

**Rhoades Construction Building
Old Oregon Trail
Redding, CA 96002**

Drainage Study

Prepared by:



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Hydrology Summary

Introduction

Improvement plans are being processed for a building with parking facilities for the Rhoades Construction. This project is to be located on Old Oregon Trail in Redding, California on APN #054-440-050.

To accommodate the proposed improvements, just under 5 acres will be disturbed. The project will consist of a 14,016-square-foot building with surrounding landscape and a parking lot.

The purpose of this drainage study is to highlight the pre and post project runoff scenarios occurring on the site. The proposed site will increase impervious surfaces and in doing so could increase stormwater runoff from the site. To mitigate this increase, stormwater will be captured by infiltration basins. Excess runoff will flow as it would naturally in its given direction.

Existing Project Setting

Currently, the site is farmland covered with field grasses and some tree cover. Surrounding the site to the north is another building company with multiple shop buildings, to the west and east are undeveloped lots, and to the south more of the same farmland.

Existing Runoff and Project Tributary Areas

Currently, this site slopes at 0.4-1.5% in multiple directions see Figure 1 for drainage directions. Runoff on-site flows generally away with some of the low spots collecting the runoff until it percolates away into the ground and or evaporates away. The current soil conditions are a gravelly loam, loam, and gravelly loam with gravelly clay loam substratum according to USDA's Web Soil Survey. See Appendix G for results.

The existing project site has been analyzed as four pre-construction Drainage Management Areas (DMAs). See Figure 1 for a map of the existing pre-construction DMAs. The entire pre-existing site has been calculated to have a pre-construction curve number of 75 over an area of 5.00 acres. The curve number calculations for each DMA can be found in Appendix A.

Post-Construction Runoff and Proposed Storm Water Mitigation

The proposed site is 5.00 acres and has been analyzed as 4 distinct post-construction DMAs. See Figure 2 for a map of the proposed DMAs. DMA #2 has been sized oversized to be able to store the remaining volume needed from DMA 1. The intention of this stormwater mitigation is to store excess runoff and improve stormwater runoff quality.

DMA #1 contains three bio-retention basins to capture runoff. These three basins will be all at the same pond elevation. All three basins are linked together with a 24" perforated stormwater pipe with a filter fabric & drain rock wrap in the trench section to maintain an equal water level in all three basins. Each bio-retention basin will have an 18-inch layer of specified soil mix designed to percolate at a minimum rate of 5 inches per hour over a 24-inch layer of clean/washed drain rock. Each basin will have a 2:1 side slope. The air volume depth will be 18-inches in all three of the basins. See construction plans for details.

DMA #2-4 each contain a single retention basin to help assist in the capture of silts, contaminants, and other debris before percolating down to the groundwater table. Each retention basin will be at a 2:1 side slope. The air volume depth will vary with the basin. The surrounding landscape and gravel lot will be graded to slope stormwater into the basin.

All six basins have been sized to capture the difference in runoff volume from the pre- vs post-construction site conditions with a 10-year design storm event. The pre-construction hydrology analysis can be found in Appendix A and Appendix B will contain the post-construction hydrology analysis and runoff difference calculations. When any of the basins reach full capacity, runoff will release out at designated overflow weirs. Outflow releases flow away from all structures and down existing low areas along the perimeter of the site.

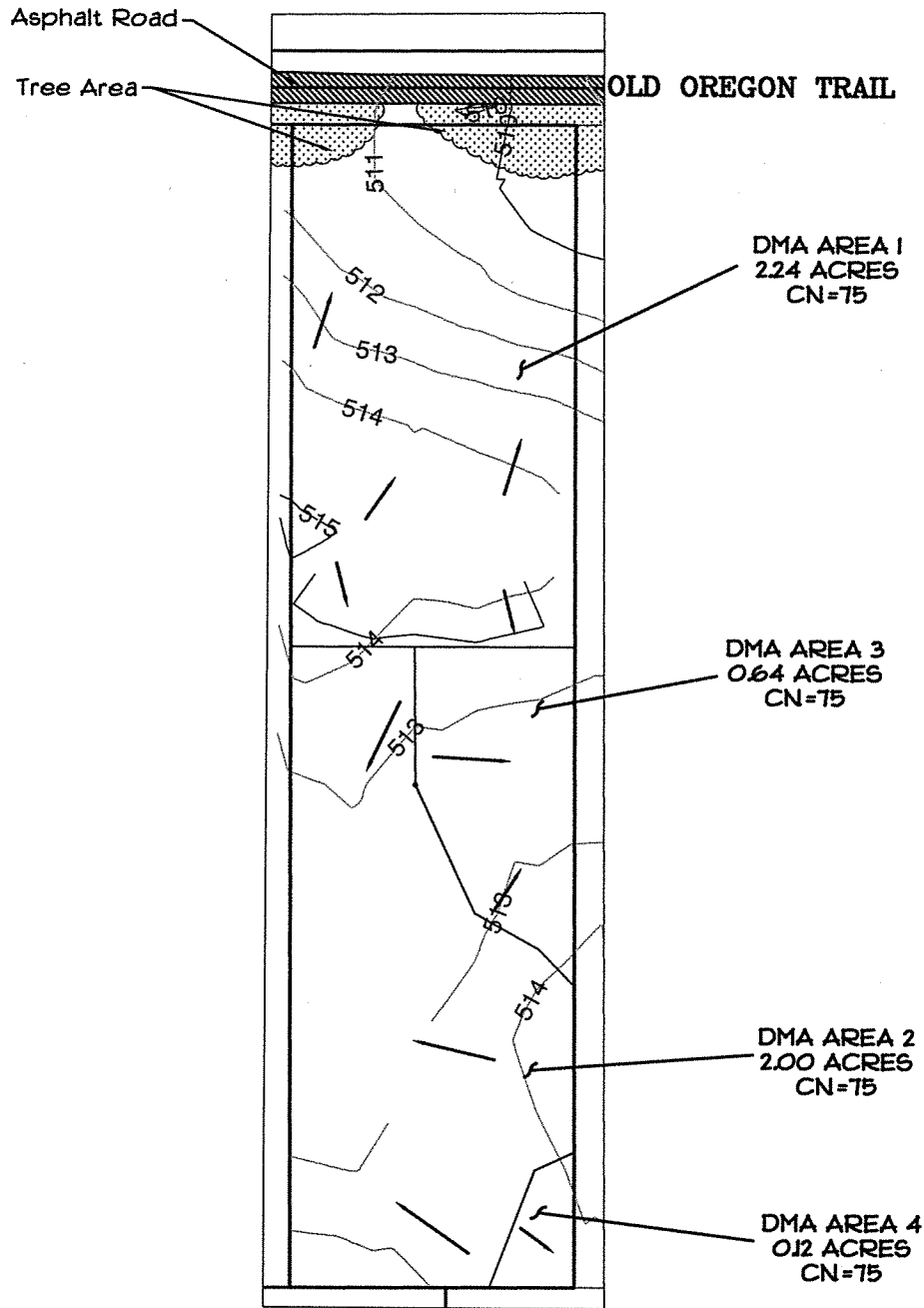
Calculations

Hydrology calculations for this site were performed using the SDS curve number method outlined in the County of Shasta, Public Works and Water Agency's "Hydrology Analysis for Small Watersheds" worksheets. See Appendix A & B for these hydrology calculations. See Appendix C for the "Hydrology Analysis for Small Watersheds" worksheets. The provided storage is calculated based on the volume (air) of the retention basin. The perforated pipe trench section volume is calculated within the pore space of the drainage rock layer and pipe air volume. The bio-retention basin volume is calculated with the open pore space of the drainage rock layer & specified soil mix and the open-air volume of the bio-retention basin. See Appendix D for volume calculations.

Conclusion

If constructed and maintained properly, the proposed stormwater plan will effectively mitigate stormwater quality and quantity. By installing the bio-retention & retention basins sized to store/treat runoff for each DMA, the stormwater runoff will be cleaned of silts, contaminants, and other debris before percolating down to the groundwater table or flowing offsite. Should any system be overwhelmed, the runoff will be released from the site at current low areas along the perimeter of the parcel.

