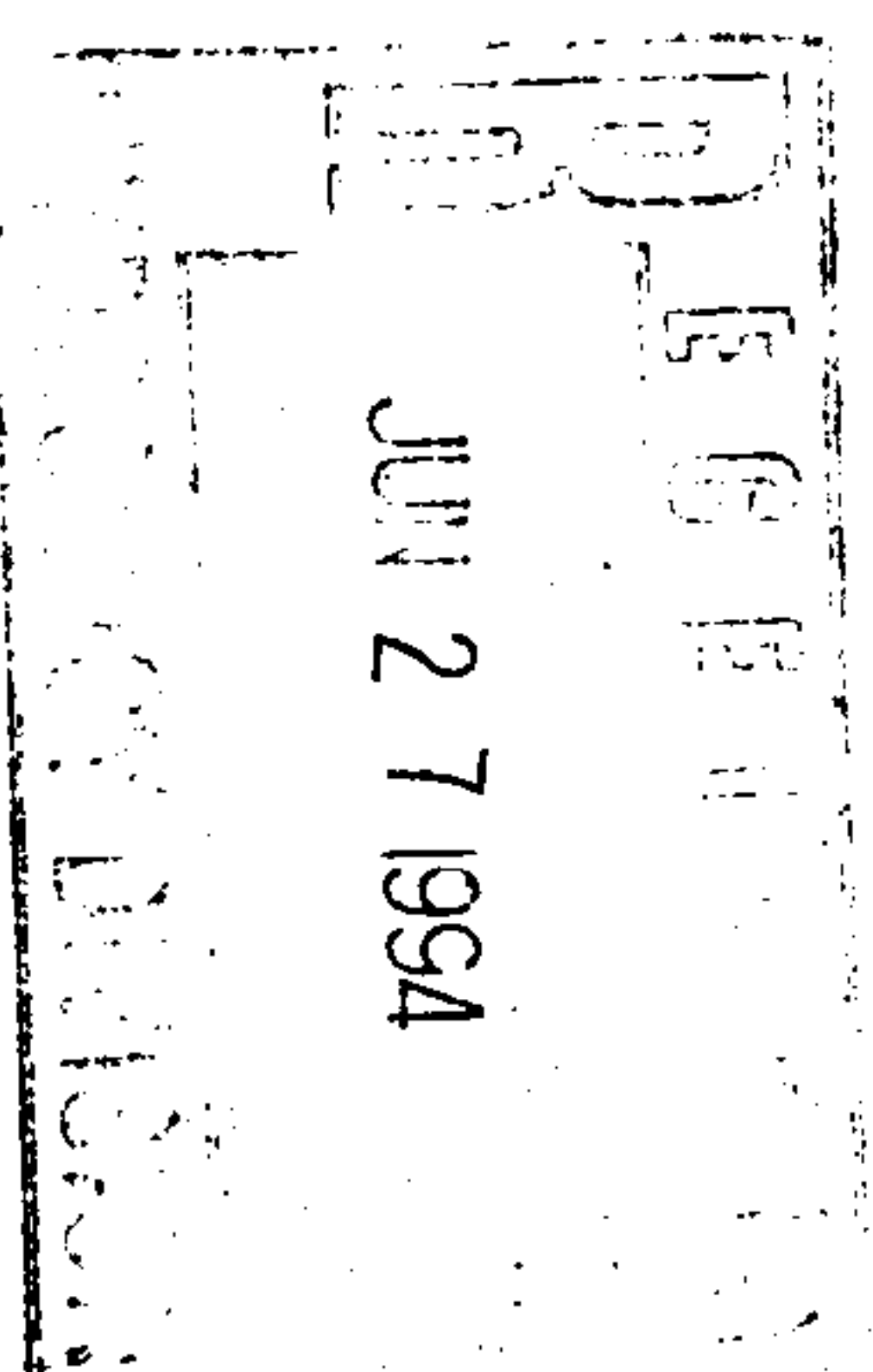
THE NAME OF THE PROJECT HAS BEEN CHANGED

FROM: FOUR HILLS WEST UNIT ONE

TO: FOUR HILLS VILLAGE, 20TH INSTALLMENT

FOUR HILLS WEST - UNIT ONE SUBDIVISION

DRAINAGE REPORT



Prepared By:



RESOURCE TECHNOLOGY, INC.
2129 Osuna Road NE, Suite 200
Albuquerque, New Mexico 87113
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June 24, 1994

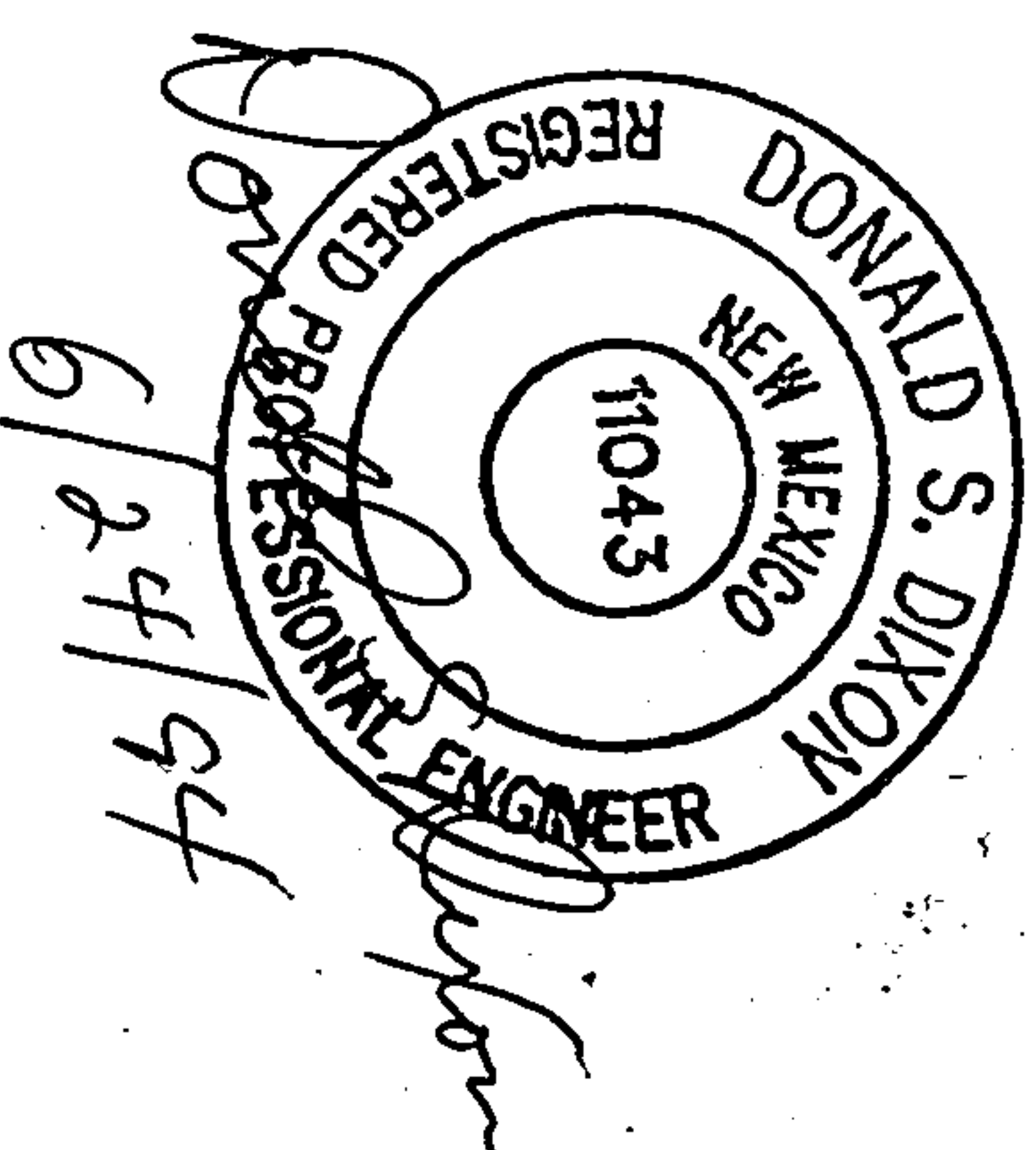


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2 Miles

10 000 Feet

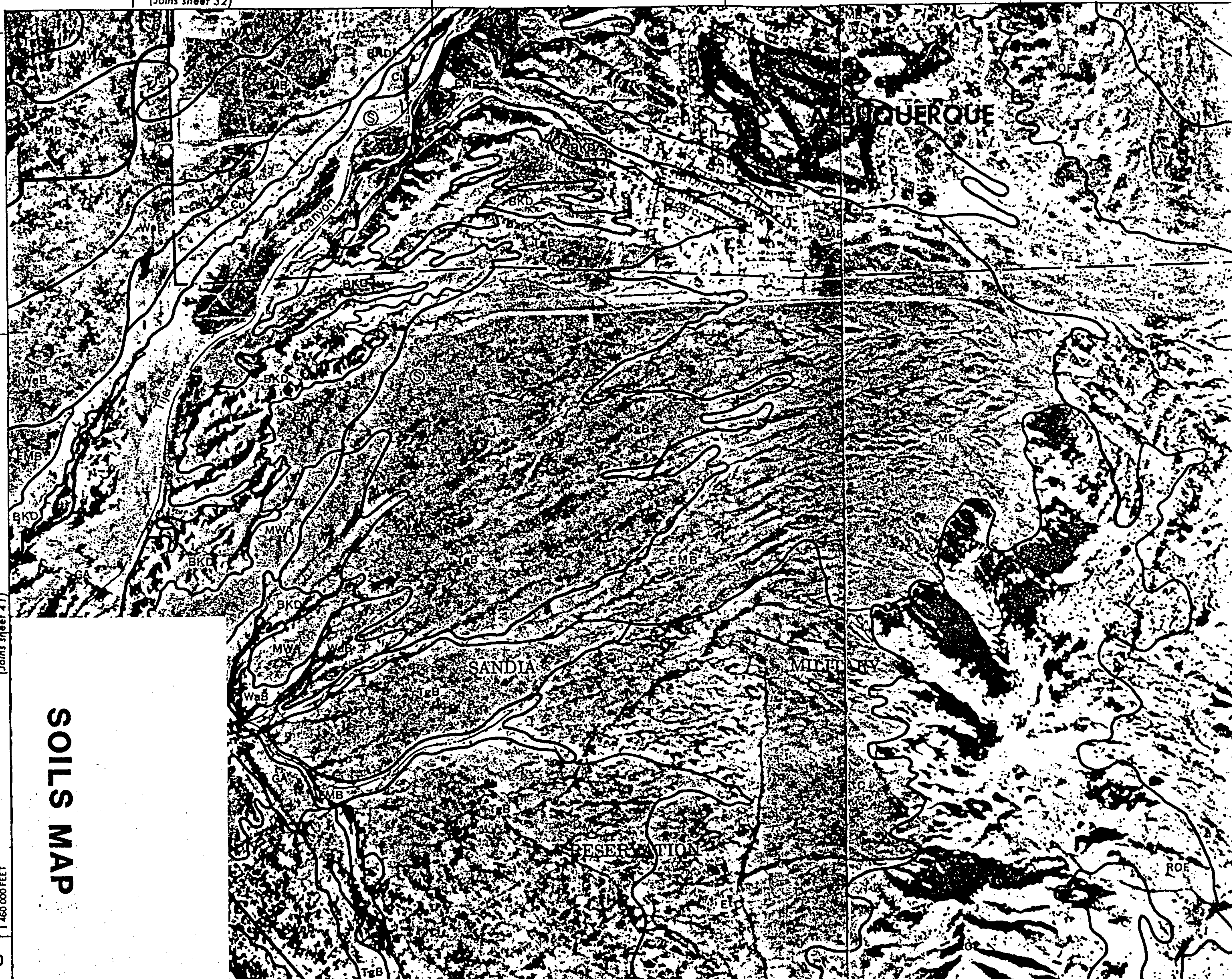
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SOILS MAP

1 460 000 FEET



JUAN TABO 8

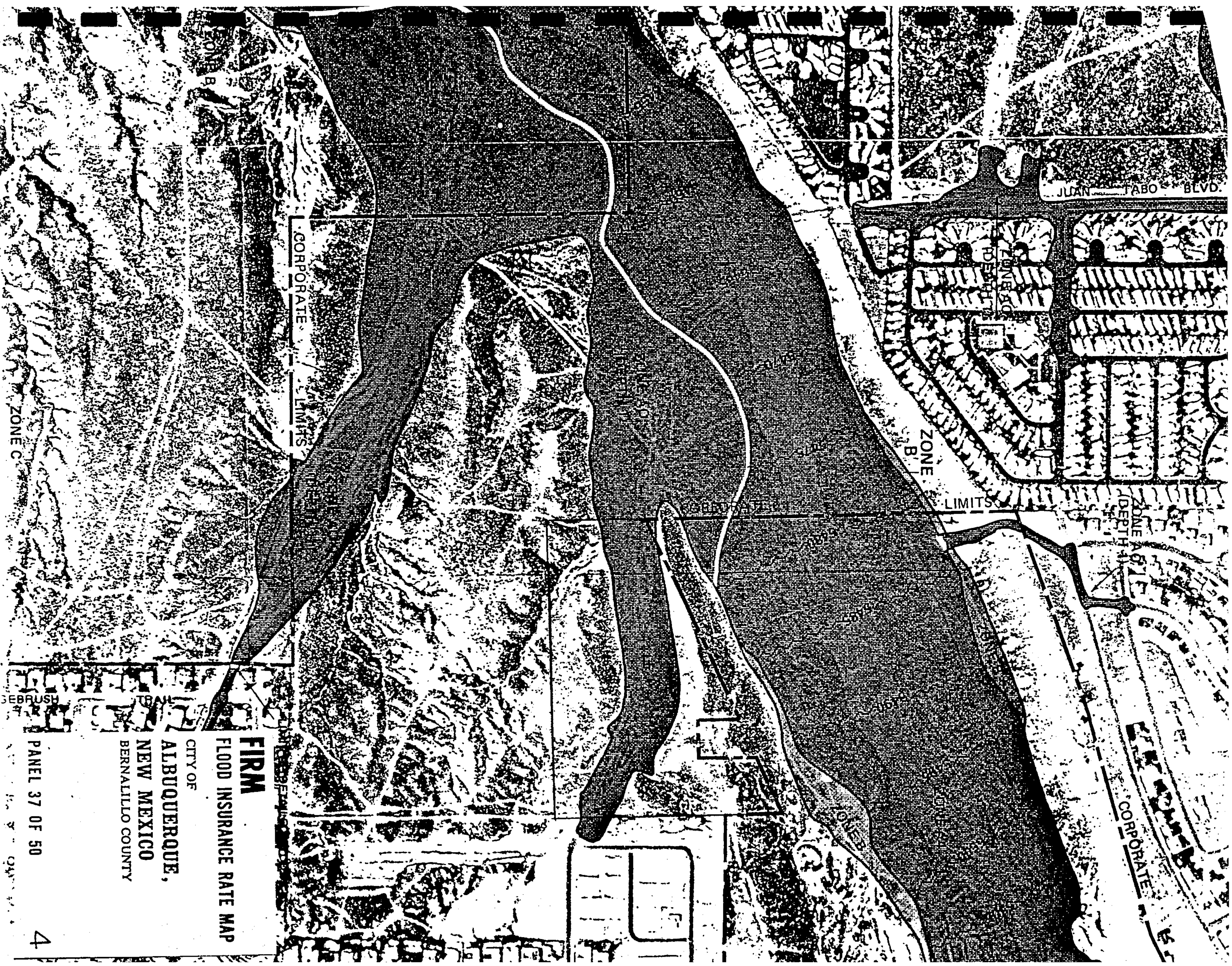
CORPORATE

FLOODWAY

FLOOD BOUNDARY AND
FLOODWAY MAP

CITY OF
ALBUQUERQUE,
NEW MEXICO
BERNALILLO COUNTY

PANEL 37 OF 50



FIRM
FLOOD INSURANCE RATE MAP

CITY OF
ALBUQUERQUE,
NEW MEXICO
BERNALILLO COUNTY

INTRODUCTION

The purpose of this drainage study is to address the drainage problems associated with the proposed Four Hills West - Unit One subdivision. This study and the associated recommendations incorporated into the grading and drainage plans for the subdivision are to serve as the basis for a Conditional Letter of Map Revision (CLOMR) to be submitted to FEMA for modifications to existing floodplain designations in this areas.

PROJECT LOCATION AND DESCRIPTION

Four Hill West Unit One consists of 21.5 acres of land located in the southeast section of the City of Albuquerque. It is bordered on the east by the Vista Four Hills subdivision, on the north and west by the Tijeras Arroyo, on the south by City owned open space (see Exhibit 1). The parcel consists of gravelly sand and decomposed granite covered by sparse amounts of native grasses and brush. The land slopes to the west at approximately 4-6%. The proposed development consists of 58 single dwelling unit lots to be developed by individual owners and/or builders.

METHODS

The hydrology used to develop the storm water flow rates is based on the January 1993 revisions to the City of Albuquerque Development Process manual, Vol. 2, Design Criteria, Section 22.2, Hydrology. Because of the substantial nature of the revisions compared to the former methodology used in previous drainage studies for adjacent areas impacting this site, all off-site flows entering the site were re-computed using the new hydrology. Off-site flows in the Tijeras Arroyo do not enter the site and were not re-evaluated.

EXISTING CONDITIONS

Via Posada Flows

Runoff from the east enters the Four Hills West subdivision through an existing 36" storm drain and as street flows in Via Posada. These flows are combined at a concrete rundown and riprap lined energy dissipator at the end of this street before entering a natural arroyo that drains to the Tijeras Arroyo. This arroyo and its overbank areas are shown as zone AO on current floodplain maps. Table 1 compares the flow rates previously reported (Drainage Plan for Vista Four Hills, BHI, 1978) and those generated using the current hydrological standards.

Open Space Flows

Runoff from the south originates from City owned Open Space property. These flows enter the 4-Hills property in four natural swales or minor arroyos. Table 2 summarizes the calculated runoff rates and volumes.

Sediment generated by runoff from this area was of some concern as large volumes of silt could block swales and storm drain inlets. The largest of these basins, basin 940, was analyzed using procedures presented in the AMAFCA Erosion Design Guide and the 1/94 version of AHYMO. It was found that the average annual yield was only 2.7 tons (approximately 2 cy). If the remaining three open space generated sediment at the same rate, they would generate another .9 tons of sediment annually.

On-Site Flows

A ridge extending from east to west divides the northern quarter of the property from the remaining portion. This northern quarter drains by sheet flow directly to the Tijeras Arroyo. The remaining southern three-fourths drains to the natural arroyo that now starts at the western end of Via Posada and drains to the west before discharging to the Tijeras Arroyo. On-site flow rates are shown in Table 3.

TABLE 1
EXISTING (FULLY DEVELOPED) VIA POSADA FLOWS

Location / Basin	100-Year		10-Year		
	Q (cfs)	Vol (Ac-ft)	BHI Q	Q (cfs)	Vol (Ac-ft)
Via Posada Street Flow	67.3	5.71	54	3.2	.40
Via Posada Storm Drain	60.0	5.09	60	60.0	4.45
Total Off-Site at Via Posada	127.3	10.82	114	63.2	4.75

DEVELOPED CONDITIONS

The Four Hills West Grading and Drainage Plan calls for the existing Via Posada storm drain to be extended through the proposed site following the existing 50-foot utility and drainage easement (see Exhibit 1). This storm drain will convey runoff from the east as well as site generated flows to a point west of the proposed site, thereby allowing the existing arroyo through the site to be filled and taken out of floodplain. A riprap basin energy dissipator will be constructed at the pipe outfall that will reduce the 100-year velocity to approximately 5 ft/sec at normal depth, velocity in the natural arroyo is 6 ft/sec.

The two major drainages from the Open Space parcel (Basins 940 and 930) are to be intercepted by a lined swale and catch basin and pipe as shown on Exhibit 2. These flows will then be conveyed to the proposed storm drain. The minor drainages (Basins 920 and 950) will be incorporated into the lot drainage plan where they enter the site (at Lot 1 and

Lot 20). Because this is City owned open space, future development of this area is not anticipated. The minor amounts of sediment generated by these areas will not present any major problems for the proposed drainage improvements.

TABLE 2

EXISTING (UNDEVELOPED) OPEN SPACE OFF-SITE FLOWS

Basin / Location	100-Year			10-Year	
	Q (cfs)	Q (cfs)	Vol (Ac-ft)	Q (cfs)	Vol (Ac-ft)
	BHI	RTI		RTI	
950	.7	1.3	.04	.4	.01
940	14.1	26.7	.77	7.9	.22
930	3.5	6.7	.19	2.0	.06
920	.6	1.1	.03	.3	.01

PROPOSED SITE GRADING

In addition to filling in the existing arroyo that bisects the site, the proposed grading plan calls for extensive use of split level building sites and retaining walls. The ridge on the south property line will be graded down at a 3:1 slope. The same concept will be applied to the northern ridge and the high ground on the east. A fill area at the southwest end of the site will require a retaining wall behind Lots 4, 5 and 6. Additional retaining walls will be required between some individual lots due to the steep grade from east to west and between split level lots and flat pad lots. Wherever runoff is trapped behind these retaining walls it will be drained in lined swales and drainage easement to a point of safe discharge.

FLOODPLAIN MAPPING

The floodplain effecting this site is shown on Panel 37 of the FEMA floodway and insurance rate maps. Four Hills West Unit One is in Zone AO, depth 1.0 foot. The Tijeras Arroyo floodway is immediately downstream from the proposed subdivision, with cross-section AT's southern end only 200 feet from the west boundary of the subdivision. The 100-year water surface elevation for this cross-section was obtained from the 1983 FEMA Flood Insurance Study. This is reported to be 5472.4-feet. This is some 18-feet lower than the outlet for the proposed storm drain pipe, therefore, it was concluded that water surface elevations in the Tijeras Arroyo have no impact on this site.

Another concern is the potential of lateral migration of the Tijeras Arroyo. The subdivision site is separated on the north from the Tijeras Arroyo by a ridge rising 50 to 75 feet above the arroy flow line. Since the 100-year flow rate for the Tijeras Arroyo is reported as 14,300 cfs (FIS, 1983) with a velocity of 10.2 ft/sec, the potential exists for extensive lateral migration over time. However, the floodplain in this reach of the arroyo is over 1,000-feet wide and it appears that arroyo has confined its meander to this area in recent times. Any changes in the natural channel causing it to move to the south causing bank failure along the protective ridge would surely be noted and mitigation measures implemented before there was a major threat to this subdivision.

TABLE 3
ON-SITE FLOWS

Location / Basin	DEVELOPED		EXISTING	
	100-Year		100-Year	
	Q (cfs)	Vol (Ac-ft)	Q (cfs)	Vol (Ac-ft)
400	12.9	.44	7.6	.23
401	8.4	.29	5.0	.16
402	7.4	.27	4.5	.15
403	5.9	.21	3.6	.12
404	4.9	.17	3.0	.10
405	9.5	.34	5.8	.19
406	17.5	.63	10.7	.36
TOTAL Site Runoff	66.5	2.35	40.2	1.31
			34.2	1.02
			12.2	0.33



APPENDIX

CITY OF ALBUQUERQUE
PUBLIC WORKS DEPARTMENT
UTILITY DEVELOPMENT DIVISION/HYDROLOGY SECTION

PRE-DESIGN CONFERENCE

DRAINAGE FILE/ZONE ATLAS PAGE NO.: M-22 DATE: 02-23-94

EPC NO.: _____ DRB NO.: _____ ZONE: _____

SUBJECT: Four Hills West, Unit One

STREET ADDRESS: Via Posada

LEGAL DESCRIPTION: Four Hills West, Unit One

APPROVAL REQUESTED: ☒ PRELIMINARY PLAT ☐ FINAL PLAT

☐ SITE DEVELOPMENT PLAN ☐ BUILDING PERMIT

☒ GRADING/PAVING PERMIT ☐ OTHER _____

WHO

REPRESENTING

ATTENDANCE: Don Dixon

Resource Technology

GILBERT ADEZ

CITY OF ALBUQ.

FINDINGS:

1. A SUBDIVISION PROPOSED, A DESIGNATED COORDINATOR
TRAVELS THROUGH MIDDLE OF SITE

2. A LOMR required for Final Plat of this
REFERENCED subdivision. The Developer may note
"LOMR required prior to Financial Guarantee
Release" on the infrastructure list. If the
would like to proceed to construction prior
to securing the CLONE from FEMA

3. IF THE DEVELOPER DOES NOT WANT TO GUARANTEE
THAT A CLONE SHOULD BE RECEIVED PRIOR TO PRELIMINARY
PLAT AND BOND FOR LOMR ONLY

4. A DRAINAGE REPORT MEETING FEMA Criteria
Required for Preliminary Plat.

The undersigned agrees that the above findings are summarized accurately and are only
subject to change if further investigation reveals that they are not reasonable or that
they are based on inaccurate information.

SIGNED: [Signature]

SIGNED: [Signature]

TITLE: Project Eng.

TITLE: RTT P.M.

DATE: 02-23-94

DATE: 2/23/94

NOTE PLEASE PROVIDE A COPY OF THIS PRE-DESIGN FORM WITH THE DRAINAGE SUBMITTAL.

TABLE A-1

DRAINAGE BASIN CHARACTERISTICS

BASIN ID	AREA (sq mi)	TP (hrs)	LAND TREATMENT			
			A (%)	B (%)	C (%)	D (%)
950 (E)	.0011	.133	100	0	0	0
940 (E)	.0220	.133	100	0	0	0
930 (E)	.0055	.133	100	0	0	0
920 (E)	.0009	.133	100	0	0	0
910 (E)*	.0397	.20	0	29	29	42
900 (E)*	.1502	.50	0	100	0	0
400 (F)	.0054	.133	0	20	50	30
401 (F)	.0034	.133	0	29	29	42
402 (F)	.0029	.133	0	24	26	50
403 (F)	.0023	.133	0	24	26	50
404 (F)	.0019	.133	0	24	26	50
405 (F)	.0037	.133	0	21	30	49
406 (F)	.0068	.133	0	21	30	49

(E) Existing Conditions
 (F) Future, Fully Developed Conditions
 * Existing Conditions are Fully Developed

BAGIN 900

Lot to be left vacant until
access to Juan Tabo is available

Emergency Exit

Well
Site

Wagon Train Drive
12'x2' CATTLE GUARD INLET
30" RCP

FOUR HILLS MANOR
UNIT ONE

(FILED FEB. 6, 1968)
BOOK 84 PAGE 119

Bench Mark
6-M22, ACS
Elev. 5620.745
located at Wagontrain Dr. & Toro

BAGIN 910

IMPACT
BASIN

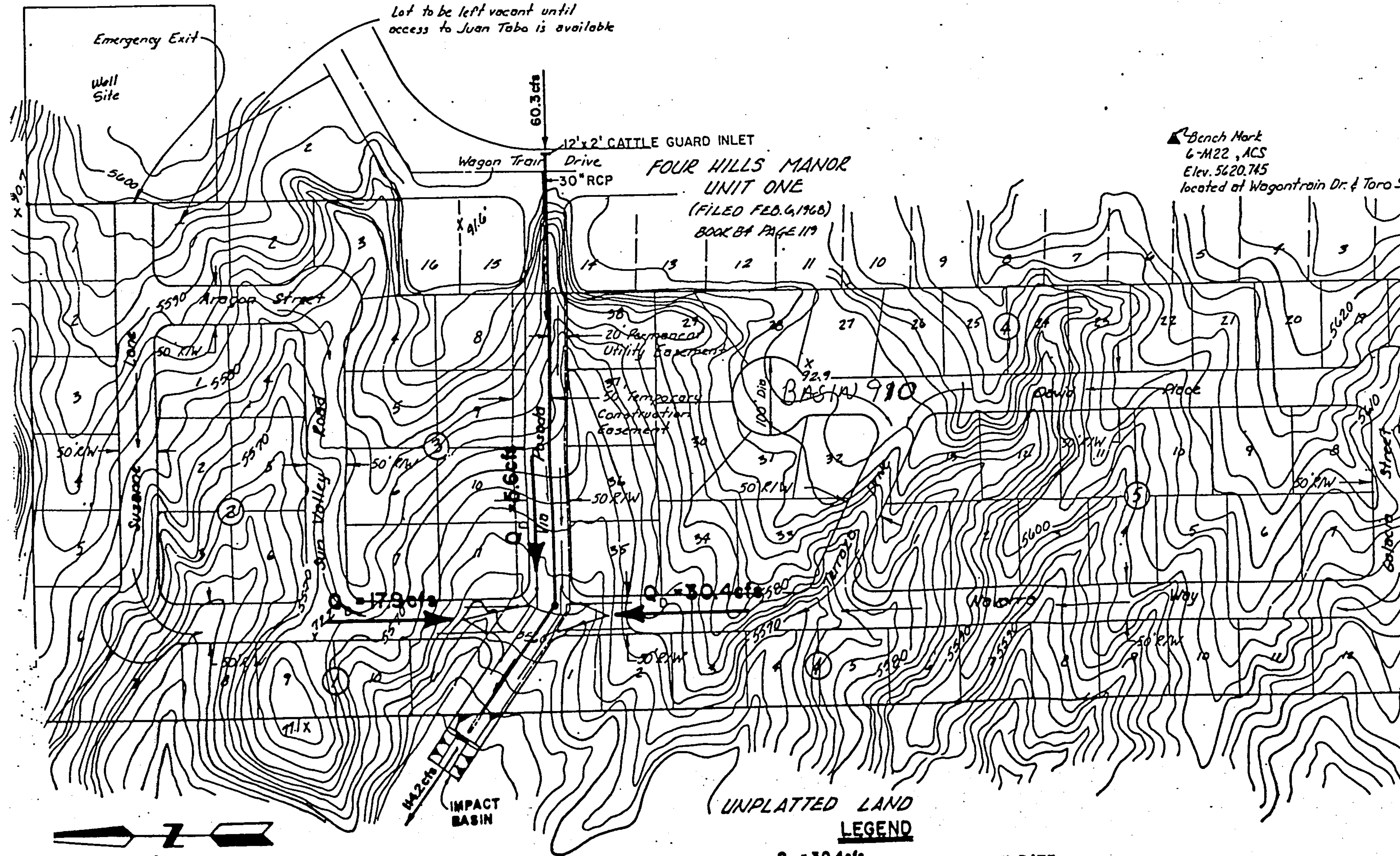
UNPLATTED LAND
LEGEND

$Q_0 = 30.4 cfs$

DEVELOPED FLOW RATE
AND DIRECTION
MANHOLE

PIPE FLOW DIRECTION

STREET FLOW DIRECTION



RESOURCE TECHNOLOGY, INC.

ENGINEERS & ENVIRONMENTAL SCIENTISTS

2129 Osuna Road, NE Suite 200

Albuquerque, NM 87113

Phone: (505) 345-3115

Fax: (505) 345-4132

PROJECT NO. _____

SHEET _____

OF _____

BY ALD

DATE

5/11/54

CHECKED _____ DATE _____

APPROVED _____ DATE _____

TITLE Hydrology

Basin 900

$L = 4150 \text{ ft}$

$S = .047 \text{ ' / '}$

$K = .7$

$L_{ca} = 2000$

$K_n = .025$

eqn 6-6

$$T_c = (12000 - L) / (72000 \times K \times S^{.5}) +$$

$$((L - 4000) \times K_n \times (\frac{L_{ca}}{L})^{.33}) / (55212 \times S^{.165})$$

$$T_c = \frac{7850}{10926} + \frac{2.95}{333.4}$$

$$.718 + .088 = .806 \text{ hr}$$

$$T_p = .67 T_c = .54 \text{ hours}$$

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PROJECT NO. _____

SHEET _____ OF _____

BY _____ DATE 5/23

CHECKED _____ DATE _____

APPROVED _____ DATE _____

TITLE Hydrology

Zone 3, UNDEVELOPED RUN OFF

16.89 Acres Basin 400' TOTAL

90% A 10% C

$$[.9(1.87) + .1(3.45)] \quad 16.89 = 34.2 \quad (100 \text{ yr})$$

$$[.9(.58) + .1(2)] \quad 16.89 = 12.2 \quad (10 \text{ yr})$$

No 1

$$[.9(.66) + .1(1.29)] \quad \frac{16.89}{12} = 1.02 \quad 100 \text{ yr}$$

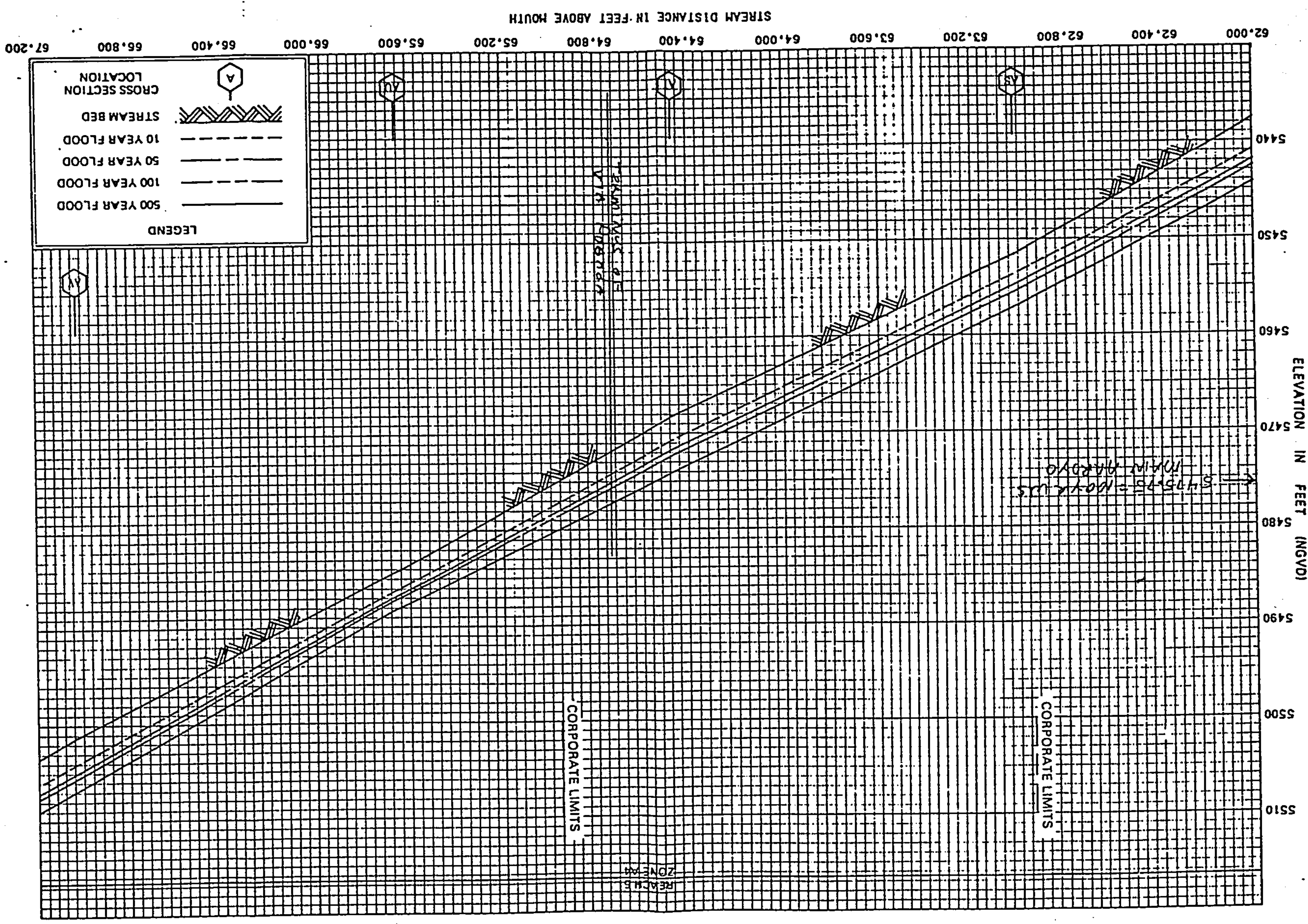
$$[.9(.19) + .1(.62)] \quad \frac{16.89}{12} = .33 \quad 10 \text{ yr}$$

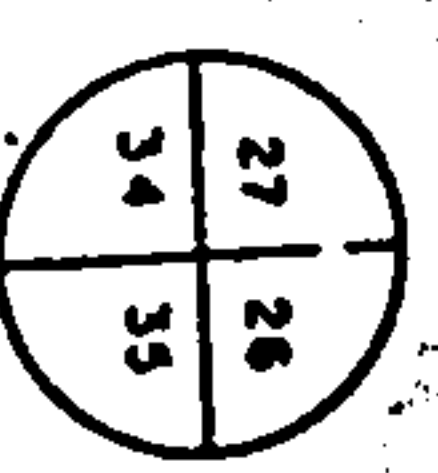
HYMO SUMMARY TABLE (AHYMO993) - AMFCA VERSION OF HYMO - SEPTEMBER, 1993
 INPUT FILE = AHILLPRO.100

RUN DATE (MON/DAY/YR) = 06/15/1994
 USER NO. = RSTECNM.101

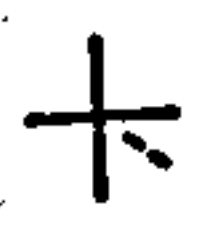
COMMAND	HYDROGRAPH IDENTIFICATION	FROM ID	TO ID	AREA (SQ MI)	PEAK DISCHARGE (CFS)	RUNOFF VOLUME (AC-FT)	RUNOFF (INCHES)	TIME TO PEAK (HOURS)	CFS PER ACRE	PAGE = 1
START										
RAINFALL TYPE= 1										
COMPUTE NM HYD	900.00	-	1	.15020	89.19	7.385	.92187	1.914	.928 PER IMP=	.00
COMPUTE NM HYD	910.00	-	2	.03370	77.86	3.433	1.62125	1.584	3.064 PER IMP=	42.00
ADD HYD	910.10	14 2	13	.18930	127.31	10.817	1.06808	1.716	1.047	
COMPUTE NM HYD	920.00	-	1	.00090	1.10	.031	.65617	1.518	1.911 PER IMP=	.00
ADD HYD	910.20	134 1	1	.13080	127.78	10.849	1.06613	1.716	1.046	
COMPUTE NM HYD	930.00	-	2	.00550	6.68	.192	.65617	1.518	1.899 PER IMP=	.00
COMPUTE NM HYD	940.00	-	3	.02200	26.71	.770	.65617	1.518	1.897 PER IMP=	.00
COMPUTE NM HYD	950.00	-	4	.00110	1.34	.038	.65617	1.518	1.908 PER IMP=	.00
COMPUTE NM HYD	400.00	-	5	.00540	12.92	.440	1.52706	1.518	3.738 PER IMP=	30.00
ADD HYD	910.30	54 1	1	.19620	134.18	11.289	1.07882	1.650	1.069	
COMPUTE NM HYD	401.00	-	6	.00340	8.37	.294	1.62125	1.518	3.847 PER IMP=	42.00
ADD HYD	910.40	14 6	1	.19360	138.97	11.583	1.08806	1.650	1.088	
COMPUTE NM HYD	402.00	-	7	.00230	7.45	.267	1.72614	1.518	4.012 PER IMP=	50.00
COMPUTE NM HYD	403.00	-	8	.00230	5.91	.212	1.72614	1.518	4.015 PER IMP=	50.00
COMPUTE NM HYD	404.00	-	9	.00190	4.89	.175	1.72614	1.518	4.017 PER IMP=	50.00
COMPUTE NM HYD	405.00	-	10	.00370	9.52	.341	1.72672	1.518	4.020 PER IMP=	49.00
ADD HYD	910.50	14 10	1	.20330	144.93	11.923	1.09368	1.617	1.114	
ADD HYD	910.60	14 2	1	.20880	149.92	12.116	1.08739	1.617	1.122	
ADD HYD	910.70	14 7	1	.21170	154.84	12.383	1.03674	1.617	1.143	
ADD HYD	910.80	14 8	1	.21400	159.41	12.595	1.10350	1.584	1.164	
COMPUTE NM HYD	406.00	-	11	.00680	17.48	.626	1.72672	1.518	4.016 PER IMP=	49.00
ADD HYD	910.90	14 11	1	.22080	173.02	13.221	1.12269	1.584	1.224	
ADD HYD	910.91	14 3	1	.24280	197.43	13.991	1.08042	1.551	1.271	
ADD HYD	910.92	14 9	1	.24470	201.86	14.166	1.08543	1.551	1.289	
ADD HYD	910.93	14 4	1	.24580	203.15	14.204	1.08351	1.551	1.291	
FINISH										

AP1 = MH 1
 AP2 = MH 2
 AP3 = MH 3
 AP5 = MH 4
 AP8 = MH 5
 AP10 = MH 6

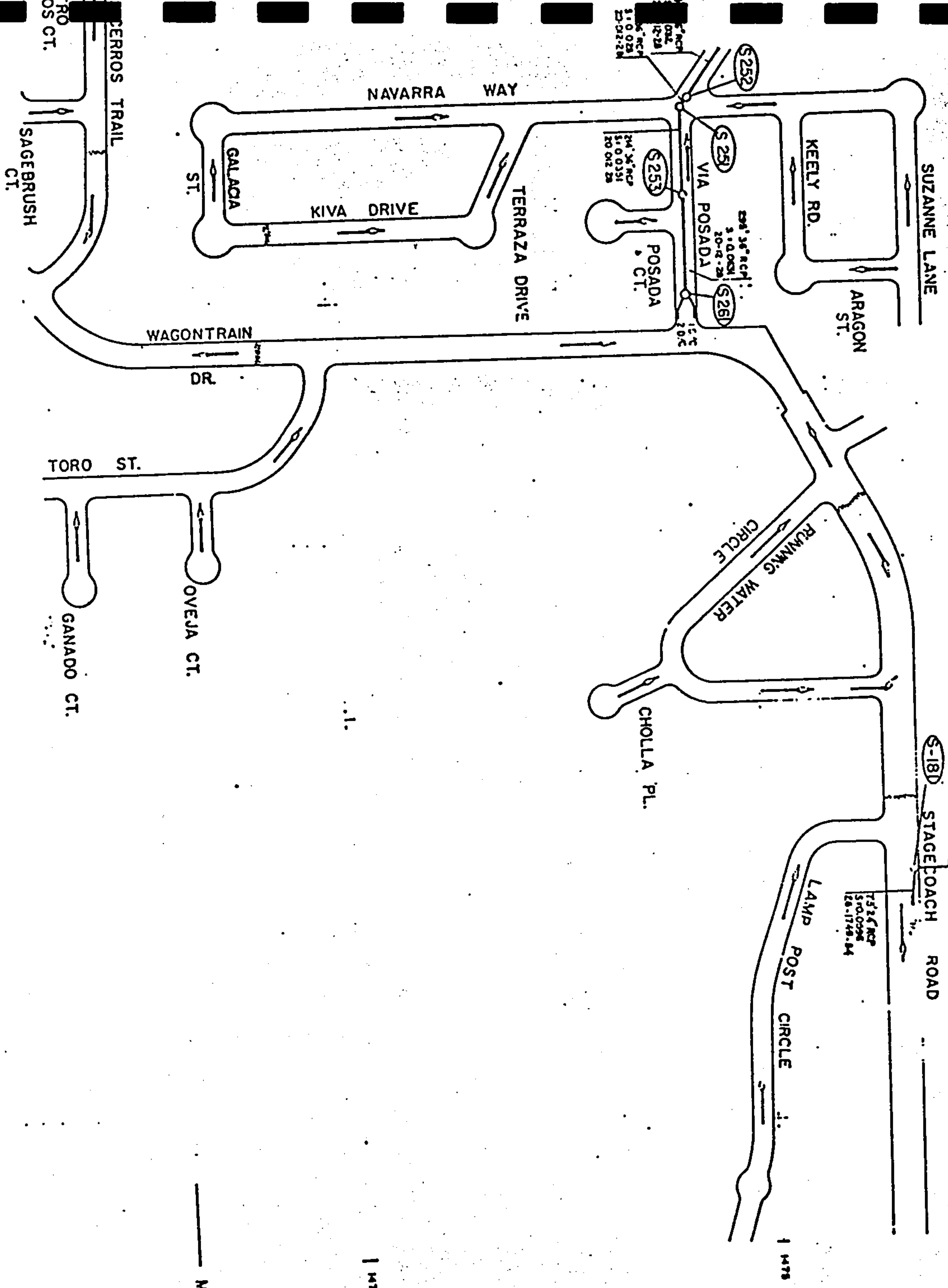




27
26
34
35



1476



LEGEND

STORM SEWER LINE

MANHOLE

NOTES

MANHOLE IDENTIFICATION REQUIRES BOTH THE MAP GRID & MANHOLE NO

DATE

10-2-84

REVISIONS

20 NOV 84 / 150.0 - 11.5 114

DRAINAGE FACILITIES N

MAP GRID

M22

RESOURCE TECHNOLOGY, INC.
ENGINEERS & ENVIRONMENTAL SCIENTISTS

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PROJECT NO. _____

SHEET _____ OF _____

CHECKED _____ DATE _____
APPROVED _____ DATE _____

TITLE _____ BY _____ DATE _____

#1 24+73

$d = .55'$ $S \sim 330$ 2-Type A 10 cfs ea

167 cfs - 20 cfs = 47 cfs street
80 cfs pipe

#2 22+50

$d = .45'$ $S \sim 630$ 2-Type CC 10 cfs ea

47 cfs - 20 = 27 cfs street
100 cfs pipe

#4 17+75

100 cfs pipe
39 cfs street

$d = .47'$ $S = 390$ 2-Type C 8 cfs ea

16 cfs + 7 cfs side flow = 23 cfs
123 cfs pipe
16 cfs street

#5 14+00 159 cfs, 123 in pipe, 36 cfs street

$d = .46'$ $S = 390$ 2-Type C 8 cfs ea
36 - 16 = 20 cfs street 139 in pipe

#6 12+00

side pipe = 27 cfs
27 + 139 = 166

At 10+00 no MH or intels,

37 cfs street flow
166 cfs pipe flow

STORM DRAIN

36"

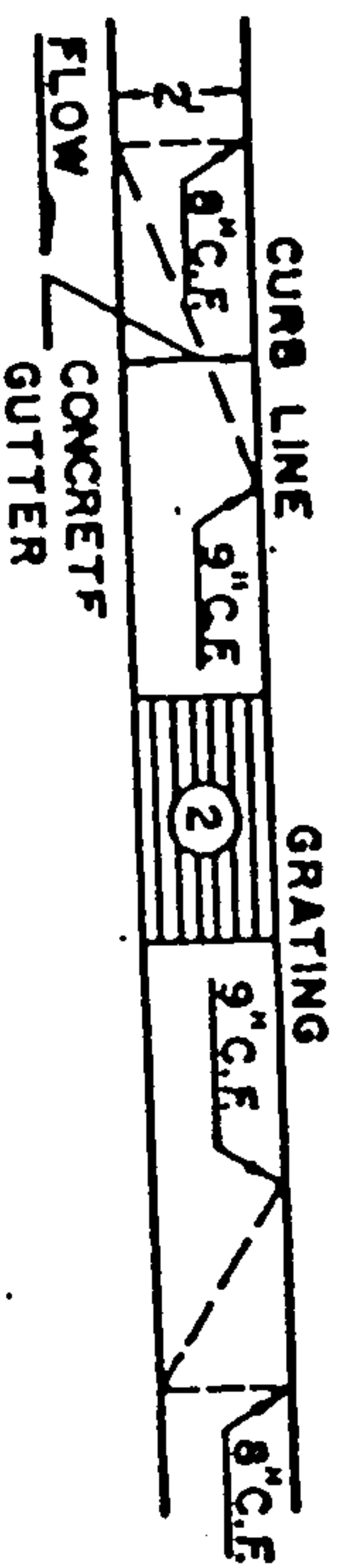
RUN NO.	PIPE FLOW CFS	SLOPE '/	N	DIAMETER (FT)	PIPE CAPACITY CFS	D/D	VELOCITY '/S
1	60.00	.030	.013	3.00	115.73	0.51	16.55
RUN NO.	PIPE FLOW CFS	SLOPE '/	N	DIAMETER (FT)	PIPE CAPACITY CFS	D/D	VELOCITY '/S
2	80.00	.054	.013	3.00	155.26	0.51	22.07
RUN NO.	PIPE FLOW CFS	SLOPE '/	N	DIAMETER (FT)	PIPE CAPACITY CFS	D/D	VELOCITY '/S
3	100.00	.030	.013	3.00	115.73	0.72	18.47

STORM DRAIN

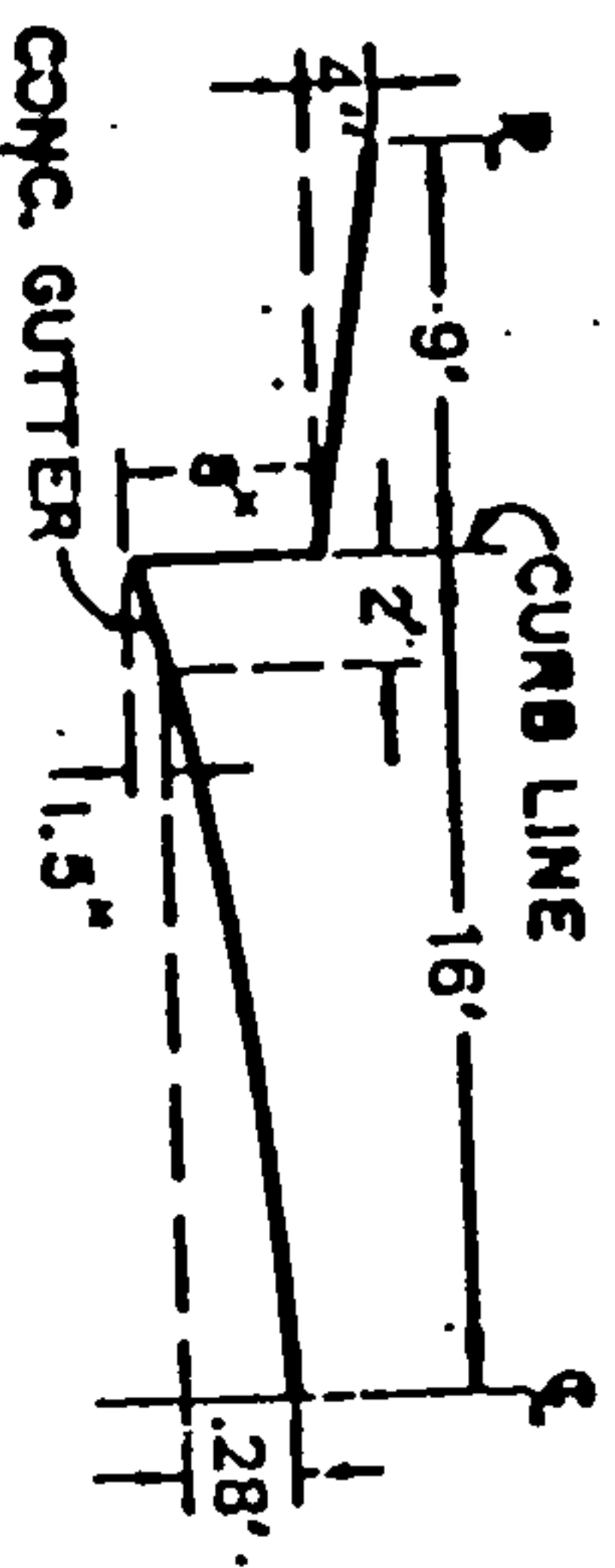
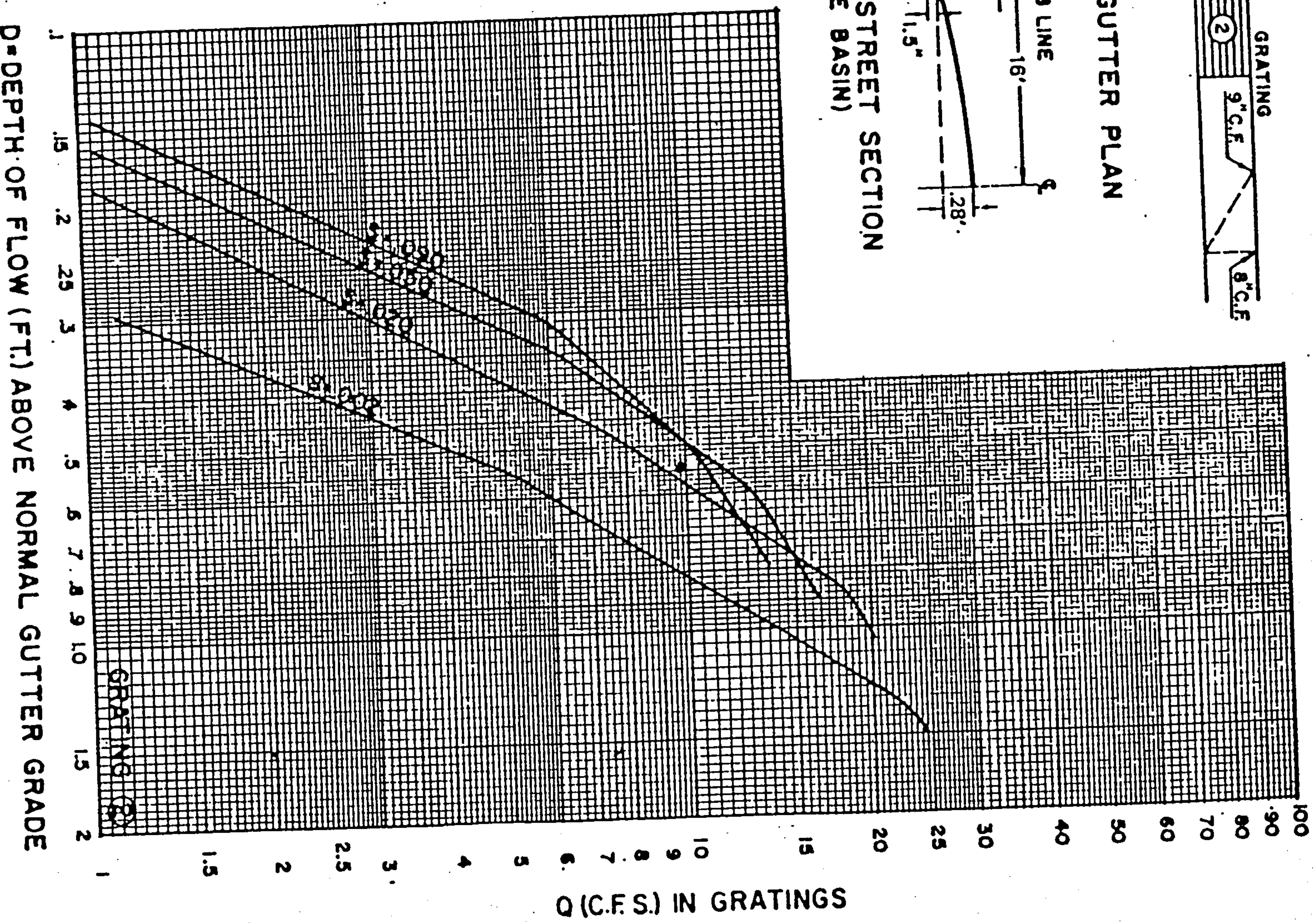
42"

RUN NO.	PIPE FLOW CFS	SLOPE '/	N	DIAMETER (FT)	PIPE CAPACITY CFS	D/D	VELOCITY '/S
1	123.00	.038	.013	3.50	196.57	0.57	21.61
2	139.00	.038	.013	3.50	196.57	0.62	22.19
3	166.00	.036	.013	3.50	191.32	0.72	22.43

GRATING CAPACITIES FOR TYPE "A", "C" and "D"

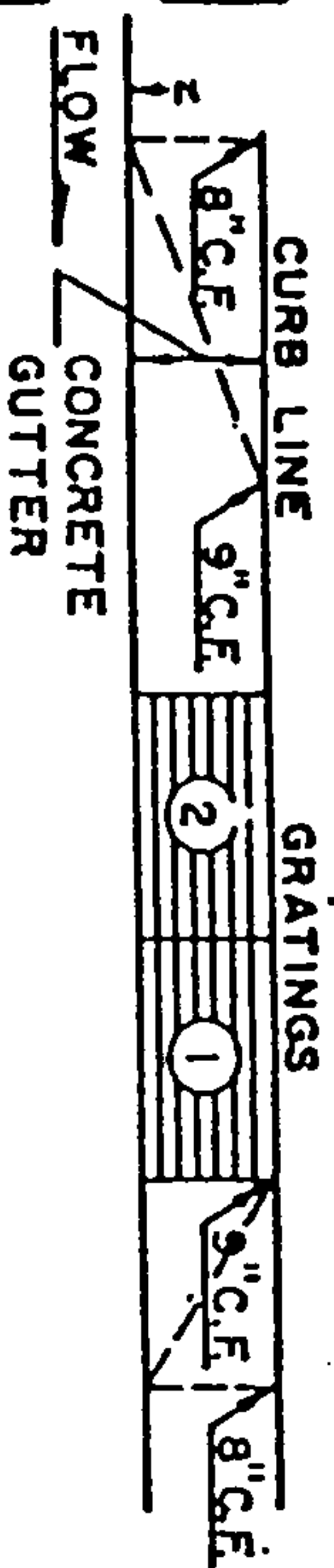


GRATING & GUTTER PLAN

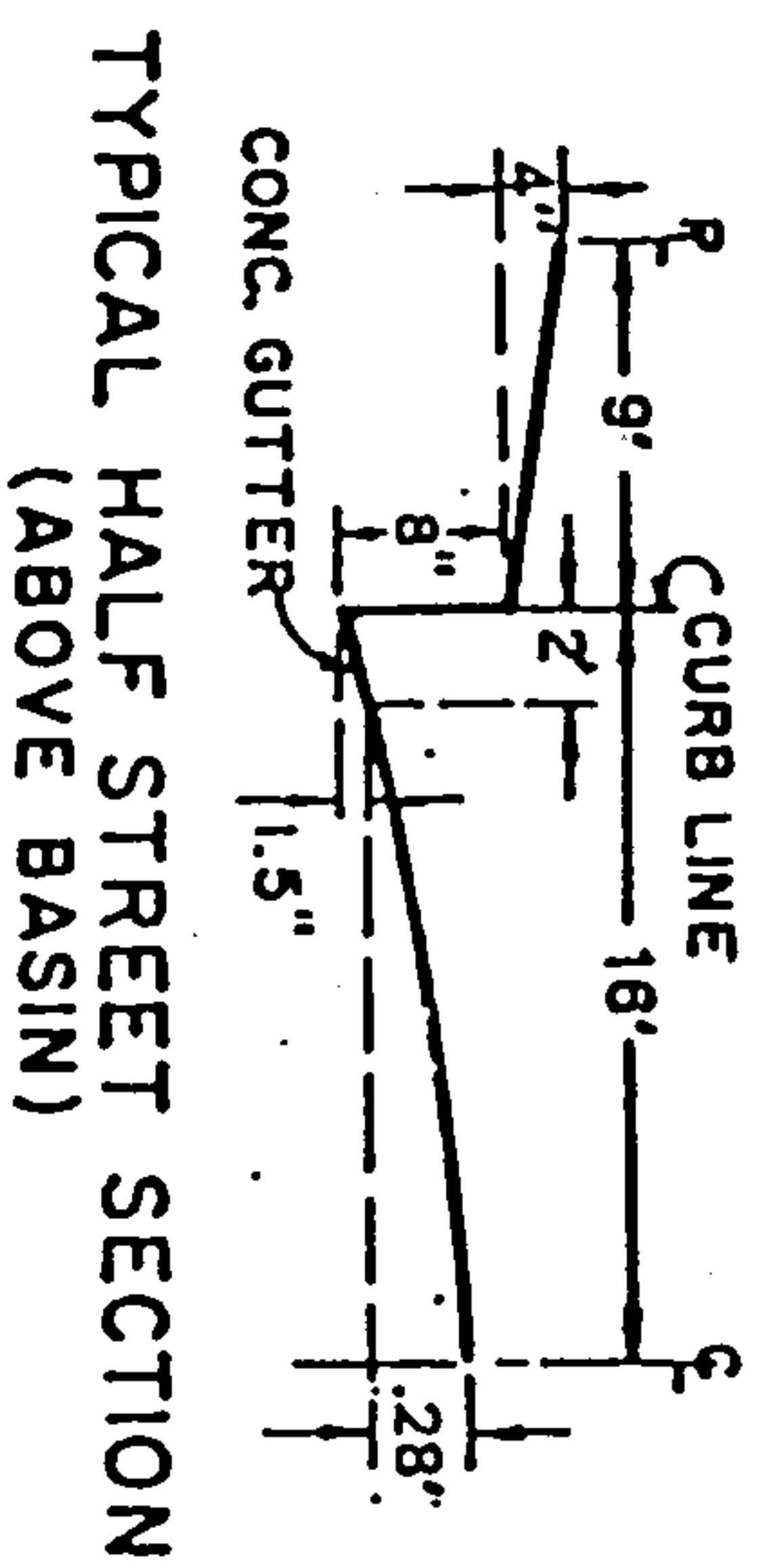
TYPICAL HALF STREET SECTION
(ABOVE BASIN)

GRATING CAPACITIES FOR TYPE DOUBLE

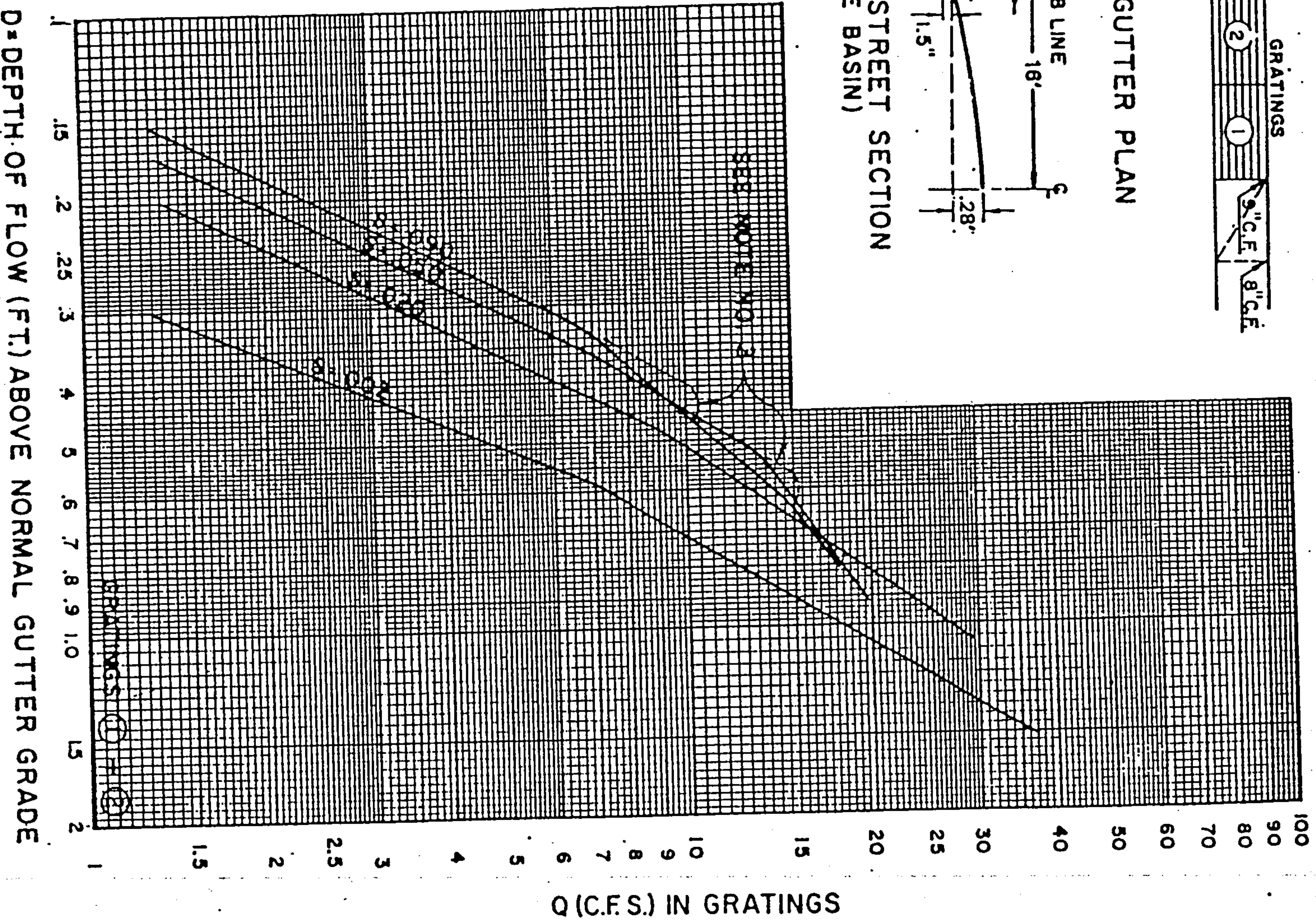
"C," AND "D"



GRATING & GUTTER PLAN



TYPICAL HALF STREET SECTION
(ABOVE BASIN)



RESOURCE TECHNOLOGY, INC.

