DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 27TH SUPPORT GROUP (TAC)
CANNON AIR FORCE BASE, NM 88103

ENTERED

26 DEC 1991

Mr. Benito Garcia, Chief
Hazardous & Radioactive Materials Bureau
New Mexico Environment Department
1190 St. Francis Drive
Santa Fe, NM 87502

RECEIVED DEC 30 1991

RE: Request for Additional Information, dtd 9 Dec 91
Cannon AFB, NM5572124456

Dear Mr. Garcia

Cannon AFB received your request for additional information regarding the Notice of Deficiency for the Melrose AFR permit application on 12 Dec 91. The responses to each of your concerns are listed below.

1d. 100 Year Floodplain Standard

After several unsuccessful attempts to locate a floodplain boundary map we decided to calculate the 100 year floodplain as best we could. Based on our assumptions we determined that the open burning/open detonation unit is in the 100 year floodplain. Realizing that a more detailed study would cost $10,000 we are willing to accept this finding. In the area of the treatment unit we estimate there would be one to two feet of standing water. Therefore, we propose to build a two foot earthen berm around the perimeter of the treatment unit. This would minimize the effects of the 100 year flood by preventing any runoff from occurring. We believe this would satisfy the regulatory requirements due to the minimal amount of waste which is treated at the range and the fact that the open detonation process completely consumes the waste munition's energetic (reactive) material. The floodplain map and the associated calculations and assumptions are attached.

2b. Waste Characteristics

Although we were unable to locate Material Safety Data Sheets for the waste munitions, we did locate a technical manual, "Description of, and Disposal Procedures for, Conventional Explosives and Related Hazardous Materials" dated 2 Nov 87 which lists their ingredients.

a. Smokeless powders consist of pyrocellulose with 13% nitrogen which is colloidized with ether-alcohol.

b. Solid propellants contain a fuel, usually a hydrocarbon, and an oxidizer, which contains a large percentage of oxygen.

c. Typical high explosives may contain TNT [$C_6H_2CH_3(NO_2)_3$] or Tetryl [$C_6H_2(NO_2)_3NOH_3NO_2$].

d. Initiating explosives consist of lead azide or mercury fulminate.

e. A typical incendiary is similar to black powder which consists of 75% sodium nitrate or potassium nitrate, 15% charcoal and 10% sulfur.

f. Pyrotechnic explosives include items such as flares which are made up of a fuel such as magnesium, aluminum, charcoal or sulfur mixed with an oxidizer such as nitrades of barium, strontium, sodium or potassium.

The net explosive weights which were listed for each waste munition in our 18 Nov 91 response is the amount treated during the once a month treatment process. Regarding the dud fired practice bombs, three pounds is the net explosive weight of all 150 bombs not the individual bombs.

2c. Gate Hours

The gates which are used to access the impact area on Melrose AFR are usually open on weekdays from 06:30 AM until 11:30 PM. The gates are locked at all other times unless a special exercise is taking place.

2e. Traffic Routes

We have enclosed a map with the routes used by Explosive Ordnance Disposal clearly marked with a yellow highlighter.

5. Hazard Prevention

Due to the small quantities of munitions involved in our operations all of the munitions are loaded and unloaded by hand. The people who handle the waste munitions are trained professionals in the area of managing explosive items. Their extensive training and experience insure that any potential hazards are minimized to the maximun extent possible.

We hope that the above information will complete our permit application. Please contact Lt Gregg Demers or Mr. Jim Richards (784-4639) if you require any additional information.

Sincerely

David E Benson

DAVID E. BENSON, Colonel, USAF
Commander

2 Atch
1. Floodplain map and calculations
2. Map of Impact Area (1":1000')

cc: Mr. Richard Mayer, EPA
HQ TAC/DEV
Dr. Herb Grover, NMED

100 YEAR FLOOD PLAIN ANALYSIS
MELROSE AIR FORCE RANGE

RE: Reference to 12 Dec 91 reply requesting additional information for permit NM 557214456.

This report determines the boundaries of the 100 year flood plain. Using the TR-55 Urban Hydrograph Method developed by the Soil Conservation Service we have found the Open Detonation/Open Burn (OD/OB) Facility is within the flood plain.

The calculations required four steps:

1. Soil Profile. Using the SCS Soils Map for Roosevelt County (page 12) and the Corps of Engineers Topographic Map for Melrose Air Force Range (attachment), the drainage area and drainage characteristics were determined. The drainage basin covers 9.47 acres and is composed of primarily hydrologic group B and C soils with moderate to rapid runoff and good internal drainage. The composite curve number is 76 and the 100 year, 24 hour rainfall is 5.5 inches.

2. Time of Concentration. The stream bed was divided into 1,000 foot segments and the total travel time for the watershed equaled 1.72 hours (103 min).

3. Tabular Discharge Summary. After segmenting the watershed into twelve sections, the outflow hydrographs for each section was calculated (page 10). Using these results the maximum discharge for each 1,000 foot segment of the stream was tabulated (page 11). The discharge for a given section was found by summing the outflow hydrograph values for the previous sections and then finding the peak value.

4. Flood Plain Width. Assuming the average velocity of water over short prairie grass is 2.5 feet per second (St. Johns River Water Management District, Florida - SJM BP 314) and that required area = discharge/velocity, the cross sectional width for each segment was calculated (page 4). The width was found by:

a. Assume average cross section for the basin is triangular unless noted, and flow tends toward lowest areas;

b. Area = (.5)*(width)*(elevation change)

c. Estimate a width and elevation change using the topographic map; calculate the actual area of the drainage area.

d. Compare required area with actual area calculated. If variance is less than 10% then estimated width = width of flood plain. If variance is greater than 10% repeat steps c-d.

TABLE OF CONTENTS

ATTACHMENT

LIST OF SYMBOLS

SYMBOL	UNIT	DEFINITION
A	sq units	Area of a region
Am	sq. mi.	Drainage area
CN		Runoff curve number
I_a	in	Initial abstraction
L	ft	Flow length
n		Manning`s roughness coefficient
P	in	Rainfall
P_2	in	Two-year frequency, 24-hour rainfall
Q	cfs	Peak outflow discharge
Q_r	in	Runoff
s	ft/ft	Slope of hydraulic grade line
S	in	Potential maximum retention after runoff begins
T_c	hr	Time of Concentration
T_t	hr	Travel time
V	fps	Average velocity
*		Multiplication sign
/		Division sign
↑		Raised to the power of

LIST OF EQUATIONS

1. Runoff Curve Number

   Equation 2.3 $Q_r = (P-.2*S)\uparrow 2 \;/\; (P+.8*S)$

   Equation 2.4 $S = (1000 \;/\; CN) - 10$

2. Time of Concentration

   a. Sheet flow (_300 ft)

   $T_t = (.007 * (n*L)\uparrow .8) \;/\; (P_2\uparrow .5 * s\uparrow .4)$

   b. Shallow, concentrated flow

   $T_t = L \;/\; (3600*V)$

   c. T_c = Summation of T_t

3. Drainage Area (Subareas divided into geometric regions)

   a. Triangle: A = .5*(base)*(height)

   b. Square: A = length * width

   c. Trapazoid A = .5*(base1 + base2)*(height)

   d. Multiply sq ft by .143 to get sq mi

4. Tabular Discharge Hydrograph

   Discharge = A_m*Q_r*(tabular value)
   where tabular value comes from the Table 5-II

5. Flood Plain Width

   A = .5*(flood plain width)*(elevation change)

GLOSSARY

Average Velocity - The average value of the velocities measured across the area of study.

Composite Curve Number - Curve number representing a combination of soil groups over the entire watershed.

Curve Number - an empirical description for infiltration and rainfall excess used to calculate the ability of a soil to hold water.

Hydraulic Group - A list developed by the Soil conservation Service to relate texture, class, water capacity, and infiltration rates for soils.

Type	Description
B	Moderately low runoff potential. Mostly sandy soils with above average infiltration after thorough wetting.
C	Moderately high runoff potential. Comprises shallow soils and soils containing considerable clays. The group has below average infiltration after wetting.

Hydrograph - Plot of flow rate versus time for a rainfall event.

Infiltration - Movement of water from the ground surface into the soil. The rate and quantity of water that infiltrates is a function of soil type, soil moisture, soil permeability, ground cover, drainage conditions, and depth of water table.

Initial Abstraction - Water intercepted by vegetation and stored in surface depressions.

Shallow, Concentrated Flow - After a maximum of 300 feet, sheet flow usually becomes shallow, concentrated flow. The water has settled into more defined flow paths and the average velocity is a function of the watercourse slope and type of channel.

Sheet Flow - Flow over plane surfaces. It usually occurs in the headwater of streams.

Time of Concentration - Longest travel time it takes a particle of water to reach a discharge point in a watershed. Measurement of time of concentration can be made for overland flow, channel flow, and pipe flow.

Topographic Map - Map showing elevation changes, usually in increments of 10 feet.

TR-55 Method - Simplified procedure developed by the Soil Conservation Service for estimating runoff and peak discharges in small watersheds.

Floodplain analysis - Melrose Bombing Range

1. Used TR-55 method to determine outflow hydrographs

2. Worksheet 2: Runoff Curve Number and Runoff

used SCS soil map and topographic map (page 12) to roughly define boundaries for each soil group present in the area of study. Soil boundaries are outlined in red. Calculated total soil group area using knowledge that 1 square inch = 91.83 acres, and counting the number of squares within the boundary.

Runoff, Q

$$Q_r = (P-.2S)^2/(P+.8S) \qquad \text{Eq 2.3}$$

$$S = \frac{1000}{CN} - 10 \qquad \text{Eq 2.4}$$

$$S = \frac{1000}{76} - 10 = 3.16$$

$$Q_r = \frac{(5.5-(.2)(3.16))^2}{(5.5+.8(3.16))} = 2.95 \text{ in}$$

3. Worksheet 3: Time of Concentration and Travel Time (page 7)

Since there were more than 4 flow segments, calculation sheet was done separately.

4. Worksheet 4: Graphical Peak Discharge Method

Not used since need outflow at end of each segment

5. worksheet 5a/b: Basic Watershed Data (page 8)

Assumptions:

a) Runoff is constant over entire watershed, 2.95 in

b) Initial Abstraction is base on composite curve number from worksheet 2.

5. (cont.)

drainage area: see topo map for boundary outline of each segment

section	area components	area A_m
I	$[(.7)(.7) + \frac{1}{2}(.7)(.6) + \frac{1}{2}(.7)(2)] .143$	.11 mi^2
II	$[\frac{1}{2}(1.2 + 2.2)(1.6)] .143$	.39 mi^2
III	$[\frac{1}{2}(1.7 + 3.9)(2.4)] .143$	.96 mi^2
IV	$[\frac{1}{2}(3 + 4.4)(3)] .143$	1.59 mi^2
V	$[\frac{1}{2}(3.35 + 5.75)(3.9)] .143$	2.54 mi^2
VI	$[2.9(6) + \frac{1}{2}(6 + 3.8)(1.9)] .143$	3.82 mi^2
VII	$[3.15(6) + \frac{1}{2}(1.9)(1.75) + \frac{1}{2}(1.9)(4.15)] .143$	4.02 mi^2
VIII	$[(6)(4.6) + \frac{1}{2}(1.65)(1.1) + \frac{1}{2}(1.1 + 1.65)(4.95)] .143$	5.05 mi^2
IX	$[(6)(4.6) + \frac{1}{2}(2.5)(2.1) + \frac{1}{2}(2.5 + 1.55)(5.5)] .143$	5.91 mi^2
X	$[(6)(4.6) + \frac{1}{2}(3.5 + 1.4)(2) + \frac{1}{2}(3.5 + 1.8)(6)] .143$	6.92 mi^2
XI	$[(6)(4.6) + \frac{1}{2}(4.3 + 2.9)(1.35) + \frac{1}{2}(4.3 + 3.2)(6.65)] .143$	8.21 mi^2
XII	$[(6)(4.6) + 5(8)] .143$	9.67 mi^2

* See attached topographic map for subarea boundaries

6. Worsheet 5b: Tabular Hydrograph Discharge Summary (page 10)

Assumptions:

a) all subareas drain directly into proceeding subarea. For example: subarea I drains into subarea II; subareas I, II drain into subarea III.

b) Runoff, Q, is constant throughout watershed 2.95 in

c) I_a/P ratio, .115, has been rounded to .100 to facilitate data compilation.

d) Discharge is product of (A_mQ)(tabular value) where tabular value is interpolated from exhibit 5-II of TR-55 book.

7. Max flow per subarea (worksheet 5b - 2nd page) (enclosed contour map)

This worksheet traces the peak outflow through each subarea.

8. Floodplain cross Sectional Areas by subarea

Assumptions:

a. According to the St. Johns River Water Management District, Melbourne, Florida, the average velocity of water over short, praire grass ranges from 2 to 3 fps. Therefore we have assumed to average velocity of the runoff to be 2.5 fps.

b. Since $Q = VA$ where V = velocity and A = cross area, $A = Q/V$

subarea	Q (From Max Flow per subarea) CFS	V Velocity fps	Area A ft^2
I	107	2.5	43
II	360	2.5	144
III	921	2.5	369
IV	1518	2.5	607
V	2407	2.5	963
VI	3868	2.5	1547
VII	4111	2.5	1644
VIII	4959	2.5	1983
IX	5565	2.5	2226
X	5878	2.5	2351
XI	6373	2.5	2550
XII	6773	2.5	2709

9. Floodplain width by subarea

Assumptions:

a. All cross sections are triangular unless otherwise noted. The overall area, A_1 = ½(base)(height)

b) The height, h, is estimated from the topographic map by interpolating the height from the point along the streambed to the top of the surrounding sides.