FIGURE I

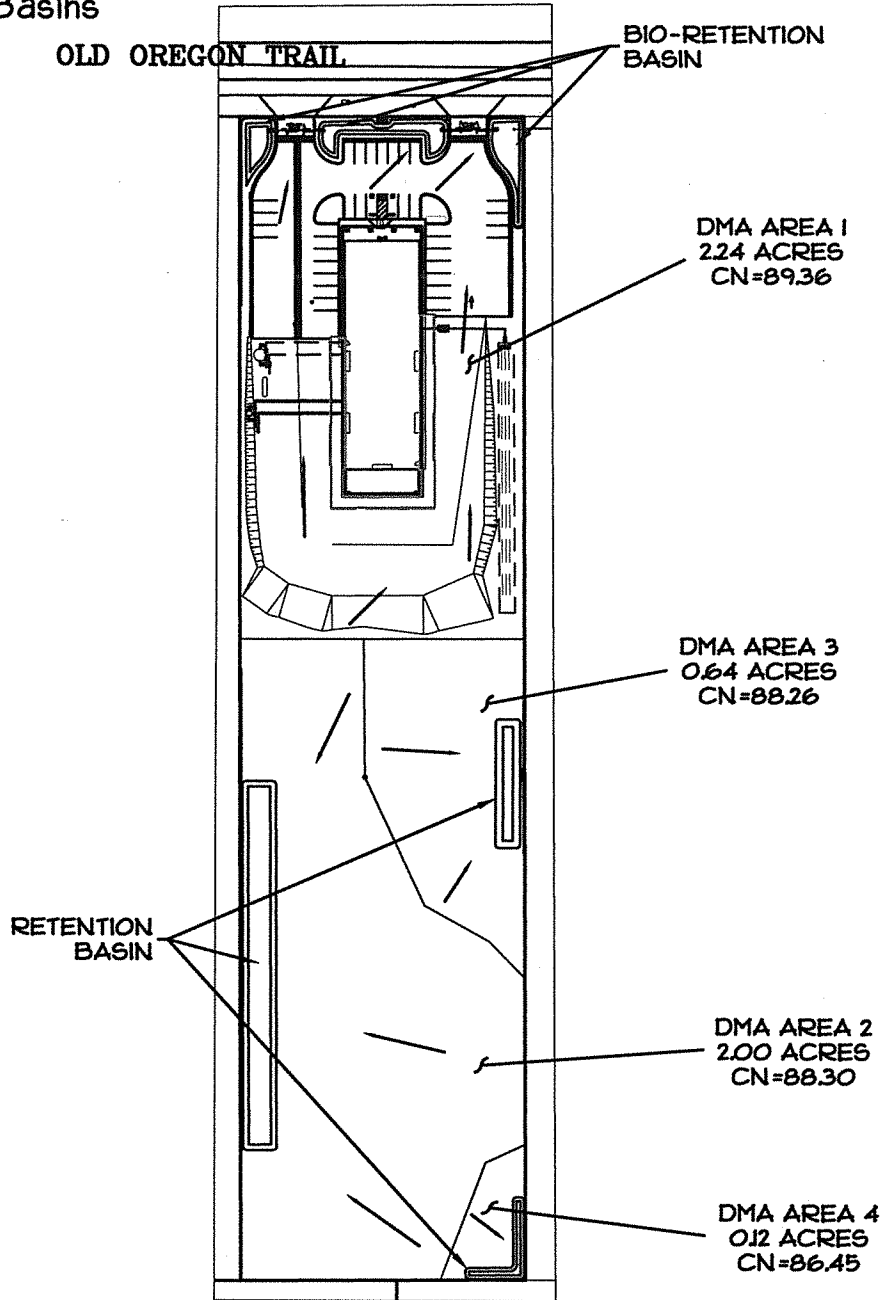


Note:
Arrows show general direction of storm water runoff

DRAWN BY: FG	Fig. I: Pre-Const. Map	Robertson Erickson
DATE: 06/06/2023	PROJECT: RHODES CONSTRUCTION	Civil Engineers and Surveyors
SCALE: 1" = 150'	APN: 054-440-050	888 Manzanita Court, Suite 101
APPROVED BY: RE	REDDING, CA	Chico, CA 95926 530-894-3500 894-8955 fax

FIGURE 2

Proposed Site Design & Treatment Control Measures:
 -Bio-Retention Basins
 -Retention Basins



Note:
 Arrows show general direction of storm water runoff

DRAWN BY: FG
 DATE: 06/06/2023
 SCALE: 1" = 150'
 APPROVED BY: RE

Fig. 2: Post-Const. Map
 PROJECT:
 RHODES CONSTRUCTION
 APN: 054-440-050
 REDDING, CA

Robertson Erickson
 Civil Engineers and Surveyors
 888 Manzanita Court, Suite 101
 Chico, CA 95926
 530-894-3500 894-8955 fax

Appendix A

Pre-construction Hydrology Analysis

Note: all attachments from County of Shasta, Department of Public works and Water Agency "Hydrology Analysis for Small Watersheds"

DMA #	Step 1: Watershed data					STEP 3: Find Tc			Step 5: Runoff Volume			Step 6: Peak Flow Rate		
	AREA		Length		ΔElev.	k*	Tc		**R _{24-D}	V _{24-D}		CP	***q	Q
	acres	mi. ²	ft	mi.	ft		hrs.	mins	in.	ac-ft	c.f.		csm/in.	CFS
DMA 1	2.24	0.0035	404	0.08	5.91	0.7	0.30	18.0	2.1	0.39	17098	0.1465	123	0.91
DMA 2	2.00	0.0031	229	0.04	2.29	0.7	0.26	15.5	2.1	0.35	15282	0.1465	127	0.84
DMA 3	0.64	0.0010	164	0.03	2.05	0.7	0.22	12.9	2.1	0.11	4849	0.1465	133	0.28
DMA 4	0.12	0.0002	111	0.02	0.48	0.7	0.23	13.7	2.1	0.02	887	0.1465	132	0.05
Total	5.00	0.00781												

TC use 5 minute minimum

Step 2 - Select Design Frequency

Design Frequency: 10 Year Design (less than 40 acres only)

See page one of "Hydrology Analysis for Small Watersheds" to determine design frequency

*Land use constant, K use attachment no. 1

**R_{24-D}, use attachment no. 10 and 11

***q, Unit flow rate, use attachment no. 12 - 14

Step 4: Weighted Curve Number

DMA Area	Hardscape		Building		Landscape		Gravel		Total		CN	% Impervious
	S.f.	Acres	S.f.	Acres	S.f.	Acres	S.f.	Acres	S.f.	Acres		
1	0	0.00	0	0.00	97705	2.24	0	0.00	97705	2.24	75.00	0
2	0	0.00	0	0.00	87323	2.00	0	0.00	87323	2.00	75.00	0
3	0	0.00	0	0.00	27711	0.64	0	0.00	27711	0.64	75.00	0
4	0	0.00	0	0.00	5066	0.12	0	0.00	5066	0.12	75.00	0
Total	0	0.00	0	0.00	217805	5.00	0	0.00	217805	5.00	75.00	0

Note: Curve numbers factors calculated as follows: Hardscape, CN = 98, Building, CN=98, Landscape, CN = 75, and Gravel, CN=89

Step 5: Runoff Volume

P _{6-D}	2.13 inches	use attachment no. 4-6
P _{24-D}	4.55 inches	use attachment no. 7-9
P _{6-D} /P _{24-D}	0.4681	

Equations:

Step 3:
$$T_c = \frac{k}{60} * \left(\frac{L^3 ft}{H ft} \right)^{.2}$$

Step 4:
$$\bar{CN} = \frac{\Sigma(CN * A)}{\Sigma A}$$

Step 5:
$$V_{24-D} = R_{24-D} * \frac{A ac.}{12}$$

Step 6:
$$CP = \frac{\frac{200}{CN} - 2}{P_{24-d}}$$

Step 6:
$$Q = q * A_{mi^2} * R_{24-D}$$

Appendix B

Post-construction Hydrology Analysis

Note: all attachments from County of Shasta, Departement of Public works and Water Agency "Hydrology Analysis for Small Watersheds"

	Step 1: Watershed data					STEP 3: Find Tc			Step 5: Runoff Volume			Step 6: Peak Flow Rate		
	AREA		Length		ΔElev.	k*	Tc		**R _{24-D}	V _{24-D}		CP	***q	Q
	acres	mi. ²	ft	mi.	ft		hrs	mins	in.	ac-ft	c.f.		csm/in.	CFS
DMA 1	2.24	0.0035	360	0.07	4.31	0.55	0.23	14	3.4	0.64	27683	0.052	130	1.55
DMA 2	2.00	0.0031	229	0.04	2.29	0.55	0.20	12.1	3.25	0.54	23650	0.058	130	1.32
DMA 3	0.64	0.0010	164	0.03	2.05	0.55	0.17	10.2	3.25	0.17	7505	0.058	133	0.43
DMA 4	0.12	0.0002	111	0.02	0.48	0.55	0.18	10.7	3.1	0.03	1309	0.069	132	0.07
Total	5.00	0.00781												

TC use 5 minute minimum

Step 2 - Select Design Frequency

Design Frequency: 10 Year Design (less than 40 acres only)

See page one of "Hydrology Analysis for Small Watersheds" to determine design frequency

*Land use constant, K use attachment no. 1

**R_{24-D}, use attachment no. 10 and 11

***q, Unit flow rate, use attachment no. 12 - 14

Step 4: Weighted Curve Number

DMA Area	Hardscape		Building		Landscape		Gravel		Total		CN	% Impervious
	S.f.	Acres	S.f.	Acres	S.f.	Acres	S.f.	Acres	S.f.	Acres		
1	29199	0.67	14016	0.32	23579	0.54	30910	0.71	97705	2.24	89.36	76
2	0	0.00	0	0.00	4087	0.09	83236	1.91	87323	2.00	88.30	95
3	0	0.00	0	0.00	1369	0.03	26343	0.60	27711	0.64	88.26	95
4	0	0.00	0	0.00	860	0.02	4206	0.10	5066	0.12	86.45	83
Total	29199	0.67	14016	0.32	29895	0.69	144695	3.32	217805	5.00	88.73	86

Note: Curve numbers factors calculated as follows: Hardscape, CN = 98, Building, CN=98, Landscape, CN = 74, and Gravel, CN=89

Step 5: Runoff Volume

P _{6-D}	2.13	inches	use attachemnt no. 4-6
P _{24-D}	4.55	inches	use attachemnt no. 7-9
P _{6-D} /P _{24-D}	0.4681		

Equations:

Step 3:

$$T_c = \frac{k}{60} * \left(\frac{L^3 ft}{H ft} \right)^{.2}$$

Step 4:

$$\bar{CN} = \frac{\Sigma(CN * A)}{\Sigma A}$$

Step 5:

$$V_{24-D} = R_{24-D} * \frac{A ac.}{12}$$

Step 6:

$$CP = \frac{200 - 2}{CN} * P_{24-d}$$

Step 6:

$$Q = q * A_{mi^2} * R_{24-D}$$

	Difference in Pre vs Post	
	ΔV _{24-D}	ΔQ
	ft ³	CFS
DMA 1	10585	0.64
DMA 2	8368	0.49
DMA 3	2656	0.15
DMA 4	422	0.02

**Appendix C:
Hydrology Analysis for Small Watersheds
Worksheets**

COUNTY OF SHASTA
DEPARTMENT OF PUBLIC WORKS AND WATER AGENCY

HYDROLOGY ANALYSIS
FOR
SMALL WATERSHEDS

PROJECT NAME _____ SHEET _____ OF _____
 DRAINAGE AREA NO. _____ SCALE _____ CALC. BY _____ DATE _____
 SOURCE _____ CK'D. BY _____ DATE _____
 (Attach Copy)

STEP I - WATERSHED DATA

(a) TOTAL DRAINAGE AREA (A) A= ac. = A= mi.²
 (b) LENGTH OF WATERSHED (L) L= ft. = L= mi.
 (c) ELEV. OF HIGHEST POINT IN WATERSHED (E_h) = _____ ft.
 (d) ELEV. OF LOWEST POINT IN WATERSHED (E_l) = _____ ft.
 (e) HEIGHT OF WATERSHED (H) = $E_h - E_l$ H= ft.

