AN ANALYSIS OF THE NORTH FORK MATTOLE RIVER WATERSHED

Presented To Douglas Jager

In Fulfillment Of The Requirements For

W.M. 220 - Watershed Analysis

By Ross Carkeet

June, 1967

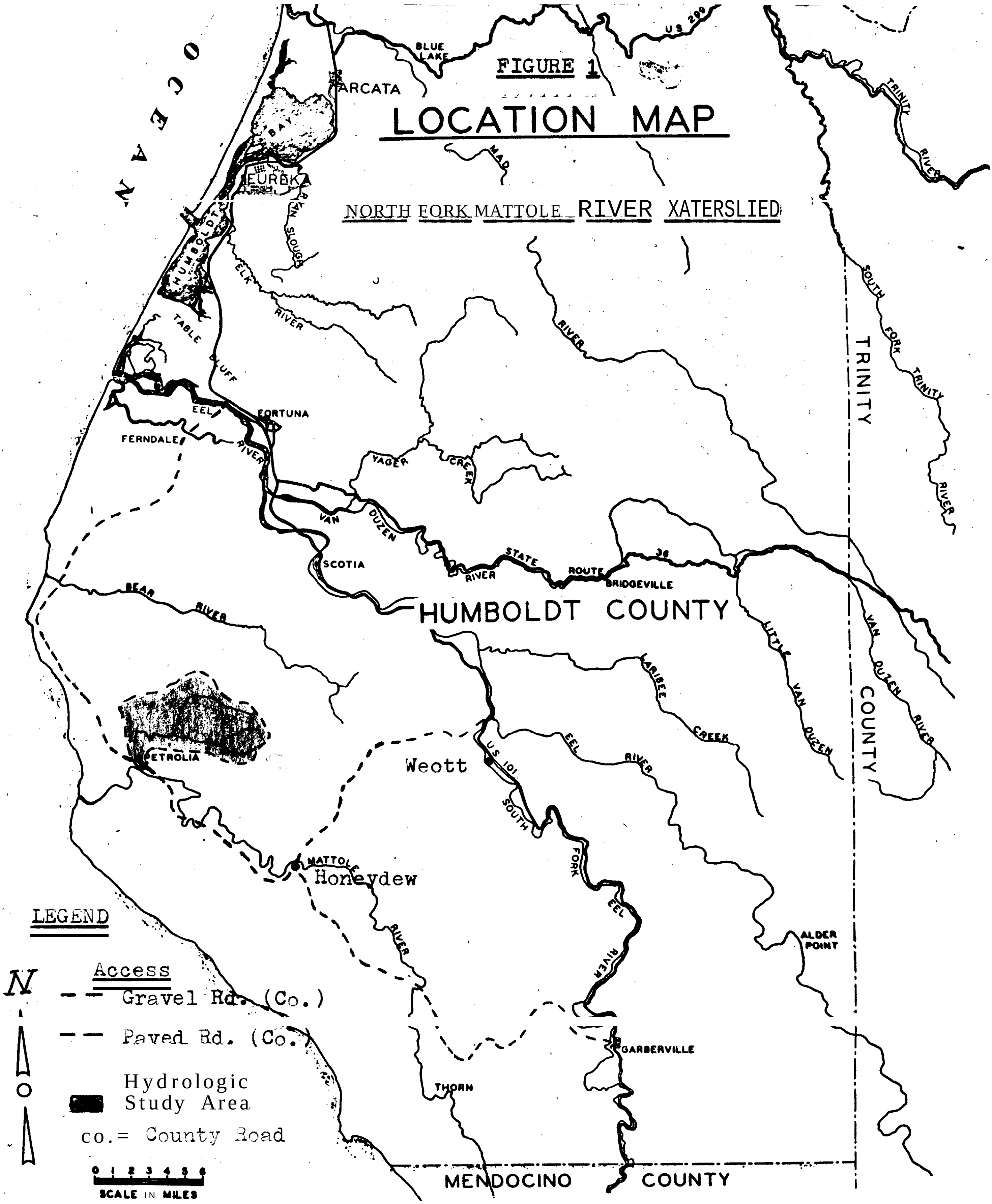
FIGURE 1
LOCATION MAP
NORTH FORK MATTOLE RIVER XATERSLIED
OCEAN
ARCATA
BLUE LAKE
US 299
EUREKA
BAY
HUMBOLDT
MAD
RIVER
TRINITY
SOUTH FORK TRINITY RIVER
ELK RIVER
TABLE BLUFF
EEL
FORTUNA
FERNDALE
RIVER
YAGER CREEK
VAN DUZEN
SCOTIA
RIVER
STATE ROUTE 36
BRIDGEVILLE
HUMBOLDT COUNTY
BEAR RIVER
LARIBEE CREEK
LITTLE VAN DUZEN
VAN DUZEN RIVER
COUNTY
PETROLIA
Weott
US 101
EEL RIVER
SOUTH FORK EEL RIVER
MATTOLE
Honeydew
RIVER
ALDER POINT
GARBERVILLE
THORN
MENDOCINO COUNTY
LEGEND
Access
Gravel Rd. (Co.)
Paved Rd. (Co.)
Hydrologic Study Area
co.= County Road
N
0 1 2 3 4 5 6
SCALE IN MILES

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INTRODUCTION

Purpose And Scope

The intent of this study is to provide a comprehensive presentation and corresponding analysis of available and pertinent information in reference to the North Fork Mattole River Watershed. The analysis of this watershed is presented with no predetermined land management objective in mind. Rather, it is intended that the compiled information will be of use to anyone interested in applying specific land management objectives to a given portion of' the watershed. Thus, any current or prospective manager and user of the natural resources of the watershed will find that useful information can be gleaned from this report in relation to his present or future land management objectives and uses.

The analysis will be presented in six portions: physiographic, socio-economic, general problems, potentials of the area, resource summary, and conclusions. Because of the availability of certain information and the author's experience and interest, a major devotion of effort in the watershed analysis will be physiographic in nature. However, a consideration and discussion of certain other characteristics of the area, such as history, problems, and biotic aspects that play an instrumental role in evaluating the feasibility and consequences of land-use activity, will be more than superficial in the analysis.

LIST OF FIGURES

LIST OF TABLES

PART I

PHYSIOGRAPHIC (TOPOGRAPHIC) ANALYSIS

Introduction

To provide a more intensive and effective analysis of the study area, the North Fork Mattole River Watershed has been subdivided into two basins, the North Fork Basin, and the East Branch North Fork Basin (Fig. 2).

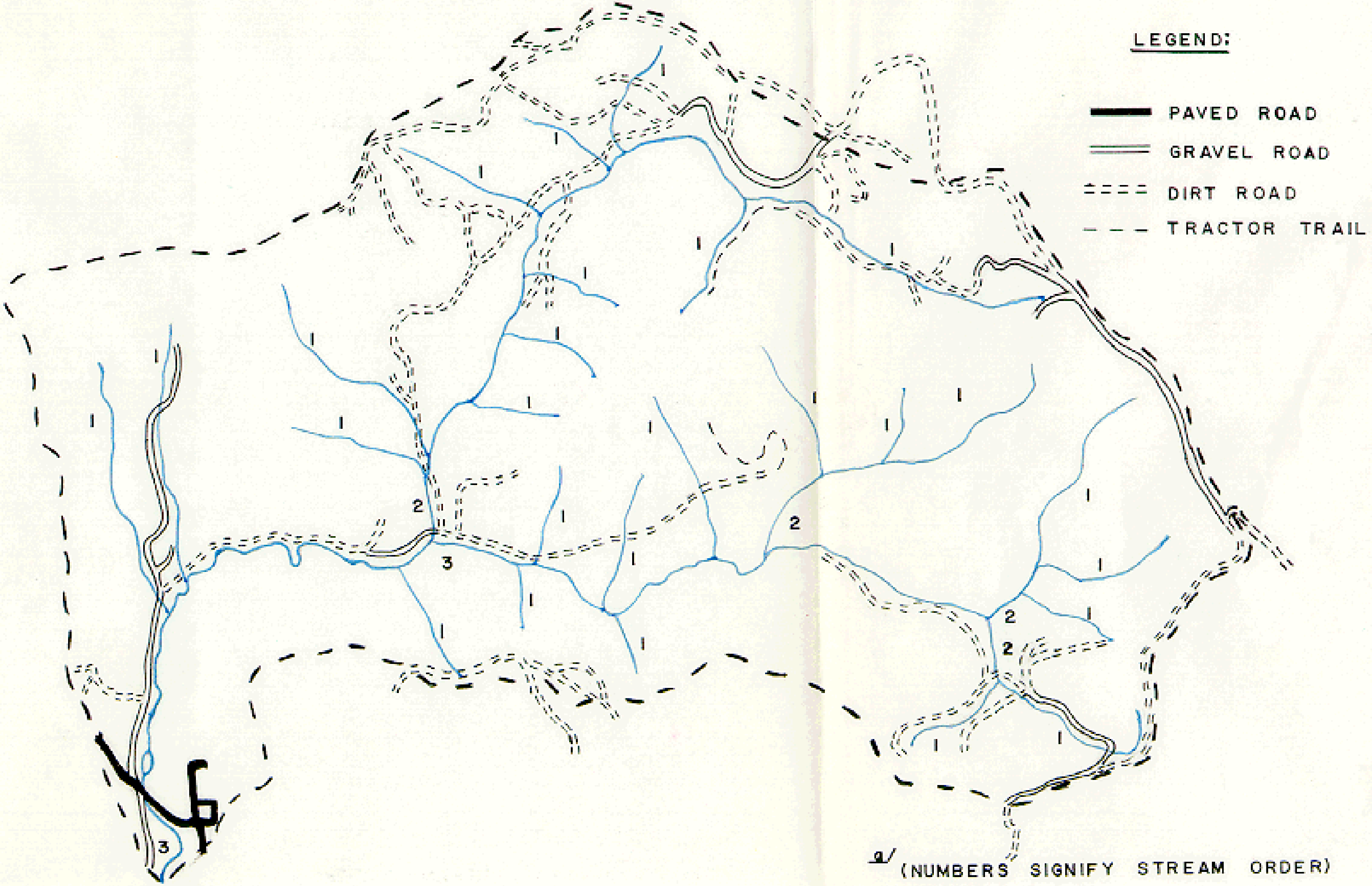
Location And Description

The 24,064 acre North Fork Mattole River Watershed is located in the rugged and sparsely-populated coastal mountains of southern Humboldt County, five miles inland from the Pacific Ocean (Fig. 1). Road access to the watershed is provided throughout the year from three directions: south from Ferndale, west from Weott, and northwest from Garberville. All three roads are maintained County Roads, branching off from U.S. Highway 101. The town of Petrolia is situated near the lower entrance of the watershed, where the North Fork empties into the main Mattole River. Access within the watershed itself is facilitated by 2.1 miles of paved road, 11.6 miles of gravel road, and 33.0 miles of dirt road (Fig. 2A).

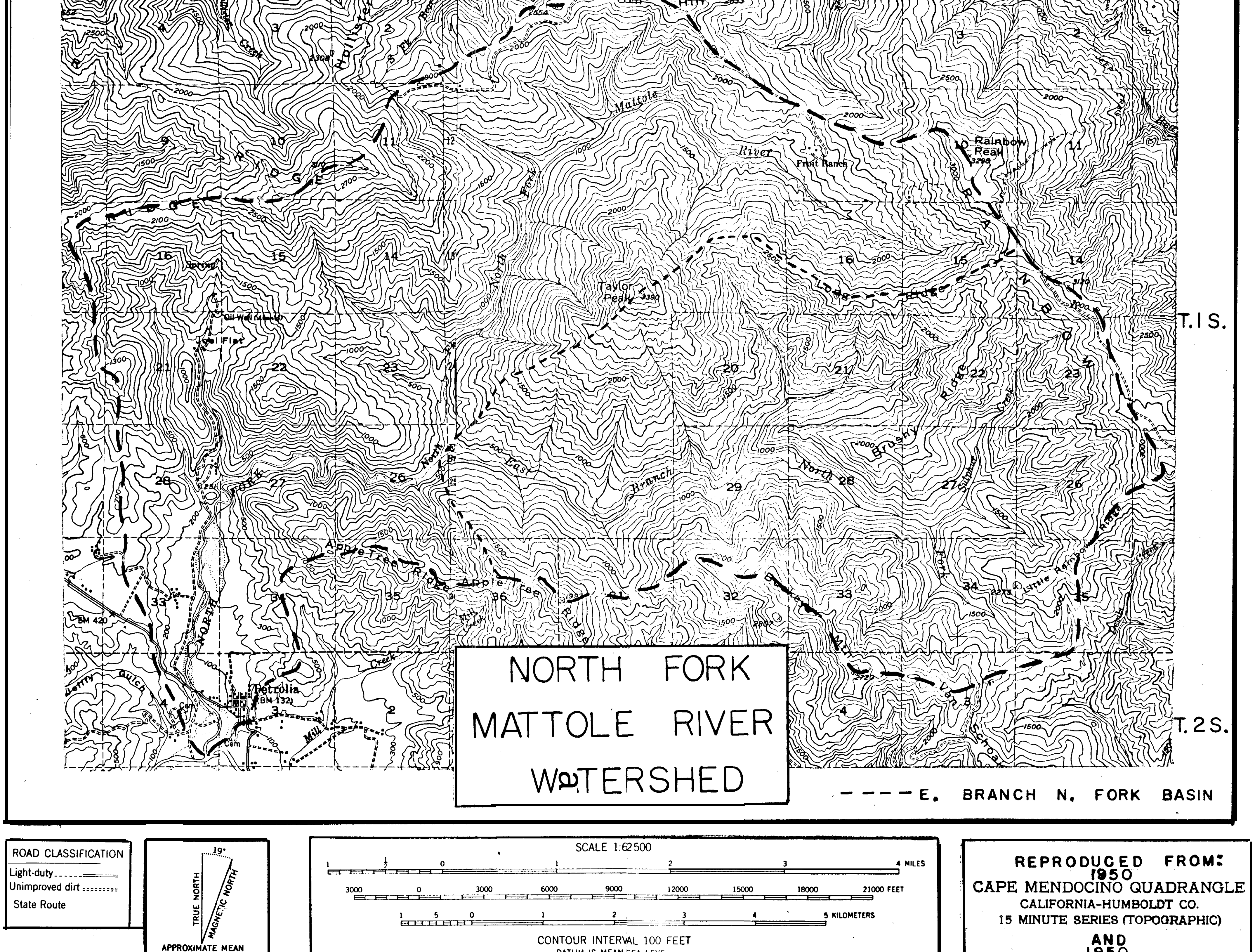
Three major tributaries comprise the stream network in the North Fork Mattole River Watershed. They are the following: North Fork Mattole River, East Branch of the North Fork, and Sulphur Creek, located near the headwaters of the East Branch (Fig. 2). Total length of perennial streams within the watershed is 46.7 miles. According to the U.S. Geological Survey stream classification, no intermittent streams exist

FIG. 2A

ACCESS AND STREAM ORDER[a] OVERLAY



a/ (NUMBERS SIGNIFY STREAM ORDER)


NORTH FORK
MATTOLE RIVER
WATERSHED
E. BRANCH N. FORK BASIN
T.1S.
T.2S.
Rainbow Peak
Taylor Peak
Mattole River
North Fork
East Branch
Rainbow Ridge
Long Ridge
Brushy Ridge
Apple Tree Ridge
Petrolia
Joel Flat
Fruit Ranch
ROAD CLASSIFICATION
Light-duty
Unimproved dirt
State Route
TRUE NORTH
MAGNETIC NORTH
19°
APPROXIMATE MEAN
SCALE 1:62500
CONTOUR INTERVAL 100 FEET
4 MILES
21000 FEET
5 KILOMETERS
REPRODUCED FROM:
1950
CAPE MENDOCINO QUADRANGLE
CALIFORNIA-HUMBOLDT CO.
15 MINUTE SERIES (TOPOGRAPHIC)
AND

in the watershed (Fig. 2). Additional stream length information can be found on page A, Table 5.