9. Floodplain Width by Subarea (cont.)

Assumptions: (cont.)

c. The base is estimated using scale factor of 1" = 2000'

d. Method of Calculation:

1) Find area estimated on topographic map.
2) compare area with that determined in Step 8.
3) Iterate until the two areas are close (with 100 ft^2)

Subarea 1

1. needed area: 43 ft^2

2. Estimated: 1. width = 175 ft ht = .5 ft
   2. Area = 44 ft^2 ok.

Subarea 2

1. needed area: 144 ft^2

2. Estimated: 1. width = 250 ft ht = 1 ft
   2. Area = 125 ft^2 close enough.

Subarea 3,

1. needed area: 369 ft^2

2. Estimated: 1. width = 400 ft ht = 1 ft
   ~~200 ft~~
   500 ft * .5 ft * square section b/c area flattens out.
   2. Area = 450 ft^2 close - make borders closer on drawing.

Subarea 4:

1. needed area: 607 ft^2

2. Estimated 1. width = 600 ft ht = 2 ft
   2. Area = 600 ft^2 ok.

Subarea 5:

1. needed area: 963 ft^2

2. Estimated 1. width = 400 ft ht = 5 ft
   2. Area = 1000 ft^2 ok.

9. Floodplain width by Subarea (cont.)

Subarea VI

1. needed area: 1547 ft^2

2. Estimated: 1. width: 800 ft ht = 4ft
   2. Area = 1600 ft^2 ok.

Subarea VII

1. needed area: 1644 ft^2

2. Estimated: 1. width 1600 ft ht = 1ft
   2. Area: 1300 ft^2 no.

   Estimated: 1. width 1600 ft ht = 1ft
   + 1700 ft .50ft * rect. section b/c plain flattens out.
   2. Area = 1650 ft^2 ok.

Subarea VIII

1. needed area: 1983 ft^2

2. Estimated: 1. width 1600 ft ht = 1ft
   2200 ft .5ft * rect. section b/c plain flattens out.
   2. Area = 1900 ft^2 ok.

Section IX

1. needed area: 2226 ft^2

2. Estimated: 1. width 1800 ft ht = 1 ft
   2300 ft ht = .5ft * rect. Section b/c plain flattens out.
   2. Area = 2050 close enough.

Section X

1. needed area: 2351 ft^2

2. Estimated 1. width = 2000 ft ht = 2.5ft
   2. Area = 2500 ft^2 ok.

Section XI

1. needed area: 2550 ft^2

2. Estimated: 1. width = 2800 ft ht = 2ft
   2. Area = 2600 ft^2 ok.

Section XII This final section was estimated after drawing on earlier segments to the floodplain.

Worksheet 2: Runoff curve number and runoff

Project Melrose Bombing Range - Floodplain By SDW Date 20 Dec 91

Location Cannon AFB Checked ____ Date ____

Circle one: (Present) Developed ____________________

1. Runoff curve number (CN)

Soil name and hydrologic group (appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN 1/ Table 2-2	CN 1/ Fig. 2-3	CN 1/ Fig. 2-4	Area ☒ acres ☐ mi² ☐ %	Product of CN x area
Bippus, Bb B	0% impervious, Praire grass covering (Short)	71			830	58,930
Mansker B	same	71			1,095	77,745
Olton Loam C	same	81			2,879	233,199
Portales Loam C	same	81			460	32,660
Amarillo Loam B	same	71			925	65,675

1/ Use only one CN source per line. Totals = 6,189 | 468,209

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = ______ = ______; Use CN = 76

2. Runoff

		Storm #1	Storm #2	Storm #3
Frequency	yr	100		
Rainfall, P (24-hour)	in	5.5		
Runoff, Q .... (Use P and CN with ~~table 2-1~~, ~~fig. 2-1~~, or eqs. 2-3 and 2-4.)	in	2.95		

Worksheet 3 : Time of Concentration or Travel Time

	segment	calculation
Sheet flow	I	
1. surface description	Short praire	
2. mannings coef, n	.15	
3. flow length	300 ft	
4. 2-yr 24-hr rainfall, P_2	2.25 in	
5. Land slope, s	60/300 ft	
6. $T_t = \frac{.007(nL)^{.8}}{P_2^{.5} s^{.4}}$	.19 hr	

Shallow, concentrated flow

1. Segment id:	I	II	III	IV	V	VI	VII
2. Surface description.	unpaved	same	Same	same	same	same	same
3. water course slope, s	700 ft	1000	1000	1000	1000	1000	1000
4. Average velocity, V	20/700	30/1000	.025	.025	.025	.016	.020
6. Flow length, L	2.8 fps	2.8	2.5	2.5	2.5	1.6	2.2
5. $T_t = \frac{L}{360 V}$	.07	.26	.14	.11	.11	.17	.13

1. segment id:	VIII	IX	X	XI	XII
2. surface description	same	same	same	same	same
3. flow length, L	1000	1000	1000	1000	1000
4. watercourse slope, S	.025	.020	.025	.010	.010
5 Average velocity, V	2.5	2.8	2.5	1.6	1.6
6 $T_t = \frac{L}{360V}$	.11	.13	.15	.17	.17

ΣT_t = .19 + 1.53 = T_c

T_c = 1.72 hr (103 min)

Worksheet 5a: Basic watershed data

Project Melrose Bombing Range   Location Cannon AFB   By DW   Date 20 Dec 91

Circle one: (Present) Developed ______   Frequency (yr) 100   Checked ______   Date ______

Subarea name	Drainage area A_m (mi^2)	Time of concentration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr Rainfall P (in)	Runoff curve number CN	Runoff Q_r (in)	$A_m Q_r$ (mi^2-in)	Initial abstraction I_a (in)	I_a/P
I	.11	.26	.26	II - XII	1.46	5.5	76	2.95	.33	.632	.115
II	.28	.10	.10	III - XII	1.36	5.5	76	2.95	.83	.632	.115
III	.57	.11	.11	IV - XII	1.25	5.5	76	2.95	1.68	.632	.115
IV	.63	.11	.11	V - XII	1.14	5.5	76	2.95	1.86	.632	.115
V	.95	.11	.11	VI - XII	1.03	5.5	76	2.95	2.80	.632	.115
VI	1.28	.17	.17	VII - XII	.86	5.5	76	2.95	3.78	.632	.115
VII	.20	.13	.13	VIII - XII	.73	5.5	76	2.95	.59	.632	.115
VIII	1.03	.11	.11	IX - XII	.62	5.5	76	2.95	3.04	.632	.115
IX	.86	.13	.13	X - XII	.49	5.5	76	2.95	2.54	.632	.115
X	1.01	.15	.15	XI - XII	.34	5.5	76	2.95	2.98	.632	.115

From worksheet 3 (Time of concentration, Travel time)   From worksheet 2 (Runoff curve number, Runoff)   From table 5-1 (Initial abstraction) page 21

Page 1 of 2

Worksheet 5a: Basic watershed data

Project ______________________ Location ______________________ By ________ Date ________

Circle one: Present Developed ______________________ Frequency (yr) ________ Checked ________ Date ________

Subarea name	Drainage area A_m (mi^2)	Time of concentration T_c (hr)	Travel time through subarea T_t (hr)	Downstream subarea names	Travel time summation to outlet ΣT_t (hr)	24-hr Rainfall P (in)	Runoff curve number CN	Runoff Q_r (in)	$A_m Q_r$ (mi^2-in)	Initial abstraction I_a (in)	I_a/P
XI	1.29	.17	.17	XII	.17	5.5	76	2.95	3.81	.632	.115
XII	1.46	.17	.17	—	0	5.5	76	2.95	4.31	.632	.115

↑ ↑ ↑ From worksheet 3 (Time of concentration, Travel time through subarea)

↑ ↑ ↑ From worksheet 2 (Runoff curve number, Runoff)

↑ ↑ From table 5-1 (Initial abstraction) page 21

Page 9

42-381 50 SHEETS 5 SQUARE
42-382 100 SHEETS 5 SQUARE
42-389 200 SHEETS 5 SQUARE
NATIONAL

Worksheet 5b: Tabular hydrograph Discharge Summary

Project: Melrose Bombing Range - Floodplain Location: Cannon AFB By DW Date 20 Dec 91

Circle one: (Present) Developed Frequency (yr): 100 Checked ______ Date ______

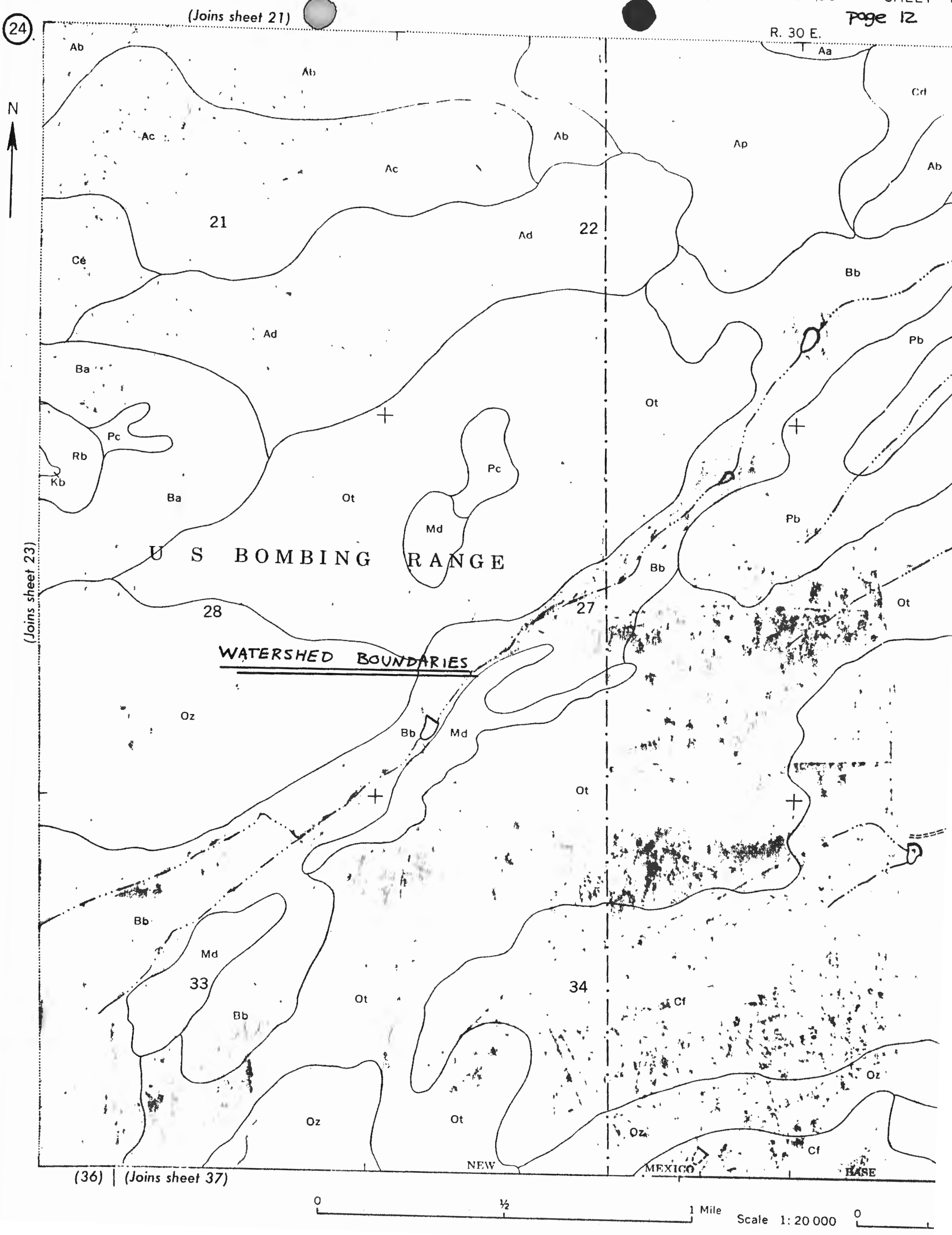
Subarea	Basic watershed data used: Subarea Tc (hr)	ΣTt to outlet (hr)	I_a/P	$A_m Q_r$ (mi²-in)	Select and enter hydrograph times in hours from exhibit 5-I From page 22-25: 11.3	11.9	12.1	12.3	12.5	12.7	13.0	13.4	13.8	14.3	15.0	16.0	17.0	18.0	20.0	26.0
					* (AmQ)(tabular value) Discharges at Selected times cfs															
I	.26	1.46	.115	0.33	*3	4	5	6	7	10	25	92	107	51	19	11	9	7	6	1
II	.10	1.36	.115	0.83	7	13	15	19	31	47	134	277	231	97	92	27	22	17	14	2
III	.11	1.25	.115	1.68	17	29	35	44	67	153	427	552	319	162	79	54	44	34	29	2
IV	.11	1.14	.115	1.86	20	35	45	56	91	232	641	597	312	141	80	58	45	37	30	9
V	.11	1.03	.115	2.80	34	59	70	93	154	415	1130	889	364	174	115	84	67	56	45	6
VI	.17	.86	.115	3.78	45	83	106	136	261	714	1503	1076	464	230	151	113	87	76	57	0
VII	.13	.73	.116	0.59	8	15	20	34	91	201	243	117	53	31	22	17	13	11	9	0
VIII	.11	.62	.115	3.04	55	112	489	1240	1404	1392	848	343	195	140	103	82	64	58	43	0
IX	.13	.49	.115	2.54	46	96	152	459	1192	1253	606	231	150	112	84	69	53	48	38	0
X	.15	.34	.115	2.98	72	164	524	1776	1609	757	313	191	149	116	92	75	63	54	42	0
XI	.17	.17	.115	3.81	84	194	544	1861	2150	1199	472	255	198	152	122	95	80	69	53	0
XII	.17	Ø	.115	4.31	138	1172	3769	1503	625	405	293	224	185	146	125	99	86	78	56	0
Composite hydrograph at outlet					529	1976	5774	7227	7683	6777	6643	4839	2778	1451	1034	837	632	545	373	5

