A WATERSHED ANALYSIS OF
FRESHWATER CREEK
HUMBOLDT COUNTY, CALIFORNIA

BY

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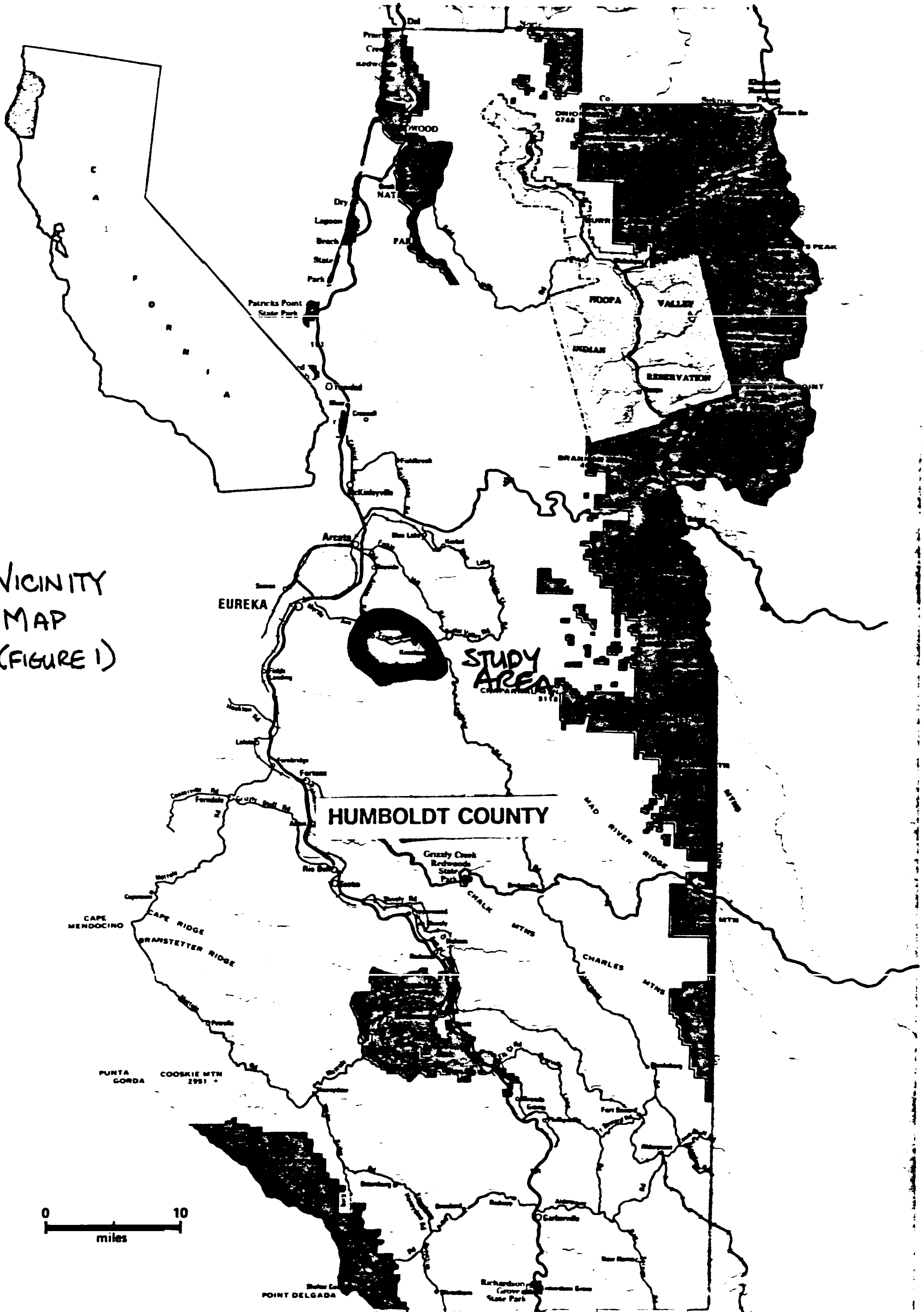
Location and Description

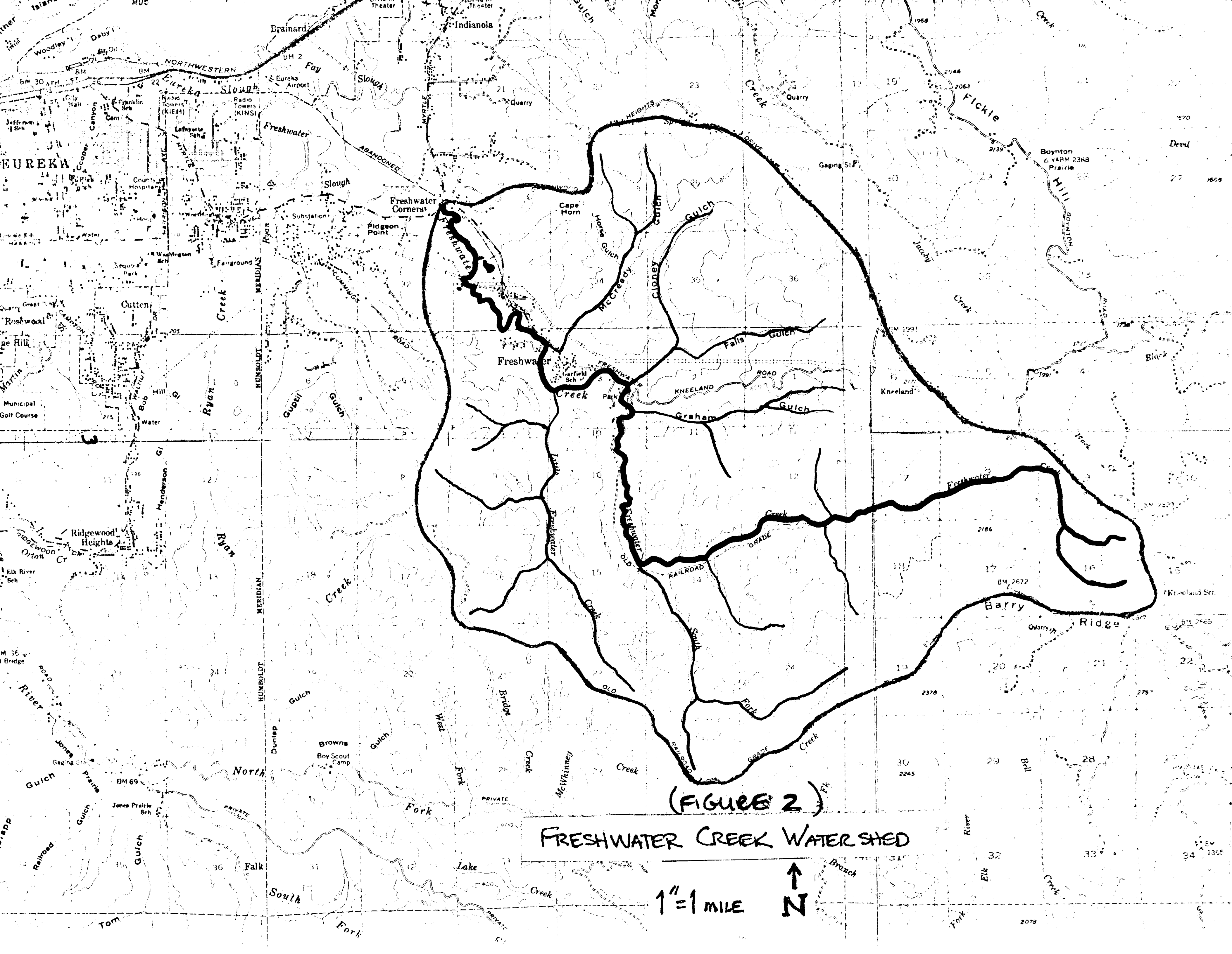
The Freshwater Creek drainage basin is located on the north coast of California in central Humboldt County. Situated southeast of Arcata and northeast of Eureka, the watershed encompasses an area of **30.93** square miles or **80.1** square kilometers, surrounding the small town of Freshwater. Because of the L-shaped configuration of the mainstem of Freshwater Creek, the watershed has a slightly southwestern aspect in its upper reaches, bending toward the northwest as it drops from the hills to the Humboldt Bay plain. The center of the basin is at 70°45' N Lat and 124°01' W Long.

The basin is bounded on the north and east by Greenwood Heights Drive, on the south by Barry Ridge and its continuation which divides this watershed from that of the Elk River, and on the west by a hill line separating the basin from the Ryan Creek drainage. The lower limit of the study area is at Freshwater Corners, for here the creek begins to feel tidal influence as it joins Freshwater Slough and ultimately, Eureka Slough and Humboldt Bay.