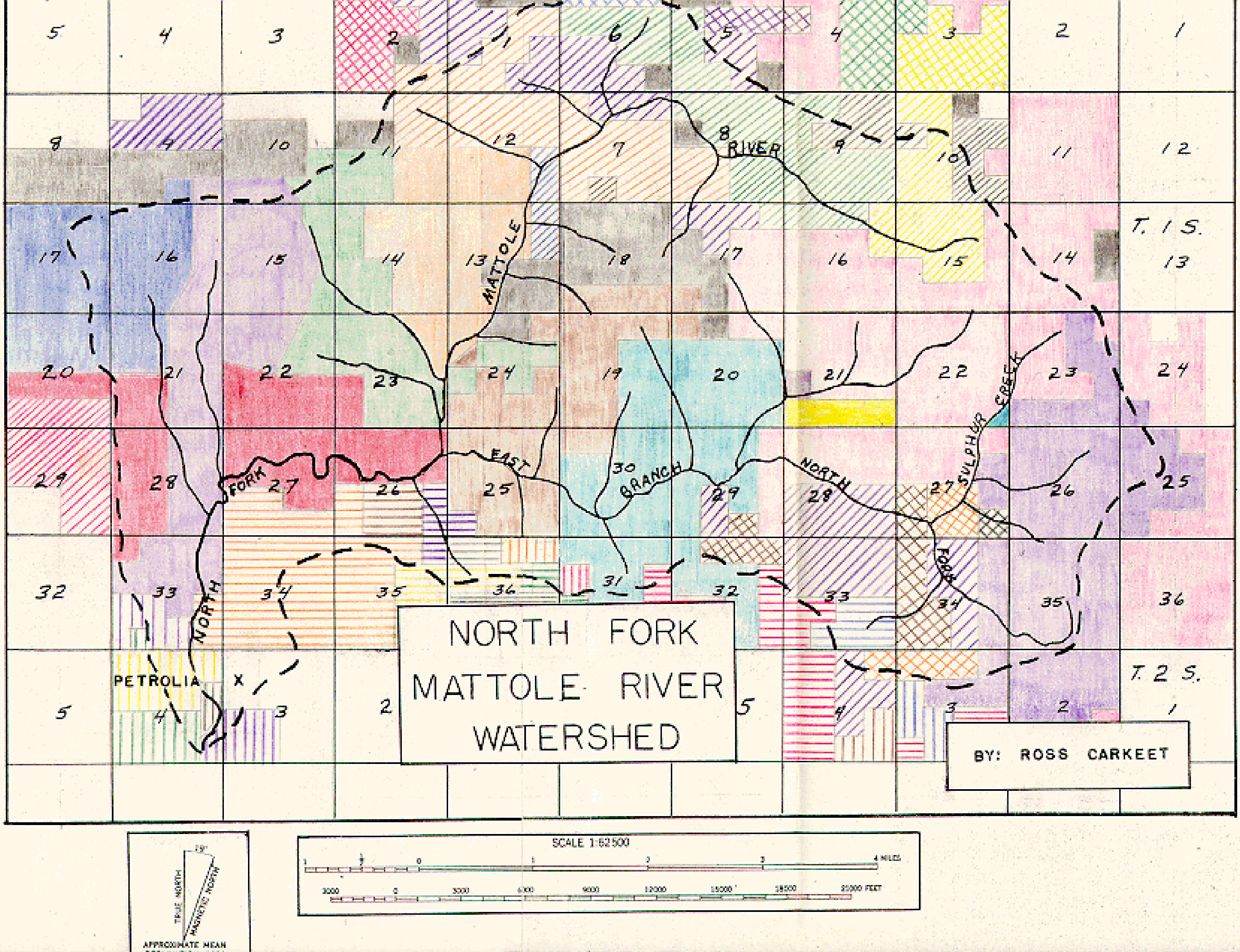
Ownership

Figure 3 illustrates the present existing ownership pattern within the study area. All of the land within the watershed is In private ownership except for 40 acres of unappropriated land. The map displays the obvious; this being that numerous titles of ownership exist within the basin. However, large consolidated parcels are held by The Pacific Lumber Company and by J.L. and G. Chambers. The diversity of ownership pattern that exists within the watershed contributes significantly to the complexity of the management and use of the resources of the area. Diversity of ownership implies diversity of management objectives and specific land uses. It is more likely that widespread misuse and abuse of the land resources will occur in areas where ownership is not monopolistic, as will be explained later. Addresses of land owners within the watershed are given in Table A, appendix.

CLIMATE

Temperature

Published temperature data is lacking for the study area as well as for the immediate Mattole Valley area. An analysis of temperature data from other inland stations such as Alderpoint, or Scotia, for which published temperature information exists, might give reliable approximations of mean monthly maximum and minimum temperatures of the study area. In general, the temperature characteristics of the study area are similar in nature


NORTH FORK
MATTOLE RIVER
WATERSHED
BY: ROSS CARKEET
T. 1 S.
T. 2 S.
MATTOLE
RIVER
EAST
BRANCH
NORTH
FORK
SULPHUR
CREEK
FORK
NORTH
PETROLIA
X
SCALE 1:62500
MILES
FEET
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN

KEY TO OWNERSHIP COLORS

The Pacific Lumber Company
Chambers, J.L. and G.
Edmonston, R.M. and D.R.
Clark, W.H. and P.M.
U.S.A., Dept. of the Interior
Cook, R.P. and B.E.
Graham, S. and M.A.
Cook, F.C.
Wright, C.E.
Walker, M.L.
Zanone, A. and S.
Madsen, F.
Rochlin, A.
White, R.M. and M.C.
Henley, I.M.
Brown, I.M.
Lowry, S.E. and D.C.
Unappropriated
Lowry, W.E. and M.A.
Hough, V.S.
Hansen, T.
Russ, J. and A.

Erickson, A.
Calif. State Lands Commission
Sound Lumber Company
Dale, O.A.
Stewart, H.H.
Ohman, W.I. and A.S.
Hunter, R.E. and M.E.
Hunter, E.
Thompson, R.H. and R.M.
Boots, A. and A.S.
Lytel, B.R.
Glines, W.L.
Lowdermilk, D.
Westfall, N.S. and M.A.
Cook, M.M.
Clark, T.K.
Rackliff, C.C.
Titus, F. and M.
Chambers, R.
Tooby and Prior, Inc.

to the coastal area of Humboldt County, where extremes between mean monthly maximum and minimum temperatures are uncommon. However, summer temperatures in the Mattole area are generally higher than along the coast, because summer fog usually disappears from the area by mid-morning. Midsummer maximum temperatures are often in the 90's (Community of Petrolia, 1962).

Precipitation

A rain gage has been located in Petrolia by the Department of Water Resources. Records began in 1958, but have only been published for the period from 1963-1965. Table 1 and Figure 4 display the precipitation data for the published period. Two-thirds of the mean seasonal precipitation of 62.2 inches at Petrolia occurred during this period in the four months of November, December, January, and April. June through September are characteristically dry months, during which fire hazard becomes more acute throughout the area.

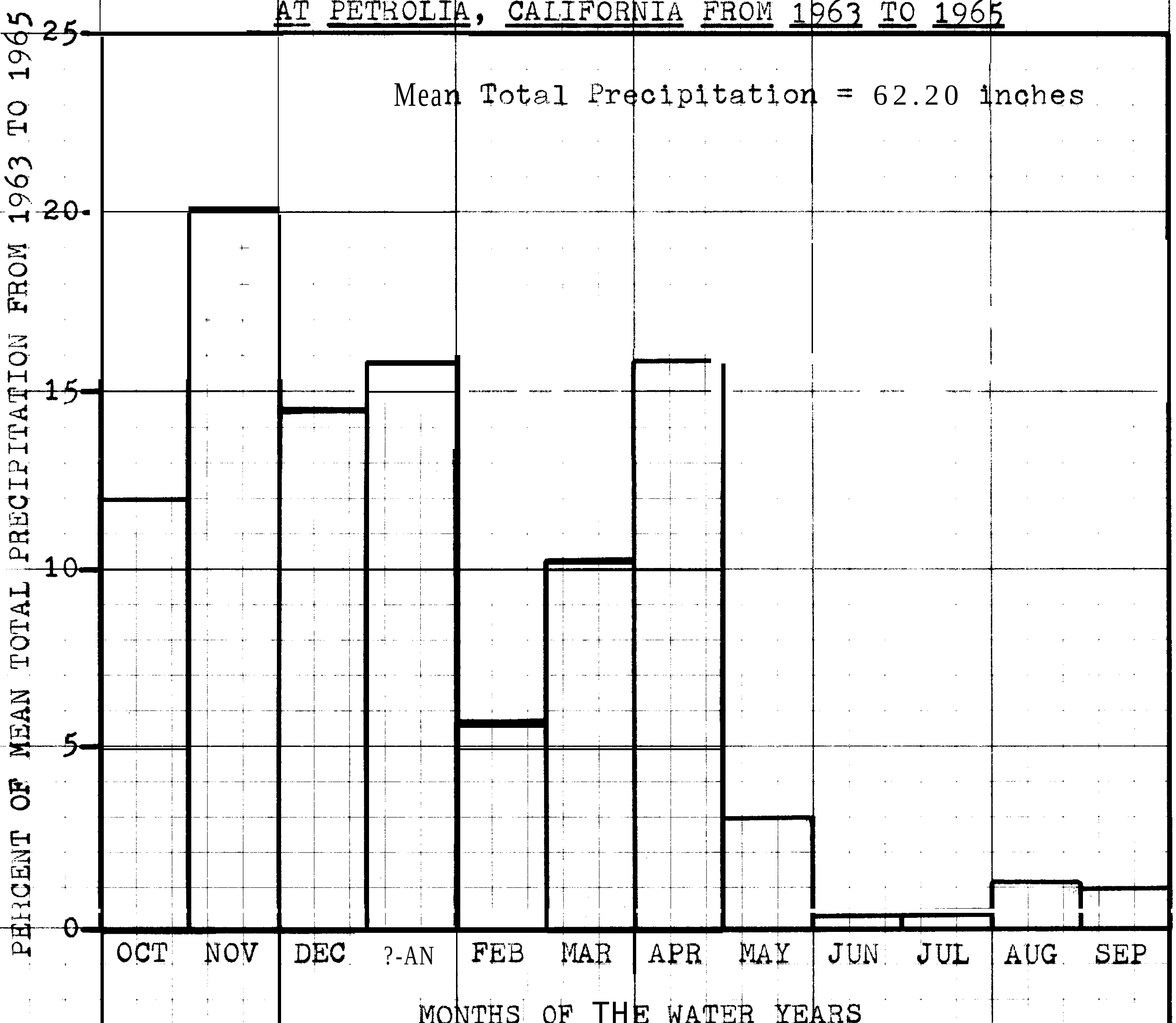
Figure 5 provides additional information on the mean annual precipitation of the watershed as a whole. Elevation increases eastward throughout the watershed, and as a result mean annual precipitation increases eastward to a maximum of 80 inches in the vicinity of the ridge south of Rainbow Peak (Rainbow Ridge). The general direction of storm movement in this area is from the southwest; thus precipitation increases in a northeasterly direction as the isohyets of Figure 5 suggest. Mean annual precipitation for the basin is 73.0 inches (U.S. Dept. of' the Interior, 1960).

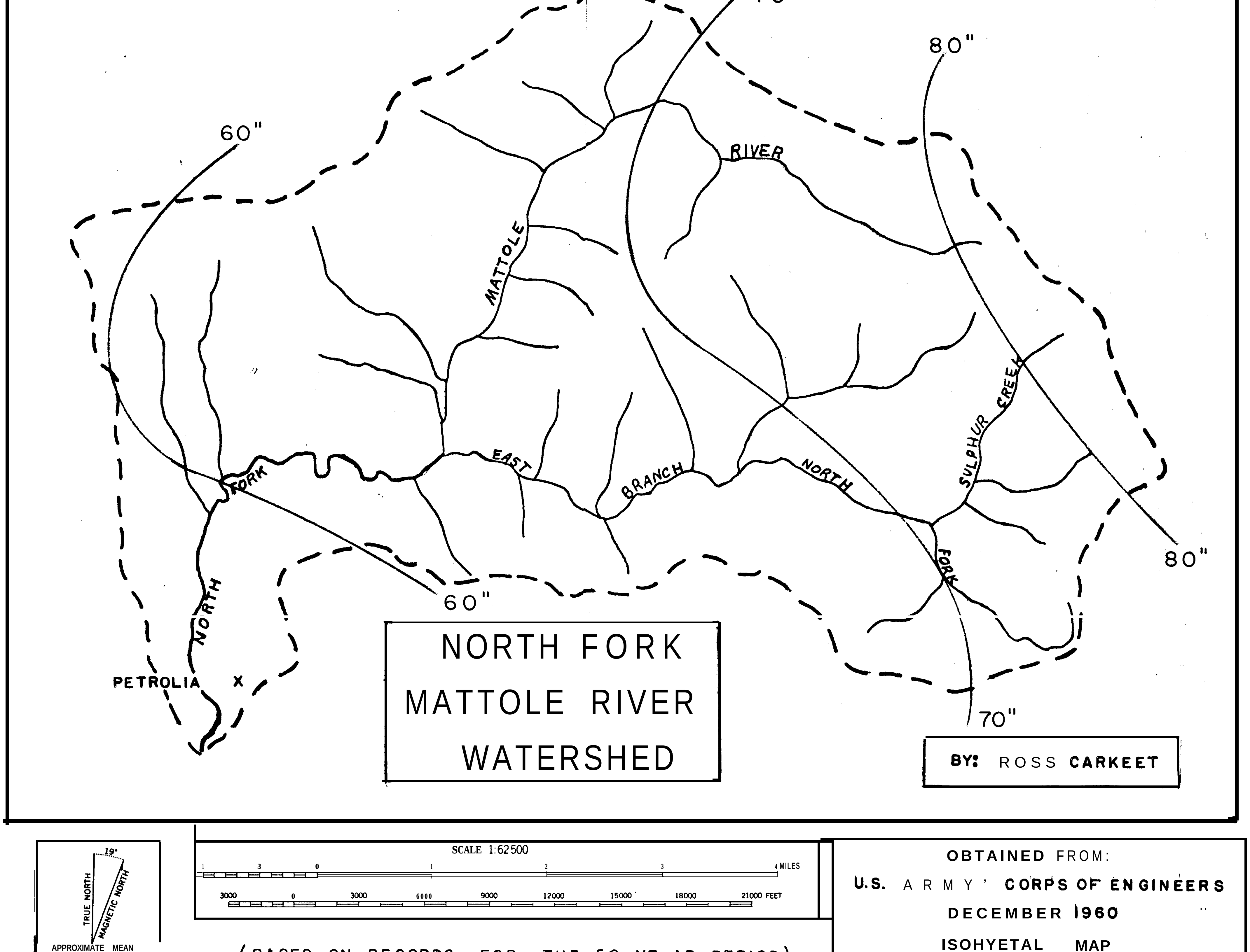
TABLE 1 - MONTHLY AND MEAN DISTRIBUTION OF PRECIPITATION AT PETROLIA, CALIFORNIA FROM 1963 TO 1965a/