ENGINEERS & ENVIRONMENTAL SCIENTISTS

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Fax: (505) 345-4132

PROJECT NO. _____

SHEET _____ OF _____

CHECKED _____ DATE _____

APPROVED _____ DATE _____

TITLE _____ BY _____ DATE _____

1/2 Street 1

$D = 1.40$

$D = .60$

S

Q

V

Q

V

330

12

4.5' / 5

46

7' / 5

690

17

6.3' / 5

65

10' / 5

590

15

4.8' / 5

60

9' / 5

Via Portal at start of project

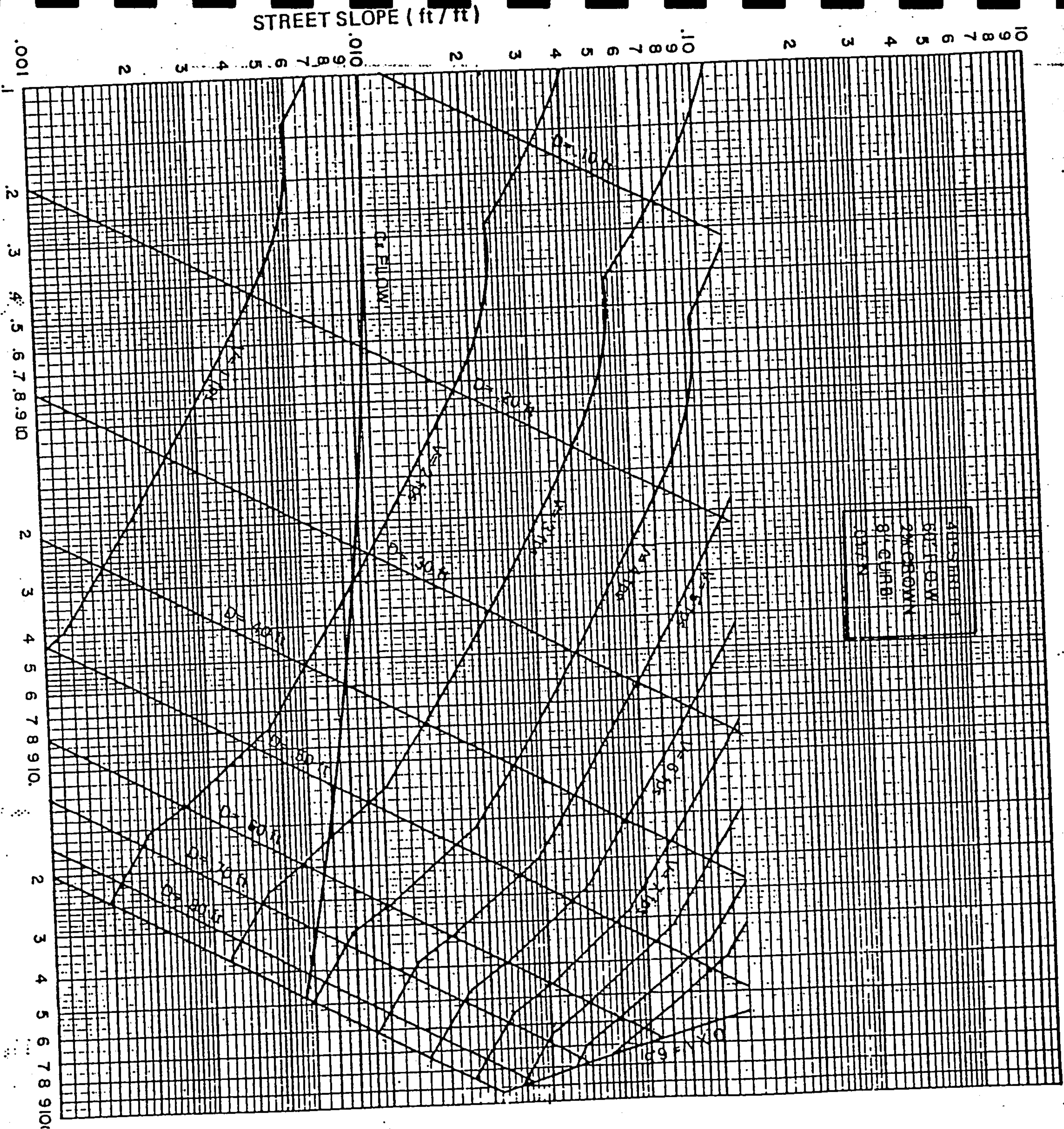
$Q = 67 cfs$

1/2 Street = 34' < 46

$d = .55'$

$V = 6.1' / 5$

STREET CAPACITY



ONE HALF STREET FLOWS (cfs)

Natural Arroy at Point of Discharge

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS					
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)		
90.00	4.0	4.0	0.041		
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient	
Concrete	99.00	203.0	0.35	0.025	
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks	
0.36	33.40	6.07	0.93	Stable	

CHANNEL LINING ANALYSIS

CHANNEL LINING ANALYSIS				
Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)	
90.00	1.0	1.0	0.041	
Lining	Permissible Shear (lb/sf)	Discharge (cfs)	Hydraulic Radius (ft)	Manning Coefficient
Concrete	99.00	203.0	0.36	0.025
Normal Depth (ft)	Area (sf)	Velocity (ft/sec)	Calculated Shear (lb/sf)	Remarks
0.36	33.11	6.13	0.93	Stable

Sediment Calculations

RESOURCE TECHNOLOGY, INC.

ENGINEERS & ENVIRONMENTAL SCIENTISTS

2129 Osuna Road, NE Suite 200

Albuquerque, NM 87113

Phone: (505) 345-3115

Fax: (505) 345-4132

PROJECT NO. _____

SHEET _____

OF _____

CHECKED _____ DATE _____

APPROVED _____ DATE _____

TITLE

Area 940 (B)

BY

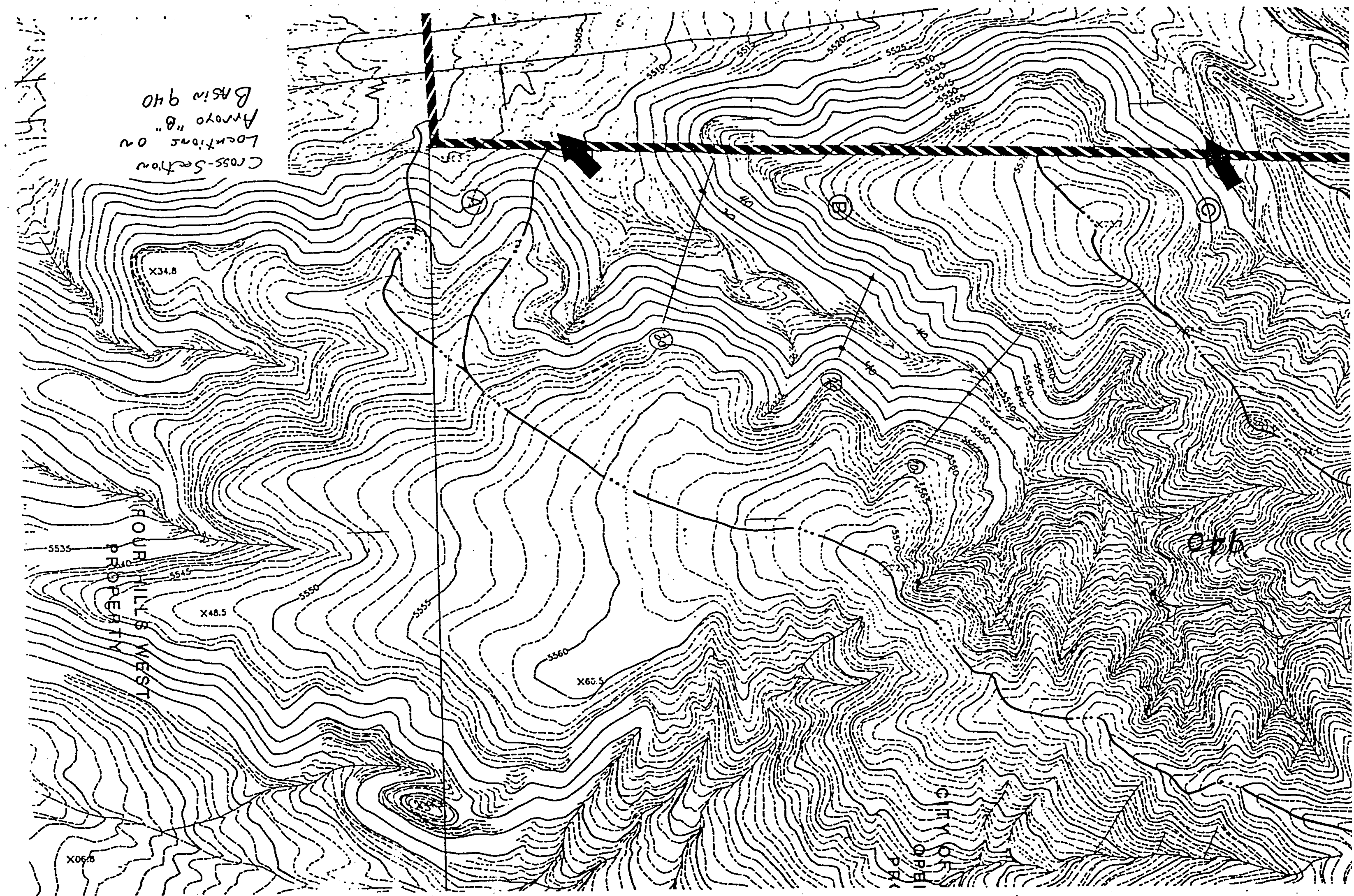
DATE

5/21/94

P_{60} , P_{360} , P_{1440} for indicated return period.

	2	5	10	25	50	100
0.93	1.21	1.43	1.71	1.93	2.14	
1.13	1.47	1.73	2.08	2.34	2.60	
1.34	1.76	2.07	2.48	2.79	3.10	

See Table A-3



* WATER SURFACE PROFILES *

* VERSION OF NOVEMBER 1976 *

* UPDATED MAY 1984 *

* IBM-PC-XI VERSION *

* RUN DATE 06/20/94 TIME 21:19:19 *

* U.S. ARMY CORPS OF ENGINEERS
* THE HYDROLOGIC ENGINEERING CENTER
* 609 SECOND STREET, SUITE D
* DAVIS, CALIFORNIA 95616
* (916) 440-2105 (FTS) 448-2105

*HEC-2 Input File used to develop channel rating curves for
sediment Transport calculation using
AHYMO.*

Basin 940

X	X	XXXXXX	XXXXX	XXXXX
X	X	X	X	X
X	X	X	X	X
XXXXXX	XXXX	X	XXXXX	XXXXX
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	XXXXXX	XXXXX	XXXXXX

THIS RUN EXECUTED 06/20/94 21:19:20

HEC2 RELEASE DATED NOV. 76 UPDATED MAY 1984
ERROR CORR - 01,02,03,04,05,06
MODIFICATION - 50,51,52,53,54,55,56
IBM-PC-XI VERSION 1.1

T1 FOUR HILLS
T2 HEC-2 RUN FOR SUPERCRITICAL FLOW
T3

J1	ICHECK	IND	NINW	IDIR	STRT	METRIC	HVINS	Q	WSEL	FD
	0.	0.	0.	1.	.000000	.00	.0	5.	534.500	.000
J2	NPROF	IPLOT	PREVS	XSECV	XSECH	FN	ALDC	IBM	CHNIM	ITRACE
	-1.000	.000	.000	.000	.000	.000	-1.000	.000	.000	.000
MC	.040	.040	.035	.100	.300	.000	.000	.000	.000	.000
	11.000	11.000	120.000	135.000	400.000	300.000	350.000	.000	.000	.000

PAGE
2

#PROD 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS

DOH= .100 CEH= .300

*SECOND 10.000

3720 CRITICAL DEPTH ASSUMED

10.00	.49	533.49	533.49	534.50	533.61	.12	.00	.00	540.00
5.	0.	5.	0.	0.	2.	0.	0.	0.	540.00
.00	.00	2.83	.00	.040	.035	.040	.000	533.00	152.57
.029637	0.	0.	0.	0	16	0	.00	7.28	159.86

***SECOND 20.000**

3685 20 TRIALS ATTEMPTED WSEL, CHSEL

3633 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

20.00	.43	523.93	523.93	.00	524.04	.11	10.55	6.10	530.00
5.	0.	5.	0.	0.	2.	0.	0.	0.	530.00
.04	.00	2.67	.00	.040	.035	.040	.000	523.50	200.27
.030662	400.	350.	300.	20	11	0	.00	8.66	208.93

*SECOND 30.000

3685 20 TRIALS ATTEMPTED, WSEL, CWSEL

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

30.00	.46	512.46	512.46	.00	512.57	.12	13.76	8.06	520.00
5.	0.	5.	0.	0.	2.	0.	0.	0.	520.00
.08	.00	2.75	.00	.040	.035	.040	.000	512.00	225.44
.030515	450.	450.	450.	20	8	0	.00	7.97	233.42

06/20/94 21:19:20

PAGE 3

HEC2 RELEASE DATED NOV 76 UPDATED MAY 1984

ERROR CORR - 01,02,03,04,05,06

MODIFICATION - 50, 51, 52, 53, 54, 55, 56

IBM-PC-XT VERSION 1.1

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

SUMMARY PRINTOUT TABLE 150

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CMSL	CRIMS	EG	10K*5	VCH	AREA	.01K
* 10.000	.00	.00	.00	533.00	5.00	533.49	533.49	533.61	296.37	2.83	1.77	.29
* 20.000	350.00	.00	.00	523.50	5.00	523.93	523.93	524.04	306.62	2.67	1.87	.29
* 30.000	450.00	.00	.00	512.00	5.00	512.46	512.46	512.57	305.15	2.75	1.82	.29

06/20/94 21:19:20

PAGE 4

SUMMARY PRINTOUT TABLE 150

SECNO	Q	CMSL	DIFMSP	DIFMSX	DIFKMS	TOPWID	XLCH
* 10.000	5.00	533.49	.00	.00	-1.01	7.28	.00
* 20.000	5.00	523.93	.00	-9.55	.00	8.66	350.00
* 30.000	5.00	512.46	.00	-11.48	.00	7.97	450.00

06/20/94 21:19:20

PAGE 5

SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION SECNO= 10.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 20.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 20.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 20.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO= 30.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 30.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY

CAUTION SECNO= 30.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

06/20/94 21:19:24

PAGE 1

HEC2 RELEASE DATED NOV 76 UPDATED MAY 1984

ERROR CORR - 01,02,03,04,05,06

MODIFICATION - 50,51,52,53,54,55,56

IBM-PC-XT VERSION 1.1

THIS RUN EXECUTED 06/20/94 21:19:24

Sediment Calculations

RESOURCE TECHNOLOGY, INC.

ENGINEERS & ENVIRONMENTAL SCIENTISTS

2129 Osuna Road, NE Suite 200

Albuquerque, NM 87113

Phone: (505) 345-3115

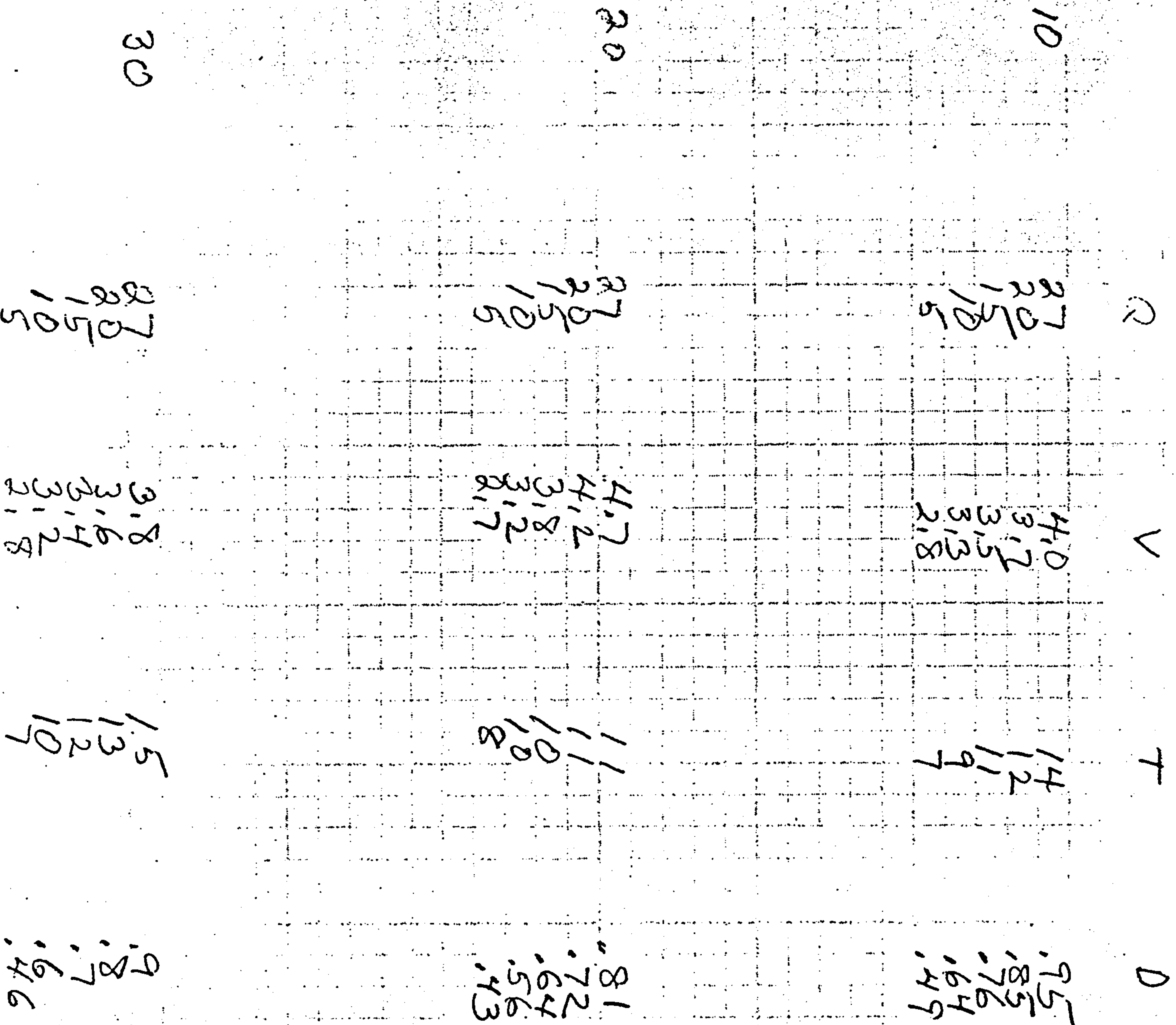
Fax: (505) 345-4132

PROJECT NO. _____

SHEET _____ OF _____

BY _____ DATE _____

CHECKED _____ DATE _____
APPROVED _____ DATE _____
TITLE X-Section Rating Curves



RESOURCE TECHNOLOGY, INC.
ENGINEERS & ENVIRONMENTAL SCIENTISTS

2129 Osuna Road, NE Suite 200

Albuquerque, NM 87113

Phone: (505) 345-3115

Fax: (505) 345-4132

PROJECT NO. _____

CHECKED _____ DATE _____

APPROVED _____ DATE _____

SHEET _____ OF _____

TITLE Sed. Calc's

BY gcl DATE 5/22/94

$$Y_m = .015 Y_{100} + .015 Y_{50} + .04 Y_{25} + .08 Y_{10} + .2 Y_5 + .4 Y_2$$

$$Q_2 = 0$$

$$Y_m = .015(22.6) + .015(22.4) + .04(15.8) + .08(8) + .2(3.2)$$

$$Y_m = 2.69 \text{ Tons}$$

$$Y_{30yr} = 30 \times Y_m = 80.76 \text{ Tons}$$

$$\approx 2800 \text{ lb/cy}$$

30 year sed. Trans out of system

$$57.7 \text{ cy degradation} =$$

Channel 1200' long. $b \sim 10'$

.13' along bottom,

RESOURCE TECHNOLOGY, INC.

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CHECKED _____ DATE _____

PROJECT NO. _____

APPROVED _____ DATE _____

SHEET _____ OF _____

TITLE Sed Chlcs

BY 5/20/94 DATE ASL

Basin B, Area = .0220 sq mi
(940)

Basin C, Area = .0055 sq mi
(930)

Basin C Sed Yield ~ 2590 Basin B

$Y_m = .25(2.69) \text{ tons} = .67 \text{ tons}$

$Y_{30} = 20.2 \text{ tons (14.4 cy)}$

September 30, 1994

Post-it® Fax Note		7671	Date <u>10-2-94</u>	# of pages <u>1</u>
To <u>FRED A.</u>	From <u>KURT JB</u>			
Co./Dept. <u>CITY HYD.</u>	Co. <u>AMAFCA</u>			
Phone #	Phone #			
Fax # <u>08</u>	Fax # <u>-</u>			

TO: Mr. Fred Aguirre

FR: AMAFCA, Kurt Browning *KB*
 RE: Tijeras Arroyo DRB Case
 Terry Brown and Four Hills Village 20th Installment

In this particular case, AMAFCA has agreed to accept the easement that has been in question. Please note that the City has a masterplan for the Tijeras Arroyo (Leedshill-Herkenhoff-1990) that includes a prudent line assessment.

We understand that City Hydrology will set the technical requirements for the study of this easement and will perform the required coordination and review. AMAFCA suggests a revised prudent line assessment, based on the new procedures outlined in the Sediment and Erosion Design Guide. Perhaps these revised results can be compared to the prudent line/setback techniques used in the City's 1990 study, and an agreeable width can be determined. Erosion setback and scour are major concerns. As Susan is aware, any construction within the erosion setback area should require floodproofing, floodwall, etc.

We suggest the easement be based on EGL or sequent depth, which will require a HEC-2 analysis. Will the City require a new hydrological analysis based on the new hydrology? It appears that a significant amount of engineering regarding setbacks, scour depths, flood protection, water surface profile, etc., might need to be completed.

Once City Hydrology is comfortable with these analyses (as needed), including the width of the easement, AMAFCA will accept the easement.

10-2-94

Fred:
I spoke w/ Terry about this. The City will take the lead and AMAFCA will accept the document when the City is satisfied with the analysis.

KB

APPLICA FOR APPROVAL OF EXTRAORDINA

BACKGROUND INFORMATION:

Post-it Fax Note	7671	Date	8/29/94	Pages	2
To	Susan Calogayue	From	Don Dixon		
Co./Dept.	Floodplain Admin.	Co.	RTI		
Phone #		Phone #	345-3115		
Fax #	768-3629	Fax #	345-4132		

I. DESCRIPTION OF OPEN SPACE AREA ON OR ADJACENT TO WHICH PROPOSED FACILITY WOULD BE INSTALLED OR CONSTRUCTED

- A. Common name of Open Space Property: Four Hills Open Space
- B. Size and Location of Open Space Property: Approximately 40 Acres located south of the proposed Four Hills Village, Twentieth Installment located west of the intersection of Via Posada / Navarra Way (Zone Atlas Page M-22-Z - Attached).
- C. Public Purpose(s) or Functions of Open Space Property and Documentation of Stated Purpose (i.e., Comprehensive Plan, Area Plan, Sector Plan or Open Space Register): This tract of Open Space was the result of a court order.

II. DESCRIPTION OF PROPOSED FACILITY

- A. Physical Description of Facility: It is proposed to place up to approximately 2 feet of compacted soil in the invert of a steep arroyo at the edge of the Open Space in an area of about 0.1 acres near the northeast corner of the Open Space and to place approximately 1 foot of compacted soil in the invert of an arroyo at the edge of the Open Space in an area of about 0.05 acres near the northwest corner of the Open Space. (Please see Exhibits 1 and 2 - attached).
- B. Public Purpose(s) of Facility: To collect offsite flows from the Open Space property onto our proposed residential subdivision.
- C. Public Benefits(s) Associated with Locating Facility on or Adjacent to Open Space: To facilitate the City of Albuquerque's access to and maintenance of drainage structures that will be constructed for this project to collect the offsite flows from the Open Space.
- D. Alternatives to Facility and Facility Location: The alternative that will be required if the arroyo invert on the Open Space cannot be raised is to construct underground storm sewer pipe with an inlet to collect the subject offsite flows. Additionally, since an inlet structure associated with underground pipe is subject to plugging, an overflow structure would have to be constructed in the event that the pipe or inlet became plugged, or a pond would be required to hold the water from the 100 year storm which could not enter the plugged inlet or pipe. The alternative would be costly from both a construction and a maintenance point of view, and is not recommended by the City's Hydrology Department.
- E. Measures to Mitigate Impact of Facility on Open Space: The developer will re-seed the area of Open Space disturbed as a result of this request. Owner is also providing permanent legal pedestrian access to this currently land-locked Open Space parcel by dedication with this plat.
- F. Public or Private Entity Responsible for Construction and Maintenance of Facility: The developer of this proposed subdivision (Four Hills Village,

**APPLICATION FORM
FOR APPROVAL OF EXTRAORDINARY FACILITIES ON CITY OPEN SPACE**

Twentieth Installment) will construct the facility at his sole expense subject to the approval by the City. The City of Albuquerque Hydrology Department will then accept the proposed concrete surface channel to maintain in the future.

G. Cost and Source of Funding for Construction and Maintenance of Facility:

The cost to construct the proposed compacted soil (fill) and to seed the area is approximately \$1,500. The source of funds for the construction will be 100% developer. There should be no maintenance of the fill required once the revegetation is established.

H. Cost, Source of Funding, and Entity Responsible for Implementation of Approved Mitigating Measures: See above.

- I. Additional Comments or Information:** This request is being made as a result of difficulties encountered when attempting to obtain Hydrology's approval for the proposed Four Hills Village, Twentieth Installment Subdivision. One of the requirements of Hydrology for the subdivision process is that the developer of the subdivision accept and handle offsite drainage from adjacent upstream properties. In order to maintain adequate slope limitations within the proposed subdivision without having substantial grading into the Open Space, the proposed Via Posada roadway was raised to an elevation such that surface flows from the open space could not be maintained. By raising the open space areas in question a slight amount (as per this request), those surface flows can be transported to the new Via Posada. By maintaining surface flows in a narrow (10' wide) concrete channel, future maintenance for the City will be minimized.

III. ATTACH PUBLIC COMMENTS AND EVALUATIONS OR PROPOSAL

APPLICANT: Stan Strickman, HAT, Ltd.

ADDRESS: P. O. Box 817, Albuquerque, NM 87103

TELEPHONE: 766-9103

Signature: 

Date: 8/11/54



2129 OSUNA ROAD NE, SUITE 200
ALBUQUERQUE, NEW MEXICO 87113
(505) 345-3115
FAX (505) 345-4132

November 8, 1994

Ms. Susan Calongne, P.E.
City/County Floodplain Administrator
P.O. Box 1293
Albuquerque, New Mexico 87103

NOV 9 1994

RE: PRUDENT LINE FOR FOUR HILLS 20TH INSTALLMENT (M23/D11)
RTI File No. 94-060

Dear Susan,

I had a telephone conversation with Fred Aguirre on 10/7/94 concerning the methodology for a prudent line analysis for the above referenced project, at which time we discussed several options. Given the fact that Leeds Hill-Herkenhoff, Inc. had conducted a similar study for the City of Albuquerque in 1988 as part of the Tijeras Arroyo Drainage Management Plan Phase II (DMP) we decided to use their results, if the following could be shown:

1. The 100-year flow rate used by Leeds Hill-Herkenhoff, Inc. (L-HI) 1988 for this reach of Tijeras Arroyo was equal to or greater than that proposed for the FEMA re-study (in progress) by Resource Technology, Inc. (RTI).
2. The methodology used for the determination of the prudent line for the L-HI analysis was comparable to or more conservative than that presented in the AMAFCA "Sediment and Erosion Design Guide" (SEDG), 1994. This would include sediment yield and transport analysis.

If both of the above two points could not be demonstrated or the L-HI study showed that this project was impacted by the prudent line, then a new study, utilizing the current version of AHYMO and the SEDG would be required.

We have conducted the necessary evaluation which is contained in Attachment 1, and these are our findings:

1. Table 1 in Attachment 1, shows the results of several hydrologic studies conducted on Tijeras Arroyo. RTI is proposing to use the USGS data because it is based on stream flow gage data for the longest period of record. As can be seen from the table, the L-HI study utilized a significantly higher flow rate.

2. The sediment transport analysis conducted by L-HI indicated a higher sediment yield and sediment transport capacity than would be found by using the SEDG for the watershed bed material gradations reported. An evaluation for Reach 3 (located along Four Hills 20th installment) results, as presented in the DMP, indicated a 14 to 49 percent greater sediment transport capacity for the L-HI results, than would be found by using the current methodology (SEDG). Therefore, even if an AHYMO analysis of the basin were to result in a 100-year flow rate substantially higher than that used by L-HI, the sediment transport capacity of the arroyo would still be expected to be lower using the current methodology (SEDG). See Attachment 1.
3. The prudent line based on the L-HI methodology is shown on Exhibit 1 (attached). As can be seen, it abuts the proposed subdivision but all proposed building pads and infrastructure improvements are well outside the indicated area.
4. An identical analysis was also completed for Reach 4 which is located upstream of Reach 3. The purpose for the Reach 4 analysis was to determine if the results would be similar to Reach 3. The analysis results for Reach 4 are very similar to Reach 3 and Attachment 2 contains this analysis.

In summary, the L-HI determination of the prudent line appears to be very comparable to that which would have been computed using the SEDG. Since that prudent line places this proposed project outside the impacted area, a more detailed analysis for this project is not warranted at this time.

RESOURCE TECHNOLOGY, INC.



Elvidio V. Dimiz, P.E.
President

EVD/rjg

Attachments

ATTACHMENT 1

4-Hills 20th Installment

A1.1

RTI File No. 94-060

M23/D11

Terry O. Brown, P.E.

P. O. Box 92051
Albuquerque, NM 87199-2051
(505) 883-8807
(505) 837-1386 FAX

Facsimile Cover Page

Total Pages Including Cover Sheet: 1
If you did not receive all pages, please contact this
office. Thank you.

To: Calongne, P.E., Susan		From : Terry O. Brown	
Fax Number : 768-3629		Company : Terry O. Brown, P.E.	
Date : 1/30/95	Time : 17:06:28	For Information Call: (505) 883-8807	
Subject : Four Hills Village Drainage Plan Review		Fax Number : (505) 837-1386	

Don,

I spoke with Glen Jergensen this afternoon requesting that he review the improvement plans for the storm drainage portion of the Four Hills Village, Twentieth Installment Subdivision. Since Susan has reviewed and commented on the plans at D.R.C., Glen stated that he saw no need for him to review the plans. Therefore, you may proceed with the addressing of Susan's comments as I related them to you last week. The revised plans are scheduled to be submitted back to D.R.C. near the end of this week. If you have questions, please call me.

Terry Brown

cc: Susan Calongne, Hydrology Development

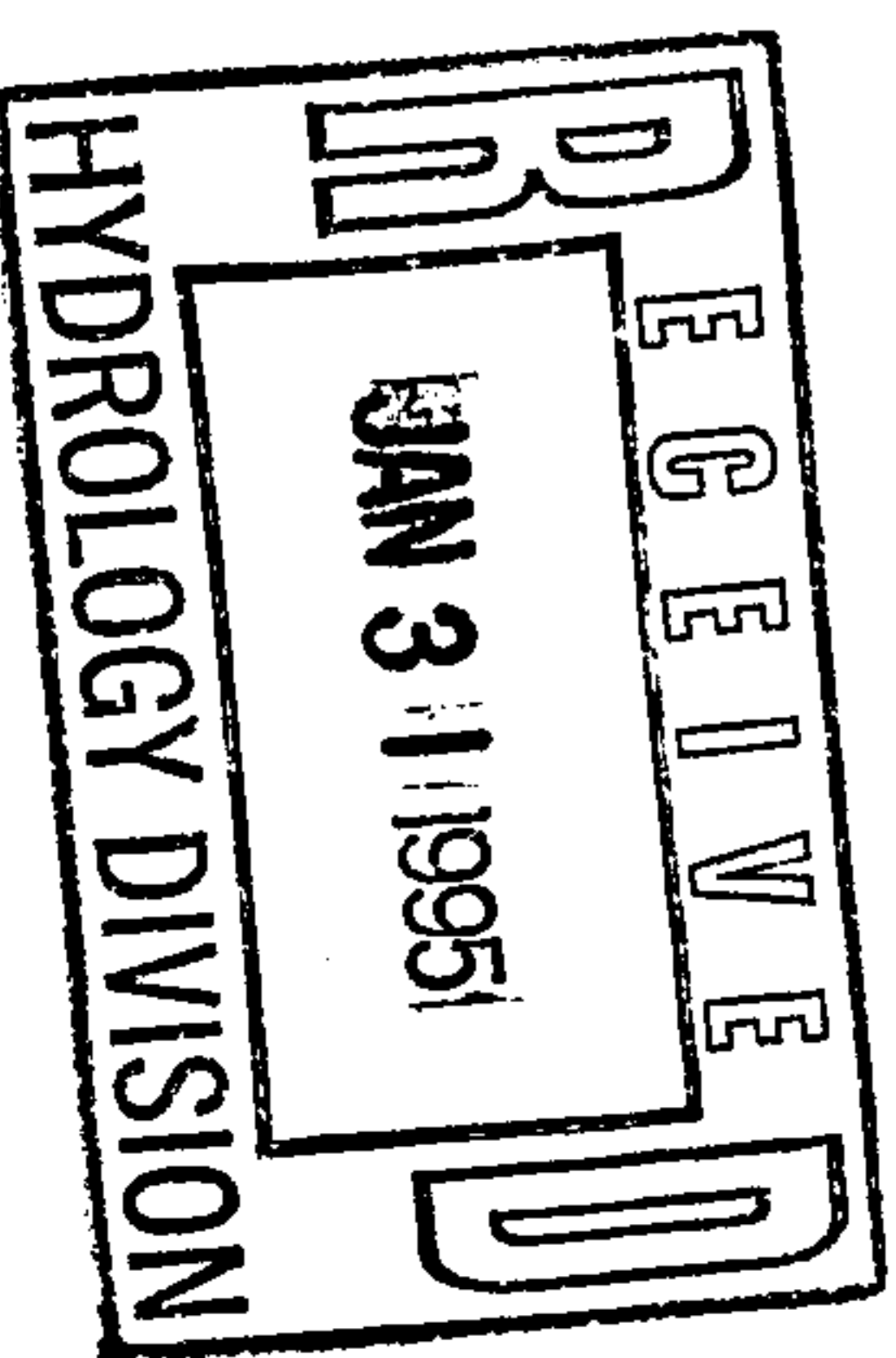


TABLE 1

Tijeras Arroyo Peak Discharge (cfs) Information				
Return Period, Yrs.	COE 1974 (a)	RTI/USGS (b)	L-HI 1988 - DMP (c)	FEMA/USGS 1983
500	22,600 (IRF)	25,694	18,065	28,600
100		12,875		14,300
50		9,102		10,000
10		3,344		5,120

(a) Floodplain Information Albuquerque Arroyos Part IV, Albuquerque, New Mexico. Department of the Army, Albuquerque, New Mexico; Corps of Engineers, Albuquerque, New Mexico. June 1974 (pg. 9-11).

Discussion with Army Corps of Engineers (10-21-94) indicate background information is unavailable and therefore we assume the peak discharge was developed with a HEC-1 model. IRF = Intermediate Regional Flood = 100-yr. flood. Drainage Area = 76 sq.mi.

(b) RTI used USGS Stream Gage No. 08330500 data, 41 years of record, although 15 years of the peak flow data were below the gage base discharge of 250 cfs and were eliminated before the Log-Pearson Type III flood probability analysis was completed by the U.S. Geological Survey. The gage is located approximately 1 mile upstream of Four Hills Road. Discharges shown include Conditional Probability. Drainage Area = 75.30 sq.mi.

(c) L-HI - DMP at Four Hills Road (approximately). Peak discharge was obtained from a HEC-1 model. Drainage Area = 78 sq.mi.

COMPARISON OF DMP SEDIMENT TRANSPORT EQUATION RESULTS
TO THE MPM-WOO EQUATION (SEDG) RESULTS

PURPOSE

Perform a brief comparison of the sediment transport equation results between the equations presented in the "Tijeras Arroyo Drainage Management Plan (DMP) Phase II" Report (Leedshill-Herkenhoff, Inc., February, 1988), and the MPM-Woo Equation presented in the "Sediment and Erosion Design Guide" (SEDG) (Resource Consultants and Engineers, Inc., March 1994).

PROCEDURE

Locate the 4-Hills 20th Installment Subdivision with respect to the DMP designated reaches and determine the applicable reach and its associated data and results as presented in the DMP. The Sheets and Tables referenced below are included at the end of this attachment.

LOCATION	-	Sheet M-22 in DMP
HEC-2 Sections	-	AT to AU (Sheet M-22 in DMP)
D ₅₀	-	Average of all samples = 2.63mm (Table VIII-6 in DMP). As shown on Sheet M-22, Sample No.'s BG #5 and BG #6 are near the proposed subdivision. Table VIII-6 indicates BG #5 is a bed sample with D ₅₀ = 8.0mm and BG #6 is a bank sample with D ₅₀ = 0.6mm. Due to this range of extreme sizes compared to the other D ₅₀ values presented in Table VIII-6, the mean D ₅₀ of all samples was assumed which is 2.63mm (Table VIII-6).

Reach No. 3 - Table VIII-7 in DMP

V, Y, S₀ and D₅₀ (Table VIII-2 in DMP) are all within range of values for which the MPM-Woo Equation is applicable (Table 3.6 in SEDG)

Therefore, based on D₅₀ = 2.63mm, compute MPM-Woo Equation coefficient and exponents from Figure 3.10 in SEDG.

a	=	0.000002
b	=	5.67
c	=	-0.76
d	=	-1.6

Cf - assume 1 PPM and repeat for maximum concentration = 60,000 PPM because DMP did not present or consider Cf

Select 10-yr. and 100-yr. Q and Qs discharge values presented in DMP for Reach 3 (Appendix C, DMP), obtain V and Y for the 10-yr and 100-yr. Q's from Table VIII-2 (DMP), apply MPM-Woo Equation and compute Qs. Compare the results of the 10-yr. and 100-yr. Qs computations between DMP results and MPM-Woo Equation.

NOTE: This data is for one-time period at maximum discharge on the hydrograph.

Data Type	Return Period	
	10-yr.	100-yr.
Q (cfs)	6,285	18,065
V (ft/sec)	7.10	9.95
Y (ft)	2.24	3.54
TW (ft)	395	513

Hyd. Ord. Time Interval = 0.1 hrs. = 360 sec.

SEDIMENT TRANSPORT CAPACITY RESULTS (REACH 3)

Q	DMP		MPM-WOO *		Difference	
	Cf *	Qs	Qs	qs	Qs	% of DMP
(cfs)	(assumed)	(tons)	(cu ft)	(cfs/ft)	(cu ft)	
6,285	1 PPM	2,163	26,154	0.07269	10,337	—
6,285	60,000 PPM	2,163	26,154	0.08025	11,412	44
18,065	1 PPM	6,839	82,696	0.34789	62,248	—
18,065	60,000 PPM	6,839	82,696	0.38450	71,009	86

(a) assume specific weight of sediment = 165.4 lbs/cu.ft.
 $\text{tons} \frac{(2000 \text{ lbs})}{(1 \text{ cu ft})} = \text{cu ft}$
 $(\text{ ton })(165.4 \text{ lbs})$

(b) $Q_s = q_s (TW)(360)$
 $Q_s = \frac{\text{cu ft/sec}(\text{ft})(\text{sec})}{\text{ft}} = \text{cu ft}$

(c) tons in DMP is for Q lasting 360 (see Appendix C in DMP)

RESULTS SUMMARY FOR REACH 3 ONLY

The MPM-Woo Equation produces values of only 44% (10-yr.) to 86% (100-yr.) of the values computed in the DMP (if Cf = 60,000 PPM).

PRUDENT LINE ASSUMPTIONS IN DMP

Only the long term 25-yr. aggradation/degradation volume was used in the DMP to predict the aggradation/degradation in the reach and lateral bank movement. However, the current methodology states that the long term volume plus the 100-yr. volume is the total volume that should be used to develop the Prudent Line.

ROUGH ADJUSTMENT TO DMP PRUDENT LINE RESULTS

A rough adjustment and comparison of the DMP long term and 100-yr. sediment transport capacity results was completed to determine the increase (in percent) that would occur in the DMP results if the 100-yr. transport capacity volume were added to the long term sediment transport capacity volume. The following values were obtained from Table VIII-3 in the DMP for the total sediment transport capacity of the hydrograph.

100-yr. volume	= 34,603 CY
25-yr. long term volume	= <u>131,520 CY</u>
TOTAL	166,123 CY

Therefore $\frac{25\text{-yr. long term}}{\text{Total}} = \frac{131,520}{166,123} = 79\%$
(100-yr. + long term)

CONCLUSION

For Reach 3, the addition of the 100-yr. volume to the long term volume would increase the total such that the 25-yr. long term volume is 79% of the total volume. For simplicity this may be converted to a 21% increase in the prudent line if the total (100-yr. + 25-yr. long term) were used. Note that the previous comparison to the MPM-Woo Equation results indicated that the MPM-Woo Equation produced results 86% (100-yr.) of the DMP results. This may be converted to state that the DMP results are 14% greater than the MPM-Woo results. Also, the peak flow rates in the DMP are approximately 50% greater than those being considered at present.

Therefore, if the MPM-Woo Equation results were used to develop the Prudent Line based on the total 100-yr. and long term results, the result may be very similar to the Prudent Line determined in the DMP based on the analysis and comparison of results presented here for Reach 3.

COMPARISON OF DMP SEDIMENT TRANSPORT EQUATION RESULTS TO THE MPM-EINSTEIN EQUATION (SEDG) RESULTS

PURPOSE

Compare DMP 100-yr. results with the Meyer-Peter, Muller-Einstein Equation results.

MPM - Einstein Equation (see Sediment & Erosion Design Guide, March 1994 for more information, pg. 3-29)

$$q_b = \frac{12.85}{\sqrt{\rho \gamma_s}} (\tau_o - \tau_{oc})^{1.5}$$

PROCEDURE

Use hydraulic results for Reach 3 from Table VIII-2 (DMP) to compute τ_o and τ_c .
Compute τ_c from Shield's Method (copy of graph attached).

COMPUTATION

$$q_b = \frac{12.85}{\sqrt{1.94(165.4)}} (2.6 - 0.049)^{1.5}$$
$$q_b = 0.22726 \text{ cfs/ft}$$

Now convert to $Q_s = q_s \times TW \times 360$

$$Q_s = 0.22726 \text{ cfs/ft}(513 \text{ ft})(360 \text{ sec})$$

$$Q_s = 41,970 \text{ cu ft} = 100\text{-yr. result for one hydrograph ordinate at peak discharge.}$$

Note that the DMP 100-yr. result for the hydrograph ordinate is 82,696 cu ft

RESULTS SUMMARY FOR REACH 3 ONLY

The MPM-Einstein Equation produces values of only 51% of the values computed in the DMP.

COMPARISON OF DMP, MPM-WOO AND MPM-EINSTEIN RESULTS

Source or Equation	Peak Q for 360 sec 100-yr. Results - Q_s (Sediment Transport Capacity)		
	(cu ft)	% of DMP	% by which the DMP is greater
DMP	82,696	—	—
MPM-Woo	71,009	86	14
MPM-Einstein	41,970	51	49

CONCLUSION

The purpose of this analysis was to determine if the Prudent Line as developed in the DMP is adequate as compared to results from two other equations and the Prudent Line methodology presented in the SEDG. Based on the comparison of the sediment transport capacity results presented in this analysis and the description of the procedure used to plot the Prudent Line as presented in the DMP, the following conclusion may be derived. Development of a Prudent Line based on the MPM-Woo and MPM-Einstein Equations using the methodology described in the SEDG would result in a Prudent Line very similar to the Prudent Line presented in the DMP.

INCIPIENT MOTION ANALYSIS USING SHIELD'S METHOD

Computed by Resource Technology, Inc.

TABLE

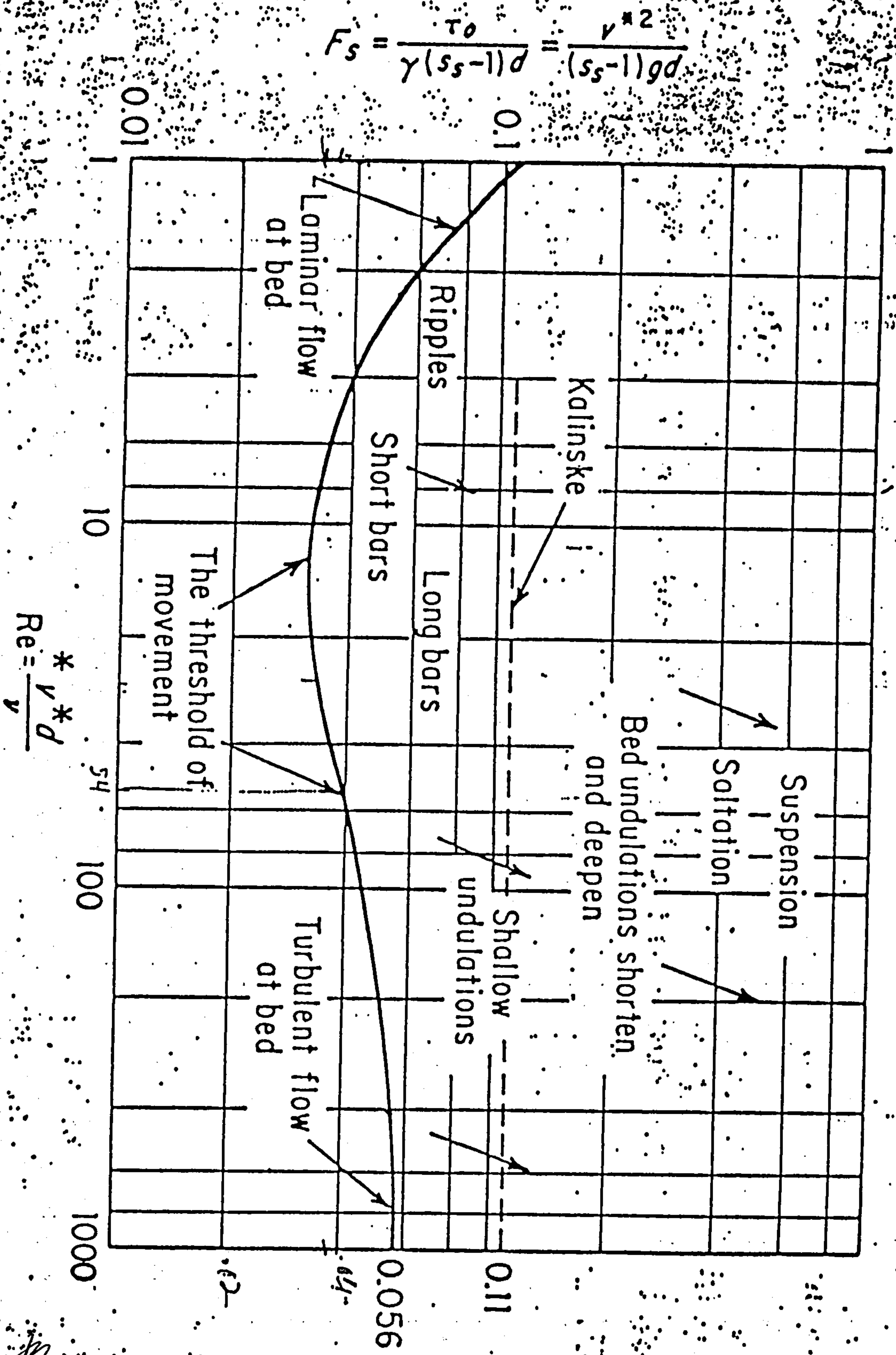
ARROYO NAME / SUBREACH NAME TIJERAS ARROYO / REACH 3
INCIPIENT MOTION USING SHIELD'S DIAGRAM

RETURN PERIOD (YR)	$\bar{Q}_p$ (CFS)	$\bar{V}$ (ft/sec)	$\bar{A}$ (ft ²)	$\bar{TW}$ (ft)	$\bar{Y}$ (ft) _a	$\bar{R}$ (ft) _b	$\bar{S}$ (ft/ft) _c	γ_o (lb/ft ²) _d	d_{50} (ft) _e	V^* (ft/sec) _f	RE^* _g	F_s _h	γ_c (lb/ft ²) _i	$\frac{\gamma_o}{\gamma_c}$	COMMENT
USE	HYDRAULIC RESULTS IN DMP (TABLE VIII-2) TO COMPUTE HYDRAULIC DATA NEEDED.														
100	18065	9.95	1,816 (a)	513	3.54	3.5 (b)	0.012126	2.6 (c)	0.0086 (d)	1.16	830	0.056	0.049	$\frac{2.6}{0.049}$	ALL SED WILL MOVE
(a)	$\frac{18065}{9.95}$	= 1,816	(b) $R = \frac{A}{P}$, ASSUME $P = 2(Y) + TW$	$R = \frac{1,816}{2(3.54) + 513} = 3.47 \approx 3.5$		(c) $\gamma = \gamma R S$ $= 62.4 (3.5) 0.012126$ $\gamma = 2.6$		(d) $d_{50} = 2.63 \text{ mm}$ $2.63 \text{ mm} \left(\frac{0.0328 \text{ ft}}{1 \text{ mm}} \right)$ $= 0.0086 \text{ ft}$							

a) $Y = A / TW$ b) $R = A / P$, ASSUME $P = TW + Y \therefore R = A / (TW + Y)$
c) $S = \text{bed slope}$ d) $\gamma_o = \gamma R S$ e) $d_{50} = \text{sediment size analyzed (\% finer FROM GRAD CURVE)}$
f) $V^* = \sqrt{\frac{\gamma_o}{C_f}}$ g) $Re^* = \frac{V^* d_{50}}{\nu}$ h) $F_s = \text{OBTAINED FROM SHIELD'S DIAGRAM}$
i) $\gamma_c = F_s \gamma (S_s - 1) d_{50}$

NOTE:
FOR $d_{50} > \frac{1}{4}$ or 0.25' and $Re^* > 400$
CRITICAL STONE SIZE = $d_c = 11 R S$
 $\frac{\gamma_o}{\gamma} = R S$

CONSTANTS $\gamma = 62.4 \frac{\text{lb}}{\text{ft}^3}$, $C_f = 1.94 \frac{\text{lb-sec}^2}{\text{ft}^4}$, $\nu = 1.2 \times 10^{-5} \frac{\text{ft}^2}{\text{sec}}$



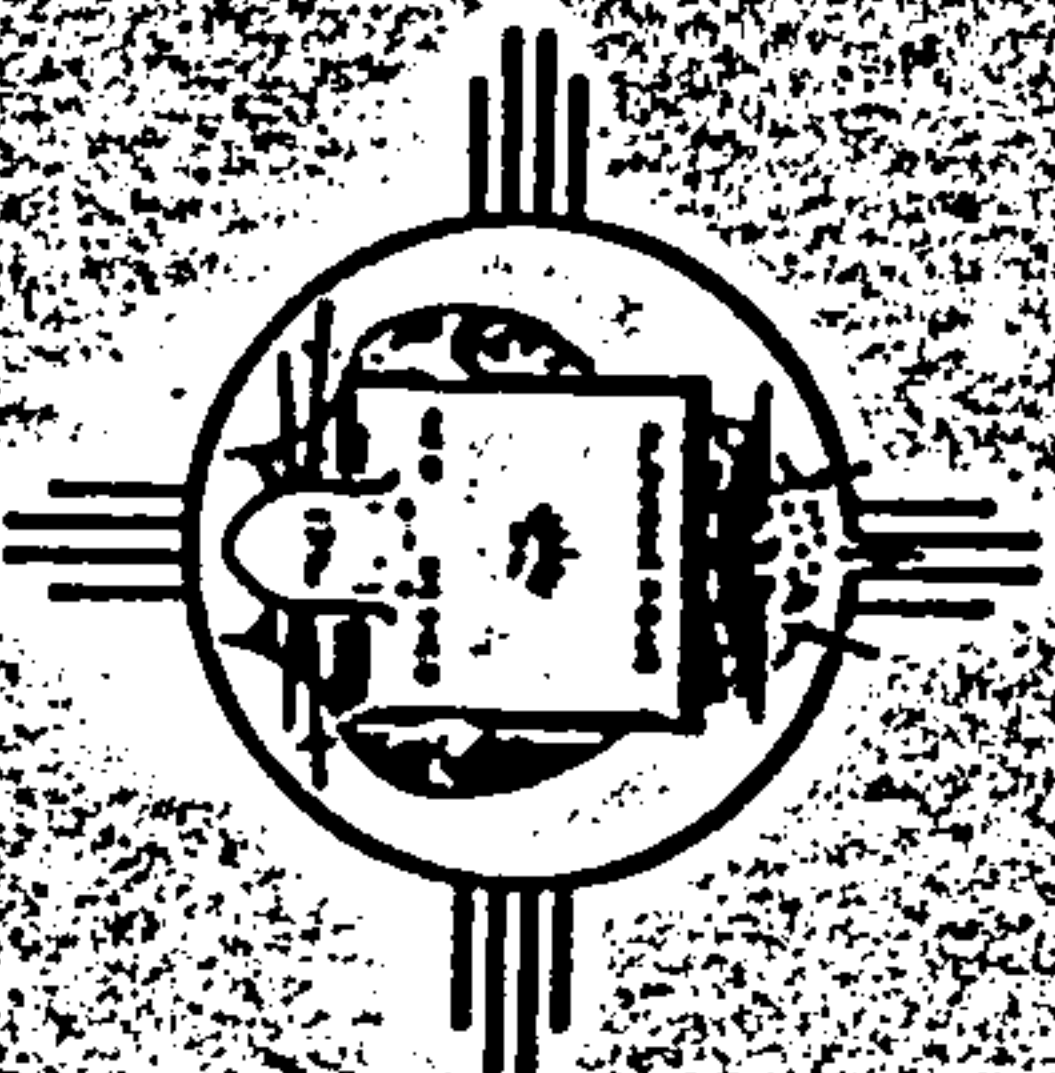
Debbie
Debra Dixon

6016.21

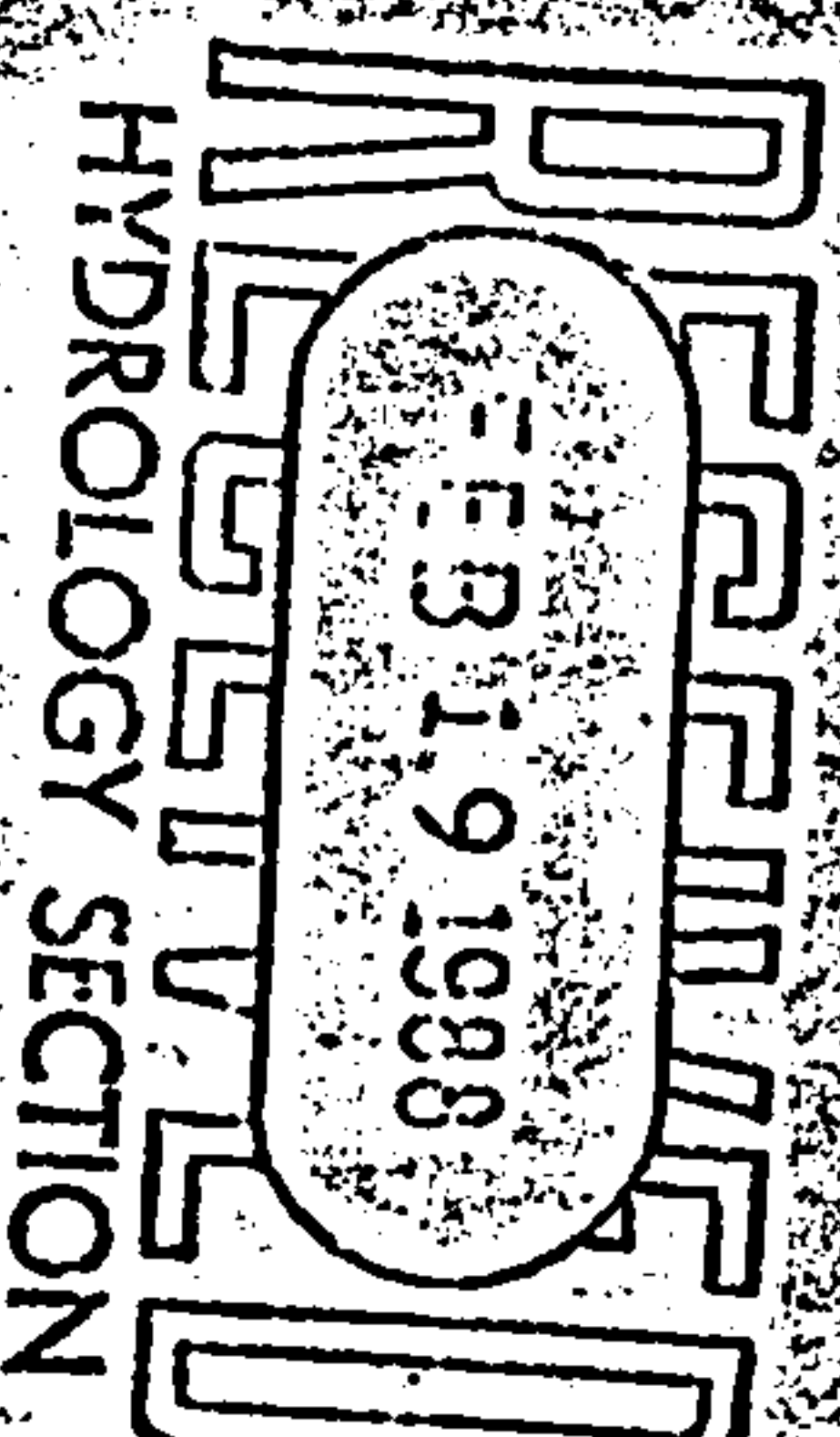
TIJERAS ARROYO DRAINAGE MANAGEMENT PLAN PHASE II

Prepared for
CITY OF ALBUQUERQUE

DRAFT



FEBRUARY 1988



LEEDSHILL-HERKENHOFF, INC.

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

ENGINEERS

ARCHITECTS

TABLE VIII-2
CHANNEL FLOW CHARACTERISTICS

Hydraulic \		Velocity (fps)	Width (Feet)	Slope (Ft/Ft)	Sediment Transfer Qs (cfs)
Discharge (cfs)	Depth (Feet)				
Reach 1					
1560	2.61	8.19	73	.01232	11.46
3360	4.08	10.29	80	.01232	25.49
6285	5.88	11.88	90	.01232	49.36
11570	8.28	13.31	105	.01232	97.81
17210	9.95	15.04	115	.01232	152.78
18065	10.22	15.24	116	.01232	161.53
Reach 2					
1560	2.26	7.12	97	.01325	11.80
3360	3.41	8.01	123	.01325	26.53
6285	4.47	8.79	160	.01325	53.90
11570	5.50	10.36	203	.01325	105.82
17210	6.10	12.37	228	.01325	160.90
18065	6.20	12.56	232	.01325	169.75
Reach 3					
1560	1.37	4.65	245	.012126	9.29
3360	1.78	5.90	370	.012126	21.91
10- ~~18~~ 6285	2.24	7.10	395	.012126	43.61
11570	2.88	8.73	460	.012126	85.91
17210	3.47	9.82	505	.012126	131.83
100- ~~18~~ 18065	3.54	9.95	513	.012126	138.89
Reach 4					
1560	1.10	5.56	255	.01394	13.32
3360	1.76	6.89	277	.01394	28.10
→ 6285	2.54	8.25	300	.01394	53.91
11570	3.62	9.77	327	.01394	104.47
17210	4.57	11.08	340	.01394	163.67
18065	4.70	11.30	340	.01394	173.05
Reach 5					
1560	2.85	7.82	70	.01520	14.16
3360	4.16	9.28	87	.01520	33.20
→ 6285	5.64	10.72	104	.01520	68.19
11570	7.48	12.78	121	.01520	137.30
17210	9.00	14.38	133	.01520	217.38
18065	9.22	14.62	134	.01520	229.80

TABLE VIII-3

SEDIMENT TRANSPORT CAPACITY VOLUMES (CUYD)
FOR VARIOUS STORM EVENTS

<u>REACH</u>	<u>2-yr</u>	<u>5-yr</u>	<u>10-yr</u>	<u>25-yr</u>	<u>50-yr</u>	<u>100-yr</u>	<u>25-yr Accum.</u>
1	3,634	7,412	13,643	25,287	38,693	39,940	155,620
2	3,765	7,739	14,336	26,743	41,093	42,435	163,253
3	2,997	6,206	11,567	21,710	33,494	34,603	131,520
4	4,277	8,529	15,406	28,028	42,370	43,681	176,682
5	4,418	9,397	17,909	34,365	53,789	55,652	202,622

TABLE VIII-4

VOLUMES OF EROSION OR DEPOSITION (CUYD)

<u>REACH</u>	<u>2-yr</u>	<u>5-yr</u>	<u>10-yr</u>	<u>25-yr</u>	<u>50-yr</u>	<u>100-yr</u>	<u>25-yr Accum.</u>
1	+131	+327	+693	+1,456	+2,400	+2,495	+7,633
2	-768	-1,533	-2,769	-5,033	-7,599	-7,832	-31,733
3	+1,280	+2,323	+3,839	+6,318	+8,876	+9,078	+45,162
4	+141	+868	+2,503	+6,337	+11,419	+11,971	+25,940
5	NA	NA	NA	NA	NA	NA	NA

(-) Erosion
 (+) Deposition
 NA Not Applicable

TABLE VIII-6
SOIL SAMPLE SUMMARY

SAMPLE NO.	LOCATION		D-50% IN MM	D-90% IN MM
LH #1	Channel Bed	Approx. Sec. AS	4.0	12.0
LH #2	Floodplain	Approx. Sec. AS	2.0	15.0
LH #3	North Bank	Approx. Sec. AS	2.0	11.0
LH #4	Channel Bed	Between Sec. AQ & AR	1.7	5.4
LH #5	South Bank Low Flow Channel	Between Sec. AP & AQ	0.07	1.2
LH #6	350'± Below Four Hills Rd. Floodplain	Approx. Sec. AX	1.3	6.8
BG #2*	Sta. 575 Bed	Approx. Sec. BB	6.0	18.0
BG #3*	Sta. 575 Bank	Approx. Sec. BB	0.23	0.9
BG #4*	Sta. 575 Floodplain	Approx. Sec. BB	3.0	8.0
BG #5*	Sta. 644+30 Bed	Approx. Sec. AT	8.0	39.0
BG #6*	Sta. 644+30 Bank	Approx. Sec. AT	0.6	2.9
			<u>28.90</u>	<u>120.20</u>
		Mean	2.63	10.93

Note:

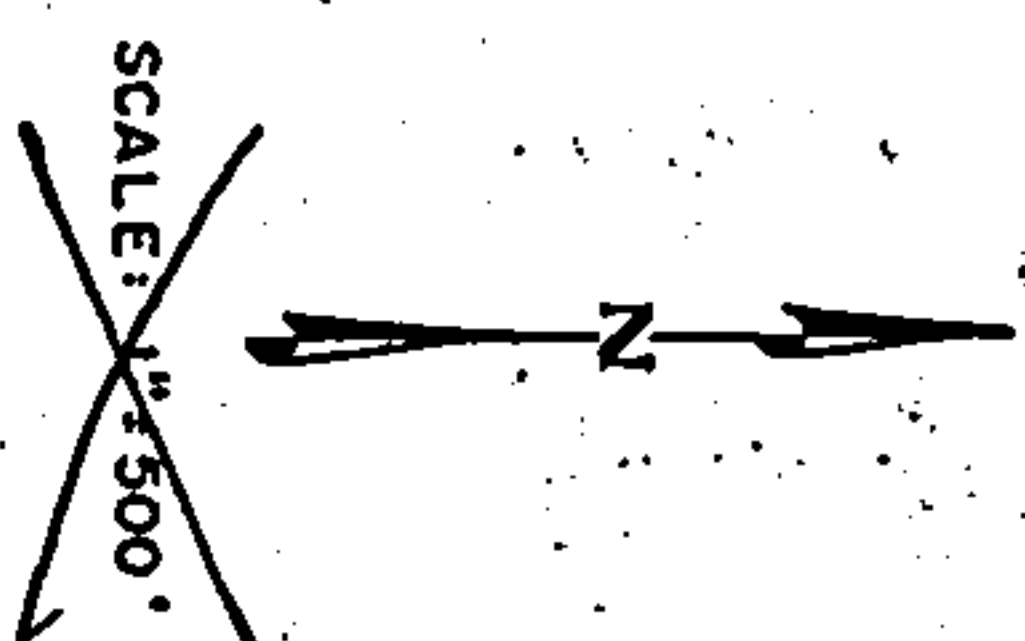
* Soil tests by Butch Gerbrandt, 1986.
Soil sample locations are plotted on sheets L-23, M-21, and M-22.