STEP II - SELECT DESIGN FREQUENCY

(a) CHECK APPROPRIATE BOXES	(b) BOXES CHECKED	USE
1. <input type="checkbox"/> $A < 40ac.$	(1) only	10 year design <input type="checkbox"/>
2. <input type="checkbox"/> $40ac. \leq A \leq 4 \text{ mi.}^2$	(2) only or (1 and 4) or (1 and 5)	25 year design <input type="checkbox"/>
3. <input type="checkbox"/> $A > 4 \text{ mi.}^2$	(3) or (6) or (2 and 5)	100 year design <input type="checkbox"/>
4. <input type="checkbox"/> Streets with curb and gutter		
5. <input type="checkbox"/> Roadway fills exceed 10 feet		
6. <input type="checkbox"/> Sumps or retention ponds		

STEP III - FIND (T_c)

(a) FOR NATURAL DRAINAGE BASINS WHERE $A > 4 \text{ mi.}^2$ $T_c = \frac{11.9L^3}{H_{ft}}^{0.385} = \underline{\hspace{2cm}}$

(b) ALL OTHER BASINS $T_c^{(2)} = \frac{K^{(1)}}{60} \frac{L^3}{H_{ft}}^{0.20} = \underline{\hspace{2cm}}$

$T_c = \hspace{2cm} \text{hrs.}$

① K = Land use constant (see attachment no. 1)
 ② Use 5 minute minimum

STEP IV - FIND WEIGHTED (\bar{CN}) CURVE NUMBER

(a) SOIL SYMBOL ^①	HYDROLOGIC SOIL GROUP ^②	LAND USE ^③	AREA ^④ ac.	CN ^③	AREA X CN
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

TOTALS $\sum A =$ _____ $\sum A \times CN =$ _____

(b)
$$\bar{CN} = \frac{\sum(A \times CN)}{\sum A} = \frac{\text{_____}}{\text{_____}} = \text{_____}$$

$\bar{CN} =$

- ① From "Soil Survey of Shasta County Area, Ca., "by the U.S. Dept. of Agriculture, S. C. S. and F. S., Aug. 1974.
- ② See attachment no. 2
- ③ See attachment no. 3
- ④ Include copy of soil survey map with soil boundaries delineated or other appropriate documentation.

STEP V - FIND RUNOFF VOLUME V_{24-D}

(a) P_{6-D} (6 hour precipitation) ^① = _____ $\frac{P_{6-D}}{P_{24-D}} =$ $\frac{P_{6-D}}{P_{24-D}} =$

(b) P_{24-D} (24 hour precipitation) ^② = _____ P_{24-D}

(c) R_{24-D} ^③ = _____ $R_{24-D} =$ in.

(d) V_{24-D} (Total volume of runoff) = $R_{24-D} \times \frac{A \text{ ac.}}{12}$ $V_{24-D} =$ ac-ft.

- ① See attachment no's 4 thru 6
- ② See attachment no's 7 thru 9
- ③ See attachment no's 10 and 11

STEP VI - FIND PEAK FLOW RATE (Q) @ T_C

(a) SELECT CURVE TYPE ^①

1A $\frac{P_{6-D}}{P_{24-D}} < 0.518$ 1 $0.518 \leq \frac{P_{6-D}}{P_{24-D}} \leq 0.639$ 2 $0.639 < \frac{P_{6-D}}{P_{24-D}} \leq 0.767$

(b) CALCULATE CURVE PARAMETER (CP)

$$CP = \frac{200 - 2}{\frac{CN}{P_{24-D}}} = \frac{\text{_____}}{\text{_____}}$$
 $CP =$

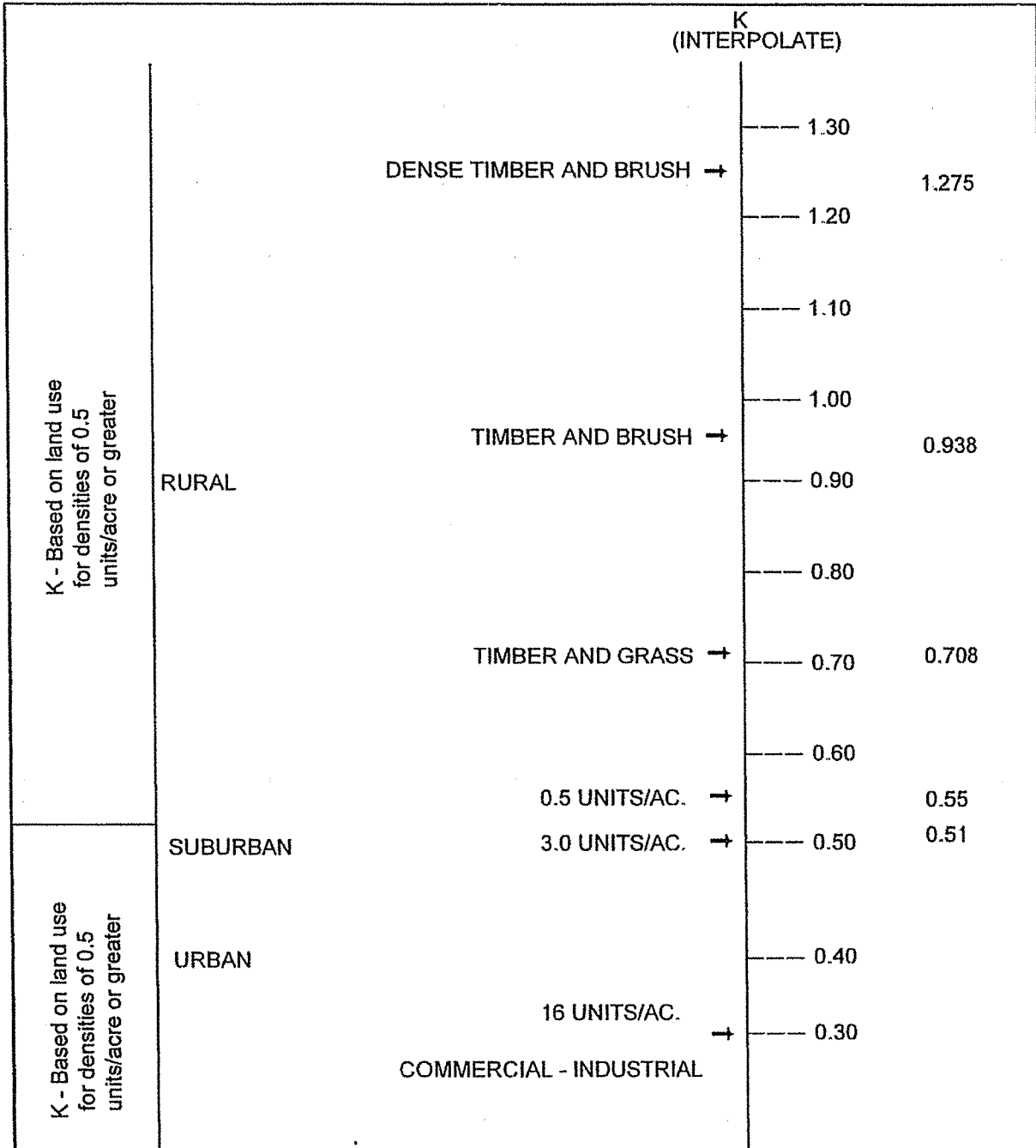
(c) FIND UNIT FLOW RATE (q) ^① = _____ $q =$ csm/in

(d) $Q = q \times A_{mi^2} \times R_{24-D} = \text{_____}$ $Q =$ CFS

① See attachment no's 12 thru 14

ATTACHMENT NO. 1

HYDROLOGY ANALYSIS
FOR
SMALL WATERSHEADS
INTERPOLATION CHART



NOTE: Use current General Plan designations to determine ultimate development pattern of area.

For drainage areas with subareas of different development types, Tc should be calculated by summing the Tc of each subarea.

ATTACHMENT NO. 3
 HYDROLOGY ANALYSIS
 FOR
 SMALL WATERSHEDS

**"CN" RUNOFF CURVE NUMBERS FOR
 HYDROLOGIC SOIL-COVER COMPLEXES
 IN SHASTA COUNTY**

LAND USE ³		HYDROLOGIC SOIL GROUP ²			
		A	B	C	D
Irrigated pasture		32	58	72	79
Annual grass		38	61	75	81
Broadleaf chaparral		31	57	71	78
Meadow		30	58	72	78
Open brush		41	63	75	81
Woodland-grass		32	58	72	79
Woods (Woodland)		27	55	70	77
Barren		77	86	91	93
Urban Land ¹					
Average Lot size	Average % Impervious				
1/8 acre	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/2 acre	30	57	72	81	86
3/4 acre	25	54	70	80	85
1 acre ¹	20	51	68	79	84
Commercial and business area (85% impervious)		89	92	94	95
Open spaces, lawns, parks, golf courses, cemeteries		39	61	74	80
Industrial districts (72% impervious)		81	88	91	93
Paved parking lots, roofs, driveways		98	98	98	98
Streets and roads					
Paved with curbs and storm sewers		98	98	98	98
Gravel and hard surface		76	85	89	91
Dirt		72	82	87	89

¹ For urban lands with lots greater than 1 acre, use native cover.

² Where hydrologic soil group is not known, use group D.

³ All facilities shall be designed based on ultimate land use using current general plan densities for the entire drainage area.

SUPPLEMENT TO
ATTACHMENT NO. 3
HYDROLOGY ANALYSIS
FOR
SMALL WATERSHEDS

DESCRIPTIONS OF LAND USE COVER TYPES

Irrigated pasture - Irrigated land that is planted to perennial grasses and legumes for production of forage and which is cultivated only to establish or renew the stand of plants. For hydrologic purposes, dryland pasture is considered as annual grass.

Annual grass - Areas on which the principal vegetation consists of annual grasses and weeds.

Broadleaf chaparral - Areas where the principal vegetation consists of evergreen shrubs with broad, hard, and stiff leaves. The brush cover is usually dense or moderately dense.

Meadow - Areas with seasonally high water tables, locally called cienegas, on which the principal vegetation consists of sod-forming grasses and other plants.

Open brush - Areas on which the principal vegetation consists of soft-woody shrubs which are grayish in color. It also includes vegetation on desert-facing slopes where Broadleaf chaparral species predominate in an open shrub cover.

Woodland-grass - Areas with an open cover of broadleaf or coniferous trees and with the intervening ground space occupied by annual grasses or weeds. The trees may occur singly or in small clumps. Canopy density, the amount of ground surface shaded at high noon, is from twenty to fifty percent.

Woods (Woodland) - Areas where coniferous or broadleaf trees predominate. The crown or canopy density is at least 50 percent. Open areas may have a cover of annual or perennial grasses or of brush. Herbaceous plant cover under the trees is usually sparse because of leaf or needle litter accumulation.