The watershed has a perimeter of 23.5 miles (37.8 km) encircling an area of 30.93 sq, mi, (80.1 sq. km.) From these data the compactness coefficient (k_c) is calculated as 1.18. This parameter describes the ratio of the perimeter of the watershed to the area encompassed, High values of k_c (I.4 -2.0+) show that there is relatively little area in comparison to the length of the perimeter. Conversely, low values (1.0-1.4) show a greater enclosed area for a given perimeter, or an **approximately** circular basin, The value 1.18 reflects the circular **shape of** this basin,



VICINITY
MAP
(FIGURE 1)



(FIGURE 2)

FRESHWATER CREEK WATERSHED

1" = 1 MILE

N

Physical Resources

Climate

The Freshwater Creek basin is affected greatly by the coastal marine influence since almost all of the watershed lies within the coastal fog belt. This moist coastal air mass causes moderate seasons, although in the more inland reaches of the watershed more rigorous conditions and variability is seen.

The North Pacific High Pressure Zone tends to ward **off** unstable air masses descending from the northwest during summer, thus preventing significant rainfall during this season. (Baca **1970)** As the North Pacific High cell drifts south during the winter, increased precipitation occurs. The summer climate is characteristically cool and foggy as on-shore winds accumulate a low-lying fog layer against the rising topography. When the temperature gradient between inland areas and the coast is great, the onshore wind movement is greatest and fog will accumulate far into the basin. On occasions of less relative temperature difference, the fog layer will barely penetrate the watershed or will remain offshore,

The winter climate typically consists of days of high cool cloudiness accompanied by precipitation, and on cloudless days, with morning frost and ground fog.

Table 1 is a compilation of rainfall and temperature data from the U.S. Weather Bureau for the years 1931-1952. (Calif. State Dept. Water Resources, 1963) Eureka is the closest monitoring station to the study basin, and thus reflects the gen- climate of the watershed. Variability in rainfall exists within the watershed, however, because as Dean's 1971 study of rainfall of north coastal California showed "precipitation was found to increase with increasing elevation and distance from the ocean.. ..Precipitaion was more dependent upon elevation than distance from the ocean in relative terms." Thus, the headwaters of the basin, being higher in elevation and further inland, receive greater amounts of rainfall than the lower reaches,

Table 1 Precipitation and Temperature Data

Station	Elevation (in feet):	Annual ppt max	Annual ppt min	Estimated 50 year mean	Avg temp °F Jan	Avg temp °F July	Avg temp °F Ann	Extreme High	Extreme Low
Eureka	43	74.10	20.72	36.66	47.0	55.6	51.6	85	20

A further expression of the mildness of the climate in the basin, as reflected in the data recorded at Eureka, is that the average daily temperature fluctuation is only 10.8°F, while the average number of frost-free days per year is 318. (Calif. Water Quality Control Board, 1975).

Physiography

There are three basic landforms found within the Freshwater Creek watershed:

1) Alluvial plains and terraces bordering the lower reaches of Freshwater Creek as it enters the Humboldt Bay plain.

2) Gently rising slopes above the alluvial terraces

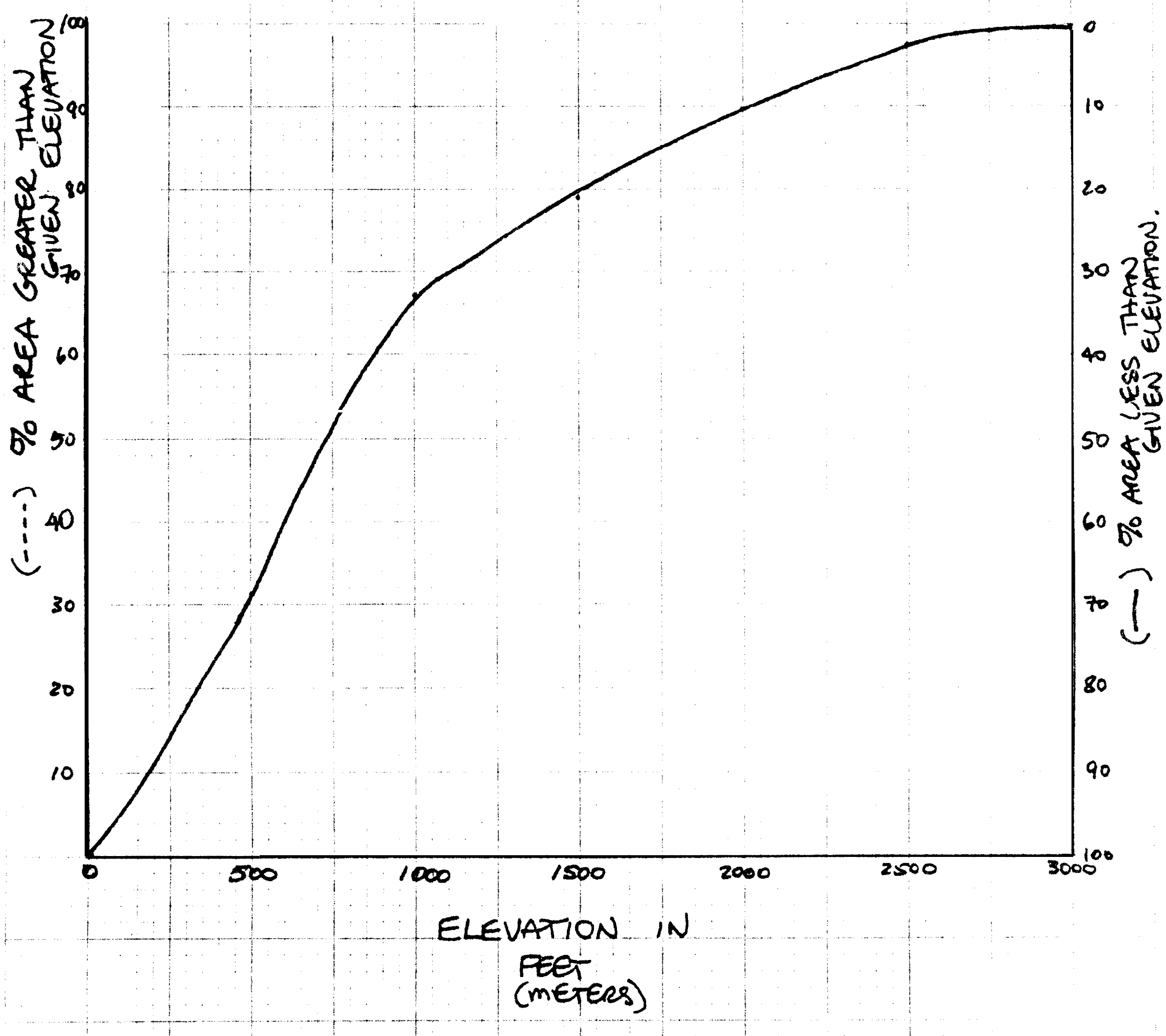
3) Steeply inclined slopes rising above the 400 ft. elevations, mainly in the eastern portion of the basin above the town of Freshwater, These slopes reach their highest point in Barry Ridge.