TABLE VIII-7

SUBREACH PHYSICAL CHARACTERISTICS

Subreach Number	From	To	Length (ft.)	Slope ft/ft
1	Sec KBU	500' below Sec A0	2070	.01232
2	500' below Sec. A0	Sec AR	2700	.01325
3	Sec. AR	500' below Sec. AW	6350	.012126
4	500' below Sec. AR	Sec. F2	2367	.01394
5	Sec. F2	Sec. BE	5460	.01520

Note: Section locations are illustrated on Sheet Nos. L-22, L-23, M-21, M-22.

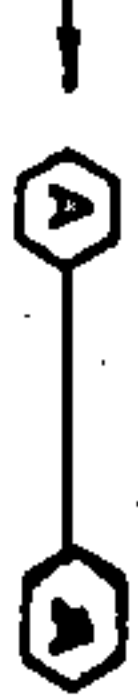


KEY TO MAP

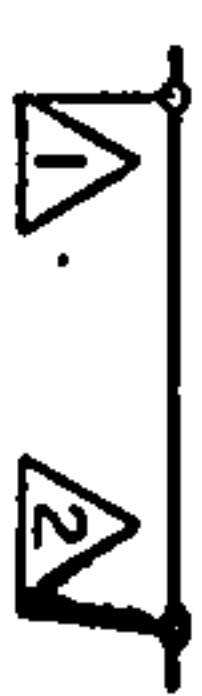
100-YEAR FLOOD BOUNDARY



CROSS SECTION LINE



OFFSET TANGENT LINES
DELINEATING BOUNDARIES
BEYOND WHICH DEVELOPMENT
WOULD NOT BE PRUDENT.



SOIL SAMPLE LOCATION

⑤ BG#5

NOTES TO USER

BOUNDARIES OF THE FLOODPLAINS WERE COMPUTED AT CROSS SECTIONS AND INTERPOLATED BETWEEN CROSS SECTIONS.

THIS MAP WAS PREPARED TO FACILITATE FLOODPLAIN MANAGEMENT ACTIVITIES ONLY. IT MAY NOT SHOW ALL SPECIAL FLOOD HAZARD AREAS IN THE COMMUNITY OR ALL PLANNING FEATURES OUTSIDE OF THE FLOODPLAIN. REFER TO THE LATEST OFFICIAL FLOOD INSURANCE RATE MAP FOR ANY ADDITIONAL AREAS OF SPECIAL FLOOD HAZARD.

THIS MAP WAS PRODUCED BY PHOTOGRAMMETRIC METHODS USING PREVIOUSLY PREPARED (BY OTHERS) MATERIALS OBTAINED FROM THE CITY OF ALBUQUERQUE. DATE OF PHOTOGRAPHY 1962. 2-FOOT CONTOUR INTERVAL ESTABLISHED ON NATIONAL GEODETIC DATUM OF 1929. COORDINATES SHOWN ARE NEW MEXICO STATE PLAIN COORDINATES. CENTRAL ZONE. SHEET INDEX GRID EQUALS CITY ZONE ATLAS.

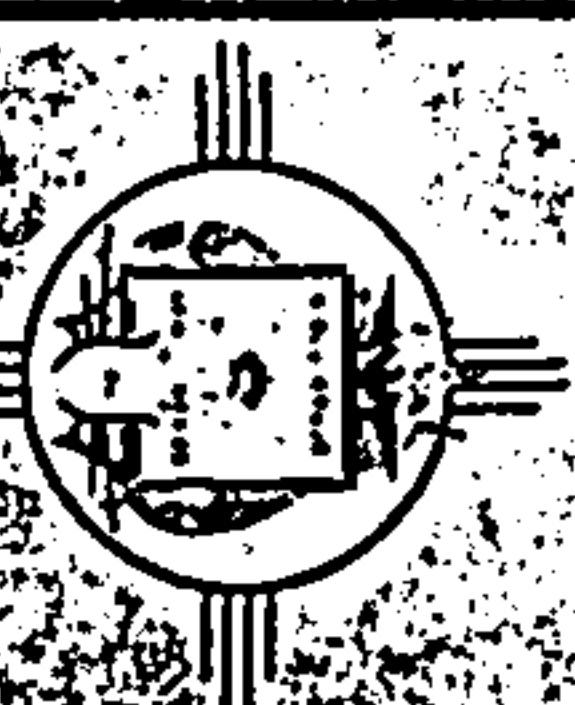
A 10x10 grid with columns labeled L, M, N, P, Q and rows labeled 14 to 23. A wavy line is drawn across the grid, and a shaded square is in cell (M, 22).

SHEET INDEX

TIJERAS, ARROYO DRAINAGE
MANAGEMENT PLAN

PHASE II PRUDENT LIMITS

FEBRUARY 1988



LEEDSHILL-HERKENHOFF, INC.
ENGINEERS ARCHITECTS

SHEET
M-22

APPENDIX C

SEDIMENT TRANSPORT COMPUTER PRINTOUTS

Sediment Transport Calculation for Channel Reach 3

Peak

10-year Discharge
6284 cfs

Bedload Transport Factor 0.46641
Bedload Transport Exponent 1.10380

Time (Hr.Min)	Discharge (cfs)	Average Discharge (cfs)	Time Interval (min)	Bedload Transport (lbs/sec)	Sediment Transport (lbs)	Cumul. Transport (tons)
0.00	0	0	10.00	0.0	0	0
0.10	0	0	10.00	0.0	0	0
0.20	0	0	10.00	0.0	0	0
0.30	120	60	10.00	42.8	25683	13
0.40	484	305	10.00	237.1	134278	90
0.50	862	676	10.00	619.6	371757	276
1.00	1135	444	10.00	933.8	572268	362
1.10	1544	1367	10.00	1349.1	809432	967
1.20	2342	1471	10.00	2014.4	1211416	1513
1.30	3266	2804	10.00	2481.4	1788860	2467
1.40	4234	3703	10.00	4112.3	2467484	3701
1.50	5136	4688	10.00	5237.2	3154308	5278
2.00	5814	5475	10.00	6240.2	3744101	7150
2.10	6200	6007	10.00	6912.7	4147643	9224
2.20	6284	6242	10.00	7211.8	4327105	11387
2.30	6130	6207	10.00	7167.2	4300332	13538
2.40	5703	5917	10.00	6797.4	4078724	15577
2.50	5161	5432	10.00	6186.1	3711656	17433
3.00	4543	4852	10.00	5461.2	3276714	19071
3.10	3401	4222	10.00	4684.0	2810387	20476
3.20	3282	3592	10.00	3918.2	2350892	21652
3.30	2715	2999	10.00	3210.5	1926308	22815
3.40	2214	2465	10.00	2585.6	1551349	23391
3.50	1787	2001	10.00	2053.8	1232298	24007
4.00	1431	1609	10.00	1615.0	968982	24491
4.10	1139	1285	10.00	1260.0	756008	24869
4.20	904	1022	10.00	978.1	586836	25163
4.30	716	810	10.00	757.1	454280	25340
4.40	567	642	10.00	585.3	351158	25565
4.50	444	508	10.00	452.4	271426	25701
5.00	356	403	10.00	344.4	204423	25806
5.10	282	314	10.00	270.7	162406	25887
5.20	224	253	10.00	204.6	125743	25930
5.30	178	201	10.00	162.6	97341	25944
5.40	142	160	10.00	126.4	7368	2607
5.50	113	128	10.00	98.4	54018	26068
6.00	0	57	10.00	40.1	24062	26078

$\Delta = 2163$

7.17 ACFT
11357.24 CUB

04/11/72
10:10
0-0-0

Sediment Transport Calculation for Channel Reach 3

100-Year Peak Discharge 18063 cfs
Bedload Transport Factor 0.46641
Bedload Transport Exponent 1.10380

Time (HR.MN)	Discharge (cfs)	Average Discharge (cfs)	Time Interval (min)	Bedload Transport (lbs/sec)	Sediment Transport (lbs)	Cumul. Transport (tons)
0.00	0	0	10.00	0.0	0	0
0.10	0	1	10.00	0.2	130	0
0.20	1	1	10.00	0.2	130	0
0.30	721	361	10.00	310.3	186164	93
0.40	2023	1372	10.00	1354.5	812701	499
0.50	3025	2524	10.00	2654.6	1592742	1296
1.00	4337	3681	10.00	4026.1	2415640	2504
1.10	6657	5497	10.00	6267.9	3760710	4384
1.20	4720	8189	10.00	9731.1	583672	7303
1.30	12869	11295	10.00	13877.9	8326715	11467
1.40	15544	14207	10.00	17876.5	10729915	16830
1.50	17349	16447	10.00	21012.1	12602269	23133
2.00	18063	17706	10.00	22792.2	13677114	24472
2.10	17778	17221	10.00	23100.2	13860119	36902
2.20	16731	17255	10.00	22154.4	13222662	43548
2.30	15155	15943	10.00	20303.2	12181923	49639
2.40	13278	14217	10.00	17890.4	10734249	59006
2.50	11355	12317	10.00	15270.3	9162184	69387
3.00	9230	10443	10.00	12726.7	7636168	65406
3.10	7886	8708	10.00	10414.8	6298864	66530
3.20	6449	7168	10.00	8400.8	5040504	67030
3.30	5223	5836	10.00	6695.9	4017512	71059
3.40	4194	4709	10.00	5283.2	3169910	72644
3.50	3349	3772	10.00	4155.5	2481278	73885
4.00	2663	3006	10.00	3219.4	1931627	74850
4.10	2112	2388	10.00	2496.6	1497935	75599
4.20	1676	1894	10.00	1933.5	1160088	76179
4.30	1350	1503	10.00	1497.9	898766	76629
4.40	1056	1193	10.00	1160.8	696490	76977
4.50	840	948	10.00	900.7	540406	77247
5.00	670	755	10.00	700.6	420336	77457
5.10	535	603	10.00	546.1	327669	77621
5.20	427	481	10.00	425.9	255547	77749
5.30	341	384	10.00	332.2	199298	77849
5.40	272	307	10.00	259.0	155396	77926
5.50	218	245	10.00	202.3	121361	77987
6.00	0	109	10.00	82.7	49640	78012

$\Delta = 68.39$

21.45 ACFT
34602.73 CUYD

25 YEAR SED. (10NS) 246511
25 YEAR SED. (C.Y.) 131320
100 YR STORE (10NS) 78012
100 YR STORE (C.Y.) 34603

SEDIMENT AND EROSION DESIGN GUIDE

Prepared for

Albuquerque Metropolitan Arroyo
Flood Control Authority
(AMAFCA)

Prepared by

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RCE Ref. No. 90-560

March 1994

RCE

RESOURCE CONSULTANTS & ENGINEERS, INC.
A KIH Engineering Group Company

The conditions for which most of the available bed material transport relations were developed are significantly different from those encountered in most arroyos in the Albuquerque area, due to the combination of steep gradients and relatively small sediment sizes found in the typical arroyos. In spite of this shortcoming, various transport equations have been applied to specific projects in the area. Several of these relations are discussed in the following sections to provide a basis for understanding previous studies. These include the Meyer-Peter, Muller-Einstein (MPM-Einstein) method, the Colby method, Yang's equation, and an empirical power function relation developed by Zeller and Fullerton (1983).

In addition to the above, a power function relation developed by Resource Consultants & Engineers, Inc. (Mussetter, 1993, in-press) specifically for steep, sand-bed channels with high suspended sediment concentrations is presented. As discussed below, this relation overcomes many of the shortcomings of the other relations when applied to steep, sand-bed channels such as those found in the Albuquerque area and thus may provide more realistic results over the range of conditions encountered in these channels. It is recommended that this power function relation (Equation 3.41) be used in the Albuquerque area, unless there is analysis and calibration which demonstrates that other methods are more representative of actual conditions.

Meyer-Peter, Muller-Einstein Method

This method gives good results when both the bed-load and suspended load compose a significant portion of the total bed material load. The Meyer-Peter, Muller (MPM) formula, because of its formulation as an excess shear stress equation, is well suited to modeling the transport of sand as well as gravel- and cobble-sized material. The formula, rearranged by USBR (1960), is given by:

$$q_b = \frac{12.85}{\sqrt{\rho \gamma_s}} (\tau_0 - \tau_c)^{1.5} \quad (3.29)$$

where q_b = bed load transport capacity per unit width of channel (cfs/ft) for particle size i

ρ = density of water (1.94 slugs/cu ft)

γ_s = unit of weight of the sediment (pounds/cu ft)

τ_0 = bed shear stress in (lb/sq ft)

τ_c = critical shear stress (lb/sq ft)

The value of τ_c is computed from the Shields relation (Equation 3.25) with Shields dimensionless shear stress equal to 0.047. (Note that at critical conditions the bed shear and critical shear are equal, thus τ_c is obtained by substituting τ_c for τ_0 in Equation 3.25 and rearranging.) To apply Equation 3.29 by size fraction, divide the particle size distribution into discrete size ranges (usually 5 to 10 ranges is sufficient), compute the

geometric mean of each size range and compute the unit bed load, transport capacity is the sum of each transport capacity times the percentage of material in each size range given by:

$$Q_{Btotal} = \sum Q_{Bi} \Delta \%_i \quad (3.30)$$

where Q_{Btotal} = transport capacity
 Q_{Bi} = transport capacity of the i-th size range
 $\Delta \%_i$ = incremented percentage of material in the i-th size range

The suspended sediment-transport capacity is estimated using a solution developed by Einstein (1950). This method relies upon integration of the sediment concentration profile over the depth of flow assuming equilibrium conditions such that the rate at which sediment is transported upward due to turbulence is exactly equal to the rate at which the sediment is settling downward due to gravity. This equilibrium condition is described by the diffusion equation. The equations used in this method are quite complex and are beyond the scope of this Design Guide. They are discussed in detail in Vanoni (1977) and Simons, Li & Associates, Inc. (1982a). Additional discussion of the applicability of the method and computer code to solve the equations is presented in USGS (1989).

Yang's Bed Material Equation

Yang (1972) developed a relationship for the concentration of bed material discharge as a function of the rate of energy dissipation in the flow using dimensional analysis and the unit stream power concept. The basic form of Yang's equation is

$$\log C_s = M + N \log \frac{VS}{\omega} \quad (3.31)$$

where C_s = bed material concentration in ppm by weight
 V = flow velocity
 S = slope
 ω = fall velocity of the sediment
 M and N = dimensionless parameters related to the flow

The values of M and N were determined by regression analysis of laboratory data.

For suspended sediment concentrations less than about 4 percent by weight, the original derivation provides reasonable results for most conditions. Einstein and Chien (1955) however, found that the vertical distribution of sands in the water column deviates significantly from that predicted by the original Einstein method for suspended sediment concentrations above approximately 4 percent. The concentration profile becomes progressively more uniform with depth with increasing concentration. Based on their experimental results, they suggested a correction for the exponent on the concentration profile equation to partially compensate for the differences. Subsequent investigators (Chien and Wan, 1965; Ordonez, 1970; Lavelle and Thacker, 1978, van Rijn, 1984; Woo, 1985 and Woo et al., 1988) considered the effects of fall velocity reduction, fluid viscosity, and fluid density on the suspended sand concentration profile. The work of Woo (1985) and Woo et al. (1988) resulted in a complex differential equation that appears to account for the significant changes in fluid characteristics with increasing sediment concentration, and converges to essentially the same solution as obtained from Rouse's (1937) equation at low concentrations. Results obtained from the application of this relationship match the available measured data well.

Mussetter (1993, in-press) linked Woo's (1985) relationship for computing the suspended sediment concentration with the MPM bed-load equation to obtain a method for computing bed material load in streams carrying high concentrations of suspended sediment. Results obtained from this method were compared with the results from other available relations and, to the extent possible, measured sediment yield data. This comparison indicates that the new method may provide more realistic results over the range of flow and sediment transport conditions encountered in arroyos in the Albuquerque area.

The MPM-Woo method was used to estimate bed material transport capacities for a broad range of hydraulic and bed material conditions (see Table 3.6) typical of the Albuquerque area. The results of these computations were then used to develop the following power function relation using multiple regression:

$$q_s = aV^b Y^c (1 - C_r/10^6)^d \quad (3.41)$$

Table 3.6. Range of Conditions for which Equation 3.41 was Developed.

q (cfs)	V (fps)	Y (ft)	S _o	C _r (ppm)	D ₅₀ (mm)
1	1.9	0.3	0.005	0	0.2
80*	20.8*	7.2*	0.04*	60,000*	4.0*

* 3'

where q_s = unit width bed material load in cfs/ft
 V = average velocity in fps
 Y = hydraulic depth in feet
 C_f = fine sediment (silt and clay) concentration by weight.
 S_o = channel slope

Values for the coefficient (a) and exponents (b, c, and d) are shown in Figure 3.10 as a function of the median bed material size. In applying Equation 3.41, the predicted bed material concentration (C_s) should not exceed the maximum concentration given by the equation:

$$C_{s_{max}} = 510,000 - 65,000 D_{50} \quad (3.42)$$

where D_{50} = medium bed material size in mm
 C_s = computed from the relation:

$$C_s = \frac{2.65 \times 10^6 Q_s}{(Q + 2.65 Q_s)} \quad (3.43)$$

and

$$Q_s = q_s W \quad (3.44)$$

When $C_{s_{max}}$, as given by Equation 3.42 is exceeded, non-Newtonian flow conditions are indicated and the assumptions upon which Equation 3.41 (and the other bed material transport equations presented in this Design Guide) is based are no longer valid. For these conditions, procedures applicable for non-Newtonian fluids (e.g., mudflows) should be considered.

Note that Equation 3.41 predicts bed material load only; the total sediment load is computed by adding the bed material and fine sediment loads, where the fine sediment load is computed from:

$$Q_f = \frac{C_f Q}{2.65 \times 10^6} \quad (3.45)$$

and the total sediment load is given by:

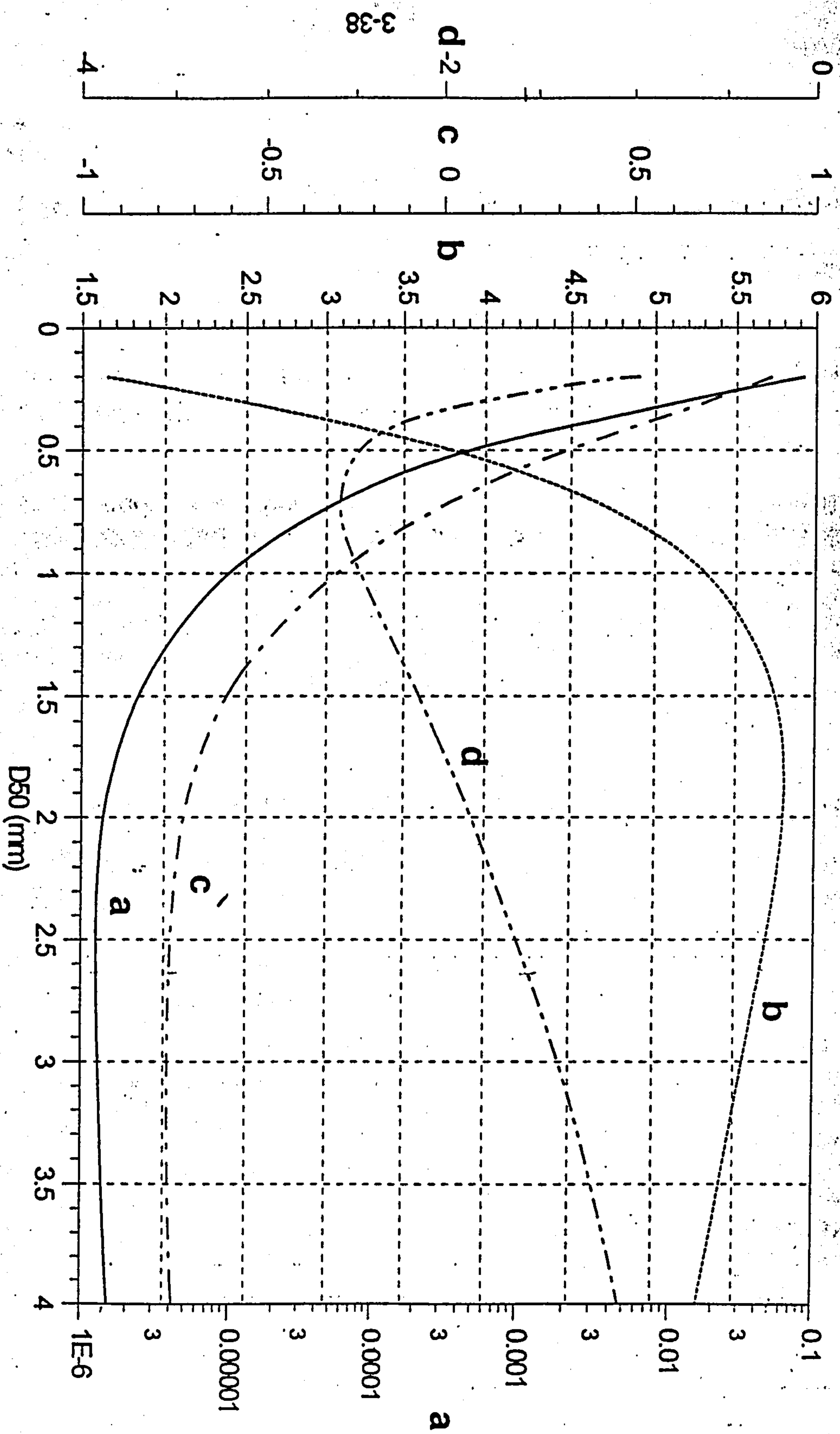


Figure 3.10. Coefficient and exponents for Equation 3.41, developed using MPM-Woo method.

ATTACHMENT 2

4-Hills 20th Installment

A2.1

RTI File No. 94-060

TABLE 1

Tijeras Arroyo Peak Discharge (cfs) Information				
Return Period, Yrs.	COE 1974 (a)	RTI/USGS (b)	L-HI 1988 - DMP (c)	FEMA/USGS 1983
500	22,600 (IRF)	25,694	18,065	28,600
100		12,875		14,300
50		9,102		10,000
10		3,344		5,120

(a) Floodplain Information Albuquerque Arroyos Part IV, Albuquerque, New Mexico. Department of the Army, Albuquerque, New Mexico; Corps of Engineers, Albuquerque, New Mexico. June 1974 (pg. 9-11).

Discussion with Army Corps of Engineers (10-21-94) indicate background information is unavailable and therefore we assume the peak discharge was developed with a HEC-1 model. IRF = Intermediate Regional Flood = 100-yr. flood. Drainage Area = 76 sq.mi.

(b) RTI used USGS Stream Gage No. 08330500 data, 41 years of record, although 15 years of the peak flow data were below the gage base discharge of 250 cfs and were eliminated before the Log-Pearson Type III flood probability analysis was completed by the U.S. Geological Survey. The gage is located approximately 1 mile upstream of Four Hills Road. Discharges shown include Conditional Probability. Drainage Area = 75.30 sq.mi.

(c) L-HI - DMP at Four Hills Road (approximately). Peak discharge was obtained from a HEC-1 model. Drainage Area = 78 sq.mi.

TO THE MPM-WOO EQUATION (SEDG) RESULTS

PURPOSE

Perform a brief comparison of the sediment transport equation results between the equations presented in the "Tijeras Arroyo Drainage Management Plan (DMP) Phase II" Report (Leedshill-Herkenhoff, Inc., February, 1988), and the MPM-Woo Equation presented in the "Sediment and Erosion Design Guide" (SEDG) (Resource Consultants and Engineers, Inc., March 1994).

PROCEDURE

Locate the 4-Hills 20th Installment Subdivision with respect to the DMP designated reaches and determine the applicable reach and its associated data and results as presented in the DMP. The Sheets and Tables referenced below are included at the end of this attachment.

LOCATION	-	Sheet M-22 in DMP
HEC-2 Sections	-	AT to AU (Sheet M-22 in DMP)
D ₅₀	-	Average of all samples = 2.63mm (Table VIII-6 in DMP). As

Average of all samples = 2.63mm (Table VIII-6 in DMP). As shown on Sheet M-22, Sample No.'s BG #5 and BG #6 are near the proposed subdivision. Table VIII-6 indicates BG #5 is a bed sample with $D_{50} = 8.0\text{mm}$ and BG #6 is a bank sample with $D_{50} = 0.6\text{mm}$. Due to this range of extreme sizes compared to the other D_{50} values presented in Table VIII-6, the mean D_{50} of all samples was assumed which is 2.63mm (Table VIII-6).

Reach No. 4 - Table VIII-7 in DMP (Located upstream of Reach 3)
V, Y, S₀ and D₅₀ (Table VIII-2 in DMP) are all within range of values for which the MPM-
Woo Equation is applicable (Table 3.6 in SEDG)

Therefore, based on $D_{50} = 2.63\text{mm}$, compute MPM-Woo Equation coefficient and exponents from Figure 3.10 in SEDG.

$$a = 0.000002$$

$p = 5.67$

$$c = -0.76$$

$$v = -1.6$$

Cf - assume 1 PPM and repeat for maximum concentration = 60,000 PPM because DMP did not present or consider Cf

Select 10-yr. and 100-yr. Q and Q_s discharge values presented in DMP for Reach 4 (Appendix C, DMP), obtain V and Y for the 10-yr and 100-yr. Q 's from Table VIII-2 (DMP), apply MPM-Woo Equation and compute Q_s . Compare the results of the 10-yr. and 100-yr. Q_s computations between DMP results and MPM-Woo Equation.

NOTE: This data is for one-time period at maximum discharge on the hydrograph.

Data Type	Return Period	
	10-yr.	100-yr.
Q (cfs)	6,285	18,065
V (ft/sec)	8.25	11.30
Y (ft)	2.54	4.70
TW (ft)	300	340

Hyd. Ord. Time Interval = 0.1 hrs. = 360 sec.

SEDIMENT TRANSPORT CAPACITY RESULTS (REACH 4)

Q	DMP		MPM-WOO		Difference	
	Cf	Qs	Qs	qs	Qs	% of DMP
(cfs)	(assumed)	(tons)	(cu ft)	(cfs/ft)	(cu ft)	
		(c)	(a)		(b)	
6,285	1 PPM	2,773	33,531	0.15476	16,714	—
6,285	60,000 PPM	2,773	33,531	0.17086	18,453	55
18,065	1 PPM	8,305	100,423	0.57702	70,627	—
18,065	60,000 PPM	8,305	100,423	0.63707	77,977	77

(a) assume specific weight of sediment = 165.4 lbs/cu.ft.
 $\text{tons} \frac{(2000 \text{ lbs})}{(1 \text{ cu ft})} = \text{cu ft}$
 $(1 \text{ ton}) (165.4 \text{ lbs})$

(b) $Q_s = q_s (TW)(360)$
 $Q_s = \frac{\text{cu ft/sec(ft)}}{\text{ft}} (\text{sec}) = \text{cu ft}$

(c) tons in DMP is for Q lasting 360 sec (Appendix C in DMP)

RESULTS SUMMARY FOR REACH 4 ONLY

The MPM-Woo Equation produces values of only 55% (10-yr.) to 77% (100-yr.) of the values computed in the DMP (if Cf = 60,000 PPM).

PRUDENT LINE ASSUMPTIONS IN DMP

Only the long term 25-yr. aggradation/degradation volume was used in the DMP to predict the aggradation/degradation in the reach and lateral bank movement. However, the current methodology states that the long term volume plus the 100-yr. volume is the total volume that should be used to develop the Prudent Line.

ROUGH ADJUSTMENT TO DMP PRUDENT LINE RESULTS

A rough adjustment and comparison of the DMP long term and 100-yr. sediment transport capacity results was completed to determine the increase (in percent) that would occur in the DMP results if the 100-yr. transport capacity volume were added to the long term sediment transport capacity volume. The following values were obtained from Table VIII-3 in the DMP for the total sediment transport capacity of the hydrograph.

100-yr. volume	= 43,681 CY
25-yr. long term volume	= $\frac{176,682 \text{ CY}}{220,363 \text{ CY}}$
TOTAL	220,363 CY

Therefore $\frac{25\text{-yr. long term}}{\text{Total}} = \frac{176,682}{220,363} = 80\%$
(100-yr. + long term)

CONCLUSION

For Reach 4, the addition of the 100-yr. volume to the long term volume would increase the total such that the 25-yr. long term volume is 80% of the total volume. For simplicity this may be converted to a 20% increase in the prudent line if the total (100-yr. + 25-yr. long term) were used. Note that the previous comparison to the MPM-Woo Equation results indicated that the MPM-Woo Equation produced results 77% (100-yr.) of the DMP results. This may be converted to state that the DMP results are 23% greater than the MPM-Woo results. Also, the peak flow rates in the DMP are approximately 50% greater than those being considered at present.

Therefore, if the MPM-Woo Equation results were used to develop the Prudent Line based on the total 100-yr. and long term results, the result may be very similar to the Prudent Line determined in the DMP based on the analysis and comparison of results presented here for Reach 4.

COMPARISON OF DMP SEDIMENT TRANSPORT EQUATION RESULTS TO THE MPM-EINSTEIN EQUATION (SEDG) RESULTS

PURPOSE

Compare DMP 100-yr. results with the Meyer-Peter, Muller-Einstein Equation results.

MPM - Einstein Equation (see Sediment & Erosion Design Guide, March 1994 for more information, pg. 3-29)

$$q_b = \frac{12.85}{\sqrt{\rho} \gamma_s} (\tau_o - \tau_{oc})^{1.5}$$

PROCEDURE

Use hydraulic results for Reach 4 from Table VIII-2 (DMP) to compute τ_o and τ_{*} . Compute τ_o from Shield's Method (copy of graph attached).

COMPUTATION

$$q_b = \frac{12.85}{\sqrt{1.94(165.4)}} (4.4 - 0.049)^{1.5}$$
$$q_b = 0.5062 \text{ cfs/ft}$$

Now convert to $Q_s = q_s \times TW * 360$

$Q_s = 0.5062 \text{ cfs/ft}(340 \text{ ft})(360 \text{ sec})$

$Q_s = 61,962 \text{ cu ft} = 100\text{-yr. result for one hydrograph ordinate at peak discharge.}$

Note that the DMP 100-yr. result for the hydrograph ordinate is 100,423 cu ft.

RESULTS SUMMARY FOR REACH 4 ONLY

The MPM-Einstein Equation produces values of only 62% of the values computed in the DMP.

COMPARISON OF DMP, MPM-WOO AND MPM-EINSTEIN RESULTS

Source or Equation	Peak Q for 360 sec 100-yr. Results - Q_s (Sediment Transport Capacity)		
	(cu ft)	% of DMP	% increase in DMP
DMP	100,423	—	—
MPM-Woo	77,977	77	23
MPM-Einstein	61,962	62	38

INCIPIENT MOTION ANALYSIS USING SHIELD'S METHOD

Computed by Resource Technology, Inc.

TABLE
ARROYO NAME / SUBREACH NAME TIJERAS ARROYO / REACH 4
INCIPIENT MOTION USING SHIELD'S DIAGRAM

RETURN PERIOD (YR)	$\bar{Q}_P$ (CFS)	$\bar{V}$ (ft/sec)	$\bar{A}$ (ft ²)	$\bar{TW}$ (ft)	$\bar{Y}$ (ft) _a	$\bar{R}$ (ft) _b	$\bar{S}$ (ft/ft) _c	γ_o (lb/ft ²) _d	d_z _e	V^* (ft/sec) _f	Re^* _g	F_s _h	γ_c (lb/ft ²) _i	$\frac{\gamma_o}{\gamma_c}$	COMMENT
USE	HYDRAULIC RESULTS IN				DMP (TABLE VIII-2)				TO						
	COMPUTE HYDRAULIC DATA				NEEDED.										
100	18065	11.30	1599 (a)	34.0	4.70	4.6 (b)	0.01394	4.4 (c)	0.0086 (d)	1.5	1079	0.056	0.049	$\frac{4.4}{0.049}$	ALL SED. WILL MOVE
(a)	$\frac{18065}{11.30}$	= 1599	(b) $R = \frac{A}{P}$ assume $P = 2(Y) + TW$				(c) $\gamma_o = \gamma R S$				(d) $d_{50} = 2.63 \text{ mm}$				
			$R = \frac{1599}{2(4.7) + 34.0} = 4.6$				$= 62.4(4.6) = 287.0$				mod ft. $2.63 \text{ mm} (0.00328 \text{ ft})$				
							$\gamma_o = 4.4$				$= 0.0086 \text{ ft.}$				

a) $Y = A / TW$ b) $R = A / P$, ASSUME $P = TW + Y \therefore R = A / (TW + Y)$
c) $S = \text{bed slope}$ d) $\gamma_o = \gamma R S$ e) $d_z = \text{sediment size analyzed (\% finer FROM GRAD CURVE)}$
f) $V^* = \sqrt{\frac{\gamma_o}{C_f}}$ g) $Re^* = \frac{V^* d_z}{\nu}$ h) $F_s = \text{OBTAINED FROM SHIELD'S DIAGRAM}$
i) $\gamma_c = F_s \gamma (S_s - 1) d_z$

NOTE:
FOR $d_z > \frac{1}{4}$ or 0.25' and $Re^* > 400$
CRITICAL STONE SIZE = $d_c = 11 R S$
 $\frac{\gamma_o}{\gamma} = R S$

CONSTANTS $\gamma = 62.4 \frac{\text{lb}}{\text{ft}^3}$, $C_f = 1.94 \frac{\text{lb-sec}^2}{\text{ft}^4}$, $\nu = 1.2 \times 10^{-5} \frac{\text{ft}^2}{\text{sec}}$

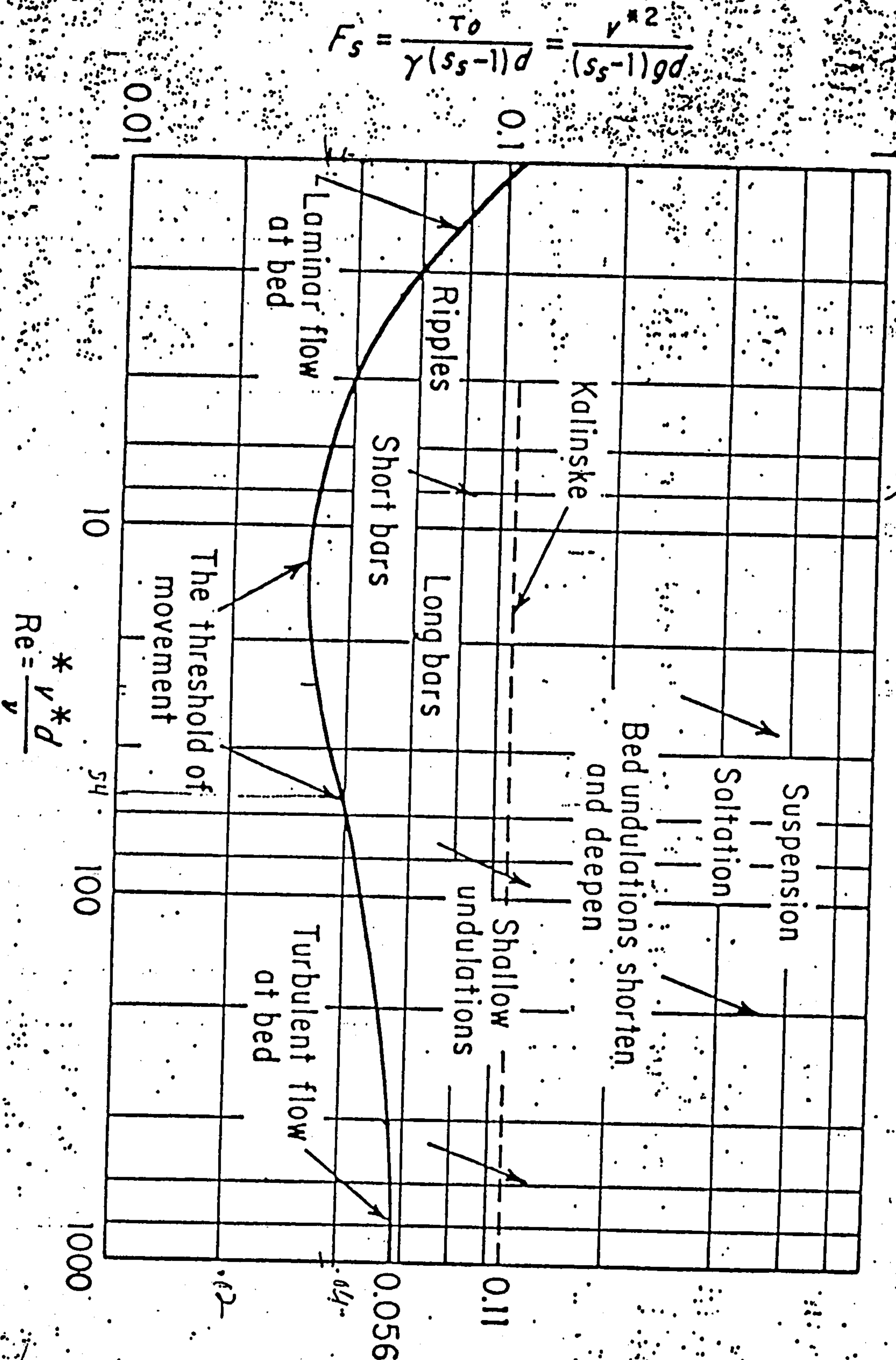


Figure 10-3. The Entrainment Function, after A. Shields [5]

of interest lies in the annotations in the region above the curve, representing a moving bed. These are based mainly on the work of A. Shields [5].

Sediment Transport Calculation for Channel Reach 4

Year

10-Year

Discharge

Bedload Transport Factor 0.93957
Bedload Transport Exponent 1.05206

cfs

Time (HR:MM)	Discharge (cfs)	Average Discharge (cfs)	Time Interval (min)	Bedload Transport (lbs/sec)	Sediment Transport (lbs)	Cumul. Transport (tons)
0.00	0	0	10.00	0.0	0	0
0.10	0	0	10.00	0.0	0	0
0.20	0	0	10.00	0.0	0	0
0.30	120	60	10.00	69.8	41860	21
0.40	489	305	10.00	385.3	231187	137
0.50	862	676	10.00	891.0	534584	404
1.00	1135	999	10.00	1344.1	806445	807
1.10	1599	1367	10.00	1870.4	1122269	1368
1.20	2342	1971	10.00	2748.0	1648817	2193
1.30	3266	2804	10.00	3982.9	2389735	3387
1.40	4239	3753	10.00	5411.6	3246985	5011
1.50	5136	4688	10.00	6838.8	4103237	7063
2.00	5814	5475	10.00	8052.6	4831531	9478
2.10	6200	6007	10.00	8877.8	5326660	12142
2.20	6284	6242	10.00	9243.5	5546113	14915
2.30	6130	6207	10.00	9189.0	5513401	17671
2.40	5703	5917	10.00	8737.1	5242265	20293
2.50	5161	5432	10.00	7986.0	4791618	22688
3.00	4543	4852	10.00	7091.5	4254908	24816
3.10	3901	4222	10.00	6126.2	3675726	26654
3.20	3382	3592	10.00	5167.6	3100587	28204
3.30	2715	2999	10.00	4274.1	2564437	29486
3.40	2214	2465	10.00	3477.2	2086328	30529
3.50	1787	2001	10.00	2792.1	1675237	31367
4.00	1451	1609	10.00	2220.3	1332201	32033
4.10	1139	1285	10.00	1752.6	1051557	32559
4.20	904	1022	10.00	1376.7	825999	32972
4.30	716	810	10.00	1078.5	647115	33295
4.40	567	642	10.00	843.9	506314	33549
4.50	449	508	10.00	660.2	396106	33747
5.00	356	403	10.00	516.8	310063	33902
5.10	282	319	10.00	404.6	242783	34023
5.20	224	253	10.00	317.1	190242	34118
5.30	178	201	10.00	248.9	149342	34193
5.40	142	160	10.00	195.8	117475	34252
5.50	113	128	10.00	154.2	92513	34298
6.00	0	57	10.00	65.6	39739	34318

→ Δ = 2773

9.55 ACFT
15406.29 Cuyd

Sediment Transport Calculation for Channel Reach 4

Peak

100-Year Discharge 18063 cfs
 Bedload Transport Factor 0.93957
 Bedload Transport Exponent 1.05206

Time (HR.MN)	Discharge (cfs)	Average Discharge (cfs)	Time Interval (min)	Bedload Transport (lbs/sec)	Sediment Transport (lbs)	Cumulative Transport (tons)
0.00	0	0	10.00	0.0	0	0
0.10	0	1	10.00	0.3	272	0
0.20	1	1	10.00	0.3	272	0
0.30	721	361	10.00	460.7	276523	138
0.40	2023	1372	10.00	1877.6	1126388	702
0.50	3025	2524	10.00	3565.6	2139353	1771
1.00	4557	3661	10.00	5303.2	3181928	3362
1.10	6657	5497	10.00	8086.6	4851958	5788
1.20	9720	8189	10.00	12298.6	7379147	9478
1.30	12869	11295	10.00	17250.0	10349984	14653
1.40	15544	14207	10.00	21958.1	13174859	21240
1.50	17349	16447	10.00	25614.8	15368896	28925
2.00	18063	17706	10.00	27682.6	16609555	37230
2.10	17778	17921	10.00	28035.5	16821314	45640
2.20	16731	17255	10.00	26940.4	16164263	53722
2.30	15155	15943	10.00	24790.5	14874290	61159
2.40	13278	14217	10.00	21974.4	13184615	67752
2.50	11355	12317	10.00	18895.9	11337531	73421
3.00	9530	10443	10.00	15883.7	9530240	78186
3.10	7886	8708	10.00	13120.8	7872469	82122
3.20	6449	7168	10.00	10690.7	6414437	85329
3.30	5223	5836	10.00	8612.1	5167252	87913
3.40	4194	4709	10.00	6871.0	4122619	89974
3.50	3349	3772	10.00	5440.5	3264283	91606
4.00	2663	3006	10.00	4285.3	2571186	92892
4.10	2112	2388	10.00	3363.0	2017806	93901
4.20	1676	1894	10.00	2635.7	1581542	94691
4.30	1330	1503	10.00	2066.7	1240029	95311
4.40	1056	1193	10.00	1620.8	972503	95798
4.50	840	948	10.00	1272.7	763572	96180
5.00	670	755	10.00	1001.6	600971	96480
5.10	535	603	10.00	790.0	473982	96717
5.20	427	481	10.00	623.3	373988	96904
5.30	341	384	10.00	491.8	295088	97052
5.40	272	307	10.00	388.0	232785	97168
5.50	218	245	10.00	306.5	183919	97260
6.00	0	109	10.00	130.7	78447	97299

> Δ = 8305

25 YEAR SED. (10MS) 393560
 25 YEAR SED. (C.Y.) 176682
 100 Yr Stor (10MS) 97299
 100 Yr Stor (C.Y.) 43681

27.07 Acft
 43680.86 Cuyd

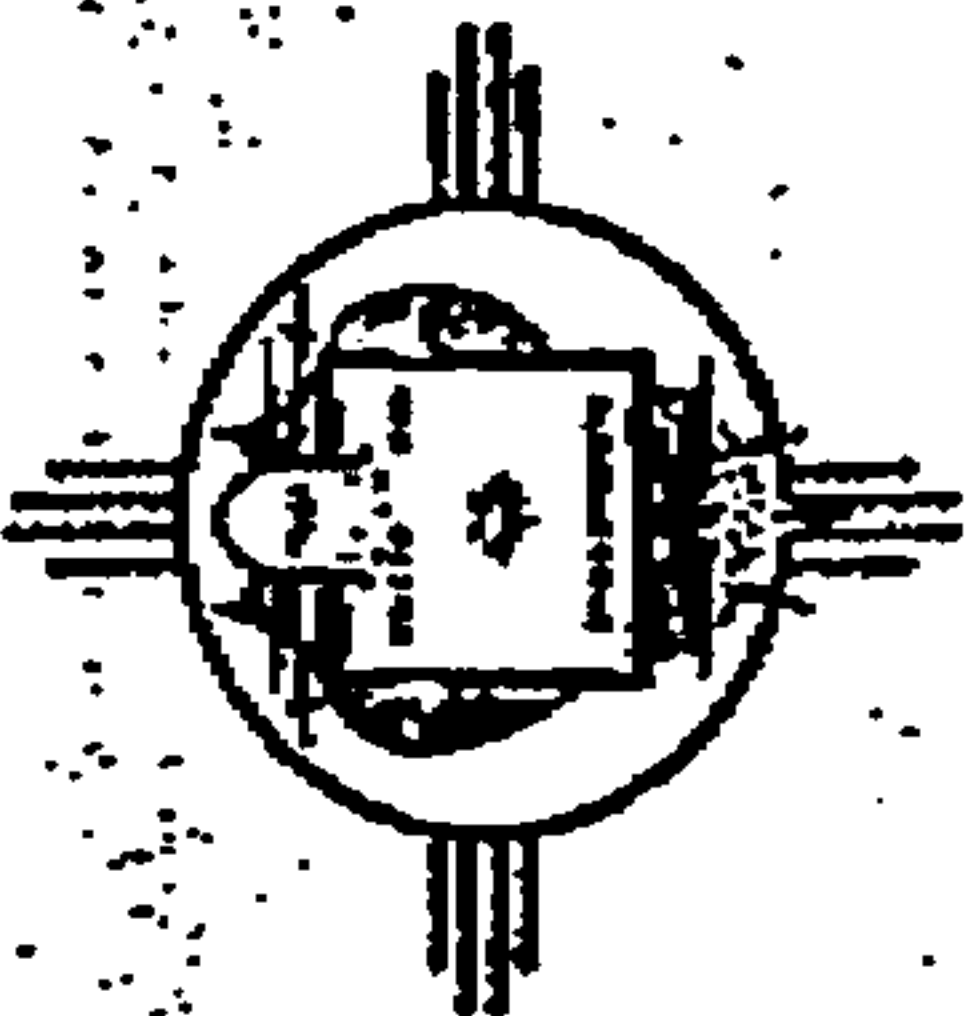
Debbie
Debra Dixon

6016.21

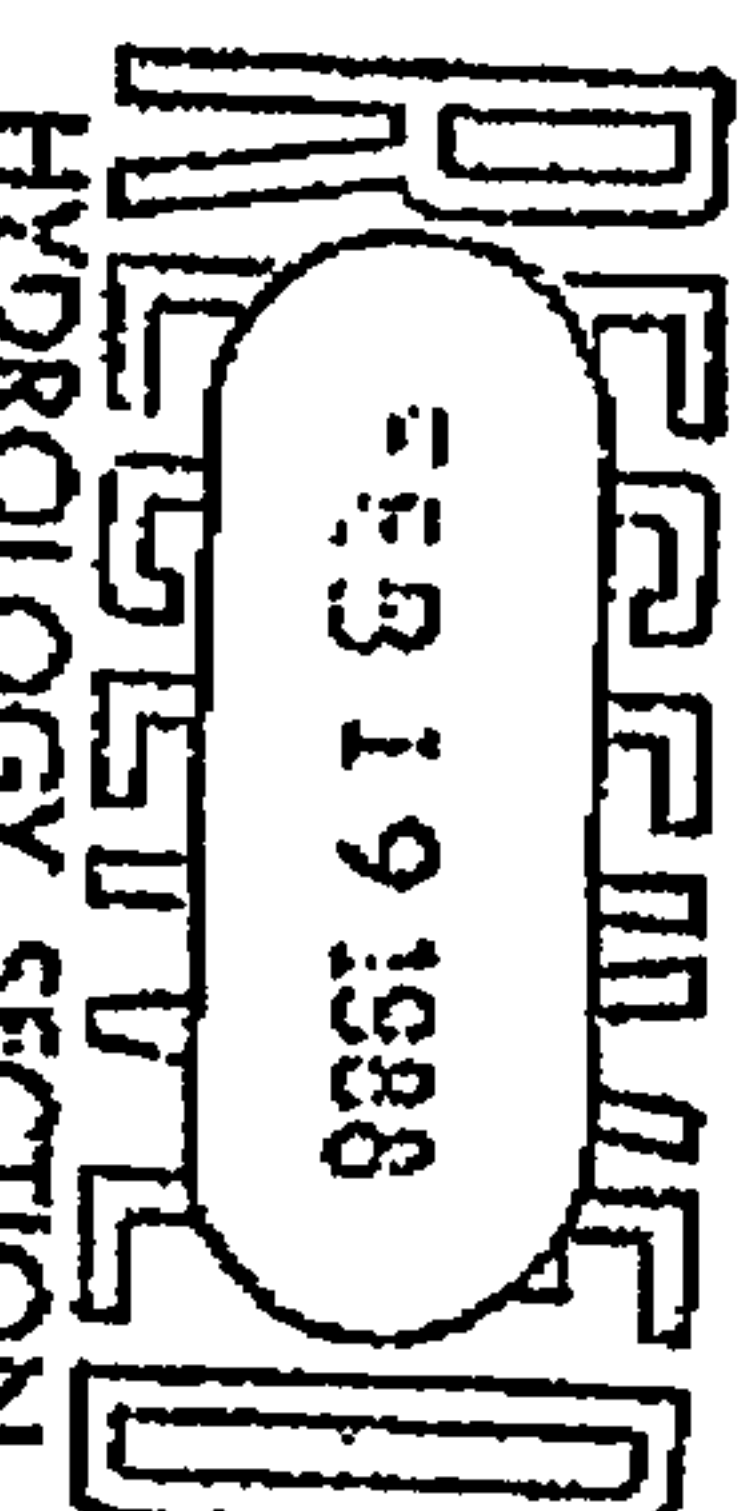
TIJERAS ARROYO DRAINAGE MANAGEMENT PLAN PHASE II

Prepared for
CITY OF ALBUQUERQUE

DRAFT



Post-It Fax Note	7671	Date	9/19/94	# of pages	5
To	TERRY BROWN	From	Don Dixon		
Co/Dept		Co.	RT1		
Phone #		Phone #			
Fax #	837-1386	Fax #	345-4132		



FEBRUARY 1988

LEEDSHILL-HERKENHOFF, INC.



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

ENGINEERS

ARCHITECTS

CHAPTER VI
GENERAL ARROYO TREATMENTS

A. FACILITY PLAN GUIDELINES

The Facility Plan for Arroyos adopted by the City of Albuquerque in February 1986, specifically designates portions of the Tijeras Arroyo as a Major Open Space Arroyo. This includes the area between the north and south escarpments from just east of I-25 to the west property line of Kirtland Air Force Base (the southward extension of San Mateo Boulevard), and between the north and south escarpments from the east property line of KAFB (southerly extension of Eubank Boulevard) to a point about one mile east of Four Hills Road.

The Facility Plan states that "Major Open Space Arroyos are to remain in a natural or semi-natural condition with native vegetation and channel stabilization consisting primarily of naturalistic treatments such as ungrouted riprap, gabions, and geotextile mats. Tinted concrete may be used in limited applications such as in low-flow channels or as needed to control erosion at points where developed runoff enters the arroyo." Additional statements are made that the natural floodplain shall be retained and other appropriate channel stabilization treatments may include gabion weirs and soil cement.

A low-flow channel is defined in the Plan as a drainage channel designed to carry less than the 100-year storm flows at full capacity. Floodplain is defined as the area within the 100-year flood boundary as described by Flood Insurance Rate Maps prepared by the Federal Emergency Management Agency (FEMA).

The purposes of Major Public Open Space as it relates to drainageways and relevant policies for Major Open Space Arroyos are summarized in Appendix E.

APPENDIX E
PURPOSES OF MAJOR PUBLIC OPEN SPACE AND
POLICIES FOR MAJOR OPEN SPACE ARROYOS

As provided in the "Facility Plan for Arroyos", the purposes of Major Public Open Space in relation to drainageways are:

1. Conservation of geologic formations, biologic communities, or other natural resources.
2. Conservation of ground water recharge, air purification, or other natural processes.
3. Conservation of significant landforms, scenic views, or other visual resources that are related to the natural environment.
4. Provision of opportunities for hiking, picnicking, or other recreational activities that are enhanced by the natural environment.
5. Conservation of corridors that are used for hiking, equestrian, or other trails that link Major Public Open Space areas.
6. Conservation of areas with high flood potential, steep slopes, or other physical characteristics that limit their use for safe, economic, urban development.

There are seven specific policies with regard to Major Open Space Arroyos given in the Facility Plan. These are summarized below:

Policy 1: Preservation of the Existing Floodplain.

Where appropriate, the entire 100-year floodplain of the arroyo shall be dedicated to or purchased by the City as a Major Public Open Space. Right-of-way beyond the 100-year floodplain should be

acquired when development would be imprudent because of potential bank erosion or other environmental factors, or when necessary to ensure continuous trail development.

Policy 2: Drainage Facilities Within Designated Open Space.

Drainage facilities should be designed to blend visually with adjacent land. Channel stabilization treatments which allow the growth of vegetation are preferred.

Policy 3: Drainage Controls for Adjacent Development.

Necessary drainage controls for development adjacent to Major Open Space Arroyos shall be developed jointly by AMAFCA and the City Engineering Division. The Development Review Board shall review the appropriate site plans, drainage plans, plats, etc. for compliance.

Policy 4: Preserving Topsoil and Existing Vegetation.

Construction within or adjacent to Major Open Space Arroyos shall minimize disturbance of existing vegetation and topsoil. Reseeding with native or naturalized vegetation shall be necessary to replace vegetation lost during construction.

Policy 5: Landscaping Within the Public Right-of-Way.

Landscaping of drainage rights-of-way with low maintenance native-type plant materials shall be encouraged, in order to enhance elements of topography, scenic views, and areas containing public amenities. Said landscaping shall be defined and considered at the arroyo corridor plan level.

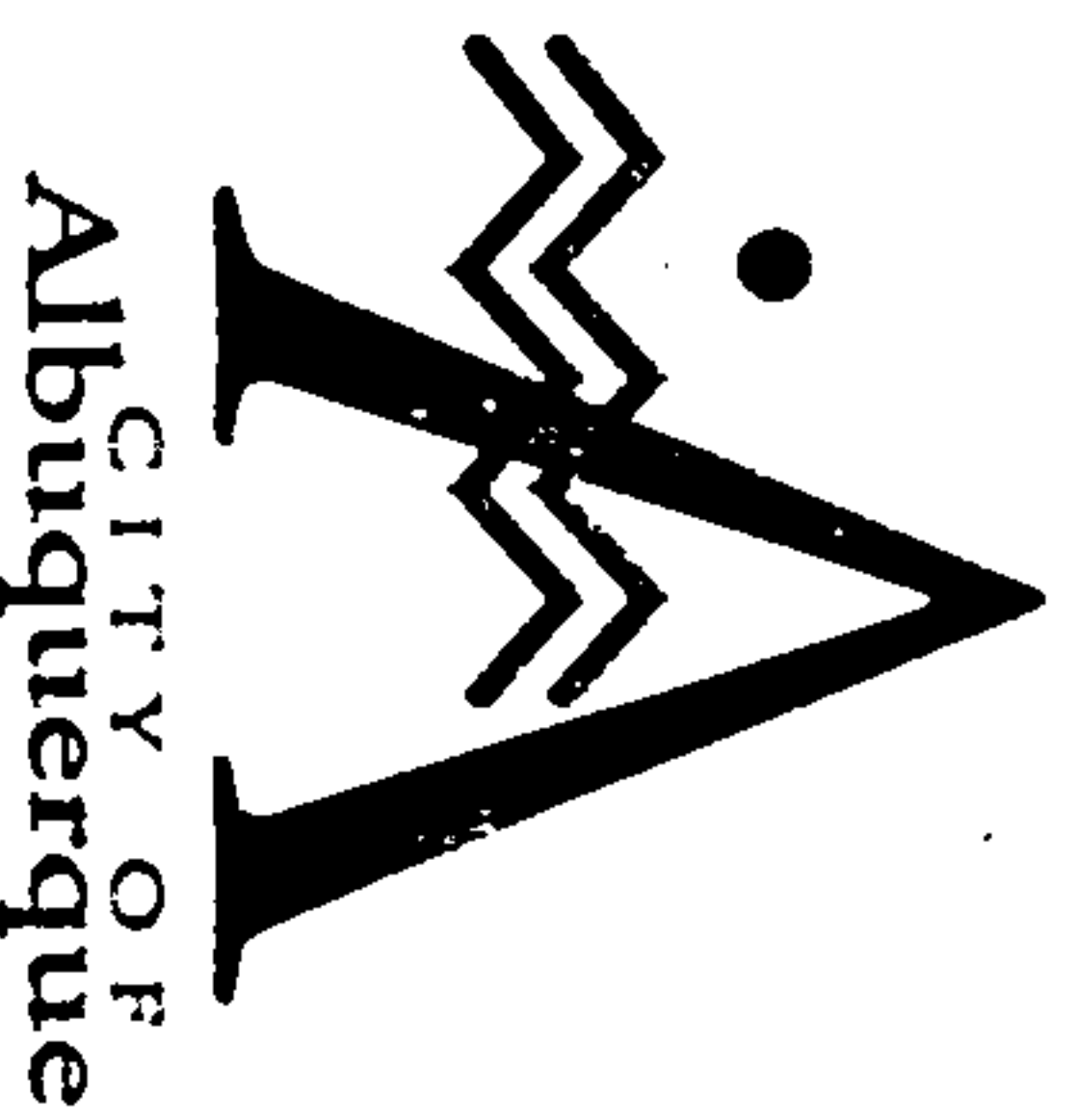
Policy 6: Open Space Dedication.

In areas designated Developing Urban, a portion of development's open space requirement should be aligned with drainage facilities associated with Major Open Space Arroyos.

The entire (natural) 100-year floodplain of a Major Open Space Arroyo along with associated right-of-way required for trails, shall be credited as open space, less right-of-way required for drainage control if a concrete lined 100-year channel were constructed.

Policy 7: Programming Recreational Amenities.

The design of public amenities shall be planned and programmed as part of the arroyo corridor planning process.



September 23, 1997

Martin J. Chávez, Mayor

Kenneth P. Cordova
Public Service Company of New Mexico
Alvarado Square-Mail Stop 2101
Albuquerque, New Mexico 87158

RE: Scour Analysis for The Proposed 6-Inch Gas Line Crossing of the Tijeras Arroyo at
Four Hills Village 20th Installment (M23/D11) Report Dated August 1997.

Dear Mr. Cordova:

It appears that the scour analysis is adequate, however, prior to release of the Grading Permit, the following comments must be addressed:

1. Please revise the proposed gas line profile so that the 15' depth is maintained under the entire main channel, per the attached markup of Figure 2. Since this is a dynamic channel, it appears that Point B may become the main flow line at any time in the future. It also appears that 8' to 10' of cover should be provided under the 100-year water surface area.
2. The report must be signed, stamped and dated by a registered Professional Engineer.
3. This gas line must be located within an easement. Please coordinate with the property owner and provide the documentation that an easement has been obtained for this work.
4. Please provide a profile through the subdivision to show that there are no conflicts with the proposed utilities.

If you should have any questions regarding these comments, please call me at 924-3982.

Sincerely,


Susan M. Calongne, P.E.
City/County Floodplain Administrator

c: Mary Strickman, HAT Limited
Don Dixon, Resource Technology
Terry Brown
Kurt Browning, AMAFCA

File 1

Good for You, Albuquerque!