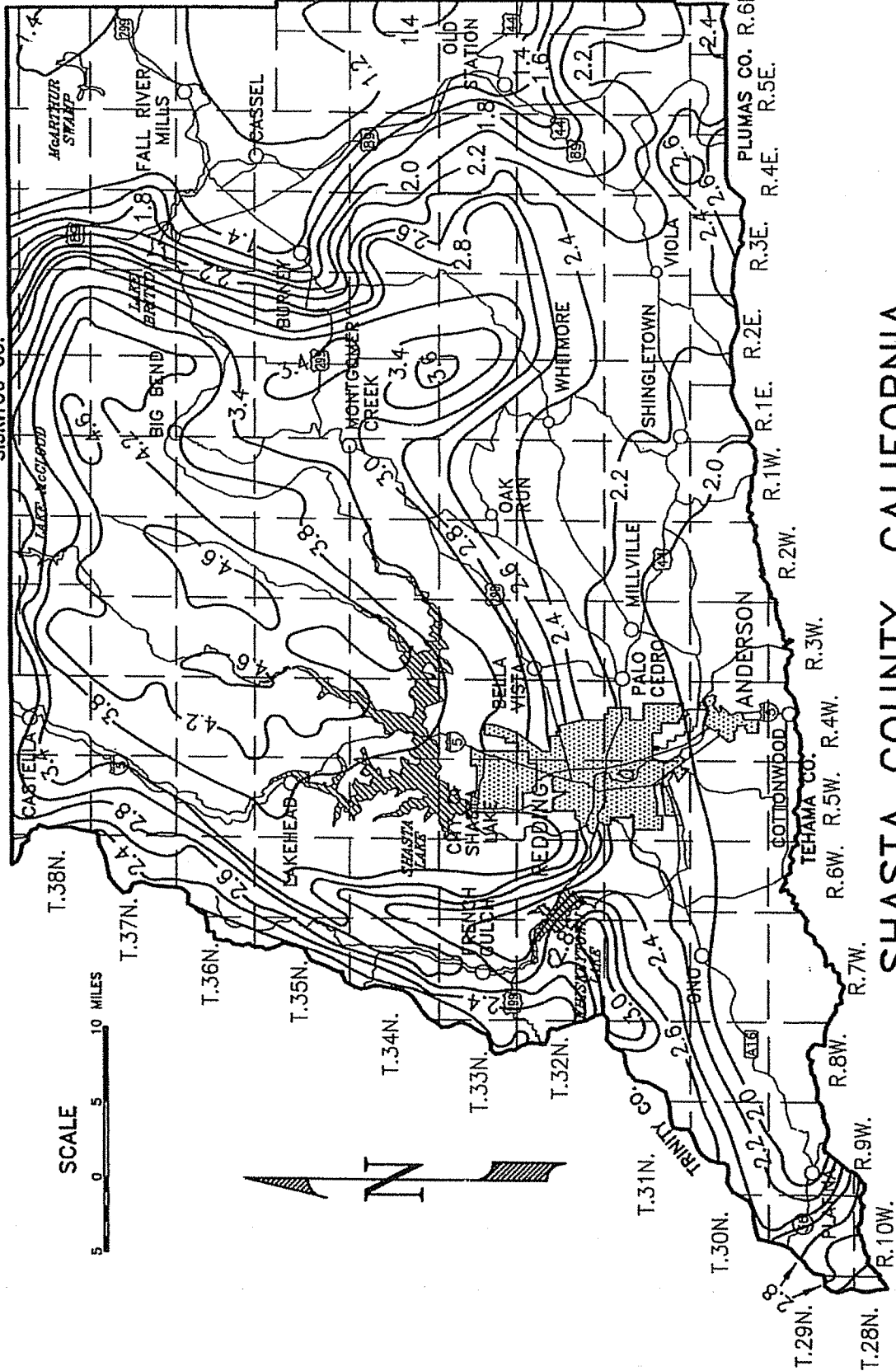
Barren - Areas with no, or practically no, plant cover; where 15 percent or less of the ground surface is protected by plants or litter. This includes rocklands, land destroyed by erosion, and shaped or graded land.

Urban Land - Urban, industrial, roads, open space, and other lands where the amount of pavements and other impervious surfaces significantly effect the runoff. Individual items are not discussed here as the table is fairly complete.

T.39N

SISKIYOU CO.

LASSEN CO.



SHASTA COUNTY, CALIFORNIA

ATTACHMENT No. 4

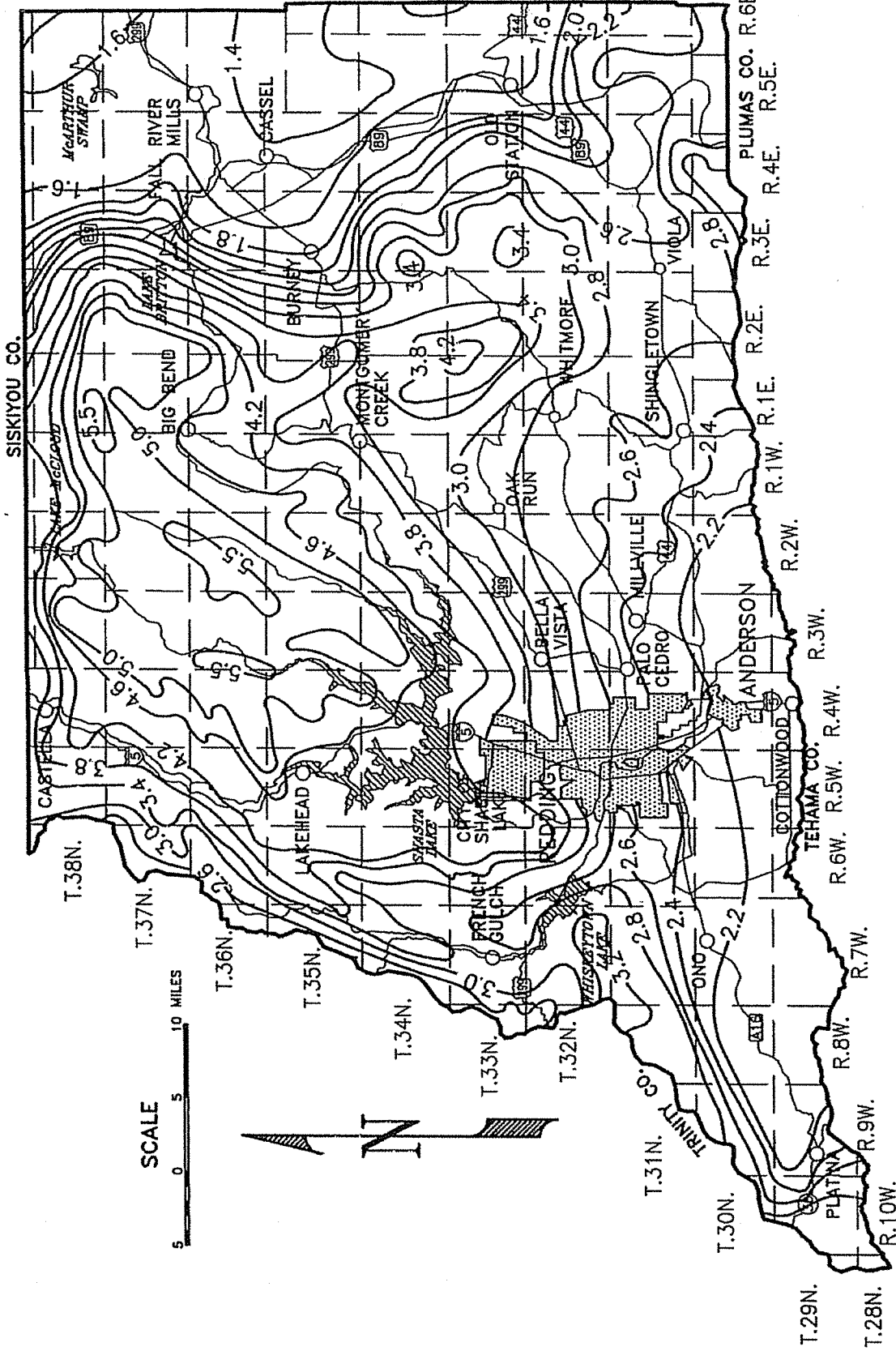
10 YEAR - 6 HOUR PRECIPITATION
ISOPLUVIALS IN INCHES

T.39N

LASSEN CO.

SISKIYOU CO.

PLUMAS CO. R.6E
R.4E. R.5E.