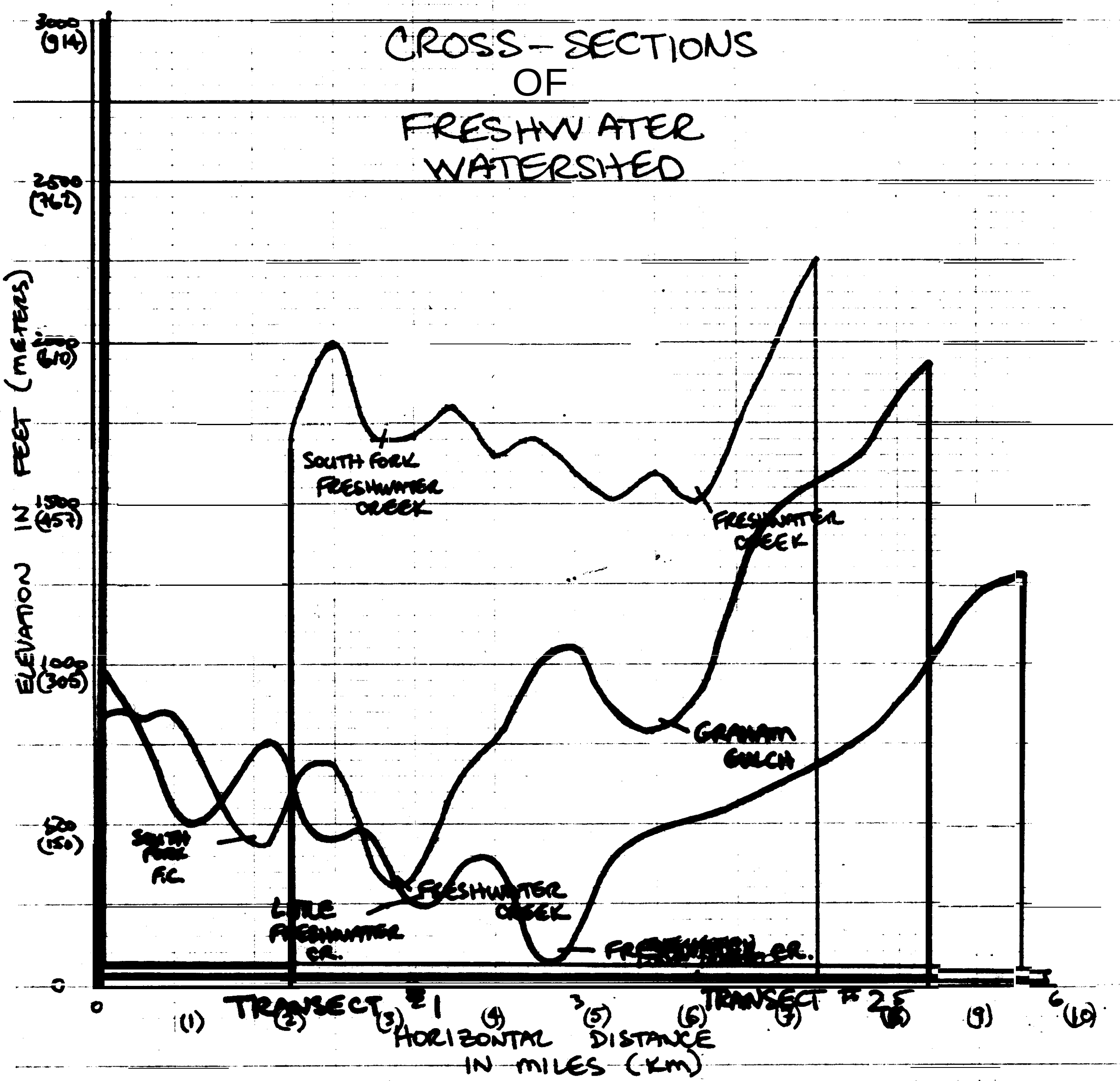
Figures 3, 3a, and 3b show the relative topography of the watershed, From Figure 3 it is seen that there is a great deal of area higher than 1000 feet, and that the terrain rises

A

HYPSOMETRIC CURVE FOR FRESHWATER CREEK WATERSHED.

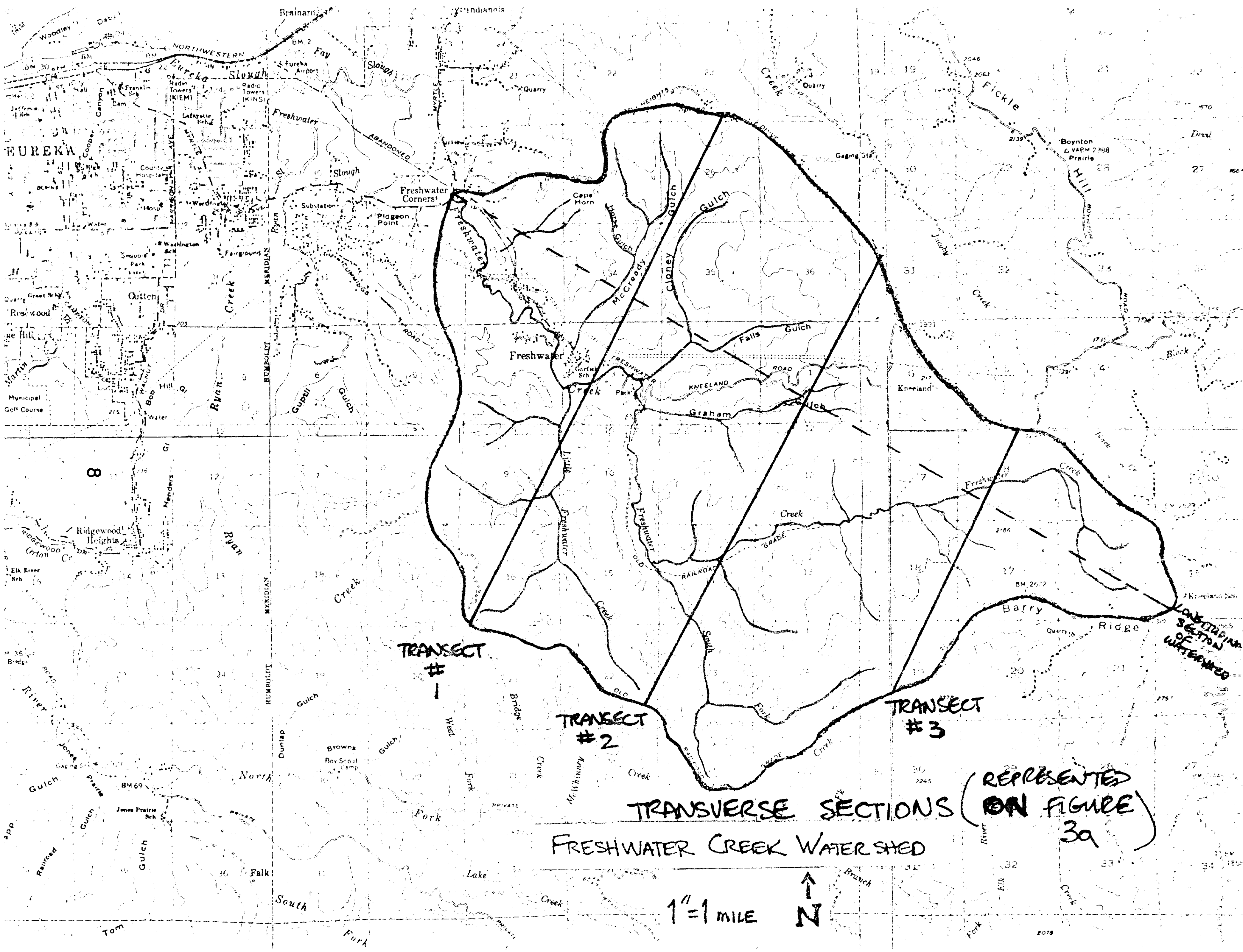
(FIGURE 3)

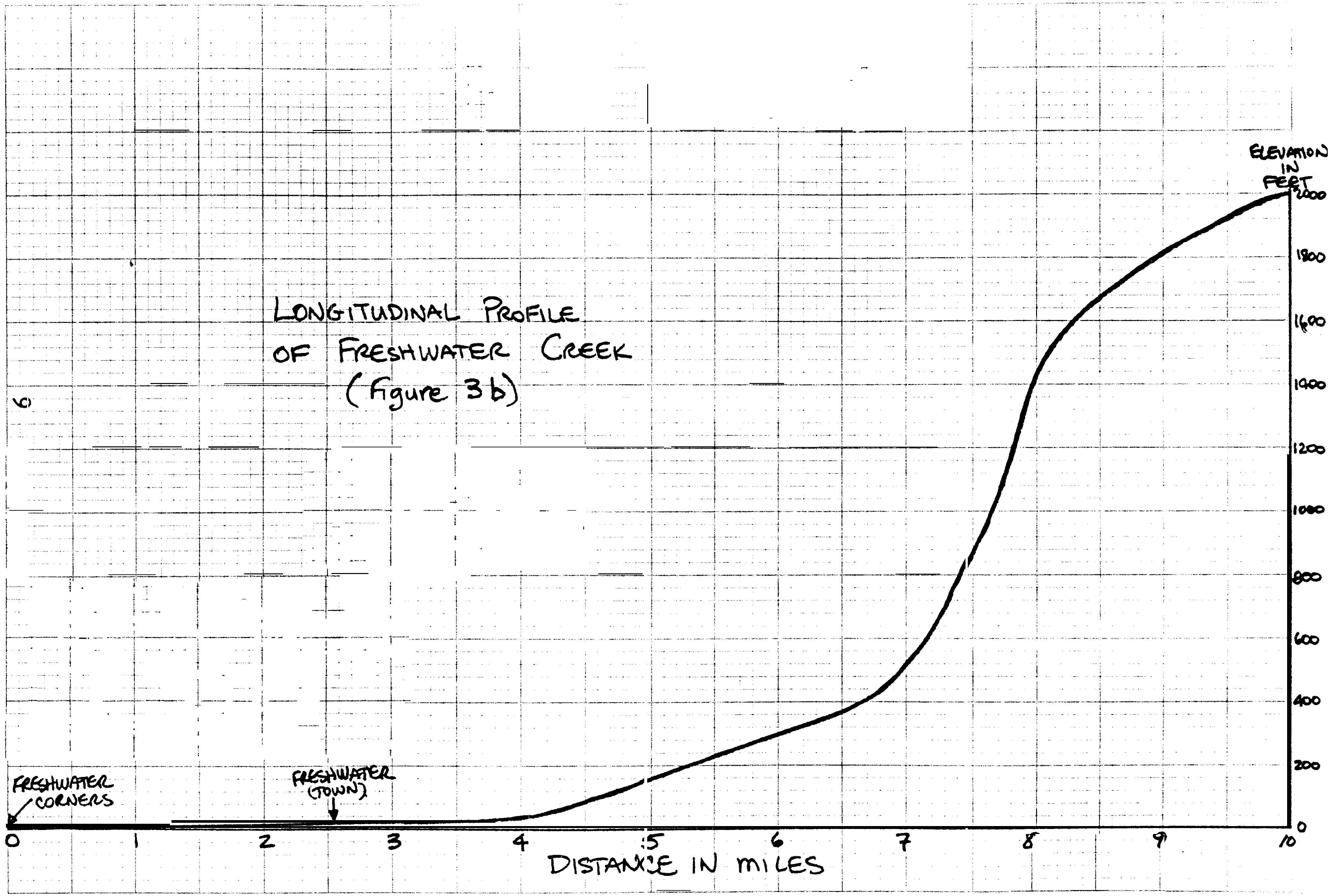




TRANSECT #3

(FIGURE 3a)