Month	PRECIPITATION IN INCHES 1963	1964	1965	Mean	Percent Of Mean Total
Jan.	5.40	13.47	10.81	9.89	15.9
Feb.	7.14	1.36	2.18	3.56	5.7
Mar.	IO.90	5.92	2.19	6.34	10.2
Apr.	19.12	0.26	10.23	9.88	15.9
May	3.83	1.44	0.32	1.86	3.0
June	0.32	0.30	0.00	.21	.3
July	0.00	0.04	0.59	.21	.3
Aug.	2.00	0.04	0.00	.68	1.1
Sept.	0.95	0.96	0.00	.64	1.0
Oct.	lo.24	8.82	3.26	7.44	12.0
Nov.	9.46	12.05	16.02	12.50	20.1
Dec.	5.81	3.62	17.77	9.06	14.5
TOTAL	75.17	48.28	63.37	62.20	**100.0**

a/ From Calif. State Dept. of Water Resources(1963-1965)

FIGURE 4 - MONTHLY DISTRIBUTION OF PRECIPITATION AT PETROLIA, CALIFORNIA FROM 1963 TO 1965





NORTH FORK
MATTOLE RIVER
WATERSHED
BY: ROSS CARKEET
60"
60"
80"
80"
70"
MATTOLE
RIVER
EAST
BRANCH
NORTH
FORK
NORTH
FORK
NORTH
FORK
SULPHUR CREEK
PETROLIA X
19°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN
SCALE 1:62500
4 MILES
21000 FEET
OBTAINED FROM:
U.S. ARMY CORPS OF ENGINEERS
DECEMBER 1960
ISOHYETAL MAP

Snowfall

Snowfall data is sorely lacking for this area, as well as for the remainder of Humboldt County. However, during the month of March in 1967, up to 22 inches of snow depth was reported above the 3,000 foot level in the vicinity of Rainbow Ridge within the watershed (Humboldt Standard, 1.967). This heavy snowfall presented a livestock feeding problem to cattlemen owning ranches in the vicinity. Ranchers in the area have agreed that this was the worst March that they have seen in the last 20 years as far as snow is concerned. Thus it can be expected that occasional, seasonal snow coverage in the upper elevations of the watershed can be expected.

GEOLOGY

General Geology

Geologically speaking, in general the North Fork Mattole River Watershed is in a youthful stage. Numerous v-shaped canyons, rugged topography, and relatively straight stream channels are characteristics of this area and are representative of geologic youth. However, in the lower region of the watershed near Petrolia, the widening flood plain and the extensive alluvial deposition indicates that the geologic age is approaching maturity In this local area. Alluvial deposition has created a region of fertility in the lower portion of the watershed.

Structural geologic characteristics of the study area are depicted in Figure 6. The stratigraphy of the area is

Figure 6

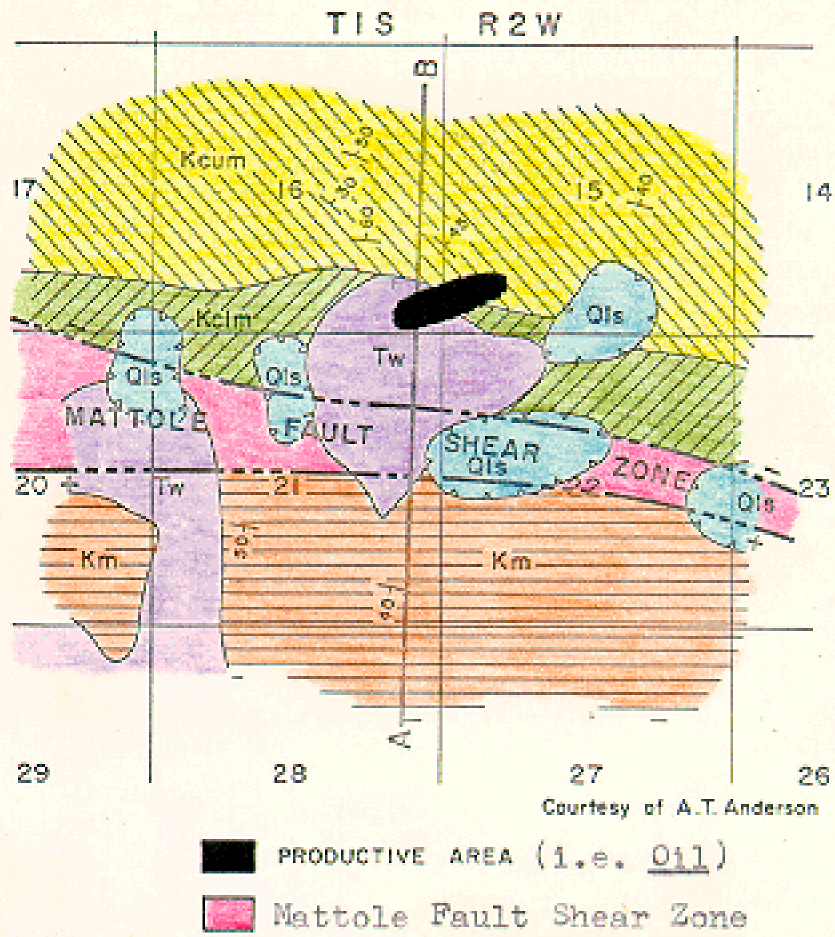
could not be included
due to its size.

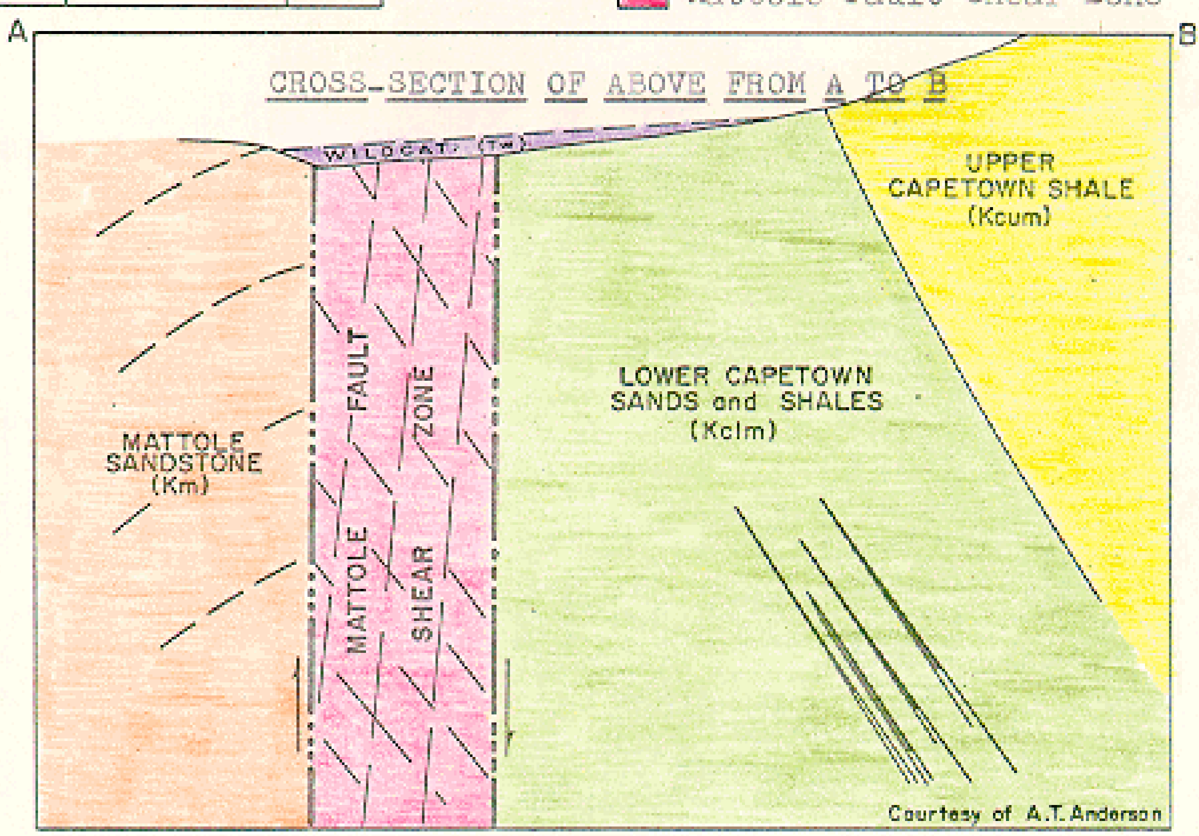
It was a foldout geologic map.

FIGURE 7 - GEOLOGIC MAP (WITH CROSS-SECTION) OF THE PETROLIA OIL FIELDa/

PETROLIA AREA

EPOCH	FORMATION	Thick-ness (Feet)
RECENT	(landslide) Qls	?
PLIOCENE to MIOCENE	Wildcat Tw	50 to 100
UPPER CRETACEOUS	Kcum Upper Capetown (Shale)	7000
	Kclm Lower Capetown (Sandstones And Shales)	
	Km Mattole (Sandstone)	5000





a/ From Calif. Div. Of Mines And Geology, Bul. No. 181. 1962.

essentially that of marine sedimentary rocks (graywacke and shale) of the Cretaceous geologic period.

Specific Geology

The contact between the younger Tertiary sedimentary rocks and the older Cretaceous sedimentary rocks exerts a structural control that has resulted In the North Fork being diverted eastward, at a point two miles north of Petrolia. A few encised stream meanders exist along the North Fork in sections 26-28, T. 1S., R. 2W. Encised meanders are formed when geologically older stream areas with meandering tributaries undergo regional uplift, thus causing the stream to rapidly downcut where mature meanders once existed.

Figure 6 also shows that a northwest-trending fault shear zone (The Mattole Fault Shear Zone) crosses the watershed near the location where the North Fork and the East Branch of the North Fork divide. A closer examination of the shear zone is offered in Figure 7. Township, Range, and Section designations of this geologic map allow the sbear zone to be pinpointed on the topographic map (Fig. 2). The significance of the shear zone is twofold: 1) A one-time productive area of oil accumulation exists near the shear zone, and 2) the shear zone is responsible for initiating local landslides where unstable soils exist.

SOILS AND VEGETATION

Forest Soils And Associated Vegetation

Use of the Soil-Vegetation Map (Figure 8) and accompanying 'Tables 2 and 3 provide vital information on vegetation-soil

Soil Series Name	Symbol	Soil Type	Parent Material	Permeability b/	General Drainage c/	Erosion Hazard d/	Suitabi Timber Pro
Hugo	812	Timber	Sandstone And Shale	Rapid	Good	High	Moderate
Melbourne	814	Timber	Sandstone And Shale	Rapid	Good	Medium	High
Usal	818	Timber	Sandstone And Shale	Rapid	Good	Moderate	High
Hoover	822	Timber	Sandstone	Rapid	Good	Moderate	Medium
Atwell	823	Timber	Sheared Sedimentary Rocks	Slow	Imperfect	Moderate	High
Kneeland	835	Grassland	Sandstone And Shale	Moderate	Good	Moderate	Unsuited
Kinman	835V	Wood-Grassland	Sandstone And Shale	--	--	--	--
McMahon	839	Grassland	Sandstone	Slow	Imperfect	Moderate	Unsuited
Wilder	840	Transition	Sandstone	Rapid	Good	High	Variable
Laughlin	847	Wood-Grassland	Sandstone And Shale	Moderate	Good	Moderate	Unsuited
Zanone	852	Wood-Grassland	Sandstone And Shale	Slow	Imperfect	Moderate	Unsuited
Mattole	952	Wood-Grassland	Soft Sedimentary Rock	Slow	Imperfect	Moderate	Unsuited
Boomer	7118	Timber	Basic Igneous Rocks (metamorphosed)	Moderate	Good	Moderate	Medium

a/ From Black (1964)

b/ Refers to the Rate of Movement of Water Through the Soil Profile

c/ Refers to the Rate and Extent of Removal of Water from the Soil, Either by Runoff or by Percolation

d/ Refers to Probable Susceptibility of a Soil to Erosion After Material Disturbance of Protective Vegetative Cover

TABLE 2 - SOIL-VEGETATION CLASSIFICATION FOR USE WITH THE
NORTH FORK MATTOLE RIVER WATERSHED SOIL-VEGETATION MAP [a]/

Soil Series Name	Symbol	Soil Type	Parent Material	Permeability [b]/	General Drainage [c]/	Erosion Hazard [d]/	Suitabil Timber Prod
Hugo	812	Timber	Sandstone And Shale	Rapid	Good	High	Moderate
Melbourne	814	Timber	Sandstone And Shale	Rapid	Good	Medium	High
Usal	818	Timber	Sandstone And Shale	Rapid	Good	Moderate	High
Hoover	822	Timber	Sandstone	Rapid	Good	Moderate	Medium
Atwell	823	Timber	Sheared Sedimentary Rocks	Slow	Imperfect	Moderate	High
Kneeland	835	Grassland	Sandstone And Shale	Moderate	Good	Moderate	Unsuited
Kinman	835V	Wood-Grassland	Sandstone And Shale	--	--	--	--
McMahon	839	Grassland	Sandstone	Slow	Imperfect	Moderate	Unsuited
Wilder	840	Transition	Sandstone	Rapid	Good	High	Variable
Laughlin	847	Wood-Grassland	Sandstone And Shale	Moderate	Good	Moderate	Unsuited
Zanone	852	Wood-Grassland	Sandstone And Shale	Slow	Imperfect	Moderate	Unsuited
Mattole	952	Wood-Grassland	Soft Sedimentary Rock	Slow	Imperfect	Moderate	Unsuited
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c/ Refers to the Rate and Extent of Removal of Water from the Soil, Either by Runoff or by Percolation

d/ Refers to Probable Susceptibility of a Soil to Erosion After Material Disturbance of Protective Vegetative Cover

TABLE 3 - ADDITIONAL INFORMATION FOR USE WITH THE NORTH FORK MATTOLE RIVER WATERSHED SOIL-VEGETATION MAP[a]/

SOILS

Soils are designated on the map by symbols written as fractions. The numerator of the fraction designates the soil series. Depth class of soil is designated by the first digit in the denominator of the fraction:

Depth Class Symbol	Depth in Feet	Depth Class Name
1	less than 1	Very Shallow
2	from 1 to 2	Shallow
3	from 2 to 3	Moderately Shallow
4	from 3 to 4	Moderately Deep
5	more than 4	Deep

A second number in the denominator of the fraction (separated from the depth or other phase symbol by a hyphen) indicates the dominant slope class in the delineated area:

Slope class 1 is less than 30%
Slope class 2 is from 30 to 50%
Slope class 3 is from 50 to 70%
Slope class 4 is more than 70%

Letters immediately following the depth class symbol in the denominator are used to designate other phases as follows:

S = Coarse fragments in the soil (gravel, cobbles, or stones)
E = Severe erosion

TIMBER SITES

Douglas-fir types are graded in terms of the total height that average dominant and codominant Douglas-fir trees reach at 100 years of age--by 30-foot classes. These classes are designated by Roman numbers on the map as follows:

Site Class Symbol	Site Index Height in feet of dominant and codominant trees at 100 years
I	200
II	170
III	140
IV	110
V	80

a/ From Black (1964)

TAELE 3 - CONTD.