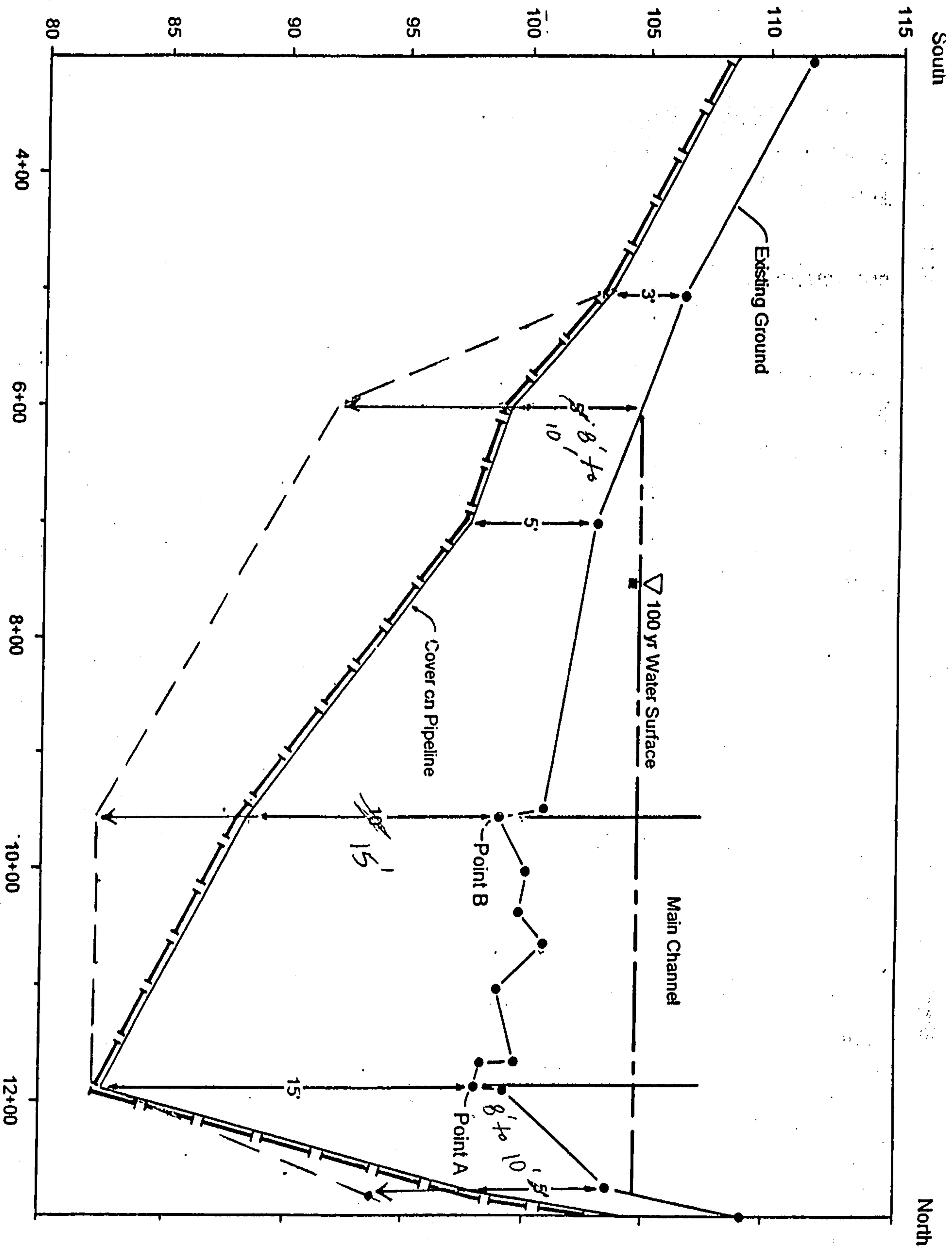
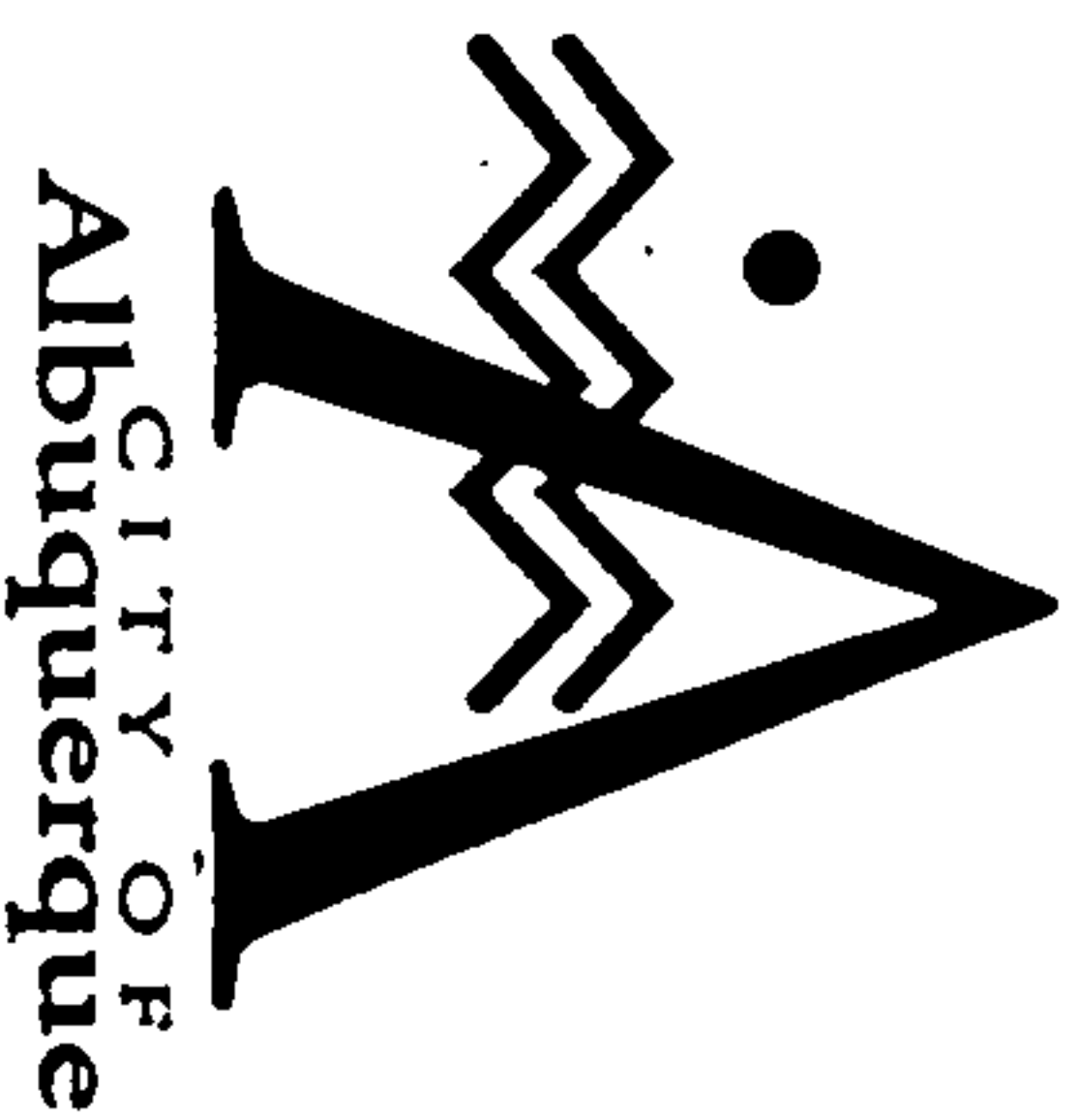


FIGURE 2

CROSS SECTION OF TIJERAS ARROYO
AT GAS LINE CROSSING



October 14, 1997

Martin J. Chávez, Mayor

Kenneth P. Cordova
Public Service Company of New Mexico
Alvarado Square-Mail Stop 2101
Albuquerque, New Mexico 87158

RE: Scour Analysis for The Proposed 6-Inch Gas Line Crossing of the Tijeras Arroyo at
Four Hills Village 20th Installment (M23/D11) Engineer's Stamp Dated 9/25/97.

Dear Mr. Cordova:

Based on the information provided in the submittal of September 30, 1997, along with the additional information provided on October 9, 1997, the above referenced project is approved for Grading Permit release.

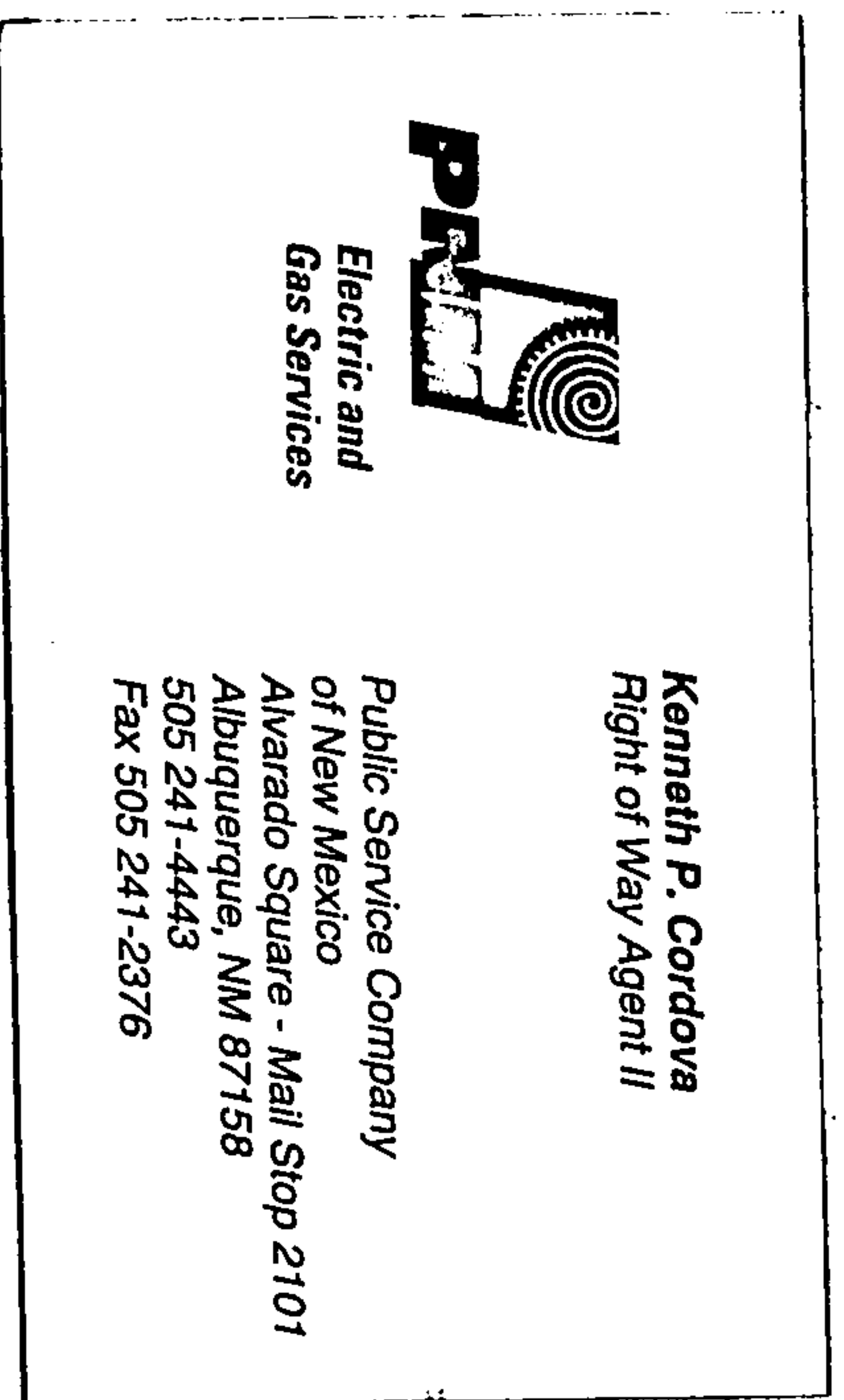
Please provide a copy of the gas line plan and profile to Don Dixon at Resource Technology so that this information may be added to the subdivision plans. The plans indicate that there will be a three foot clearance between the gas line and the proposed 54" RCP storm drain pipe where these cross. At other locations, the storm drain laterals will cross above the gas line. It appears that there are no conflicts with the proposed subdivision utilities.

If you should have any questions, or if I may be of further assistance to you, please feel free to call me.

Sincerely,


Susan M. Calonghe, P.E.
City/County Floodplain Administrator

c: Andrew Garcia, City Hydrology
Mary Strickman, HAT Limited
Don Dixon, Resource Technology
Terry Brown
File



Good for You, Albuquerque!



97101741

AGREEMENT TO CONSTRUCT GAS LINE AND GRANT EASEMENT

THIS AGREEMENT TO CONSTRUCT GAS LINE AND GRANT EASEMENT ("Agreement") is entered into as of the 29th day of September, 1997, by and between HAT LTD., a New Mexico Limited partnership ("HAT"), and the PUBLIC SERVICE COMPANY OF NEW MEXICO, a New Mexico corporation ("PNM").

RECITALS:

A. HAT is the owner of the following property located in Bernalillo County, New Mexico:

Four Hills West as the same is shown and designated on said plat filed for record in the office of the County Clerk of Bernalillo County, New Mexico in Plat Book C17,

Page 174 on January 7, 1981 (the "HAT Property");

STATE OF NEW MEXICO
COUNTY OF BERNALILLO
FILED FOR RECORD

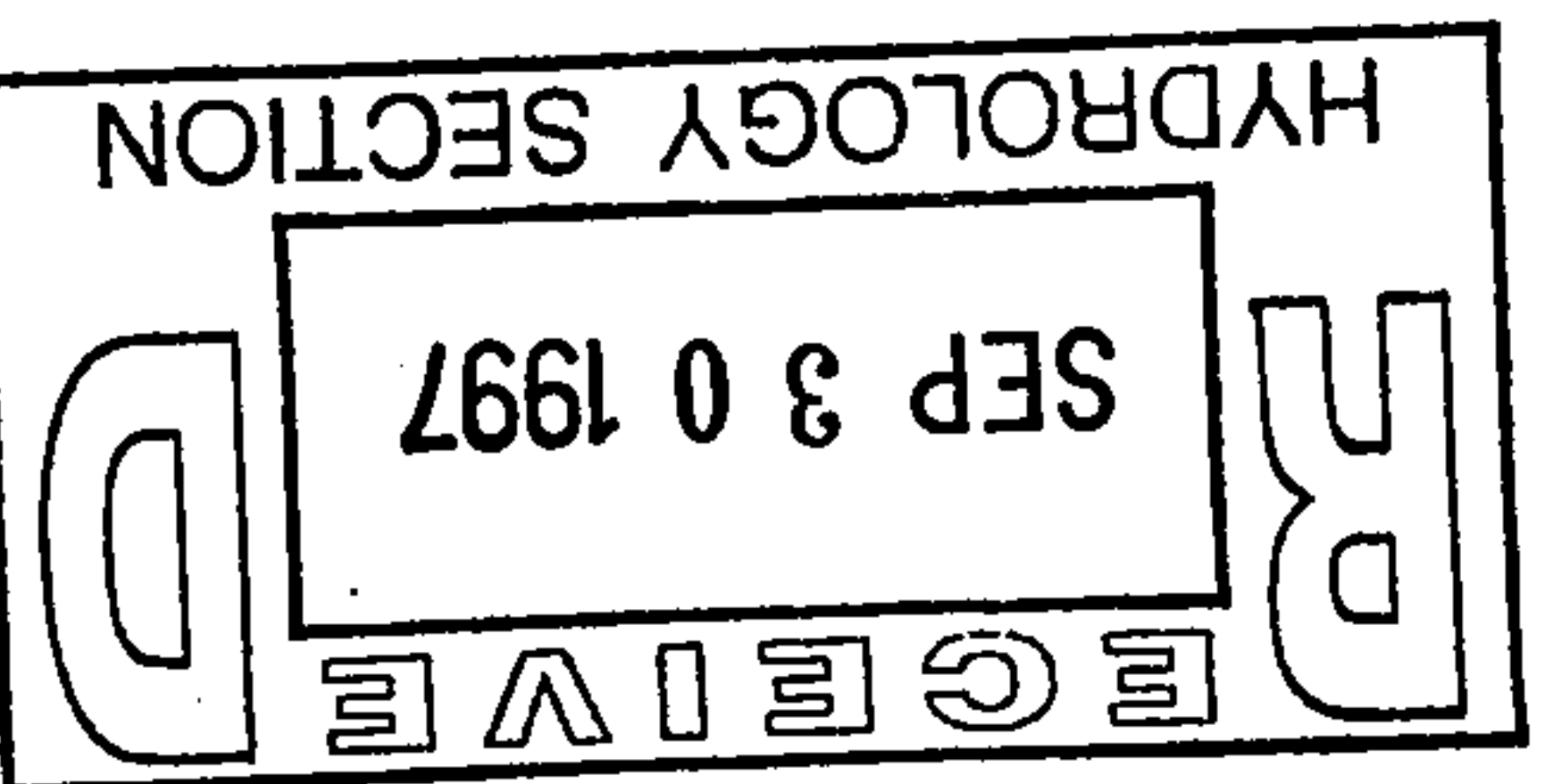
1997 SEP 30 AM 10:09

BK _____ PG _____
JUDY D. WOODWARD
CO. CLERK & RECORDER DEPUTY

B. PNM has requested that HAT allow PNM to expeditiously construct a gas line on the HAT Property and that HAT grant to PNM a right of way and easement over the portion of the HAT Property described on Exhibit "A" attached hereto, and pursuant to the terms of the form of easement attached hereto as Exhibit "B" (the "Easement").

C. HAT is in the process of platting its Property pursuant to the unfiled plat for Four Hills Village twentieth installment (the "New Plat"), and has agreed to grant the Easement after the recording of the New Plat in the Bernalillo County, New Mexico real estate records.

NOW, THEREFORE, for good and valuable consideration, HAT agrees to allow PNM to construct a gas line on HAT's Property, and that HAT will then grant to PNM the Easement upon the sooner of: (a) within thirty days of the recording in the Bernalillo County, New Mexico real estate records of the New Plat, or (b) the third



(3rd) anniversary date of this Agreement. This Agreement shall be recorded in the Bernalillo County, New Mexico real estate records and the obligations contained herein shall run with, be appurtenant to, and burden the HAT Property and HAT's successors and assigns.

HAT LTD., a New Mexico Limited Partnership

By: Trails Management Inc., a New Mexico corporation, General Partner

By: Mary S. Strickman
Mary S. Strickman, President

PUBLIC SERVICE COMPANY OF NEW MEXICO,
a New Mexico corporation

By: Rob Roberts
Its: Manager, Right of Way Dept

STATE OF NEW MEXICO)
)ss.
COUNTY OF BERNALILLO)

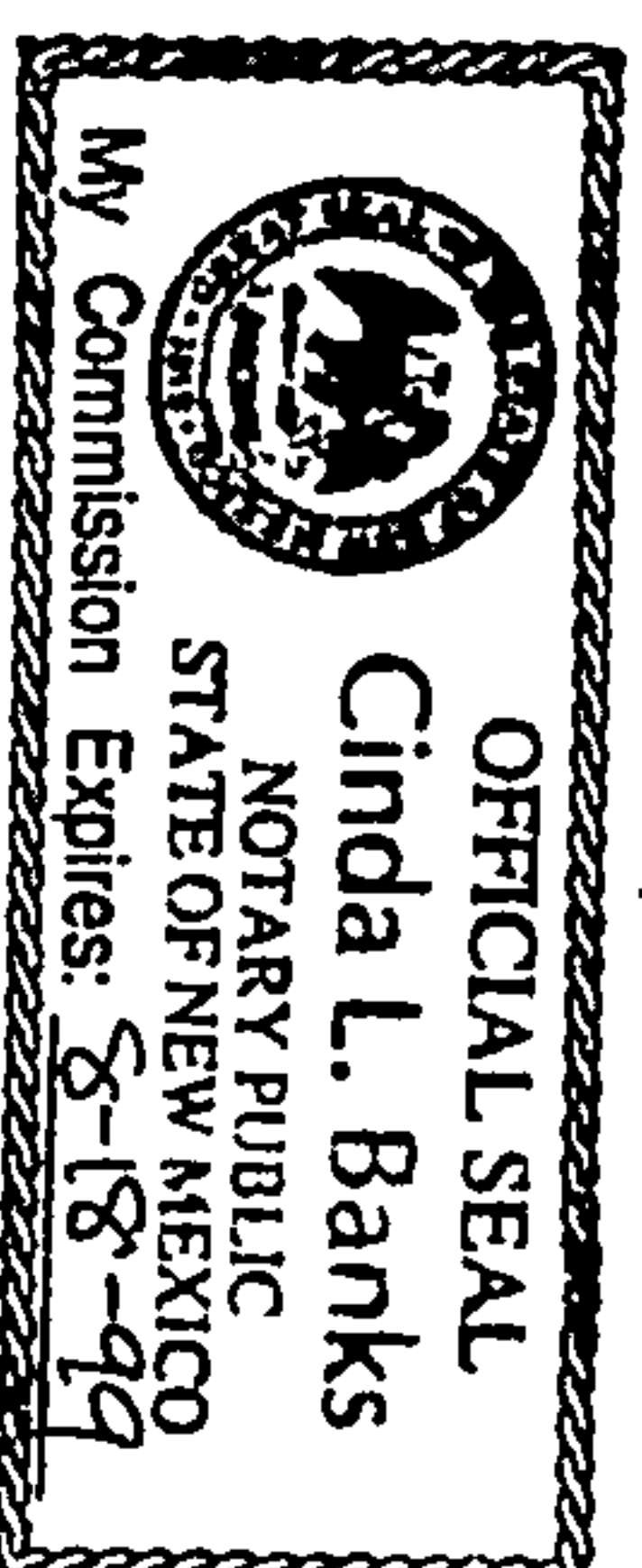
This instrument was acknowledged before me on September 29, 1997, by Mary S. Strickman, President of Trails Management Inc., a New Mexico corporation, as general partner of HAT Ltd., a New Mexico limited partnership.

Cinda L. Banks
Notary Public

My Commission Expires:

8-18-99

STATE OF NEW MEXICO)
)ss.
COUNTY OF BERNALILLO)

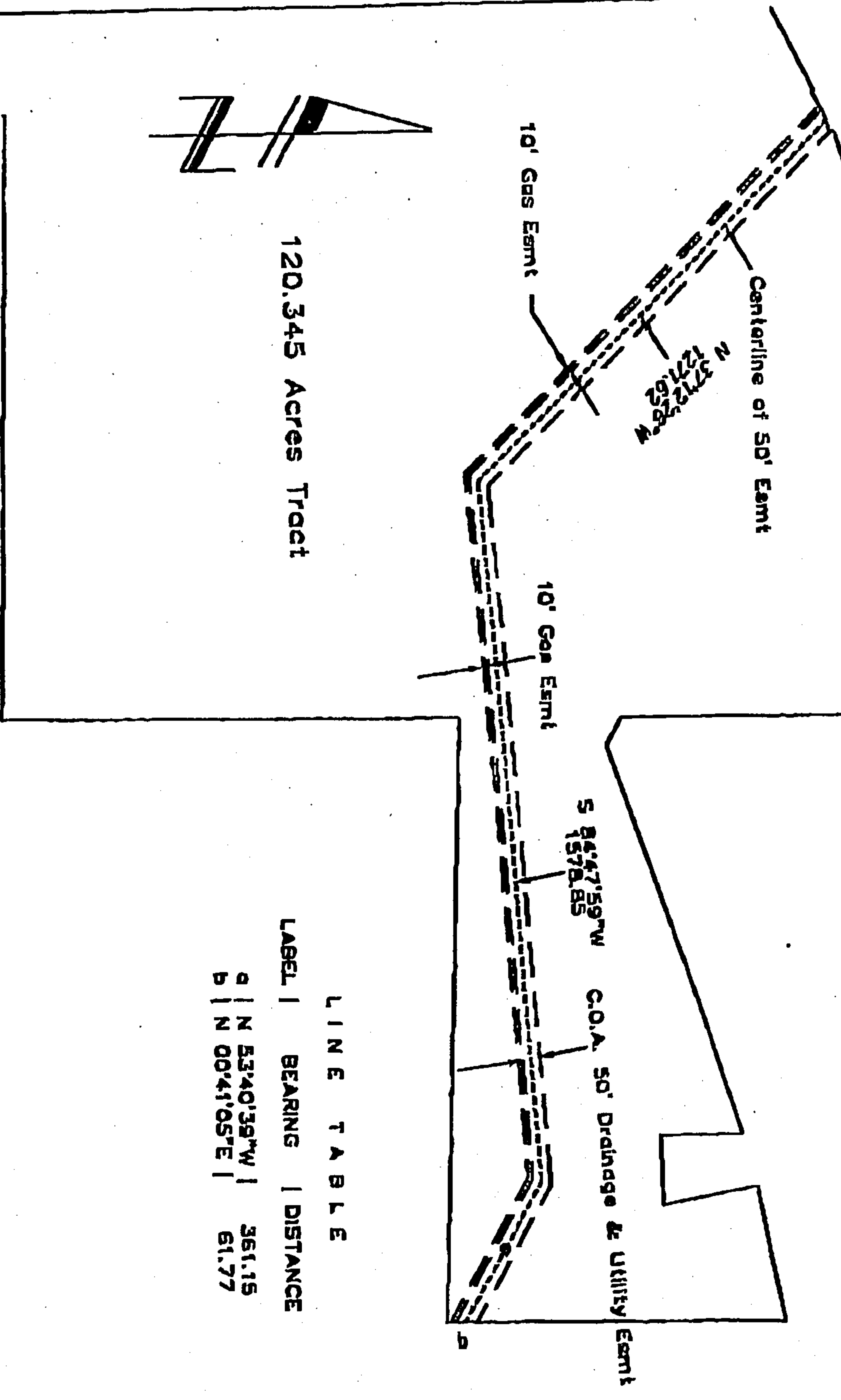
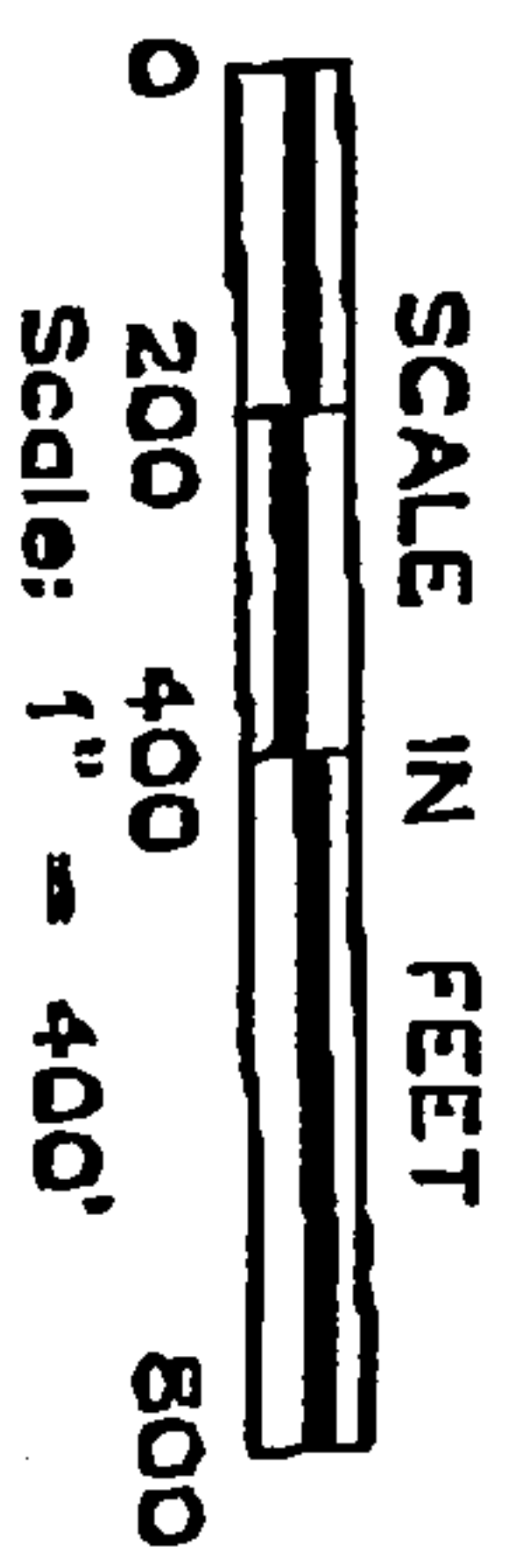


This instrument was acknowledged before me on September 26, 1997, by Rob Roberts, Manager, Right of way of the Public Service Company of New Mexico, a New Mexico corporation.

David L. Banks
Notary Public

My Commission Expires:

3-1-2001



LINE TABLE		
LABEL	BEARING	DISTANCE
a	N 53°40'39"W	361.15
b	N 00°41'05"E	61.77

SURVEYOR'S CERTIFICATION

I, Leonard G. Martinez, New Mexico Professional Land Surveyor No. 9801, certify that this map was prepared from field notes of actual surveys made by me or under my supervision; and that it is true and correct to the best of my knowledge and belief.


Leonard G. Martinez, N.M.L.S. No. 9801

EXHIBIT "A"

PROPOSED GAS LINE XING
FOUR HILLS WEST 120.345 ACRE TRACT
WITHIN SEC. 27, 33 & 34, T.10 N., R.4 E., N.M.P.M.
BERNALILLO COUNTY, NEW MEXICO

PUBLIC SERVICE CO. OF NEW MEXICO
ALBUQUERQUE, NEW MEXICO

DWN BY: L.G.M. DATE: 09-18-97
DWN BY: J.P.C. SCALE SHOWN

Req. No. R1912B

PNM GAS SERVICES RIGHT OF WAY AND EASEMENT

THIS INDENTURE made this _____ day of _____, 19____ by and between

(Grantor) and PNM GAS SERVICES, an unincorporated division of Public Service Company of New Mexico, a New Mexico Corporation, (Grantee), and its successors and assigns:

WITNESSETH:

Grantor, for and in consideration of the sum of One Dollar (\$1.00) in hand paid and other valuable consideration, the receipt of which is acknowledged, does hereby give, bargain, sell, grant and convey unto Grantee, a right of way and easement to build, rebuild, construct, reconstruct, locate, relocate, change, remove, replace, modify, renew, operate and maintain one or more gas pipelines, for the transmission and distribution of natural gas, with appurtenant interests, and facilities for communication purposes, or either of any or all such purposes, including lines, cables, conduits, and other fixtures and structures necessary to maintain such facilities, and appurtenances thereto (all of which are hereinafter collectively referred to as "facilities"), on, over, beneath, through, and across the right of way and easement, hereinafter described, together with the right of way and easement, with the right and privilege of going upon, over and across adjoining lands of Grantor for the purposes set forth herein and with the right to utilize the right of way and easement to extend services to customers of Grantee, and to trim and remove any trees, shrubs or bushes and remove any structures which interfere with the purpose set forth herein. The right of way and easement granted herein is within lands situated in _____ County, New Mexico and is more particularly described as follows to wit:

PNM Project No. R1912B

An easement within a 120.345 Acre Tract as shown on Plat of FOUR HILLS WEST situate in Sections 27, 33 & 34, T.10N., R.10E., N.M.P.M., Bernalillo County, New Mexico, as the same is shown and designated on said Plat filed for record in the office of the County Clerk of Bernalillo County in Plat Book C17, Page 174, on January 7, 1981 and being more particularly described as follows:

An easement ten (10) feet wide, adjoining the south and west line of a 50' wide City of Albuquerque drainage and utility easement, being 25.00 feet left of the following described centerline of said 50' easement: Beginning at a point on the east boundary line of said 120 Acre Tract, whence the southeast corner of said 120 Acre Tract bears S.00°41'05"W. 61.77 feet distant; running thence as an easement N.53°40'39"W. 361.15 feet to a point; thence S.84°47'59"W. 1578.85 feet to a point; thence N.37°12'26"W. 1271.62 feet to the north boundary line of said 120 Acre Tract.

See Exhibit "A" for drawing of Legal Description

Grantor hereby covenants that Grantee is the true and lawful owner of the land described herein.

Grantor shall have the right to use the above described right of way and easement for the purposes not inconsistent with the rights hereby granted, provided that Grantee shall not erect any structures on any building, pool or other structure thereon, nor shall it operate any well thereon, nor conduct any activity which interferes with Grantee's exercise of the rights granted herein.

The provisions hereof shall inure to the benefit of and bind the heirs, assigns, successors, assigns, licensees and assigns of the parties hereto. Grantee shall have the undivided right to sell, transfer, assign, pledge, mortgage, lease, grant license or other use of occupancy right with respect to, or otherwise dispose of, in whole or in part, any interest in the easement and such rights shall have the further right to convey, in whole or in part, the rights granted them by Grantee.

WITNESS _____ hand _____ and seal _____ this _____ day of _____, 19____

(SEAL)

ACKNOWLEDGEMENT FOR NATURAL PERSONS

STATE OF NEW MEXICO
COUNTY OF _____
This instrument was acknowledged before me on _____, 19____

by _____
My commission expires: _____
(Seal)

Notary Public

ACKNOWLEDGEMENT FOR CORPORATION

STATE OF NEW MEXICO
COUNTY OF _____
This instrument was acknowledged before me on _____, 19____

by _____ (Name of Officer) _____ (Title of Officer)
of _____ (Corporation Acknowledgement)
a _____ corporation, on behalf of said corporation.
(State of Incorporation)
My commission expires: _____
(Seal)

Notary Public

FOR RECORDER'S USE ONLY

PNM
REFERENCE
NUMBER

PNM
REFERENCE
NUMBER

EXHIBIT B

PNM 718-076 7184



State of New Mexico
ENVIRONMENT DEPARTMENT
Surface Water Quality Bureau



GARY E. JOHNSON
GOVERNOR

Harold Runnels Building
1190 St. Francis Drive, P.O. Box 26110
Santa Fe, New Mexico 87502
(505) 827-0187

MARK E. WEIDLER
SECRETARY
EDGAR T. THORNTON, III
DEPUTY SECRETARY

February 10, 1997

Lieutenant Colonel Lloyd E. Wagner
Albuquerque District, U.S. Army Corps of Engineers
4101 Jefferson Plaza NE
Albuquerque, NM 87109

Re: State of New Mexico Section 401 Water Quality Certification of Nationwide Section 404 permits

Dear Lt. Col. Wagner:

Under authority delegated by the New Mexico Water Quality Control Commission, the New Mexico Environment Department (NMED) has reviewed the Nationwide Permits (NWP) final rule in the Federal Register dated December 13, 1996. This letter updates NMED's January 24, 1992 letter to your office regarding State of New Mexico Section 401 water quality certification of the Section 404 Nationwide permits as proposed in the Federal Register on June 17, 1996.

NMED agrees with your staff that the following permits do not apply in New Mexico: 1 (aids to navigation), 2 (structures in artificial canals), 8 (oil and gas structures), 9 (structures in floating and anchorage areas), 10 (mooring buoys) 11 (temporary recreational structures), and 24 (state administered Section 404 programs). The State therefore waives its right to certification for these NWPs only. The State finds that all other proposed NWPs should be subject to State water quality certification under Section 401 of the Clean Water Act.

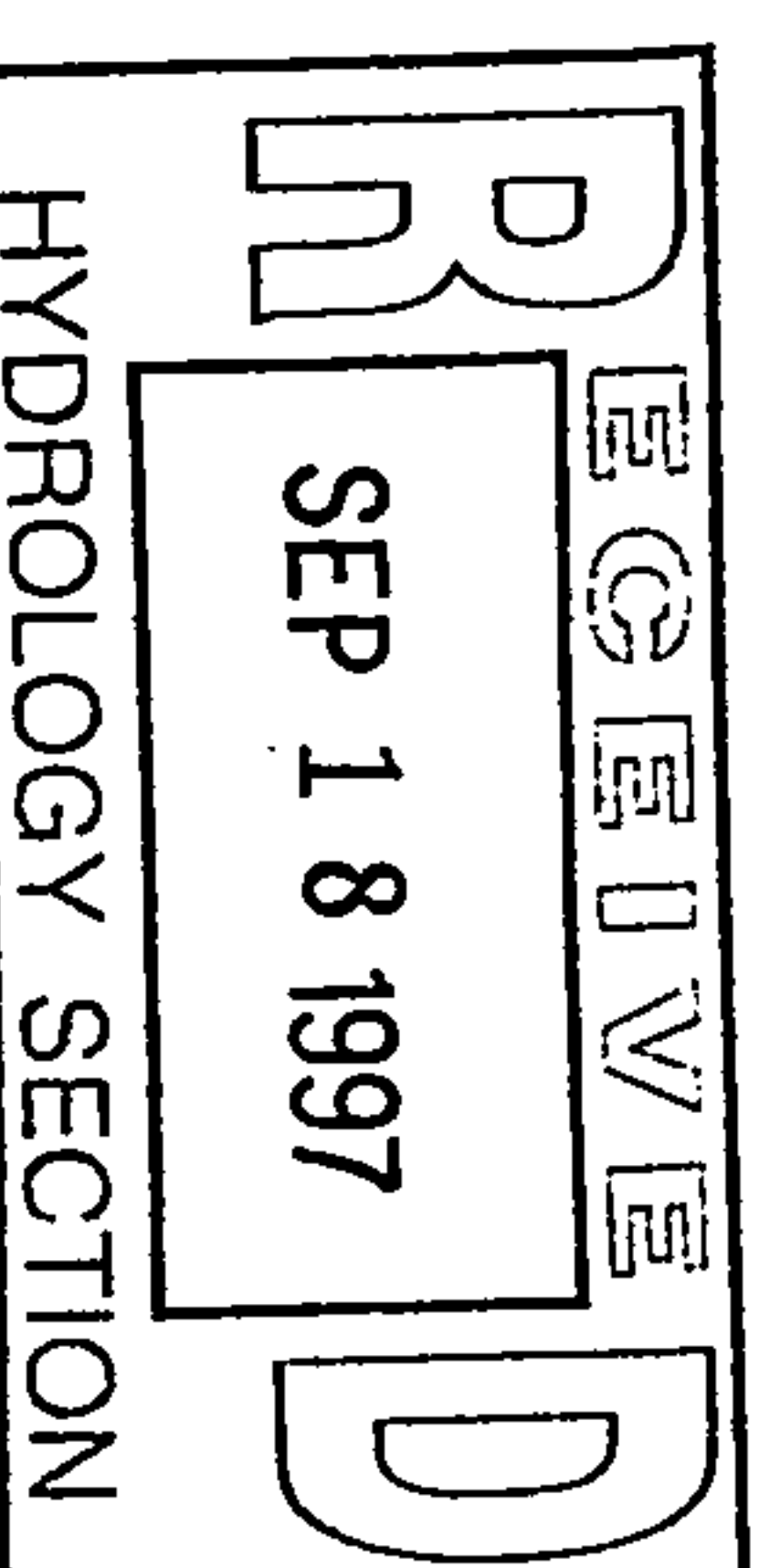
NMED hereby issues unconditional section 401 certification for the following NWPs: 20 (oil spill cleanup), 22 (vessel removal), 27 (wetland restoration), 30 (moist soil management for wildlife), and 38 (hazardous and toxic waste cleanup). In addition, the State issues unconditional certification for incidental discharges authorized under NWP 18 (minor discharges). "Incidental" is defined in this certification as any activity that causes the placement or dislodging of rock or soil in a manner that is not meant to be the discharge of dredged or fill material. Such amounts typically are extremely small in nature (1/10 cubic yard or less). Actions such as rock skipping, driving across a stream at a low water crossing, or the accidental dislodging of stream substrate during activities such as hiking or fishing are examples of incidental discharges.

Kenneth P. Cordova
Right of Way Agent II



Electric and
Gas Services

Public Service Company
of New Mexico
Alvarado Square - Mail Stop 2101
Albuquerque, NM 87158
505 241-4443
Fax 505 241-2376



Lt. Col Wagner

February 10, 1997

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NMED finds that discharges permitted under the following permits could adversely affect the State's waters to an extent which would negatively affect designated uses: 3 (maintenance), 4 (fish and wildlife harvesting, enhancement, and attraction devices and activities), 5 (scientific measurement devices, 6 (survey activities), 7 (outfall structures) 12 (utility line backfill and bedding), 13 (bank stabilization) 14 (road crossings), 15 (U.S. Coast Guard approved bridges), 16 (return water from upland contained disposal areas), 17 (hydropower projects), 18 (minor discharges), 19 (25 cubic yard dredging), 21 (surface coal mining), 23 (approved categorical exclusions), 25 (structural discharges), 26 (headwaters and isolated waters discharges), 28 (modifications of existing marinas), 29 (single family housing), 31 (maintenance of existing flood control projects), 32 (completed enforcement activities), 33 (temporary construction and access), 34 (cranberry production), 35 (maintenance dredging of existing basins), 36 (boat ramps), 37 (emergency watershed protection), and 40 (farm buildings). To prevent such impacts, the following conditions are specifically included in the certification for the permits listed above.

1. Fill material placed in a watercourse or in a location and manner where a reasonable probability exists that the material will be moved to the watercourse shall be free of toxic materials or materials which may decompose to become a toxic material.
2. No work shall be performed in or near any perennial surface water or perennial reach of an interrupted or intermittent surface water of the State under any of the conditioned Nationwide Permits until the permittee has notified the Surface Water Quality Bureau of the NMED and has received NMED approval of plans and specifications detailing how water quality standards will be attained.

3. No work shall be done under any of the conditioned Nationwide permits in any wetland of the State (as defined in the New Mexico Water Quality Control Commission's *Water Quality Standards for Interstate and Intrastate Streams in New Mexico*) greater than 1/3 acre in size until the permittee has notified the Surface Water Quality Bureau of the NMED and has received NMED approval of plans and specifications detailing how water quality standards will be attained.

The following conditions apply to NWP 12 only:

1. All utility lines must be installed perpendicular or as close as possible to perpendicular to a channel to minimize disturbance.
2. Applicants must justify the need to cross wetlands or streams. Certification shall not be issued until all reasonable alternatives have been explored that avoid construction or maintenance in waters of the State.
3. The project must be restored to pre-construction contours and stabilized with native vegetation.

Lt. Col Wagner

February 10, 1997

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The Environment Department previously issued unconditional certification for NWP's 4, 5, and 32. However, upon review of the Nationwide permit summaries and the Federal Register. NMED has determined that these permits could cause, at a minimum, violations of the State's turbidity standard. Therefore, written water quality approval from NMED is now required.

According to the Federal Register, NWP 39 is reserved. This document does not certify NWP 39 or waive the State's right to review NWP 39 for state certification when and if NWP 39 is developed.

The State of New Mexico specifically reserves the right to amend or revoke these certifications if such activity is necessary to ensure attainment of State water quality standards. Please address any questions concerning these certifications to Ms. Cecilia Brown of my staff at (505) 827-0106.

Sincerely,



Ed Kelley, Acting Bureau Chief
Surface Water Quality Bureau

cc: Members of the NM Water Quality Control Commission
District Managers, Environment Department
Chris Cudia, Program Manager, NMED Silver City
Laura Talbot, NPS Coordinator, Region VI, EPA
Jim Ratterree, Wetlands, Region VI, USEPA
John Pitenger, NM Department of Game and Fish
Jennifer Fowler-Propst, U.S. Fish and Wildlife Service



DEPARTMENT OF THE ARMY

ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS

4101 JEFFERSON PLAZA NE

ALBUQUERQUE, NEW MEXICO 87109-3435

FAX (505) 342-3498

REPLY TO
ATTENTION OF:

June 26, 1997

Operations Division
Regulatory Branch

Mr. Pete H. Metzner
Metric Corporation
8429 Washington Place NE, Suite A
Albuquerque, New Mexico 87113

Dear Mr. Metzner:

This is in reference to your June 20, 1997, letter regarding the Public Service Company of New Mexico's (PNM) proposed 6-inch natural gas high pressure pipeline in Tijeras Arroyo in Albuquerque, Bernalillo County, New Mexico (Action No. 1997 00173). Our site visit today noted that the Tijeras Arroyo ordinary high water mark is in two channels, the north about 20 ft wide and the south about 50 ft wide. The pipeline will be excavated in an existing utility easement that is nearly perpendicular (approx. 80°) to the channel.

The Corps of Engineers has published Nationwide Permits pursuant to Section 404 of the Clean Water Act (33 CFR 330). Nationwide Permit No. 12 authorizes discharges of dredged or fill materials into waters of the United States for utility line backfill and bedding. A summary of Nationwide Permit No. 12 and a brochure describing the Corps regulatory program are enclosed for your information.

PNM's utility line can be constructed under authority of the nationwide permit. The permittee must insure compliance with all conditions of the permit, including submittal of the enclosed Compliance Certification required by General Condition No. 14. Notification is required if this nationwide permit is combined with another nationwide permit No. 12 through 40 as part of a single, complete project (see General Condition Nos. 13 and 15).

No work can be performed in any wetland (affecting over 1/3 acre), in or near any perennial surface water, or perennial reach of an interrupted or intermittent surface water of New Mexico under this nationwide permit until the permittee has notified the Surface Water Quality Bureau of the New Mexico Environment Department, and has received Environment Department approval of plans and specifications detailing how water quality standards will be attained. Tijeras Arroyo at this location is an

intermittent stream. There are no wetlands at the project site. Water quality certification was issued by the NMED on February 10, 1997, for work authorized by this nationwide permit in intermittent streams (copy enclosed). Note the conditions cited in the certification. You may contact the NMED for additional information at: New Mexico Environment Department, 1190 St. Francis Drive, P.O. Box 26110, Santa Fe, New Mexico 87502; Attn: Ms. Cecilia Brown, ph. (505) 827-0106.

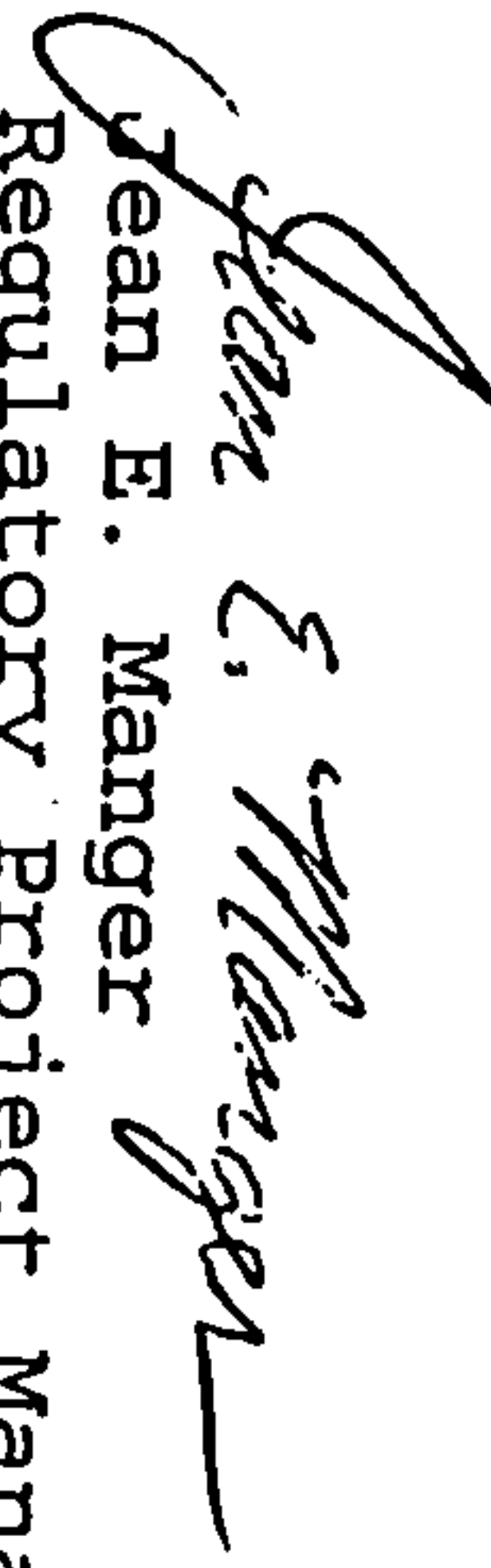
General Condition No. 11 requires that no activity is authorized under any Nationwide Permit which is likely to jeopardize the continued existence of a listed or proposed threatened or endangered species, as identified under the Federal Endangered Species Act, or which is likely to destroy or adversely modify the critical habitat of such species. We have determined that your proposed work, as described, will have no affect on any listed or proposed endangered or threatened species or its critical habitat.

To avoid violation of the National Historic Preservation Act, you should immediately notify this office if you encounter an archeological or historic site. You should avoid activities that impact the site until clearance is obtained.

This verification will be valid for 2 years unless the nationwide permit is modified, reissued or revoked. The verification will remain valid if, during that time, the nationwide permit is reissued without modification or the activity complies with any subsequent modification of the nationwide permit authorization. If the nationwide permit authorization expires, is suspended, revoked, or modified such that the activity would no longer comply with the terms and conditions of the nationwide permit, the provisions of 33 CFR 330.6(b) will apply.

If you have any questions regarding these regulations, please feel free to write or call me at (505) 342-3216.

Sincerely,


Jean E. Manger
Regulatory Project Manager

4 Enclosures

1. Nationwide Permit Summary
2. Brochure
3. Compliance Certification form
4. WQ Cert, 2/10/97

Copies furnished w/ cy incoming:

Ms. Cecilia Brown

NMED - Surface Water Quality Bureau
P.O. Box 26110
Santa Fe, NM 87502-6110

Caring for Our Nation's Waters

U.S. Army Corps of Engineers Regulatory Program

Water is one of our nation's most valuable resources. It is becoming increasingly important that we protect the quality of our inland waters and wetlands for the use and benefit of future generations.

This brochure discusses the regulatory program of the U.S. Army Corps of Engineers: what it is, how it began, how it may affect you and what you as a concerned citizen can do to help.

If you are planning work in an arroyo, river, stream, or wetland, a Corps permit (Section 10 or Section 404) may be required.

The program provides for the consideration of all concerns of the public -- environmental, social and economic -- in the Corps' decision-making process to either issue or deny permits. As part of its responsibility to protect water quality, the Corps of Engineers Section 404 permit program extends to many areas that were not regulated prior to the Clean Water Act.

The purpose of the Section 404 program is to insure that the biological and chemical quality of our nation's waters is protected from irresponsible and unregulated discharges of dredged or fill material that could permanently alter or destroy these valuable resources.

You are urged to understand and support this program.

Corps of Engineers Involvement

The Corps' permit program is not new. When it began in 1886, its purpose was principally to avoid obstructions in navigable waters. In response to changing environmental, social and economic conditions, the scope has been broadened. Sections 9 and 10 of the River and Harbor Act of 1899 were established to regulate dams, dikes, and obstruction or alteration of navigable waters of the United States.

The Corps of Engineers regulatory function was expanded when Congress passed the Federal Water Pollution Control Act Amendments of 1972. Section 404 of the Act established a permit program to be administered by the Corps of Engineers to regulate the discharge of dredged or fill material into waters of the United States. The Act, renamed the Clean Water Act, was further amended in 1977 to provide exemptions, general permits and program turnover to states having approved programs.

The Corps has published regulations in the Code of Federal Regulations (33 CFR, Parts 320-330) to administer these laws.

Activities Requiring Permits

A Corps permit is required if you plan to locate a structure or discharge dredged or fill material, including excavation, in waters or navigable waters of the United States. This information is directed to those individuals, companies, corporations, and government agencies planning construction activities in a river, stream, lake or wetland within the jurisdiction of the Corps of Engineers.

Examples of regulated activities are materials excavated or placed in a waterway or wetland for any purpose including: commercial, industrial or recreational construction; roadfills and causeways where portions of the construction are in waters or wetlands; dams and dikes; and protection devices such as levees, groins, riprap and other bank stabilization.

Waters of the United States

Waters of the United States are administratively defined as (1) the traditional "navigable waters of the United States" including adjacent wetlands; (2) all interstate waters including interstate wetlands; (3) all other waters such as interstate lakes, rivers, streams (including intermittent streams), prairie potholes, mudflats, playa lakes, etc.; (4) all impoundments of these waters; (5) tributaries of the above listed waters; and (6) wetlands adjacent to the above waters. Section 404 permits are required for construction activities in these waters.

Navigable waters are defined as waters that have been used in the past, are now used or susceptible to use as a means to transport interstate or foreign commerce up to the head of navigation. Section 10 and/or Section 404 permits are required for construction activities in these waters.

"Wetlands" are areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

The landward regulatory limit for non-tidal waters (in the absence of adjacent wetlands) is the ordinary high water mark. The ordinary high water mark is the line on the shores established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving; changes in the character of the soil; destruction of terrestrial vegetation; the presence of litter and debris; or other appropriate means that consider the characteristics of the surrounding areas.

Exempted Activities

There are a few activities which involve

placement of fill or excavation in a waterway that are not subject to the Section 404 regulatory program. These exempted activities are briefly described here. The fill must not change the use of the water and the flow must not be impaired.

1. Normal farming, silviculture and ranching activities such as plowing, seeding cultivating, minor drainage and harvesting.
2. Maintenance or emergency repair of a currently serviceable structure such as dams, riprap, abutments, and levees. The original design may not be changed.
3. Maintenance or construction of stock ponds or irrigation ditches. Maintenance (not construction) of drainage ditches. Discharges associated with irrigation facilities are included.
4. Construction of temporary sedimentation basins at construction sites if fill material is not placed in waters of the United States.
5. Activities for which a state has an approved program under Section 208 of the Clean Water Act for non-point pollution sources.

5. Construction or maintenance of farm roads, forest roads or temporary mining roads. Best management practices must be followed to reduce flow pattern impairment and aquatic impacts (see regulations for more information).

Regional Permits

Regional permits are issued by the District Engineer for a general category of fill activities when (1) the activities are similar in nature and cause minimal environmental impact (both individually and cumulatively), and (2) the regional permit reduces duplication of regulatory control by State and Federal agencies. Contact the Albuquerque District Corps of Engineers for information regarding regional permits in this area.

Pre-Application Consultation

You are encouraged to contact the Albuquerque District Corps of Engineers for proposed work in waters in this jurisdictional area (see map inside).

Exemptions, nationwide, regional and individual permit requirements will be reviewed. By discussing all information prior to application submittal, your application will be processed more efficiently.

An official determination as to the need for a Department of the Army permit will be provided on request.

Application for an Individual Permit

An individual Section 404 permit will be required for placement of dredged or fill material, including excavation, in waters of the United States if the project is not exempted from the Section 404 program and does not fall under one of the nationwide or regional permits.

If an individual permit is required, an application form should be completed. This application is available from the Corps of Engineers.

Information needed includes (1) drawings (size 8½" X 11") sufficient for others to understand your project; (2) location, purpose, types and quantities of fills, and intended use; (3) expected start and completion dates; (4) names and addresses of adjoining landowners; and (5) location and dimensions of adjacent structures.

Individual Permits

Upon receipt of your application for a Section 404 permit, a public notice is issued to all known interested persons.

Historical/archeological impacts and effects on endangered species and critical habitat are reviewed. An environmental assessment is prepared to further evaluate the project's impact.

Water quality certification is requested from the appropriate state, federal, or tribal agency. Comments are received from interested individuals, groups, and government agencies. A public hearing may be held to acquire information and allow the public an opportunity to present their views.

In evaluating a permit application, the Corps of Engineers thoroughly analyzes the impacts of the proposed activity on the public interest.

Consideration is given to many factors, including: conservation, economics, aesthetics, general environmental concerns, wetlands, cultural values, fish and wildlife values, flood hazards, flood plain values, land use, navigation, shoreline erosion, recreation, water supply and conservation, water quality, energy needs, safety, food production, and, in general, the needs and welfare of the people. Individual and cumulative impacts are evaluated.

The decision to issue a permit is based on the benefits which may accrue from the proposed project. Benefits are weighed against foreseeable detriments, and a permit is issued only when its issuance is found to be in the public interest.

After evaluating the above considerations, the District Engineer makes the final decision to issue or deny the permit.

Processing time usually takes less than 120 days unless a public hearing is required or an environmental impact statement must be prepared.

Nationwide Permits

A nationwide permit is a form of general permit authorizing a category of activities throughout the nation. These permits are valid only if their terms and conditions are met. If the conditions cannot be met, a regional or individual permit will be required. Summaries of the nationwide permits are available. A few of the nationwide permits commonly used in this region are briefly listed here:

NWP 3, Maintenance. Repair, rehabilitation or replacement of a structure of fill which was previously authorized and currently serviceable. The structure must not be significantly changed.

NWP 12, Utility Line backfill and bedding, including outfall and intake structures provided there is no change in preconstruction contours. Materials from the trench may be used as a cofferdam.

NWP 13, Bank Stabilization projects necessary for erosion prevention less than 500 feet long containing less than an average of one cubic yard of material per running foot. Materials may not exceed the amount needed for erosion protection, fill is not to be placed in wetland areas or in a manner that impairs water flow, and the activity must be a single and complete project. Projects of longer length or greater fill quantities will be considered for authorization under the Notification general condition. Materials that will erode may not be used.

NWP 14, Road Crossing fills (temporary or permanent) limited to a filled area of no more than 1/3 acre. Less than a total of 200 linear feet of fill may occur in wetlands (wetland fills require advanced written Notification to the District Engineer). This NWP may not be combined with NWP 18 or NWP 26. The crossing must be bridged, culverted, or otherwise designed to prevent restriction of flows.

NWP 18, Minor Discharges of less than 25 cubic yards (fills exceeding 10 cubic yards require advance written Notification to the District Engineer). The discharge may not cause a loss of more than 1/10 acre of wetlands. The activity must be part of a single and complete project and may not divert flows.

NWP 25, Structural Discharge of materials such as concrete, sand, rock, etc. into tightly sealed forms or cells where the structural member is not otherwise regulated.

NWP 26, Discharges of dredged or fill material into Headwaters and Isolated Waters are authorized providing the discharge doesn't cause the loss of more than 3 acres of waters of the United States nor a cause the loss of more than 500 linear feet of the stream bed. Discharges causing a loss of greater than 1/3 acre of waters of the United States require advanced written notification to the District Engineer. For discharges causing a loss of 1/3 acre or less of waters of the United States, the permittee must submit a report within 30 days of completion of the work. "Loss" includes the filled area plus waters of the United States that are adversely affected by flooding, excavation or drainage.

"Headwaters" means the point where the average annual stream flow is 5 cubic feet per second (cfs). For an intermittent stream, the headwater point is where the stream flows at or above 5 cfs 50 percent of the time. "Isolated waters" involve waters that are not part of a tributary system to interstate waters or navigable waters of the United States. Maps are available which show these streams. Note: This permit expires December 13, 1998.

NWP 36, Boat Ramps. The total discharge into waters of the United States must be less than 50 cubic yards of concrete, rock, gravel in forms or as pre-cast slabs. Width must be under 20 feet, base material of crushed stone or gravel, excavated material is limited to site preparation, and no material may be placed in wetlands. All excavated material must be removed to uplands. Dredging requires an additional permit.

General Conditions for Use of Nationwide Permits

You must comply with the following conditions when using a nationwide permit.

1. The activity may not cause more than a minimal adverse effect on navigation.
2. Any structure or fill must be properly maintained.
3. Appropriate erosion and siltation controls must be used and maintained.
4. The activity may not substantially disrupt aquatic life movements.
5. Heavy equipment in wetlands must be placed on mats or use other measures to minimize soil disturbance.
6. The activity must comply with any regional or case-by-case conditions added by the Corps. There is a regional condition in Colorado.
7. Fill is not to be placed in a Wild or Scenic River or "study river."
8. Construction or operations of the activity may not impair reserved tribal rights such as water rights and treaty fishing and hunting rights.
9. In certain states, an individual water quality certification must be obtained. This is a requirement in New Mexico.
10. In certain states, an individual coastal zone management consistency concurrence must be obtained.
11. The activity may not jeopardize threatened or endangered species or destroy critical habitat.
12. You must notify the Corps of effects to listed or eligible National Register historic properties. You should immediately notify the Corps of unlisted or eligible historic properties encountered before or during the work.
13. When required by the terms of a nationwide permit, the prospective permittee must provide advance written notification to the District Engineer, and may not begin work until notified by the District Engineer that (a) the work may proceed, (b) that an individual permit is required, or (c) 30 days (45 days for NWP 26) have passed after the Corps receives a complete notification. Check with the Regulatory Office regarding submittal information required.

... compliance requirements. Every permittee who has received a Nationwide Permit verification from the Corps will submit a signed certification regarding the completed work and any required mitigation. The certification will be forwarded by the Corps with the authorization letter and will include:

- a. A statement that the authorized work was done in accordance with the Corps authorization, including any general or specific conditions.
- b. A statement that any required mitigation was completed in accordance with the permit conditions.
- c. The signature of the permittee certifying the completion of the work and mitigation.

15. Multiple Use of Nationwide Permits: In any case where any NWP number 12 through 40 is combined with any other NWP number 12 through 40, as part of a single and complete project, the permittee must notify the District Engineer. Any NWP 1 through 11 may be combined with any other NWP without notification to the Corps, unless notification is otherwise required by the terms of the NWPs. As provided in 33 CFR 330.6(c) two or more different NWPs can be combined to authorize a single and complete project. However, the same NWP cannot be used more than once for a single and complete project.

Nationwide Permit Section 404 Special Conditions

1. The fill will not occur near a public water supply intake.
2. The fill will not occur in an area of concentrated shellfish production.
3. No discharge will consist of unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.) and materials used will be free from toxic materials in toxic amounts.
4. **Mitigation.** Minimize or avoid fill placement in waters of the United States at the project site.
5. Avoid discharges in spawning areas during spawning seasons.
6. The fill will not permanently restrict or impede the passage of normal or expected flows or cause the relocation of the water, unless the project is an impoundment.

7. If water is impounded by the fill, adverse environmental impacts due to increased or restricted flow must be minimized.

8. Avoid fill placement in migratory waterfowl breeding areas.

9. Remove all temporary fills in their entirety and return affected areas to their preexisting elevation.

Further Information about Nationwide Permits

1. The Corps is authorized to determine if an activity complies with the terms and conditions of a nationwide permit.
2. Use of a nationwide permit does not obviate the need to obtain other federal, state or local authorizations required by law.
3. Nationwide permits do not grant any property rights or exclusive privileges.
4. Nationwide permits do not authorize any injury to the property or rights of others.
5. Nationwide permits do not authorize interference with any existing or proposed federal project.

Nationwide permit conditions are periodically revised. Please call or write for a determination and for a summary of current nationwide permit conditions.

You Can Help

The understanding and support of the American people is vital to the success of this program. To protect our nation's water resources and assure their use and enjoyment of future generations, we must all join this vital effort. We ask your help in "passing the word" to others concerning the permit requirements outlined in this brochure and solicit your views and comments on better ways of attaining the goals of this program. Your comments, questions, and suggestions should be directed to the addresses in this brochure.

Section 10 River and Harbor Act of 1899

Structures or work affecting navigable waters of the United States are regulated under Section 10 of the River and Harbor Act of 1899. The law applies to all structures, from small recreational docks to large commercial structures, and includes any dredging or excavation, bank protection, overhead powerlines or other work.

Even structures or work outside the limits defined for navigable waters of the United States could require a Section 10 permit if the structure or work affects the course, location or condition of the water body in such a manner as to impact the navigable capacity of the water body.

Navigable waters within the Albuquerque District include Navajo Reservoir and the Rio Grande along the International boundary. The Corps of Engineers will provide more information and an application form upon request.

For More Information

In New Mexico:

Albuquerque District Corps of Engineers
ATTN: Regulatory Branch
4101 Jefferson Plaza, NE
Albuquerque, New Mexico 87109-3435
Phone: (505) 342-3283

In southeastern Colorado:

Southern Colorado Project Office
720 North Main Street, Room 205
Pueblo, Colorado 81003-3046
Phone: (719) 543-9459

In southern New Mexico and western Texas:

El Paso Regulatory Office
P.O. Box 6096
Ft. Bliss, Texas 79906-0096
Phone: (915) 568-1359

February 1997



U.S. Army Corps
of Engineers

Albuquerque District

Nationwide Permit Summary

UTILITY LINE DISCHARGES

(NWP Final Notice, 61 FR 65914, para. 12)

Discharges of dredged or fill material associated with excavation, backfill or bedding for utility lines, including outfall and intake structures, provided there is no change in preconstruction contours. A "utility line" is defined as any pipe or pipeline for the transportation of any gaseous, liquid, liquefiable, or slurry substance, for any purpose, and any cable, line, or wire for the transmission for any purpose of electrical energy, telephone and telegraph messages, and radio and television communication. The term "utility line" does not include activities which drain a water of the United States, such as drainage tile; however, it does apply to pipes conveying drainage from another area. This NWP authorizes mechanized landclearing necessary for the installation of utility lines, including overhead utility lines, provided the cleared area is kept to the minimum necessary and preconstruction contours are maintained. However, access roads, temporary or permanent, or foundations associated with overhead utility lines are not authorized by this NWP. Material resulting from trench excavation may be temporarily sidecast (up to three months) into waters of the United States, provided that the material is not placed in such a manner that it is dispersed by currents or other forces. The DE may extend the period of temporary side-casting not to exceed a total of 180 days, where appropriate. The area of waters of the United States that is disturbed must be limited to the minimum necessary to construct the utility line. In wetlands, the top 6" to 12" of the trench should generally be backfilled with topsoil from the trench. Excess material must be removed to upland areas immediately upon completion of construction. Any exposed slopes and stream banks must be stabilized immediately upon completion of the utility line. (See 33 CFR part 322).