Worksheet 5b: Tabular hydrograph Discharge Summary
[Maximum Flow per Subarea]

Project: Melrose Bombing Range - Floodplain Location: Cannon AFB By: SDW Date: 20 Dec 91

Circle one: (Present) Developed Frequency (yr): 100 Checked: ____ Date: ____

Subarea	Basic watershed data used: Subarea T_c (hr)	ΣT_t to outlet (hr)	I_a/P	$A_m Q_r$ (mi²-in)	11.3	11.9	12.1	12.3	12.5	12.7	13.0	13.4	13.8	14.3	15.0	16.0	17.0	18.0	20.0	26.0
					Select and enter hydrograph times in hours from exhibit 5-II — Discharges at selected times cfs															
I													107							
II												369								
III												921								
IV												1518								
V												2407								
VI											3868									
VII											4111									
VIII											4959									
IX											5565									
X											5878									
XI										6373										
XII										6773										
Composite hydrograph at outlet																				


24
(Joins sheet 21)
R. 30 E.
N
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Ab
Ac
Ad
Aa
Cd
Ap
Ab
21
22
Cé
Bb
Ba
Pc
Rb
Kb
Pb
Ot
Md
Pc
U S BOMBING RANGE
28
27
WATERSHED BOUNDARIES
Oz
Bb
Md
33
34
Cf
Oz
Cf
NEW
MEXICO
BASE
(36)
(Joins sheet 37)
0
½
1 Mile
Scale 1: 20 000

SOIL LEGEND

SYMBOL	NAME
Aa	Amarillo loamy fine sand, 0 to 3 percent slopes
Ab	Amarillo fine sandy loam, 0 to 1 percent slopes
Ac	Amarillo fine sandy loam, 1 to 3 percent slopes
Ad	Amarillo loam, 0 to 1 percent slopes
Ae	Amarillo loam, 1 to 3 percent slopes
Af	Amarillo and Clovis soils, 0 to 3 percent slopes, severely eroded
Ag	Arch loamy fine sand
Ah	Arch fine sandy loam
Ak	Arch loam
Am	Arch soils, severely eroded
An	Arvana loamy fine sand, 0 to 3 percent slopes
Ao	Arvana loamy fine sand, shallow, 0 to 1 percent slopes
Ap	Arvana fine sandy loam, 0 to 1 percent slopes
Ar	Arvana fine sandy loam, 1 to 3 percent slopes
As	Arvana fine sandy loam, shallow, 0 to 1 percent slopes
Av	Arvana soils, 0 to 3 percent slopes, severely eroded
Ba	Berthoud sandy loam, 2 to 9 percent slopes
Bb	Bippus and Spur soils
Bc	Blackwater loam
Bd	Blown-out and dune land
Be	Brownfield fine sand
Bf	Brownfield soils, severely eroded
Ca	Church clay loam
Cb	Church soils, severely eroded
Cc	Clovis loamy fine sand, 0 to 3 percent slopes
Cd	Clovis fine sandy loam, 0 to 1 percent slopes
Ce	Clovis fine sandy loam, 1 to 3 percent slopes
Cf	Clovis loam, 0 to 1 percent slopes
Cg	Clovis loam, 1 to 3 percent slopes
Dr	Drake soils
Go	Gomez loamy fine sand
Hg	Hilly gravelly land
Ka	Kimbrough fine sandy loam
Kb	Kimbrough loam
Mc	Mansker and Portales fine sandy loams, 1 to 3 percent slopes
Md	Mansker and Portales loams, 1 to 3 percent slopes
Me	Montoya clay loam
Ot	Olton loam, 0 to 1 percent slopes
Oz	Olton-Zita loams, 0 to 1 percent slopes
Pa	Portales fine sandy loam, 0 to 1 percent slopes
Pb	Portales loam, 0 to 1 percent slopes
Pc	Potter soils, 0 to 9 percent slopes
Ra	Riverwash
Rb	Rough broken land
Sf	Springer loamy fine sand
Sp	Springer soils, severely eroded
St	Stegall loam, 0 to 1 percent slopes
Su	Stegall loam, 1 to 3 percent slopes
Sw	Stegall loam, shallow, 0 to 1 percent slopes
Tf	Tivoli fine sand
Th	Tivoli-Arch complex
Tr	Travessilla loam
Zf	Zita fine sandy loam, 0 to 1 percent slopes
Zm	Zita loam, 0 to 1 percent slopes

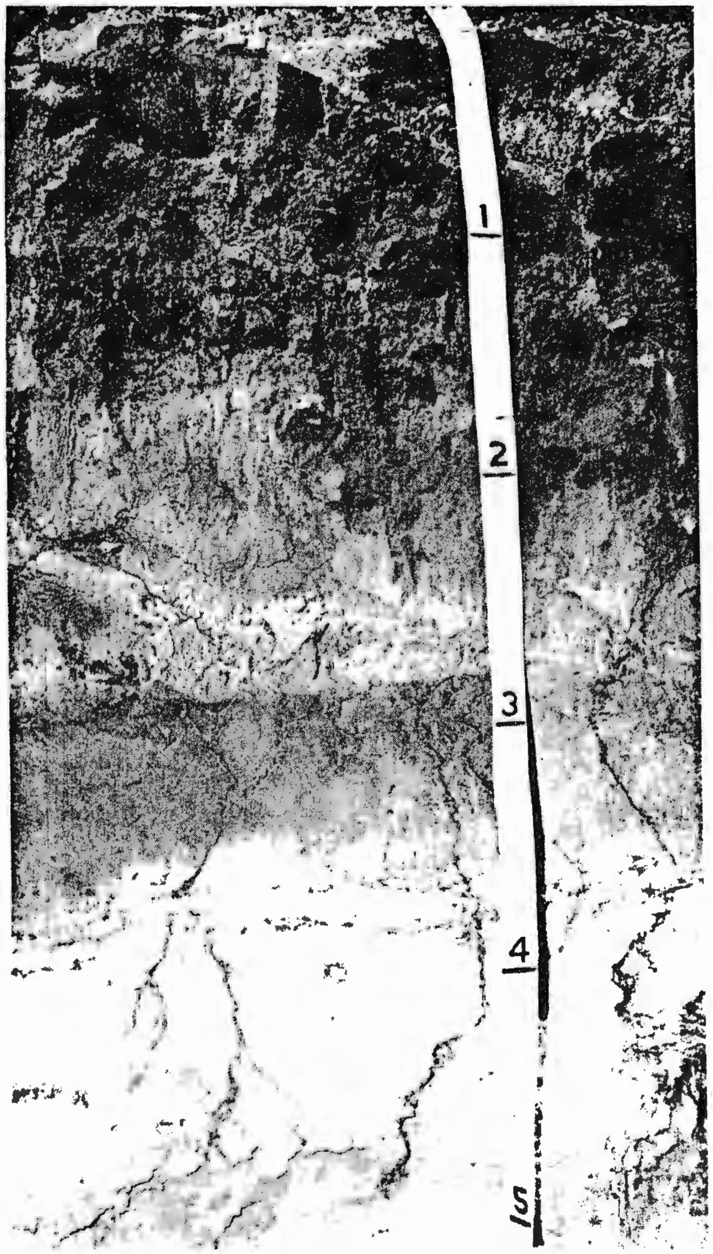

***Figure 4.*—Profile of Amarillo fine sandy loam, 0 to 1 percent slopes.**

The Amarillo soil has good internal drainage and moderate runoff. It takes water well and is capable of storing large amounts for plant use. It is moderately susceptible to both wind and water erosion.

If irrigated, this soil is productive of peanuts, cotton, sweetpotatoes, small grain, and grain sorghum. As dry cropland, it is suited to grain and forage sorghum. A limited acreage can be used for wheat during years of favorable seasonal moisture. The range is productive of both mid and short grasses. *Dryland capability unit IIIe-1 if in climatic zone 3, and unit IVe-1 if in climatic zone 4; irrigated capability unit IIIe-4; Sandy Upland range site.*

Amarillo loam, 0 to 1 percent slopes (Ad).—This deep, medium-textured soil occurs in smooth, nearly level areas.

Both the surface layer and subsoil are reddish brown. The surface layer consists of about 10 inches of noncalcareous, friable, granular loam. The subsoil, which ranges from 30 to 40 inches in thickness, is noncalcareous, prismatic sandy clay loam. It grades to a strongly calcareous, massive, pinkish-white substratum. The substratum varies from 36 inches to several feet in thickness and in many places contains numerous fragments of hard caliche.

This soil is adjacent to Clovis loam, 0 to 1 percent slopes, and Stegall loam, 0 to 1 percent slopes, and some small areas of these soils are included in the areas mapped.

Internal drainage is good, runoff is slow or moderate, and the movement of air and water through the subsoil is moderate. The water-holding capacity is good, and the moisture stored is readily available for plant use. If cultivated, this soil is slightly susceptible to wind erosion.

If irrigated, this soil is productive of peanuts, cotton, vegetables, and grain. As dry cropland, it is especially well suited to wheat. However, in climatic zone 4, which is the lower rainfall area of the county, or during years of countywide subnormal moisture, this soil is best suited to grain or forage sorghum. Blue grama and buffalograss are the dominant range grasses. *Dryland capability unit IIIce-1 if in climatic zone 3, and unit IVce-1 if in climatic zone 4; irrigated capability unit IIe-1; Loamy Upland range site.*

Amarillo loam, 1 to 3 percent slopes (Ae).—This is a deep soil that occurs in smooth, gently sloping areas throughout the county.

The surface layer is noncalcareous, friable, granular, reddish-brown loam that is about 10 inches thick. The subsoil is noncalcareous, reddish-brown sandy clay loam about 30 to 40 inches thick. It has moderate to strong, prismatic structure and grades gradually to the substratum of pinkish-white, soft caliche. The substratum contains many fragments of hard caliche and is strongly calcareous and massive.

This soil is associated with Clovis loam, 1 to 3 percent slopes, which is moderately deep; with Mansker loam, 1 to 3 percent slopes, which is calcareous; and with Portales loam, 1 to 3 percent slopes. Small areas of these soils are included in the areas mapped.

Internal drainage is good, runoff is moderate or rapid, and permeability is moderate. The water-holding capacity is high, and the moisture stored in the soil is readily available for plant use. Wind erosion is a slight hazard on this soil, and water erosion is a slight or moderate hazard.

If this soil is properly irrigated, it is well suited to peanuts, cotton, small grain, and vegetables. Alfalfa and sorghum are also well suited. In climatic zone 3, which is the area of higher rainfall in the county, wheat grows well in years of average rainfall. If seasonal moisture is below normal, grain sorghum should be grown. In climatic zone 4, grain sorghum is suitable. Blue grama and buffalograss are the dominant grasses on the range. *Dryland capability unit IIIce-1 if in climatic zone 3, and unit IVce-1 if in climatic zone 4; irrigated capability unit IIIe-3; Loamy Upland range site.*

Amarillo and Clovis soils, 0 to 3 percent slopes, severely eroded (Af).—These soils represent areas that have been farmed and severely damaged by wind. The surface caliche. Wind erosion and water erosion are moderate hazards.

If dryfarmed, this soil is used principally for sorghum and broomcorn. Some slopes are terraced or farmed on the contour, or both. If management is good, the range supports fair to good stands of mid and short grasses. *Dryland capability unit IIIe-2 if in climatic zone 3, and unit IVe-6 if in climatic zone 4; irrigated capability unit IIIe-7; Sandy Upland range site.*

Arvana fine sandy loam, shallow, 0 to 1 percent slopes (As).—This soil occurs in the Portales irrigated area.

The surface layer is brown, noncalcareous fine sandy loam. It is about 4 to 8 inches thick and has fine granular structure. The subsoil is noncalcareous, brown to reddish-brown clay loam. It has medium prismatic structure to fine, subangular, blocky structure. A layer of hard caliche occurs at a depth of about 14 inches.

Some small areas of Arvana fine sandy loam, 0 to 1 percent slopes, are included in the areas mapped.