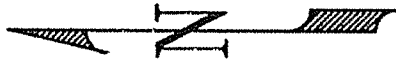


SHASTA COUNTY, CALIFORNIA

ATTACHMENT No. 5

25 YEAR - 6 HOUR PRECIPITATION
ISOPLUVIALS IN INCHES

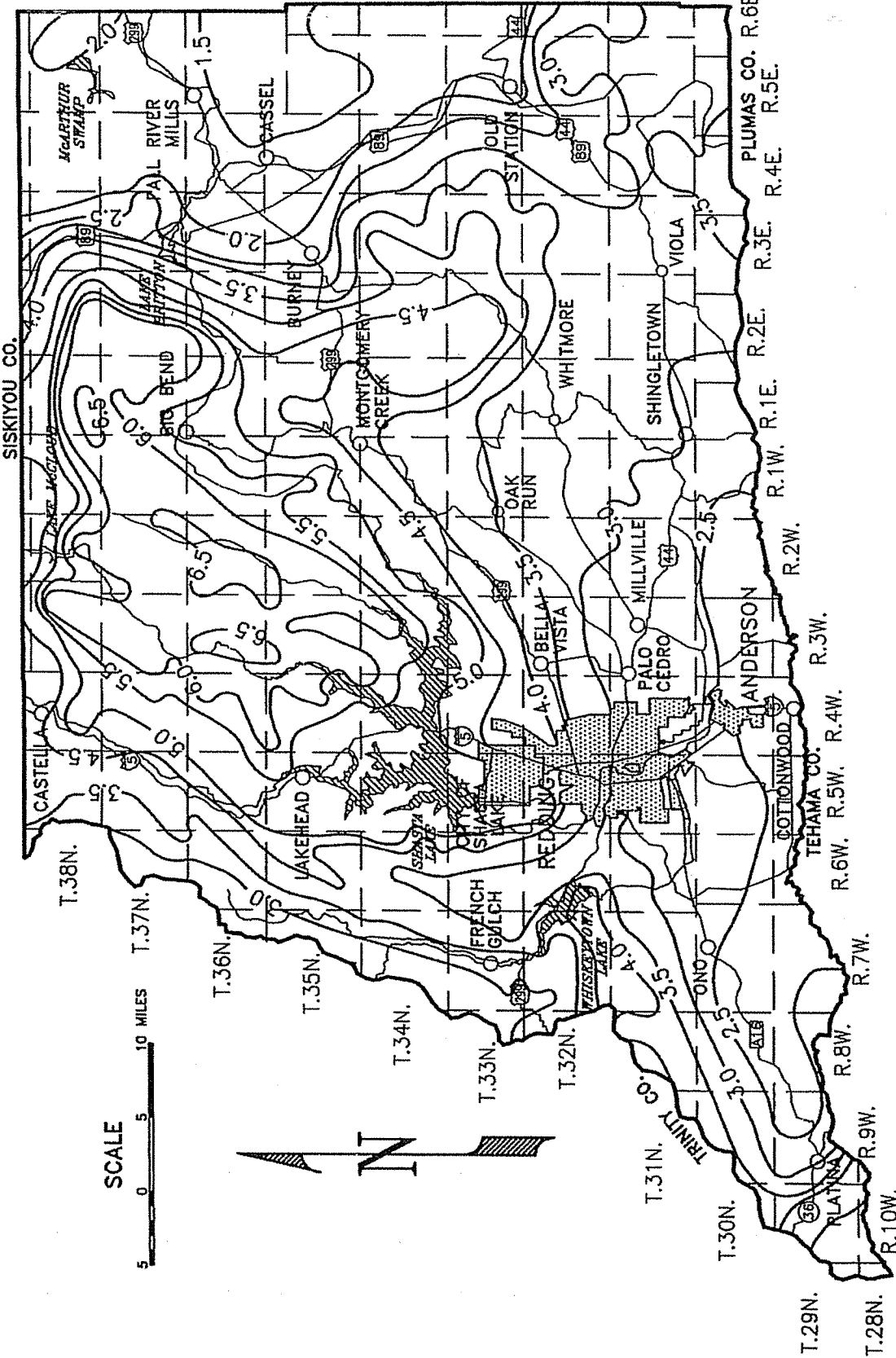
SCALE



T.39N

LASSEN CO.

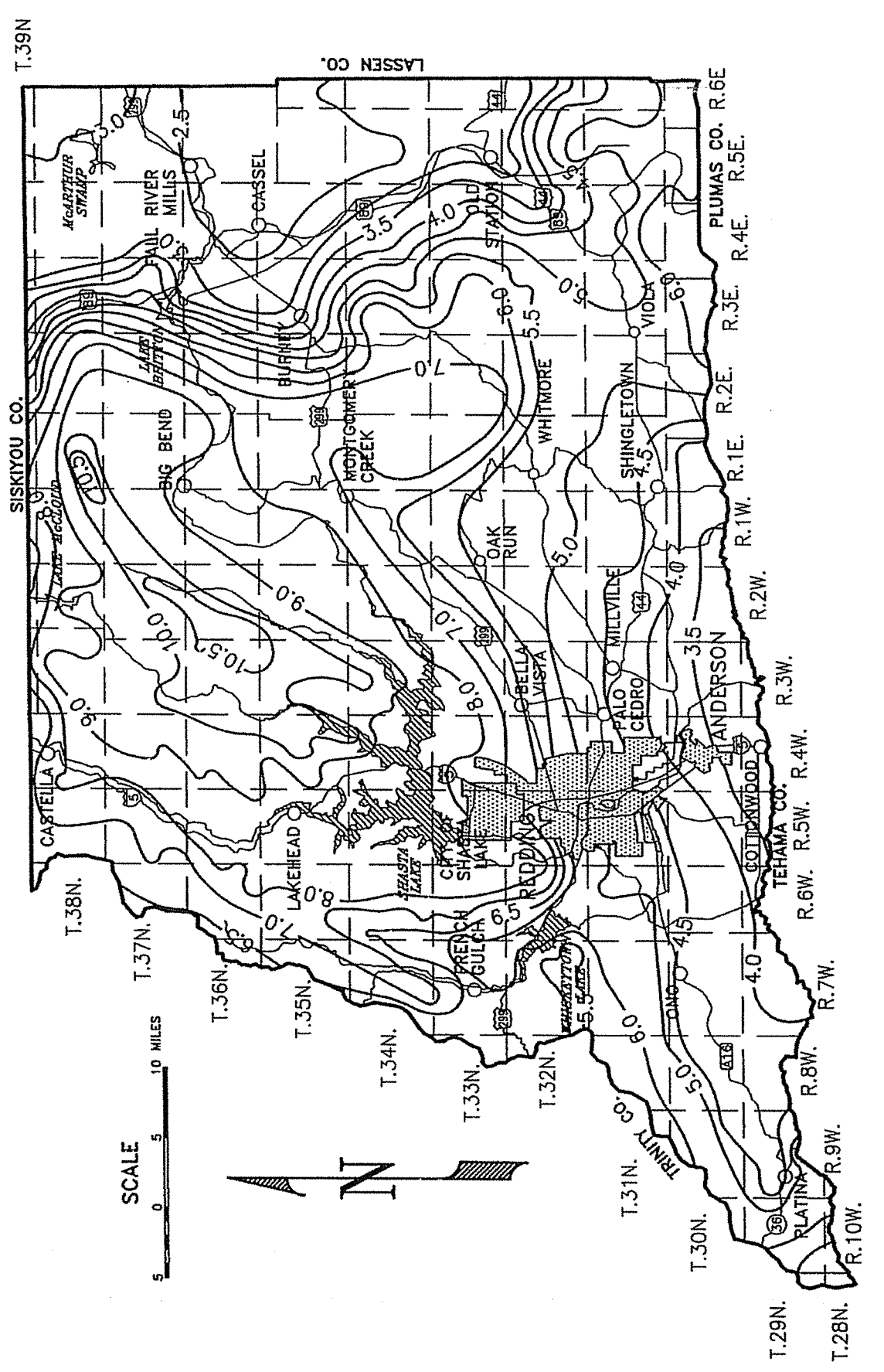
SISKIYOU CO.



SHASTA COUNTY, CALIFORNIA

ATTACHMENT No. 6

100 YEAR - 6 HOUR PRECIPITATION
ISOPLUVIALS IN INCHES



SHASTA COUNTY, CALIFORNIA

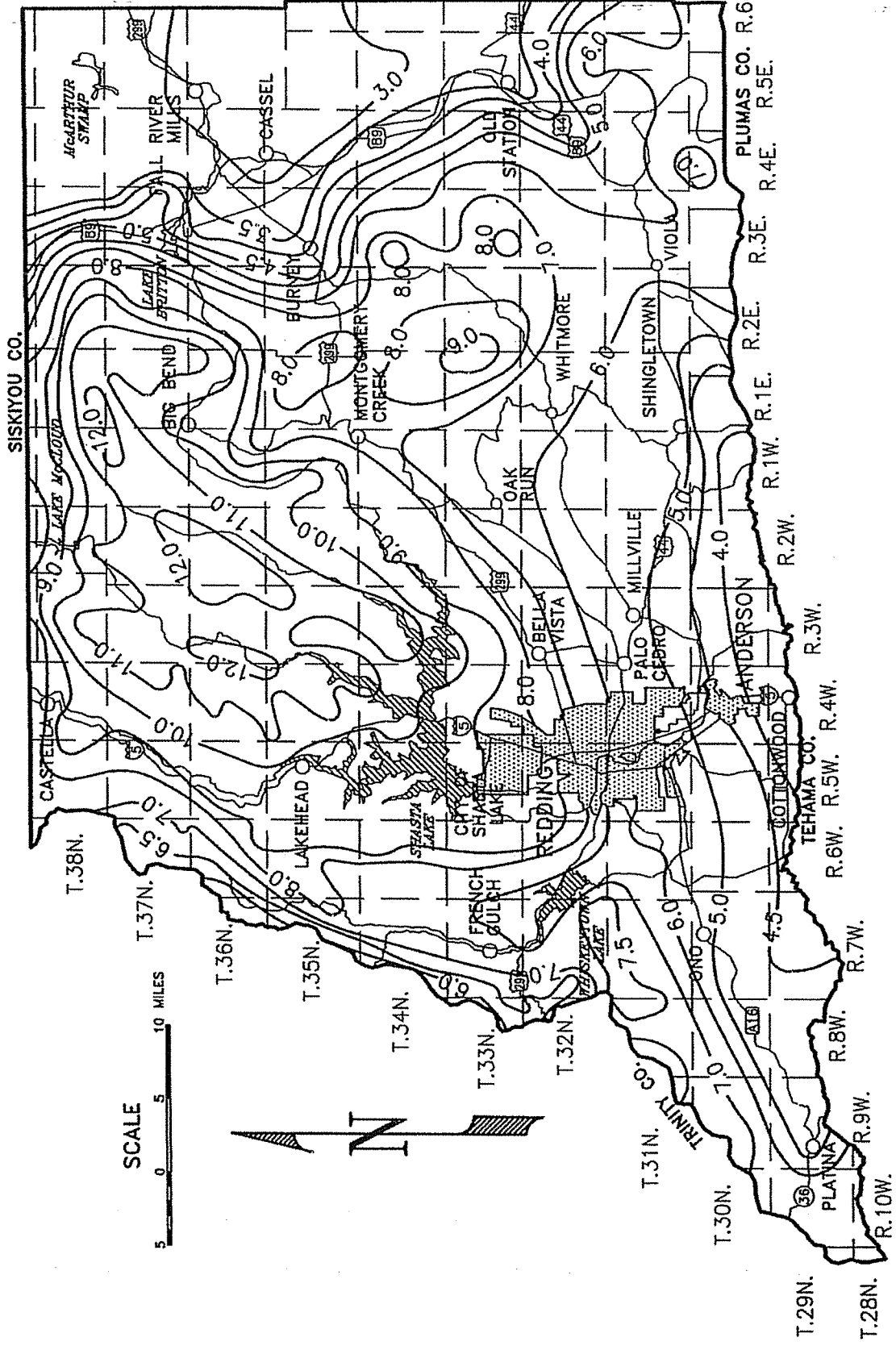
ATTACHMENT No. 7
 10 YEAR - 24 HOUR PRECIPITATION
 ISOPLETHS IN INCHES

T.39N

SISKIYOU CO.

LASSEN CO.

PLUMAS CO. R.6E
R.4E. R.5E.
R.3E. R.2E. R.1E.
R.1W. R.2W.
R.3W.
R.4W. R.5W. R.6W.
R.7W. R.8W. R.9W.
R.10W.