Notification: The permittee must notify the district engineer in accordance with the "Notification" general condition, if any of the following criteria are met:

- (a) Mechanized landclearing in a forested wetland;
- (b) A Section 10 permit is required for the utility line;
- (c) The utility line in waters of the United States exceeds 500 feet; or,
- (d) The utility line is placed within a jurisdictional area (i.e., a water of

the United States), and it runs parallel to a streambed that is within that jurisdictional area. (Sections 10 and 404)

NATIONWIDE PERMIT CONDITIONS

General Conditions: The following general conditions must be followed in order for any authorization by a NWP to be valid:

1. **Navigation.** No activity may cause more than a minimal adverse effect on navigation.
2. **Proper Maintenance.** Any structure or fill authorized shall be properly maintained, including maintenance to ensure public safety.
3. **Erosion and Siltation Controls.** Appropriate erosion and siltation controls must be used and maintained in effective operating condition during construction, and all exposed soil and other fills, as well as any work below the ordinary high water mark or high tide line, must be permanently stabilized at the earliest practicable date.
4. **Aquatic Life Movements.** No activity may substantially disrupt the movement of those species of aquatic life indigenous to the waterbody, including those species which normally migrate through the area, unless the activity's primary purpose is to impound water.
5. **Equipment.** Heavy equipment working in wetlands must be placed on mats, or other measures must be taken to minimize soil disturbance.
6. **Regional and Case-by-Case Conditions.** The activity must comply with any regional conditions which may have been added by the Division Engineer (see 33 CFR 330.4(e)) and with any case specific conditions added by the Corps or by the state or tribe in its section 401 water quality certification. Note: To date, one regional condition has been added to this permit (see condition #3, Section 404 only conditions).

7. **Wild and Scenic Rivers.** No activity may occur in a component of the National Wild and Scenic River System; or in a river officially designated by Congress as a "study river" for possible inclusion in the system, while the river is in an official study status; unless the appropriate Federal agency, with direct management responsibility for such river, has determined in writing that the proposed activity will not adversely effect the Wild and Scenic River designation, or study status. Information on Wild and Scenic Rivers may be obtained from the appropriate Federal land management agency in the area (e.g., National Park Service, U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service.)

8. **Tribal Rights.** No activity or its operation may impair reserved tribal rights, including, but not limited to, reserved water rights and treaty fishing and hunting rights.

9. **Water Quality Certification.** In certain states, an individual Section 401 water quality certification must be obtained or waived (see 33 CFR 330.4(c)). **Note for work in Albuquerque District:** Required water quality certification for non-tribal lands in Colorado was issued by the State of Colorado. The State of New Mexico, State of Texas, EPA Region 8, EPA Region 6, and tribal certifying authorities have variously issued, conditionally issued, or denied water quality certification for this nationwide permit. An information summary sheet is enclosed. You must insure compliance with the applicable water quality certification requirements for your project.

10. **Coastal Zone Management.** In certain states, an individual state coastal zone management consistency concurrence must be obtained or waived (see Section 330.4(d)). **Note:** Not applicable in Albuquerque District.

11. **Endangered Species.**

(a) No activity is authorized under any NWP which is likely to jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act, or which is likely to destroy or adversely modify the critical habitat of such species. Non-federal permittees shall notify the District Engineer if any listed species or critical habitat might be affected or is in the vicinity of the project, and shall not begin work on the activity until notified by the District Engineer that the requirements of the Endangered Species Act have been satisfied and that the activity is authorized.

(b) Authorization of an activity by a nationwide permit does not authorize the "take" of a threatened or endangered species as defined under the Federal Endangered Species Act. In the absence of separate authorization (e.g., an ESA section 10 Permit, a Biological Opinion with "incidental take" provisions, etc.) from the U.S. Fish and Wildlife Service or the National Marine Fisheries Service, both lethal and non-lethal "takes" of protected species are in violation of the Endangered Species Act. Information on the location of threatened and endangered species and their critical habitat can be obtained directly from the offices of the U.S. Fish and Wildlife Service and National Marine Fisheries Service or their world wide web pages at <http://www.fws.gov/~r9endspp/endspp.html> and http://kingfish.ssp.mnls.gov/mcnltyr/prot_res.html respectively.

12. **Historic Properties.** No activity which may affect historic properties listed, or eligible for listing, in the National Register of Historic Places is authorized, until the DE has complied with the provisions of 33 CFR part 325, appendix C. The prospective permittee must notify the District Engineer if the authorized activity may affect any historic properties listed, determined to be eligible, or which the prospective permittee has reason to believe may be eligible for listing on the National Register of Historic Places, and shall not begin the activity until notified by the District Engineer that the requirements of the National Historic Preservation Act have been satisfied and that the activity is authorized. Information on the location and existence of historic resources can be obtained from the State Historic Preservation Office and the National Register of Historic Places (see 33 CFR 330.4(g)).

13. **Notification:**

(a) **Timing.** Where required by the terms of the NWP, the prospective permittee must notify the District Engineer with a Pre-Construction Notification (PCN) as early as possible and shall not begin the activity:

(1) Until notified by the District Engineer that the activity may proceed under the NWP with any special conditions imposed by the District or Division Engineer; or

(2) If notified by the District or Division Engineer that an individual permit is required; or

(3) Unless 30 days (or 45 days for NWP 26 only) have passed from the District Engineer's receipt of the notification and the prospective permittee has not received notice from the District or Division Engineer. Subsequently, the permittee's right to proceed under the NWP may be modified, suspended, or revoked only in accordance with the procedure set forth in 33 CFR 330.5(d)(2).

(b) **Contents of Notification.** The notification must be in writing and include the following information:

(1) Name, address and telephone numbers of the prospective permittee;

(2) Location of the proposed project;

(3) Brief description of the proposed project; the project's purpose; direct and indirect adverse environmental effects the project would cause; any other NWP(s), regional general permit(s) or individual permit(s) used or intended to be used to authorize any part of the proposed project or any related activity; and

(4) For NWPs 14, 18, 21, 26, 29, 34, and 38, the PCN must also include a delineation of affected special aquatic sites, including wetlands (see paragraph 13(f));

(5) For NWP 21--Surface Coal Mining Activities, the PCN must include an OSM or state approved mitigation plan.

(6) For NWP 29--Single-Family Housing, the PCN must also include:

(i) Any past use of this NWP by the individual permittee and/or the permittee's spouse;

(ii) A statement that the single-family housing activity is for a personal residence of the permittee;

(iii) A description of the entire parcel, including its size, and a delineation of wetlands. For the purpose of this NWP, parcels of land measuring 0.5 acre or less will not require a formal on-site delineation. However, the applicant shall provide an indication of where the wetlands are and the amount of wetlands that exists on the property. For parcels greater than 0.5 acre in size, a formal wetland delineation must be prepared in accordance with the current method required by the Corps. (See paragraph 13(i));

(iv) A written description of all land (including, if available, legal descriptions) owned by the prospective permittee and/or the prospective permittee's spouse, within a one mile radius of the parcel, in any form of ownership (including any land owned as a partner, corporation, joint tenant, co-tenant, or as a tenant-by-the-entirety) and any land on which a purchase and sale agreement or other contract for sale or purchase has been executed;

(7) For NWP 31--Maintenance of Existing Flood Control Projects, the prospective permittee must either notify the District Engineer with a Pre-Construction Notification (PCN) prior to each maintenance activity or submit a five year (or less) maintenance plan. In addition, the PCN must include all of the following:

(i) Sufficient baseline information so as to identify the approved channel depths and configurations and existing facilities. Minor deviations are authorized, provided that the approved flood control protection or drainage is not increased;

(ii) A delineation of any affected special aquatic sites, including wetlands; and,

(iii) Location of the dredged material disposal site.

(8) For NWP 33--Temporary Construction, Access, and Dewatering, the PCN must also include a restoration plan of reasonable measures to avoid and minimize adverse effects to aquatic resources.

(c) *Form of Notification.* The standard individual permit application form (Form ENG 4345) may be used as the notification but must clearly indicate that it is a PCN and must include all of the information required in (b) (1)-(7) of General Condition 13. A letter may also be used.

(d) *District Engineer's Decision.* In reviewing the pre-construction notification for the proposed activity, the District Engineer will determine whether the activity authorized by the NWP will result in more than minimal individual or cumulative adverse environmental effects or may be contrary to the public interest. The prospective permittee may, optionally, submit a proposed mitigation plan with the pre-construction notification to expedite the process and the District Engineer will consider any optional mitigation the applicant has included in the proposal in determining whether the net adverse environmental effects of the proposed work are minimal. If the District Engineer determines that the activity complies with the terms and conditions of the NWP and that the adverse effects are minimal, the District Engineer will notify the permittee and include any conditions the DE deems necessary.

Any mitigation proposal must be approved by the District Engineer prior to commencing work. If the prospective permittee elects to submit a mitigation plan, the District Engineer will expeditiously review the proposed mitigation plan, but will not commence a second 30-day (or 45-day for NWP 26) notification procedure. If the net adverse effects of the project (with the mitigation proposal) are determined by the District Engineer to be minimal, the District Engineer will provide a timely written response to the applicant stating that the project can proceed under the terms and conditions of the nationwide permit.

If the District Engineer determines that the adverse effects of the proposed work are more than minimal, then he will notify the applicant either: (1) That the project does not qualify for authorization under the NWP and instruct the applicant on the procedures to seek authorization under an individual permit; (2) that the project is authorized under the NWP subject to the applicant's submitting a mitigation proposal that would reduce the adverse effects to the minimal level; or (3) that the project is authorized under the NWP with specific modifications or conditions.

(e) *Agency Coordination.* The District Engineer will consider any comments from Federal and State agencies concerning the proposed activity's compliance with the terms and conditions of the NWPs and the need for mitigation to reduce the project's adverse environmental effects to a minimal level.

[Note: Paragraphs (e)(i), (ii), (iii) of the NWP Final Notice (61 FR 65921) are deleted here for brevity. These paragraphs provide specifics regarding the Corps' internal coordination with agencies.]

(i) *Wetlands Delineations.* Wetland delineations must be prepared in accordance with the current method required by the Corps. For NWP 29 see paragraph (b)(6)(iii) for parcels less than 0.5 acres in size. The

permittee may ask the Corps to delineate the special aquatic site. There may be some delay if the Corps does the delineation. Furthermore, the 30-day period (45 days for NWP 26) will not start until the wetland delineation has been completed and submitted to the Corps, where appropriate.

(g) *Mitigation.* Factors that the District Engineer will consider when determining the acceptability of appropriate and practicable mitigation include, but are not limited to:

(i) To be practicable, the mitigation must be available and capable of being done considering costs, existing technology, and logistics in light of the overall project purposes;

(ii) To the extent appropriate, permittees should consider mitigation banking and other forms of mitigation including contributions to wetland trust funds, "in lieu fees" to organizations such as The Nature Conservancy, state or county natural resource management agencies, where such fees contribute to the restoration, creation, replacement, enhancement, or preservation of wetlands. Furthermore, examples of mitigation that may be appropriate and practicable include but are not limited to: Reducing the size of the project; establishing wetland or upland buffer zones to protect aquatic resource values; and replacing the loss of aquatic resource values by creating, restoring, and enhancing similar functions and values. In addition, mitigation must address wetland impacts, such as functions and values, and cannot be simply used to offset the acreage of wetland losses that would occur in order to meet the acreage limits of some of the NWPs (e.g., for NWP 26, 5 acres of wetlands cannot be created to change a 6-acre loss of wetlands to a 1 acre loss; however, 2 created acres can be used to reduce the impacts of a 3-acre loss.).

14. *Compliance Certification.* Every permittee who has received a Nationwide permit verification from the Corps will submit a signed certification regarding the completed work and any required mitigation. The certification will be forwarded by the Corps with the authorization letter and will include: a. A statement that the authorized work was done in accordance with the Corps authorization, including any general or specific conditions; b. A statement that any required mitigation was completed in accordance with the permit conditions; c. The signature of the permittee certifying the completion of the work and mitigation.

15. *Multiple Use of Nationwide Permits.* In any case where any NWP number 12 through 40 is combined with any other NWP number 12 through 40, as part of a single and complete project, the permittee must notify the District Engineer in accordance with paragraphs a, b, and c on the "Notification" General Condition number 13. Any NWP number 1 through

11 may be combined with any other NWP without notification to the Corps, unless notification is otherwise required by the terms of the NWPs. As provided at 33 CFR 330.6(c) two or more different NWPs can be combined to authorize a single and complete project. However, the same NWP cannot be used more than once for a single and complete project.

Section 404 Only Conditions: In addition to the General Conditions, the following conditions apply only to activities that involve the discharge of dredged or fill material into waters of the U.S., and must be followed in order for authorization by the NWPs to be valid:

1. **Water Supply Intakes.** No discharge of dredged or fill material may occur in the proximity of a public water supply intake except where the discharge is for repair of the public water supply intake structures or adjacent bank stabilization.

2. **Shellfish Production.** No discharge of dredged or fill material may occur in areas of concentrated shellfish production, unless the discharge is directly related to a shellfish harvesting activity authorized by NWP 4.

3. **Suitable Material.** No discharge of dredged or fill material may consist of unsuitable material (e.g., trash, debris, car bodies, asphalt, etc.) and material discharged must be free from toxic pollutants in toxic amounts (see section 307 of the Clean Water Act).

4. **Mitigation.** Discharges of dredged or fill material into waters of the United States must be minimized or avoided to the maximum extent practicable at the project site (i.e., on-site), unless the District Engineer approves a compensation plan that the District Engineer determines is more beneficial to the environment than on-site minimization or avoidance measures.

5. **Spawning Areas.** Discharges in spawning areas during spawning seasons must be avoided to the maximum extent practicable.

6. **Obstruction of High Flows.** To the maximum extent practicable, discharges must not permanently restrict or impede the passage of normal or expected high flows or cause the relocation of the water (unless the primary purpose of the fill is to impound waters).

7. **Adverse Effects From Impoundments.** If the discharge creates an impoundment of water, adverse effects on the aquatic system caused by the accelerated passage of water and/or the restriction of its flow shall be minimized to the maximum extent practicable.

8. **Waterfowl Breeding Areas.** Discharges into breeding areas for migratory waterfowl must be avoided to the maximum extent practicable.

9. **Removal of Temporary Fills.** Any temporary fills must be removed in their entirety and the affected areas returned to their preexisting elevation.

[Excerpted from the December 13, 1996 Federal Register, Final Notice of Issuance, Reissuance, and Modification of Nationwide Permits (61 FR 65874)].

CONDITIONS, LIMITATIONS, AND RESTRICTIONS (Information from 33 CFR 330.4)

1. **General.** A prospective permittee must satisfy all terms and conditions of an NWP for a valid authorization to occur. Some conditions identify a "threshold" that, if met, requires additional procedures or provisions contained in other paragraphs in this section. It is important to remember that the NWP's only authorize activities from the perspective of the Corps regulatory authorities and that other Federal, state, and local permits, approvals, or authorizations may also be required.

2. Further Information:

(a) District Engineers have authority to determine if an activity complies with the terms and conditions of a NWP.

(b) NWP's do not obviate the need to obtain other Federal, state, or local permits, approvals, or authorization required by law.

(c) NWP's do not grant any property rights or exclusive privileges.

(d) NWP's do not authorize any injury to the property or rights of others.

(e) NWP's do not authorize interference with any existing or proposed Federal project.

ADDITIONAL INFORMATION

For additional information concerning the nationwide permits or for a written determination regarding a specific project, please contact the office below:

In New Mexico:

Chief, Regulatory Branch
Albuquerque District, US Army Corps of Engineers
4101 Jefferson Plaza, N.E., Room 313
Albuquerque, NM 87109-3435
Telephone: (505) 342-3283
E-Mail: ceswa-od-r@usace.army.mil

In southeastern Colorado:

Southern Colorado Project Office
720 North Main Street, Room 205
Pueblo, Colorado 81003-3046
Telephone: (719) 543-9459

In southern New Mexico and western Texas:

El Paso Regulatory Office
P.O. Box 6096
Ft. Bliss, Texas 79906-0096
Telephone: (915) 568-1359

Information about the U.S. Army Corps of Engineers regulatory program, including nationwide permits, may also be accessed on our Internet page:
<http://www.swa.usace.army.mil/reg/>

This nationwide permit is effective February 11, 1997 and expires on February 11, 2002, unless sooner modified, suspended, or revoked.

Summary Version: 2/20/97

**WATER QUALITY CERTIFICATION INFORMATION SUMMARY
FOR NATIONWIDE PERMIT USE IN THE ALBUQUERQUE DISTRICT**

Section 401 water quality certification for nationwide permits (NWPs) in the Albuquerque District has been variously issued, waived, denied, or conditioned by certifying agencies. Review the following list to determine the status of water quality certification for the type of NWP and area of use. This list is a summary of information received from the certifying agencies; the specific requirements are available in each agency's water quality certification. You must obtain any required individual water quality certification from the appropriate water quality certification authority for your project area prior to construction under the specified nationwide permits:

State of Colorado. Water quality certification for all nationwide permits is issued by State of Colorado statute.

State of New Mexico. Issued unconditional certification for NWPs 20, 22, 27, 30, 38, and "Incidental" discharges under NWP 18 (e.g., *de minimus* discharges). Conditional certification is issued for NWPs 3-7, 12-19, 21, 23, 25-26, 28-29, 31-37, and 40. If your project is in or near a perennial surface water, perennial reach of an interrupted or intermittent surface water, or wetland greater than 1/3 acre, you must obtain individual water quality certification from the New Mexico Environment Department to use these conditionally certified NWPs. Any use of NWP 18 exceeding 1/10 cu yd will require an individual water quality certification. NWP 12 is further conditioned requiring all utility lines to be installed perpendicular or as close to perpendicular as possible to a channel to minimize disturbance; any crossing of wetlands or streams must be justified and alternatives explored to avoid construction or maintenance in waters of the State; and the project must be restored to pre-construction contours and stabilized with native vegetation. Contact:

New Mexico Environment Department
Surface Water Quality Bureau
Harold Runnels Building, 1190 St. Francis Drive
P.O. Box 26110
Santa Fe, New Mexico 87502 Phone: (505) 827-0106

State of Texas. Issued conditional water quality certification (Standard Provisions) for all NWP use in Texas. Additional Conditions are included for NWPs 3, 7, 13, 16, 19, 26, 31, and 35. Copies of the conditions may be obtained from the Albuquerque District or from the Texas Natural Resource Conservation Commission. Contact:

Texas Natural Resource Conservation Commission
P.O. Box 13087
Austin, Texas 78711-3087 Phone: (512) 239-1000

Pueblo of Sandia lands. Requires individual water quality certification for use of any nationwide permit on tribal lands. Contact:

Environmental Director
Pueblo of Sandia
Box 6008
Bernalillo, New Mexico 87004 Phone: (505) 867-4533

Santa Clara Pueblo lands. Water quality certification is denied without prejudice for NWPs 6-7, 12-14, 18-19, 23, 25-26, 29, 30, 33, 36, and 40. You must obtain an individual water quality certification for your project to use these NWPs on Pueblo lands. Contact:

Santa Clara Pueblo - Office of Environmental Affairs
Surface Water Division
P.O. Box 580
Española, New Mexico 87532 Phone: (505) 753-7326, ext. 23.

Picuris Pueblo lands. Requires individual water quality certification for use of any nationwide permit on Pueblo lands. Contact:

Environment Department
Picuris Pueblo
P.O. Box 127
Penasco, New Mexico 87553 Phone: (505) 587-2519

San Juan Pueblo lands. Requires individual water quality certification for use of any nationwide permit on Pueblo lands. Contact:

Office of Environmental Affairs
San Juan Pueblo
P.O. Box 1099
San Juan Pueblo, New Mexico 87566 Phone: (505) 852-4212

Pueblo of Isleta lands. Water quality certification for all NWPs is denied.

You must obtain an individual water quality certification to use any NWP on Pueblo lands. Contact:

Water Quality Program
Pueblo of Isleta
P.O. Box 1270
Isleta, New Mexico 87022 Phone: (505) 869-2710

Nambe Pueblo lands. Water quality certification for all NWPs is denied. You must obtain an individual water quality certification to use any NWP on Pueblo lands. Contact:

U.S. Department of Environment and Natural Resources
Route 1, P.O. Box 117BB
Nambé Pueblo, New Mexico 87501 Phone: (505) 455-2036

Pojoaque Pueblo lands. No certification information received. The Corps of Engineers considers that water quality certification is waived for NWP use on Pojoaque Pueblo lands; however, you must contact the Pueblo prior to conducting work on Pueblo lands. Contact:

Environmental Officer
Pojoaque Pueblo
Route 11, Box 71
Santa Fe, New Mexico 87501 Phone: (505) 455-3383

Tribal lands in Colorado, certifying agency: EPA, Region 8 (Note: EPA certifies projects on tribal lands in Colorado where the tribe does not have water quality certifying authority). EPA waived certification of NWPs 3-6, 14-15, 19-23, 25, 27, 29-30, 32, 34, 36-38, and 40. EPA, Region 8, has denied certification of NWPs 7, 12-13, 16-18, 26, 31, and 33. Individual water quality certification for use of these NWPs must be obtained from the EPA, Region 8. Contact:

U.S. Environmental Protection Agency, Region 8
Ecosystems Protection Program
999 18th Street, Suite 500
Denver, Colorado 80202-2466 Phone: (303) 312-6192

Tribal lands in New Mexico, certifying agency: EPA, Region 6 (Note: EPA certifies projects on tribal lands in New Mexico where the tribe does not have water quality certifying authority). Issued water quality certification for NWPs 3-4, 6-7, 13-18, 20-21, 23, 27, 30-32, 35-38, and 40. Water quality certification is denied without prejudice for all activities under NWPs 12, 25-26, and 29. Certification is denied for sand and gravel dredging, mining, and excavation under NWP 19. In addition, certification is denied under NWP 33 for activities resulting in the temporary loss of more than 1 acre of special aquatic sites, including wetlands. You must obtain individual water quality certification to use any NWP where water quality certification is denied without prejudice. Contact:

U.S. Environmental Protection Agency, Region 6
Ecosystems Protection Branch
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733 Phone: (214) 665-6694

Navajo Nation, certifying agency: EPA, Region 9. Water quality certification for all NWPs is denied without prejudice. You must obtain an individual water quality certification to use any NWP on Navajo Nation lands. Contact:

U.S. Environmental Protection Agency, Region 9
Water Division
75 Hawthorne Street
San Francisco, California 94105-3901 Phone: (415) 744-1967

General Information regarding Section 401 water quality certification and Section 404 permit requirements may be obtained from:

Chief, Regulatory Branch
Albuquerque District, U.S. Army Corps of Engineers
4101 Jefferson Plaza, NE, Room 302
Albuquerque, New Mexico 87109-3435
Phone: (505) 342-3283

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WQ Summary Version: 4/15/97

METRIC
Corporation ENVIRONMENTAL ENGINEERING AND SCIENCE

8429 WASHINGTON PLACE NE, SUITE A
ALBUQUERQUE, NEW MEXICO 87113
Phone: (505) 828-2801
Fax: (505) 828-2803

August 6, 1997

Ms. Debbie O'Callaghan
PNM Gas Services
4625 Edith NE
Albuquerque, NM 87107

Dear Debbie:

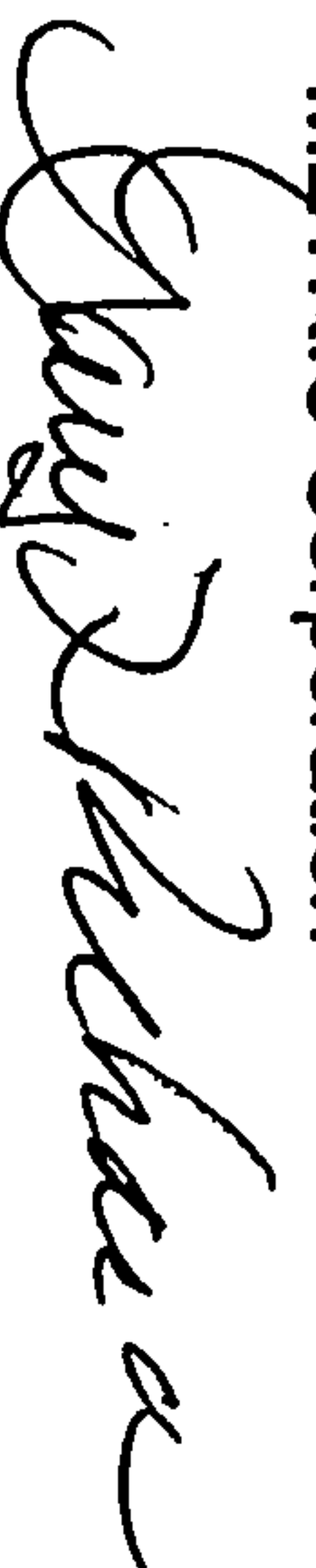
Enclosed are 5 copies of our report "Scour Investigation for Proposed 6-inch Gas Line Crossing of Tijeras Arroyo" for your review. If you have any comments, please return all 5 copies and we will make changes to all copies. If the report is acceptable, you can use the 5 copies as finals.

We have discussed the analysis results with John Kelley (engineer with AMAFCA), and we believe the results are acceptable to him.

If you have any questions or comments, please contact us.

Sincerely,

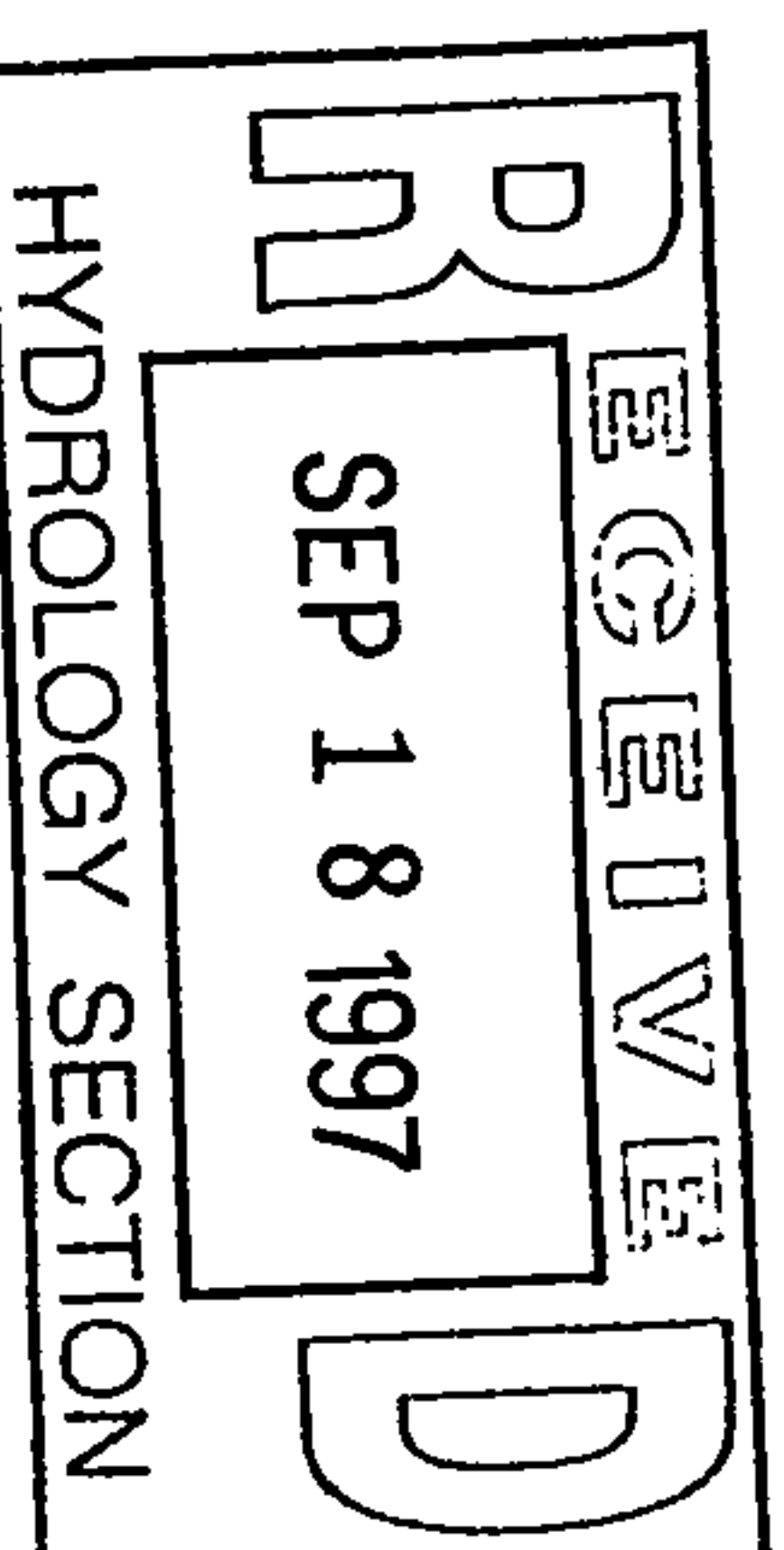
METRIC Corporation



Gary L. Richardson, P.E.
Executive Vice President

GLR/rkh

Enclosures



**SCOUR INVESTIGATION FOR
PROPOSED 6-INCH GAS LINE CROSSING
OF TIJERAS ARROYO
AT SOUTH END OF JUAN TABO BLVD.
ALBUQUERQUE, NEW MEXICO**

PREPARED FOR

**PUBLIC SERVICE COMPANY OF NEW MEXICO
GAS SERVICES
ALBUQUERQUE, NEW MEXICO**

PREPARED BY

**METRIC CORPORATION
ALBUQUERQUE, NEW MEXICO**

AUGUST 1997

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INTRODUCTION

Public Service Company of New Mexico (PNM) Gas Services has proposed crossing Tijeras Arroyo at the south end of Juan Tabo Blvd. in southeast Albuquerque, New Mexico with a 6 inch diameter polyethylene natural gas pipeline. The purpose of the proposed gas line is to provide a second gas feed to the Four Hills neighborhood to alleviate low gas pressure problems experienced in the past.

The proposed gas line would be installed in a City of Albuquerque drainage and utility easement extending from the south end of Juan Tabo Blvd. to the west end of Via Posada in Four Hills (see FIGURE 1). The gas line would be installed along the west and south edge of the easement.

PNM Gas Services has contracted with METRIC Corporation to conduct a scour analysis to estimate the depth to which the gas line should be buried to avoid being damaged by erosional scour in Tijeras Arroyo.

At the proposed gas line crossing location, Tijeras Arroyo is an unlined natural channel with a drainage area exceeding 100 square miles.

The proposed gas line crossing does not cross any formal Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) right-of-way. However, it does cross a FEMA designated flood plain, and as a result, City of Albuquerque approval will probably be required. It is likely the City of Albuquerque will request AMAFCA review of the gas line crossing design.

ANALYSIS CRITERIA

Since it is likely that AMAFCA review will be sought, AMAFCA criteria were used for the scour analysis.

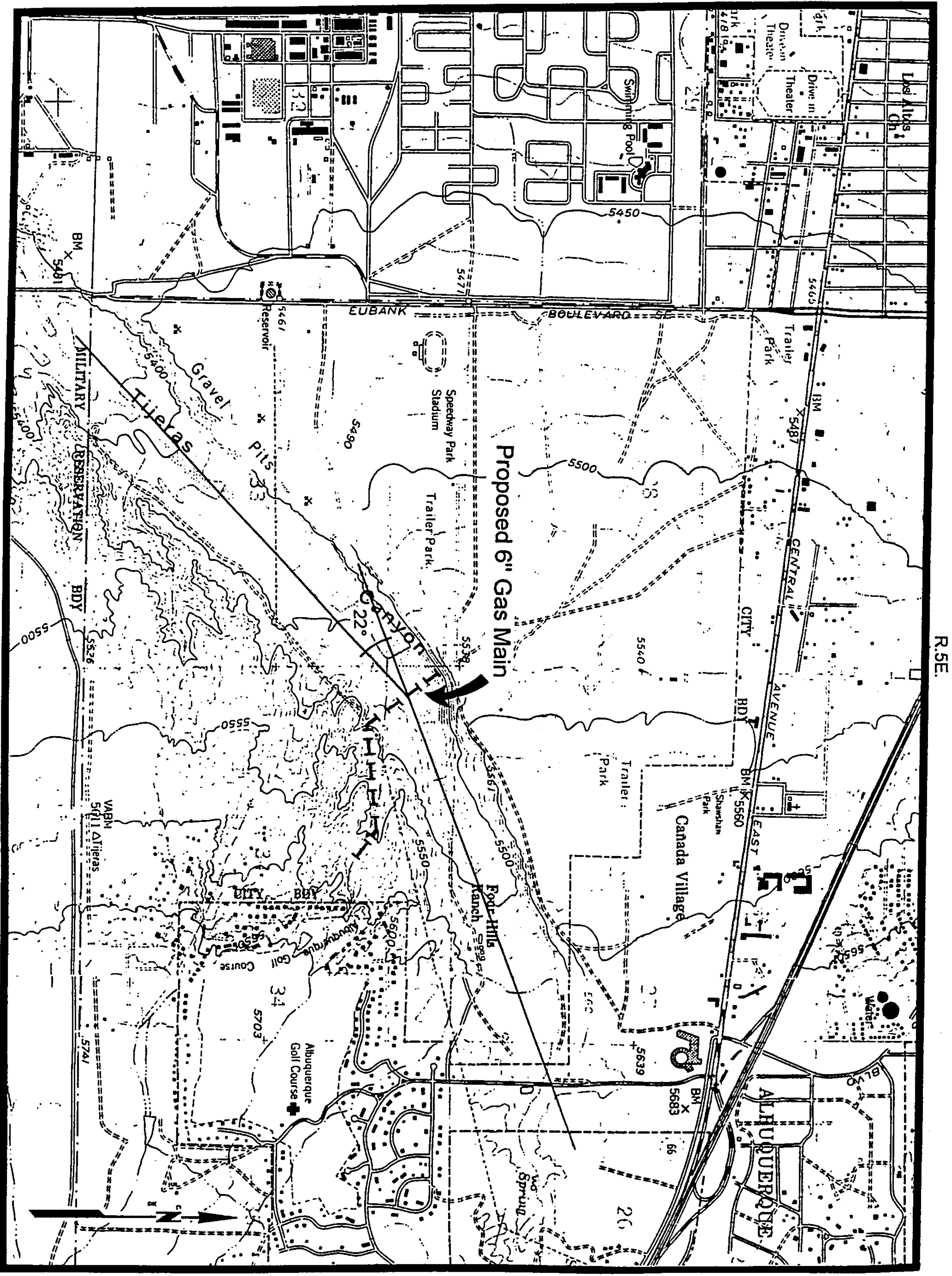


FIGURE 1

LOCATION MAP OF PROPOSED TIJERAS ARROYO
GAS LINE CROSSING

The Leeds-Hill-Herkenhoff, Inc. report dated January 1994 entitled "Tijeras Arroyo Bank Stabilization at South Eubank Landfill Final Report", contains a detailed discussion of expected 100 year peak flows. The South Eubank Landfill Stabilization project is located just downstream from the proposed gas line crossing, and as a result, the peak flow used for the Landfill Stabilization is applicable to the gas line crossing. For this analysis, a 100 year peak flow of 24,860 CFS was used. This flow includes 10% sediment bulking.

The AMAFCA "Design and Policy Guide for Utility Crossings of Flood Control Channels" dated May 1983 indicates the preferred clearance (bury depth) between unlined channel bottom and the top of a buried conduit is 5 feet. The procedures presented in the AMAFCA "Sediment and Erosion Design Guide" dated November 1994 were used for the scour analysis.

HYDRAULIC ANALYSIS

As shown in FIGURE 1, the slope and cross section of Tijeras Arroyo are quite uniform throughout the reach where the gas line crossing is contemplated. As a result, uniform flow was assumed for the reach and Manning's equation was used to generate a stage discharge curve.

A cross section of Tijeras Arroyo at the gas line crossing location was generated using a local datum and an engineering level survey (see FIGURE 2). The average channel slope was measured as 1% from the Albuquerque East 7 ½ minute USGS Quadrangle Map. Based on visual observation, Manning's n was chosen as 0.032. The Manning's calculations are presented in APPENDIX A, and the resulting stage discharge curve is presented as FIGURE 3. The maximum depth of flow during passage of the 10-year peak flow is 6.8 feet at Point A on FIGURE 3.

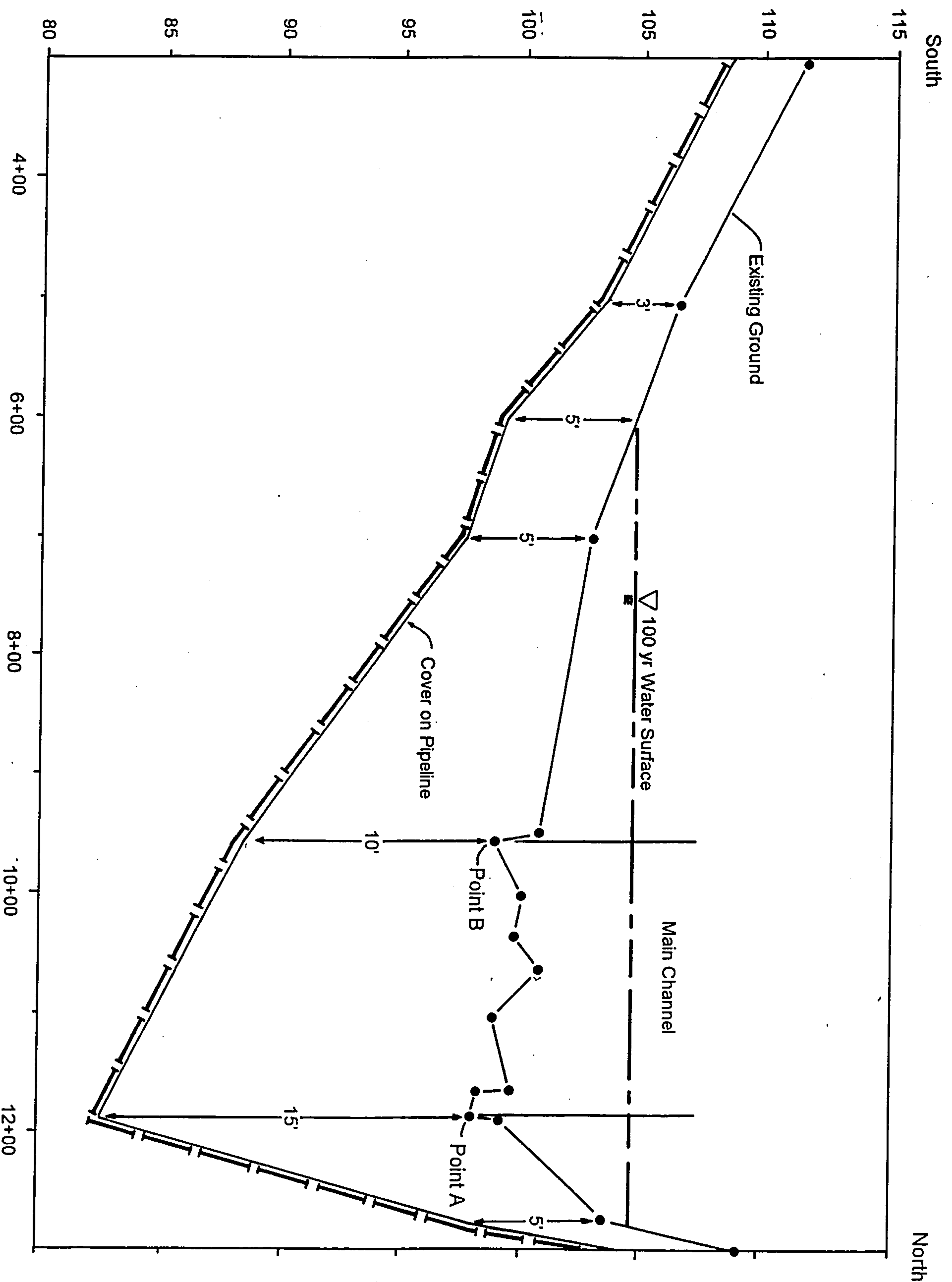


FIGURE 2

CROSS SECTION OF TIJERAS ARROYO
AT GAS LINE CROSSING

The average Froude number for the 100 year peak is:

$$Y_1 = \frac{A}{P_w} = \frac{2340.56}{677.26} = 3.46 \text{ ft.}$$

$$F_r = \frac{V}{\sqrt{gY_1}} = \frac{10.64}{\sqrt{32.2 \times 3.46}} = 1.01$$

The Froude number along the north bank of the arroyo at Point A (FIGURE 2) can be calculated using the depth of flow at that point of 6.8 ft.

$$V = \frac{1.49 R^{2/3} S^{1/2}}{n} = \frac{1.49}{0.032} (6.8)^{2/3} (0.010)^{1/2} = 16.7 \text{ fps}$$

$$F_r = \frac{16.7}{\sqrt{32.2 \times 6.8}} = 1.13$$

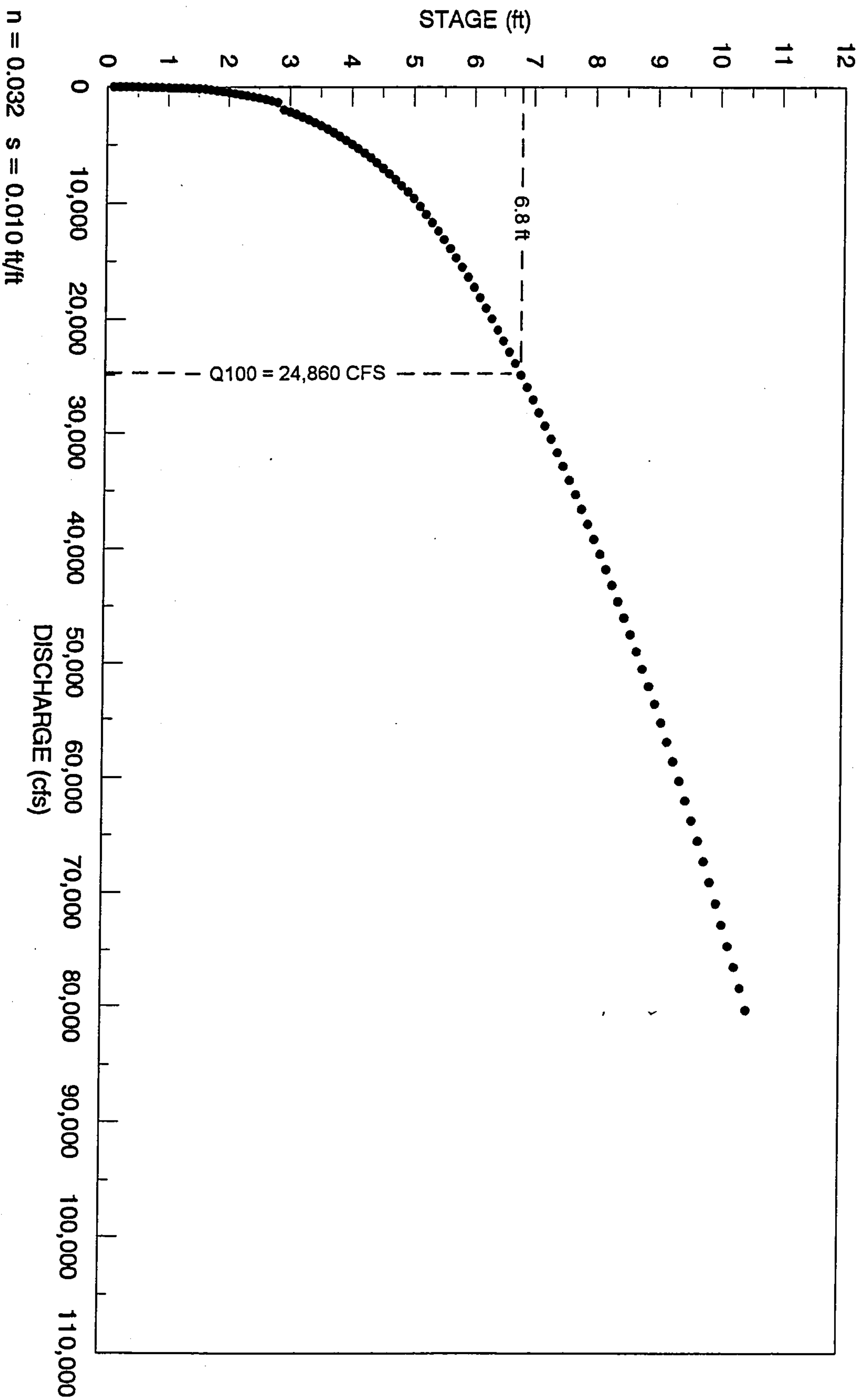
Thus, the average flow is near critical flow and near the north bank the flow is in the supercritical range.

SCOUR ANALYSIS

An evaluation of the scour potential at the gas line crossing location suggests that long term changes in the channel profile are not anticipated since large scale development in the watershed is not anticipated. Likewise, contraction scour caused by constriction of the flood plain is not anticipated since bridges or other constrictions are not planned in the vicinity of the gas line crossing. The effects of the channel bend (see FIGURE 1) are considered in the impingement term as described below.

The effects of local scour can be evaluated using equation 3.90 from the AMAFCA Sediment Erosion and Design Guide, November 1994.

FIGURE 3
 PNM GAS COMPANY
 TIJERAS ARROYO CROSSING AT JUAN TABO
 STAGE/DISCHARGE GRAPH



Equation 3.90 considers scour effects resulting from acceleration of flow caused by reduced roughness along a flood wall, antidune scour, and impingement of flow on the bank as follows:

$$\frac{Y_s}{Y_1} = \underbrace{\text{acceleration along flood wall}}_{0.73 \cos \theta} + \underbrace{\text{antidune}}_{0.14\pi F_r^2 \cos \theta} + \underbrace{\text{impingement}}_{4 F_r^{0.33} \sin \theta}$$

Since a flood wall or other bank armoring is not anticipated, the first term can be eliminated as follows:

$$Y_s = 0.14\pi F_r^2 \cos \theta + 4F_r^{0.33} \sin \theta$$

Using a maximum depth of flow of 6.8 ft at Point A (FIGURE 2), a maximum Froude Number at 1.13, and an impingement angle of 22° yields:

$$\frac{Y_s}{Y_1} = 0.14\pi(1.13)^2 \cos 22^\circ + 4(1.13)^{0.33} \sin 22^\circ = 0.52 + 1.56 = 2.08$$

$$Y_s = 2.08 Y_1 = 2.08(6.8) = 14.15 \text{ ft.}$$

Thus the maximum anticipated scour at the gas line crossing is 14.15 ft. at Point A (FIGURE 2) along the north bank of the arroyo. Since the pilot channel presently at Point A could move anywhere within main channel, similar antidune scour and somewhat reduced impingement scour could occur at Point B (FIGURE 2).

RECOMMENDATIONS

Based on the scour analysis discussed above, it is recommended that the gas line be

buried with 15 feet of cover at Point A, near the north bank of the arroyo, reducing to 10 feet of cover at Point B, at the south edge of the main channel, as shown on FIGURE 2. Within the 100-year flood plain the minimum cover should be 5 feet reducing to 3 feet of cover beyond the flood plain.

APPENDIX A

STAGE/DISCHARGE CURVE
PNM GAS COMPANY
TIJERAS ARROYO

STAGE/DISCHARGE CURVE
 PNM GAS COMPANY
 TIJERAS ARROYO

PREDICTION POINT CROSSING AT JUAN TABO

DATE 07-25-1997
 MANNINGS N = .032
 CHANNEL SLOPE= .01

ELEVATION (ft)	STAGE (ft)	DISCHARGE (cfs)	WP ft	AREA ft^2	VELOCITY (fps)	CRIT Q (cfs)
98.00	0.10	0.34	10.77	0.54	0.63	0.68
98.10	0.20	2.15	21.54	2.15	1.00	3.86
98.20	0.30	6.80	21.93	4.32	1.58	10.89
98.30	0.40	13.34	22.32	6.51	2.05	20.04
98.40	0.50	21.55	22.72	8.74	2.46	30.95
98.50	0.60	31.26	23.11	11.01	2.84	43.39
98.60	0.70	42.38	23.50	13.30	3.19	57.24
98.70	0.80	54.83	23.89	15.63	3.51	72.40
98.80	0.90	68.56	24.28	17.99	3.81	88.79
98.90	1.00	83.52	24.68	20.38	4.10	106.35
99.00	1.10	99.67	25.07	22.80	4.37	125.04
99.10	1.20	116.97	25.46	25.26	4.63	144.83
99.20	1.30	130.62	27.49	27.83	4.69	161.16
99.30	1.40	145.88	29.53	30.60	4.77	179.27
99.40	1.50	162.81	31.56	33.56	4.85	199.20
99.50	1.60	181.48	33.59	36.72	4.94	221.00
99.60	1.70	262.63	115.21	75.05	3.50	345.10
99.70	1.80	326.15	119.33	86.68	3.76	420.81
99.80	1.90	396.03	123.45	98.72	4.01	502.79
99.90	2.00	472.27	127.57	111.17	4.25	590.99
100.00	2.10	554.92	131.70	124.03	4.47	685.41
100.10	2.20	644.02	135.82	137.31	4.69	786.05
100.20	2.30	739.63	139.94	151.00	4.90	892.92
100.30	2.40	841.82	144.06	165.09	5.10	1006.05
100.40	2.50	950.66	148.18	179.60	5.29	1125.47
100.50	2.60	1066.22	152.31	194.52	5.48	1251.21
100.60	2.70	1188.59	156.43	209.86	5.66	1383.33
100.70	2.80	1317.85	160.55	225.60	5.84	1521.86
100.80	2.90	1952.92	270.05	351.69	5.55	2283.47
100.90	3.00	2141.24	284.00	379.23	5.65	2492.90
101.00	3.10	2344.20	297.96	408.17	5.74	2717.24
101.10	3.20	2562.25	311.92	438.50	5.84	2956.84
101.20	3.30	2795.80	325.87	470.22	5.95	3212.02
101.30	3.40	3045.31	339.83	503.34	6.05	3483.13
101.40	3.50	3311.20	353.79	537.86	6.16	3770.47
101.50	3.60	3593.89	367.75	573.77	6.26	4074.37
101.60	3.70	3893.82	381.70	611.07	6.37	4395.16
101.70	3.80	4211.41	395.66	649.78	6.48	4733.13
101.80	3.90	4547.08	409.62	689.87	6.59	5088.62
101.90	4.00	4901.25	423.58	731.37	6.70	5461.91

PREDICTION POINT CROSSING AT JUAN TABO CONTINUED

ELEVATION (ft)	STAGE (ft)	DISCHARGE (cfs)	WP ft	AREA ft ²	VELOCITY (fps)	CRIT Q (cfs)
102.00	4.10	5274.34	437.53	774.25	6.81	5853.32
102.10	4.20	5666.77	451.49	818.54	6.92	6263.13
102.20	4.30	6078.92	465.45	864.22	7.03	6691.65
102.30	4.40	6511.23	479.41	911.29	7.15	7139.17
102.40	4.50	6964.08	493.36	959.76	7.26	7605.97
102.50	4.60	7437.88	507.32	1009.63	7.37	8092.34
102.60	4.70	7933.02	521.28	1060.89	7.48	8598.55
102.70	4.80	8449.90	535.23	1113.54	7.59	9124.88
102.80	4.90	8988.90	549.19	1167.59	7.70	9671.60
102.90	5.00	9550.41	563.15	1223.04	7.81	10238.98
103.00	5.10	10209.05	570.45	1279.55	7.98	10886.20
103.10	5.20	10888.81	577.75	1336.79	8.15	11550.94
103.20	5.30	11589.70	585.05	1394.76	8.31	12233.15
103.30	5.40	12311.77	592.35	1453.46	8.47	12932.84
103.40	5.50	13055.12	599.65	1512.89	8.63	13650.04
103.50	5.60	13839.04	605.62	1572.98	8.80	14399.72
103.60	5.70	14644.23	611.59	1633.66	8.96	15166.38
103.70	5.80	15470.69	617.56	1694.95	9.13	15949.97
103.80	5.90	16318.45	623.53	1756.83	9.29	16750.49
103.90	6.00	17187.51	629.50	1819.30	9.45	17567.89
104.00	6.10	18077.91	635.47	1882.37	9.60	18402.16
104.10	6.20	18989.70	641.44	1946.04	9.76	19253.31
104.20	6.30	19922.88	647.41	2010.30	9.91	20121.29
104.30	6.40	20877.51	653.38	2075.16	10.06	21006.14
104.40	6.50	21853.63	659.35	2140.62	10.21	21907.83
104.50	6.60	22851.30	665.32	2206.67	10.36	22826.39
104.60	6.70	23870.54	671.29	2273.32	10.50	23761.79
104.70	6.80	24911.42	677.26	2340.56	10.64	24714.06
104.80	6.90	25974.00	683.23	2408.40	10.78	25683.22
104.90	7.00	27058.32	689.20	2476.83	10.92	26669.26
105.00	7.10	28164.44	695.17	2545.86	11.06	27672.21
105.10	7.20	29292.45	701.14	2615.49	11.20	28692.10
105.20	7.30	30442.37	707.11	2685.72	11.33	29728.92
105.30	7.40	31614.29	713.08	2756.53	11.47	30782.70
105.40	7.50	32808.27	719.05	2827.95	11.60	31853.48
105.50	7.60	34024.39	725.02	2899.96	11.73	32941.27
105.60	7.70	35262.70	730.99	2972.57	11.86	34046.10
105.70	7.80	36523.28	736.96	3045.77	11.99	35168.00
105.80	7.90	37806.20	742.93	3119.57	12.12	36306.98
105.90	8.00	39111.55	748.90	3193.97	12.25	37463.11
106.00	8.10	40439.36	754.87	3268.96	12.37	38636.36
106.10	8.20	41789.76	760.84	3344.55	12.49	39826.82
106.20	8.30	43162.79	766.81	3420.73	12.62	41034.50
106.30	8.40	44558.54	772.78	3497.51	12.74	42259.43
106.40	8.50	45977.11	778.75	3574.88	12.86	43501.66
106.50	8.60	47418.53	784.72	3652.85	12.98	44761.19
106.60	8.70	48944.81	789.15	3731.34	13.12	46081.70
106.70	8.80	50493.89	793.57	3810.28	13.25	47418.74
106.80	8.90	52065.65	798.00	3889.65	13.39	48772.22
106.90	9.00	53660.16	802.43	3969.47	13.52	50142.16

2100

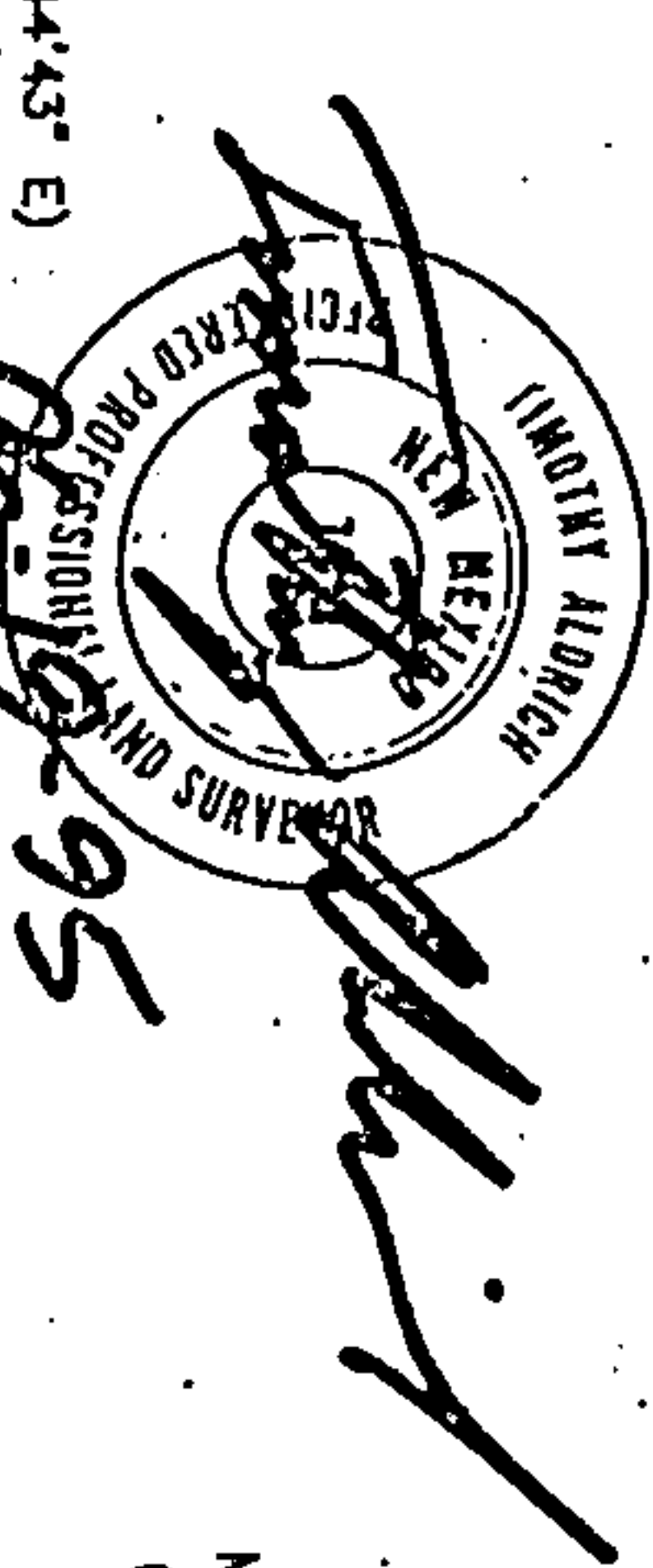
PREDICTION POINT CROSSING AT JUAN TABO CONTINUED

ELEVATION (ft)	STAGE (ft)	DISCHARGE (cfs)	WP ft	AREA ft ²	VELOCITY (fps)	CRIT Q (cfs)
107.00	9.10	55277.41	806.86	4049.72	13.65	51528.54
107.10	9.20	56917.42	811.28	4130.42	13.78	52931.34
107.20	9.30	58580.20	815.71	4211.56	13.91	54350.55
107.30	9.40	60265.77	820.14	4293.15	14.04	55786.18
107.40	9.50	61974.19	824.57	4375.17	14.16	57238.23
107.50	9.60	63705.45	828.99	4457.64	14.29	58706.68
107.60	9.70	65459.56	833.42	4540.55	14.42	60191.54
107.70	9.80	67236.59	837.85	4623.90	14.54	61692.80
107.80	9.90	69036.54	842.28	4707.69	14.66	63210.47
107.90	10.00	70859.45	846.70	4791.92	14.79	64744.56
108.00	10.10	72705.34	851.13	4876.60	14.91	66295.06
108.10	10.20	74574.22	855.56	4961.71	15.03	67861.95
108.20	10.30	76466.18	859.99	5047.27	15.15	69445.30
108.30	10.40	78381.19	864.41	5133.27	15.27	71045.03
108.40	10.50	80319.33	868.84	5219.71	15.39	72661.23
108.50	10.60	82280.63	873.27	5306.60	15.51	74293.87
108.60	10.70	84265.06	877.70	5393.92	15.62	75942.91
108.70	10.80	86272.76	882.12	5481.69	15.74	77608.44
108.80	10.90	88303.69	886.55	5569.90	15.85	79290.43

PLAY FOR

WITHIN

JULY, 1994



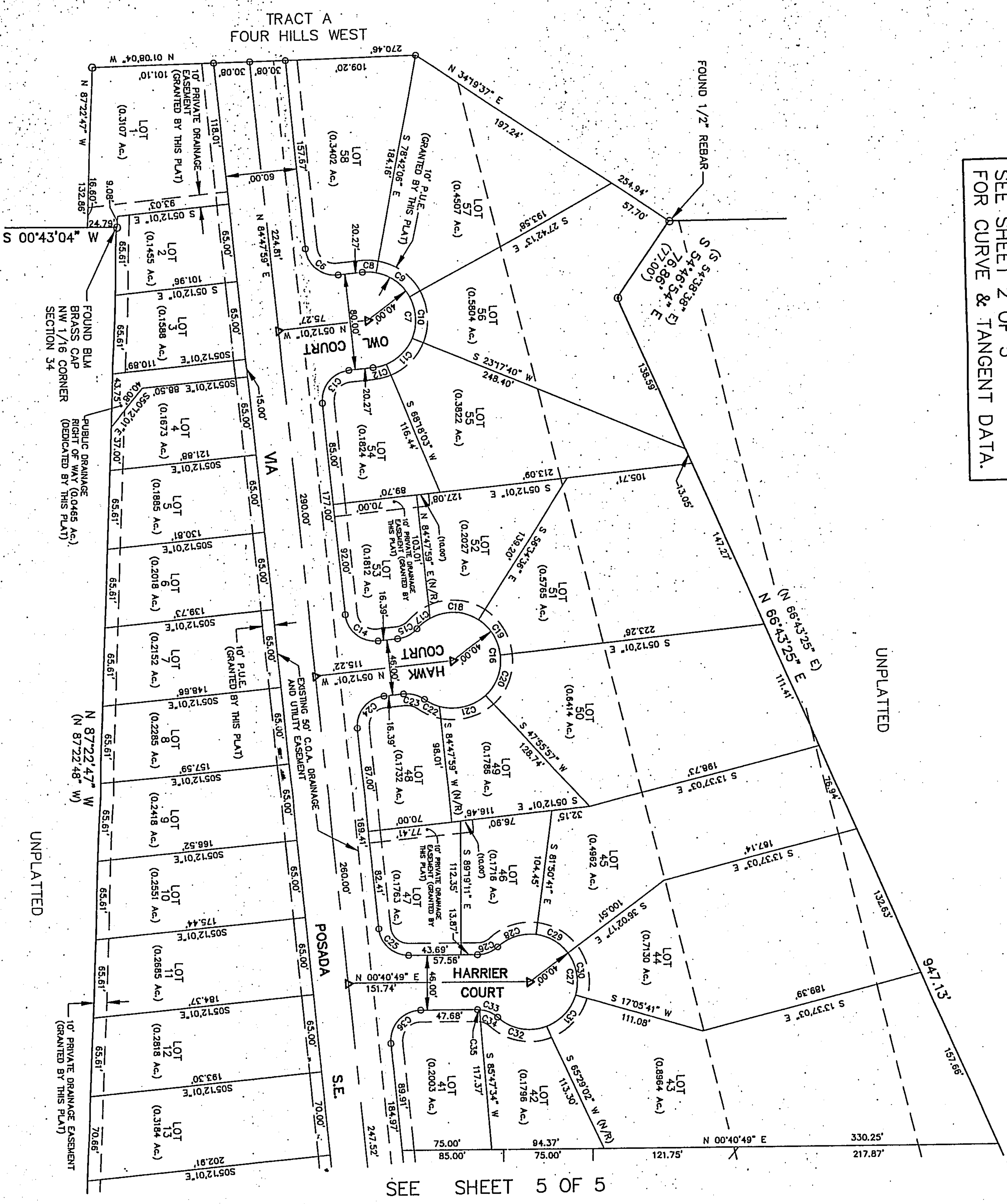
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ELEV.= N/A
(NAVD 1929)

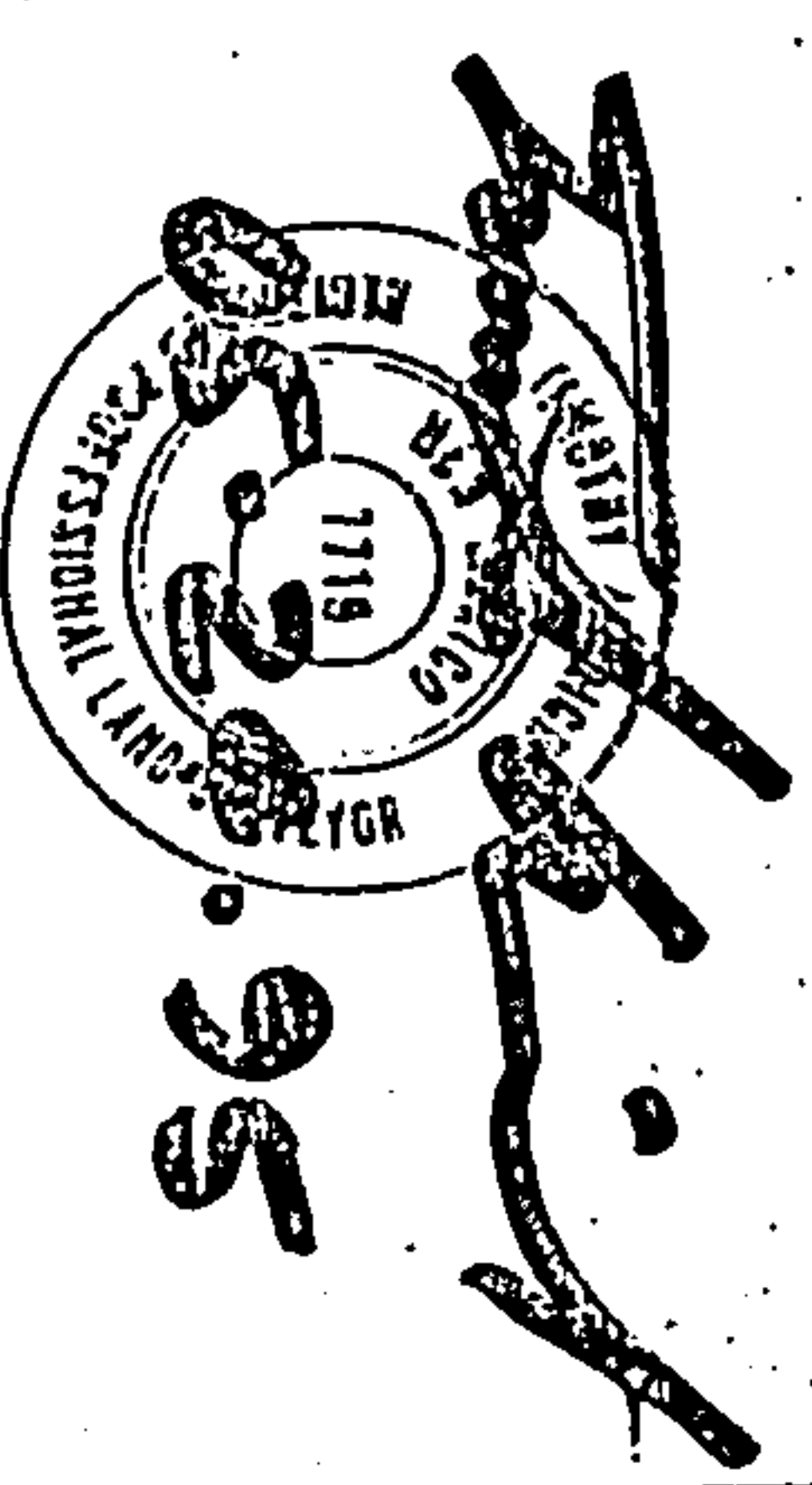
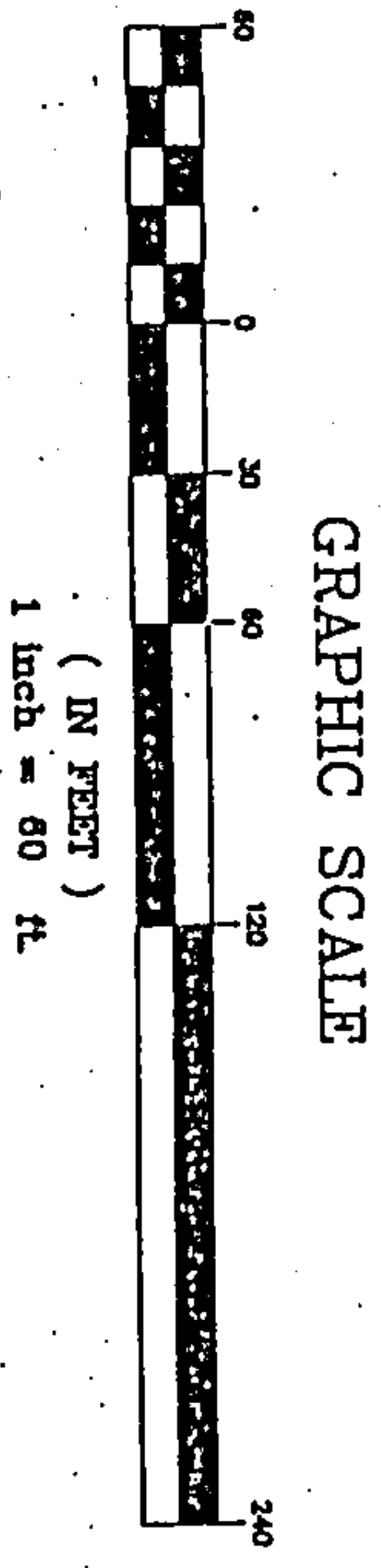
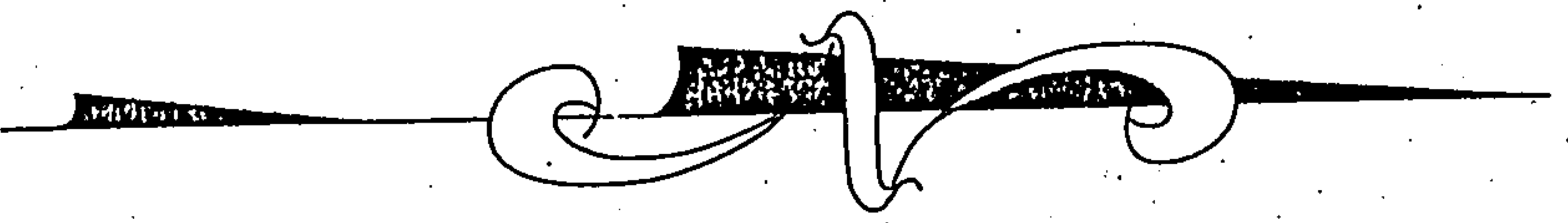
DETAIL FOR EASEMENTS (17 & 18)

NTS

SEE SHEET 2 OF 5
FOR CURVE & TANGENT DATA.