Runoff on this soil is moderate, the rate of water intake is high, and the water-holding capacity is low. Moisture is readily released for plant use. The subsoil is moderately permeable, but the layer of hard caliche restricts internal drainage. Wind erosion is a moderate hazard.

This soil requires light but frequent irrigation because of its low water-holding capacity and shallowness to hard caliche. Suitable crops under irrigation are peanuts, sweetpotatoes, small grain, alfalfa, and pasture plants. *Dryland capability unit VIe-1, climatic zone 3; irrigated capability unit IVe-13; Sandy Upland range site.*

Arvana soils, 0 to 3 percent slopes, severely eroded (Av).—These severely eroded soils consist mainly of previously cultivated fields in the dryfarmed area of the county and of a very limited acreage in the irrigated area.

Most of the original 8- to 10-inch surface layer has been removed by wind erosion, and the present surface layer is only about 2 to 5 inches thick. The subsoil of sandy clay loam is within plow depth. In places the substratum of hard caliche is near the surface, or it is exposed.

Included in the areas mapped are some small areas of Arvana fine sandy loam, shallow, 0 to 1 percent slopes, and of Kimbrough fine sandy loam.

These soils are hummocky because of the damage done by wind. They are so severely eroded and so shallow that they are not suitable for cultivation. Their best use is native grasses, which can be reseeded in drilled sudangrass or sorghum stubble. *Dryland capability unit VIIs-1, climatic zones 3 and 4; Shallow Upland range site.*

Berthoud sandy loam, 2 to 9 percent slopes (Ba).—This soil occurs in the western part of the county and to some extent in the panhandle.

The surface layer is about 8 inches of brown sandy loam. It has weak granular structure and contains many small or medium-sized pebbles. The subsoil is light-brown loam and is about 10 inches thick. This layer contains many roots and many medium-sized pebbles that are coated with caliche. Both the surface layer and the subsoil are strongly calcareous. The underlying substratum is strongly calcareous, structureless, pink fine sandy loam.

Some small areas of Mansker fine sandy loam, 1 to 3 percent slopes, are included in the areas mapped.

Runoff from this soil is moderate, and internal drainage generally is good. Wind erosion is slight or moderate because the caliche gravel on the surface helps to protect this soil.

Little, if any, of this soil is cultivated. The range supports stands of short and mid grasses. *Dryland capability unit VIe-1, climatic zones 3 and 4; Sandy Upland range site.*

Bippus and Spur soils (0 to 3 percent slopes) (Bb).—These are deep, moderately dark colored soils that occur on bottoms along drainageways throughout the county.

The surface layer of the Bippus soil is dark grayish-brown or brown, granular light clay loam (fig. 6). This layer is 6 to 8 inches thick and is leached of lime. The

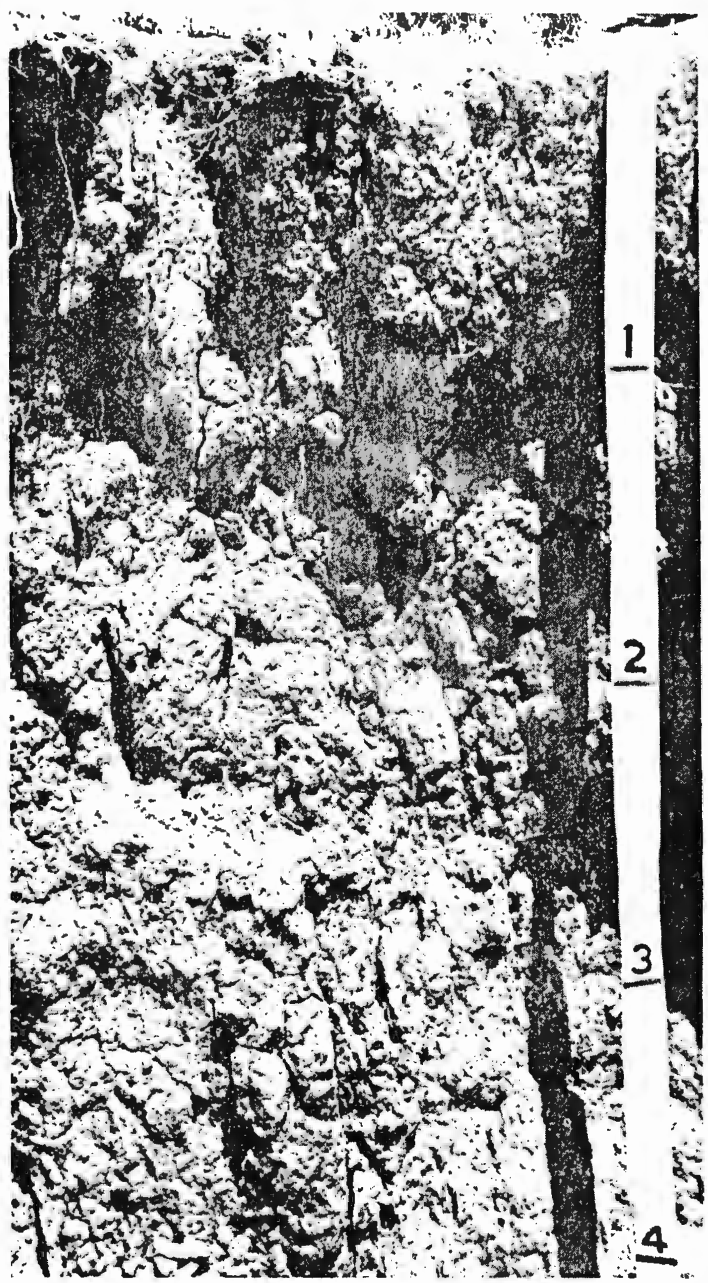

Figure 6.—Profile of Bippus clay loam.

subsoil is about 6 inches of clay loam. It has subangular blocky structure and is moderately calcareous. The substratum is strongly calcareous, lime-enriched clay loam and is about 30 inches thick. In places layers of stratified sandy sediments occur below a depth of 3 to 5 feet.

The Spur soil has a brown, calcareous, granular surface layer that is about 8 inches thick. The subsoil is calcareous, brown clay loam and in places contains thin layers of sandy sediments. It ranges between 6 and 16 inches in thickness and has weak subangular blocky structure or prismatic structure. The substratum is strongly calcareous, massive sandy clay loam. In places it is stratified with coarse sand and gravel.

Small areas of Mansker, Portales, and Berthoud soils are included in some of the areas mapped. The included soils commonly occur along the outside boundary of drainageways, on slopes to higher lying areas.

Runoff is rapid but is confined to the drainage system. Internal drainage is good. Where these soils have been compacted either by machinery or by the trampling of cattle, water remains on the surface for some time. Wind erosion is not a serious hazard, but some gullies have formed. Bank sloughing occurs where stream channeling is active.

These soils are subject to overflow and consequently are of limited use for crops. Floodwater, however, benefits range plants. Short and mid grasses are dominant on the range. *Dryland capability unit VIw-3, climatic zones 3 and 4; Loamy Bottomland range site.*

Blackwater loam (0 to 1 percent slopes) (Bc).—This soil is of limited extent in the county and occurs only within the Portales irrigated area.

The surface layer is grayish-brown loam or sandy clay loam and is about 4 to 6 inches thick. It has medium subangular blocky structure that breaks to moderate granular structure. In places it grades to a light-gray clayey layer that is about 4 inches thick. If not destroyed by tillage, this clayey layer has weak, thin, platy structure and overlies a slowly permeable subsoil of blocky clay. The subsoil is about 13 inches thick and is underlain at a depth of about 22 inches by a layer of dense, durable, hard caliche. The caliche restricts the penetration of roots and retards the movement of water. The soil above the caliche layer has been leached of lime.

Except for a few small inclusions of Stegall loam, shallow, 0 to 1 percent slopes, the areas mapped consist wholly of Blackwater loam.

This soil occurs in slightly concave areas and has no well defined outlets. Consequently, runoff generally remains within the area. The water intake rate is slow, and internal drainage is moderate or slow. This soil has the capacity to hold about 3 inches of moisture that is slowly available to plants. Wind erosion is not a hazard.

The individual areas of this soil are smaller than field size. Consequently, it is difficult to select suitable crops for these areas. Alfalfa generally does not grow well because the soil is slowly permeable. Cotton, grain sorghum, and small grain are suitable if the soil is irrigated. *Dryland capability unit IIIce-2, climatic zone 3; irrigated capability unit IIe-5; Loamy Upland range site.*

Blown-out and dune land (5 to 20 percent slopes) (Bd).—This miscellaneous land type is made up of very severely wind eroded areas that are barren of vegetation. The organic matter and fine sediments of the original surface layer have been completely removed by erosion, and large, actively blowing sand dunes, 10 to 15 feet in height, are scattered throughout the areas. Interspersed between the dunes are blowouts where the subsoil is exposed. In some places the substratum is exposed.

Blown-out and dune land is common in the sandhills in the northern part of the county. It also occurs in the southern part, where it is associated with the sandy Amarillo and Brownfield soils. Here, the dunes are red to reddish brown, and the blowouts are spots where the surface layer of either the Amarillo or the Brownfield soil has been removed and the sandy clay loam subsoil is exposed. In areas where Blown-out and dune land is associated with the Tivoli soils, white caliche is exposed between the dunes. In these areas, some saltcedar is growing on the windward side, near the base of the dunes.

Most of the eroded areas in the southern part of the county resulted from attempts to farm very sandy land (fig. 7). To the lee side of these blown-out areas, large

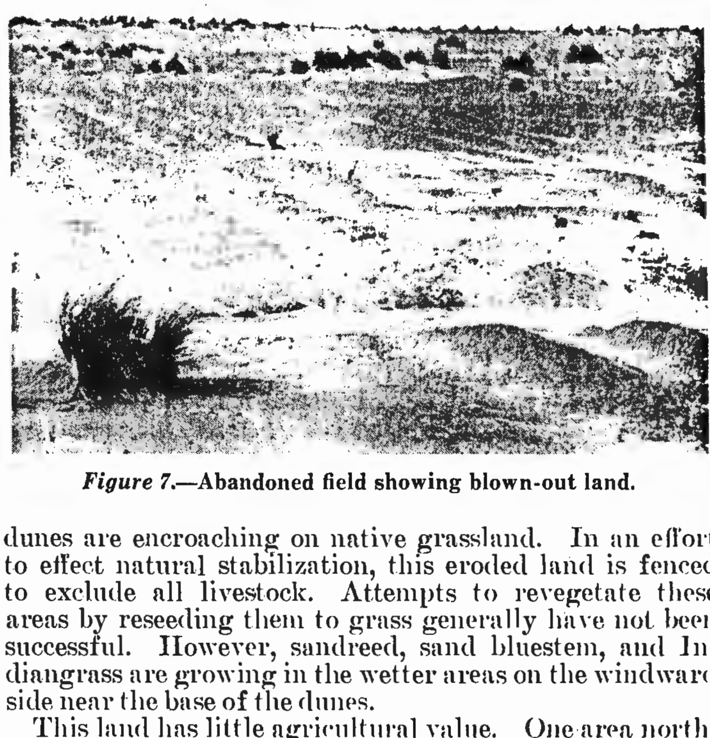

***Figure 7.*—Abandoned field showing blown-out land.**

dunes are encroaching on native grassland. In an effort to effect natural stabilization, this eroded land is fenced to exclude all livestock. Attempts to revegetate these areas by reseeding them to grass generally have not been successful. However, sandreed, sand bluestem, and Indiangrass are growing in the wetter areas on the windward side near the base of the dunes.

This land has little agricultural value. One area northeast of Portales is a State park, which is used as a picnic area and tourist attraction. *Dryland capability unit VIIe-1, climatic zones 3 and 4; Deep Sand range site.*

Brownfield fine sand (0 to 3 percent slopes) (Be).—This soil is extensive in the shin-oak section of the county, south of Milnesand, where it is closely associated with Amarillo loamy fine sand, 0 to 3 percent slopes.