TRANSECT #1
TRANSECT #2
TRANSECT #3
LONGITUDINAL SECTION OF WATERSHED
TRANSVERSE SECTIONS (REPRESENTED ON FIGURE 3a)
FRESHWATER CREEK WATERSHED
1" = 1 MILE
N
EUREKA
Freshwater Corners
Freshwater
Kneeland
Cape Horn
Pidgeon Point
McCready Gulch
Cloney Gulch
Horse Gulch
Falls Gulch
Graham Gulch
Little Freshwater Creek
South Fork
Barry Ridge
Fickle Hill
Boynton Prairie
Ridgewood Heights
Rosewood
Cutten
Brainard
Indianola
Eureka Slough
Freshwater Slough
Ryan Creek
Gaging Sta
Kneeland Road
Old Railroad Grade
Humboldt Meridian

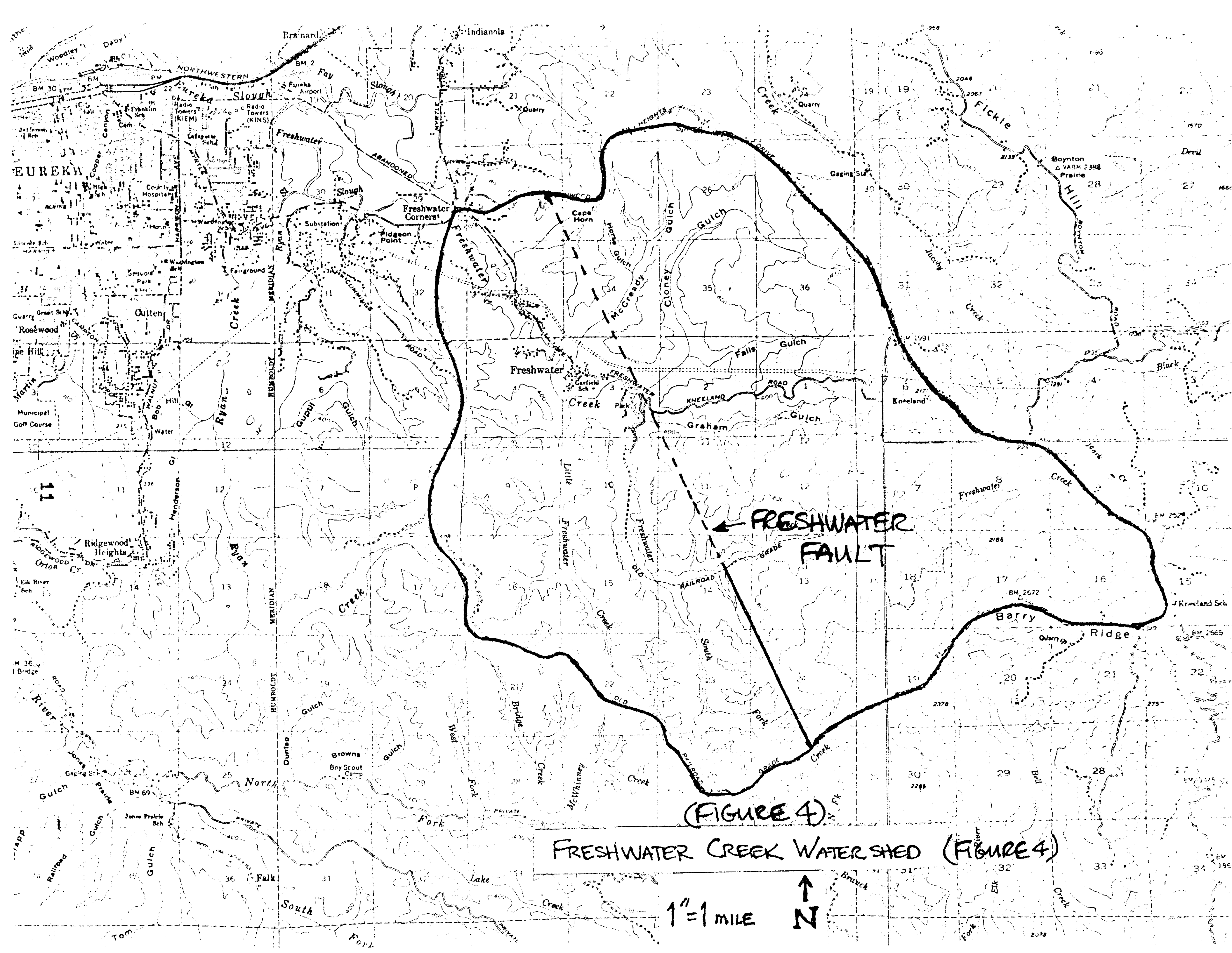

LONGITUDINAL PROFILE
OF FRESHWATER CREEK
(figure 3b)
ELEVATION IN FEET
2000
1800
1600
1400
1200
1000
800
600
400
200
0
FRESHWATER CORNERS
FRESHWATER (TOWN)
0
1
2
3
4
5
6
7
8
9
10
DISTANCE IN MILES

steeply and steadily from the alluvial plain into the hills of the upper watershed. The overall slope is 1%.

The streams of the basin for a dendritic drainage pattern, characterized by a tree-like branching system in which the tributaries join the mainstream at acute angles. The occurrence of this drainage pattern indicates overall homogeneous soil and rock materials and is typified by landforms of soft sedimentary rocks and old, dissected coastal plains (Way, 1978). There is also active down-cutting occurring in the upper portion of the watershed where gradients are steep and extensive deposition in the bottom of the basin.

Geology

The geology of the watershed is dominated by the Freshwater Fault (Figure 4). This fault has been mapped from an area near the Eel River at about the latitude of Punta Gorda, northwest for 38 miles, to the upper reach of Freshwater Creek. Throughout this distance the fault forms the boundary between the Yager Formation on the southwest, and the Franciscan on the northeast. Although Ogle (1953) mapped the Freshwater as lying beneath undifferentiated Wildcat strata and thus dormant, others have concluded that it is probably still, possibly causing as recent a seismic event as one in 1954. The most recent study (Earth Science Associates, 1975) of the seismic condition of this area concluded that "it is evident that the Freshwater Fault is an old structural feature in the bedrock, which has not moved since prior to the beginning of sedimentation in the Eel River basin, during late Miocene or early Pliocene time."



(FIGURE 4)