SHASTA COUNTY, CALIFORNIA

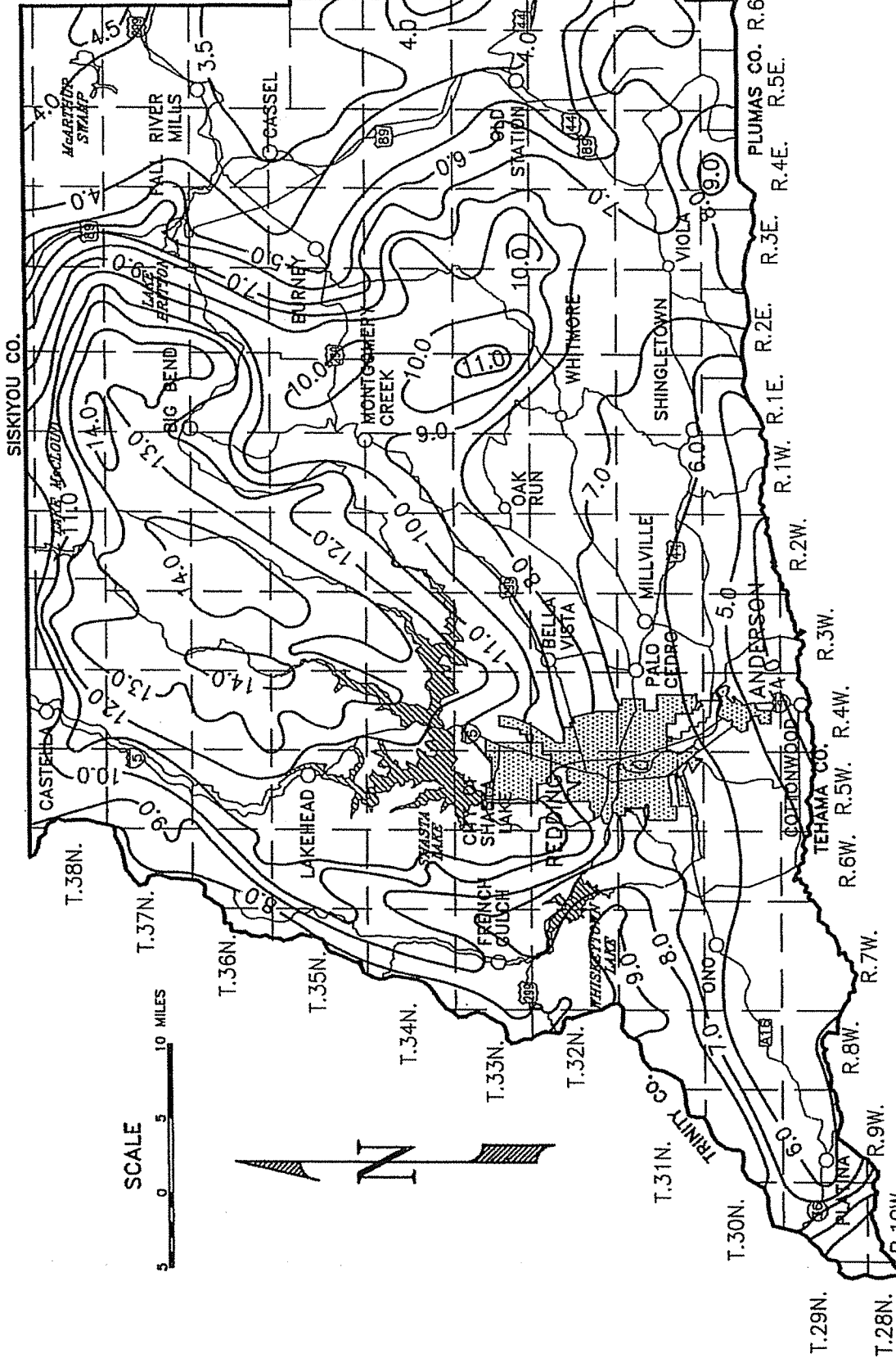
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 25 YEAR - 24 HOUR PRECIPITATION
 ISOPLETHS IN INCHES

T.39N

SISKIYOU CO.

LASSEN CO.

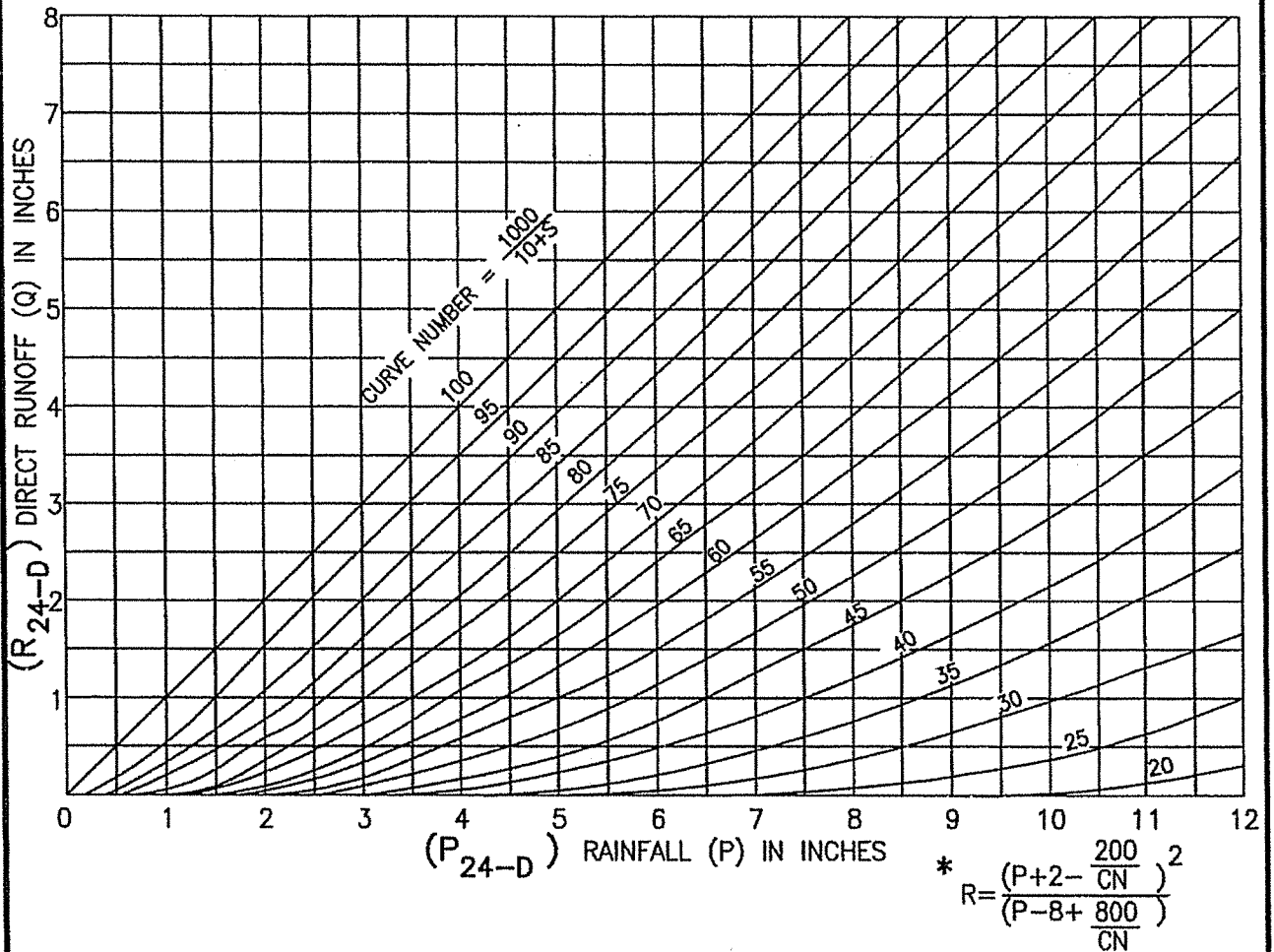
FLUMAS CO. R.6E
R.3E. R.4E. R.5E.