The surface layer is about 18 to 23 inches thick and ranges from fine sand to loamy fine sand in texture and from brown to reddish brown in color. The uppermost 2 or 3 inches commonly has weak platy structure that is easily destroyed. The surface layer rests abruptly on the sandy clay loam subsoil. The subsoil ranges from 3 to feet in thickness. It grades gradually from prismatic structure in the upper part to massive in the lower part and also is redder with depth. It is underlain by a red

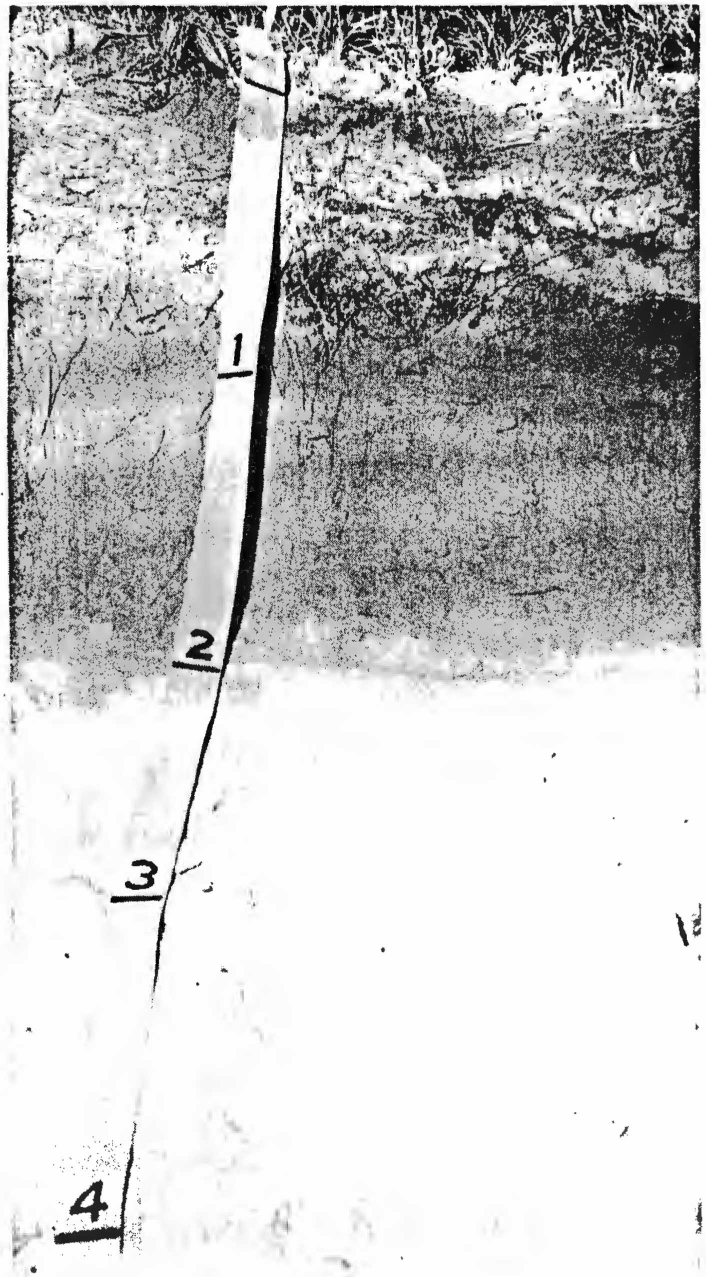

Figure 10.—**Profile of Gomez loamy fine sand.**

loam. It is subangular blocky in structure and is also noncalcareous. This layer is underlain abruptly at a depth of about 8 inches by a layer of hard caliche that varies in thickness.

This soil is associated with the Potter soils and with Arvana fine sandy loams, and small areas of these soils are included in the areas mapped.

The control of runoff is not a problem, but slight to moderate wind erosion can be expected. The layer of hard caliche limits the depth of the root zone and restricts internal drainage.

This shallow soil supports fair to good stands of mid and short grasses. *Dryland capability unit VIIs–1, climatic zones 3 and 4; Shallow Upland range site.*

Kimbrough loam (0 to 1 percent slopes) (Kb).—This is a shallow soil that occurs in small, widely scattered areas throughout the county.

The surface layer of dark grayish-brown loam ranges from 2 to 4 inches in thickness, is noncalcareous, and has moderate to strong granular structure. The subsoil has subangular blocky structure and ranges from 4 to 8 inches in thickness. This layer is noncalcareous in the upper part and slightly calcareous in the lower part. It is underlain abruptly by a layer of hard caliche that varies in thickness.

This soil is closely associated with the level or nearly level Stegall and Clovis soils, and small areas of these soils are included in the areas mapped.

Runoff is slow, except in wet weather when the soil becomes saturated. The resistance to wind erosion is good. Both root penetration and internal drainage are restricted by the layer of hard caliche.

The principal grasses on this soil are blue grama, black grama, hairy grama, sideoats grama, and little bluestem. *Dryland capability unit VIIs–1, climatic zones 3 and 4; Shallow Upland range site.*

Mansker and Portales fine sandy loams, 1 to 3 percent slopes (Mc).—This undifferentiated mapping unit occurs on gently sloping uplands throughout the county. About 60 percent of the mapping unit is Mansker fine sandy loam.

The soils of this unit are similar in color, and both have a brown, moderately coarse textured, calcareous, granular surface layer that is about 5 inches thick. In both, the subsoil is calcareous, but it is more strongly calcareous in the Mansker soil. In the Mansker soil, the subsoil is 8 to 10 inches thick and massive. It overlies a yellowish-brown substratum that contains many medium-sized and large fragments of caliche. Fragments of caliche occur on the surface and throughout the soil material. In the Portales soil, the subsoil has weak prismatic structure and is about 12 inches thick. This layer overlies a prominent, chalky substratum. The Portales soil contains few, if any, caliche fragments.

Small areas of the more nearly level Potter soils and of Clovis fine sandy loam, 1 to 3 percent slopes, are included in the areas mapped.

The Mansker and Portales soils are well drained and are moderately susceptible to wind erosion. Both have a moderately permeable subsoil. Runoff is moderate.

Suitable dryfarmed crops are grain and forage sorghum. Suitable irrigated crops are small grain, alfalfa, and pasture plants. The range supports fair stands of mid and tall grasses. *Mansker fine sandy loam is in dryland capability unit IVe–3 if in climatic zone 3, and unit VIe–2 if in climatic zone 4; irrigated unit IVe–7; Limy Upland range site. Portales fine sandy loam is in IVe–3 if in climatic zone 3, and unit VIe–1 if in climatic zone 4; irrigated unit IIIe–7; Sandy Upland range site.*

Mansker and Portales loams, 1 to 3 percent slopes (Md).—This undifferentiated mapping unit occupies many of the gentle slopes throughout the county.

The soils of this unit have similar profile characteristics. Both have a 5-inch, brown to grayish-brown, calcareous surface layer that has weak granular structure. In both, the subsoil is sandy clay loam, but in the Mansker soil, this layer is massive, or structureless, and in the Portales it has weak to moderate prismatic structure. The Mansker soil is underlain at a depth of less than 20 inches by yellowish-brown caliche, and there are many medium-sized and large fragments of caliche on the surface and throughout the soil material. The Portales soil is underlain at a depth of 20 to 36 inches by a soft, chalky, prominent lime zone.

Included in the areas mapped are small areas of Clovis loam, 1 to 3 percent slopes, and of Potter soils, 0 to 9 percent slopes.

The Mansker and Portales soils are well drained and are moderately permeable. Runoff is moderate or rapid. Wind erosion is slight, but water erosion is moderate, and there are some scattered gullies.

If dryfarmed, these soils are suited to grain and forage sorghum and can be used occasionally for wheat. Under irrigation, they are suited to vegetables, small grain, cotton, and alfalfa. The range supports fair to good stands of mid and short grasses. *Mansker loam is in dryland capability unit IVe-2 if in climatic zone 3, and unit VIe-2 if in climatic zone 4; irrigated unit IVe-7; Limy Upland range site. Portales loam is in dryland capability unit IVe-2 if in climatic zone 3, and unit IVce-2 if in climatic zone 4; irrigated unit IIIe-6; Loamy Upland range site.*

Montoya clay loam (0 to 3 percent slopes) (Me).—This is a reddish-brown soil that developed in fine-textured alluvium from areas of red-bed shale. It occurs southwest of Elida and in the vicinity of Red Lake, between Elida and Dora. It is limited in extent.

The surface layer consists of about 12 inches of calcareous, granular heavy clay loam. Roots are abundant in this layer. The subsoil is silty clay. It is about 18 inches thick, has weak, coarse, subangular blocky structure, and is strongly calcareous. It is underlain by reddish-brown, massive, strongly calcareous clay or silty clay that contains numerous fragments of weathered shale. This underlying layer generally is moist and mottled, an indication that the soil formed under wet conditions.

Included in the areas mapped are a few areas of Berthond sandy loam, 2 to 9 percent slopes, and small areas of Travessilla loam.

Runoff is rapid on this soil, and internal drainage is slow. Soil piping is common. Some gullies have formed in areas where the vegetation has been destroyed by roads or cattle trails. It will be difficult to prevent further erosion of many of these gullies because runoff is rapid. When wet, this soil is unstable and very slick.

This soil is not farmed, but it provides fair grazing. Tobosa is the principal grass, but grama grasses and buffalograss occur in the plant cover. *Dryland capability unit VIw-1, climatic zones 3 and 4; Valley Clay range site.*

Olton loam, 0 to 1 percent slopes (Ot).—This soil occurs in the wheat-growing section of the county in the vicinity of Rogers and Dora. It is not extensive.

The surface layer consists of about 4 inches of brown to dark-brown loam. It has strong granular structure and is noncalcareous. The subsoil is noncalcareous clay loam. It is about 24 inches thick and has subangular blocky structure (fig. 11). This layer overlies a strongly calcareous layer that is 18 to 20 inches thick, light reddish brown in color, and massive. The substratum is very strongly calcareous pink silt loam. It is similar to the parent sediments of the Amarillo soils.

Included in the areas mapped are a few small areas of Amarillo loam, 0 to 1 percent slopes, and of Stegall loam, 0 to 1 percent slopes.

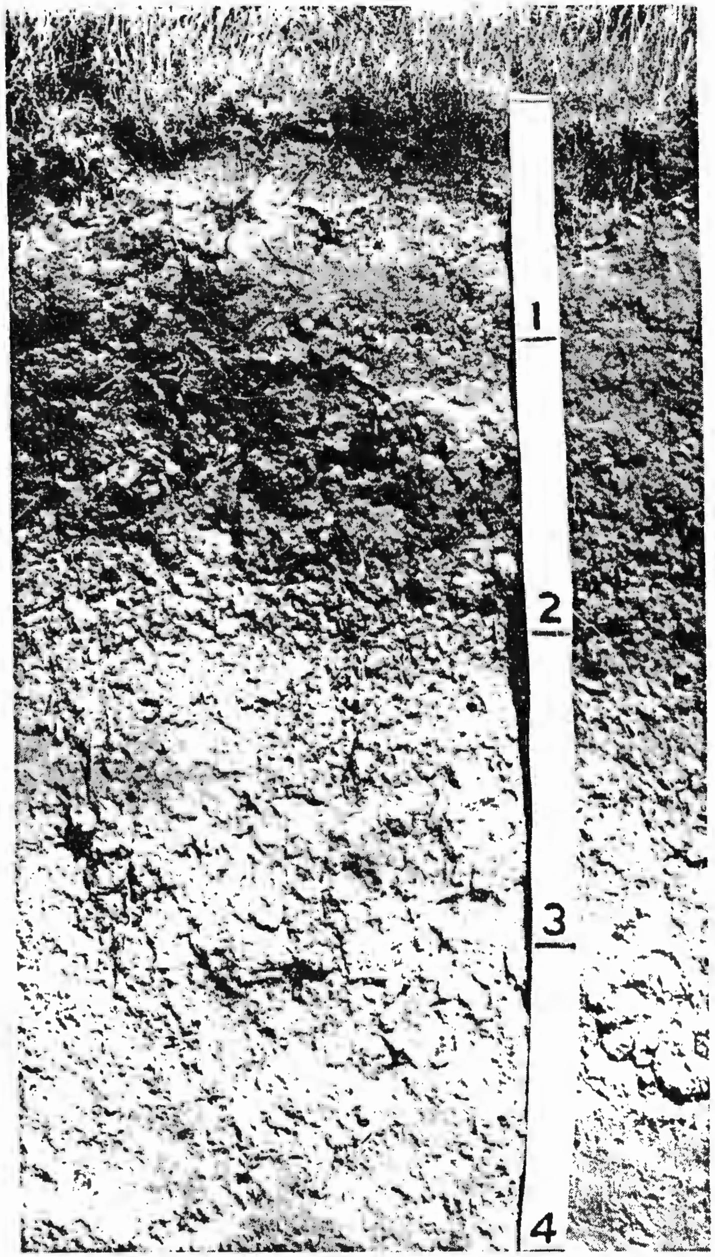

***Figure 11.*—Profile of Olton loam, 0 to 1 percent slopes, showing subangular blocky structure of subsoil.**

Runoff is moderate, and internal drainage is slow. Puddling is common following a hard rain. Wind erosion is a slight or moderate hazard.

If dryfarmed, this soil is used principally for wheat, but it also produces good yields of grain sorghum. The range is productive of both short and mid grasses. *Dryland capability unit IIIce-1 if in climatic zone 3, and IVce-1 if in climatic zone 4; irrigated capability unit IIe-4; Loamy Upland range site.*

Olton-Zita loams, 0 to 1 percent slopes (Oz).—This complex consists of a limited acreage of wheat-producing soils in the panhandle section of the county.

The surface layer of both soils is about 4 to 6 inches of dark grayish-brown to brown heavy loam. This layer has moderate, medium, granular structure. In the Olton soil, the clay loam subsoil is about 21 inches thick and has prismatic structure that breaks to moderate subangular blocky structure. It is underlain by a pink to reddish-yellow, strongly calcareous, massive substratum that contains fragments of caliche. In the Zita soil, the sandy clay loam subsoil is 15 inches thick and has moderate, medium, prismatic structure. It is underlain by white, chalky, soft caliche.

Included in the areas mapped are small areas of Amarillo loam, 0 to 1 percent slopes, and of Clovis loam, 0 to 1 percent slopes.

The soils of this complex have good internal drainage, a moderately permeable subsoil, and moderate runoff. Wind erosion is a slight or moderate hazard.