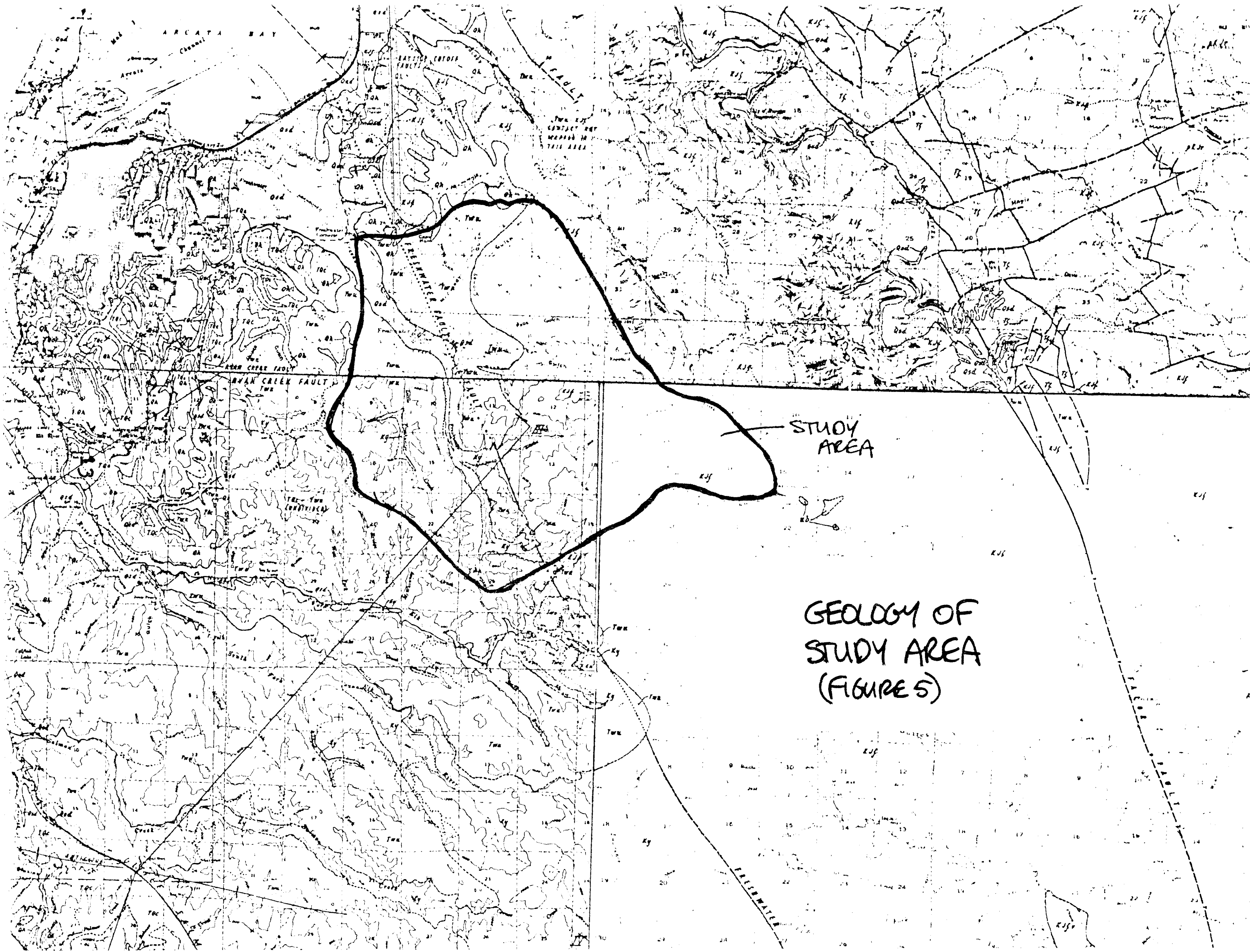
FRESHWATER CREEK WATERSHED (FIGURE 4)

The upper reaches of the watershed are made up of Franciscan formation (Figures 5 & 6). The formation is a heterogeneous mix of igneous, metamorphic, and sedimentary rocks buried by a deeply weathered, clay-rich soil mantle. This formation undoubtedly extends at depth beneath Humboldt Bay, forming the basement rock of the region. Exposures are often deeply weathered, with outcrops of relatively fresh rocks limited to canyon bottoms and road cuts, Several of these are evident are along the Freshwater-Kneeland Road east of the town of Freshwater,

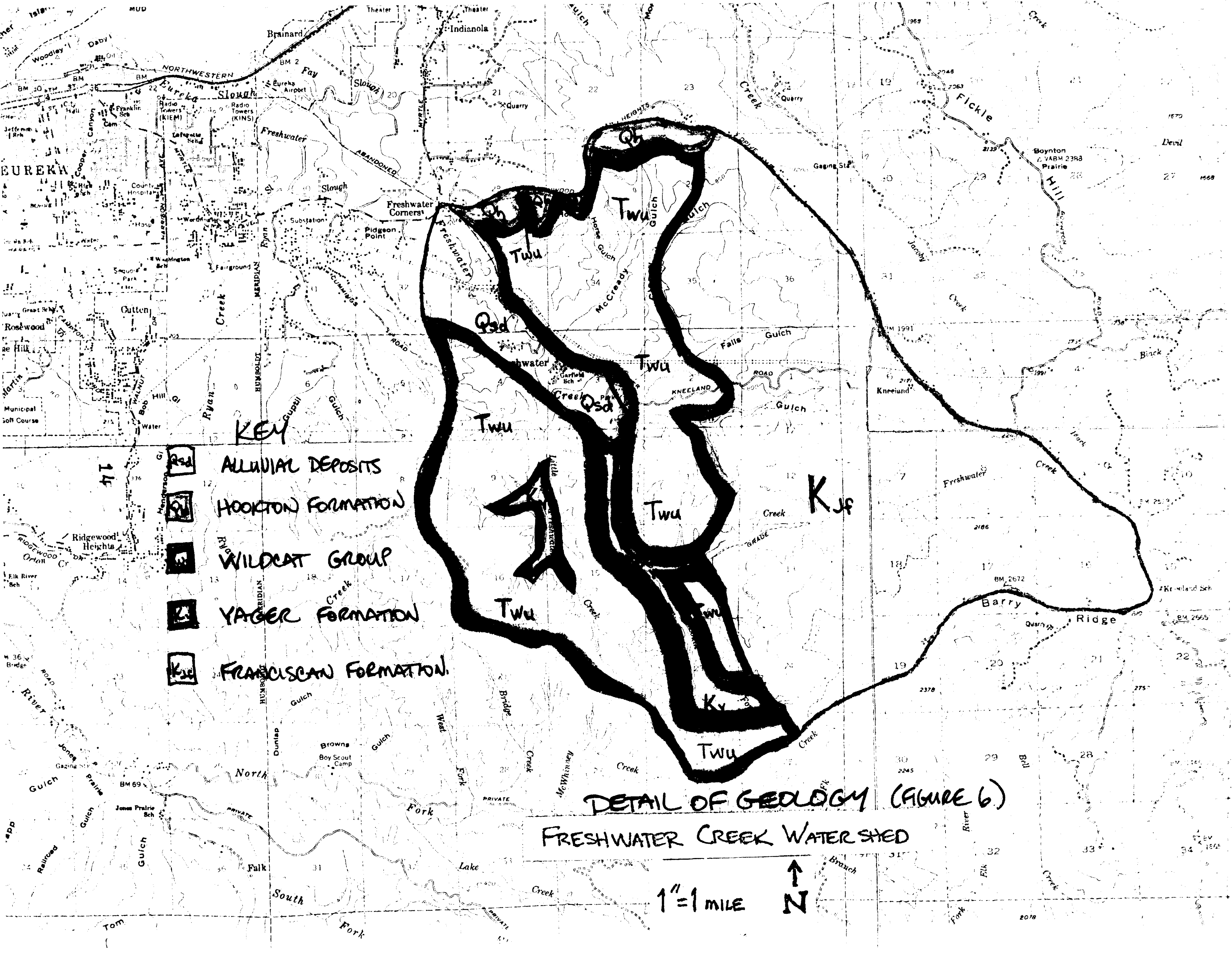
The predominant formation in the western portion of the watershed is the Wildcat group, This formation is a sequence of clastic sedimentary rocks of upper Miocene through lower Pleistocene age. This group is composed of a number of unconformably bedded formations forming sedimentary rocks such as various sandstones and mudstones with minor limestone inclusions, Surface expression of these layers are present along the banks of the tributaries to Freshwater Creek, such as Cloney and McCready Gulches,

In the upper northwest corner of the basin small areas of Hookton formation are found. This formation consists of old, semi-consolidated alluvial deposits of pebbly and silty sand usually less than 30 meters thick. The depositional environment of the local Hookton deposits was probably marginal marine. (Earth Science Associates, 1975).

Small areas along Little Freshwater Creek and South Fork are areas of Yager Formation. This Cretaceous formation crops out in areas west of the Freshwater Fault and is composed of clastic marine sediments, including conglomerate, sandstone, and shale. This group forms rocks physically similar to coastal belt



GEOLOGY OF STUDY AREA (FIGURE 5)



KEY
Qsd ALLUVIAL DEPOSITS
Qh HOOKTON FORMATION
Tw WILDCAT GROUP
Ky YAGER FORMATION
Kjf FRANCISCAN FORMATION
Twu
Qsd
Qh
Ky
Kjf
DETAIL OF GEOLOGY (FIGURE 6)
FRESHWATER CREEK WATERSHED
1" = 1 MILE
N

Franciscan.