PLAT FOR
FOUR HILLS VILLAGE 20TH INSTALLMENT
WITHIN
SECTIONS 27, 33 AND 34
TOWNSHIP 10 NORTH, RANGE 4 EAST, NMPM
CITY OF ALBUQUERQUE
BERNALILLO COUNTY, NEW MEXICO
JULY, 1994



**ALDRICH LAND
SURVEYING**

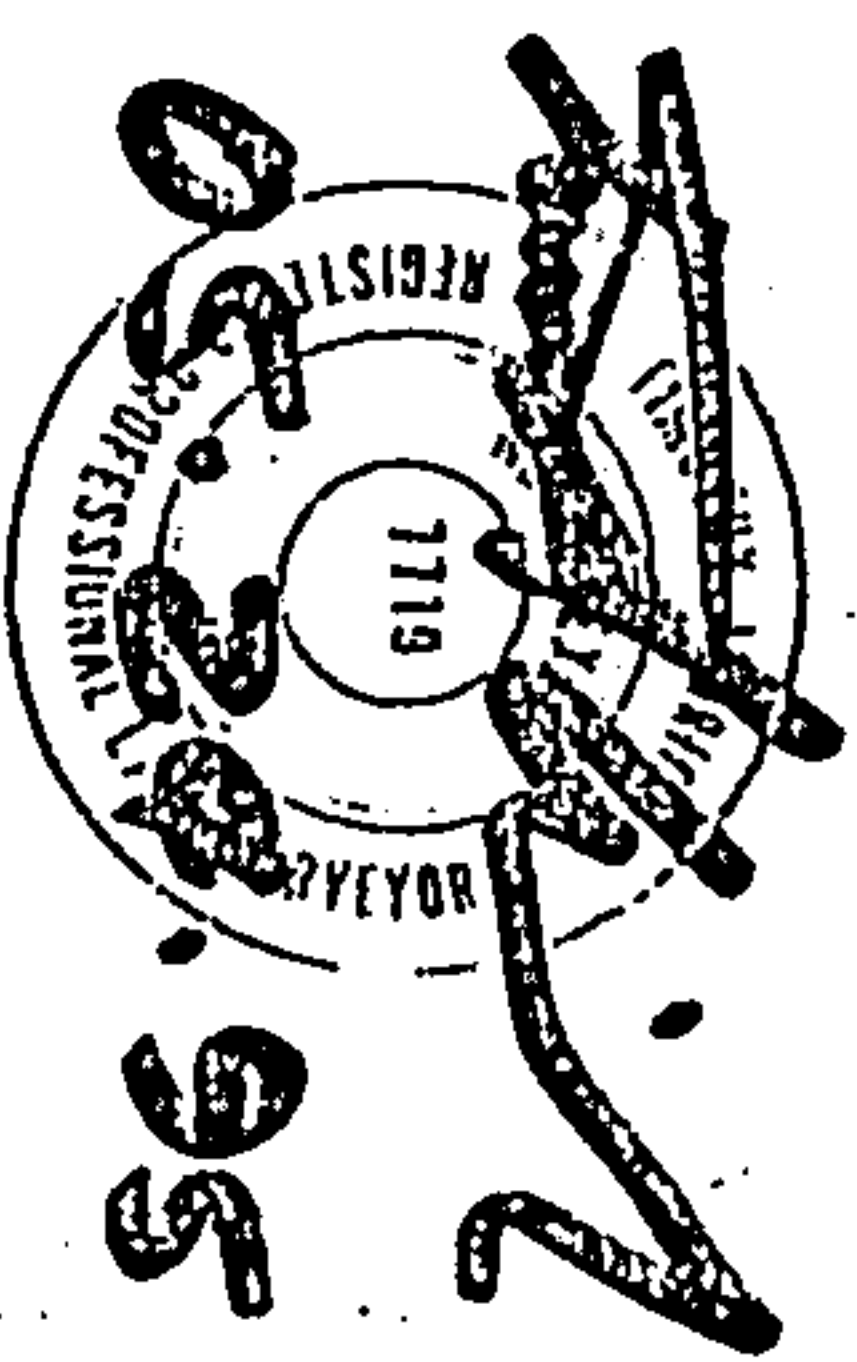
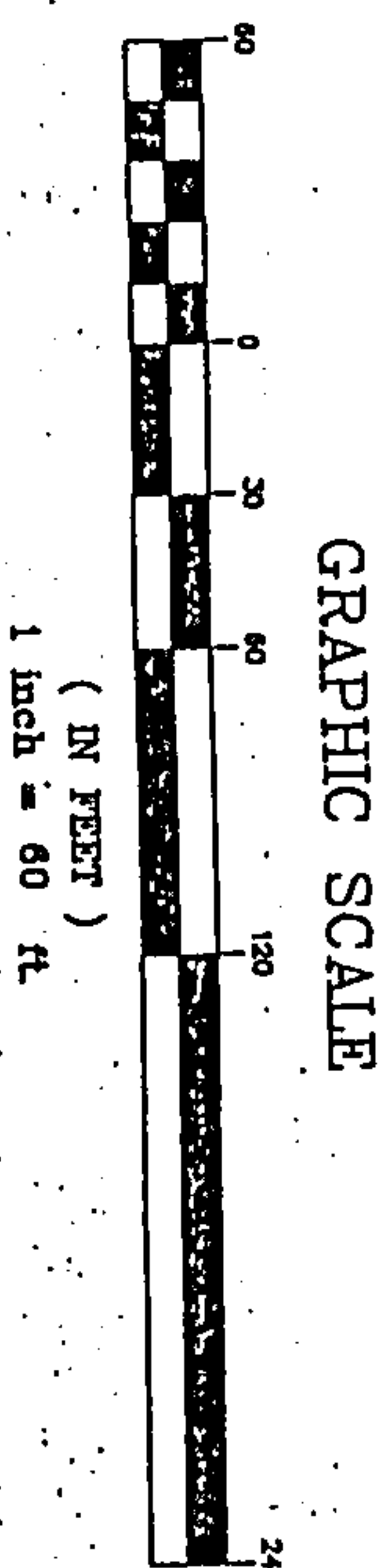
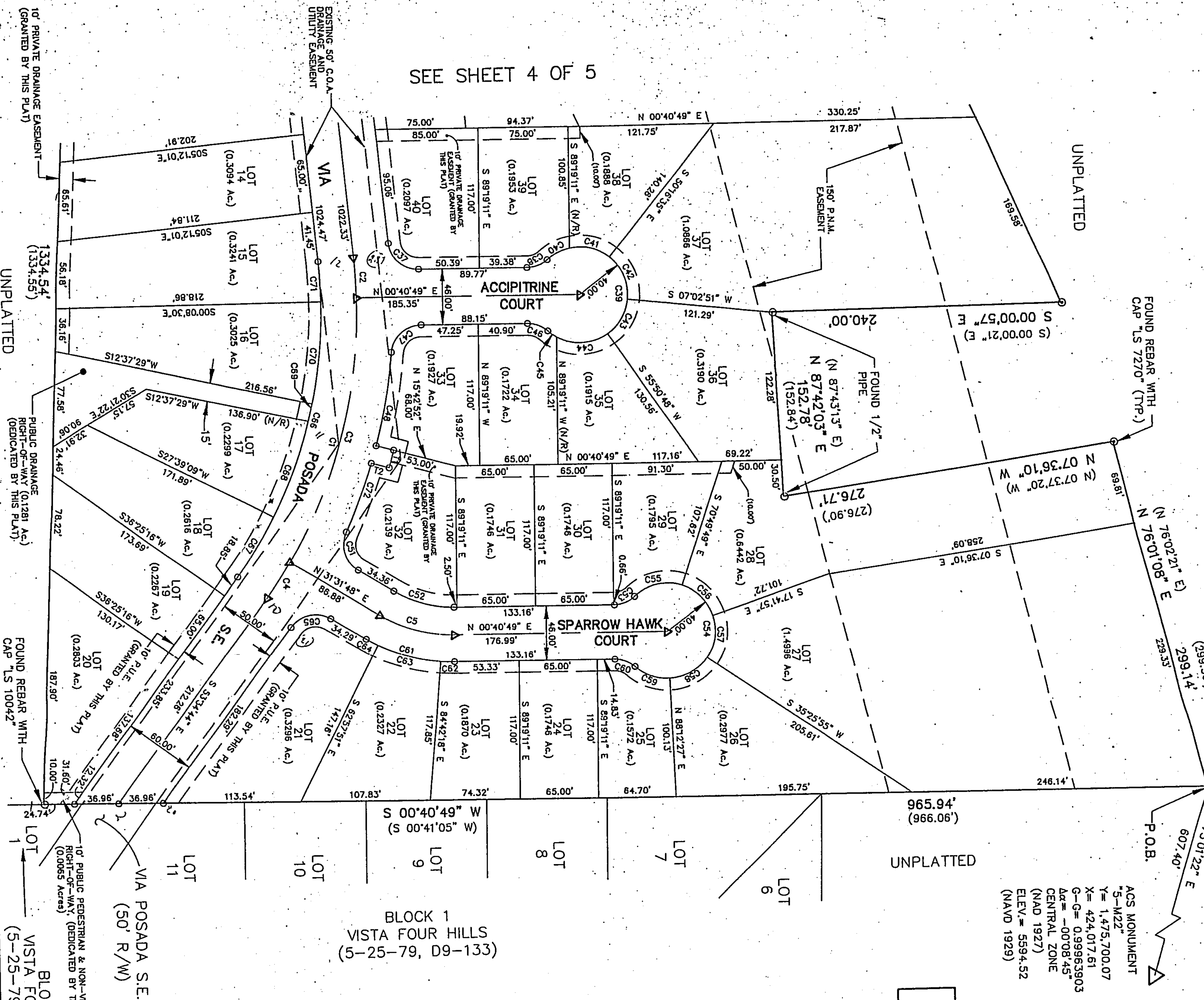
P.O. BOX 30701, ALBU., N.M. 87190
505-884-1990

PLAT FOR
FOUR HILLS VILLAGE 20TH INSTALLMENT
WITHIN
SECTIONS 27, 33 AND 34
TOWNSHIP 10 NORTH, RANGE 4 EAST, NMPM
CITY OF ALBUQUERQUE
BERNALILLO COUNTY, NEW MEXICO
JULY, 1994

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(NAVD 1929)

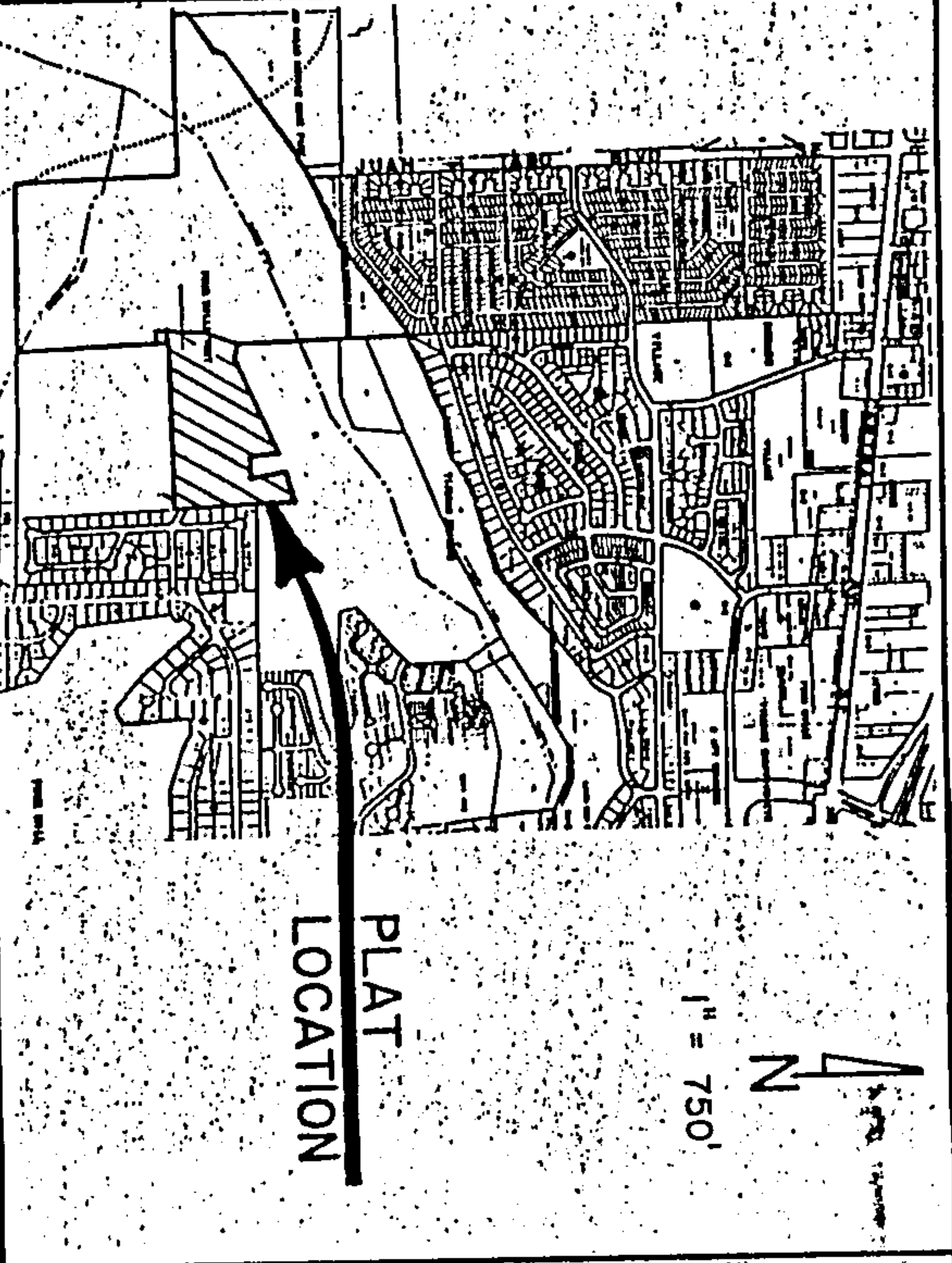
SEE SHEET 2 OF 5
FOR CURVE & TANGENT DATA.

SEE SHEET 4 OF 5



ALDRICH LAND
SURVEYING

P.O. BOX 30701, ALBU., N.M. 87190
505-884-1990



LOCATION MAP L-22, M-21 AND M-22

PURPOSE OF PLAT

1. Subdivide Four Hills West into 58 residential lots and 2 tracts.
2. Dedicate public drainage right-of-way and public right-of-way for residential streets.
3. Grant public utility easements, public drainage easements, private drainage easements, private access easement and public access easement.

SUBDIVISION DATA

1. DBB Case No.: 94-257
2. Zone Atlas Index No.: L-22, M-21 and M-22
3. Total Number of Lots created: 58
4. Total Number of Tracts created: 2
5. Gross Subdivision Acreage: 120.3401 Acres
6. Total Mileage of Full Width Streets Created: 0.4884 Miles

1. Bearings are grid based on the New Mexico State Plane Coordinate System (Central Zone).
2. Distances are ground distances.
3. Bearings and distances in parentheses are record.

4. Basis of boundary are the following plats of record entitled:
"SUMMARY PLAT FOR ANNEXATION, FOUR HILLS WEST" (S-7-81, D9-133)
"AMENDED REPLAT OF TRACT 1, VISTA FOUR HILLS" (S-7-81, D9-133)
"SUMMARY PLAT FOR ANNEXATION TO THE CITY OF ALBUQUERQUE OF NW 1/4, NE 1/4, S1/2NE 1/4, NW 1/4 AND NW 1/4SW 1/4 OF SECTION 35, T10N, R4E, N.M.P.M." (8-24-82, C20-24)
"UNIT NO. 1, 2, 3, 4 AND 5, FOUR HILLS MOBILE HOMES PARK" (12-7-78, D9-39)
"AMENDED PLAT OF TIERRAS HEIGHTS" (12-18-78, D9-42)
"SUMMARY PLAT, BEING A REPLAT OF A SUMMARY PLAT OF TIERRAS HEIGHTS" (5-31-78, D8-139)
"WARRANTY DEED" (Document No. 82-18044)
"QUITCLAIM DEED" (Document No. 82-18045)
"WARRANTY DEED" (Document No. 86-122458)
"WARRANTY DEED" (Document No. 86-122461)
"WARRANTY DEED" (Document No. 86-122464)

5. Field Survey performed in March 18, 1994.
6. Centerline (in lieu of R/W) monumentation to be installed at all centerline P.C.'s, P.T.'s, angle points and street intersections as shown hereon, and will consist of a four inch (4") aluminum alloy cap, stamped "City of Albuquerque", "Centerline Monument", "Do Not Disturb", P.S. # 7719.
7. Lots denoted with a double asterisk (**) shall comply with Section 40.C1.9 of the City of Albuquerque Comprehensive City Zoning Code.
8. UTILITY COUNCIL LOCATION SYSTEM LOG NO. 94033110200189

9. This Report provided by Rio Grande Title Company, Inc., Policy No. 09 32 0022 60 3774, File No. 11-28987-m, dated December 16, 1993.
10. Maintenance of the private drainage easements as shown hereon shall be the responsibility of the owners and/or proprietors of the individual properties of which the easements serve.
11. Maintenance of the private access easement as shown hereon shall be the responsibility of the owner(s) and/or proprietor(s) of Tract B.

PUBLIC UTILITY EASEMENTS:

PUBLIC UTILITY EASEMENTS shown on this plat are granted for the common and joint use of:

1. The Public Service Company of New Mexico for the installation, maintenance, and service of overhead and underground electrical lines, transformers, poles and any other equipment, fixtures, structures and related facilities reasonably necessary to provide electrical services.
2. The Gas Company of New Mexico for installation, maintenance, and service of natural gas lines, valves and other equipment and facilities reasonably necessary to provide natural gas.
3. U.S. West for installation, maintenance and service of all buried and aerial communication lines and other related equipment and facilities reasonably necessary to provide communication services, including but not limited to above ground pedestals and closures.
4. Jones Intercoable for the installation, maintenance, and service of such lines, cable, and other related equipment and facilities reasonably necessary to provide Cable TV service.

Included, is the right to build, rebuild, construct, reconstruct, locate, relocate, change, remove, modify, renew, operate, and maintain facilities for the purposes described above, together with free access to, from, and over said easements, including sufficient working area space for electric transformers, with the right and privilege to trim and remove trees, shrubs or bushes which interfere with the purposes set forth herein. No building, sign, pool (aboveground or subsurface), hot tub, concrete or wood pool deck, or other structure shall be erected or constructed on said easements, nor shall any well be drilled or operated thereon. Property owners shall be solely responsible for correcting any violations of the National Electrical Safety Code caused by construction of pools, decking, or any structures adjacent to within or near easements shown on this plat.

In approving this plat, The Public Service Company of New Mexico did not conduct a title search of the properties shown hereon. Consequently, The Public Service Company of New Mexico does not waive or release any easement or easement rights which may have been granted by prior plat, replat or other document and which are not shown on this plat.

By approving this document, the utility companies do not waive or release any easement rights which may have been granted by prior plat, replat or document.

FREE CONSENT AND DEDICATION

The subdivision hereon described is with the free consent and in accordance with the desires of the undersigned owner(s) and/or proprietor(s) (herein and sold owner(s) and/or proprietor(s)) do hereby dedicate all streets and public right-of-ways shown hereon to the City of Albuquerque in fee simple with warranty covenants, and do hereby grant, all access utility and drainage easements, shown hereon, whether public or private, including the right to construct, operate, inspect, and maintain facilities therein; and all public utility easements shown hereon for the services for buried use of gas, electrical power, and communication services for buried distribution lines, conduits, and pipes for underground utilities where shown or indicated; and including the right of ingress and egress for construction and maintenance, and the right to trim interfering trees and shrubs. Sold owner(s) and/or proprietor(s) do hereby consent to all of the foregoing and do hereby certify that this subdivision is their free act and deed.

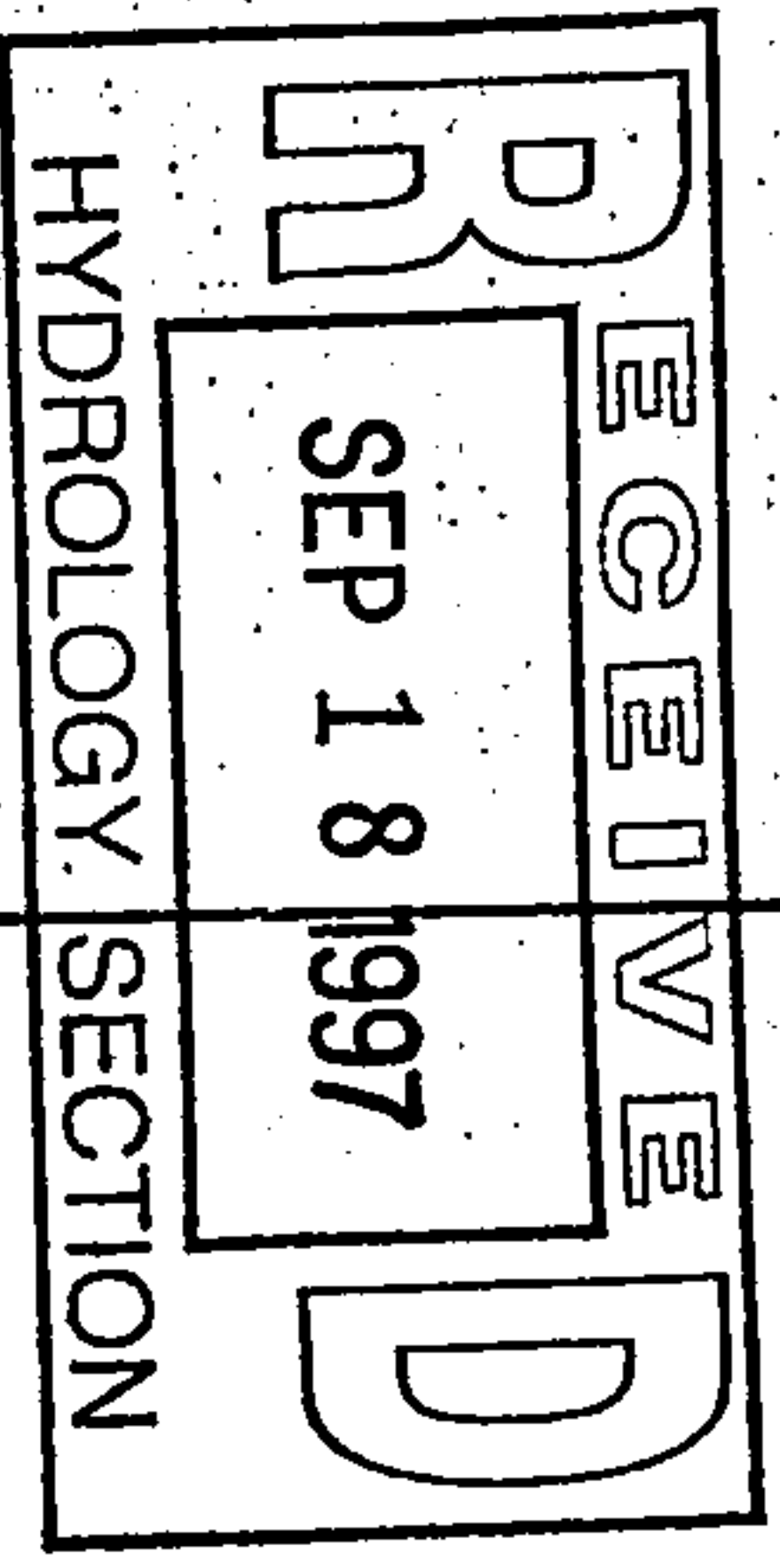
Owner: Tract A and Lots 1 through 58
HAI Limited, a New Mexico Limited Partnership
Mary S. Strickman 6-28-94
Mary S. Strickman, President Date

STATE OF NEW MEXICO
BERNALILLO COUNTY
On this 28 day of June, 1994, this instrument was acknowledged before me by Mary S. Strickman of HAI Limited, a New Mexico Limited Partnership, as its President.
Mary S. Strickman DIANE ALDRICH
Notary Public JOINTLY PUBLIC STATE OF NEW MEXICO
My commission expires: 6-9-98

Owner: Tract B
Shaw, Mitchell and Melory Partnership
Shaw, Mitchell and Melory Partnership 6-29-94
Shaw, Mitchell and Melory Partnership Date

STATE OF NEW MEXICO
BERNALILLO COUNTY
On this 29 day of June, 1994, this instrument was acknowledged before me by Shaw, Mitchell and Melory Partnership, as its General Partner.
Shaw, Mitchell and Melory Partnership

PLAT FOR
FOUR HILLS VILLAGE 20TH INSTALLMENT
WITHIN
SECTIONS 27, 33 AND 34
TOWNSHIP 10 NORTH, RANGE 4 EAST, NMPM
CITY OF ALBUQUERQUE
BERNALILLO COUNTY, NEW MEXICO
JULY, 1994



APPROVED AND ACCEPTED BY:

Subdivision Case No. _____ Date _____
Planning Director, City of Albuquerque, N.M. _____ Date _____
City Engineering Div., City of Albuquerque, N.M. _____ Date _____

Albuquerque Metropolitan Arroyo Flood Control Authority
Robert W. Kane 6-6-95
Traffic Div., City of Albuquerque, N.M. Date
Robert W. Kane 7-12-95
Water Utilities Dept., City of Albuquerque, N.M. Date

Port and Planning Dept., City of Albuquerque, N.M. Date
William J. Smith 6-30-94
City Surveyor, City of Albuquerque, N.M. Date
Dee R. Ruler 1-13-95
Property Management, City of Albuquerque, N.M. Date

County Treasurer, Bernalillo County, N.M. Date
Dee R. Ruler 1-12-95
Gas Company of New Mexico Date
Robert W. Kane 1-18-95
U.S. West Telecommunications Date
Robert W. Kane 1-12-95
Public Service Company of New Mexico Date
Lawrence A. Shaw 1-12-95
Jones Intercoable, Inc. Date

SURVEYOR'S CERTIFICATION

"I, Timothy Aldrich, a duly qualified Registered Professional Land Surveyor under the laws of the State of New Mexico, do hereby certify that this plat and description were prepared by me or under my supervision, shows all easements as shown on the plat of record or mode known to me by the owners and/or proprietors of the subdivision shown hereon, utility companies and other parties expressing an interest and meets the minimum requirements for monumentation and surveys of the Albuquerque Subdivision Ordinance, and further meets the Minimum Standards for Land Surveying in the State of New Mexico (Effective November 1, 1989 and revisions effective December 25, 1991 and February 2, 1994), and is true and correct to the best of my knowledge and belief."

Timothy Aldrich 6-28-94
Timothy Aldrich, P.S. No. 7719 Date

ALDRICH LAND
SURVEYING
P.O. BOX 30701, ALBQ., N.M. 87190
505-884-1990

TANGENT DATA
DIRECTION TANGENT
T1 57°47'06"E 15.00'
T2 S15°42'32"E 15.26'

CURVE DATA

CURVE	RADIUS	LENGTH	TANGENT	CHORD	BEARING	DELTA
C1	410.00'	297.84'	155.83'	291.33'	N 74°23'22" W	41°37'17"
C2	410.00'	33.85'	16.94'	33.84'	N 87°09'54" E	0°43'51"
C3	410.00'	228.98'	117.56'	226.02'	N 74°28'11" W	31°58'58"
C4	410.00'	15.00'	17.51'	34.93'	N 56°01'28" W	0°43'328"
C5	120.00'	64.81'	33.11'	63.83'	N 16°08'19" E	30°50'59"
C6	25.00'	38.27'	25.00'	35.36'	N 39°47'59" W	90°00'00"
C7	40.00'	123.86'	113.32'	114.48'	S 84°47'59" W	160°00'00"
C8	40.00'	11.32'	5.80'	11.48'	S 03°02'56" W	162°29'45"
C9	40.00'	35.60'	19.08'	34.44'	S 36°47'50" W	50°58'53"
C10	40.00'	35.60'	19.08'	34.44'	S 87°47'43" W	44°00'23"
C11	40.00'	31.42'	16.57'	30.82'	N 44°12'08" W	16°29'56"
C12	40.00'	11.52'	5.80'	11.48'	N 13°28'59" W	48°29'56"
C13	25.00'	39.27'	25.00'	35.36'	S 50°12'01" E	90°00'00"
C14	25.00'	39.27'	25.00'	35.36'	N 39°47'59" E	90°00'00"
C15	25.00'	18.50'	9.70'	18.08'	N 26°24'00" W	42°23'58"
C16	40.00'	184.86'	—	—	—	264°47'56"
C17	40.00'	13.99'	7.07'	13.92'	S 37°34'56" E	20°02'05"
C18	40.00'	42.58'	23.56'	40.60'	S 02°56'45" W	80°59'18"
C19	40.00'	35.87'	19.24'	34.68'	S 59°08'42" W	51°22'35"
C20	40.00'	37.09'	20.00'	35.78'	N 68°38'02" W	53°07'58"
C21	40.00'	41.35'	22.74'	39.53'	N 122°10'5" W	591°3'59"
C22	40.00'	13.99'	7.07'	13.92'	N 27°10'54" E	20°02'05"
C23	25.00'	18.50'	9.70'	18.08'	S 15°56'58" W	42°23'58"
C24	25.00'	39.27'	25.00'	35.36'	S 50°12'01" E	90°00'00"
C25	25.00'	39.27'	25.00'	35.36'	N 39°47'59" E	90°00'00"
C26	25.00'	36.70'	22.56'	33.50'	N 42°44'24" E	84°07'10"
C27	40.00'	18.50'	9.70'	18.08'	N 20°31'10" W	42°23'58"
C28	40.00'	34.82'	18.60'	33.73'	S 16°46'55" E	48°32'28"
C29	40.00'	31.98'	16.90'	31.13'	S 31°03'31" W	43°48'24"
C30	40.00'	37.09'	20.00'	35.78'	S 60°31'42" W	53°07'58"
C31	40.00'	37.09'	20.00'	35.78'	N 48°20'20" W	53°07'58"
C32	40.00'	43.88'	24.44'	41.71'	N 11°39'13" E	62°51'08"
C33	25.00'	18.50'	9.70'	18.08'	S 21°52'48" W	42°23'58"
C34	25.00'	16.83'	8.75'	16.82'	S 23°47'34" W	38°34'28"
C35	25.00'	1.87'	0.83'	1.67'	S 02°35'35" W	03°49'30"
C36	25.00'	41.84'	27.71'	37.12'	S 47°53'38" E	96°52'50"

CURVE	RADIUS	LENGTH	TANGENT	CHORD	BEARING	DELTA
C37	25.00'	36.70'	22.56'	33.50'	N 42°44'24" E	84°07'10"
C38	25.00'	18.50'	9.70'	18.08'	N 20°31'10" W	42°23'58"
C39	40.00'	184.86'	—	—	—	264°47'56"
C40	40.00'	21.33'	10.63'	21.08'	S 26°26'29" E	30°33'20"
C41	40.00'	35.83'	19.03'	34.37'	S 14°16'48" W	53°07'58"
C42	40.00'	40.02'	21.86'	38.37'	S 68°23'08" W	57°19'26"
C43	40.00'	34.07'	18.14'	33.05'	N 58°33'11" W	48°47'57"
C44	40.00'	44.95'	25.19'	42.83'	N 01°57'25" W	64°23'36"
C45	40.00'	8.96'	4.50'	8.95'	N 36°39'35" E	12°30'25"
C46	25.00'	18.50'	9.70'	18.08'	S 21°52'48" W	42°23'58"
C47	25.00'	37.13'	22.95'	33.81'	S 41°51'59" E	85°05'36"
C48	440.00'	77.77'	38.99'	77.67'	S 79°20'58" E	100°7'39"
—	—	—	—	—	—	—
C51	25.00'	36.68'	22.54'	33.48'	N 73°34'03" E	84°04'30"
C52	97.00'	52.23'	26.76'	51.60'	N 16°08'19" E	30°50'59"
C53	25.00'	18.50'	9.70'	18.08'	N 20°31'10" W	42°23'58"
C54	40.00'	184.86'	—	—	—	264°47'56"
C55	40.00'	42.31'	23.51'	40.54'	S 11°16'29" E	60°33'20"
C56	40.00'	37.09'	20.00'	35.78'	S 45°14'07" W	53°07'58"
C57	40.00'	37.09'	20.00'	35.78'	N 61°08'01" W	53°07'58"
C58	40.00'	36.84'	19.85'	35.85'	N 28°10'49" W	52°48'32"
C59	40.00'	31.33'	16.52'	30.53'	N 20°38'37" E	44°32'20"
C60	25.00'	18.50'	9.70'	18.08'	S 21°52'48" W	42°23'58"
C61	143.00'	77.00'	39.46'	76.07'	N 16°08'19" E	30°50'59"
C62	143.00'	11.52'	5.76'	11.51'	S 02°58'16" E	0°43'53"
C63	143.00'	54.26'	27.46'	53.94'	S 16°09'55" W	21°44'27"
C64	143.00'	37.14'	22.95'	5.61'	S 29°16'59" W	0°29'32"
C65	25.00'	11.22'	5.61'	11.21'	S 11°01'28" E	85°06'32"
C66	380.00'	276.04'	144.43'	270.01'	N 74°23'22" W	41°37'17"
C67	380.00'	58.15'	29.13'	58.09'	N 57°57'46" W	08°48'07"
C68	380.00'	84.87'	42.51'	84.50'	N 68°43'48" W	12°46'00"
C69	380.00'	13.00'	7.50'	15.00'	N 76°14'40" W	02°15'40"
C70	380.00'	84.87'	42.51'	84.50'	N 63°45'30" W	12°45'59"
C71	380.00'	33.55'	16.78'	33.54'	S 87°19'44" W	05°03'31"
C72	440.00'	60.95'	30.52'	60.90'	S 68°21'48" E	07°36'14"

DESCRIPTION

A tract of land situate within Sections 27, 33 and 34, Township 10 North, Range 4 East, New Mexico Principal Meridian within the City of Albuquerque, Bernalillo County, New Mexico being all of FOUR HILLS WEST as the same is shown and designated on said plat filed for record in the office of the County Clerk of Bernalillo County, New Mexico on January 7, 1981 in Volume C17, Folio 174 together with an undesignated tract of land as described in a Warranty Deed filed for record in the office of the County Clerk of Bernalillo County, New Mexico on April 6, 1982 as Document No. 82-18044 and being more particularly described as follows:

BEGINNING at the northeast corner of the herein described tract from whence the Albuquerque Control Survey Monument "S-M22" bears S 73°01'22" E, 607.40 feet:

THENCE S 00°40'49" W, 965.94 feet to the southeast corner, said point being on the westerly line of LOT 1, BLOCK 4, AMENDED VISTA FOUR HILLS as the same is shown and designated on said plat filed for record in the office of the County Clerk of Bernalillo County, New Mexico on May 25, 1979 in Volume D9, Folio 133;

THENCE leaving said westerly line N 87°22'47" W, 1334.54 feet to a point;

THENCE S 00°43'04" W, 1301.64 feet to a point;

THENCE N 87°50'40" W, 1334.73 feet to a point;

THENCE N 00°41'59" E, 1313.95 feet to a point;

THENCE N 89°15'53" W, 1301.80 feet to the southwest corner, said point being common with the southeast corner of RECO CORP. TRACT as the same is shown and designated on said plat filed for record in the office of the County Clerk of Bernalillo County, New Mexico on August 24, 1982 in Volume C20, Folio 24;

THENCE along the easterly line of said RECO CORP. TRACT N 00°42'12" E, 122.47 feet to a point, said point being common with the southwest corner of FOUR HILLS MOBILE HOME PARK, UNIT 5 as the same is shown and designated on said plat filed for record in the office of the County Clerk of Bernalillo County, New Mexico on December 7, 1968 in Volume D9, Folio 39;

THENCE leaving said easterly line along the southerly line of said FOUR HILLS MOBILE HOME PARK, UNIT 5 N 57°28'58" E, 410.16 feet to a point;

THENCE continuing N 12°37'53" E, 50.77 feet to a point;

THENCE continuing N 57°29'12" E, 1082.65 feet to a point, said point being common with the southeast corner of said FOUR HILLS MOBILE HOME PARK, UNIT 5 and further being on the westerly right-of-way line of Juan Tado Boulevard N.E.;

THENCE along said right-of-way line S 00°39'45" W, 8.73 feet to a point;

THENCE leaving said right-of-way line N 54°55'30" E, 52.84 feet to a point;

THENCE N 68°13'20" E, 46.69 feet to a point, said point being on the easterly right-of-way line of Juan Tado Boulevard N.E.;

THENCE along said right-of-way line N 00°53'32" E, 13.27 feet to a point, said point being common with the southwest corner of FOUR HILLS MOBILE HOME PARK, UNIT 4 as the same is shown and designated on said plat filed for record in the office of the County Clerk of Bernalillo County, New Mexico on December 7, 1978 in Volume D9, Folio 39;

THENCE leaving said right-of-way line along the southerly line of said FOUR HILLS MOBILE HOME PARK, UNIT 4 N 68°28'17" E, 594.70 feet to a point;

THENCE continuing N 01°08'51" E, 18.00 feet to a point;

THENCE continuing S 86°43'48" E, 64.80 feet to a point;

THENCE continuing N 52°53'46" E, 852.28 feet to a point, said point being common with the southeast corner of said FOUR HILLS MOBILE HOME PARK, UNIT 4 and further being on the westerly line of LOT 29, TUDERAS HEIGHTS as the same is shown and designated on said plat filed for record in the office of the County Clerk of Bernalillo County, New Mexico on December 18, 1978 in Volume D9, Folio 42;

PLAT FOR
FOUR HILLS VILLAGE 20TH INSTALLMENT
WITHIN
SECTIONS 27, 33 AND 34
TOWNSHIP 10 NORTH, RANGE 4 EAST, NMPM
CITY OF ALBUQUERQUE
BERNALILLO COUNTY, NEW MEXICO
JULY, 1994

THENCE S 00 32'11" W, 550.16 feet to a point, said point being common with the southwest corner of TRACT A-3, TUDERAS HEIGHTS as the same is shown and designated on said plat filed for record in the office of the County Clerk of Bernalillo County, New Mexico on May 31, 1978 in Volume D8, Folio 139;

THENCE S 00°40'21" W, 840.23 feet to a point;

THENCE S 54°46'54" E, 76.86 feet to a point;

THENCE N 66°43'25" E, 947.13 feet to a point;

THENCE S 00°00'57" E, 240.00 feet to a point;

THENCE N 87°42'03" E, 152.78 feet to a point;

THENCE N 07 36'10" W, 276.71 feet to a point;

THENCE N 76°01'08" E, 299.14 feet to the point of beginning and containing 120.3401 acres more or less.

EASEMENT DEDICATION FOR FLOOD PLAIN

DEDICATION TO THE ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY, GRANTEE, ITS SUCCESSORS AND ASSIGNS, OF LANDS, RIGHTS OF WAY, AND EASEMENTS DESIGNATED HEREIN AS "FLOOD PLAIN EASEMENT".

IS WITH THE FULL AND FREE CONSENT AND IN ACCORDANCE WITH THE DESIRE OF THE UNDERSIGNED OWNER, GRANTOR. THIS DEDICATION IS FOR DRAINAGE, FLOOD CONTROL, CONVEYANCE OF STORM WATER, AND THE CONSTRUCTION, OPERATION, AND MAINTENANCE OF, AND ACCESS TO SUCH FACILITIES, AND FOR SUBORDINATE RECREATIONAL USE AND ACCESS ON SUCH FACILITIES, EXCEPT BY THE WRITTEN APPROVAL OF GRANTEE, NO FENCE, WALL, BUILDING, OR OTHER OBSTRUCTION MAY BE PLACED OR MAINTAINED IN SAID EASEMENTS, AND THERE SHALL BE NO ALTERATION OF THE GRADES OR CONTOURS IN SAID EASEMENT. THE GRANTING OF EASEMENTS SHALL NOT OBLIGATE THE GRANTEE TO MAINTAIN NATURAL ARROYOS, DRAINAGE CHANNELS, OR FACILITIES THAT DO NOT MEET THE STANDARDS OF THE GRANTEE FOR DESIGN AND CONSTRUCTION, NOR SHALL THIS GRANTING REQUIRE THE PROTECTION OF PROPERTY LYING OUTSIDE OF THE EASEMENT GRANTED. GRANTEE SHALL ONLY MAINTAIN PROPERTY AND/OR IMPROVEMENTS THAT IT SPECIFICALLY AGREES, BY WRITTEN AGREEMENT FILED FOR PUBLIC RECORD, TO MAINTAIN, UNLESS GRANTEE SPECIFICALLY AGREES, BY SUCH WRITTEN AGREEMENT, TO MAINTAIN PROPERTY AND/OR IMPROVEMENTS, SUCH MAINTENANCE RESPONSIBILITY SHALL REMAIN WITH THE GRANTOR. ITS SUCCESSORS OR ASSIGNS. LANDSCAPING OR MAINTENANCE WORK, BY THE GRANTOR, WITHIN THE EASEMENT HEREBY CONVEYED SHALL NOT ALTER THE PRESENT FLOW-LINE, CAPACITY, OR PERMEABILITY OF THE PRESENT FLOOD WAY AREA, EXCEPT IN AN EMERGENCY. IF EMERGENCY WORK IS PERFORMED, GRANTOR SHALL NOTIFY THE GRANTEE AS SOON AS PRACTICAL THEREAFTER. GRANTEE WILL THEN DETERMINE IF THE EMERGENCY WORK CAN REMAIN OR MUST BE REMOVED OR MODIFIED. SAFE LOCATIONS FOR STRUCTURES BUILT ON LANDS ADJACENT TO THE REAL PROPERTY DESCRIBED HEREIN MAY BE SUBSTANTIALLY OUTSIDE OF THE AREA DESCRIBED HEREIN. ANY PORTION OF LANDS, RIGHT OF WAY OR EASEMENTS GRANTED HEREIN SHALL REVERT TO THE GRANTOR, ITS SUCCESSORS OR ASSIGNS, AS AND TO THE EXTENT SAID PORTION IS DECLARED UNNECESSARY FOR FLOOD CONTROL OR DRAINAGE BY THE BOARD OF DIRECTORS OF THE ALBUQUERQUE METROPOLITAN ARROYO FLOOD CONTROL AUTHORITY. ANY REVERSION SHALL BE CONVEYED BY QUITCLAIM DEED. VACATION APPROVAL CONSISTENT WITH THE CITY OF ALBUQUERQUE OR BERNALILLO COUNTY SUBDIVISION ORDINANCES WILL ALSO BE REQUIRED.

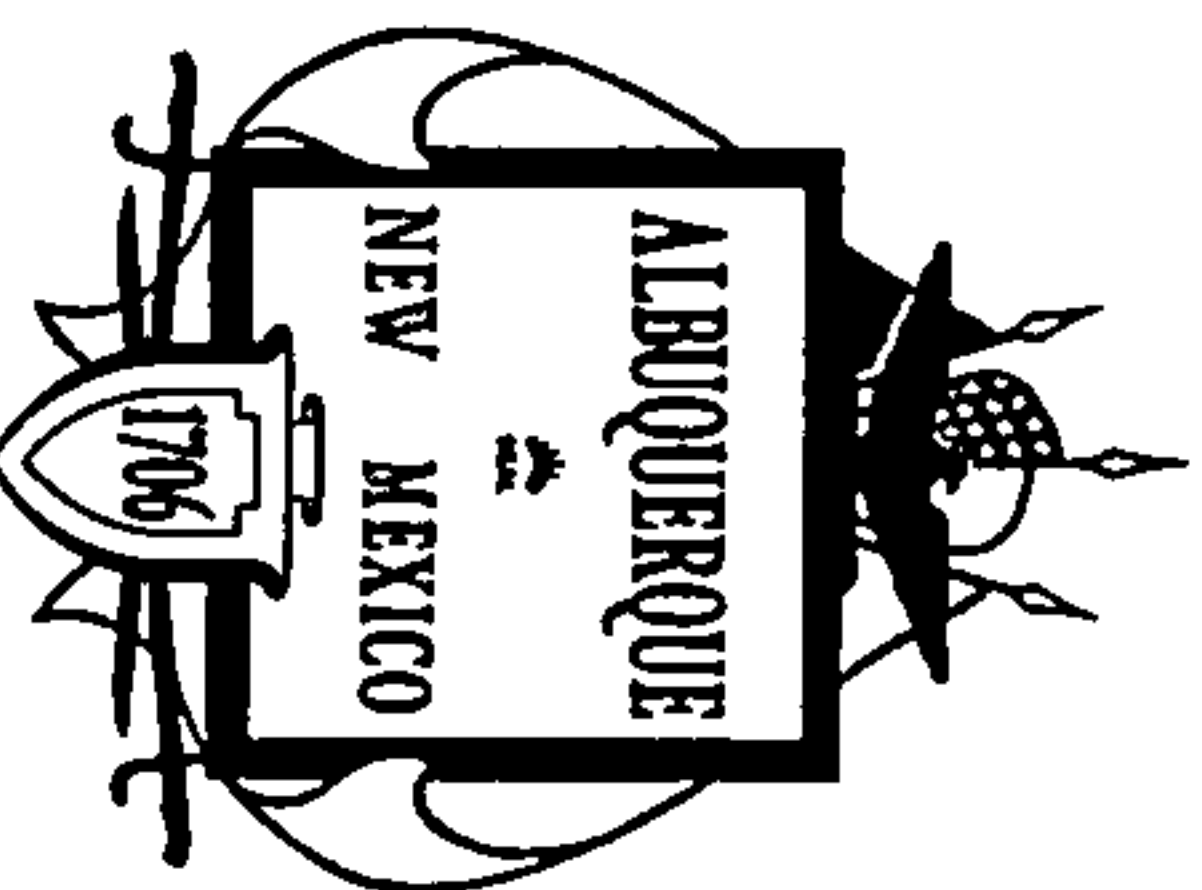
Owner: Tract A and Lots 1 through 58
HAT Limited, a New Mexico Limited Partnership

[Signature]
Mick Strickman, President
s/26/95
Date

06-19-95
05-24-95

ALDRICH LAND
SURVEYING

P.O. BOX 30701, ALBQ., N.M. 87190
505-884-1990



City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

December 7, 1994

Donald S. Dixon, P.E.
Resource Technology, Inc.
2129 Osuna Road NE, Suite 200
Albuquerque, New Mexico 87113

RE: DRAINAGE REPORT FOR FOUR HILLS VILLAGE 20TH INSTALLMENT
(M23/D11), SUBMITTED FOR PRELIMINARY PLAT APPROVAL,
ENGINEER'S STAMP DATED 11/7/94.

Dear Mr. Dixon:

Prior to Preliminary Plat approval, the following comments should be addressed:

1. The AMAFCA easement for the Tijeras Arroyo should be based on the FEMA floodplain as shown on the FIRM. You indicated that the easement takes into account the fact that the tributary through the development will be removed, therefore eliminating a portion of the existing flood plain. Until the map revision is approved by FEMA, the existing flood plain limits are valid, therefore the easement must be revised.
2. The two public drainage right-of-ways identified on the plan are acceptable. All drainage easements located across the back of the lots along the south edge of the subdivision, and between the cul-de-sacs should be labeled as "private", not "public". The easement between Lots 1 and 2 should also be private.
3. The infrastructure list must state that a LOMR is required in order to release financial guarantees for the storm drain.
4. Does the street flow (12.9 cfs) on Sparrow Hawk Court cause a hydraulic jump when it intercepts the flows in Via Posada?
5. With respect to the plans, the detail for the energy dissipator must be revised so that water will not be retained. Either provide some outlet pipes, or lower the riprap so that this structure may drain.
6. The City's Storm Drainage Maintenance crews must be able to access into the two concrete channels. Please provide curb cuts with drive pads and removable bollards to provide access.

The last two comments must be addressed prior to DRC signoff, however the others need to be resolved for preliminary plat approval. If you have any questions, please do not hesitate to call me.

Sincerely,


Susan M. Calongue, P.E.
City/County Floodplain Administrator

c: Andrew Garcia
File

**Four Hills Village,
Twentieth Installment
Page 1 of 3**

DRB Case No. 94-257
DRC Project No: 5038.90
Date Submitted: 11/18/94

**EXHIBIT A
TO SUBDIVISION IMPROVEMENT AGREEMENT
DEVELOPMENT REVIEW BOARD
REQUIRED INFRASTRUCTURE LISTING
NE/4 NE/4 SEC. 33, NW/4 SEC. 34, & SW/4 SEC. 27, T10N, R11E
FOUR HILLS SUBDIVISION, 20TH INSTALLMENT**

Following is a summary of PUBLIC/PRIVATE Infrastructure required to be constructed or financially guaranteed to be constructed for the above development. This summary is not necessarily a complete listing. During the design process, if the City determines that appurtenant items have not been included in the summary, those items will be included in the listing and related financial guarantee, if the items normally are Subdivider responsibility. In addition, any unforeseen items which arise during construction which are necessary to complete the project and which normally are the Subdivider's responsibility are the responsibility of the Subdivider and will be included in the financial guarantee provided to the City.

<u>SIZE</u>	<u>IMPROVEMENT</u>	<u>LOCATION</u>	<u>FROM</u>	<u>TO</u>
40' FF Std.	Res. Paving C & G (lt & rt)	Via Posada	East Boundary	SW Cor. Lot 58
4'	*Sidewalk (lt & rt)	"	"	"
6"	Waterline	"	"	West PL
36"	R.C.P. Storm Drain	"	"	±402' West
42"	R.C.P. Storm Drain	"	±402' West	±1,486' West
54"	R.C.P. Storm Drain	"	±1,486' West	±1,838' West
N/A	Energy Dissipator	"	West End	
28' FF Std.	Res. Paving C & G (lt & rt)	Sparrow Hawk Ct.	Via Posada	cul-de-sac
4'	*Sidewalk (lt & rt)	"	"	"
8"	Sanitary Sewer	"	"	"
6"	Waterline	"	"	"
28' FF Std.	Res. Paving C & G (lt & rt)	Accipitrine Ct.	Via Posada	cul-de-sac
4'	*Sidewalk (lt & rt)	"	"	"
8"	Sanitary Sewer	"	"	"
6"	Waterline	"	"	"

**Four Hills Village,
Twentieth Installment
Page 2 of 3**

DRB Case No. 94-257
DRC Project No: 5038.90
Date Submitted: 11/18/94

<u>SIZE</u>	<u>IMPROVEMENT</u>	<u>LOCATION</u>	<u>FROM</u>	<u>TO</u>
28' FF Std.	Res. Paving C & G (lt & rt)	Harrier Ct.	Via Posada	cul-de-sac
4'	*Sidewalk (lt & rt)	"	"	"
8"	Sanitary Sewer	"	"	"
6"	Waterline	"	"	"
28' FF Std.	Res. Paving C & G (lt & rt)	Hawk Ct.	Via Posada	cul-de-sac
4'	*Sidewalk (lt & rt)	"	"	"
8"	Sanitary Sewer	"	"	"
6"	Waterline	"	"	"
60' FF Std.	Res. Paving C & G (lt & rt)	Owl Ct.	Via Posada	cul-de-sac
4'	*Sidewalk (lt & rt)	"	"	"
8"	Sanitary Sewer	"	"	"
6"	Waterline	"	"	"

Miscellaneous

Residential street lighting per DPM.

Grading: Certification per DPM (prior to release of financial guarantees). To include private retaining walls and concrete rundowns between lots as defined on the approved grading plan (not to be financially guaranteed).

* Sidewalks to be deferred.

All water to include fire hydrants, valves, and appurtenances per DPM.

Signed By: Terry O. Brown
Print Name: Terry O. Brown
Firm: Terry O. Brown, P.E.

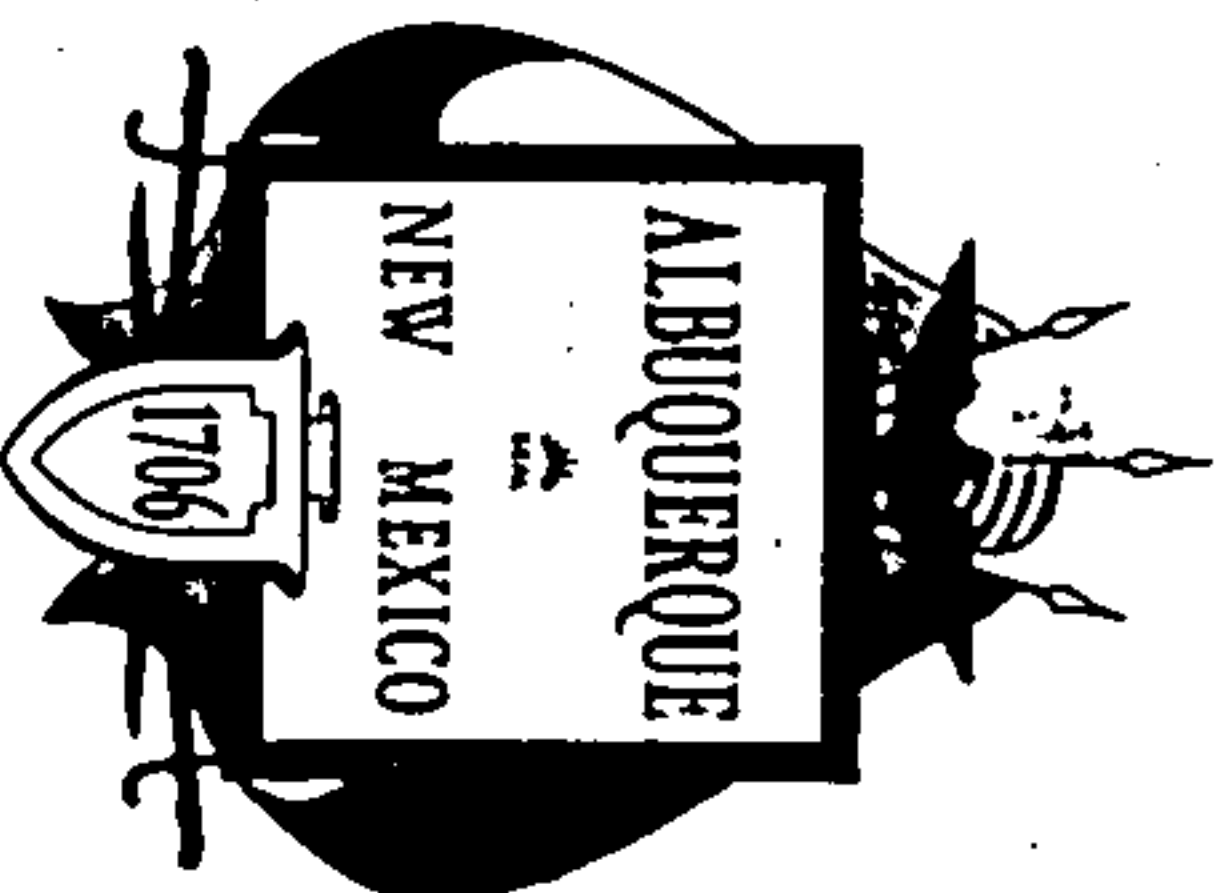
DRB Case No. 94-257
DRC Project No: 5038.90
Date Submitted: 11/18/94

DEVELOPMENT REVIEW BOARD MEMBER APPROVALS

<u>Traffic</u>	<u>Date</u>	<u>PWD</u>	<u>Date</u>	<u>Parks & Rec</u>	<u>Date</u>
----------------	-------------	------------	-------------	------------------------	-------------

<u>City Engineer</u>	<u>Date</u>	<u>DRB Chairman</u>	<u>Date</u>
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<u>AMAFCA</u>	<u>Date</u>
---------------	-------------



City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

October 4, 1994

Donald S. Dixon, P.E.
Resource Technology, Inc.
2129 Osuna Rd. NE, Suite 200
Albuquerque, NM 87113

RE: FOUR HILLS VILLAGE 20TH INSTALLMENT (M23/D11) SUBMITTED FOR
PRELIMINARY PLAT APPROVAL, ENGINEER'S STAMP DATED 6/24/94.