If moisture conditions are favorable at planting time, these soils are suited to wheat. In dry years, they can be summer fallowed or seeded to grain sorghum. The dominant vegetation on the range is mid and short grasses. *Olton loam is in dryland capability unit IIIce-1 if in climatic zone 3, and unit IVce-1 if in climatic zone 4; irrigated unit IIe-4; Loamy Upland range site. Zita loam is in dryland capability unit IIIce-2 if in climatic zone 3, and unit IVce-2 if in climatic zone 4; irrigated unit IIe-3; Loamy Upland range site.*

Portales fine sandy loam, 0 to 1 percent slopes (Pa).—This soil occurs mainly south and east of Portales, within the Portales irrigated area.

The surface layer is calcareous, grayish-brown fine sandy loam. It is about 6 inches thick and has fine granular structure. The subsoil is moderately permeable, calcareous loam. It is about 12 inches thick and has weak prismatic structure. The substratum is limy, massive, gray clay loam. Water moves into the substratum readily, but few roots occur in this layer.

Small areas of light-colored Arch fine sandy loam are included in the areas mapped.

The Portales soil takes water readily, and it holds a moderate amount of moisture that crops can use. Runoff is slow, and internal drainage is good. Wind erosion is a moderate hazard, and careful management is needed to minimize damage by wind.

This soil is suited to peanuts, cotton, sweetpotatoes, and alfalfa. The range supports good stands of mid grasses. *Dryland capability unit IVe-3 if in climatic zone 3, and VIe-1 if in climatic zone 4; irrigated capability unit IIe-9; Sandy Upland range site.*

Portales loam, 0 to 1 percent slopes (Pb).—This soil occurs mainly west and northwest of Portales in the vicinity of Bethel.

The surface layer, which is about 4 to 8 inches thick, has good tilth and fine granular structure. In places this layer is calcareous. The subsoil is calcareous, prismatic sandy clay loam about 15 inches thick. It is underlain by a lime zone that is light gray in color and ranges from sandy loam to clay loam. Few roots occur in this chalky substratum, but movement of moisture through this layer is moderate. Included in the areas mapped are small areas of Arch loam.

Control of runoff is not difficult on this soil, except following intense storms of short duration. Drainage through the soil is good. This soil takes water readily, and it is capable of holding a moderate amount of moisture that crops can use.

The principal crops under irrigation are peanuts, cotton, and sweetpotatoes. Grain sorghum is suitable if the soil is dryfarmed. Mid and short grasses are dominant on the range. *Dryland capability unit IVe-2 if in climatic zone 3, and IVce-2 if in climatic zone 4; irrigated capability unit IIe-3; Loamy Upland range site.*

Potter soils, 0 to 9 percent slopes (Pc).—These soils are extensive on the ridges and escarpments throughout the county, and they commonly occur on the windward slopes of playas.

These are soils that have a pale-brown, calcareous surface layer about 6 inches thick. This layer has very weak subangular blocky structure that breaks to weak granular structure. It grades to a strongly calcareous layer that contains many loose, medium-sized fragments of coarse caliche.

Small areas of Mansker loam, 1 to 3 percent slopes, are included in some of the areas mapped.

Runoff is moderate or rapid on these soils, but water erosion is not a serious hazard, because of the resistance of the imbedded caliche rock. Wind erosion is negligible. Internal drainage is good.

These soils are not suited to crops. They support fair stands of short and mid grasses, but in places there are heavy invasions of snakeweed. They are often used as base material in the construction of roads. *Dryland capability unit VIIs-1, climatic zones 3 and 4; Shallow Upland range site.*

Riverwash (Ra).—This land type occurs in the panhandle section of the county. It consists mainly of loose, medium-textured and coarse-textured sandy material and beds of gravel in unstable stream channels. There is no profile development. These areas are subject to occasional overflow and flooding.

This material has little agricultural value. It is used to some extent for construction purposes. In a few places, saltcedar and cottonwood trees grow on or near the creekbed. Riverwash is not shown in a range site, but it generally is included in the range site of adjacent areas. *Dryland capability unit VIIIw-1, climatic zones 3 and 4.*

Rough broken land (5 to 25 percent slopes) (Rb).—This land type is known locally as the Breaks and as the High Plains escarpments. The Breaks are the very steep, very shallow ridges that occur in rough, broken areas in the panhandle. The High Plains escarpments occur mainly in the vicinity of Elida and Kenna.

The surface layer of this land type is thin and ranges from sandy loam to loam. Many rocks of sandstone or caliche are exposed, and in some areas shale red beds are exposed near the base of steep breaks.

Wind erosion is negligible, but water erosion has caused the formation of many gullies. Runoff is rapid, and internal drainage is good.

These areas have limited use for grazing because their slopes are not readily accessible. However, these slopes offer some protection to cattle during inclement weather. Some areas provide good base material for road construction.

Black grama, sideoats grama, juniper, and yucca are the common vegetation. *Dryland capability unit VIIs-1, climatic zones 3 and 4; Shallow Upland range site.*

Springer loamy fine sand (0 to 5 percent slopes) (Sf).—This soil occurs throughout the county but is most extensive north of Portales and south of Causey.

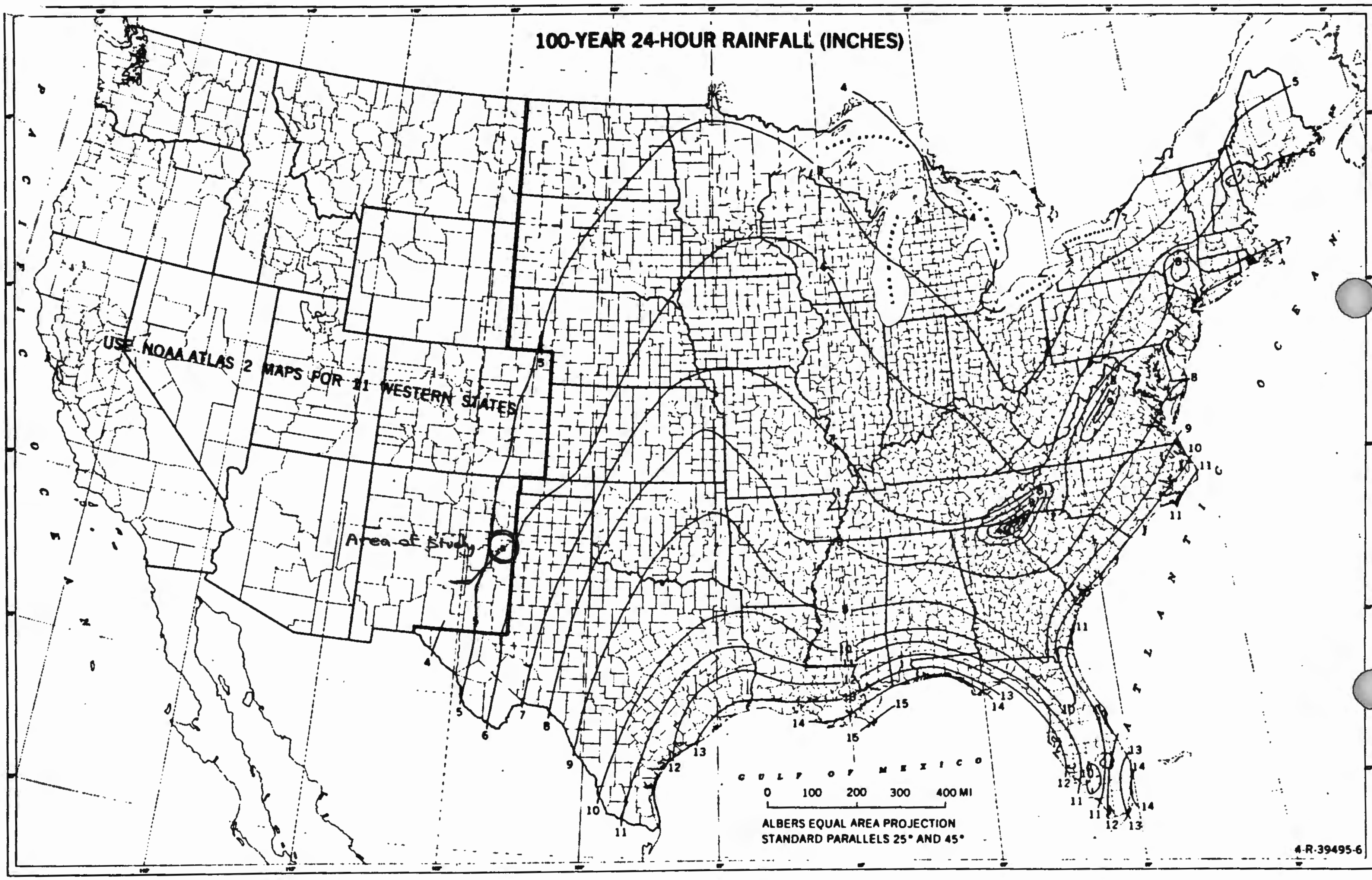

Figure B-8.—One-hundred-year, 24-hour rainfall.

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Development of composite flood hydrograph

This section describes the procedure for developing the peak discharge and selected discharge values of a composite flood hydrograph.

Selecting T_c and T_t

First, use worksheet 5a to develop a summary of basic watershed data by subarea. Then use worksheet 5b to develop a tabular hydrograph discharge summary; this summary displays the effect of individual subarea hydrographs as routed to the watershed point of interest. Use ΣT_t for each subarea as the total reach travel time from that subarea through the watershed to the point of interest. Compute the hydrograph coordinates for selected ΣT_t's using the appropriate sheets in exhibit 5. The flow at any time is

$$q = q_t A_m Q \qquad \text{[Eq. 5-1]}$$

where

q = hydrograph coordinate (cfs) at hydrograph time t;
q_t = tabular hydrograph unit discharge from exhibit 5 (csm/in);
A_m = drainage area of individual subarea (mi^2); and
Q = runoff (in).

Since the timing of peak discharge changes with T_c and T_t, interpolation of peak discharge for T_c and T_t values for use in exhibit 5 is not recommended. Interpolation may result in an estimate of peak discharge that would be invalid because it would be lower than either of the hydrographs. Therefore, round the actual values of T_c and T_t to values presented in exhibit 5. Perform this rounding so that the sum of the selected table values is close to the sum of actual T_c and T_t. An acceptable procedure is to select the results of one of three rounding operations:

1. Round T_c and T_t separately to the nearest table value and sum;
2. Round T_c down and T_t up to nearest table value and sum; and
3. Round T_c up and T_t down to nearest table value and sum.

From these three alternatives, choose the pair of rounded T_c and T_t values whose sum is closest to the sum of the actual T_c and T_t. If two rounding methods produce sums equally close to the actual sum, use the combination in which rounded T_c is closest to actual T_c. An illustration of the rounding procedure is as follows:

Table 5-1.—I_a values for runoff curve numbers

Curve number	I_a (in)	Curve number	I_a (in)
40	3.000	70	0.857
41	2.878	71	0.817
42	2.762	72	0.778
43	2.651	73	0.740
44	2.545	74	0.703
45	2.444	75	0.667
46	2.348	76	0.632
47	2.255	77	0.597
48	2.167	78	0.564
49	2.082	79	0.532
50	2.000	80	0.500
51	1.922	81	0.469
52	1.846	82	0.439
53	1.774	83	0.410
54	1.704	84	0.381
55	1.636	85	0.353
56	1.571	86	0.326
57	1.509	87	0.299
58	1.448	88	0.273
59	1.390	89	0.247
60	1.333	90	0.222
61	1.279	91	0.198
62	1.226	92	0.174
63	1.175	93	0.151
64	1.125	94	0.128
65	1.077	95	0.105
66	1.030	96	0.083
67	0.985	97	0.062
68	0.941	98	0.041
69	0.899		