VEGETATION

Vegetation symbols are listed on the map in decreasing order of ground. coverage density. The following symbols represent the vegetation within the North Fork Mattole River Watershed on the Soil-Vegetation map:

Mapbol	Common Name	Scientific Name
BP	Chaparral Broom	*Baccharis pilularis*
C	Canyon Live Oak	*Quercus chrysolepis*
Cso	Jim Brush	*Ceanothus sorediatus*
Ct	Blue Blossom	*Ceanothus thyrsiflorus*
D	Douglas-fir	*Pseudotsuga menziesii*
G	Grand Fir	*Abies grandis*
H	California Buckeye	*Aesculus californica*
L'	California Laurel	*Umbellularia calif ornica*
M	Madrone	*Arbutus menziesii*
M	Bigleaf Maple	*Acer macrophyllum*
Pta	Western Bracken	*Pteridium aquilinum*
T	Tanoak	*Lithocarpus densiflora*

Other Symbols:	Description
Gr	Grasses and other associated herbaceous plants--includes meadows
Ba	Bare or litter--covered ground., essentially devoid of vegetation

Figure 8

SOIL-VEGETATION MAP

could not be included
due to its size.

relationships in the watershed.

The Hugo soil series covers approximately two-thirds of the total watershed area. This fact is supported by the coloration on the Soil-Vegetation Map. The Hugo soil series possesses moderate suitability for timber production and drains well in most cases. However, surface erodability of this soil is high if sites are severely disturbed (Black, 1964). Mean depth of the soil throughout the watershed is four feet. The prevalent vegetative covering on areas where Hugo soil exists is Tanoak (Lithocarpus densiflora), Madrone (Arbutus menziesii), Ca? ifornia Laurel (Umbellularia californica), and Douglas-fir (Pseudotsuga menziesii), in varied arrangements of ground coverage density. Douglas-fir is usually classified as a minor component of the vegetation throughout the watershed in terms of density (Fig. 8).

Other forest soils in the watershed occupying relatively small areas are: Melbourne (814), Usal (818), Hoover (822), Boomer (7118), and Atwell (823). The significance of the Atwell soil series in certain locations should not be overlooked. This soil series is notorious for instability following site disturbance. Instability problems with this soil have arisen in various locations throughout Humboldt County (Boe,1963).

Grassland Soils And Associated Vegetation

Typical grassland soils of the watershed are Kneeland (835), and McMahon (839). A large percentage of the grassland area in the watershed is found on the transition-classified Wilder (840) soil series, as well as the wood-grassland classified Zanone (852) soil series. The absence of other woodland vegetation with the prevalence of grasses on the last two mentioned soil series in the watershed, has resulted in the classification of these two soils as representing typical grassland soils for the study area.

CLASSIFICATION

Table 4 and Figure 9 provide information on land classification within the North Fork Mattole River Watershed. Approximately one-fourth of the total watershed area supports commercial forest land with stands of Douglas-fir ranging in density from 10 to 70 percent. Only 2.2 percent of the total watershed area supports stands of Douglas-fir in densities ranging from 71 to 100 percent. Of significant importance is the fact that nearly 25 percent of the total watershed area has been logged of 70 percent of the merchantable timber volume within the last five years; whereas only 3.2 percent of the total watershed area has been logged prior to five years, to the extent that no merchantable timber remains to date.

A comparison between the 1957 Soil-Vegetation Map (Fig. 8), and the 1962 Timberstand Naps in the Humboldt County Assessor's Office (upon which Fig. o is partially based) indicate a change during the five year period in the amount of area classified as grassland. Total area of grassland on the Soil-Vegetation Map 4s computed as 7,500, or 31.2 percent of the total watershed area. Total srea of grassland In Figure 9 is 8,220 acres, or 34.1 percent of the total watershed area. During this five year period, 720 acres of the watershed has been converted from

TABLE 4 - INFORMATION ON LAND CLASSIFICATION OF THE NORTH FORK MATTOLE RIVER WATERSHED

Classification Of Land	Acres In Watershed	Percent Of Total Watershed Area
Urban Lands	90	.4
Smooth Lying Irrigable Lands	540	2.3
Gently Sloping Irrigable Lands	464	2.0
	1,004	4.3
Brush	290	1.2
Unlogged Area (Hd. Wds.)	1,300	5.4
Irrigable Grasslands Better Suited For Forest Mgt.	1,290	5.4
Grassland	6,930	28.7
	8,220	34.1
Unlogged Old-Growth D.F.a/ - 10-40% Density	2,850	11.9
Unlogged 2nd-Growth D.F. - 41-70% Density	3,240	13.4
Unlogged 2nd-Growth D.F. - 71-100% Density	540	2.2
	6,630	27.5
Areas Logged Of 70% Timber Volume Within The Last 5 Years	5,740	23.9
Areas Logged Prior To 5 Years (No Timber Remaining)	790	3.2
Sum Total	24,064	100.0

a/ Douglas-fir

some other vegetative cover (or bare ground) to grassland.

Approximately 1,000 acres of irrigable farmlands are located in the lower portion of the watershed, immediately north of Petrolia. Brush and hardwoods are found in minor quantities throughout the watershed.

HYDROLOGIC CHARACTERISTICS OF THE WATERSHED

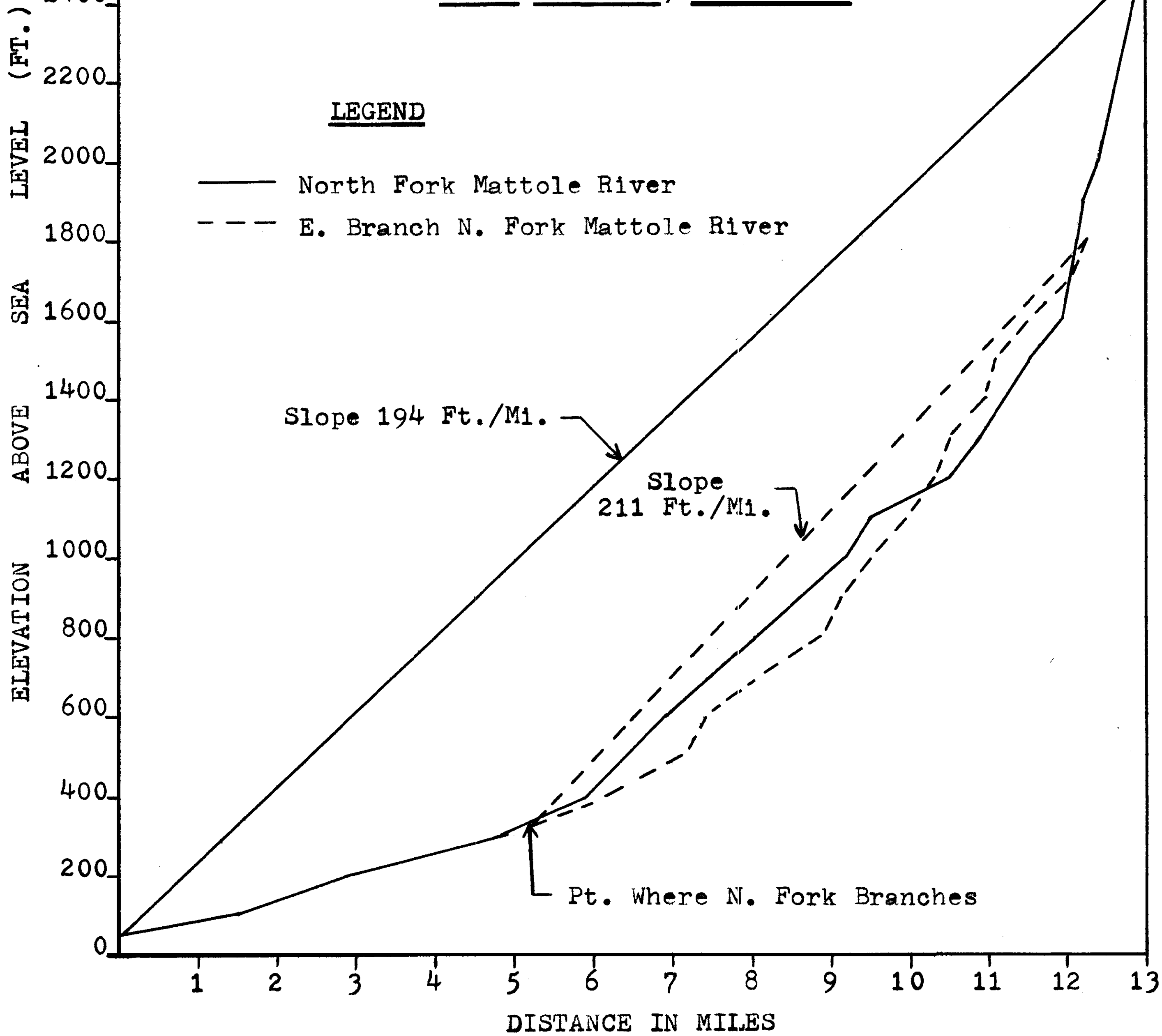
Drainage

The drainage pattern of the tributaries within the study area is basically dendritic, although a characteristic radial drainage pattern exists in the vicinity of Taylor Feak, in the center of the watershed. A dendritic drainage pattern indicates that no variation exists in the resistivity of the rocks to influence the stream pattern. In other words, the pattern suggests homogeneity of geologic formations with a definite lack of structural control, such as faulting, jointing, folding, etc. A radial drainage pattern exists on Taylor Peak because the North Fork and East Branch of the North Fork of the Mattole have downcut in different directions, an& the tributaries have circled to almost join again, thus leaving a higher residual landform (Taylor Peak) between them.

Stream Profile

The profile of the main stream of the North Fork and the East Branch of the North Fork have been plotted in Figure 10. The mainstream of the North Fork extends to a region of higher elevation than does the East Branch, the difference being 700 vertical feet. The fell of each main stream differs to a degree, and the values suggest that the East Branch of

FIGURE 10 - STREAM PROFILE OF THE NORTH FORK OF THE MATTOLE RIVER ABOVE PETROLIA, CALIFORNIA



the North Fork has a slight advantage in sediment transport potential and cutting power over the main stream of the North Fork basin. A larger fall in feet per mile implys that stream velocity will be greater, with a resulting increase in scouring potential.

Drainage And Stream Density

Page A, of Table 5 provides stream and drainage density information for the study area. It should be noted that both expressions of density are largest in the basin of the East Branch of the North Fork, although the comparative differences are not extreme.

Compactness Coefficient

The compactness coefficient is used to express the relationship of a hydrologic basin to that of a circular basin having the same area as the hydrologic basin. A circular-shaped basin is the most hazardous from-a drainage standpoint because it will yield the shortest time of concentration before peak flow occurs in the basin. Compactness coefficient values approaching unity (i.e. 1.00) indicate drainage basins that are circular. The following formula is used to compute the coefficient: Compactness Coefficient = $\frac{\text{Basin Perimeter In Miles}}{2\sqrt{(\pi)(\text{Basin Area In Mi.}^2)}}$.

Compactness coefficient values on page B, Table 5 indicate that the basin of the East Branch of the North Fork possesses the most hazardous natural flood potential; while the North Fork basin (because of its longitudinal shape) is significantly less critical as far as timing of peak flow is concerned.

TABLE 5 - PHYSIOGRAPHIC WATERSHED PARAMETERS OF THE NORTH FORK MATTOLE RIVER WATERSHED

Area	Acres	Sq. Miles
North Fork Basin	13,765	21.5
E. Branch N. Fork Basin	10,299	14.1
N. Fork Mattole River Watershed	24,064	37.6

Stream Lengths	Miles	No.
Total Stream Length, N. Fork Basin	26.5	
Total Stream Length, E. Branch N. Fork Basin	20.2	
Total Stream Length, N. Fork Mattole River W.S.[a]	46.7	
Length Of Main Stream Of The N. Fork Branch	12.9	
Length Of Main Stream Of 'The E. Br. N. Fork	7.0	
Length Of 1st Order Streams In Total Watershed	30.2	26
Length Of 2nd Order Streams In Total Watershed	8.3	5
Length Of 3rd Order Streams In Total Watershed	8.2	1

Stream Density	No. Of Streams/Sq. Mi. Of W.S.
North Fork Basin	.69
E. Branch N. Fork Basin	1.06
N. Fork Mattole River Watershed	.85

Drainage Density	Stream Miles/Sq. Mi. Of W.S.
North Fork Basin	1.23
E. Branch N. Fork Basin	1.25
N. Fork Mattole River 'datershed	1.24

Elevations	Feet
Minimum Elevation, N. Fork Basin	50
Mean Elevation, N. Fork Basin	1,400
Maximum Elevation, N. Fork Basin	3,390
Minimum Elevation, E. Branch N. Fork Basin	330
Mean Elevation, E. Branch N. Fork Basin	1,830
Maximum Elevation, E. Branch N. Fork Basin	3,500
Minimum Elevation, N. Fork Mattole River W.S.	50
Mean Elevation, N. Fork Mattole River W.S.	1,590
Maximum Elevation, N. Fork Mattole River W.S.	3,500

a/ W.S. Refers To Watershed

TABLE 5 - CONTD.

Mean Slope	Percent
North Fork Basin	33.8
E. Branch N. Fork Basin	37.5
North Fork Mattole River W.S.	35.5

MEAN SLOPE OF WATERSHED BY ASPECT

Location	Mean Percent Slope			
	North Aspect	South Aspect	East Aspect	West
North Fork Basin	40.6	29.4	32.2	38.4
E. Branch N. Fork Basin	35.3	38.5	45.0	38.8
N. Fork Mattole River W.S.	36.9	33.0	34.5	38.5

PERCENT OF WATERSHED AREA REPRESENTED BY ASPECT

Location	Percent Of Area			
	North Aspect	South Aspect	East Aspect	West Aspect
North Fork Basin	13.2	29.7	29.7	19.4
E. Branch N. Fork Basin	38.0	29.3	8.1	16.1
N. Fork Mattole River W.S.	23.5	29.0	20.6	18.7

PERCENT OF WATERSHED AREA REPRESENTED BY STREAMS AND RIDGES

Location	Percent Of Area	
	Streams	Ridges
North Fork Basin	3.2	4.8
E. Branch N. Fork Basin	3.5	5.0
N. Fork Mattole River W.S.	3.3	4.9

Perimeter Length	Compactness Coefficient
North Fork Basin - 25.2 miles	1.52
E. Branch N. Fork Basin - 17.3 miles	1.21
N. Fork Mattole River W.S. - 28.3 miles	1.29

TABLE 5 - CONTD.

Basin Relief	Feet
North Fork Basin	3,340
E. Branch N. Fork Basin	3,170
N. Fork Mattole River W.S.	3,450

Ruggedness Number	Value
North Fork Basin	4,110
E. Branch N. Fork Basin	3,940
North Fork Mattole River W.S.	4,280

Fall Of Main Stream	Fall In Feet Per Mile
Main Stream Of the N. Fork Branch	194
Main Stream Of the E. Br. N. Fork	211

Stream Order

Stream Order is a classification reflecting the degree of branching, or bifurcation, within a basin. A stream order of 1 is assigned to small, unbranched tributaries, order 2 is given to those streams which have branches of the first order only, order 3 to streams with branches of second and lower orders, etc. (Linsley, Kohler, and Paulhus, 1949).