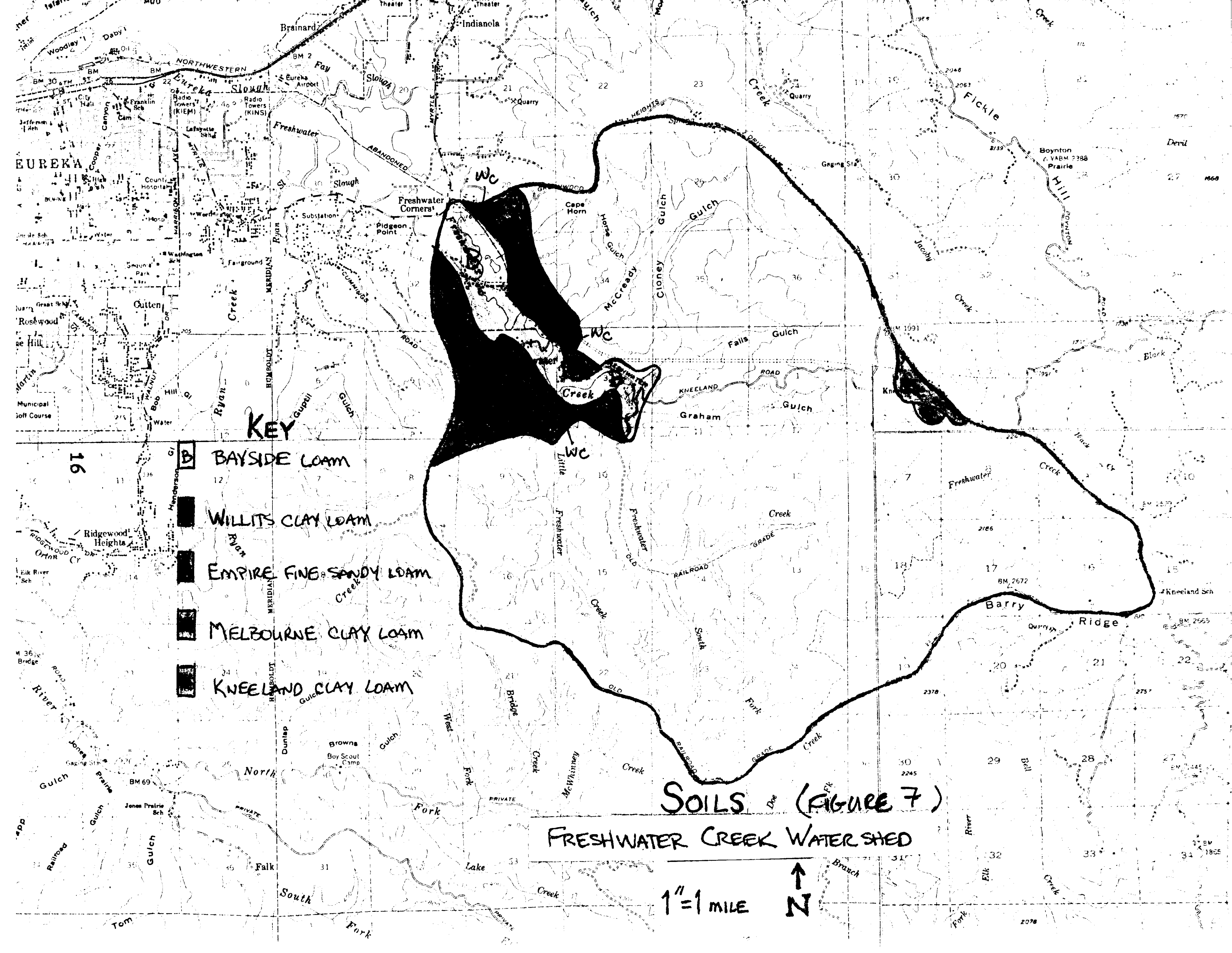
Along the lower reaches of Freshwater Creek itself, is an area of alluvial sand and sediment deposits. This youngest of the formations in the basin (Holocene) is derived from the erosion of the formations of the upper watershed.

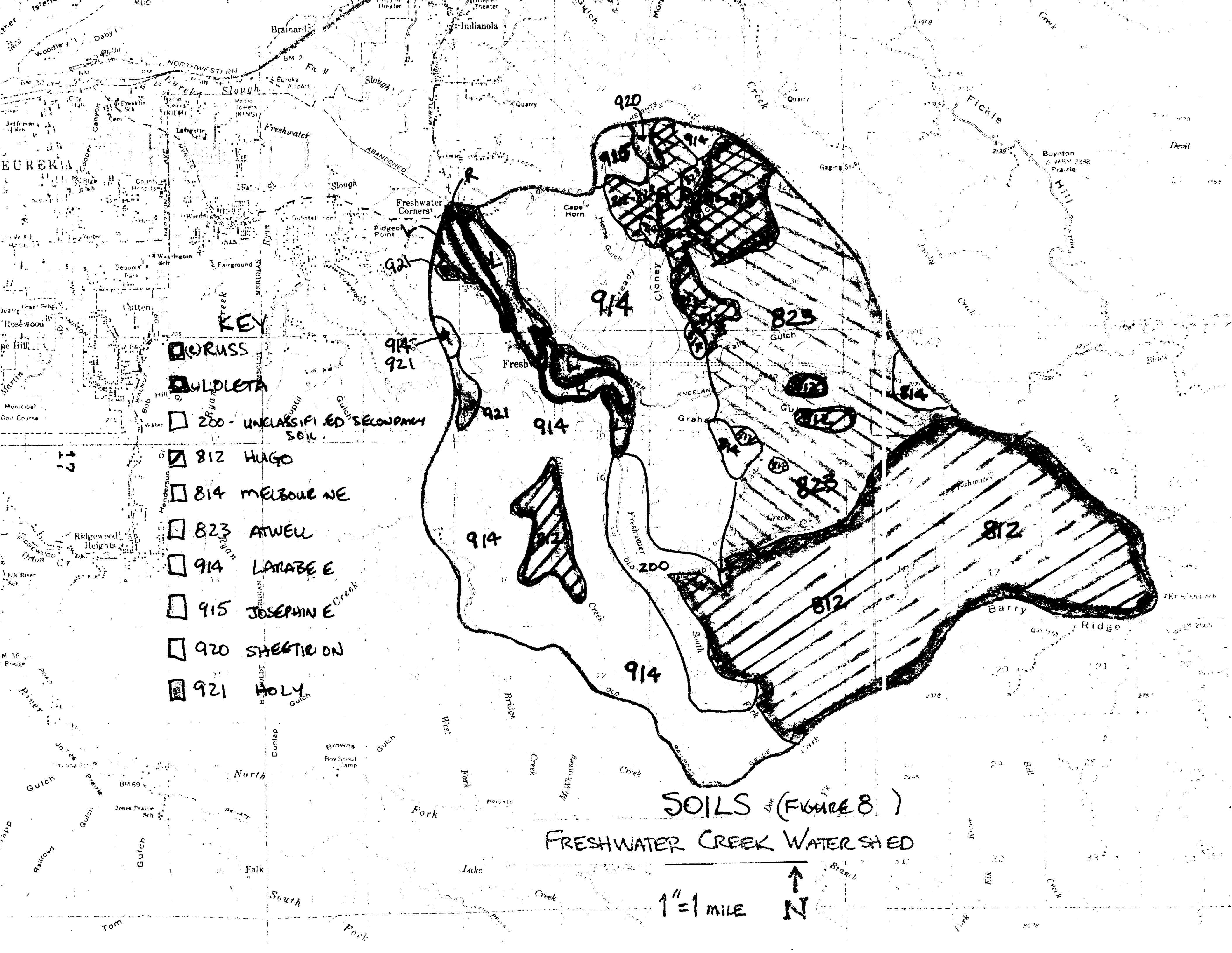
Soils

The soils of this region, including the Freshwater Creek basin, have been mapped and classified several times. Figure 7 shows the soil classification from the US Department of Agriculture, published in 1921. A later study of soils produced a series of soil-vegetation maps by the U.S. Soil Conservation Service, accompanied by an interpretation guide by Black (1964). Figure 8 was derived from the most recent classification of soils in the county (McLaughlin and Harradine, 1965). The characteristics of these soil types are represented in Tables 2 & 3.

The three major soil types, representing more than 85% of the basin are Hugo, Atwell and Larabee series, The upper portions of the watershed are represented by Hugo and Atwell soil types. In the western portion of the watershed is found mainly the Hugo series, Along the South Fork and main stem of Freshwater Creek are located sedimentary, depositional soils, such as Russ and Loleta series. These latter two soils are agricultural designations.