Dear Mr. Dixon:

AMAFCA has agreed to accept the floodplain easement for the Tijeras Arroyo adjacent to the above referenced development. Please note that this easement must be dedicated to AMAFCA prior to the plat action.

Typically, the limits of the floodplain easement for a natural arroyo are determined by the energy grade line (EGL) or the sequent depth as calculated by a HEC-2 analysis. Use the new hydrology when calculating the EGL for the arroyo. Also, erosion setback and scour calculations are required per the Sediment and Erosion Design Guide. If any construction is proposed within the limits of the erosion setback area, then a floodwall or floodproofing will be required.

Please plot the easement and the EGL on the drainage plan along with the erosion setback line, and include all calculations. Also, please include a copy of the plat showing the proposed easement with your resubmittal.

If you should have any questions, please feel free to call me at 768-2666.

Sincerely,

Susan M. Calongne, P.E.
City/County Floodplain Administrator

smc/WPHYD/495

c: Andrew Garcia
Terry Brown
Kurt Browning, AMAFCA
File

GENEVA MEEKER, CHAIR
DANIEL W. COOK, VICE-CHAIR
RONALD D. BROWN, SECRETARY-TREASURER
MICHAEL MURPHY, ASST. SECRETARY-TREASURER
TIM EICHENBERG, DIRECTOR

LARRY A. BLAIR
EXECUTIVE ENGINEER



**Albuquerque
Metropolitan
Arroyo
Flood
Control
Authority**

2600 PROSPECT N.E. - ALBUQUERQUE, N.M. 87107 June 5, 1995
TELEPHONE (505) 884-2215

Mr. Fred Aguirre, P.E.
City of Albuquerque
PWD Hydrology
P.O. Box 1293
Albuquerque, NM 87103

RE: Plat for Four Hills 20th Installment, Map # L-22

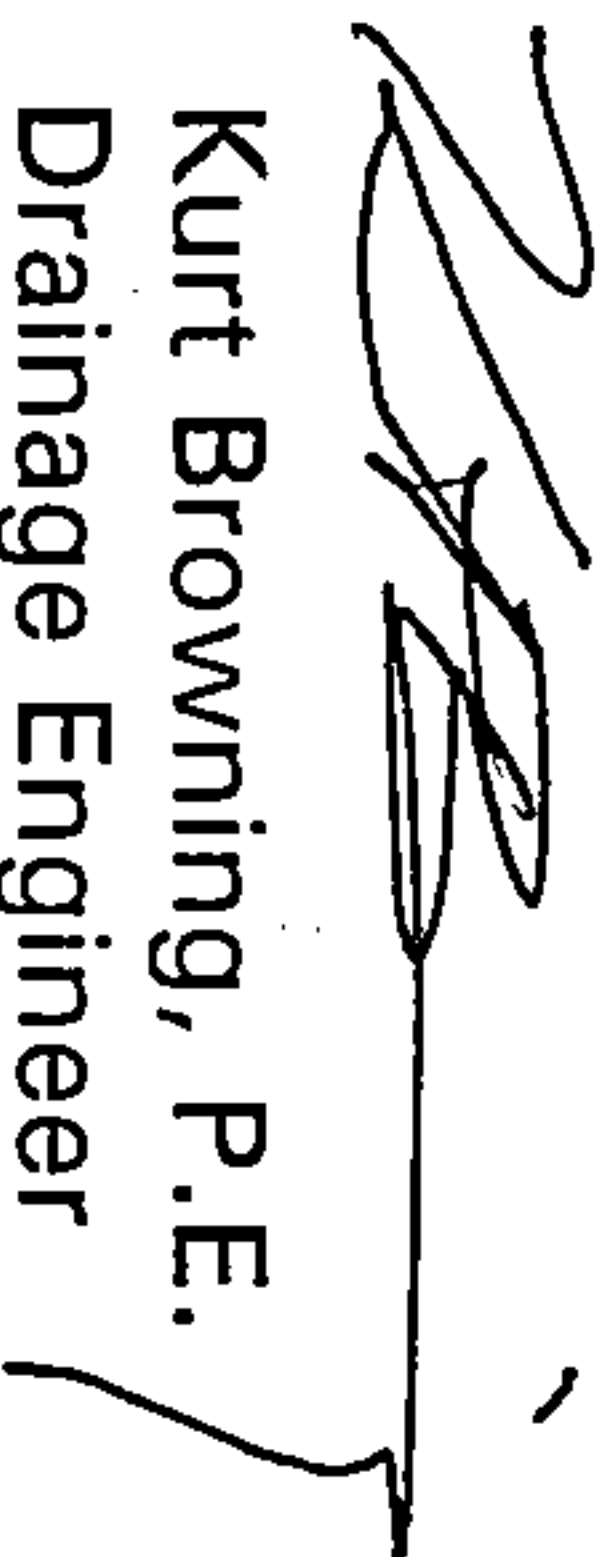
Dear Fred:

Per our meeting on Friday, the referenced plat requires some revisions before AMAFCA will approve it. As we have stated previously, AMAFCA does not typically accept easements in the Tijeras Arroyo area however, it is our understanding that AMAFCA will accept the floodplain easement for the Tijeras Arroyo portion of the subdivision. We will not maintain any portion of this easement and it is strictly for the conveyance of storm runoff.

Per City staff review, we understand that the "prudent line" based on 1995 criteria is similar to the prudent line established in the City's Tijeras Arroyo Drainage Management Plan. Does the easement match the erosion setback line on the plat? The plat references the "City of Albuquerque Prudent Line" from the City's study. Is this the same line as our proposed easement?

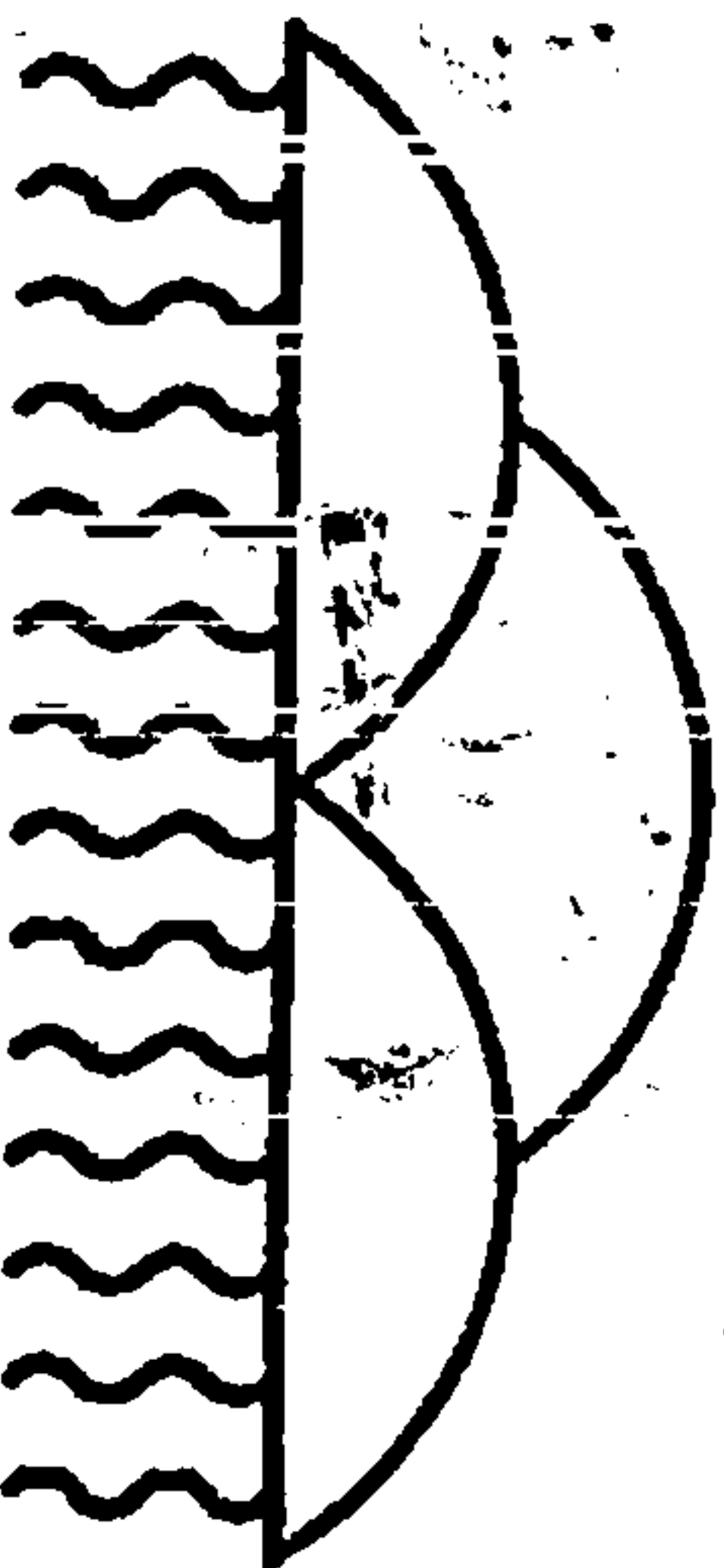
We will not accept any other easements for the interior of this subdivision including the extension of Via Posada. The dedication and language for these easements should be clearly addressed on the plat. These items should be addressed prior to AMAFCA approving the plat. Should you have any questions, do not hesitate to call me.

Sincerely,
AMAFCA


Kurt Browning, P.E.
Drainage Engineer

encl

c: Terry Brown



Fax Transmission

ALBUQUERQUE METROPOLITAN ARROYO

FLOOD CONTROL AUTHORITY

2600 PROSPECT, NE

ALBUQUERQUE, NM 87107

To: FRED AGUIRRE

From: KJET BROWNS

Company: CITY HYD

Date: 6-5-95

Fax #: _____

Topic: 20th instalment

9-46:115

You should receive 2 page(s) including this one.
If you do not receive all pages, please call 884-2215

Message: _____

6

JUN-5-95 MON 11:50

P. 02

GENEIVA MEEKER, CHAIR
DANIEL W. COOK, VICE-CHAIR
RONALD D. BROWN, SECRETARY, TREASURER
MICHAEL MURPHY, ASST. SECRETARY, TREASURER
J. L. THOMPSON, DIRECTOR

LARRY A. BLAIR
EXECUTIVE ENGINEER



**Albuquerque
Metropolitan
Arroyo
Flood
Control
Authority**

2600 PROSPECT N.E., ALBUQUERQUE, N.M. 87106
TELEPHONE (505) 804-2219
June 5, 1995

Mr. Fred Aguirre, P.E.
City of Albuquerque
PWD Hydrology
P.O. Box 1293
Albuquerque, NM 87103

RE: Plat for Four Hills 20th Installment, Map # L-22

Dear Fred:

Per our meeting on Friday, the referenced plat requires some revisions before AMAFCA will approve it. As we have stated previously, AMAFCA does not typically accept easements in the Tijeras Arroyo area however, it is our understanding that AMAFCA will accept the floodplain easement for the Tijeras Arroyo portion of the subdivision. We will not maintain any portion of this easement and it is strictly for the conveyance of storm runoff.

"Per City staff review, we understand that the "prudent line" based on 1995 criteria is similar to the prudent line established in the City's Tijeras Arroyo Drainage Management Plan. Does the easement match the erosion setback line on the plat? The plat references the "City of Albuquerque Prudent Line" from the City's study. Is this the same line as our proposed easement?

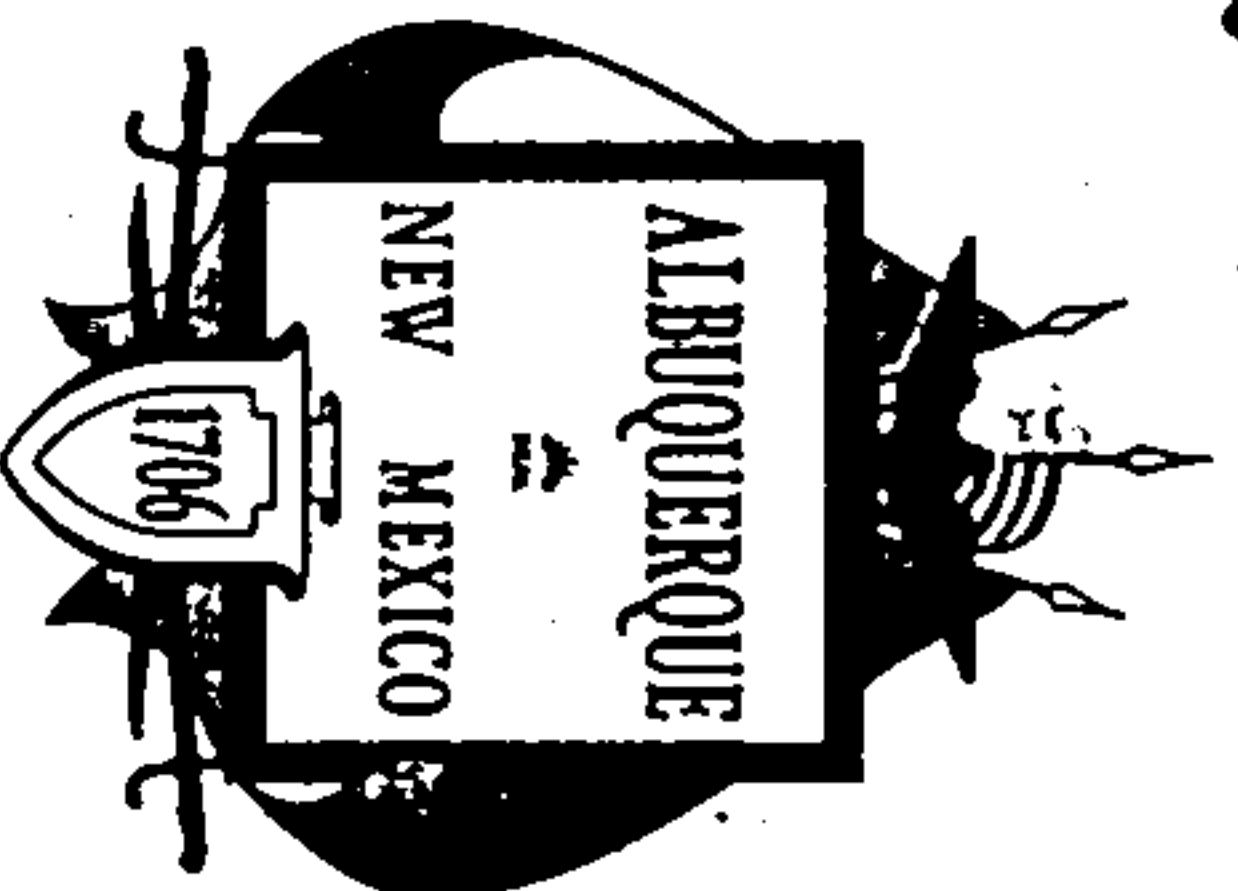
We will not accept any other easements for the interior of this subdivision including the extension of Via Posada. The dedication and language for these easements should be clearly addressed on the plat. These items should be addressed prior to AMAFCA approving the plat. Should you have any questions, do not hesitate to call me.

Sincerely,
AMAFCA

Kurt Browning, P.E.
Drainage Engineer

encl

cc: Terry Brown



City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

July 20, 1994

Donald S. Dixon, P.E.
Resource Technology, Inc.
2129 Osuna Rd. NE, Suite 200
Albuquerque, NM 87113

RE: DRAINAGE REPORT AND GRADING PLAN FOR FOUR HILLS VILLAGE 20TH
INSTALLMENT (M23/D11) SUBMITTAL DATED 6/27/94 FOR PRELIMINARY
PLAT APPROVAL, ENGINEER'S STAMP DATED 6/24/94.

Dear Mr. Dixon:

The following issues need to be addressed on the above referenced
submittal before Preliminary Plat approval:

- Demonstrate how the off-site flows from the east do or do not enter the site by showing spot elevations on-site and beyond the property lines, flow arrows and any existing or proposed retaining walls/garden walls.
- Show how off-site flows from the south are intercepted and identify any drainage easements required on this Open Space property to intercept these flows. Also address the need for sediment ponds for the sediment generated off site.
- Identify the floodway boundary of the Tijeras Arroyo. This area needs to be dedicated on the plat as a drainage easement or right-of-way.
- A detail of the dissipator at the storm drain outfall is required. This should be designed to City standards and needs to be constructed to the bottom of the Tijeras Arroyo. Show any drainage easement required for this structure.
- The drainage channels that carry off-site flows through the lots should be in dedicated drainage easements. If these channels are to be maintained by the City of Albuquerque, then the channels must meet the minimum City maintenance requirements (such as 10' bottom width, minimum turning radii, etc.)

Donald S. Dixon, P.E.
Page 2

- Street hydraulics calculations should address the potential for hydraulic jumps per Section 22.3 in the D.P.M.
- Show details of the retaining walls.
- Spot elevations, top of curb elevations, flow arrows, right-of-way widths and easement widths should be shown on the grading plan. Pad elevations should also be indicated on this plan.
- All developed flows, i.e., all impervious area and new grading must be discharged to an improved public system.
- Financial guarantees for the storm drain improvements will be withheld until after a Letter of Map Revision (LOMR) is received from FEMA.

In general, the drainage report and grading plan should include the items listed in the checklists in Section 22.7 in the D.P.M. Please include the infrastructure list and a copy of the preliminary plat with your resubmittal.

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

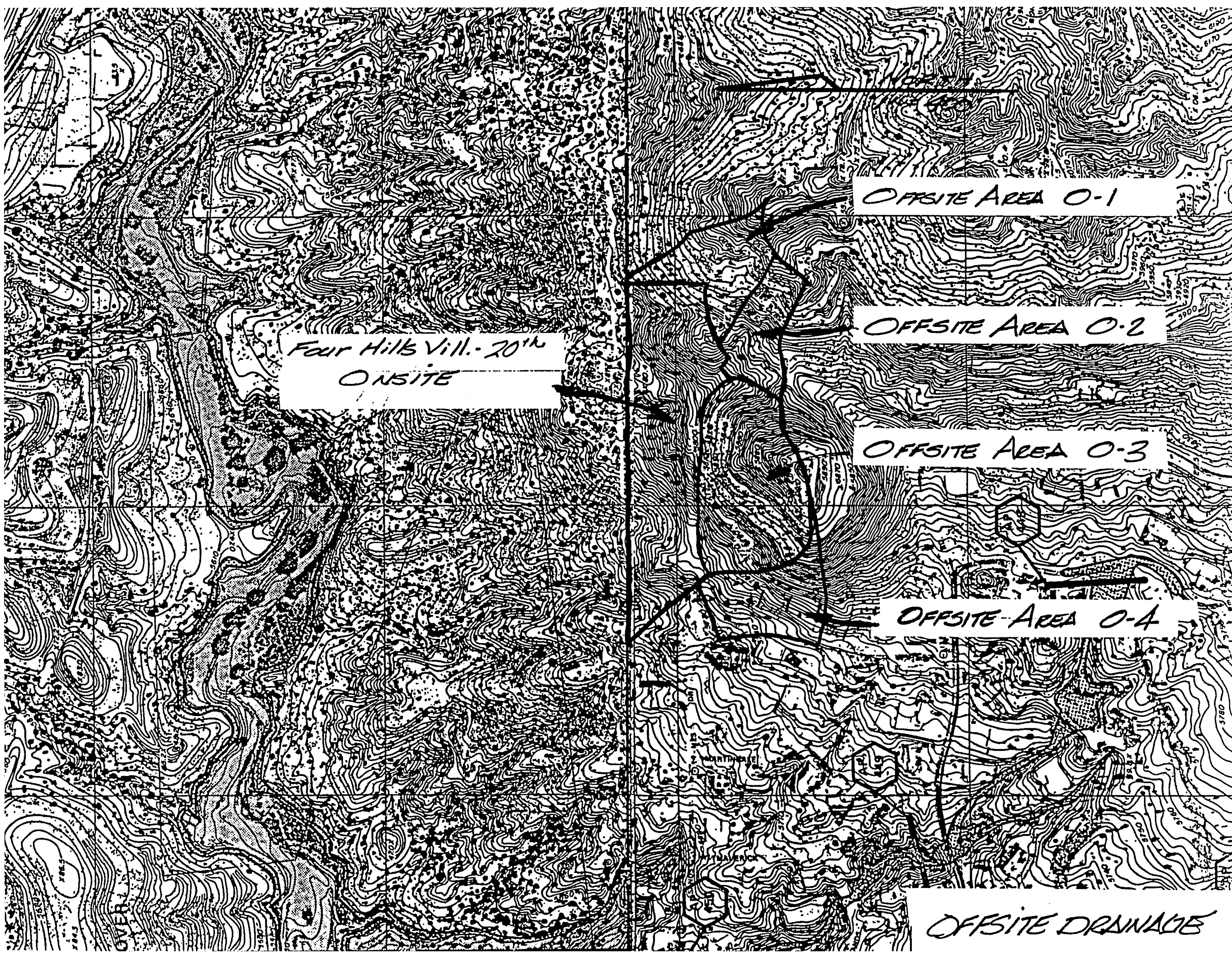
Sincerely,



Susan M. Calongne, P.E.
City/County Floodplain Administrator

SMC/d1/WPHYD/495

c: Andrew Garcia
Bob Foglesong, County PWD
John Kelly, AMAFCA
~~File~~



OFFSITE AREA 0-1

OFFSITE AREA 0-2

Four Hills Vill. - 20th
ONSITE

OFFSITE AREA 0-3

OFFSITE AREA 0-4

OFFSITE DRAINAGE

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
149 Jackson, N.E., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Project Fear Hill - 2046 Sheet 1 of 8
Drainage Calculations OCT 13 1988
By AR Chkd AR Job No. 454

HYDROLOGY SECTION

Hydrologic Calculations - Developed Condition
SCS Method

See enclosed Offsite Drainage Map for location of
Drainage Areas

ANALYSIS POINT	DRAINAGE AREA DESIGNATION	AREA (Ac)	CN	$T_c = T_P$ (min)	R (in)	Q _P (cfs)	C _P (in) (feet)
	Onsite	7.31	94	10	1.9	33.2	43.1
	Offsite O-1	2.4	89	10	1.6	10.9	17.4
1	Offsite O-2	1.9	89	10	1.6	8.6	13.8
2	Offsite O-2, portion of O-3	2.9	89	10	1.6	13.2	21.1
3	Offsite O-2 portion of O-3	3.3	89	10	1.6	15.0	24.0
4	Offsite O-2, portion of O-3	4.5	89	10	1.6	20.4	32.7
5	Offsite O-2 portion of O-3	4.8	89	10	1.6	21.8	34.9
6	Offsite O-2 of O-3	6.7	89	10	1.6	30.4	48.7
7	Onsite O-2 O-3 of O-4	9.4	90	10	1.65	42.7	70.4

See enclosed Grading & Drainage Plan for
location of analysis points

Site Hydraulics

At Augers Row 1, flow will be intercepted by double C catch basin, catch basin will be constructed @ low point of carb.

Determine inlet capacity of double C catch basin @ low pt.

$$\text{Area of throat} = 3.1985 \text{ ft}$$

$$\text{Area of grate} = 4.175 \text{ ft}^2 \text{ (net open area)}$$

$$\therefore Q_{\text{throat}} = 0.6 \times 3.198 \sqrt{2g h_2}$$

$$Q_{\text{grate}} = 0.6 \times 4.34 \sqrt{2g h_1}$$

<u>h</u>	<u>ST</u> <u>feet</u>	<u>SB</u> <u>feet</u>	<u>Dist</u>	<u>Dist - 15%</u> *	<u>Dist - 50%</u> **
1"	3.14	11.59	18.73	15.92	7.96
2"	4.45	16.39	20.84	17.71	8.86
3"	5.44	20.08	25.52	21.69	10.85
4"	6.29	23.18	29.47	25.05	12.52
5"	7.03	25.92	32.95	28.01	14.00
6"	7.70	28.40	36.10	30.69	15.34
7"	8.32	30.67	38.99	33.14	16.57
8"	8.89	32.79	41.68	35.43	17.71

* REDUCE by 15% because no upstream catch basin

** REDUCE by 50% for clogging

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
149 Jackson, N.E., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Project Fair Hills - 20th Sheet 3 of 8
Drainage Calculations Job No. 459
By BSF Chkd ✓ Date 8/1/88

At A.P. 1, expected flow $Q_{100} = 13.8 \text{ cfs}$, then
stream water will pond approximately 5" @ inlet.

Intermittent Required 1' depth for catch basin;
connector pipe = 24" RCP, $Q = 13.8 \text{ cfs}$

From plate 22.3 D-9, DPM

V. depth = 3.7 ft. Required

Top of curb @ catch basin @ elev = 28.05

Invert of catch basin @ elev = 23.41

4.64 ft o/c

Project Fair Hills - 20th Sheet 4 of 8
Drainage Cuts/Laricks Job No. 459
 By EF Chkd _____ Date 5/1/88

3-#4 continuous, #3 sharp.

#4 @ 12" o.c. vertically

3'-6"

1'-0"

1'-6"

GRATE RIGID

EXISTING GRANITE CURB/GUTTER

EXISTING GROUND

Determine depth of flow @ AP 2, 3 & 4,
from enclosed plan & profile of channel

a AP 2 , slope = 8.33%
 b AP 3 , slope = 4.35%
 c AP 4 , slope = 9.54%

∴ AP 2, $Q = 21.1 \text{ cfs}$, Slope = 8.33%
 $Q = \frac{1.486}{n} R^{4/3} S^{1/2} A$ $n = 0.045$

by trial/ error

$\Delta = 0.47'$

$A = 3.97 \text{ ft}^2$
 $P = 9.42 \text{ ft}$

$R^{4/3} = 0.5621$
 $Q = \frac{1.486}{0.045} \times 0.5621 \times 0.2086 \times 3.97 = 21.3 \text{ cfs}$
OK

$V = 5.37 \text{ ft/sec}$
 $F_r^2 = \frac{Q^2 B}{g A^3} = \frac{21.1^2 \times 8.94}{9 \times 3.97^3} = 1.976$
 $F_r = 1.41$

@ AP 3, $Q = 24 \text{ cfs}$, Slope = 4.35%
by trial/ error

$\Delta = 0.62'$

$A = 5.33 \text{ ft}^2$
 $P = 9.905 \text{ ft}$
 $R^{4/3} = 0.6616$

$Q = \frac{1.486}{0.045} \times 0.6616 \times 0.2086 \times 5.33 = 24.3 \text{ cfs}$
OK

$V = 4.56 \text{ ft/sec}$
 $F_r^2 = \frac{Q^2 B}{g A^3} = \frac{24^2 \times 9.24}{9 \times 5.33^3} = 1.0916 \Rightarrow F_r = 1.045$

@ AP 4, $Q = 32.7 \text{ cfs}$, Slope = 9.54%
by trial & error

$$V = 0.58 \text{ ft.}$$

$$A = 4.963 \text{ ft}^2$$

$$P = 9.776 \text{ ft}$$

$$R = 0.5077 \text{ ft}, R^{4/3} = 0.6364$$

$$Q = \frac{1.486}{0.045} \times 6364 \times 3.089 \times 4.963 = 32.2 \text{ OK}$$

$$V = 6.49 \text{ ft/sec}$$

$$Fr^2 = \frac{Q^2 B}{g A^3} = \frac{32.7^2 \times 9.16}{32 \times 4.963^3} = 2.488$$

$$Fr = 1.58$$

$\therefore$ AT AP 3 determines sequent depth of flow

$$Q = 24 \text{ cfs}, y_1 = 0.62 = d$$

$$y_2/y_1 = 1/2 (\sqrt{1 + 8 Fr^2} - 1) \quad \text{FOR rectangular channels}$$

$$\therefore y_2/0.62 = 1/2 (\sqrt{1 + 8 \times 1.045^2} - 1)$$

$$y_2 = 0.66 \text{ ft}$$

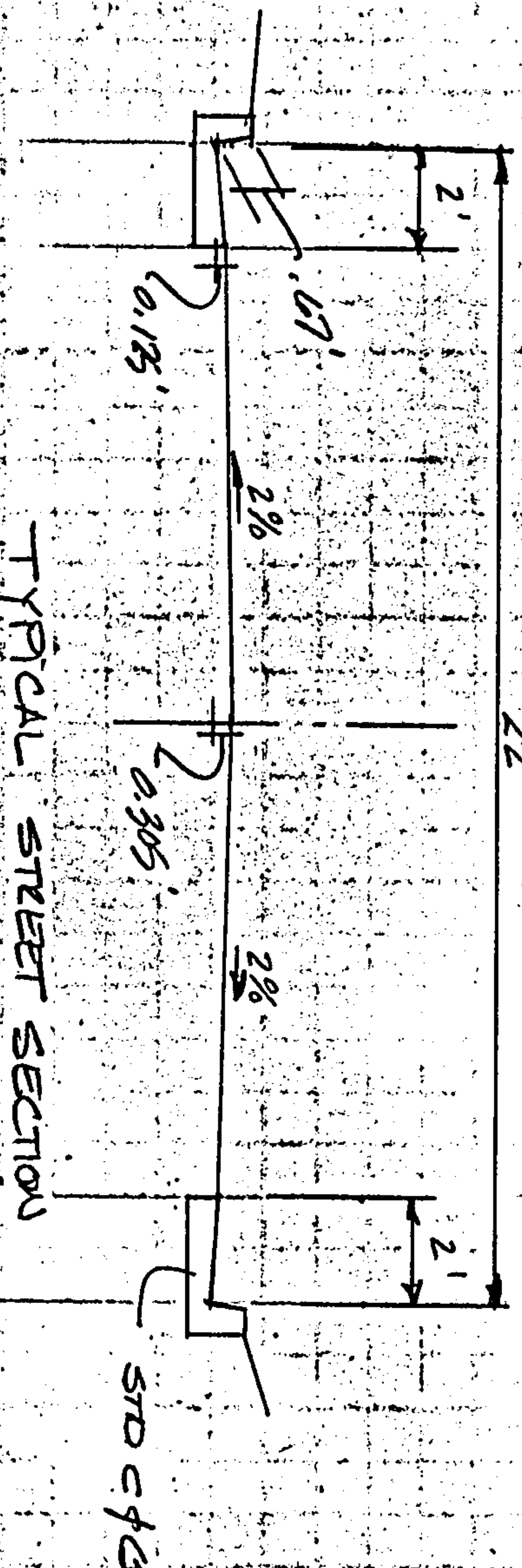
from page 61, Section 22.3, DPM
Required free board = 1.0 ft.

$$\text{Available free board} = 1.75 - .66 = 1.09 \text{ ft OK}$$

Determine depth of flow in Warm Sands Place
@ A.P. 6, Q = 48.7 cfs

Street width H.H. = 22 ft.

Slope = 2%, $n = 0.17$



by trial & error

$$A = 0.55 \text{ ft}^2 @ H$$

$$A = \left(\frac{.305 + .18}{2} \times 2 + \frac{1}{2} \times 9 \times .18 \right) 2 + 0.245 \times 22$$

$$= 2.59 + 5.139 = 7.729 \text{ ft}^2$$

$$P = 23.11 \text{ ft}, R = 0.3453 \text{ ft}, R^{2/3} = .4922$$

$$Q = \frac{1.486}{.017} \times .4922 \times .1414 \times 7.729 = 48.5 \text{ cfs} \quad \text{OK}$$

$$V = 6.08 \text{ ft/sec} \quad V \times D = 3.34 < 6.4$$

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
149 Jackson, N.E., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Project Earth Hills - 20th Sheet 8 of 8
Drainage Calculations Job No. 459
By ESF Chkd ✓ Date 8/1/88

Determine depth of flow in
Alarm Sands Drive @ AP 7

Street slope = 7% , Q = 76.4 cfs

H-H = 32'

from Plate 22.3 0-1, DPM

$$Q/2 = 76.4/2 = 38.2 \text{ cfs}$$

$$\therefore \Delta = 0.49 \text{ ft.} , V = 9.7 \text{ ft/sec.}$$

RECEIVED
OCT 13 1988

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
149 Jackson, N.E., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Project 4-Hill Village
Installment - Ref. HYDROLOGY SECTION
By JEM Chkd Date 10/10/88

6 hr - 100 year Rainfall Volume = 2.5" - 1.5"
24 hr - 100 year Rainfall Volume = 3.41"

Lot No. 1 - Drainage Area = 4.59 Acres
CN = 94, $R = 1.9''$ ∴ Runoff to be stored = 0.25 Ac-Ft
 $Q_P = 7.22$ cfs/in $Q_P = 13.7$ cfs (64s)
CN = 94, $R_{24h} = 2.7''$ ∴ Runoff to be stored = 0.36 Ac-Ft

Lot No. 2 - Drainage Area = 0.88 Acres
CN = 94, $R = 1.9''$ ∴ Runoff = 0.14 Ac-Ft
 $Q_P = 3.995$ cfs/in $Q_P = 7.6$ cfs 0.20 Ac-Ft
 $R_{24h} = 2.7''$ ∴ Runoff = 0.20 Ac-Ft

Lot No. 3 - Drainage Area = 0.85 Acres
CN = 94, $R = 1.9''$ ∴ Runoff = 0.135 Ac-Ft
 $Q_P = 3.86$ cfs/in $Q_P = 7.3$ cfs 0.19 Ac-Ft
 $R_{24h} = 2.7''$ ∴ Runoff = 0.19 Ac-Ft

Lot No. 4 - Drainage Area = 1.84 Ac
CN = 94, $R = 1.9''$ ∴ Runoff = 0.29 Ac-Ft
 $Q_P = 8.35$ cfs/in $Q_P = 15.9$ cfs 0.41 Ac-Ft
 $R_{24h} = 2.7''$ ∴ Runoff = 0.41 Ac-Ft

Lot No. 5 - Drainage Area = 2.23 Ac add 0.15 to total of 4.63 Ac
CN = 94, $R = 1.9''$ ∴ Runoff = 0.733 Ac-Ft
 $Q_P = 21.02$ cfs/in $Q_P = 39.9$ cfs 1.04 Ac-Ft
 $R_{24h} = 2.7''$ ∴ Runoff = 1.04 Ac-Ft

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
149 Jackson, N.E., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Project 4-Hills - 20th Insulation Sheet 2 of 4
By Reuben Fords Job No. 459
By JAN Chkd _____ Date 10.11.88

Lot No. 1 Required Storage = 0.36 Ac-Ft
Plenum Area / Capacity Conv

Elev	SF	Area	ΔE	Capacity Ac-Ft	Σ Capacity Ac-Ft
------	----	------	----	-------------------	---------------------

5710 350 .008

2 0.054

0.054

5712 2025 .046

2 0.0146

0.292

5714 4375 0.100

2 0.252

0.544

5716 6625 0.152

0.59

0.73

Sit Max WS @ 5714.5

0.3

Top of Dam @ 5716.0

Overflow @ 14.5 Must pass 13.7 @ 18" head

13.7 = 31 x L x 1/32

L = 4.42' 18" Pipe would have weir length of 4.71'

Lot No. 2 Required Storage = 0.20 Ac-Ft

Elev	SF	Area	ΔE	Capacity Ac-Ft	Σ Capacity Ac-Ft
------	----	------	----	-------------------	---------------------

5721 0 0

1 .0675 .0025

5722 800 .025

2 .028 .03

5724 1000 .023

2 .091 0.12

5726 2975 0.068

2 .198 .318

5728 3862 0.13

Sit Max WS @ 5722.0

Top of Dam @ 5728.0

Must pass 7.6 @ 6' head

7.6 = 31 x L x .5^{3/2}

L = 6.93'

27" Pipe would have weir length of 7.07'

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
149 Jackson, N.E., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Project 41 Hills - 20th Inlet / Inlet + Sheet 3 of 4
Retention Ponds Job No. 459
By JPM Chkd Date 10.11.88

Lot No 3 - Required Storage 0.19 Ac-Ft

Elev	Area	Area	Δd	Capacity Ac-Ft	Σ Capacity Ac-Ft
38	725	0.02	2'	0.04	0.04
40	938	0.022	2'	0.06	0.10
42	1638	0.04	2'	0.09	0.19
44	2413	0.055			

Set USC 44, Top of Dam @ 45
Must Pass 7.3 cfs @ 6' head

$$7.3 = 3.1 \times L \times 0.5^{3/2}$$

$$L = 6.66$$

27" Pipe will have weir-length of 7.07'

Lot No 4 - Required Storage = 0.21 Ac-Ft

Elev	Area	Area	Δd	Capacity Ac-Ft	Σ Capacity Ac-Ft
50	0	0	2'	0.016	0.016
52	688	0.016	2'	0.066	0.082
54	2175	0.05	2'	0.131	0.213
56	3525	0.08	2'	0.194	0.407
58	4988	0.114			

Set USC @ 56.5 Top of Dam @ 58.0

Must Pass 15.9 cfs @ 12' head

$$15.9 = 3.1 \times L \times 1^{-3/2}$$

$$L = 5.13'$$

24" Pipe will have weir-length of 6.28'

ANDREWS, ASBURY & ROBERT, INC.
CONSULTING ENGINEERS
149 Jackson, N.E., Albuquerque, N.M. 87108
Telephone (505) 265-6631

Project 4 Hills Village - 20th Sheet 4 of 4
Installation - Retention Pond Job No. _____
By JEM Chk'd _____ Date 10.11.88

Lot No. 5 - Required Storage = 1.04 ac-ft

Elev	SF	Area	Ac	Ad	Capacity Ac-ft	Σ Capacity Ac-ft
70	0	0		2	0.04	0.04
72	1675	0.04		2	0.14	0.18
74	4375	0.10		2	0.28	0.46
76	7925	0.18		2	0.44	0.90
78	11313	0.26		2	0.56	1.46
80	13000	0.30				
Set us @ 78.50						

Total Pond 80.0

Must Pond 39.9 cfs @ 1' Head

39.9 = 31 x 12 x 1^{3/2}
12.87' = L
48" - h = 12.57' L
39.9 = 3.1 x 12.57 x 1^{3/2}
1 = 1.02'

3905-

Contract Control or
Engineering Project
Number 8801049

#17

CONTRACT COVER PAGE
FOR ALL
PURCHASING & CIP CONTRACTS/AGREEMENTS

I. CONTRACT INFORMATION:

- A. TYPE OF AGREEMENT: Grant of Easement
(and is it new/renewal/extension/change order?)
B. RFP NO./DATE RFP OPENED/DATE RFP APPROVED AND BY WHOM n/a
C. SELECTION ADVISORY COMMITTEE RECOMMEND DATE n/a
D. PARTIES: CITY and William C. Kasper
(name of contracting party)

- E. PROJECT, EVENT OR PURPOSE: (name type of legal entity) Construction of slope & Cul-de-Sac
F. CONTRACT AMOUNT: n/a
(and is amount due city or does city pay? If amount due city, add Treasury office to distribution.)
G. CONTRACT TERMS, INCLUDING AMOUNT OF PAYMENTS n/a

- H. CONTRACT DATES: _____
I. FEDERAL TAX NUMBER: 1111
J. STATE OF NM TAX NUMBER: 1111
K. CITY OF ALBQ TAX REGISTRATION NUMBER: _____

II BUDGET INFORMATION:

- A. ACTIVITY/PROJECT NUMBER: _____
B. SOURCE OF FUNDS: n/a

III INSURANCE & BONDS INFORMATION:

- A. INSURANCE AND BONDS REQUIRED: n/a
(and are all necessary policies/forms attached?) _____

IV. CAO AND/OR CITY COUNCIL:

- A. TECHNICAL/PROFESSIONAL RFP WAIVED? n/a
B. ARCHITECTURAL/ENGINEERING EMERGENCY SELECTION? n/a
CAO'S SIGNATURE OBTAINED ON THE ABOVE? _____
C. EC/R NUMBER n/a DATES SUBMITTED n/a & APPROVED n/a

(This is side one of the contract cover page)

V. ROUTING INFORMATION:

	DATE DELIVERED	APPROVED BY	APPROVAL DATE
A. PURCHASING (OPERATING FUNDS)	<u>M/A</u>	<u>M/A</u>	<u>N/A</u>
B. ASSISTANT DIRECTOR/PWD-ENGINEERING	<u>5/30/87</u>	<u>WJH</u>	<u>5/21/88</u>
C. CITY ATTORNEY	<u>4-27-5/28</u>	<u>WJH</u>	<u>5-27-86</u>
D. USER DEPT.	<u>5-28-86</u>	<u>WJH</u>	<u>5-27-86</u>
E. CO. FOR RECORDING	<u>5-28-86</u>		
F. USER DEPT.			
G.			
H.			
I. CITY CLERK	<u>5-27-86</u>		

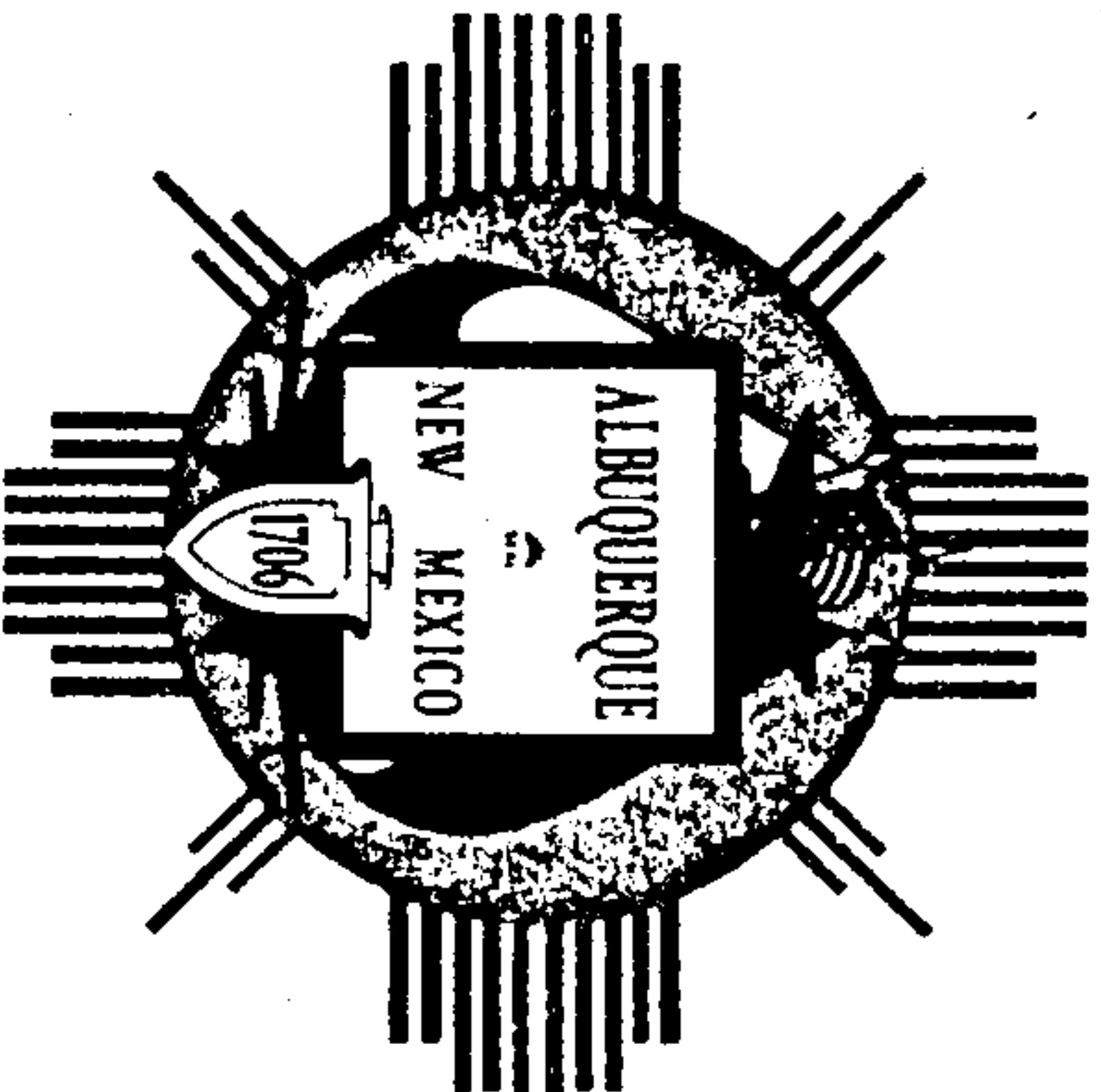
VI. DISTRIBUTION:

	DATE DELIVERED
A. USER DEPARTMENT	<u>5-28-86</u>
B. CITY CLERK	<u>5-28-86</u>
C. DEVELOPER	<u>5-28-86</u>
D. TRANSPORTATION DEVELOPMENT	<u>5-28-86</u>
E. FILE	<u>5-28-86</u>

VII. PROPERTY DESCRIPTION:

A. DESCRIPTION OF PROPERTY Lot 14, Block 4
 B. SUBDIVISION AND/OR LOCATION FAIR HILLS VILLAGE 14TH INSTALLMENT
 C. SUBDIVIDER OR DEVELOPER William G. Layne
 D. ADDRESS OR LOCATION OF PROPERTY HIDEWAY, CANE, SE
 E. NAME AND ADDRESS OF OWNER/SELLER/LESSOR/GRANTOR/ETC P.O. Box 2386, Alvarado, TX
 F. IF APPRAISED, NAME/ADDRESS OF APPRAISER AND BASIS OF APPRAISAL, INCLUDING RELATED VALUES WJH
 G. IF TITLE SEARCH, NAME AND ADDRESS OF TITLE COMPANY WJH
 H. EASEMENTS OR ENCROACHMENTS (& ARE THEY CITY OR OTHER?) WJH
 I. RESTRICTIONS WJH
 J. IF PROPERTY BEING SOLD, DATES DETERMINED NON-ESSENTIAL FOR MUNICIPAL PURPOSES WJH
 K. SUBDIVISION IMPROVEMENT/SIDEWALK VARIANCE: INFRASTRUCTURE TO BE CONSTRUCTED WJH

(This is side two of the contract cover page)



KEN SCHULTZ
MAYOR

City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

May 26, 1988

Mr. William C. Layne
P. O. Box 23286
Alexandria, VA

RE: FOUR HILLS VILLAGE, 14TH INSTALLMENT, LOT 11, BLOCK 4
CONSTRUCTION AND SLOPE EASEMENT

Dear Mr. Layne:

Enclosed please find an executed copy of the Grant of Easement for the
above noted project.

Please call me if I may be of further assistance.

Sincerely,

Della Gallegos, Administrative Assistant
Development Div./Design Review Section

Enclosure (1)

cc: Project File

DG/trs

PUBLIC WORKS DEPARTMENT

Walter H. Nickerson, Jr., P.E.
Assistant Director Public Works

ENGINEERING GROUP

Telephone (505) 768-2500

AN EQUAL OPPORTUNITY EMPLOYER

8847209

GRANT OF EASEMENT

02 MAY 1988

RECEIVED

335

Transportation Development

This grant of Easement, between William C. Layne ("Grantor"), whose address is P.O. Box 23286, Alexandria, Virginia, 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 at Lot 11, Block 4, Four Hills Village, Fourteenth Installment in Bernalillo County, New Mexico (the "Property").

2. Grant of Easement. The Grantor grants to the City a permanent easement ("Easement") in, over, upon and across the Property for Construction of slope and cul-de-sac. The Easement is more particularly described in the attached Exhibit A.

The grant of the Easement includes the right of the City of 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 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 until terminated.

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 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

GRANTOR:

By: William C. Payne
Its: (owner)
Date: 4-8-88

Approved:

By: [Signature]
Title: City Engineer
Dated: 5/20/88

STATE OF New Mexico)
COUNTY OF Bernalillo) SS

The foregoing instrument was acknowledged before me this 8th day of April, 1988, by William C. Payne.

[Signature]
NOTARY PUBLIC

My Commission Expires:

12/16/91

STATE OF NEW MEXICO
COUNTY OF BERNALILLO
FILED FOR RECORD

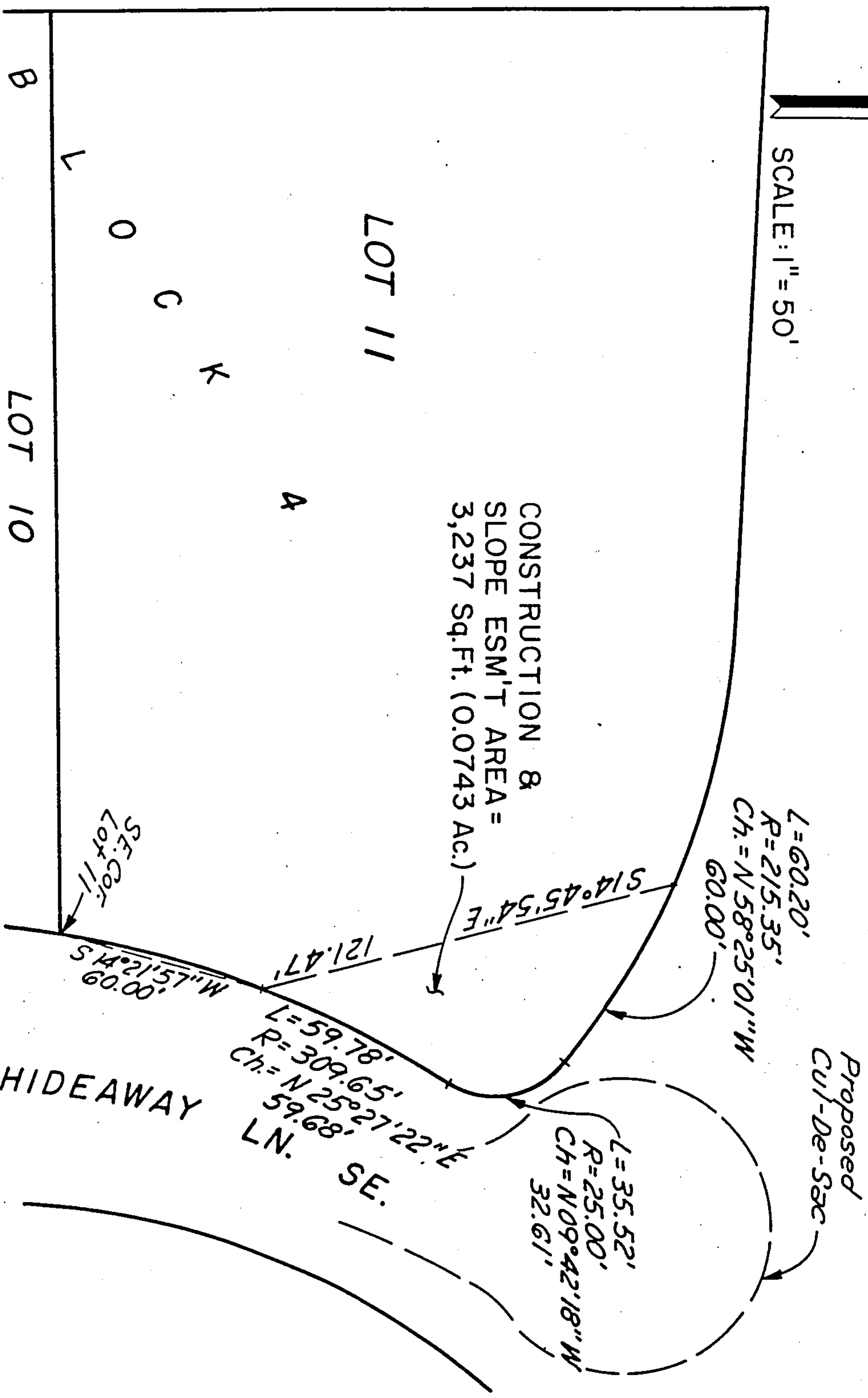
88 MAY 25 AM 9:55

Ms 6154 pg 335-337
GLADYS M. DAVIS
CO CLERK & RECORDER
[Signature]

CONSTRUCTION AND SLOPE EASEMENT
LOT 11, BLOCK 4
FOUR HILLS VILLAGE, FOURTEENTH INSTALLMENT
ALBUQUERQUE, NEW MEXICO

U 337

EXHIBIT 'A'



DESCRIPTION

A CERTAIN TRACT OF LAND SITUATE WITHIN SECTION 35, TOWNSHIP 10 NORTH, RANGE 4 EAST, N.M.P.M., BEING A PORTION OF LOT ELEVEN (11) IN BLOCK FOUR (4) OF FOUR HILLS VILLAGE, FOURTEENTH INSTALLMENT, AN ADDITION TO THE CITY OF ALBUQUERQUE, NEW MEXICO, AS THE SAME IS SHOWN ON THE PLAT OF SAID ADDITION FILED IN THE OFFICE OF THE COUNTY CLERK OF BERNALILLO COUNTY, NEW MEXICO ON OCTOBER 30, 1974 IN PLAT BOOK D6, PAGE 94 OF SAID COUNTY RECORDS, AND BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

BEGINNING AT A POINT ON CURVE ON THE EAST LINE OF SAID LOT 11, FROM WHENCE THE SOUTHEAST CORNER OF SAID LOT 11 BEARS S 14°21'57" W, 60.00 FEET DISTANT; AND RUNNING THENCE, FROM SAID POINT OF BEGINNING.

NORTHEASTERLY, 59.78 FEET ALONG THE ARC OF A CURVE BEARING TO THE RIGHT HAVING A RADIUS OF 309.65 FEET AND A CHORD WHICH BEARS N 25°27'22" E, 59.68 FEET TO A POINT OF REVERSE CURVATURE; THENCE,

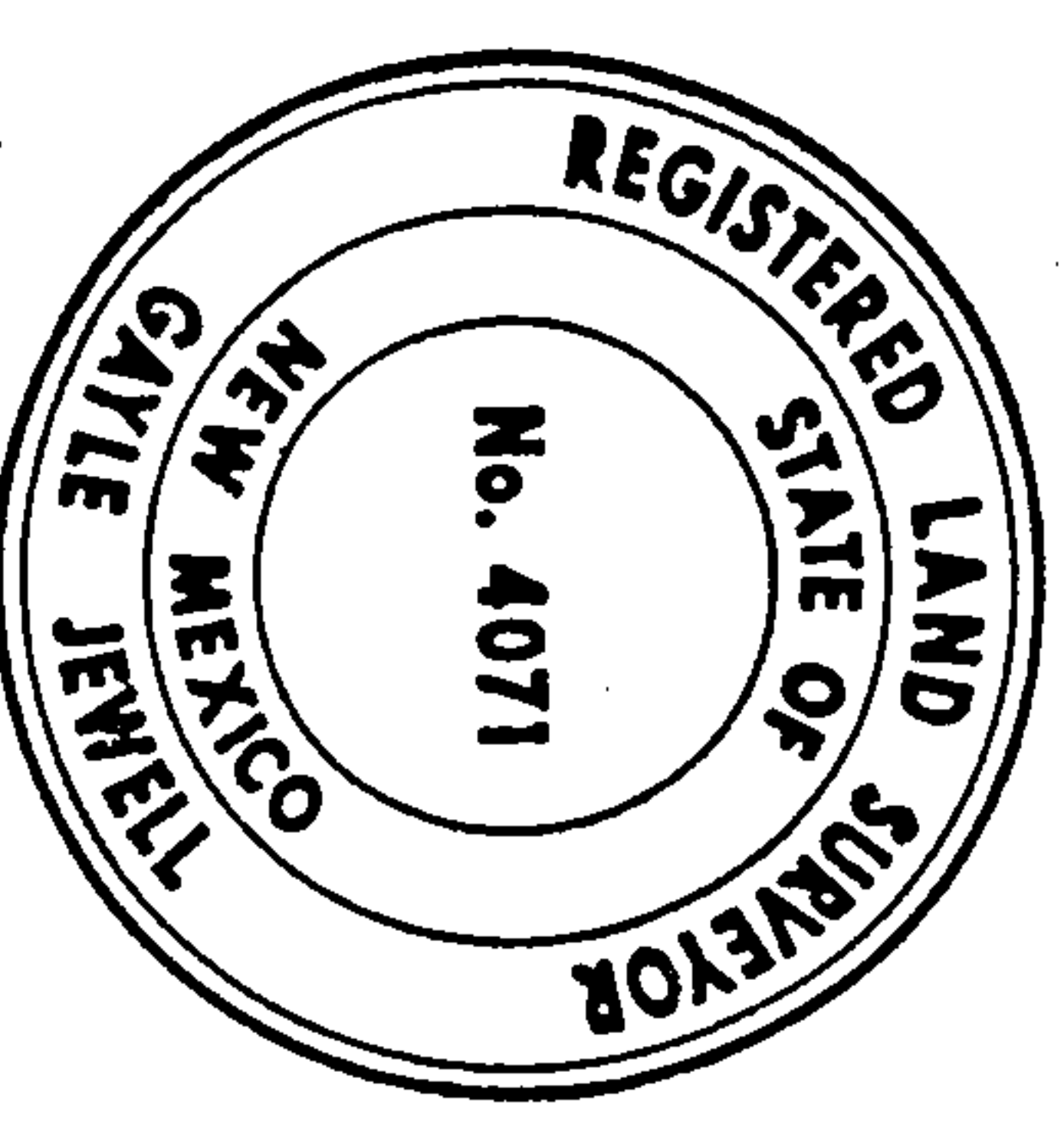
NORTHWESTERLY, 35.52 FEET ALONG THE ARC OF A CURVE BEARING TO THE LEFT HAVING A RADIUS OF 25.00 FEET AND A CHORD WHICH BEARS N 09°42'18" W, 32.61 FEET TO A POINT OF COMPOUND CURVATURE; THENCE,

NORTHWESTERLY, 60.20 FEET ALONG THE ARC OF A CURVE BEARING TO THE LEFT HAVING A RADIUS OF 215.35 FEET AND A CHORD WHICH BEARS N 58°25'01" W, 60.00 FEET TO THE NORTHWESTERLY CORNER OF THE TRACT HEREIN DESCRIBED; THENCE,

S 14°45'54" E, 121.47 FEET TO THE SOUTHERLY CORNER AND POINT OF BEGINNING OF THE TRACT HEREIN DESCRIBED, CONTAINING 0.0743 ACRES (3,237 SQUARE FEET), MORE OR LESS.

SURVEYOR'S CERTIFICATE

I, GAYLE D. JEWELL, A REGISTERED LAND SURVEYOR UNDER THE LAWS OF THE STATE OF NEW MEXICO, DO HEREBY CERTIFY THAT THIS PLAT AND DESCRIPTION WERE PREPARED UNDER MY SUPERVISION AND DIRECTIONS, AND THAT THE SAME ARE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.



GAYLE D. JEWELL, L.S. NO. 4071

4-01-88

DATE



ANDREWS, ASBURY & ROBERT, INC.
Consulting Engineers

149 Jackson, NE, Albuquerque, New Mexico 87108
(505) 265-6631

Don't return file

John A. Andrews, P.E.
Charles T. Asbury, P.E.
John B. Robert, P.E. & L.S. (1915 - 1984)
James E. Millington, P.E. - V.P.

April 27, 1988

RECEIVED

27 APR 1988

Transportation Development

Mr. David Harmon
Transportation Development
Public Works Department
City of Albuquerque
Post Office Box 1293
Albuquerque, New Mexico 87103

HAND DELIVERED

SUBJECT: FOUR HILLS VILLAGE - 20th INSTALLMENT
DRB-87-90 (ZONE ATLAS MAP M-23)

Dear Mr. Harmon:

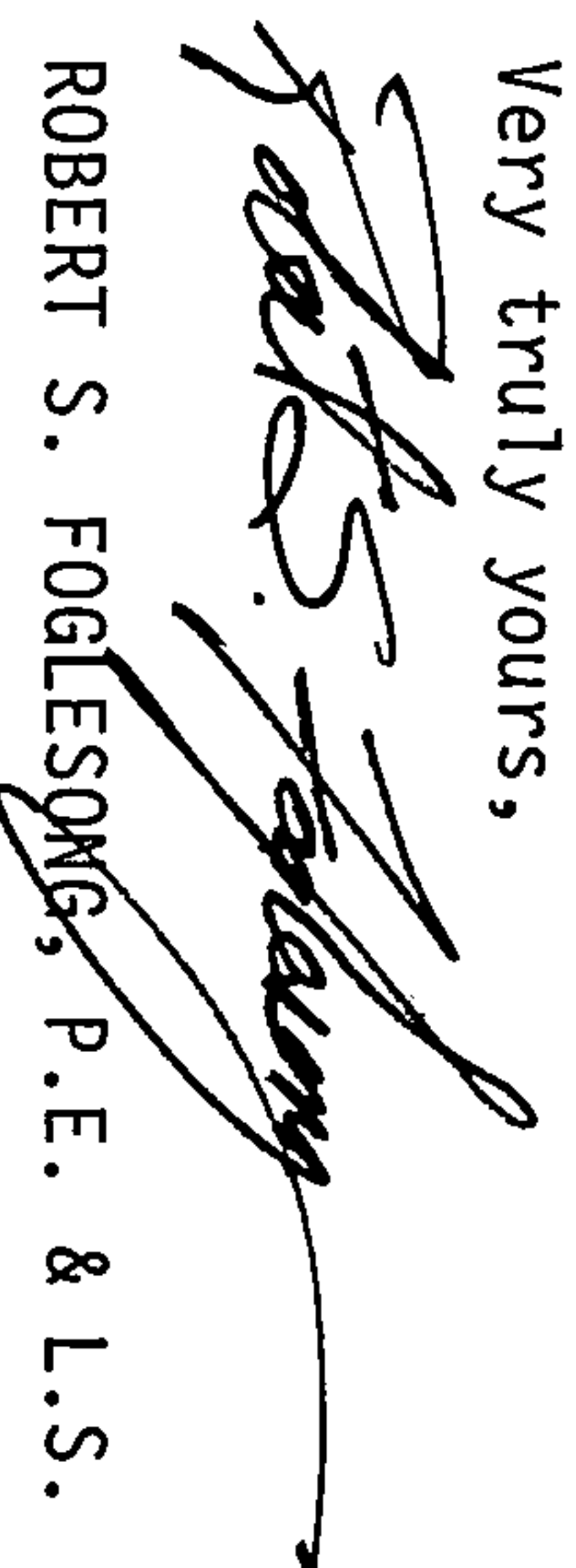
On April 1, 1988, Mr. William C. Layne, record owner of Lot 11, Block 4, Four Hills Village, Fourteenth Installment, met with representatives of the subject project, at our offices, to discuss the granting of a construction and slope easement across the northwest portion of said Lot 11. (See enclosed Exhibit "A")

After construction options and legal ramifications were presented to Mr. Layne, he agreed to grant an easement to Mr. John C. Evans, Agent, Small Business Administration, Receiver for New Mexico Capital Corporation, for the construction of a slope and cul-de-sac.

Consideration will be paid to Mr. Layne, for granting said easement, by Mr. Evans in the sum of one dollar.

Please call if you have any questions.