Exhibit 5-II: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution

TRVL TIME (HR)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
	HYDROGRAPH TIME (HOURS)																															
IA/P = 0.10	* * * TC =0.1 HR * * *																												IA/P = 0.10			
0.0	24	34	53	334	647	1010	623	217	147	123	104	86	76	66	57	51	46	42	38	34	32	29	26	23	21	20	19	18	15	13	12	0
.10	21	29	43	134	267	520	847	701	378	224	157	122	98	75	64	56	50	45	41	36	33	30	27	24	21	20	19	13	16	13	12	0
.20	18	25	35	61	110	215	478	704	702	486	312	209	151	94	73	62	54	49	46	38	34	31	28	25	22	21	19	18	16	14	12	0
.30	17	23	33	56	92	174	337	582	662	545	359	269	190	109	79	65	56	50	45	39	35	32	29	25	22	21	20	18	16	14	12	0
.40	15	20	28	41	51	78	142	272	478	601	563	447	328	172	104	76	63	55	49	42	37	33	29	26	23	21	20	19	17	14	12	0
.50	14	19	26	39	47	68	117	220	392	531	553	482	380	209	121	84	67	57	51	43	38	33	30	27	23	21	20	19	17	14	12	0
.75	12	15	21	29	33	38	49	73	126	224	343	432	464	385	252	156	103	76	62	50	43	36	31	28	25	22	21	19	17	15	12	0
1.0	9	12	15	21	23	26	29	33	40	55	86	148	238	406	434	317	205	130	89	62	50	41	34	30	27	24	22	20	18	16	[illegible]	0
1.5	7	8	10	14	15	16	18	20	22	25	29	34	45	101	220	339	373	320	234	131	80	53	40	34	30	27	24	21	19	17	12	2
2.0	4	6	7	9	9	10	11	12	13	15	16	18	20	25	37	72	150	252	336	312	216	109	58	42	34	30	27	24	20	18	13	8
2.5	3	4	5	6	7	7	8	8	9	10	11	12	13	16	19	25	39	75	142	262	303	229	108	58	41	34	30	27	22	19	14	11
3.0	1	2	3	4	4	5	5	6	6	7	7	8	8	10	12	14	17	22	31	76	169	288	236	122	64	43	35	30	24	20	16	11
IA/P = 0.30	* * * TC =0.1 HR * * *																												IA/P = 0.30			
0.0	0	0	0	154	568	936	524	217	172	149	126	107	97	86	76	69	63	58	53	48	46	42	38	34	31	30	28	27	24	20	19	0
.10	0	0	0	19	109	415	762	603	346	230	176	143	119	96	84	74	68	62	57	50	47	44	40	35	32	30	29	27	24	21	19	0
.20	0	0	0	0	13	77	302	609	605	432	297	217	167	115	94	81	73	66	60	53	48	45	41	37	33	31	29	28	25	21	19	0
.30	0	0	0	0	9	54	219	479	563	476	357	263	199	129	99	85	75	68	62	54	49	45	41	37	33	31	29	23	25	21	19	0
.40	0	0	0	0	0	6	38	159	372	500	484	399	309	183	123	96	82	73	66	58	51	46	42	38	34	31	30	28	25	22	19	0
.50	0	0	0	0	0	4	27	115	287	429	465	421	346	213	138	103	86	76	68	59	52	47	43	39	34	32	30	29	25	22	19	0
.75	0	0	0	0	0	0	1	10	46	132	246	338	381	341	243	165	119	94	80	67	58	50	45	41	37	33	31	29	26	23	19	0
1.0	0	0	0	0	0	0	0	1	4	22	69	149	241	357	331	246	170	122	96	76	64	54	47	42	38	34	32	30	27	24	19	0
1.5	0	0	0	0	0	0	0	0	0	0	0	1	4	41	142	258	310	285	224	142	97	71	55	47	43	39	35	32	29	25	20	4
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	49	130	221	279	255	182	108	70	55	47	42	38	34	30	27	20	11
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	14	52	119	224	256	193	107	70	55	47	42	38	32	28	22	[illegible]
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	52	141	240	199	117	74	56	48	43	35	30	24	[illegible]
IA/P = 0.50	* * * TC =0.1 HR * * *																												IA/P = 0.50			
0.0	0	0	0	0	70	539	377	196	171	154	134	117	108	99	89	83	77	72	67	61	59	56	51	46	43	42	40	38	34	30	28	0
.10	0	0	0	0	47	375	376	256	199	169	146	126	114	102	92	85	79	73	68	62	59	56	52	47	43	42	40	38	34	30	28	0
.20	0	0	0	0	0	31	260	338	283	227	189	160	138	112	99	90	83	77	72	64	60	57	53	48	44	42	41	39	35	30	29	0
.30	0	0	0	0	0	0	21	180	285	284	246	208	176	131	110	97	88	82	76	68	62	59	54	50	45	43	41	39	36	31	28	0
.40	0	0	0	0	0	0	14	125	232	266	253	223	192	142	115	100	91	83	77	69	63	59	55	50	45	43	41	40	36	31	29	0
.50	0	0	0	0	0	0	9	86	183	239	248	231	205	154	122	104	93	85	79	71	64	59	55	51	46	43	41	40	36	32	29	0
.75	0	0	0	0	0	0	3	31	87	147	190	211	213	184	147	121	103	92	84	75	67	61	57	52	47	44	42	40	37	32	28	0
1.0	0	0	0	0	0	0	0	0	1	13	45	92	141	205	197	165	134	112	98	84	75	65	[illegible]	55	50	46	43	41	38	34	28	0
1.5	0	0	0	0	0	0	0	0	0	0	0	2	9	51	118	170	183	167	143	111	92	77	65	59	54	50	45	43	39	35	28	2
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	15	51	103	148	168	156	127	96	76	65	58	54	49	45	41	37	29	12
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	31	69	131	159	140	101	78	66	59	54	50	43	39	31	24
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	11	46	101	151	134	99	77	65	59	54	45	41	33	26

RAINFALL TYPE = II * * * TC = 0.1 HR * * * SHEET 1 OF 10

Exhibit 5-II, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution

TRVL TIME (HR)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
IA/P = 0.10														* * * TC =0.2 HR * * *														IA/P = 0.10				
0.0	23	31	47	209	403	739	800	481	250	166	128	102	86	70	61	54	49	44	40	35	33	30	27	24	21	20	19	18	16	13	12	0
.10	19	26	39	86	168	325	601	733	565	355	229	161	122	83	69	59	53	47	43	37	34	31	28	25	22	21	19	18	16	14	12	0
.20	17	23	32	49	74	136	262	488	652	594	435	298	207	115	81	67	58	51	46	40	35	32	29	26	23	21	20	19	16	14	12	0
.30	16	22	30	46	64	112	212	396	566	585	485	360	258	139	90	71	60	53	48	41	36	32	29	26	23	21	20	19	16	14	12	0
.40	14	19	25	37	43	57	94	173	322	485	551	507	409	227	129	87	68	58	52	44	38	33	30	27	24	21	20	19	17	14	12	0
.50	13	18	24	35	40	52	80	142	262	410	504	506	441	269	153	98	73	61	53	45	39	34	30	27	24	22	20	19	17	15	12	0
.75	10	13	17	23	26	30	34	40	55	86	150	247	349	438	360	240	151	131	75	57	47	39	33	29	26	23	21	20	18	15	12	0
1.0	9	11	14	19	21	24	26	30	35	44	62	101	167	337	413	353	245	157	104	68	53	42	35	31	28	24	22	20	18	16	12	0
1.5	6	8	10	13	14	15	17	19	21	23	26	30	37	73	166	288	356	337	264	154	91	57	42	35	30	27	24	22	19	17	13	[illegible]
2.0	4	5	7	8	9	10	10	11	12	14	15	16	18	23	31	55	114	206	291	324	239	125	63	44	35	31	28	24	20	18	14	[illegible]
2.5	3	4	5	6	6	7	7	8	9	9	10	11	12	15	18	22	32	58	111	227	298	246	122	63	43	35	31	27	22	19	15	11
3.0	1	2	3	4	4	4	5	5	6	6	7	7	8	9	11	13	16	19	27	59	138	280	248	137	70	46	36	31	25	21	16	11
IA/P = 0.30														* * * TC =0.2 HR * * *														IA/P = 0.30				
0.0	0	0	0	39	180	543	697	497	276	198	158	130	110	93	81	73	67	61	56	49	46	43	39	35	32	30	29	27	24	21	19	0
.10	0	0	0	2	27	129	407	600	532	361	252	190	150	108	90	79	71	65	59	52	48	44	41	36	32	31	29	28	25	21	19	0
.20	0	0	0	2	19	92	302	501	521	415	306	228	176	119	95	82	73	67	61	53	48	45	41	37	33	31	29	28	25	21	19	0
.30	0	0	0	0	1	13	66	223	408	484	438	350	269	163	114	93	80	72	65	57	51	46	42	38	34	31	30	28	25	22	19	0
.40	0	0	0	0	1	9	47	164	327	431	436	379	306	189	127	98	83	74	67	58	52	47	43	38	34	31	30	28	25	22	19	0
.50	0	0	0	0	0	0	6	33	120	258	374	415	391	271	173	121	95	81	72	62	55	48	44	40	35	32	30	27	26	22	19	0
.75	0	0	0	0	0	0	2	13	50	126	221	302	343	323	240	167	121	96	81	68	59	50	45	41	37	33	31	29	26	23	19	0
1.0	0	0	0	0	0	0	0	0	1	6	24	69	139	285	331	280	204	145	109	82	68	56	48	43	39	35	32	30	27	24	19	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	16	79	186	271	288	247	165	110	76	58	49	44	40	35	32	29	26	20	5
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	24	80	163	235	262	202	123	76	58	49	43	39	35	30	27	21	13
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	28	77	179	242	207	120	75	57	48	43	39	32	29	22	17
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	30	101	207	227	130	80	59	49	44	35	30	24	18
IA/P = 0.50														* * * TC =0.2 HR * * *														IA/P = 0.50				
0.0	0	0	0	0	7	98	371	322	221	182	158	137	120	104	94	86	80	74	69	62	60	57	52	47	44	42	40	39	35	30	28	0
.10	0	0	0	0	4	57	270	305	249	204	174	149	130	108	97	88	82	76	71	64	60	57	53	48	44	42	41	39	35	30	28	0
.20	0	0	0	0	0	3	45	195	268	255	221	189	163	125	106	95	87	80	75	67	62	58	54	49	45	43	41	39	35	31	28	0
.30	0	0	0	0	0	2	31	140	226	245	229	203	176	134	111	98	89	82	76	68	62	59	55	50	45	43	41	39	36	31	28	0
.40	0	0	0	0	0	1	21	101	184	225	228	211	183	144	117	101	91	84	79	69	63	59	55	50	45	43	41	40	36	31	28	0
.50	0	0	0	0	0	0	1	14	72	146	199	218	213	175	137	113	99	89	82	73	66	60	56	52	47	43	42	40	36	32	28	0
.75	0	0	0	0	0	0	0	5	28	71	121	162	186	193	161	133	112	98	89	78	70	62	57	53	48	44	42	41	37	33	28	0
1.0	0	0	0	0	0	0	0	0	0	2	13	38	77	154	186	174	147	122	105	89	78	68	60	56	51	46	43	42	38	34	28	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	2	22	71	129	163	168	150	120	98	90	67	60	55	51	46	43	40	36	28	4
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	25	65	112	146	157	134	103	79	67	60	55	50	46	41	38	29	14
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	26	60	117	148	136	101	79	66	59	54	50	43	39	31	24
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	40	90	142	130	99	78	66	59	54	45	41	33	26

RAINFALL TYPE = II * * * TC = 0.2 HR * * * SHEET 2 OF 10

Exhibit 5-II, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution

IA/P = 0.10 * * * TC = 0.3 HR * * * IA/P = 0.10

TRVL TIME (HR)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	20	28	41	118	235	447	676	676	459	283	196	146	114	80	66	57	51	46	42	37	33	31	28	24	22	20	19	18	16	13	12	0
.10	19	26	39	99	189	361	571	641	520	362	251	181	136	89	70	60	53	48	43	37	34	31	28	25	22	21	19	18	16	14	12	0
.20	17	23	32	53	83	154	292	478	587	542	422	308	223	127	86	68	58	52	46	40	35	32	29	26	23	21	20	19	16	14	12	0
.30	16	22	30	49	72	127	237	398	524	536	460	359	268	151	97	73	61	53	48	41	36	32	29	26	23	21	20	19	16	14	12	0
.40	14	19	25	37	45	63	105	193	330	459	510	477	398	237	139	92	70	59	52	44	38	34	30	27	24	21	20	19	17	14	12	0
.50	13	18	24	35	42	56	89	158	272	397	472	475	424	274	163	104	76	62	54	46	39	34	30	27	24	22	20	19	17	15	12	0
.75	11	14	19	26	30	34	42	59	95	160	250	339	417	398	299	196	128	89	69	54	45	37	32	29	26	23	21	20	17	15	12	0
1.0	9	11	14	19	21	24	27	30	36	46	68	109	174	328	396	346	248	163	109	70	54	43	35	31	28	24	22	20	18	16	12	0
1.5	6	8	10	13	14	15	17	19	21	23	26	31	38	77	169	282	347	330	264	158	94	58	42	35	31	27	24	22	19	17	13	[illegible]
2.0	4	5	7	8	9	10	10	11	12	14	15	16	18	23	32	57	116	205	285	317	239	128	64	44	36	31	28	25	20	18	14	9
2.5	2	4	5	6	6	7	7	8	9	9	10	11	12	15	18	23	33	60	113	223	293	245	125	65	44	35	31	27	22	19	15	11
3.0	1	2	3	4	4	4	5	5	6	6	7	7	8	9	11	13	16	20	27	61	138	225	246	139	72	46	36	31	25	21	16	11

IA/P = 0.30 * * * TC = 0.3 HR * * * IA/P = 0.30

TRVL TIME (HR)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	11	64	251	525	574	454	303	221	173	140	104	88	77	70	64	58	51	47	44	40	36	32	31	29	28	24	21	19	0
.10	0	0	0	0	7	45	183	411	520	476	360	268	205	133	101	85	76	69	62	55	49	45	41	37	33	31	30	28	25	21	19	0
.20	0	0	0	0	5	32	132	318	452	468	396	310	240	151	109	90	78	70	64	56	50	46	42	38	33	31	30	28	25	22	19	0
.30	0	0	0	0	0	3	22	96	244	383	440	411	344	217	142	105	87	76	69	60	53	47	43	39	35	32	30	29	26	22	19	0
.40	0	0	0	0	0	2	16	69	186	317	399	407	365	246	160	115	92	79	71	61	54	48	43	39	35	32	30	29	26	22	19	0
.50	0	0	0	0	0	0	2	11	50	140	258	352	389	327	223	149	110	89	77	66	57	50	45	41	36	33	31	29	26	23	19	0
.75	0	0	0	0	0	0	1	4	20	63	135	219	290	335	281	205	146	110	89	72	62	52	46	42	38	34	31	30	27	23	19	0
1.0	0	0	0	0	0	0	0	0	0	2	9	32	78	216	320	306	243	176	128	90	72	59	49	44	40	36	33	31	28	24	19	1
1.5	0	0	0	0	0	0	0	0	0	0	0	0	2	20	84	185	264	281	246	168	112	77	58	49	44	40	36	32	29	26	20	5
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12	50	121	200	257	224	141	83	61	50	44	40	36	31	28	21	14
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	16	51	145	239	223	137	82	60	50	44	40	33	29	22	17
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	19	74	184	224	146	89	63	51	45	36	31	24	18