Russ soils consist of well to moderately drained soils developed from sedimentary alluvium occurring along small streams which drain Wildcat formations. Loleta soils comprise moderately well to imperfectly drained, medium textured, soils developed


KEY
B BAYSIDE LOAM
WILLITS CLAY LOAM
EMPIRE FINE SANDY LOAM
MELBOURNE CLAY LOAM
KNEELAND CLAY LOAM
SOILS (FIGURE 7)
FRESHWATER CREEK WATERSHED
1"=1 MILE
N
WC
EUREKA
Freshwater Corners
Pidgeon Point
Cape Horn
Kneeland Road
Graham Gulch
Falls Gulch
Cloney Gulch
McCready
Little Freshwater Creek
South Fork
Barry Ridge
Fickle Hill
Boynton Prairie
Ridgewood Heights
Cutten
Rosewood
Kneeland Sch
Browns Boy Scout Camp
Jones Prairie Sch
Falk



SOILS (FIGURE 8)

FRESHWATER CREEK WATERSHED

Table 2--Some of the important characteristics of predominant soils series mapped (After Black, 1964)

Soil Series Symbol.	Soil Series Name	Depth Range	Color of surface/subsoil	Texture of surface/subsoil	Parent material	Topography and slope classes mapped
812	Hugo	30-60	Gray brown/ pale brown	Loam/clay loam	Sandstone & shale	Hilly to very steep
814	Melbourne	30-60	Brown/strong brown	Loam/clay loam	Sandstone & shale	Hilly to very steep
823	Atwell	36-72	Dark gray brown/pale brown	Clay loam/ gravelly clay loam	Sheared sedimentary rocks (usually calcareous)	Hilly to very steep
914	Larabee	40-70	Gray brown/ strong brown	Loam/clay loam	Soft sedimentary rocks	Hilly to very steep
915	Josephine	4-o-70	Brown/reddish yellow	Loam/clay	Soft sedimentary rocks	Rolling to steep
920 921	Empire (Sheetiron, Holy)	40-70	Dark brown/ reddish brown	Loam/fine sandy clay	Soft sedimentary rocks	Hilly

Table 3-Further soil characteristics
(After Black, 1964)

Soil Series Symbol	Soil Series Name	Soil Series Symbols	Perme-ability	Erosion hazard	Mean annual precipitation	Estimated suitabilities for: Timber pro-duction	Estimated suitabilities for: Extensive range use
812	Hugo	3S	Rapid	Moderate to high	50-60	High to medium	Low
812	Hugo	4S	Moderately rapid	Moderate	50-60	High to very high	Medium
812	Hugo	5S	Moderately rapid	Moderate	50-60	Very high to extremely high	Medium
814	Melbourne	4,5S	Moderate	Moderate	50-60	Very high	Medium
823	Atwell	5	Slow	Moderate	50-60	Very high	Medium
914	Larabee	4	Moderate	Moderate	50-60	High	Medium
914	Larabee	5	Moderate	Moderate	50-60	Very high to extremely high	Medium
915	Josephine	5	Moderate	Moderate	50-60	Very high	Medium
920 921	Empire (Sheetiron, Holy)	5	Slow	Moderate to high	50-60	Very high	Medium

from sedimentary alluvium occurring on nearly level to moderately sloping alluvial fans and low terraces. (McLaughlin and Harradine 1965)

Hugo soils predominate where slopes are s-teepest, in the east of the watershed. This series is the shallowest of the three major soil types, averaging 30-40 inches in depth. The Atwell series located in the northeast corner of the watershed, are clay loam soils with moderate permeability and good timber production. Atwell soils are found at the bases of sideslopes and 3/4 of the way up the slopes, with ridgelines consisting of Hugo or Melbourne. Larabee soils range from loam to clay loam and are the deepest to the three major soil series present. The lower reaches of the watershed are almost strictly this soil type, on gentler slopes where erosive forces are lower resulting in deeper soil layers. Timber productivity potential is also quite high here .

The erosion potential of these three major soil groups varies, as does the quality of their other watershed characteristics. The Hugo series shows little tendency to erode, even considering the relatively steep slopes where they are located, Complete vegetation removal greatly increases the erosion hazard, Atwell soils are intermediate in erosion hazard, rated moderate to high, and since their bearing strength is low, desirability for road building is also low. Larabee soils have very good watershed characteristics, good drainage, moderate erosion hazard and moderate road building suitability.

Hydrology

There is very little hydrologic data for Freshwater Creek, considering the size of the watershed, output of water and sediments to Humboldt Bay, and importance as an anadramous fishery. A great deal of study has been done on Jacoby Creek, however, and it is a similar, adjacent watershed where the U.S.G.S. stationed a gaging station for several years. For these reasons when the Army Corps of Engineers completed a study of Flood Plain Information on Freshwater Creek (1975), they found it useful to extrapolate from the Jacoby Creek studies. The same procedure will be followed here, except where specified.

This year rainfall of low to moderate intensity failed to produce any noticeable increase in stream stage until soils reached field capacity in late October. Once soil moisture recharge had taken place, stream response to a typical sinter storm was observed approximately 4 hours after onset, The basin yields most of its runoff '(approximately 90%) during the rainy season which occurs from October through April. During the dry season, stream flow becomes quite low, being maintained by groundwater storage,

During the wet season, floods generally occur due to general heavy rains which causes high velocities in main stream channels, Flow characteristics at the mouth (around the most densely populated areas) are controlled by tide stages on Arcata Bay. A study by the Army Corps of Engineers (1975) developed potential runoff maxima and potential hazards due to extreme storm events. The report defines two kinds of potential floods. The Intermediate Regional Flood is defined as one whose peak flow magnitude has about one percent chance of being equalled or exceeded in any year, or a so-called 100-year event. The second potential flood, the Standard Project Flood is defined as a major flood that can be expected to occur from a severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical area. Table 4 shows expected peak discharges for portions of the watershed as a result of these events.

Table 4-Peak flows for Intermediate Regional and Standard Project floods

Location	River Mile	Drainage area (so. mi.)	Intermediate Regional flood Discharge(cfs)	-'Standard Project flood Discharge(cfs
Freshwater Corners	0.0	30.9	10,000	13,800
McCready Gulch	.0	28.5	9,500	13,200
Cloney Gulch	2 l.5	20.9	7,400	10,700
Graham Gulch	4.9	15.9	5,700	8,200

Velocity of flow during floods depend largely on size and shape of stream channel, conditions along the stream, and bed slope, all of which vary on different tributary streams and at different locations on the main stream. During an Intermediate Regional Flood, velocities of main channel flow in the upper reaches of the study area would be 6 to 10 feet per second (Army Corps of Engineers, 1975) . In the lower reaches where the gradient is less, velocities would average 4 to 6 feet per second.

The above are expected extremes. In a recent storm event measured at 2.6 inches of rainfall for a 72 hour period, the flow at Freshwater Corners was estimated at between 500 to 600 cfs. There was minor flooding in the plain below the bridge as water overflowed the manmade dikes into the sdjacent pastureland.

Groundwater

Geologic units in the basin include alluvium terrace deposits, the Hookton formation and undifferentiated Wildcat group. The alluvium underlies the valley floor and varies in depth to 150 feet. The alluvium is composed of fine clays and yields very little water to wells. Terrace deposits border the alluvium on the east and also yield little water.

The Hookton formation is the major water producing geologic unit in the area. However, yields are generally less than 100 gal/min in wells over 350 feet. The Hookton formation is over 400 feet deep and dips to the northwest and consequently directs groundwater in this direction, Recharge of the Hookton formation depends on rainfall in the outcrop areas. Milton Cole (1981), whose damming, storage, and treatment operation on McCready Gulch supplies the water for the town of Freshwater, has tried on 2 separate occasions to drill a total of 5 wells. One was drilled to a depth of over 400 feet and failed to strike water, No well drilled in the immediate vicinity of his water supply operation was successful. (1981 Personal Communication)

In the alluvial valley of Freshwater Creek, tidal sloughs extend inland as far as 2 miles and contaminate the alluvium and shallow depths. Overpumping beneathe the alluvium could easily allow inward movement of this contamination. The storage capacity of the Hook-ton formation has never been estimated in this area (Humboldt County, 1973).

The Department of Water Resources Bulletin 94-8 (1963) lists five surface water diversions for the Freshwater basin, All are used to irrigate land for the raising of livestock. The total estimated output for these five diversions was 95 acre-feet per year.

Vegetation

There are five terrestrial plant communities represented in the Freshwater Creek watershed basin. These habitat types are Grassland, Foothill Woodlands, Coastal Coniferous, Pine-Fir forest, and riparian.

The Grassland habitat is represented in two separate zones, the bottom lands in the lower reaches of the watershed, and the high prairie in the headwater area, Plants representative of these grasslands are such grasses and shrubs as F'estuca idahoensis, Danthonia californica, Bromus spp., Deschampsia caespitosa, and Calamagrotis nutkaensis, Other plants include Carex tumulicola, Iris douglasiana, Lupinus formosus, and Grindelia hirsutula.

The Foothill Woodland community includes deciduous and evergreen species. The most common deciduous species include California black oak (Quercus kellogii), Oregon oak (Quercus garryana), alder (Alnus spp.), dogwood (Cornus, spp.), and big-leaf maple (Acer marcophyllum). Evergreen species include white tan oak (Lithocarpus densiflora), madron (Arbrotus menziesii), and toyon (Photinia arbitiflora var. cerina). The evergreens predominate in the coastal zone, with deciduous trees growing more-inland.

The Pine-fir forest is only minor in its representation in this watershed, Some of the representative plants are Douglas fir (Pseudotsuga menziesii), Abies, spp., incense cedar (Libocedrus decurrens), and maples (Acer, spp.). Broad-leased trees such as tan oak, alder and madron occur interspersed in patches the Pine-fir stands. Shrubs include manzanita (Arctostyphlos spp.) and white thorn (Ceanothus mianus).