Very truly yours,

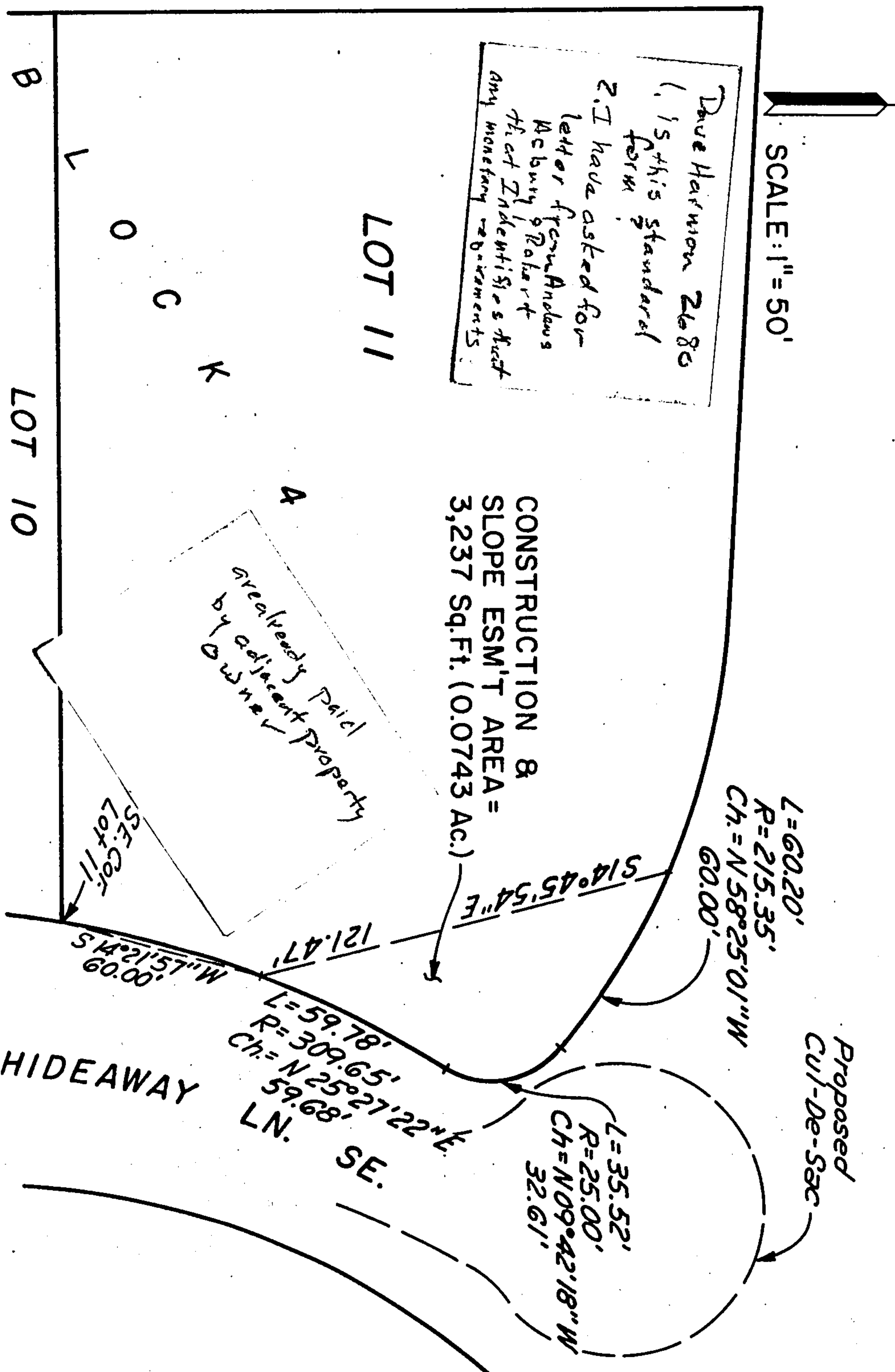

ROBERT S. FOGLESONG, P.E. & L.S.

kat/459
Enclosure

cc: Mr. John Evans, Small Business Administration

CONSTRUCTION AND SLOPE EASEMENT
LOT 11, BLOCK 4
FOUR HILLS VILLAGE, FOURTEENTH INSTALLMENT
ALBUQUERQUE, NEW MEXICO

EXHIBIT 'A'



DESCRIPTION

A CERTAIN TRACT OF LAND SITUATE WITHIN SECTION 35, TOWNSHIP 10 NORTH, RANGE 4 EAST, N.M.P.M., BEING A PORTION OF LOT ELEVEN (11) IN BLOCK FOUR (4) OF FOUR HILLS VILLAGE, FOURTEENTH INSTALLMENT, AN ADDITION TO THE CITY OF ALBUQUERQUE, NEW MEXICO, AS THE SAME IS SHOWN ON THE PLAT OF SAID ADDITION FILED IN THE OFFICE OF THE COUNTY CLERK OF BERNALILLO COUNTY, NEW MEXICO ON OCTOBER 30, 1974 IN PLAT BOOK D6, PAGE 94 OF SAID COUNTY RECORDS, AND BEING MORE PARTICULARLY DESCRIBED AS FOLLOWS:

BEGINNING AT A POINT ON CURVE ON THE EAST LINE OF SAID LOT 11, FROM WHENCE THE SOUTHEAST CORNER OF SAID LOT 11 BEARS S 14°21'57" W, 60.00 FEET DISTANT; AND RUNNING THENCE, FROM SAID POINT OF BEGINNING.

NORTHEASTERLY, 59.78 FEET ALONG THE ARC OF A CURVE BEARING TO THE RIGHT HAVING A RADIUS OF 309.65 FEET AND A CHORD WHICH BEARS N 25°27'22" E, 59.68 FEET TO A POINT OF REVERSE CURVATURE; THENCE,

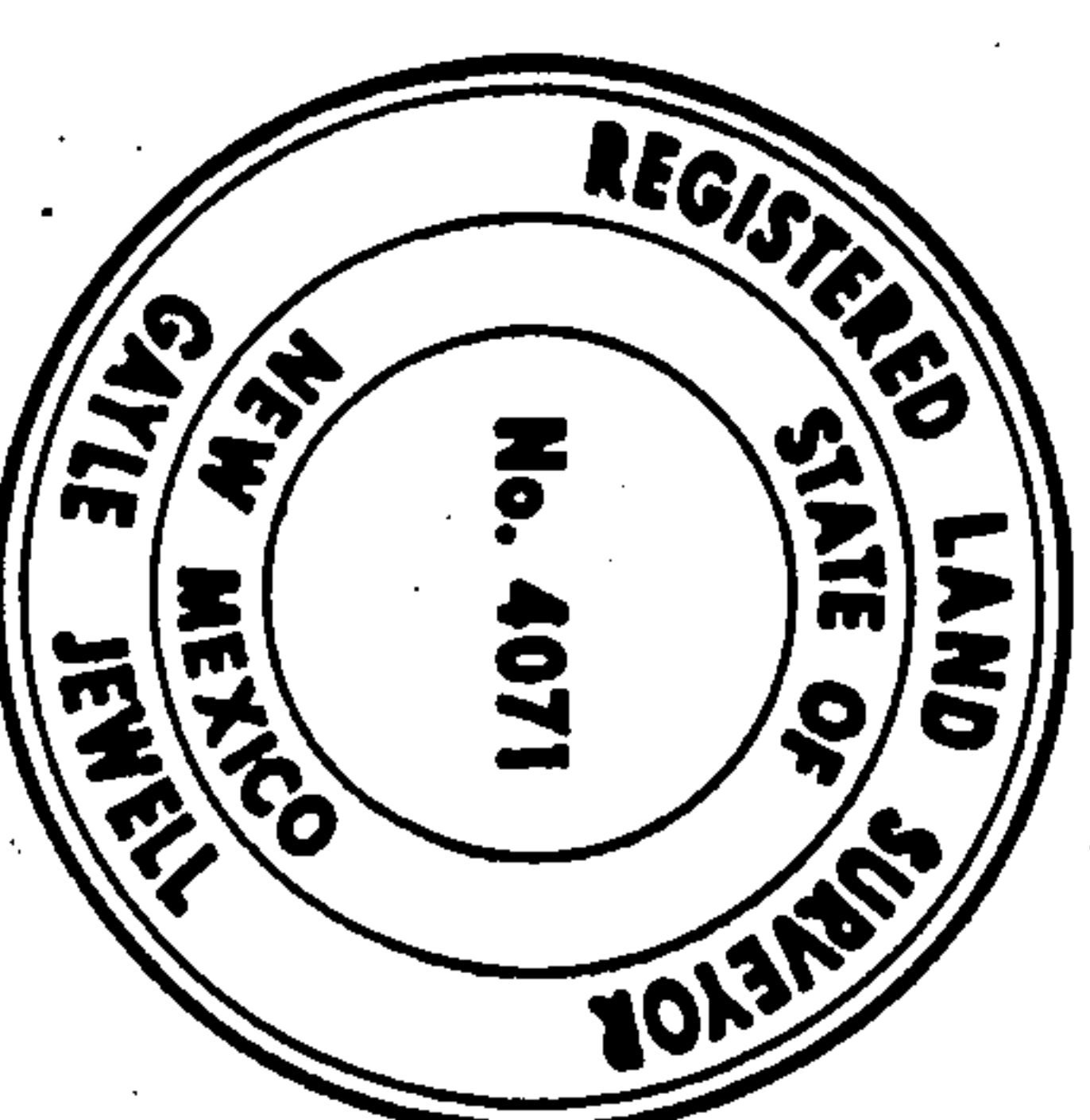
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NORTHWESTERLY, 60.20 FEET ALONG THE ARC OF A CURVE BEARING TO THE LEFT HAVING A RADIUS OF 215.35 FEET AND A CHORD WHICH BEARS N 58°25'01" W, 60.00 FEET TO THE NORTHWESTERLY CORNER OF THE TRACT HEREIN DESCRIBED; THENCE,

S 14°45'54" E, 121.47 FEET TO THE SOUTHERLY CORNER AND POINT OF BEGINNING OF THE TRACT HEREIN DESCRIBED, CONTAINING 0.0743 ACRES (3,237 SQUARE FEET), MORE OR LESS.

SURVEYOR'S CERTIFICATE

I, GAYLE D. JEWELL, A REGISTERED LAND SURVEYOR UNDER THE LAWS OF THE STATE OF NEW MEXICO, DO HEREBY CERTIFY THAT THIS PLAT AND DESCRIPTION WERE PREPARED UNDER MY SUPERVISION AND DIRECTIONS, AND THAT THE SAME ARE TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.



Gayle D. Jewell
GAYLE D. JEWELL, L.S. NO. 4071

4-01-88
DATE



ANDREWS, ASBURY & ROBERT, INC.
Consulting Engineers

149 Jackson, NE, Albuquerque, New Mexico 87108
(505) 265-6631

John A. Andrews, P.E.
Charles T. Asbury, P.E.
John B. Robert, P.E. & L.S. (1915 - 1984)
James E. Millington, P.E. - V.P.

DWG (DRB) + file
cy & hr only; JDBW-info

May 6, 1988

RECEIVED

09 MAY 1988

Transportation Development

Mr. David Harmon
Transportation Development
Public Works Department
City of Albuquerque
Post Office Box 1293
Albuquerque, New Mexico 87103

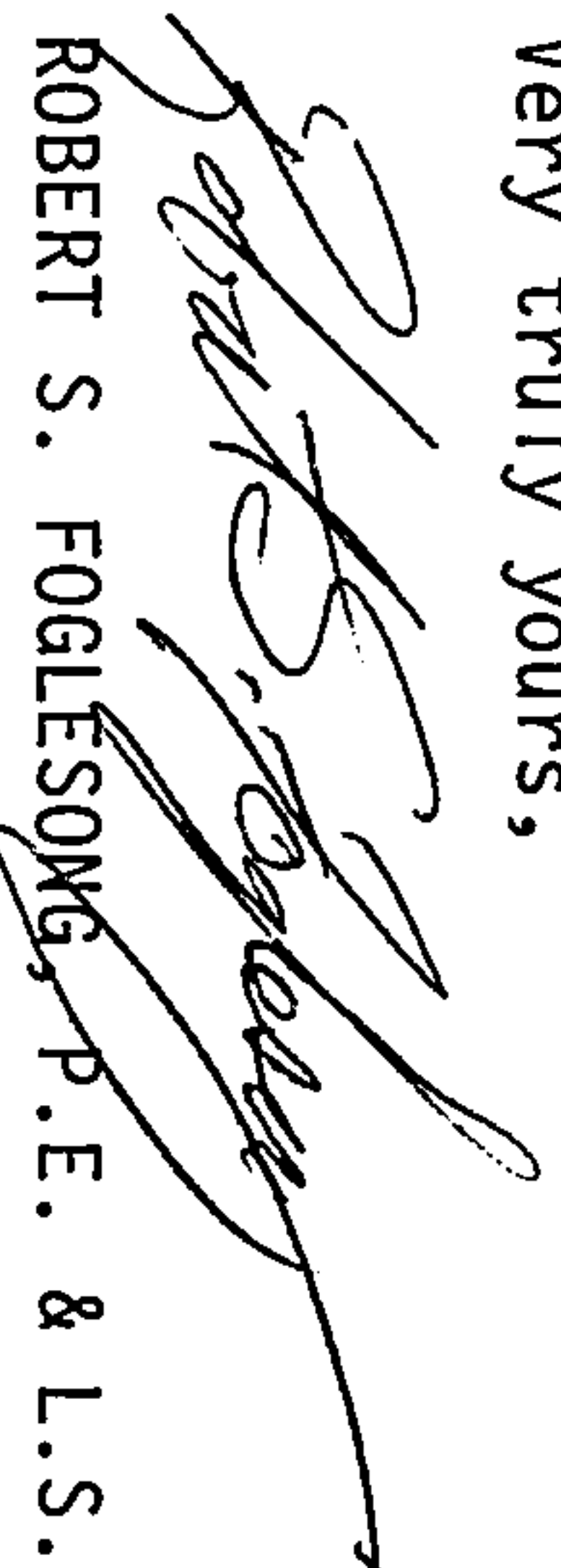
SUBJECT: ~~FOUR HILLS VILLAGE - 20th INSTALLMENT~~
DRB-87-90 (ZONE ATLAS MAP M-23)

Dear Mr. Harmon:

Please find enclosed a copy of the check issued to Mr. William C. Layne by the Small Business Administration, Receiver for New Mexico Capitol Corporation, for granting of an easement on Mr. Layne's property, for the subject project.

Please call if you have any questions.

Very truly yours,


ROBERT S. FOGLESONG, P.E. & L.S.

kat/459
Enclosure
cc: John Evans, Small Business Administration

SMALL BUSINESS ADMINISTRATION, RECEIVER

5-85

2100

FOR NEW MEXICO CAPITOL CORPORATION

3939 SAN PEDRO, NE, BLDG. F, SUITE A

ALBUQUERQUE, NM 87110

(505) 884-3600

May 5 19 88

95-32
1070

PAY
TO THE
ORDER OF **WILLIAM C. LAYNE**

\$ **1.00**

-----ONE DOLLAR AND NO CENTS-----

DOLLARS

SEEWEST

BANK

Uptown Office
(505) 765-2211
P.O. BOX 25500
Albuquerque, NM
87125-5500
of Albuquerque, N.A.

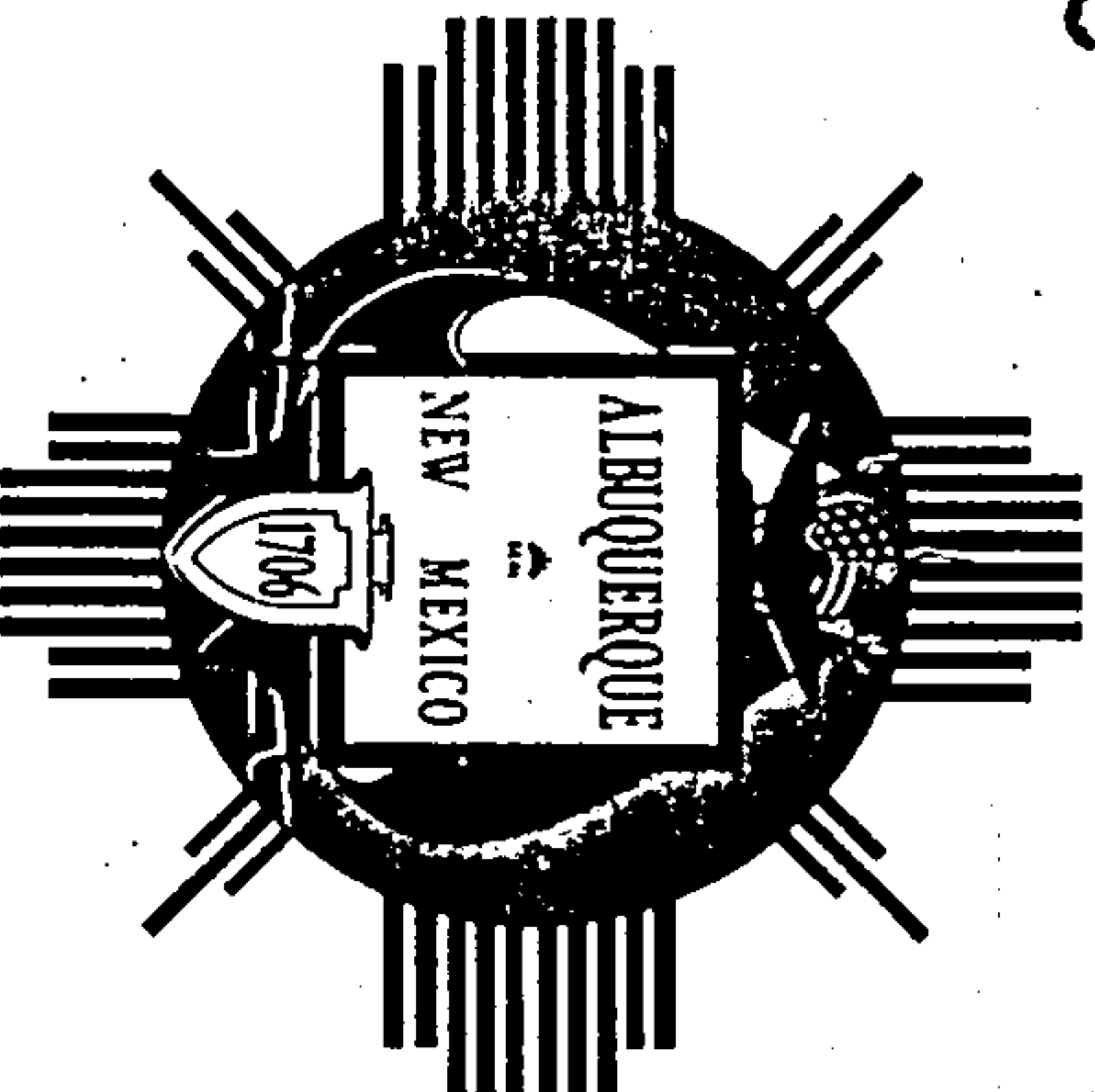
OVER \$1000.00 TWO SIGNATURES REQUIRED

FOR 4 Hills Village, DRB-87-90 Map M-23

⑈002100⑈ ⑆107000327⑆

62 1301 4⑈

[Signature]



City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

KEN SCHULTZ
MAYOR

October 31, 1988

James E. Millington, P.E.
Andrews, Asbury & Robert, Inc.
149 Jackson, NE
Albuquerque, NM 87108

RE: REVISED GRADING AND DRAINAGE PLAN OF FOUR HILLS VILLAGE 20th
INSTALLMENT, RECEIVED OCTOBER 13, 1988, FOR PRELIMINARY PLAT
APPROVAL. (M-23/D11)

Dear Mr. Millington:

The above referenced submittal, revised 10/13/88, is approved for Preliminary Plat. Prior to Final Plat sign off by the City Engineer, a Subdivision Improvements Agreement must be executed along with the required infrastructures being either built and accepted, or financially guaranteed.

The on-site retention ponding was required since it could not be demonstrated that all the developed flows could be diverted to the street, and would discharge across downstream private property without the benefit of drainage easements.

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

Cordially;

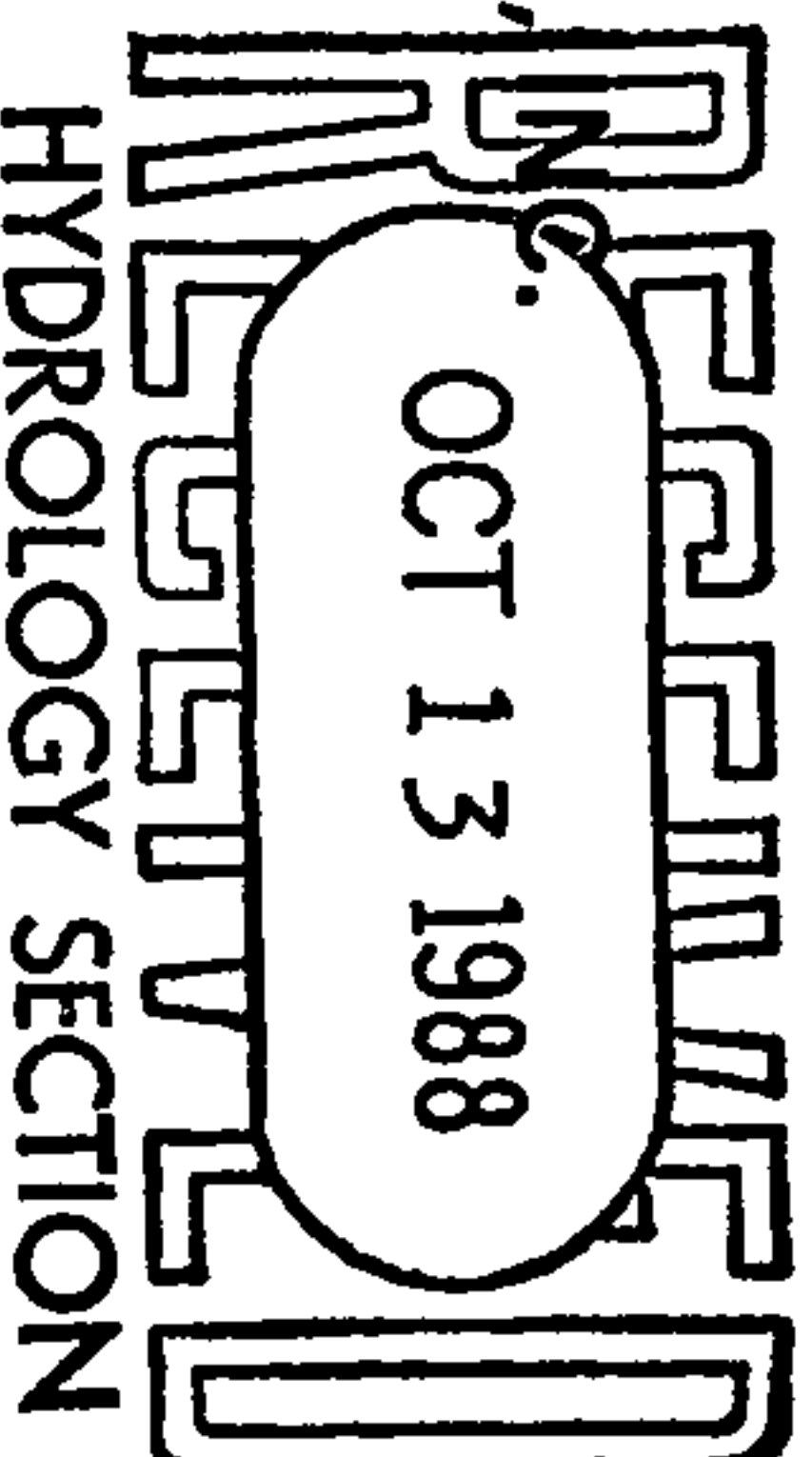
Roger A. Green
Roger A. Green, P.E.
C.E. / Hydrology Section

RAG/(WP+495)



ANDREWS, ASBURY & ROBERT, Inc.
Consulting Engineers

149 Jackson, NE, Albuquerque, New Mexico 87108
(505) 265-6631



John A. Andrews, P.E.
Charles T. Asbury, P.E.
John B. Robert, P.E. & L.S. (1915 - 1984)
James E. Millington, P.E. - V.P.

October 13, 1988

Mr. Roger Green

City of Albuquerque
Public Works Department
Hydrology Section
P. O. Box 1293
Albuquerque, N.M. 87103

SUBJECT: FOUR HILLS VILLAGE - 20TH INSTALLMENT

Dear Mr. Green:

This letter constitutes a revised drainage plan for Four Hills Village - 20th Installation.

The subject property is located west of Hideaway Lane SE and east of Warm Sands Drive SE and comprises approximately 7.31 acres south of the municipal limits boundary as shown on the attached Vicinity Map (Zone Atlas Map No. M-23)

Presently, offsite areas to the south drain north through the subject project. The offsite drainage areas are shown on the accompanying Offsite Drainage Map. The SCS soil classification for this area is R0F (rock outcrop).

	AREA (ac)	CN	$T_c I_p$ (min.)	R (in)	q_p (cfs/in)	Q_p (cfs)
Onsite	7.31	89	10	1.6	33.2	53.1
Offsite						
0-1	2.4	89	10	1.6	10.9	17.4
0-2	1.9	89	10	1.6	8.6	13.8
0-3	4.8	89	10	1.6	21.8	34.9

Both offsite and onsite flows drain to the north, with a combined flow of 119.2 CFS.

Four Hills Village - 20th Installment will be developed as a very exclusive single-family residential subdivision. It is proposed to leave the building sites in as natural condition as possible. As an initial construction project it is proposed to provide access to the site, together with the necessary utilities, as shown on the enclosed Grading & Drainage Plan (sheet 1 of 1). Hideaway Lane SE will be extended to the north, and a cul-de-sac will be constructed to the east of Warm Sands Drive SE. A drainage channel will be constructed along the south side of the project as shown on the Grading and Drainage Plan.

Page 2
Mr. Roger Green
Four Hills Village - 20th Instalment

Offsite flows generated from the south (Areas 0-2 & 0-3, Offsite Drainage Map) will be intercepted by the drainage channel and flow west to the cul-de-sac. The cul-de-sac drains west to Warm Sands Drive and away from the property. Cross sections and hydraulic calculations for this drainage channel are attached.

After development it is assumed that a maximum of 25% of each building site will be impervious. Then after development,

	AREA (ac)	CN	$T_c T_p$ (min.)	R (in)	q_p (cfs/in)	Q_p (cfs)
Onsite	7.31	94	10	1.9	33.2	63.1
Offsite						
0-1	2.4	89	10	1.6	10.9	17.4
0-2	1.9	89	10	1.6	8.6	13.8
0-3	4.8	89	10	1.6	21.8	34.9

Flows generated for each lot will be intercepted and retained in retention ponds sized to hold the 100 year, 24 hour rainfall, thus no flow will cross the northern boundary of the tract. Calculations for the retention ponds are attached.

If you have any questions, please contact me.

Very truly yours,



JAMES E. MILLINGTON, P.E.

Enclosures: Drainage Information Sheet
Sketch Plat
Grading and Drainage Plan
Four Hills - 20th Drainage Calculations (pages 1-8)
Retention Pond Calculations (pages 1-4)
Vicinity Map
Conference Recap (sheets 1 and 2)
Offsite Drainage Map

JEM/tac-459

DRAINAGE INFORMATION SHEET
Four Hills Village -

PROJECT TITLE: 20th Installation ZONE ATLAS/DRNG. FILE #: M-23/D11

LEGAL DESCRIPTION: _____

CITY ADDRESS: N/A _____

ENGINEERING FIRM: Andrews, Asbury & Robert, Inc. CONTACT: Mr. Jim Millington - _____

ADDRESS: 149 Jackson Street, N.E. PHONE: 265-6631 _____

OWNER: Small Bus. Adminis., Receiver for CONTACT: Mr. John Evans
New Mexico Capital Corporation

ADDRESS 3939 San Pedro, N.E. PHONE: 884-3600 _____

ARCHITECT: N/A CONTACT: _____

ADDRESS: _____ PHONE: _____

SURVEYOR: Andrews, Asbury & Robert, Inc. CONTACT: Mr. Jim Millington _____

ADDRESS: 149 Jackson Street, N.E. PHONE: 265-6631 _____

CONTRACTOR: N/A CONTACT: _____

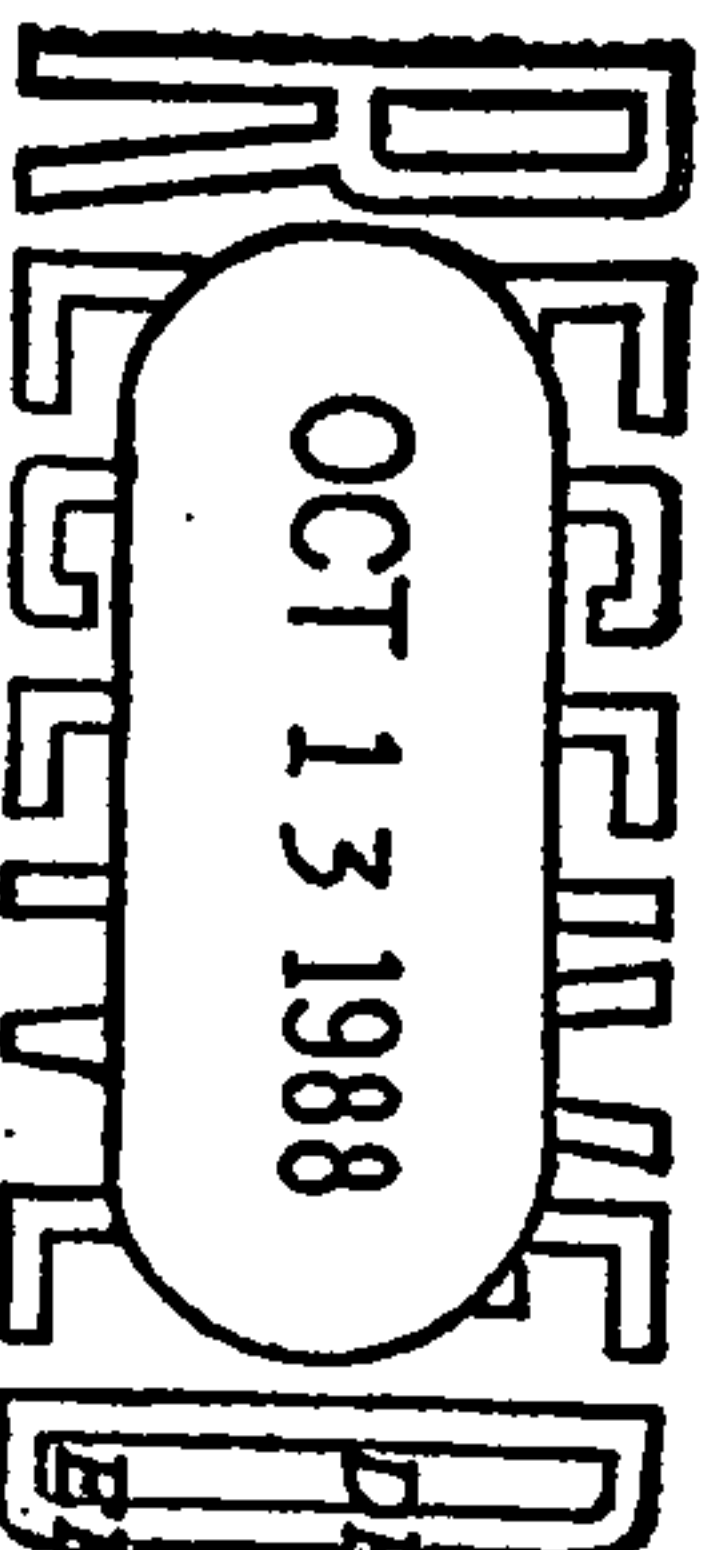
ADDRESS: _____ PHONE: _____

PRE-DESIGN MEETING:

☒ YES DRB NO. _____

☐ NO EPC NO. _____

☒ COPY OF CONFERENCE RECAP
SHEET PROVIDED PROJECT NO. _____



TYPE OF SUBMITTAL:

CHECK TYPE OF APPROVAL SOUGHT:

☐ DRAINAGE REPORT ☐ SKETCH PLAT APPROVAL

☒ DRAINAGE PLAN ☒ PRELIMINARY PLAT APPROVAL

☐ CONCEPTUAL GRADING & DRAIN. PLAN ☐ SITE DEVELOPMENT PLAN APPROVAL

☐ GRADING PLAN ☐ FINAL PLAT APPROVAL

☐ EROSION CONTROL PLAN ☐ BUILDING PERMIT APPROVAL

☐ ENGINEER'S CERTIFICATION ☐ FOUNDATION PERMIT APPROVAL

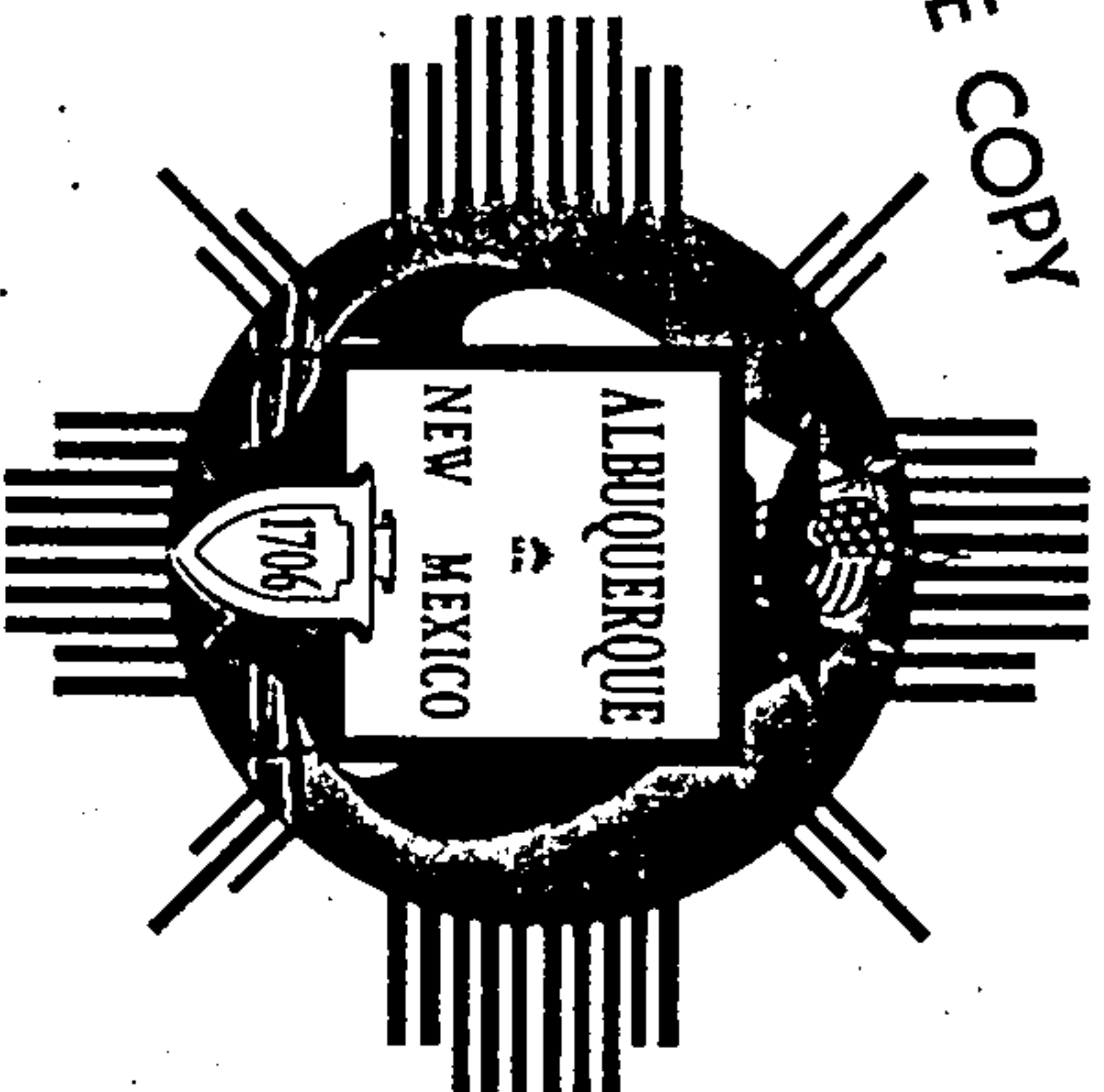
☐ CERTIFICATE OF OCCUPANCY APPROVAL

☐ ROUGH GRADING PERMIT APPROVAL

DATE SUBMITTED: 10-13-88 ☐ GRADING/PAVING PERMIT APPROVAL

BY: [Signature] OTHER _____ (SPECIFY)

FILE COPY



City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

Ken Schultz
Mayor

UTILITY DEVELOPMENT DIVISION
HYDROLOGY SECTION
(505) 768-2650

November 13, 1987

John Andrews, P.E.
Andrews, Asbury & Robert, Inc.
149 Jackson, NE
Albuquerque, New Mexico 87108

RE: GRADING & DRAINAGE PLAN SUBMITTAL OF FOUR HILLS VILLAGE
20TH INSTALLMENT RECEIVED NOVEMBER 2, 1987 FOR SITE DEVELOPMENT
PLAN APPROVAL (M-23/D11)

Dear Mr. Andrews:

The drainage scheme for the above referenced submittal, dated November 2, 1987, is approved. Any required Site Development Plans can be signed-off by the City Engineer.

Prior to Final Plat approval, the following items are required:

1. An executed Subdivision Improvements Agreement.
2. An executed Drainage Covenant for the maintenance responsibilities for the public drainage easement/rock channel between Hideway Land and Warm Sands Drive.
3. An approved Final Grading and Drainage Plan.
4. Plat shall state that the Drainage Easements shall be maintained by the individual lot owners.

Prior to Work Order construction drawing sign-off by Hydrology, a final Grading and Drainage Plan must be approved. The following information is required on the Grading and Drainage Plan prior to approval:

PUBLIC WORKS DEPARTMENT

Walter Nickerson, P.E., City Engineer

ENGINEERING GROUP

Telephone (505) 768-2500

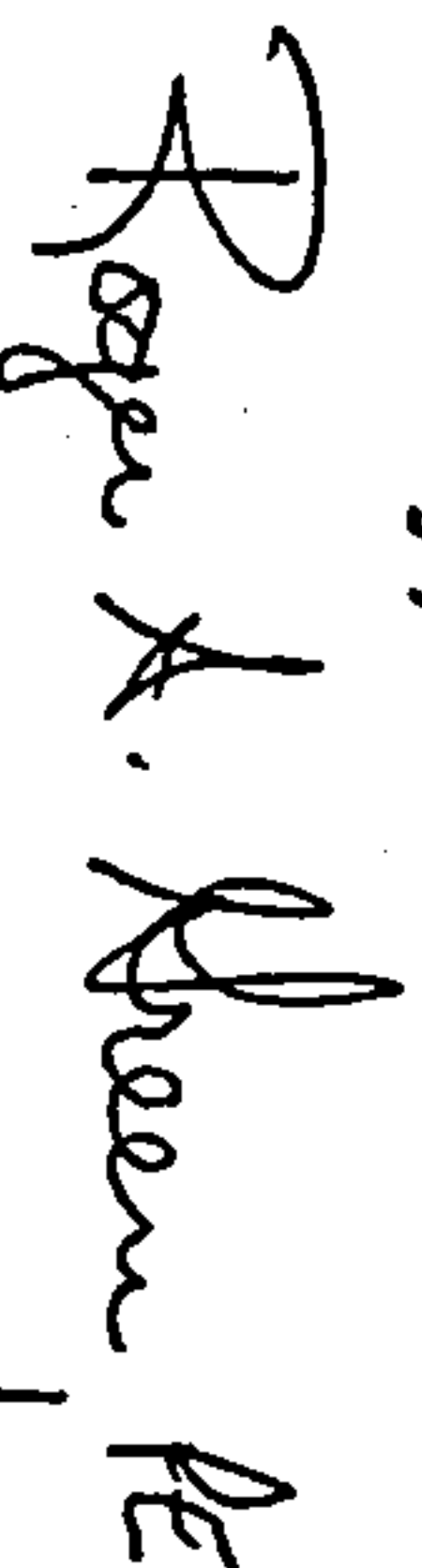
AN EQUAL OPPORTUNITY EMPLOYER

John Andrews, P.E.
November 13, 1987
Page 2

1. Label the 10' wide drainage easements as Private or Public.
2. Label the easement shown on the north end of Hideway Lane, on each side of the common property line between Lots 4 and 5.
3. Provide a profile and typical cross section of the proposed rock channel to divert the off-site flows, along with capacity calculations.
4. Notes on the plan restricting the lot grading to that only necessary for home construction.
5. Provide typical retaining wall details.

Additional comments may arise after review of the Work Order construction drawings. If you have any questions, please call me at 768-2650.

Cordially,



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

xc: Andre Houle, DRC

RAG/bsj

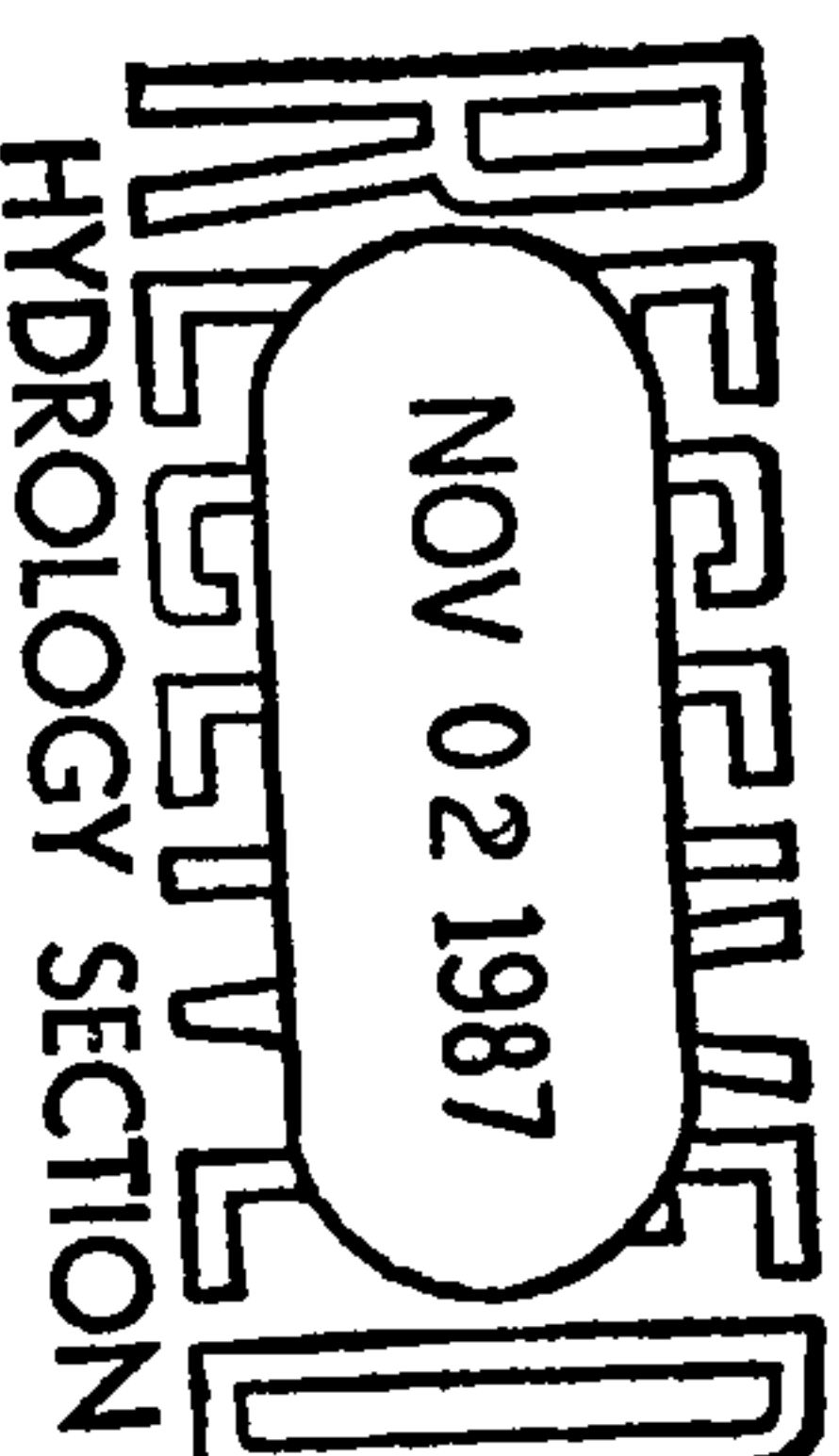


ANDREWS, ASBURY & ROBERT, INC.
Consulting Engineers

149 Jackson, NE, Albuquerque, New Mexico 87108
(505) 265-6631

John A. Andrews, P.E.
Charles T. Asbury, P.E.
John B. Robert, P.E. & L.S. (1915 - 1984)
James E. Millington, P.E. - V.P.

October 30, 1987



Mr. Roger Green
CE/Hydrology Section
Public Works Department
City of Albuquerque
Post Office Box 1293
Albuquerque, New Mexico 87103

SUBJECT: FOUR HILLS VILLAGE - 20th INSTALLMENT

Dear Mr. Green:

This letter is to serve as the drainage report for Four Hills Village - 20th Installment.

The subject property is located west of Hideaway Lane SE and east of Warm Sands Drive SE and comprises approximately 7.31 acres south of the municipal limits boundary as shown on the attached Vicinity Map (Zone Atlas Map No. M-23).

Presently, offsite areas to the south drain north through the subject project. The offsite drainage areas are shown on the accompanying Offsite Drainage Map. The SCS soil classification for this area is R0F (rock outcrop).

	AREA (ac)	CN	$T_C = T_P$ (min.)	R (in)	q_p (cfs/in)	Q_p (cfs)
Onsite	7.31	89	10	1.6	33.2	53.1
Offsite						
0-1	2.4	89	10	1.6	10.9	17.4
0-2	1.9	89	10	1.6	8.6	13.8
0-3	4.8	89	10	1.6	21.8	34.9

Both offsite and onsite flows drain to the north, with a combined flow of 119.2 CFS. ✓

Four Hills Village - 20th Installment will be developed as a very exclusive single-family residential subdivision. It is proposed to leave the building sites in as natural condition as possible. As an initial construction project it is proposed to provide access to the site, together with the necessary utilities, as shown on the enclosed Grading & Drainage Plan (sheet 1 of 1). Hideaway Lane SE will be extended to the north, and a cul-de-sac will be constructed to the east of Warm Sands Drive SE. A drainage channel will be constructed along the south side of the project as shown on the Grading and Drainage Plan.

Mr. Roger Green
October 30, 1987
Page 2

Offsite flows generated from the south (Areas 0-2 & 0-3, Offsite Drainage Map) will be intercepted by the drainage channel and flow west to the cul-de-sac. The cul-de-sac drains west to Warm Sands Drive and away from the property, thereby reducing the area draining across the north boundary of the subject project.

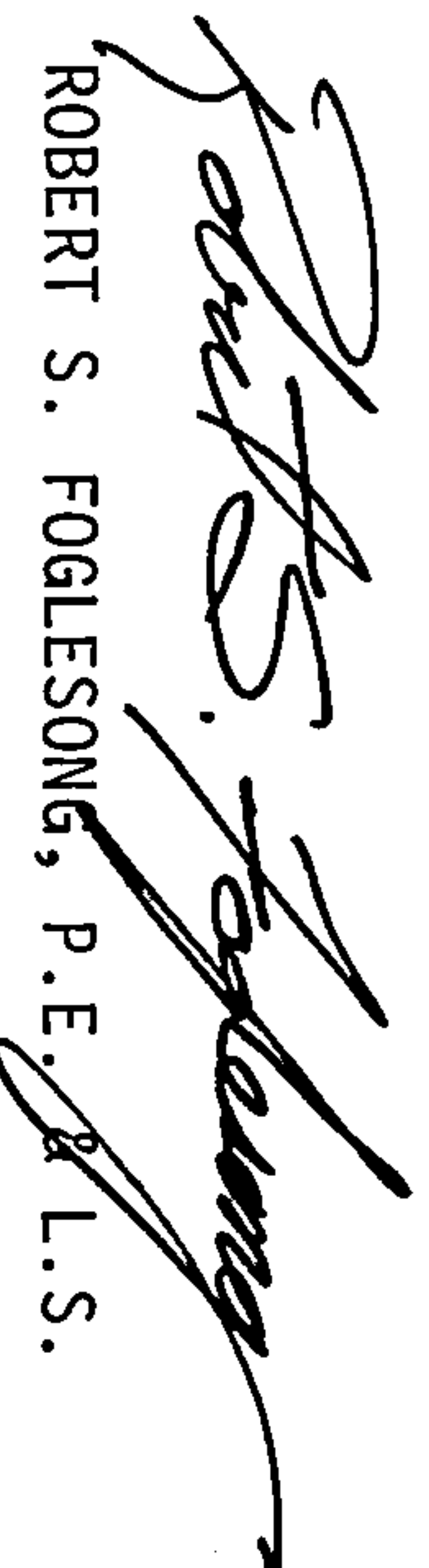
After development it is assumed that a maximum of 25% of each building site will be impervious. Then after development,

	AREA (ac)	CN	$T_C = T_P$ (min.)	R (in)	q_p (cfs/in)	Q_p (cfs)
Onsite	7.31	94	10	1.9	33.2	63.1
Offsite						
0-1	2.4	89	10	1.6	10.9	17.4
0-2	1.9	89	10	1.6	8.6	13.8
0-3	4.8	89	10	1.6	21.8	34.9
						48.1

Therefore after development, the total discharge of storm runoff across the north boundary of the subject property will be reduced from 119.2 CFS to 80.3 CFS ✓

Please call if you have any questions.

Very truly yours,


ROBERT S. FOGLESONG, P.E. & L.S.

kat/459
enclosures:

Drainage Information Sheet
Drainage Conference Recap, Sheets 1 & 2
Vicinity Map
Offsite Drainage Map
Grading & Drainage Plan, Sheet 1 of 1
Sketch Plat

DRAINAGE INFORMATION SHEET

PROJECT TITLE: 4 Hill Village - 20th Installation ZONE ATLAS/DRNG. FILE #: M-23/ D11

LEGAL DESCRIPTION: _____

CITY ADDRESS: N/A

ENGINEERING FIRM Andrews, Asbury & Robert, Inc. CONTACT: Jim Millington

ADDRESS: 149 Jackson NE PHONE: 265-6631

OWNER: Small Bus. Admins., Receiver for CONTACT: John Evans
New Mexico Capital Corporation
 ADDRESS 3939 San Pedro NE PHONE: 884-3600

ARCHITECT: N/A CONTACT: _____

ADDRESS: _____ PHONE: _____

SURVEYOR: Andrews, Asbury & Robert, Inc. CONTACT: Gayle Jewell

ADDRESS: 149 Jackson NE PHONE: 165-6631

CONTRACTOR: N/A CONTACT: _____

ADDRESS: _____ PHONE: _____

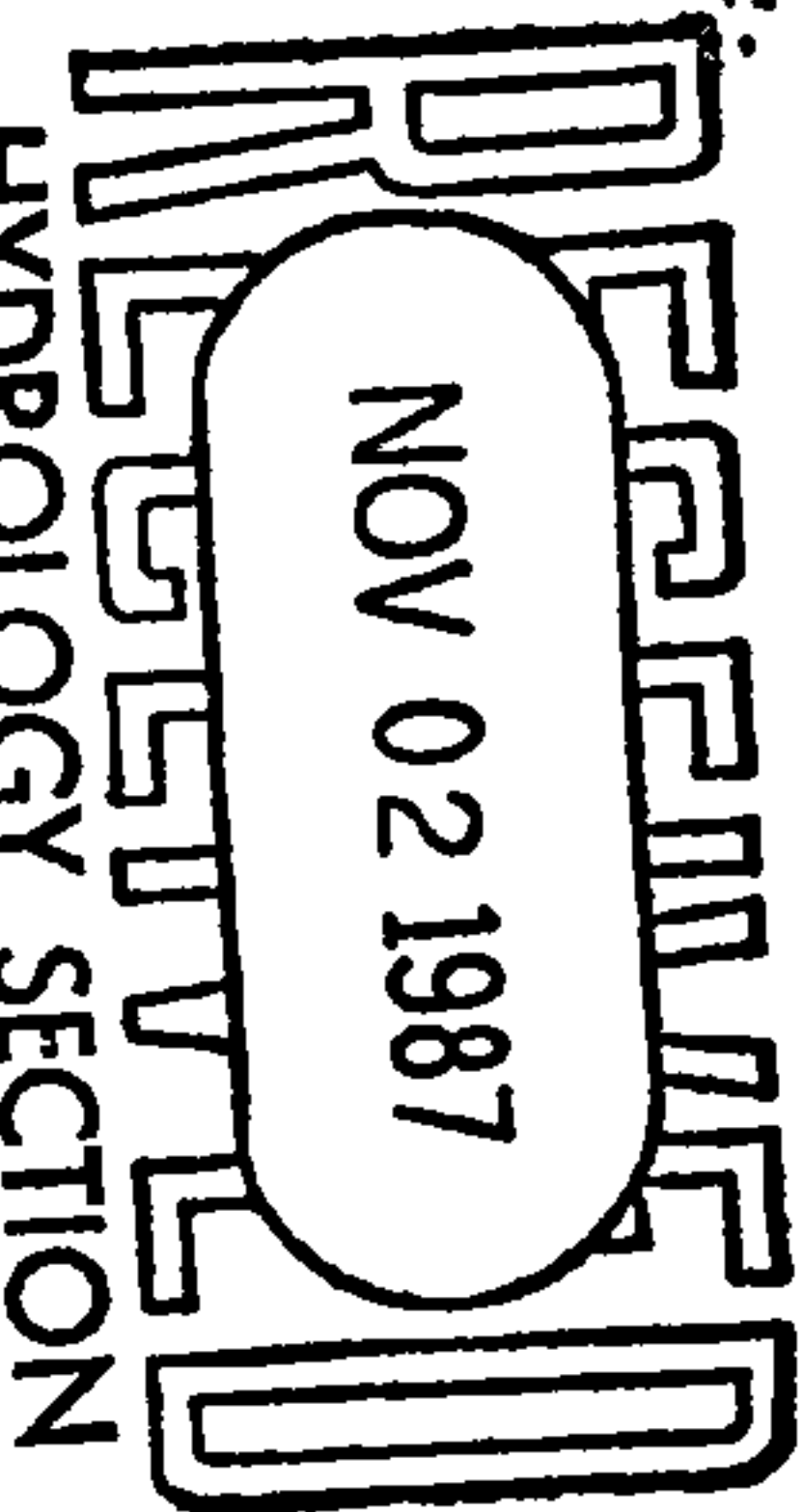
PRE-DESIGN MEETING: X YES NO

X COPY OF CONFERENCE RECAP SHEET PROVIDED

DRB NO. _____

EPC NO. _____

PROJECT NO. _____



TYPE OF SUBMITTAL: _____ CHECK TYPE OF APPROVAL SOUGHT: _____

_____ DRAINAGE REPORT _____ SKETCH PLAT APPROVAL

X DRAINAGE PLAN _____ PRELIMINARY PLAT APPROVAL

_____ CONCEPTUAL GRADING & DRAIN. PLAN X SITE DEVELOPMENT PLAN APPROVAL

_____ GRADING PLAN _____ FINAL PLAT APPROVAL

_____ EROSION CONTROL PLAN _____ BUILDING PERMIT APPROVAL

_____ ENGINEER'S CERTIFICATION _____ FOUNDATION PERMIT APPROVAL

_____ CERTIFICATE OF OCCUPANCY APPROVAL

_____ ROUGH GRADING PERMIT APPROVAL

DATE SUBMITTED: _____ GRADING/PAVING PERMIT APPROVAL

BY: _____ OTHER _____ (SPECIFY)

CITY OF ALBUQUERQUE
MUNICIPAL DEVELOPMENT DEPARTMENT
ENGINEERING DIVISION/DESIGN HYDROLOGY SECTION

CONFERENCE RECAP

DRAINAGE FILE/ZONE ATLAS PAGE NO.: M-23 DATE: 3/10/87 @ 10:00
PLANNING DIVISION NOS: EPC: _____ DRB: 87-90
SUBJECT: R-1 Subdivision
STREET ADDRESS (IF KNOWN): W. End of Highway Lane. and 1st Urban San Antonio
SUBDIVISION NAME: 4-Hills Installment 20

APPROVAL REQUESTED:

☒ PRELIMINARY PLAT ☐ FINAL PLAT
☐ SITE DEVELOPMENT PLAN ☐ BUILDING PERMIT
☐ OTHER ☐ ROUGH GRADING

ATTENDANCE: Gayle Jewell WHO Amelias Asbury REPRESENTING
Roger Green Hydrology Section

FINDINGS:

- (1) An approved Grading & Drainage Plan is required with proposed lot layouts and required infrastructure.
- (2) Proposed Plans must be submitted on each individual lot in this private drainage easement as provided to a common utility system. No HO'SCS cause number method to calculate volume of runoff.
- (3) New streets required will need to address the new drainage.

Case I: if Highway Lane is plat'd as a through street then provide erosion protection and retention and sized for street flows, within plat'd R.O.D. and a backstreet street.

Case II: if Highway Lane is left as-is with a cul-de-sac address then a smaller drainage easement is required. However, the HO'S will provide erosion and retention protection on site. An alternative to have a driveway to north side of lot for an existing developed site flows across their property.

The undersigned agrees that the above findings are summarized accurately and are only subject to change if further investigation reveals that they are not reasonable or that they are based on inaccurate information.

SIGNED: Roger A. Johnson SIGNED: Bob Smith
TITLE: City Engineer TITLE: Eng. Tech. A.A. & R. Inc.
DATE: 3/10/87 DATE: 3/10/87

CITY OF ALBUQUERQUE
MUNICIPAL DEVELOPMENT DEPARTMENT
ENGINEERING DIVISION/DESIGN HYDROLOGY SECTION

Sheet 2 of 2

CONFERENCE RECAP

DRAINAGE FILE/ZONE ATLAS PAGE NO.: 111-23 DATE: 10-16-87

PLANNING DIVISION NOS: EPC: _____ DRB: _____

SUBJECT: R-1 Subdivision - 5 Lots

STREET ADDRESS (IF KNOWN): _____

SUBDIVISION NAME: 4-Hills Tract INSTRUMENT 20

APPROVAL REQUESTED:

☒ PRELIMINARY PLAT	_____	FINAL PLAT
_____ SITE DEVELOPMENT PLAN	_____	BUILDING PERMIT
_____ OTHER	_____	ROUGH GRADING

WHO

REPRESENTING

ATTENDANCE: Jim Millington

AND

Roger Green

City Hydrology

FINDINGS:

- (4) OFFSITE FLOWS AND HIDEWAY LANE FLOWS WILL BE DIVERTED ALONG THE SOUTH PROPERTY LINE IN A PUBLIC DRAINAGE EXISTING TO LINDEN SANDS DRIVE. PLAT SHOULD MAKE PRIVATE LOTS RESPONSIBLE FOR THIS CASSEMENT MAINTENANCE.
- (5) PLAT MUST DEDICATE A PRIVATE DRAINAGE CASSEMENT ALONG THE BUTIRE NORTH PROPERTY LINE FOR FUTURE DIVERSIONS ETC. USE 10' MINIMUM IF THE LOTS ARE LEFT AS UNDEVELOPED AS POSSIBLE AND THE GRADIENT PLAN THEN LOT BURDEN MAY BE ALLOWED TO FIND OFFSITE IN EXISTING NATURAL DRAINAGEWAYS.
- (7) DRIVE PADS AND ROOF DRAINS WILL BE EXPECTED TO DRAIN TOWARD STREETS WHERE POSSIBLE.

The undersigned agrees that the above findings are summarized accurately and are only subject to change if further investigation reveals that they are not reasonable or that they are based on inaccurate information.

SIGNED:

Tom X Green

SIGNED:

Jim Millington

TITLE:

City Engineer

TITLE:

Hydro

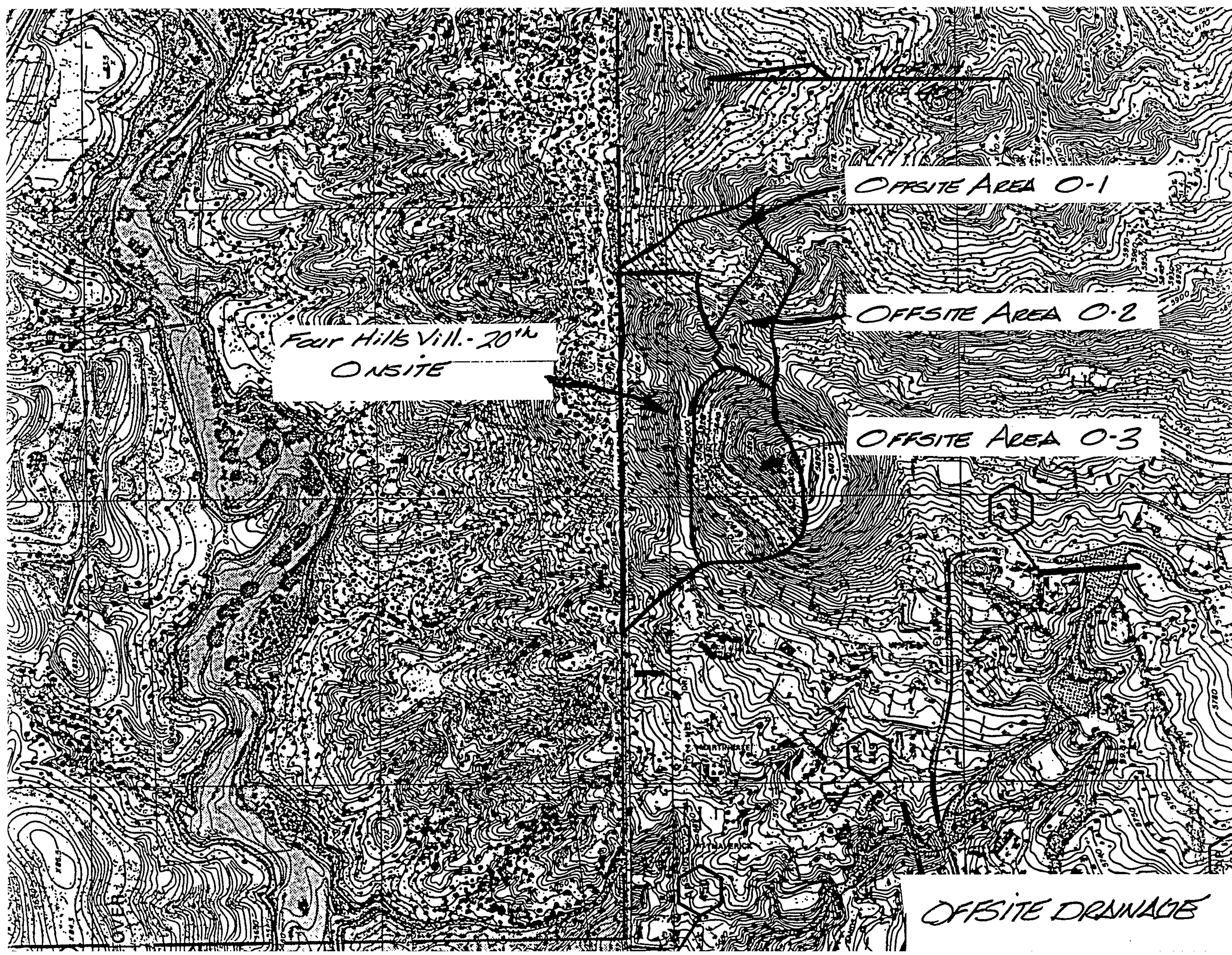
DATE:

10-16-87

DATE:

10-16-87

NOTE PLEASE PROVIDE A COPY OF THIS RECAP WITH THE DRAINAGE SUBMITTAL



Four Hills Vill. - 20th
ONSITE

OFFSITE AREA 0-1

OFFSITE AREA 0-2

OFFSITE AREA 0-3

OFFSITE DRAINAGE