A map designating stream orders in the watershed is displayed in Figure 2A. The study area contains 30.2 miles of 1st order streams and 8.2 miles of 3rd order streams. The magnitude of the length of 3rd order streams indicates that the watershed is efficiently drained, in spite of its youthful topography and the presence of a less than well-integrated stream system.

Stream Discharge

A stream-gage site exists within the study area approximately one-half mile west of Petrolia and seven-tenths of a mile upstream from the lowest end of the wrtershed. Discharge records are available for the watershed from June of 1951 to September, 1957. Table 6 lists separate monthly and yearly mean discharge values for the recorded period.

Values in Table 6 were used to construct Table 7, in which the "pooled" mean monthly and annual discharge values are given for the recorded period. The monthly values are expressed in Table 7 as a percentage of the mean total annual runoff for the watershed, which is computed to be 128,543 acre-feet.

TABLE 6 - ADDITIONAL STREAM DISCHARGE INFORMATION a/

4655. North Fork Mattole River at Petrolia, Calif.

Location.--Lat 40°19'35", long 124°17'35", in NE¼ sec.4, T.2 S., R.2 W., on left bank 0.5 mile west of Petrolia and 0.7 mile upstream from mouth.

Drainage area.--37.6 sq ml.

Records available.--June 1951 to September 1957.

Gage.--Water-stage recorder. Altitude of gage is 50 ft (from topographic map). Prior to Oct. 6, 1953, at site 200 ft downstream at same datum.

Average discharge.--6 years (1951-57), 177 cfs (ii 8 ,1 GO acre-ft per year).

Extremes.--1951-57: Maximum discharge, 9,600 cfs Dec. 21, 1955 (gage height, 10.60 ft), from rating curve extended above 1,300 cfs by logarithmic plotting; minimum, 2.0 cfs Sept. 4, 1955.

Remarks.--Small diversions for irrigation above station.

Konthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1951		-	- -	-	-				-	7.63	4.80	3.10	
1952	20.2	313	104	680	428	197	63.8	65.6	24.2	11.7	6.04	6.20	211
1953	0.90	32.4	441	743	180	291	118	173	64.7	24.6	15.4	10.1	176
1954	13.3	397	226	729	439	245	182	41.3	26.5	11.2	10.1	7.92	192
1955	15.1'	147	431	244	01.5	68.2	243	69.5	24.2	15.4	6.5	7.37	113
1956	7.95	111	1,106	054	501	204	30.6	39.1	18.8	10.1	5.39	4.23	242
1957	53.0	29.5	47.0	200	310	380	174	265	41.0	19.0	10.0	13.6	129
1958													
1959													
1960													

Monthly and yearly discharge, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1951	-	-	-	-	-	-	-	-	-	469	2951	189	
1952	1,740	18,600	43,280	41,810	24,640	12,100	3,800	4,040	1,440	719	421	369	153,000
1953	547	1,930	27,130	45,660	9,970	17,890	7,000	10,610	3,850	1,520	948	599	127,700
1954	815	23,600	13,920	44,810	24,400	15,090	10,820	2,540	1,570	687	624	471	139,300
1955	929	8,750	26,520	15,010	4,530	4,190	14,440	4,270	1,440	948	403	438	81,870
1956										618	332	252	176,000
1957											661	811	93,110
1958													
1959													
1960 1957	3,260 409	6,600 1,760	60,020 2,090	52,520 12.300	20,790 17,680	23,350 12,540	10,300 2,300	16,310 2,400	2,490 1,120	1,220			

Yearly discharge, in cubic feet per second

Year	WSP	Water year ending Sept. 30					Calendar year	
		Momentary maximum		Minimum day	Mean	Acre-feet	Mean	Acre-feet
		Discharge	Date					
1950								
1951	1245							
1952	1245	4,950	Dec. 1, 1951	4.5	211	153,000	164	110,900
1953	1205	4,950	Jan. 17, 1953	4.6	176	127,700	108	136,400
1954	1345	5,140	Nov. 23, 1953	4.7	192	139,300	190	137,200
1955	1395	5,760	Dec. 30, 1954	3.5	113	81,870	167	120,800
1956	1445	9,600	Dec. 21, 1955	3.2	242	176,000	150	108,800
1957	1515	2,650	Feb. 23, 1957	3.5	129	93,110	-	
1958								
1959								
1960								

a/ From U.S. Geological Survey, 1964

TABLE 7 - MONTHLY DISTRIBUTION OF RUNOFF ON THE NORTH FORK OF THE MATTOLE RIVER AT PETROLIA, CALIFORNIA FROM 1952-1957[a]

Month	1952	1953	1954	1945	1956	1957	Mean	Percent Of Mean Total R.O.[b]
	MONTHLY RIVER DISCHARGE, IN ACRE-FEET							
Oct.	1,740	547	815	929	459	3,260	1,298	1.0
Nov.	18,600	1,930	23,600	8,750	6,600	1,760	10,200	7.9
Dec.	43,280	27,130	13,920	26,520	68,020	2,890	30,300	23.6
Jan.	41,810	45,660	44,810	15,010	52,520	12,300	35,400	27.6
Feb.	24,640	9,970	24,400	4,530	28,790	17,680	18,340	14.2
Mar.	12,100	17,890	15,090	4,190	12,540	23,350	14,200	11.1
Apr.	3,300	7,000	10,520	14,440	2,300	10,380	8,120	6.4
May	4,040	10,610	2,540	4,270	2,400	16,310	6,690	5.2
June	1,440	3,950	1,570	1,440	1,120	2,490	1,988	1.5
July	719	1,520	687	948	618	1,220	952	.7
Aug.	421	948	624	403	332	661	565	.4
Sept.	369	599	471	438	252	811	490	.4
ANNUAL DISCHARGE:	152,959	127,654	139,347	81,868	175,981	93,112	128,543	100.0

a/ From U.S. Geological Survey (1964)

b/ R.O. Refers to Runoff

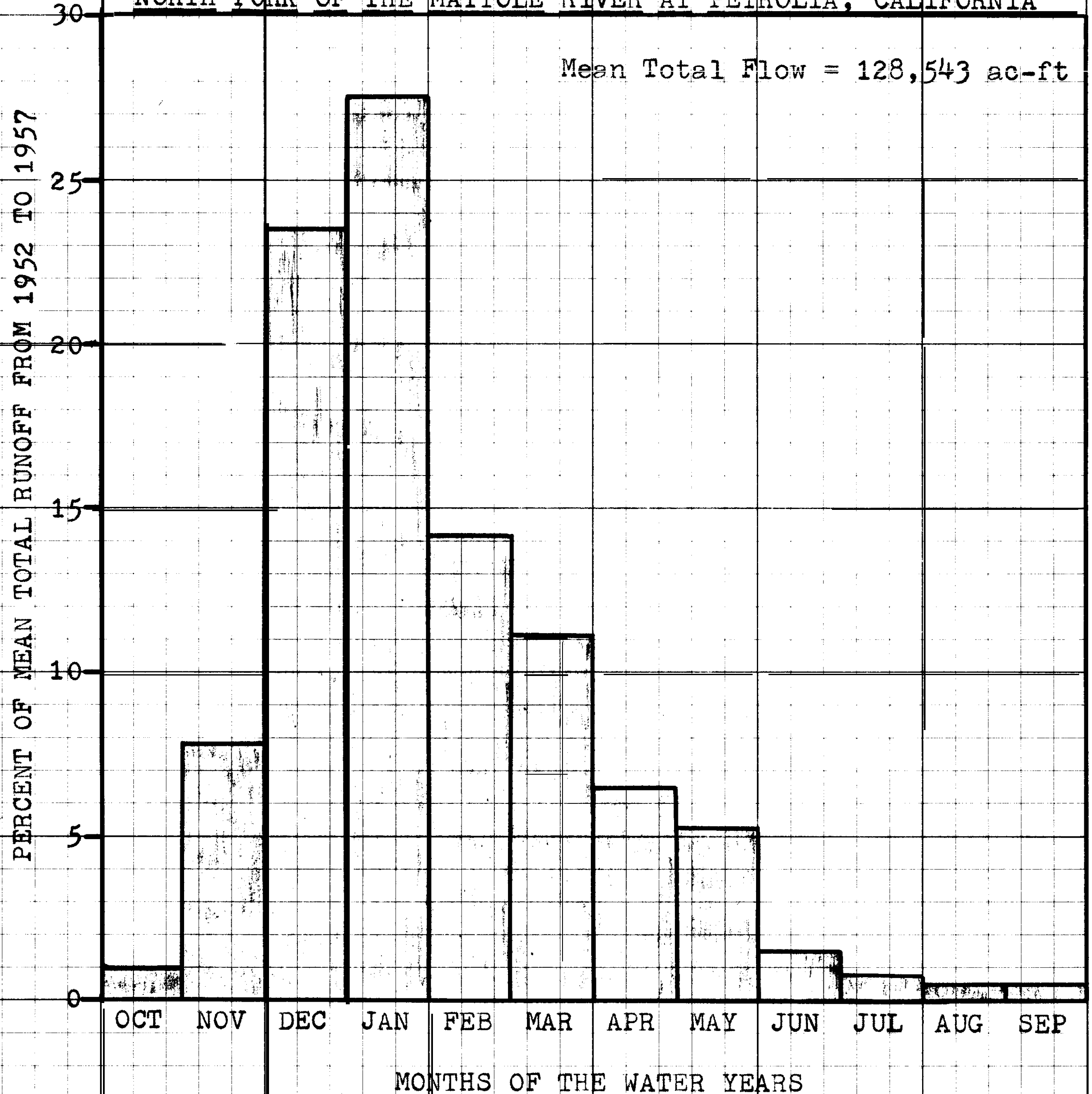
The relationship of mean monthly discharge in Table 7 to the percent of mean total annual runoff is portraved graphically in Figure 11. During the recorded period of discharge measurement, approximately 50 percent of the mean total runoff from the watershed occurred during the months of December and January. Extremely low flows occurred from June through September. A comparison between the Precipitation Graph (Fig. 4) and the Runoff Graph (Fig. 11) can be made even though they represent different periods of time. In general, precipitation and runoff are heaviest from November to January, and lowest from June to September. Heavy precipitation in March and April would probably not be reflected as a monthly increase in runoff rate, because the precipitation would be recharging a soil profile that is beginning to desiccate.

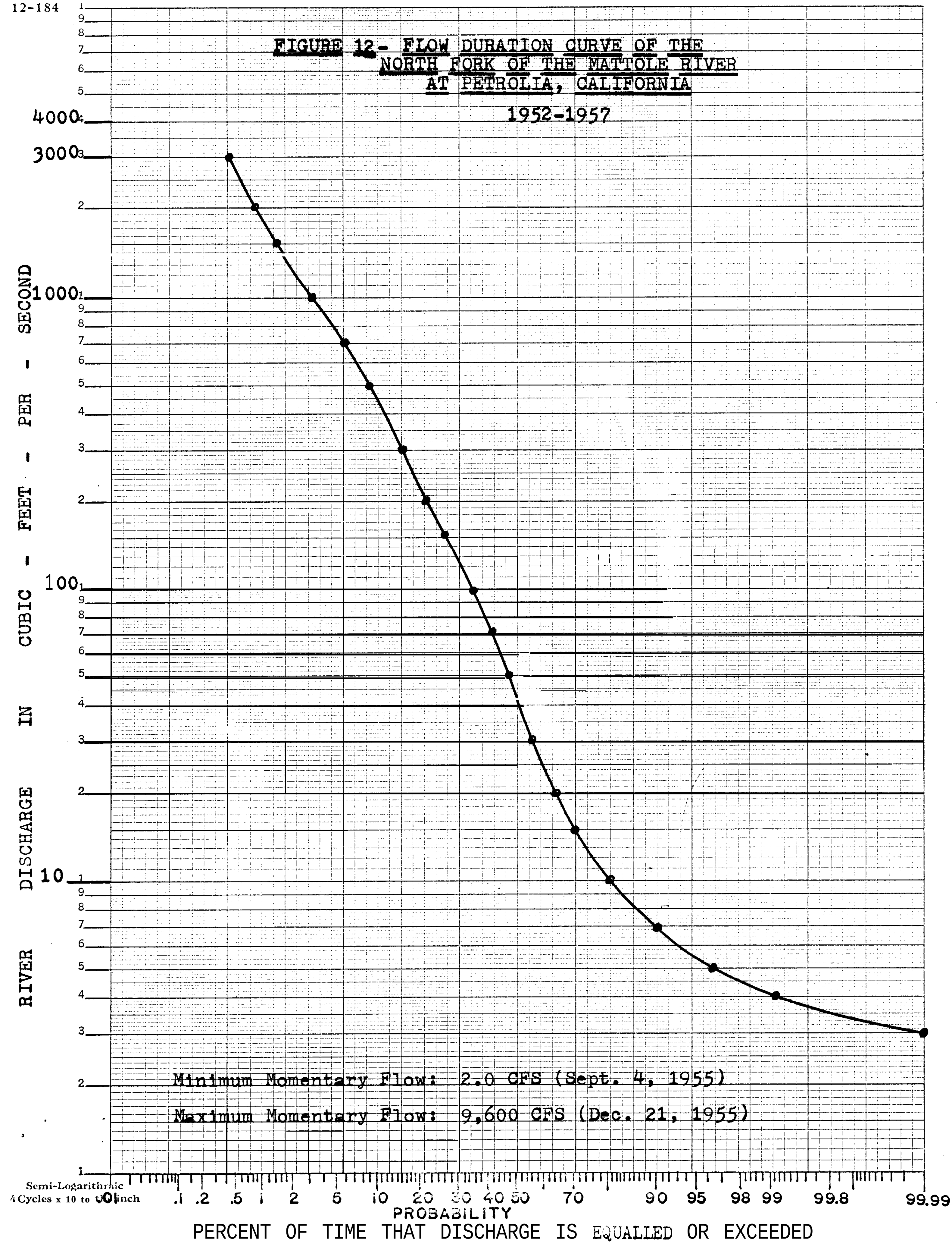
Flow Duration Curve

A flow-duration curve (Figure 12) has been constructed from annual discharge records compiled by the U.S. Geological Survey (U.S.G.S., 1952-1957). The table used (Table B) in compiling the necessary information to plot the curve is included in the appendix.

The curve provides a description of stream behavior. A relatively straight curve, such as that in Figure 12 suggests that the North Fork of the Mattole possesses flashy discharge characteristics, and that extremely high or extremely low flows seldom exist for long periods of time. Interpretation of the graph indicates that a stream discharge of 300 cubic feet per second is equalled or exceeded only 16.3 percent of the time.