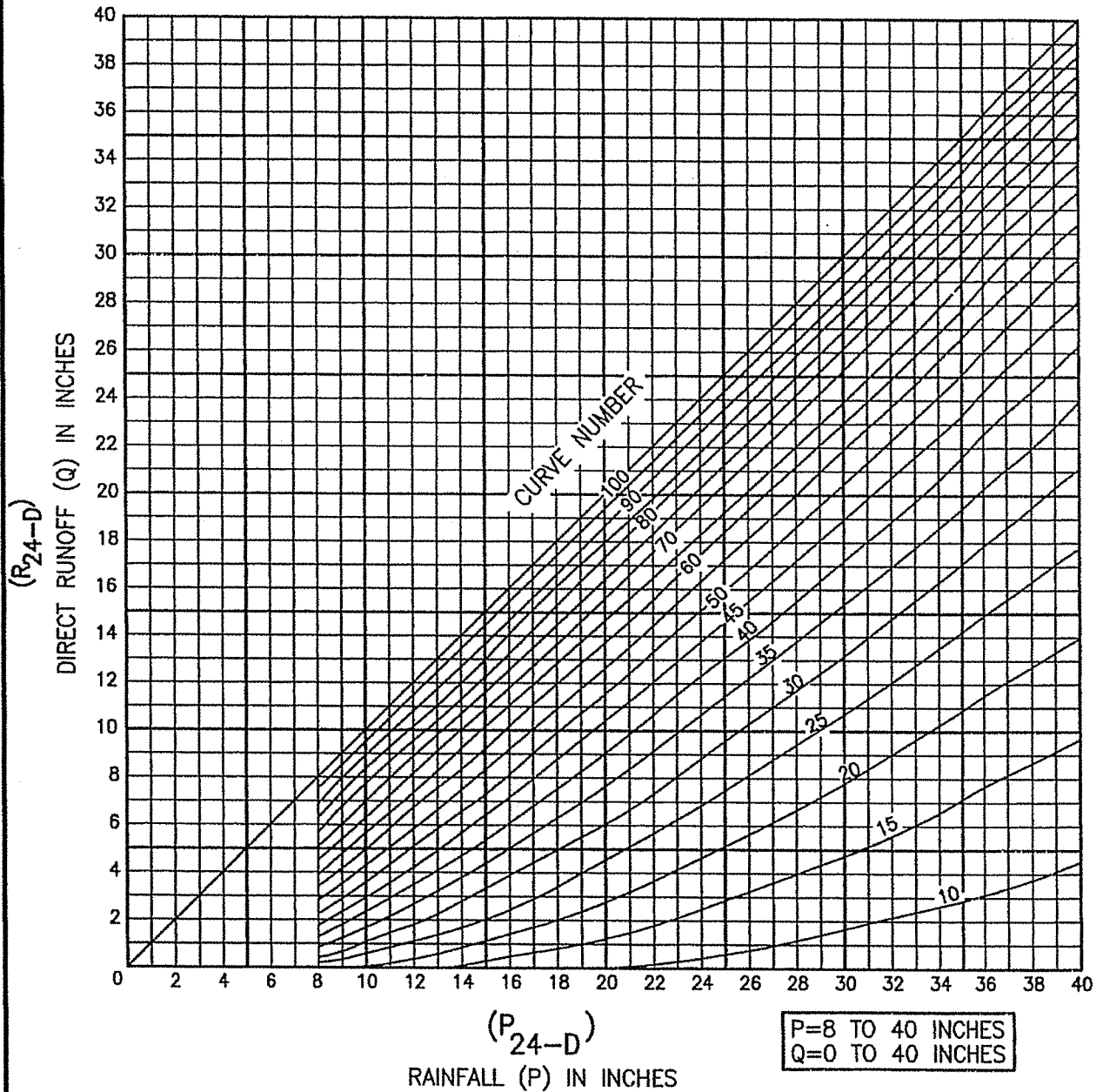
SHASTA COUNTY, CALIFORNIA

ATTACHMENT No. 9

100 YEAR - 24 HOUR PRECIPITATION
ISOPLUVIALS IN INCHES

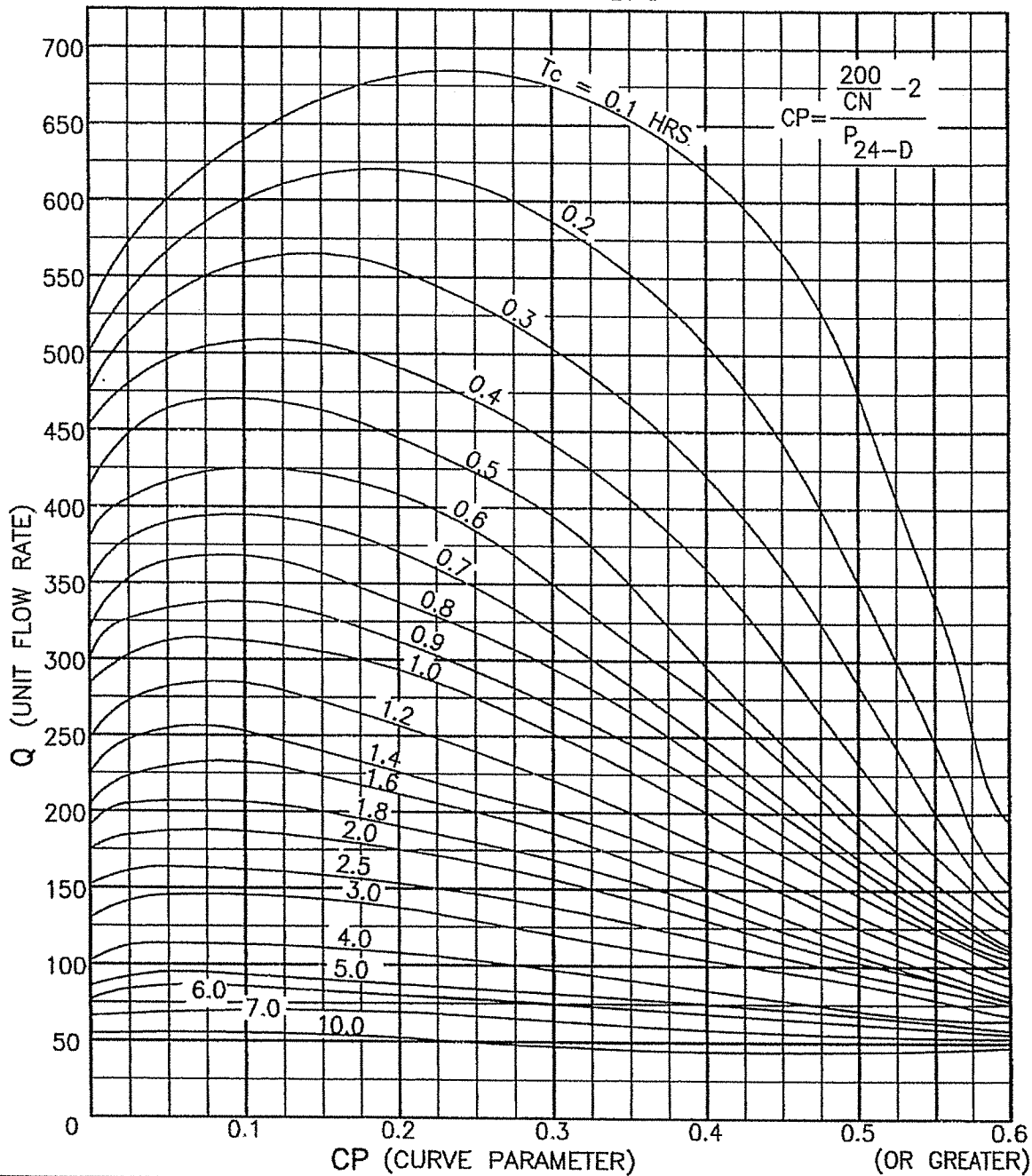


SCALE: NTS		DATE: 1996	SHASTA COUNTY DEPARTMENT OF PUBLIC WORKS	
		APPROVED BY:	HYDROLOGY ANALYSIS FOR SMALL WATERSHEDS ATTACHMENT No. 10	
		<i>William E. Lyman</i> WILLIAM E. LYMAN		
MARK	DATE	REVISION		



SCALE: NTS		DATE: 1996	SHASTA COUNTY DEPARTMENT OF PUBLIC WORKS	
		APPROVED BY:		<u>HYDROLOGY ANALYSIS</u> FOR <u>SMALL WATERSHEDS</u> ATTACHMENT No. 11
		<i>William E. Lyman</i> WILLIAM E. LYMAN		
MARK	DATE	REVISION		

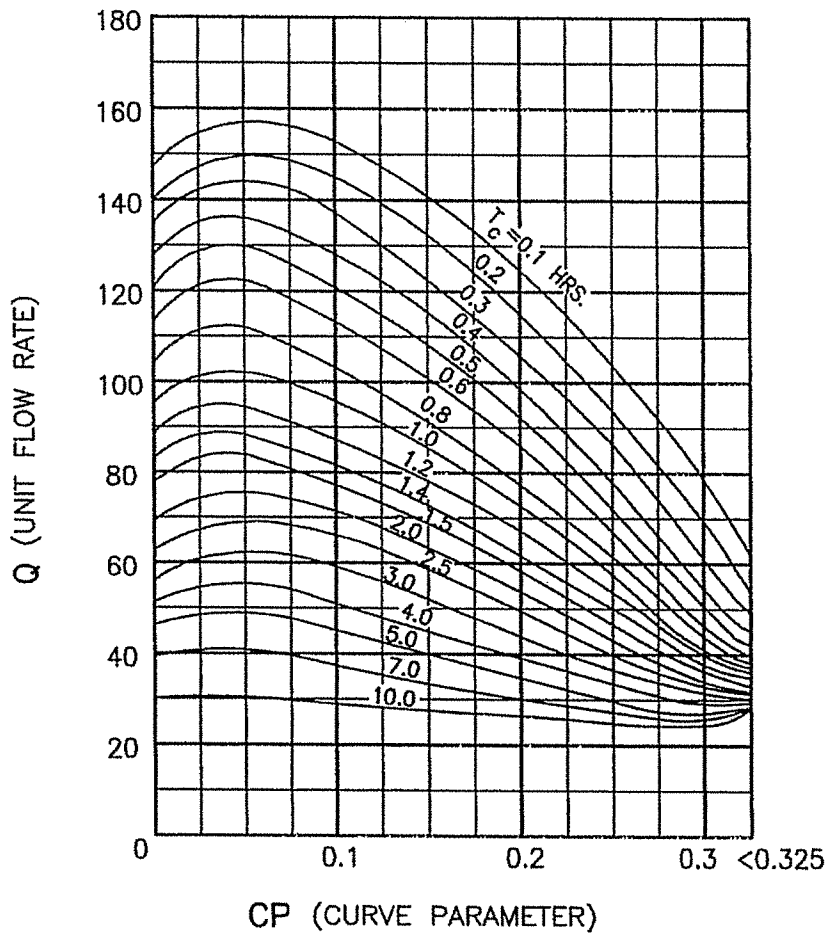
TYPE 2 CURVES FOR $0.639 \leq \frac{P_{6-D}}{P_{24-D}} \leq 0.767$

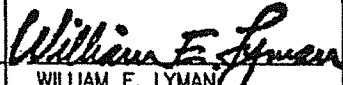


SCALE: NTS		DATE: 1996	SHASTA COUNTY DEPARTMENT OF PUBLIC WORKS	
		APPROVED BY:	HYDROLOGY ANALYSIS	
		<i>William E. Lyman</i> WILLIAM E. LYMAN	FOR	
			SMALL WATERSHEDS	
MARK	DATE	REVISION	ATTACHMENT No. 12	