IA/P = 0.50 * * * TC = 0.3 HR * * * IA/P = 0.50

TRVL TIME (HR)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
0.0	0	0	0	0	1	25	151	299	277	219	187	162	141	113	100	90	84	78	72	65	61	58	53	48	44	42	41	39	35	31	28	0
.10	0	0	0	0	1	17	106	235	263	234	202	175	152	120	104	93	85	79	73	66	61	58	54	49	44	42	41	39	35	31	28	0
.20	0	0	0	0	0	0	12	75	182	236	234	213	188	144	116	101	91	84	78	70	63	59	55	50	45	43	41	40	36	31	28	0
.30	0	0	0	0	0	0	8	52	138	203	224	217	197	154	123	105	94	86	79	71	64	59	55	51	46	43	42	40	36	32	28	0
.40	0	0	0	0	0	0	5	37	105	170	206	213	203	164	131	110	97	88	81	72	65	60	56	51	46	43	42	40	36	32	28	0
.50	0	0	0	0	0	0	0	4	26	78	140	184	203	191	155	126	107	95	86	76	69	62	57	53	48	44	42	41	37	33	28	0
.75	0	0	0	0	0	0	0	1	10	34	73	117	153	184	173	146	122	105	94	82	73	64	58	54	49	45	43	41	37	33	28	0
1.0	0	0	0	0	0	0	0	0	0	0	4	17	42	114	168	173	159	134	114	94	82	70	61	57	52	47	44	42	39	35	28	0
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	10	44	98	144	163	157	130	105	84	69	61	56	52	47	44	40	36	29	6
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	14	44	87	127	153	141	110	83	69	61	56	51	47	42	38	30	17
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	16	42	97	138	145	107	82	68	60	55	51	43	40	32	25
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	27	71	127	139	105	81	68	60	55	46	41	33	27

RAINFALL TYPE = II * * * TC = 0.3 HR * * * SHEET 3 OF 10

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Exhibit 5-II, continued: Tabular hydrograph unit discharges (csm/in) for type II rainfall distribution

TRVL TIME (HR) — HYDROGRAPH TIME (HOURS)

TRVL TIME (HR)	11.0	11.3	11.6	11.9	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.8	14.0	14.3	14.6	15.0	15.5	16.0	16.5	17.0	17.5	18.0	19.0	20.0	22.0	26.0
IA/P = 0.10														* * * TC =0.4 HR * * *														IA/P = 0.10				
0.0	18	25	36	77	141	271	468	592	574	431	298	216	163	104	77	63	55	49	44	38	34	31	28	25	22	21	20	18	16	14	12	0
.10	18	24	34	67	116	219	385	523	557	473	357	263	196	119	84	67	57	51	46	39	35	32	29	25	22	21	20	19	16	14	12	0
.20	15	20	28	44	59	97	179	316	454	523	489	401	309	178	112	81	65	56	49	42	37	33	30	26	23	21	20	19	17	14	12	0
.30	15	20	27	41	53	82	147	260	389	478	486	429	349	210	129	89	69	58	51	43	38	33	30	27	24	21	20	19	17	14	12	0
.40	13	17	23	33	38	48	71	121	214	331	429	467	442	308	189	120	85	66	56	47	41	35	31	28	24	22	20	19	17	15	12	0
.50	12	16	22	31	36	44	62	102	176	279	379	438	440	339	218	137	94	71	59	49	42	35	31	28	25	22	21	19	17	15	12	0
.75	10	13	17	24	26	30	35	45	65	106	170	251	326	393	341	245	164	112	81	59	48	39	33	30	26	23	21	20	18	15	12	0
1.0	8	10	13	17	19	21	24	27	31	37	50	75	118	251	360	376	292	205	138	83	60	45	36	32	28	25	22	21	18	16	12	1
1.5	6	7	9	12	13	14	15	17	19	21	23	26	31	56	121	224	311	333	293	192	115	66	45	36	31	28	25	22	19	17	13	[illegible]
2.0	4	5	6	8	8	9	10	10	11	12	14	15	16	20	27	43	85	159	243	306	264	154	74	47	37	32	28	25	21	18	14	[illegible]
2.5	2	3	4	5	6	6	7	7	8	9	9	10	11	13	16	20	27	46	85	184	285	262	147	74	47	37	32	28	22	19	15	[illegible]
3.0	1	2	2	3	4	4	4	5	5	6	6	7	7	8	10	12	14	17	23	47	109	227	268	160	83	50	38	32	25	21	16	11
IA/P = 0.30														* * * TC =0.4 HR * * *														IA/P = 0.30				
0.0	0	0	0	4	26	113	296	480	495	413	306	234	186	127	100	84	74	67	61	54	49	45	41	37	33	31	29	28	25	21	19	0
.10	0	0	0	0	2	18	81	224	395	462	430	347	272	172	121	96	82	73	66	57	51	46	42	38	34	31	30	28	25	22	19	0
.20	0	0	0	0	2	13	59	169	320	414	424	373	305	196	134	103	85	75	67	59	52	47	43	39	34	32	30	29	25	22	19	0
.30	0	0	0	0	0	1	9	42	127	255	361	403	383	274	181	127	99	83	73	63	55	48	44	40	36	32	30	29	26	23	19	0
.40	0	0	0	0	0	1	6	30	94	202	308	372	379	298	203	141	106	87	76	65	56	49	44	40	36	32	31	29	26	23	19	0
.50	0	0	0	0	0	0	0	4	21	70	158	258	334	364	270	187	133	102	85	70	60	51	46	41	37	33	31	30	26	23	19	0
.75	0	0	0	0	0	0	0	2	8	30	76	145	219	321	305	241	177	130	102	78	65	55	47	43	38	34	32	30	27	24	19	0
1.0	0	0	0	0	0	0	0	0	0	1	4	15	42	150	267	308	272	209	154	103	79	62	51	45	41	37	33	31	28	25	19	1
1.5	0	0	0	0	0	0	0	0	0	0	0	0	1	10	51	136	226	274	263	195	131	85	62	51	45	41	36	33	29	26	20	6
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	31	86	162	252	239	162	93	64	52	45	41	37	31	28	21	15
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	33	112	202	235	155	92	64	52	45	41	33	29	23	16
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	21	76	182	221	143	90	63	51	45	36	31	24	13
IA/P = 0.50														* * * TC =0.4 HR * * *														IA/P = 0.50				
0.0	0	0	0	0	0	7	59	168	245	257	213	186	163	128	109	96	88	81	75	67	62	58	54	50	45	43	41	39	35	31	28	[illegible]
.10	0	0	0	0	0	0	5	41	125	205	240	222	198	154	123	106	94	86	79	71	64	60	56	51	46	43	42	40	36	32	28	0
.20	0	0	0	0	0	0	3	28	93	168	216	220	205	164	131	110	97	88	81	72	65	60	56	51	46	43	42	40	36	32	28	0
.30	0	0	0	0	0	0	0	2	20	69	135	189	209	192	155	126	107	95	86	77	69	62	57	53	48	44	42	41	37	33	29	0
.40	0	0	0	0	0	0	0	1	14	50	106	161	193	202	163	133	112	98	89	78	70	62	58	53	48	44	42	41	37	33	28	0
.50	0	0	0	0	0	0	0	1	9	37	83	135	174	194	171	140	117	102	91	80	71	63	58	54	49	45	43	41	37	33	28	0
.75	0	0	0	0	0	0	0	0	0	3	15	40	76	147	177	169	146	124	107	90	79	68	60	56	51	47	43	42	38	34	23	0
1.0	0	0	0	0	0	0	0	0	0	0	1	7	21	78	141	173	167	146	125	101	86	73	63	58	53	48	45	42	39	35	28	1
1.5	0	0	0	0	0	0	0	0	0	0	0	0	0	5	26	71	121	153	159	139	113	89	72	63	57	53	48	44	40	37	[illegible]	7
2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	16	45	86	138	150	125	93	74	64	58	53	48	42	39	[illegible]	20
2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	17	59	112	143	121	91	73	63	57	53	45	[illegible]	[illegible]	[illegible]
3.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	40	101	138	117	90	73	63	57	48	[illegible]	34	27

RAINFALL TYPE = II * * * TC = 0.4 HR * * * SHEET 4 OF 10

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Table 2-2d.—Runoff curve numbers for arid and semiarid rangelands[1]

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition[2]	A[3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

[1]Average runoff condition, and $I_a = 0.2S$. For range in humid regions, use table 2-2c.

[2]*Poor:* <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: >70% ground cover.

[3]Curve numbers for group A have been developed only for desert shrub.

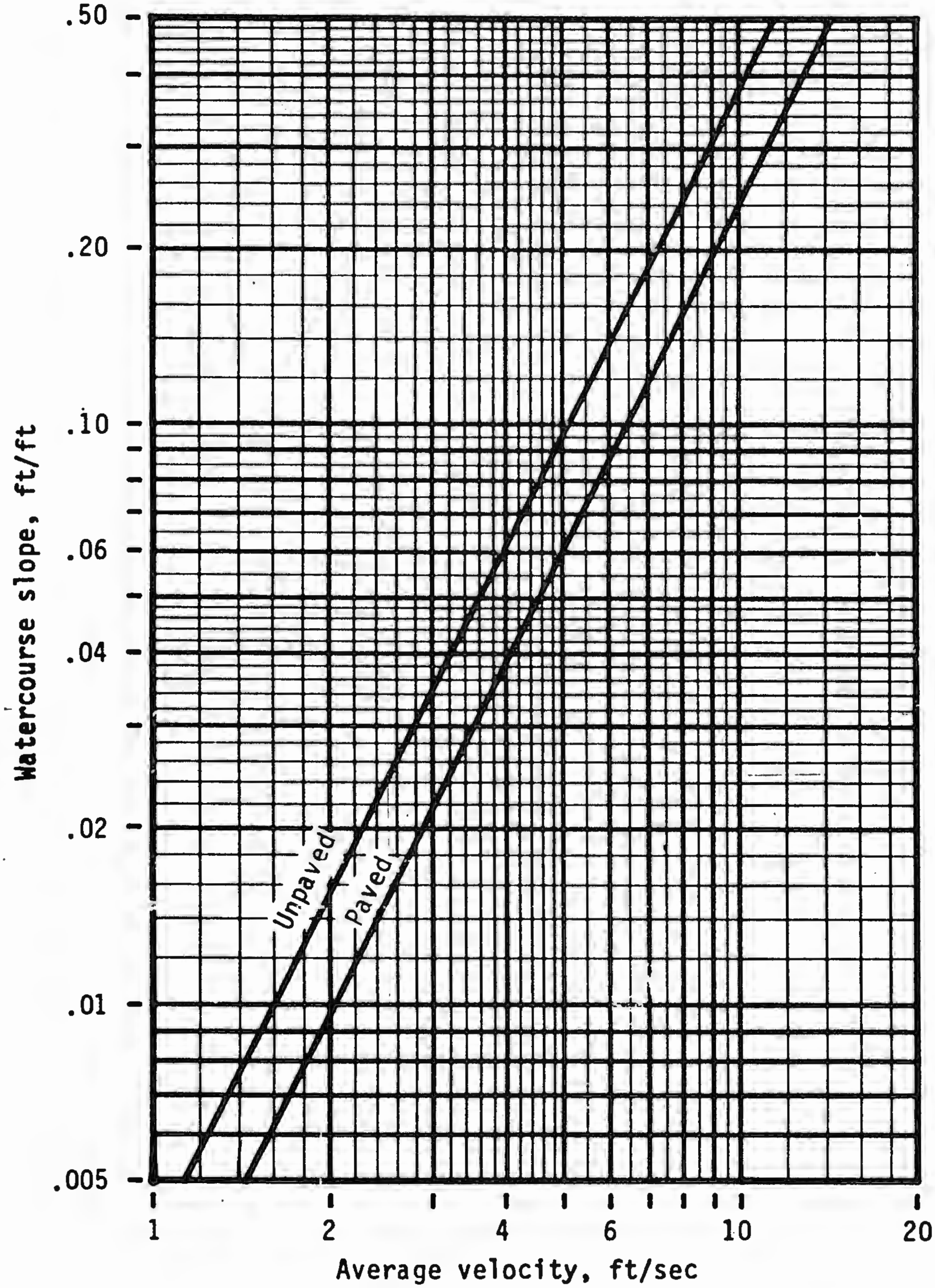

Figure 3-1.—Average velocities for estimating travel time for shallow concentrated flow.