FIGURE 11 - MONTHLY DISTRIBUTION OF RUNOFF ON THE NORTH FORK OF THE MATTOLE RIVER AT PETROLIA, CALIFORNIA




12-184
FIGURE 12 - FLOW DURATION CURVE OF THE
NORTH FORK OF THE MATTOLE RIVER
AT PETROLIA, CALIFORNIA
1952-1957
RIVER DISCHARGE IN CUBIC - FEET - PER - SECOND
4000
3000
1000
100
10
Minimum Momentary Flow: 2.0 CFS (Sept. 4, 1955)
Maximum Momentary Flow: 9,600 CFS (Dec. 21, 1955)
Semi-Logarithmic
4 Cycles x 10 to the inch
.01 .1 .2 .5 1 2 5 10 20 30 40 50 70 90 95 98 99 99.8 99.99
PROBABILITY
PERCENT OF TIME THAT DISCHARGE IS EQUALLED OR EXCEEDED

Conversely, the graph indicates that stream discharge is less than 7 cubic feet per second only 9.8 percent of the time. A discharge of 40 cubic feet per second is equalled or exceeded 50 percent of the time.

Water Use

Aside from domestic use of water obtained from wells in the Petrolia area, small diversions of water are made from the North Fork of the Mattole above Petrolia for irrigation purposes. Approximately 200 acres of land within the watershed receive full irrigation. Another 180 acres in the lower portion of the watershed are used for dry-farming. Figure 9A gives the location of these areas.

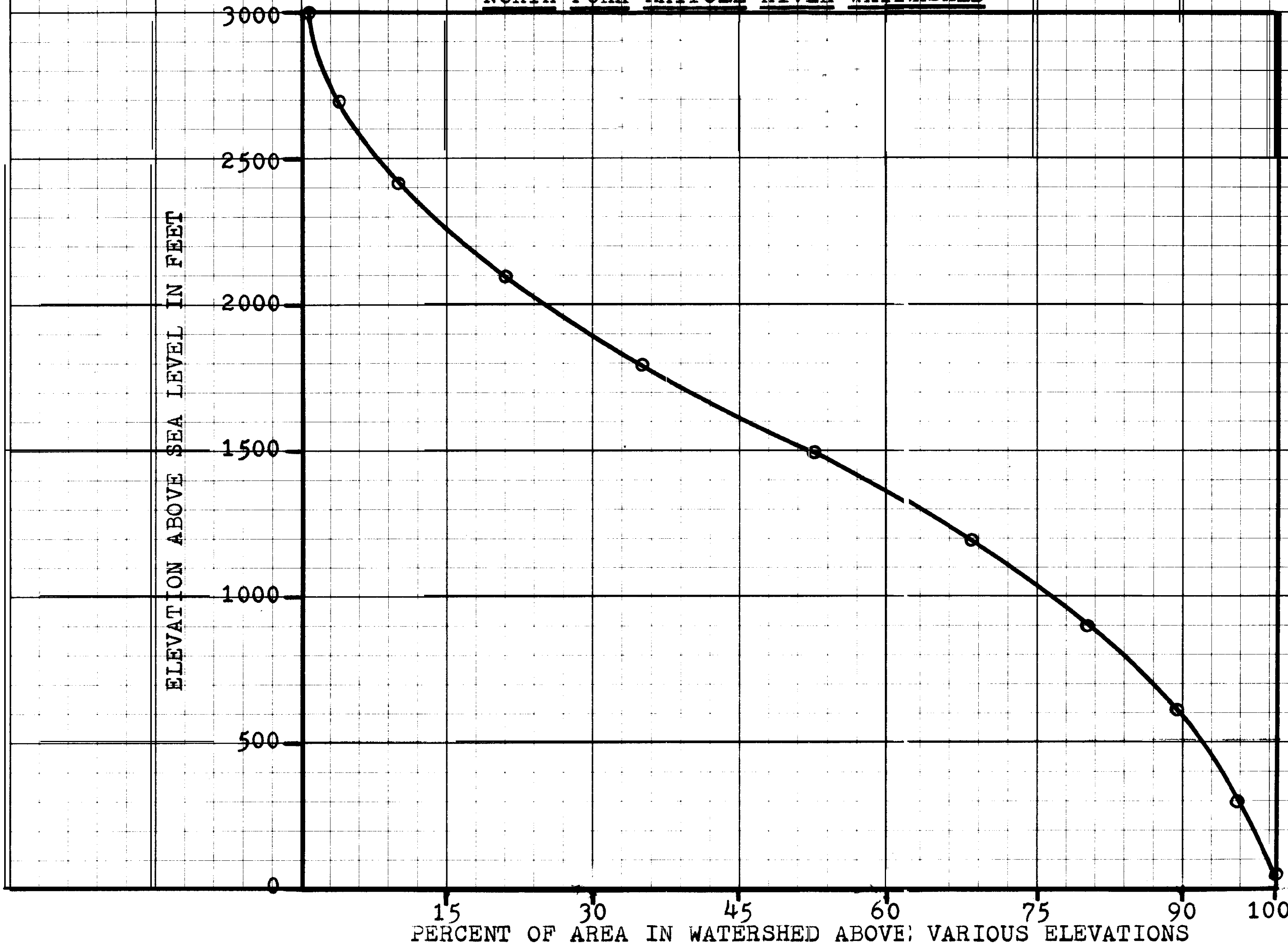
HYYSOMETRIC CURVE

A hypsometric (area-elevation) curve has been constructed for the watershed and is displayed in Figure 13. Table C, in the appendix, was used in construction of the curve. This curve provides information on the percent of area in the watershed that is located above (or below) a given elevation. The curve steepens near the top and bottom, and graphical interpretation indicates that only 11.1 percent of the area in the watershed is lower than 600 feet in elevation, and that only 9.5 percent of the watershed area is higher than 2,400 feet.

OTHER PHYSIOGRAPWIC PARAMETERS

A number of parameters have been presented in Table 5, some of which are self-explanatory, and others which need to be discussed.

FIGURE 13- HYPSOMETRIC (AREA-ELEVATION) CURVE OF THE NORTH FORK MATTOLE RIVER WATERSHED



Elevation And Slope

Mean elevation and slope values were obtained by systematically sampling 100 points within the watershed, using a grid. Slope was obtained by measuring 1,000 feet from each sample point in the direction of slope, and by counting the number of contour lines crossed, percent slope was obtained. Slope direction indicates the particular aspect at each sample point-, and mean area-aspect relations of the watershed were computed from these tabulations.

The minimum elevation in the watershed is 50 feet where the North Fork empties into the main Mattole River. The maximum elevation in the watershed is 3,500 feet, located on a peak in the extreme eastern extension of the watershed (Fig. 2). Variations between subdivided basins within the watershed in terms of minimum, mean, and maximum elevations are not extreme.

Variation in mean percent slope between the basins within the study area is not extreme, but the East Branch North Fork basin is slightly steeper. Page B, Table 5 also indicates that steepness of slope depends upon aspect in each basin. In sll basins, nearly 50 percent of the watershed area is represented by south and west aspects. This is important from a hydrologic and erosion standpoint, because it means that nearly 50 percent of the surface area of the watershed is facing in line with the general direction of storm movement in the area. Thus these slopes bear the brunt of the storm forces.

A comparison of slope values on the Soil-Vegetation Map (Fig. 8) with slope values obtained by systematic sampling indicates an underestimation of mean percent slope by the sampling method. Aerial photography (with ground checks) is used to estimate slope percent on the Soil-Vegetation Map, and uncorrected error due to vertical exaggeration of the photos may account for a portion of the discrepancy. However, it is the author's opinion that mean percent slope in each basin exceeds the values in Table 5. A sample size of greater than 100 points might prove this hypothesis.

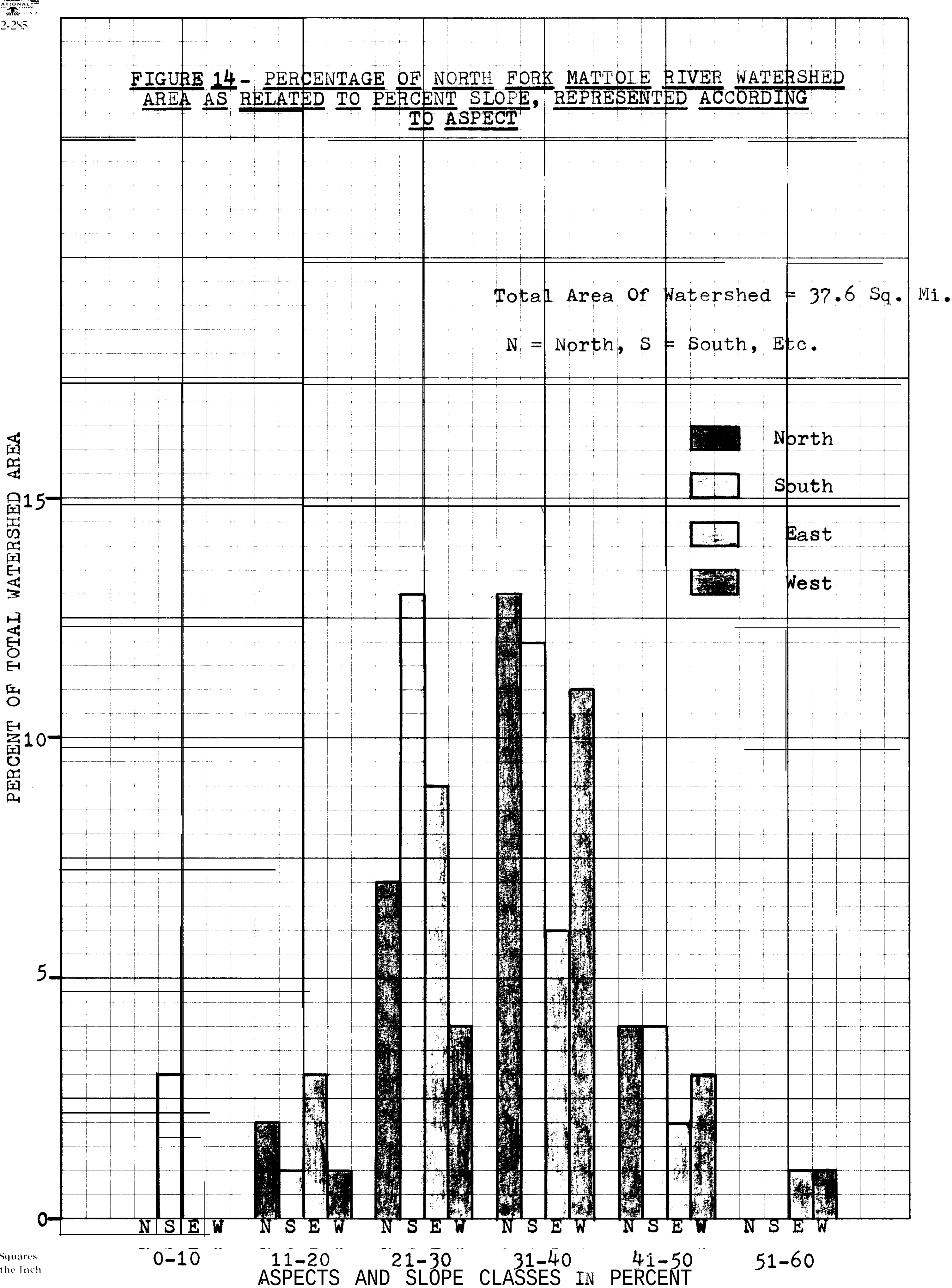
Additional information on slope for the study area as a whole is provided In Figure 14. This graph shows that 75 percent of the area within the watershed occurs on slopes from 21-40 percent, with 15 percent of the total watershed area in the 41-60 percent slope classes, and 10 percent of the total. area in the 0-20 percent slope classes.

Basin Relief

This value equals the vertical distance between the mouth of the basin and the highest point in the basin. Values recorded on page C, Table 5 indicate little variation between basins In the study area, thus indicating similar relief throughout the watershed.

Ruggedness Number

This unitless value equals the product of drainage density and basin relief. Similarity In the values for the individual basins indicates general equality of terrain ruggedness throughout the study area.



5 Squares to the Inch

PART II

SOCIO-ECONOMIC ANALYSIS

Introduction

In discussing the history and the general socio-economic considerations of the watershed, the analysis at times will include important information in reference to the entire Mattole River drainage. The occurrence of certain historical and land-use activities outside of the North Fork watershed may have directly or indirectly affected the study area itself, and for this reason, the report will not be limited to an analysis of the relatively small area represented by the watershed proper.

Early History Of Land Use

Reports indicate that Indians were the first reported inhabitants of the Mattole Valley in the early 1800's and probably earlier. It would be conjecture to evaluate the Impact of the nomadic Indians on the resources of the area, but with no doubt the intensity of land use in the area today far exceeds the degree of land use or misuse that can be attributed to the Indians.

The Mattole Township was established in 1859, although settlers were living in the Mattole Valley as early as 1854 (Community of Petrolia, 1962). An event of great importance in the history of Petrolia is the arrival of settlers to the area from the farming region of Marysville, California, during the period from 1868 to 1876. With them the settlers brought their agrarian ideas, and as a result agricultural development for commercial purposes and domestic uses ensued. Fruit crops, and other crops such as wheat, hay, corn, potatoes, etc. were introduced into the area. Livestock (cattle and sheep) began to appear in the Mattole basin.

Not only did the migration of the Marysville settlers influence the population growth and development of Petrolia, as well as the remaining Mattole basin; but the discovery and subsequent drilling of the first productive oil well in California occurred within the watershed of the North Fork of the Mattole River in 1861, and this has had a lasting impact on the area to this date. The 500 foot well was drilled by the Union Mattole Oil Company on the Edmonston Ranch, T. 1S., R. 1W., Section 30 (Lytle, 1966). The town of petrolia has derived its name from the presence of oil in the region.

After the first oil strike, the area was subjected to an exciting "oil boom" that lasted until 1866, and which increased the population of Petrolia from approximately 200 inhabitants to "many hundreds' of inhabitants, temporary and permanent (Community of Petrolia, 1962). However, the oil boom soon lost its momentum, undoubtedly because of the following factors that have been offered by Lytel. 1) The relative inaccessibility of the Mattole region resulted in an expensive and at times impossible transportation of oil-extraction equipment to the area,at a cost that could not compete with extraction and transportation of oil to the West from oil fields in Pennsylvania. 2) The quantity of the oil resource that was extracted In relation to the extraction cost resulted in the total enterprise acquiring a reputation of economic infeasibility (Lytel, 1966).

In 1865, the Union Mattole Oil Company contracted shipments of oil to a San Francisco refinery, via oceanliner, but the enterprise was short-lived. Additional and short-lived oil booms occurred in the region in 1889, 1900, 1907, 1921, and sporadically from 1953 to the present. Numerous drilling sites dot the Mattole area, and information on the most recently-productive well is given in Table 8.

During 'the first 35 years of the existence of Petrolia, the livelihood of the area was supported principally by crop raising with stock raising as 2nd in importance, and income from timber harvesting as 3rd in importance. The raising of wheat as an important crop continued until fruit and livestock raising began to pass grain production about 1900. In 1921, production of grain for commercial flour ended in the Petrolia area (Community of Petrolia, 1962).

Cattle raising has been an important stock in the area since pioneer times, and remains so today. The raising of sheep in the area Increased in popularity as predators became more scarce following the initial oil boom in the 1860's.

PRESENT LAND USE

Today cattle and sheep raising constitute the principle livelihood or occupation of the area, with logging assuming responsibility for the prime source of income to the region (Schwarzkopf, 1949, and Community of Petrolia, 1962). Logging is carried on mostly by private contract, but also by many

TABLE 8 - INFORMATION ON THE PETROLIA OIL FIELD[a]

CALIFORNIA DIVISION OF OIL AND GAS
FIELD DATA SHEET

PETROLIA AREA
Humboldt County

LOCATION 30 miles south of Eureka.