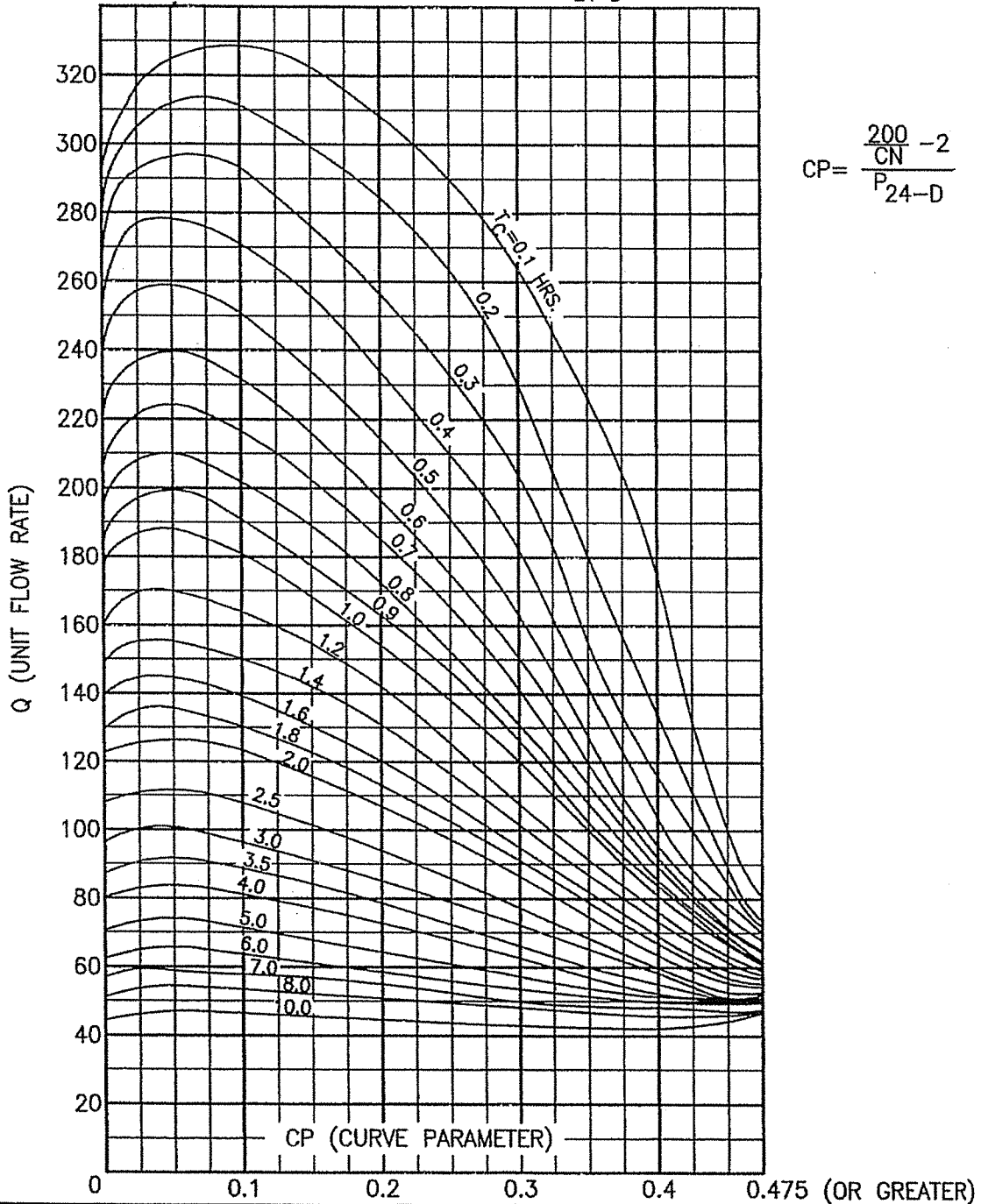
$$CP = \frac{\frac{200}{CN} - 2}{P_{24-D}}$$


TYPE 1A CURVES FOR $\frac{P_{6-D}}{P_{24-D}} < 0.518$



SCALE: NTS		DATE: 1996		SHASTA COUNTY DEPARTMENT OF PUBLIC WORKS	
		APPROVED BY:		HYDROLOGY ANALYSIS FOR SMALL WATERSHEDS ATTACHMENT NO. 13	
		 WILLIAM E. LYMAN			
MARK	DATE	REVISION			

TYPE 1 CURVES FOR $0.518 \leq \frac{P_6-D}{P_{24-D}} \leq 0.639$



SCALE: NTS		DATE: 1996	SHASTA COUNTY DEPARTMENT OF PUBLIC WORKS	
		APPROVED BY:		HYDROLOGY ANALYSIS FOR SMALL WATERSHEDS ATTACHMENT No. 14
		 WILLIAM E. LYMAN		
MARK	DATE	REVISION		

Appendix D

Volume Storage Calculations

DMA #	VOL needed ft ³	Top surface ft ²	Bottom surface area ft ²	Depth ft	Section Void Percentage			Soil volume ft ³	Rock volume ft ³	Total volume ft ³
					100% Air volume ft ³	40% Rock depth ft	20% Soil depth ft			
1	10584.68	724	395	1.5	826.88	2	1.5	579.01	217.13	1623.01
1	0.00	1649	816	1.5	1812.45	2	1.5	1319.00	494.62	3626.07
1	0.00	1471	874	1.5	1739.35	2	1.5	1176.79	441.30	3357.44
2	8368.45	8092	5238	1.5	9920.41	0	0	0.00	0.00	9920.41
3	2655.68	2100	744	2	2729.31	0	0	0.00	0.00	2729.31
4	422.20	937	304	1	591.59	0	0	0.00	0.00	591.59
Total Volume Needed	22031.00	ft³						Total Volume =	22314.05	ft³
								Extra Volume =	283.05	ft³

(Pipe & Drain Rock Trench Storage added)

DMA 1 : Pipe & Drain Rock Trench Storage	
Pipe Length =	85 ft
Pipe Size =	24 in.
Pipe Area =	3.14 ft ²
Trench Width =	3 ft
Depth Drain Rock =	3 ft
Trench Void % =	40%
Percolation Area of trench =	519 ft ²
Storage Volume of Trench =	466.22 ft ³

**Appendix E:
USDA Web Soil Survey**

Soil Map—Shasta County Area, California



Map Scale: 1:1,590 if printed on A landscape (11" x 8.5") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL:
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Shasta County Area, California
 Survey Area Data: Version 18, Sep 2, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 8, 2019—Jun 21, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

MAP LEGEND

- | | |
|------------------------|-----------------------|
| Area of Interest (AOI) | Spoil Area |
| Soils | Stony Spot |
| Soil Map Unit Polygons | Very Stony Spot |
| Soil Map Unit Lines | Wet Spot |
| Soil Map Unit Points | Other |
| Special Point Features | Special Line Features |
| Blowout | Water Features |
| Borrow Pit | Streams and Canals |
| Clay Spot | Transportation |
| Closed Depression | Rails |
| Gravel Pit | Interstate Highways |
| Gravelly Spot | US Routes |
| Landfill | Major Roads |
| Lava Flow | Local Roads |
| Marsh or swamp | Background |
| Mine or Quarry | Aerial Photography |
| Miscellaneous Water | |
| Perennial Water | |
| Rock Outcrop | |
| Saline Spot | |
| Sandy Spot | |
| Severely Eroded Spot | |
| Sinkhole | |
| Slide or Slip | |
| Sodic Spot | |

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CeB	Churn gravelly loam, 3 to 8 percent slopes	0.9	18.0%
PmA	Perkins gravelly loam, gravelly clay loam substratum, 0 to 3 percent slopes, MLRA 17	2.2	43.6%
RbA	Red Bluff loam, 0 to 3 percent slopes, MLRA 17, moist	1.9	38.4%
Totals for Area of Interest		5.0	100.0%

Shasta County Area, California

CeB—Churn gravelly loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: hfmd
Elevation: 400 to 800 feet
Mean annual precipitation: 35 inches
Mean annual air temperature: 63 degrees F
Frost-free period: 250 to 275 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Churn and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Churn

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

H1 - 0 to 13 inches: gravelly loam
H2 - 13 to 60 inches: gravelly loam

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: R017XY904CA - Subirrigated Deep Alluvial Fans
Hydric soil rating: No

Minor Components

Cobbly alluvial land

Percent of map unit: 5 percent

Landform: Channels

Landform position (three-dimensional): Tread

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: Yes

Honcut

Percent of map unit: 4 percent

Landform: Flood plains

Landform position (three-dimensional): Tread

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: No

Perkins

Percent of map unit: 3 percent

Landform: Stream terraces

Landform position (three-dimensional): Tread

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: No

Tehama

Percent of map unit: 3 percent

Landform: Stream terraces

Landform position (three-dimensional): Tread

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: No

Data Source Information

Soil Survey Area: Shasta County Area, California

Survey Area Data: Version 18, Sep 2, 2022

Shasta County Area, California

PmA—Perkins gravelly loam, gravelly clay loam substratum, 0 to 3 percent slopes, MLRA 17

Map Unit Setting

National map unit symbol: 2t7qd
Elevation: 390 to 890 feet
Mean annual precipitation: 27 to 43 inches
Mean annual air temperature: 57 to 64 degrees F
Frost-free period: 220 to 310 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Perkins and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Perkins

Setting

Landform: Stream terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile

Ap - 0 to 6 inches: gravelly loam
AB - 6 to 10 inches: gravelly loam
BAt1 - 10 to 18 inches: gravelly clay loam
BAt2 - 18 to 32 inches: gravelly clay loam
Bt1 - 32 to 41 inches: gravelly clay loam
Bt2 - 41 to 54 inches: gravelly clay loam
Bt3 - 54 to 60 inches: gravelly clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.3 to 0.5 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): 2s

Land capability classification (nonirrigated): 3s

Hydrologic Soil Group: C

Ecological site: R017XY905CA - Dry Alluvial Fans and Terraces

Hydric soil rating: No

Minor Components

Red bluff

Percent of map unit: 5 percent

Landform: Fan remnants

Landform position (two-dimensional): Summit

Landform position (three-dimensional): Tread

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: No

Moda

Percent of map unit: 5 percent

Landform: Drainageways on stream terraces

Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Tread

Down-slope shape: Linear

Across-slope shape: Linear, concave

Hydric soil rating: Yes

Churn

Percent of map unit: 5 percent

Landform: Stream terraces

Landform position (three-dimensional): Tread

Down-slope shape: Linear

Across-slope shape: Linear

Hydric soil rating: No

Data Source Information

Soil Survey Area: Shasta County Area, California

Survey Area Data: Version 18, Sep 2, 2022

Shasta County Area, California

RbA—Red Bluff loam, 0 to 3 percent slopes, MLRA 17, moist

Map Unit Setting

National map unit symbol: 2t7r0
Elevation: 450 to 1,110 feet
Mean annual precipitation: 29 to 57 inches
Mean annual air temperature: 61 to 63 degrees F
Frost-free period: 200 to 250 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Red bluff, moist, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Red Bluff, Moist

Setting

Landform: Fan remnants
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from igneous, metamorphic and sedimentary rock

Typical profile

A - 0 to 6 inches: loam
Bt1 - 6 to 18 inches: clay loam
Bt2 - 18 to 28 inches: clay loam
Bt3 - 28 to 44 inches: clay loam
Bt4 - 44 to 57 inches: clay
Bt5 - 57 to 67 inches: clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.3 to 0.5 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.0 inches)

Interpretive groups

Land capability classification (irrigated): 3s

Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C
Ecological site: R017XD089CA - ACID TERRACE
Hydric soil rating: No

Minor Components

Perkins

Percent of map unit: 5 percent
Landform: Stream terraces
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Redding

Percent of map unit: 5 percent
Landform: Fan remnants
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Moda

Percent of map unit: 4 percent
Landform: Fan remnants
Landform position (two-dimensional): Summit, toeslope
Landform position (three-dimensional): Tread
Microfeatures of landform position: Vernal pools
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: Yes

Unnamed

Percent of map unit: 1 percent
Landform: Fan remnants
Landform position (two-dimensional): Summit, toeslope
Landform position (three-dimensional): Tread
Microfeatures of landform position: Vernal pools
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Shasta County Area, California
Survey Area Data: Version 18, Sep 2, 2022

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