DISCOVERY DATA West Coast Oil Corp. well No. "West Coast" 1, Sec. 21, T. 1 S., R. 2 W., H.B.& M. Completed October 7, 1953. I.P. 30 b/d 46-degree gravity oil from the interval 1,580-1,620.

STRUCTURE Stratigraphic trap. Oil accumulation in updip lenses.

ELEVATION 800-1,400 BASE OF FRESH WATERS 40 SPACING ACT APPLIES Yes

PRODUCING ZONES

Name of Zone or E. Log Marker	Average Depth (feet)	Average Thickness (feet)	Geologic Age	Geologic Formation	Gravity or B.t.u.	Salinity of Zone Water Gr./Gal.
(unnamed)	1,570	90	L. Cretaceous	L. Capetown	46	-

DEEPEST WELL DATA Richfield Oil Corp. well No. Walker" 1, Sec. 17, T. 1 S., R. 2 W. T.D. 3,499 in Lower Cretaceous.

PRODUCTION DATA-JANUARY 1, 1960

Cumulative Oil (bbl.)	350	Total Wells Drilled	17
Cumulative Gas (Mcf.)	0	Total **Wells Completed**	2
1919 Average Oil (b/d)	0	Producing Wells (1959 Aver.)	0
1959 Average Gas (Mcf/d)	**0**	**Maximum** Proved **Acreage**	**10**
Peak Production (1954) (bbl.)	140		

USUAL CASING PROGRAM
13-3/8" cem. 300
5-1/2" combination string landed through oil zone and cem. through ports above the zone with perforations opposite oil sand

BOP EQUIPMENT Required

MISCELLANEOUS -

REFERENCES -

a/ From Calif. Div. Of Mines And Geology, Bul. No. 181. 1962.

individual landowners themselves while engaging in ranching activities. The intensity of logging in the study area within the last five years has already been mentioned, and is supported by the above as well as by information in Figure 9, Part I. Oil speculation in the area is nearly at a standstill today. However, very recent reports indicate that applications have been submitted to the Federal Government concerning leases for exploratory oil drilling purposes in the Mattole basin, and leases have subsequently been granted to private concerns for certain parcels (Humboldt Standard, 1967).

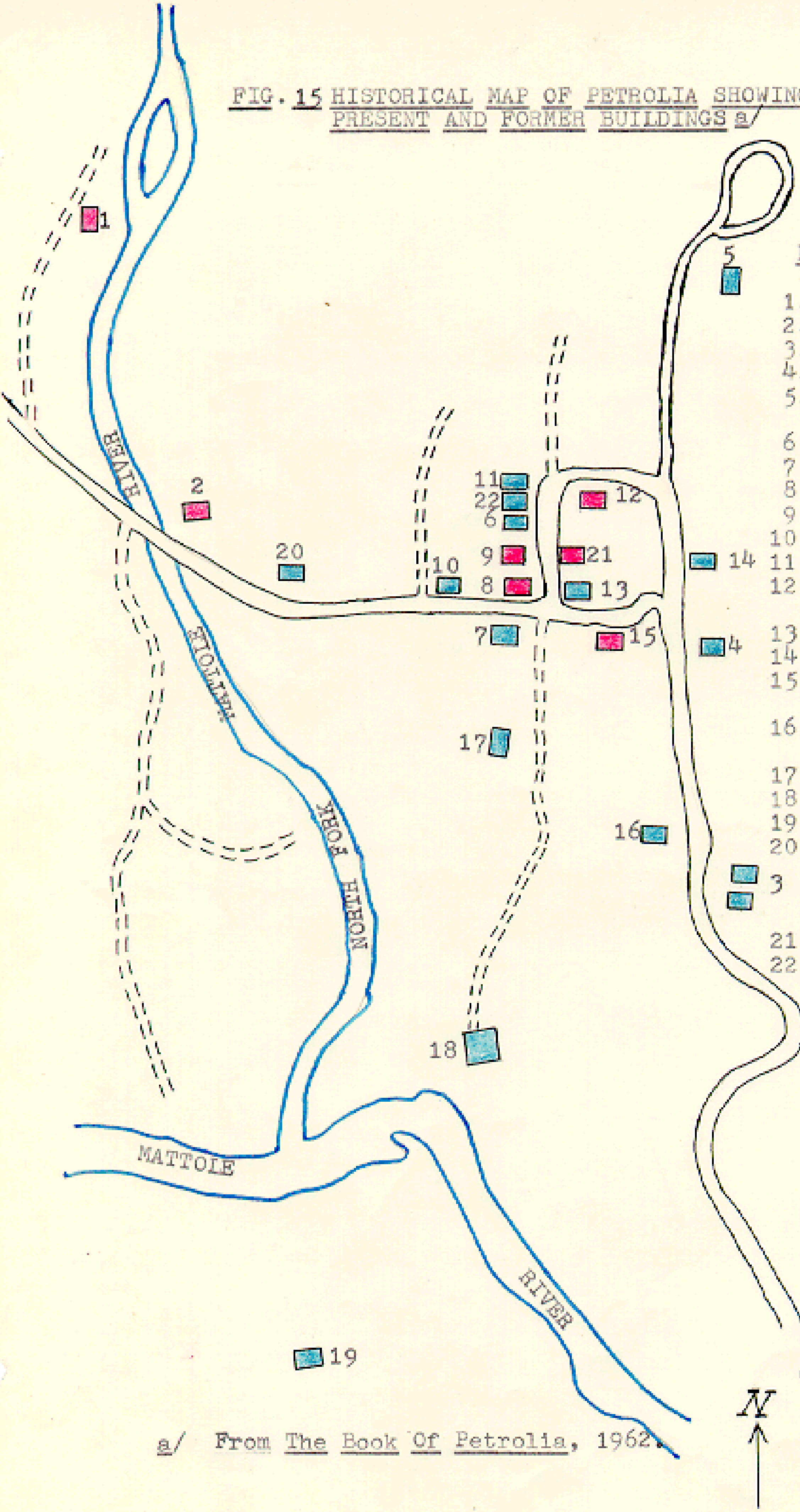
PETROLIA TODAY

At present no more than a few dozen residents occupy the town proper. The 1950 Federal census indicated that the population within the Mattole Union School District (i.e. Mattole basin) did not exceed 200 (Community of Petrolia, 1962). A historical map of Petrolia is displayed in Figure 15.

Were it not for the several following factors, Petrolia might never have grown into any semblance of a permanent town. 1) The hope of striking productive oil deposits never died, and hope has not been abandoned to this day. 2) New spurts in agricultural activity occurred from time to time during and after the oil boom periods. 3) Recently, the desirability of the Mattole drainage and the surrounding area for recreational purposes has been realized.

However, five factors have significantly contributed to the decline in population of Petrolia. 1) The collapse of the oil booms. 2) The decline in the profitability of

FIG. 15 HISTORICAL MAP OF PETROLIA SHOWING PRESENT AND FORMER BUILDINGS a/



Building Descriptions

1. First School House
2. Second School House
3. Present Schools
4. Catholic Church
5. Seventh Day Adventist Church
6. Petrolia Store
7. O'Leary Blacksmith
8. Mackey Store
9. Old Saloon
10. Mechanical Shop
11. Fire House
12. Knights' Of Pythias Hall
13. Plaque
14. Post Office
15. Old Post Office And Telephone Office
16. Present Telephone Office
17. Old Hotel
18. Cemetery
19. Abandoned Oil Well
20. Jack Wright Home
21. First Hotel
22. Service Station

LEGEND

Paved Road

Gravel Road

Present Buildings

Former Buildings

Scale: 8 In. = 1 Mile

a/ From The Book Of Petrolia, 1962.

crop raising, especially commercial fruit production. 3) The automobile has allowed residents to trade in distant communities, thus eliminating the need for many shops and services in the Petrolia area. 4) The consolidation of properties into larger holdings. 5) Several calamities have affected Petrolia: a large fire In the town in 1903, several earthquakes of great severity, the worst of which was in 1906, and the 1955 flood which destroyed some of the older buildings, as well as livestock and low-lying cropland (Community of Petrolia, 1962).

WATER REQUIREMENTS

Present and future water requirements of the complete Mattole basin, which includes the communities of Petrolia, Honeydew, and Thorn, are listed in Table 9. Use requirements indicate that the total annual water supply far exceeds the present and anticipated demand of the commodity for all forms of use. However, summer flows are not expected to be sufficient to meet future requirements until storage provisions are made to allow full development of water resources along the Mattole (U.S. Dept. of the Interior, 1960).

Within the Pacific Basins Group of the California Water Plan, a dam capable of yielding 33,000 acre-feet annually may eventually be built at Thorn near the headwaters of the main Mattole River. The proposed yield of the dam greatly exceeds the requirements of the area and the excess waters could be used for fish and recreation enhancement. Costs of such a project are estimated in excess of $7,000,000 (Winzler and

TABLE 9 - ANNUAL WATER REQUIREMENTS OF THE MATTOLE BASIN FOR THE PRESENT AND THE FUTURE[a]

TYPES OF USES						
IRRIGATION		URBAN		INDUSTRIAL OR RECREATIONAL[b]	TOTAL ANNUAL USE	
Area (Ac.)	Annual Use (Ac.-Ft.)	Area (Ac.)	An. Use (Ac.-Ft.)	Annual Use (Ac.-Ft.)	(Ac.)	(Ac.-Ft.)
Present Use[c]						
469	1,500	117	70	0	586	1,570
Projected Use For The Year 2020						
2,429	7,290	5,000	6,720	150	7,429	14,160

a/ From Winzler And Kelly, 1962.

b/ Recreational Use Does Not Include Required Minimum Flow Of Water To Maintain Fisheries Resource, Or Use Of Water For Fishing.

c/ Average Annual Flow Of The Mattole River Is 703,000 Acre-Feet (U.S. Dept. of the Interior, 1960).

TABLE 10 a/

Summary of Flood and Storm Damages (December 1964)
Coastal Streams
($1,000)

Item	Bear River	Mattole River	Usal Creek	Tenmile Creek	Noyo River	Big River	Navarro River	Garcia River	DeHaven Creek	Wages Creek	Alder Creek	Total
1. Residential		4					25					29
2. Commercial				32	98		103			1		234
3. Public Facilities				9			14					23
4. Public Utilities		2		23	8		35	12	2	6	-4	92
5. Agriculture	99	256		132			237	148	12	38	7	929
6. Bank Erosion	10	38		12	4		18	6	1	3	2	94
7. Roads and Bridges	191	337										528
8. Industrial		327	13.	24		35		77		3	10	489
9. Livestock	2	4								1		7
10. PL/99												
11. PL/875	163	134		9	9		16	10				341
12. Emergency Aid												
13. Railroad					82							82
Total:	465	1,102	13	241	201	35	448	253	15	52	23	2,848
Storm:				521			174					
Total, Flood and Storm:	465	1,102	13	762	201	35	622	253	15	52	23	3.543
Rounded Total:	,500	1,100		800	200		600	300		100		3,600

a/ From U.S. Army Corps of Engineers, 1965.

Kelly, 1962).

Because the Mattole River has not been victimized by either industrial or human pollution, the stream has been chosen by the U.S. Geological Survey for a special study. The study is related to an evaluation of the impact of dissolved minerals introduced by stream sediment on water quality. The relative purity of the stream from a chemical pollution standpoint allows thts relationship to be more easily and accurately determined (Kelsey,1967).

RECREATION

Fisheries Resource

King and Silver Salmon and Steelhead Trout in the Mattole River support the principal recreation activity In the area. King Salmon annual. runs presently number about 5,000 and Silver Salmon about 2,000. Annual runs of about 12,000 Steelhead are also estimated (U.S. Dept. of the Interior, 1960). The Mattole River is accessible to King Salmon for about 45 miles. King Salmon spawn mostly in the main river; however, certain tributaries, one of which is the North Fork, provide suitable spawning areas.

Most of the catch of King Salmon is made in November. During the 1957-1958 seasons an average 4,300 angler-days were spent on the river, resulting in a oatch of 400 salmon, 700 steelhead, and about 8,000 juvenile steelhead trout (Calif. State Dept. of Water Resources, 1965).

Game Resouroa

Deer Hunting is successful in the general area as Columbian Black-Tailed Deer (Odocoileus hemionus columbianus) has its natural range in the North-Coast area, including the Mattole drainage. However, general private ownership of the Mattole basin has presented hunting problems when lands have been posted and cooperative relations have not been achieved between hunters and landowners.

Other important game species such as the Northwestern Black Bear (Euarctos americanus altifrontalis), California Quail (Laphortyx californicus), and Mourning Dove (Zenaidura macroura) inhabit the Mattole area and offer limited hunting opportunity.

Improved Recreation Facilities

Improved recreation facilities are limited within the Mattole basin. A few private concerns provide lodging which is u-gently needed for sportsmen in season. A few private, riverside campgrounds with limited facilities exist along the main branch of the Mattole.

Wilderness Area

Of definite socio-economic significance to the Mattole basin is the King Range National Conservation Area. This 31,500 acre wilderness area is administered by the Bureau of Land Management and is situated between the Mattole River and the Pacific Ocean. The area provides access roads, campgrounds with limited facilities, trails, and breathtaking scenery from King's Peak, elevation 4,087 feet. Major access to the area is provided via Petrolia and Honeydew, and seasonal recreation activity In the King's Area Indirectly stimulates the economy of these communities to an important degree,

PART III

GENERAL PROBLEMS

Introduction

In general, the discussion of general problems within the watershed will be an expansion of facts and ideas that have been previously mentioned. However, a few important factors that have not previously been mentioned will also be included in this part of the analysis.

Accessibility

Even though access to the watershed is provided from various directions in Humboldt County, the roads are somewhat hazardous and unreliable at times. Tewporary road closures are likely to occur at any time during the winter, as slides and washouts are not uncommon. Additional road paving within the future will alleviate this problem.

Access into the watershed itself is limited during the winter by the preponderance of dirt roads. The upper portions of the watershed are generally accessible only to four-wheel-drive vehicles during the winter.

Fire'

The study area proper has received a very minor impact by wildfire within the last five years. During this period, only three fires have been reported and controlled within the watershed, and all of these have been small spot fires related to logging activities. The three fires occurred during the critical fire summer of 1964 (Calif. Division of Forestry, 1964).

During this same year, a wildfire that started near Petrolia on September 23rd was carried southeastward by the prevailing winds, ultimately consuming 20,000 acres of rugged watershed land located mainly to the west of' the Mattole River. The fire was halted near the northern boundary of the King Range. The northern advancement of the fire was stopped on Apple Tree Ridge, which forms a portion of the southern border of the North Fork Mattole River Watershed (Fig. 2, Part I). Destruction of an undetermined amount of farm acreage and some structural losses, as well as watershed losses have been attributed to this fire.

FLOODS

Flood Of 1955

Major damage occurred in the lowlands of the study area as well as along the main branch of the Mattole during the 1955 flodd (Community of Petrolia, 1952). Specific information is lacking, but it is certain that a number of structures and valuable farmland were damaged. Momentary maximum flow on the North Fork of the Mattole River at Petrolia was recorded as 9,600 cubic feet per second on December 21, 1955.

Flood Of 1964

Early reports indicated that the Mattole Valley remained relatively unscathed by the unprecedented flood of December 1964 (Humboldt Times, 1964). These reports were correct from the standpoint of residential losses, but a later evaluation of damages by the U.S. Army Corps of Engineers revealed that nearly $1,000,000 in losses (Table 10) had been incurred due to a summation of agricultural, transportation (roads and bridges), and industrial damages within the Mattole Valley (U.S. Army Corps of Engineers, 1964). During the flood, the county roads to Petrolia were closed and the town was without electricity. Bridges crossing the Mattole were not washed out, but partial bridge damage was commonplace.

The momentary maximum flow on the North Fork was not measured during the 1964 flood because of the termination of gaging measurements on the stream in 1957. However, Figure 16 provides the high water mark levels of the flood, and if stage-discharge relationships are known, the maximum flow can be reliably estimated. As Figure 16 indicates, the town of Petrolia was not flooded during the 1964 flood.

During the 72-hour storm period from December 20th to December 23rd that preceded the flood,-an average of 17 inches of precipitation fell within the North Fork Mattole River Watershed (U.S. Army Corps of Engineers, 1964). As a result, minor landslides, road washouts, and stream blockages were commonplace throughout the watershed.

Erosion And Land Misuse

The previously-mentioned Mattole Fault Shear Zone presents a natural erosion problem. Figure 6 (Part I) indicates that the shear zone prevails along the apex of an anticline, where beds dip downward on an average of 45 degrees from either side of the shear zone. Slippage of the beds near the apex of the anticline have created the shear zone. Highly unstable soil conditions have been created in this area, especially where

Figure 16

DECEMBER 1964
FLOOD PLAIN AND HIGH WATER MARKS

could not be included
due to its size.

PART IV

POTENTIALS OF THE AREA

Introduction

The biotic and physical resources within the study area that contribute to the economy or to the potential development and use of the components within the watershed are discussed in decreasing order of present importance, economic or otherwise.

Timber

Economically, timber harvesting is the most important activity within the study area. This will probably change in the near future because of the following factors. 1) A timber site class of III characterizes the average timber growth potential of the watershed (Fig. 8, Part I); meaning that dominant and codominant timber (primarily Douglas-fir) will achieve a height of 140 feet in 100 years, whereas 200 feet per year is optimum (Site I) growth. 2) Assuming the present rate of timber extraction continues, the entire forested portion-of the watershed will be logged of 70 percent of the merchantable timber volume In another 5 to 7 years. 3) Conversion of marginal timberland areas to grassland by means of logging and controlled burning will continue to preclude logging on certain land parcels.

The "average" timber site quality of the watershed is primarily a reflection of edaphic conditions. The Hugo (812) soil series that covers the majority of the timberland site acclaims only moderate suitability for timber production (Black, 1964).

Forage

The Mattole area has been acclaimed as prime range country because of the abundant rainfall, temperate climate, and fertile soil (Schwarzkopf, 1949). Abundant rainfall and temperate climate are definite attributes of the area. The information in Table 2 (Part I), supports the acclaimed fertility of the soil. The three grassland soils of the lower portion of the watershed, i.e. Kneeland (852), and Mattole (952) are classified as being "high" to "very high" in suitability for range use, Only the higher elevation Wilder (840) soil is given a low rating for suitability of forage potential. Conversion of certain timber soils to grassland, such as Usal (818), will provide additional rangeland of high quality.

Crops

Alluvial deposition has created a limited area near Petrolia for raising such crops as corn, potatoes, wheat, hay, etc. Areas directly above Petrolia are suitable for growth of orchard crops, especially apples, but the potentiality is limited by the fixed factor of acreage, as the information in Table 4 (Part I) suggests. Potential production of crops In the area for anything other than localized commercial or domestic purposes is negligible.

Recreation

Recreation offers the greatest potentialfor future use of the lower portion of the watershed, especially on those lands located near the river. A current seasonal recreation use of the area could develop into an annual endeavor if population expansion so demands.

Increased intensity of hunting and fishing in early Pall and Winter, combined with Increased Spring and Summer use In the form of camping, hiking, sightseeing, etc., could become a more tangible reality In the area. This would require a narrower disparity between logging with only short-term economic gain in mind and logging with definite consideration of the public Interest In mind.

The Introduction or buildup of certain game species is potentially feasible In the watershed. Species such as the Band-Tailed Pigeon (Columba fasciata), Mountain Quail (Oreortyx picta), and Oregon Sooty Grouse(Dendragapus fuliginosus), that find their natural range in this area, might increase in population due to habitat improvement by logging and land conversion.

Oil

The likelihood of future productive oil achievements In this region is questionable, as it always has been, and as a result the potential for development rates low on the priority list. The following citation from the 37th report of the State Minerologist appropriately expresses the possibility of future commercial production of 011 In the Mattole region:

> The widespread dips and faults In the Mattole and Bear River districts are not regarded as favorable for the accumulation of large bodies of 011. The results- that have been obtained by some of the wells In this district indicate that oil and gas are locally trapped and prevented from escape along the vertical or nearly vertical strata. Exposed structural conditions near some of the most encouraging wells,

especially that of the North Counties Oil Co., strongly suggest that at least some of these accumulations of oil and gas are in localities that have been broken by a system of faults. It seems probable that these faults have combined to produce suitable conditions for the accumulation and retention of oil and gas locally, but it is uncertain that such local deposits, when tapped by the drill, will yield oil and gas in commercial quantities. In view of the encouraging results obtained by some wells, the district mav produce small quantities of oil and gas for a considerable period. However, owing to the structural conditions, even if production is obtained in one well,each subsequent well drilled must be considered a wildcat well with much chance of failure.

(Averill, 1928).

PART V

RESOURCE SUMMARY

Introduction

This resource summary specifically lists only those resources that are found within the North Fork Mattole River Watershed.

Land Resource

The North Fork Mattole River Watershed contains 24,064 acres of land, of which 13,765 acres are In the North Fork basin and 10,299 acres are in the East Branch of the North Fork basin.

Timber Resource

Commercial timber (primarily Douglas-fir) is found on 6,630 acres within the watershed. Of this, only 2,850 acres supports old-growth timber, and the remaining 3,780 acres supports 2nd-growth timber. In addition, 1,300 acres of the watershed supports a hardwood vegetative cover, consisting primarily of Tanoak and Madrone in that order of density.

Range Resource

The study area includes 8,220 acres of grassland, of which 6,930 acres offers prime grazing land for livestock such as Romney and Suffolk Sheep, and cattle. The other 1,290 acres of grassland is better suited for forest management uses.

Cropland Resource

Fertile, irrigable croplands comprise 1,004 acres within the watershed, of which 540 acres are smooth-lying. At present only 200 acres within the watershed are receiving full. irrigation, and another 180 acres are being used for dry-farming. The fertility of the cropland as well as the general climate of the area is compatable with production of such crops as hay, corn, wheat, potatoes, beans, and other garden crops. Fruit crops, such as apples, pears, plums, and berries are found within the area.

RECREATION RESOURCES

Fisheries Resource

King and Silver Salmon, as well as Steelhead Trout are found within the watershed in undetermined but significant numbers as a result of annual migration runs that occur along the main branch of the Mattole River. There are indications that the fisheries resource has recently depreciated in value due to an Increase in stream turbidity and stream obstructions, caused by specific land misuse as well as by natural geologic problems within the area.

Game Resource

Black-tailed deer abound in the watershed. Other game species, such as Black Bear, California Quail, Mourning Dove, Black-tailed Jackrabbit (*Lepus californicus*), and Douglas Squirrel (*Tamiasciurus douglasii*), find their natural range within the area, and offer limited hunting.

Water Resource

The North Fork Mattole River drainage network Includes 46.7 miles of perennial streams. Mean annual runoff from the watershed is 128,543 acre-feet, the yield from a mean annual basin-wide precipitation of 73.0 inches less the water losses through evapo-transpiration and soil-water retention.

PART VI

CONCLUSIONS

General

The land area discussed In this report has been subjected to an Intensive impact by man, primarily during the oil boom of the 1860's and during the last five years as a result of logging and range activities. During the last 25 yesrs, as well as today, recreation activity remains as a definite asset to the area. However, the future of the recreation resource, which Is primarily based upon the fisheries and game resources of the area, will depend to a large degree on the future timber and range activities of the area, and possibly upon oil extraction activity.

Erosion And Land Misuse

Ownership within the watershed Is broken into numerous parcels. Thus, each land owner possesses varying land-use objectives and practices. Logging and land conversion activities In the watershed are regulated by the California State Forest Yractfce Acts. However, the ambiguity of phraseology that is inherent In the composition of the Forest Practice Acts,places undeniable llmltatlons on the degree of enforceability of the same, by the California Division of Forestry. The effectiveness of constructive criticism regarding private logging practices by sincere conservationists and recreatlonlsts Is often nullified by the mere existence of the Forest Practice Acts, which are dogmatically lauded by private owners with seldom mention or apparent realization of their limitations. It is easier for owners of small parcels to "get away" with poor logging practices, overgrazing, etc. Land misuse on large holdings is more likely to be detected and corrective measures demanded, either by public agencies or an irate public.

In spite of the above limitations, corrective or preventative measures can be applied in the watershed. It should be emphasized though, that certain natural characteristics of the area, such as those geologic factors previously discussed, intense rainfall, and steep slopes contribute significantly to the problems of erosion and stream sedimentation.

Landowners should strive to avoid site disturbance on the Atwell soil series in the watershed. Areas colored dark red on the Soil Vegetation map should be avoided, especially in reference to future road location.

When possible, sheep should be replaced with cattle In the watershed, especially on the steeper grassland slopes. Sheep are noted for cropping off the grass shorter than cattle, and because of this their presence offers more of a risk in terms of erosion inducing potential.

Future

Improved access to the area may create an increase in recreational demand for the watershed. An extension of State Highway 1, north from its termination point in Fort Bragg, Mendocino County, would provide the impetus for increased recreation activities.

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APPENDIX

TABLE A
ADDRESSES CONCERNING OWNERSHIP PARTIES WITHIN THE NORTH FORK MATTOLE RIVR WATERSHED

NAME	STREET OR P.O. BOX	CITY OR TOWN
Boots, A. and A.S.	P.O. Box 2	Petrolia, Calif.
Brown, I.M.	22 Juanita Way	San Francisco, Calif.
Calif. State Lands Comm.		Sacramento, Calif.
Chambers, J.L. and G.	P.O. Box 8	Petrolia, Calif.
Chambers, R.		Petrolia, Calif.
Clark T.K.		Petrolia, Calif.
Clark, W.H. and P.M.		Petrolia, Calif.
Cook, F.C.	P.O. Box 31	Petrolia, Calif.
Cook, M. M.	2135 "D" Street	Eureka, Calif.
Cook, R.P. and B.E.		Petrolia, Calif.
Dale, O.A.	P.O. Box 1071	Anchorage, Alaska
Edmonston, R.M. and D.R.	75 S. San Rafael	Pasadena, Calif.
Erickson, A.	P.O. Box 265	Fortuna, Calif.
Glines, W.L.	Rt. 1, Box 34	Half Moon Bay, Calif.
Graham, S. and M.A.	P.O. box 7	Petrolin, Calif.
Hansen, T.	109 Old Stage Rd.	Salinas, Calif.
Henley, I.M.	22 Juanita Way	San Francisco, Calif.
Hough, V.S.		Petrolia, Calif.
Hunter, E.	2135 "D" Street	Eureka, Calif.
Hunter, R.E. and M.E.	stage Rt.	Petrolia, Calif.
Lowdcrmilk, D.	2723 Jefford Pl.	Anchorage, Alaska
Lowry, S.E. and D.C.	P.O. Box 68	Ferndale, Calif.
Lowry, W.E. and M.A.	P.O. Box 595	Ferndale, Calif.

TABLE A
ADDRESSES - CONTD.

NAME	STREET OR P.O. BOX	CITY OR TOW
Lytel, B.R.	630 "H" Street	Eureka, Calif.
Madsen, F.	Address Unknown	
Ohman, W.I. and A.S.	803 "L" Street	Eureka, Calif.
Rackliff, C.C.		Petrolia, Calif.
Rochlin, A.	Drawer "K"	Arcata, Calif.
Russ, J. and A.	Ocean House	Ferndale, Calif.
Sound Lumber Company	Drawer "K"	Arcata, Calif.
Stewart, H.H.		Petrolia, Calif.
The Pacific Lumber Co.		Scotia, Calif.
Thompson, R.H. and R.M.	P.O. Box 19	Petrolia, Calif.
Titus, F. and M.	Rt. 1, Box 74	Ferndale, Calif.
Tooby and Prior, Inc.	P.O. Box 38	Eureka, Calif.
U.S.A., Dept of the Int.		San Francisco, Calif.
Walker, M.L.	F.O. Box 483	Scotia, Calif.
Westfall, N.S. and M.A.	P.O. Box 2264	Modesto, Calif.
White, R. M. and M. C.	P.O. Box 363	Ferndale, Calif.
Wright, C.E.	P.O. Box 19	Petrolia, Calif.
Zanone, A. and S.		Petrolia, Calif.

TABLE B
HUMBOLDT STATE COLLEGE

WATERSHED MANAGEMENT

Duration table summary of North Fork Mattole River At Petrolia, California

for the years 1952-1957 Drainage area 37.6 square miles

Discharge Cfs	Number of days when discharge was equal to or greater than that shown in first column and less than that shown on next line: 1952	1953	1954	1955	1956	1957	Total	Total days	% of time
3				4	14	3	21	2192	100.0
4	9	1	1	6	36	2	55	2171	99.1
5	30	9	26	33	38	3	139	2116	96.5
7	33	48	47	34	25	38	225	1977	90.2
10	41	33	47	27	21	33	202	1752	79.8
15	14	26	16	24	15	30	125	1550	70.8
20	26	23	23	39	35	59	205	1425	65.1
30	28	22	28	39	41	31	189	1220	55.7
50	21	18	13	36	13	14	115	1031	47.1
70	23	34	21	27	18	13	136	916	41.8
100	16	38	41	33	16	49	193	780	35.6
150	14	19	21	16	12	27	109	587	26.8
200	18	29	21	16	11	25	120	478	21.8
300	41	32	27	15	26	20	161	358	16.3
500	23	13	12	3	7	4	62	197	8.99
700	16	9	7	6	15	11	64	135	6.16
1000	9	9	8	4	6	3	39	71	3.24
1500	1	1	3	2	6		13	32	1.46
2000	3	1	2	1	3		10	19	.867
3000			2		7		9	9	.411
5000									
Total	366	365	365	365	366	365	2192		

Prepared by R.Carkeet Date 4/19/67 Checked by R.Carkeet Date 4/19/67

Sheet no. 1 of 1 sheets

Special Comments:

TABLE C - INFORMATION USED IN CONSTRUCTION OF THE HYPSOMETRIC (AREA-ELEVATION) CURVE OF THE NORTH FORK MATTOLE RIVER WATERSHED

Limiting Contour Elevations (Ft.)	Area Between Contours (Acres)	Percent Of Total	Percent Of Total Over Given Lower Limit
50 - 300	1297	5.4	100
300 - 600	1365	5.7	94.6
600 - 900	2019	8.4	88.9
900 - 1200	2988	12.4	80.5
1200 - 1500	3685	15.3	68.1
1500 - 1800	4280	17.8	52.8
1800 - 2100	3360	14.0	35.0
2100 - 2400	2760	11.5	21.0
2400 - 2700	1360	5.7	9.5
2700 - 3000	724	2.9	3.8
3000 - 3400	226	.9	.9