The Coastal Coniferous forest, which is by for the predominant vegetation habitat type found in the basin, inoludessuch trees as redwood (Sequoia sempervirens), Douglas fir, lowland fir (Abies prandis), tan oak, wax myrtle (Myrica californica), and coastal hemlock (Tsuga heterophylla). Other plants common to this community include salal (Gaultheria shallon), redwood sorrel (Oxalis oregona), sword fern (Polustichum munitum), rhododendron (Rhododendron macrophyllum) and California huckleberry (Vaccinium ovatum). These forests are predominant on the seaward slopes of the outer Coastal Range.

Riparian habitat is found along the streams of the basin and includes such plants as willows (Salix spp.), cottonwood (Populus spp.), box elder (acer negundo), poison oak (Rhus diversiloba), coast nettle (Urtica californica) and California wild grape (Vitis californica).

The dominant vegetation community present, the Coastal Coniferous forest is present as second growth redwood forest, generally 90-100 years old, as it was first cut in this watershed in the 1880-1890's, A small amount of this acreage has been set aside, near the town of Freshwater, by Pacific Lumber as a study forest for students of Humboldt State University in nearby Arcata, California.

Wildlife and Fish

Wildlife present in the watershed, as elsewhere, often is found associated with certain vegetation habitat communities. For this reason some representative species of wildlife will be given for each vegetation habitat type.

The Grassland community is ideal habitat for such amphibians and reptiles as the western toad, racer, common garter snake, gopher snake, and western fence lizard. Birds often found associated with this habitat are a variety of raptors, swallows, western meadowlark, killdeer, mourning dove, common nighthawk, horned lark, and other song and passarine birds. Mammals common to the Grasslands are the coast mole, Townsend's mole, striped skunk, gophers, and various rodents,

The Foothill Woodlands habitat is preferred by such herptiles as western toad, foothill yellow-legged frog, clouded salamander, western fence lizard, gopher snake, common kingsnake, and the California alligator lizard. Birds common to this habitat include turkey vulture, kestrel, California quail, mourning dove, acorn woodpecker, America1 crow, scrub jay, titmouse, among others. Common mammals of the Foothill Woodlands include deer mouse, pallid bat, western gray squirrel, California gray fox, raccoon, oppossum, and black-tailed deer.

The Pine-fir forest is home to such amphibians and reptiles as western toad, yellow-legged frog, long-toed salamander, western skink, northern alligator lizard, ring-neck snake, and northwestern garter snake, Birds commonly found in this habitat type are red-tailed hawk, mountain quail, Stellar's jay, thrushes, hermit warbler, pine siskin, golden-crowned kinglet, and other small birds. Mammals found in the Pine-fir forest include various shrews, various bats, raccoon, black bear, flying squirrel, wood rat, various other rodents, black-tailed deer, and bobcat (uncommon).

The Coastal Coniferous forest is the preferred habitat of such herptiles as the Pacific giant salamander, Ensantina, Dunn's salamander, tailed frog, northern alligator lizard, sharp-tailed snake, western aquatic garter snake, and western pond turtle. Birds common th this community include various raptors, common raven, thrushes, Clark's nutcracker, mountain chickadee, chestnut-backed chickadee, brown creeper winter wren, and other small birds. Mammals often represented in this habitat include the shrew mole and other moles, gophers, various bats, wapiti, various rodents, and black bear.

Amphibians and reptiles commonly found in the riparian habitat include the black salamander, Ensantina, western toad, Pacific giant salamander, red-legged forg, bullfrog, and western aquatic garter snake, Birds found in these areas include raptors (ospreys, hawks, owls, and the turkey vulture), dipper, Stellar's jay, Swainson's thrush, and a wide variety of song and passarine birds. The brush mouse, oppossum, broad-footed mole, raccoon, ring-tailed cat, river otter, beaver, short-tailed weasel, and spotted skunk are mammalian inhabitants of this habitat.

Freshwater Creek and its tributaries contain both anadramous and non-anadramous species of fish. The main non-migratory species include rainbow trout, cutthroat trout, stickleback, sculpin, and the migratory but non-salmonid lamprey ee, The anadramous salmonids which return annually to this system include king salmon, silver salmon, and steelhead trout.

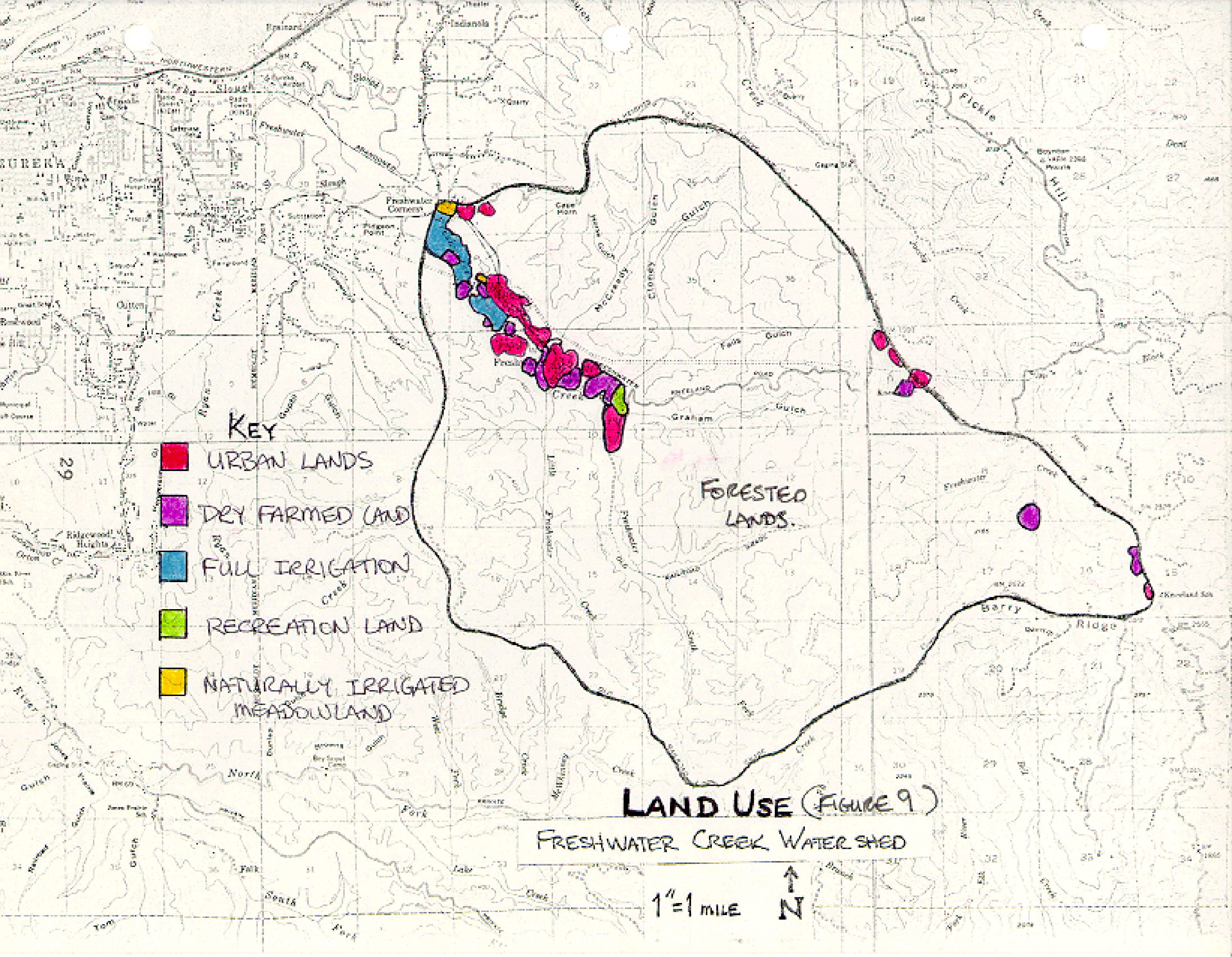
Silver salmon return in the greatest numbers to these streams partially due to the past actions of a local concerned citizen's group made up of commercial fishermen, sportsmen, and students from Humboldt State University. This group, the Humboldt Fish Action Council, has,. for the past 111 years been trapping, spawning and returning juvenile silver salmon to the mainstem of Freshwater Creek. Last year, while other streams in the north coast area were suffering low returns of salmon, the Fish Action Council's temporary trapping facility captured 202 silver salmon, 88 steel-head, and 5 king salmon, These fish were spawned and the juveniles will be returned to Freshwater Creek this year, (Humboldt Fish Action Council, 1981).

The HFAC has recently applied for and received funding for a permanent fish trapping and holding facility on the mainstem of the creek about 1/4 mile above Freshwater Corners, The facility should be functioning in the Fall of 1982.

Land Use

The majority of the land area of the Freshwater basin in made up of forested lands owned by Pacific Lumber Company (Figures 9 & 10). Other land use areas are located in the lower reaches of the watershed immediately along the mainstem creek and in some small areas around Kneeland. Figures 9 and 10 define these land use activities.

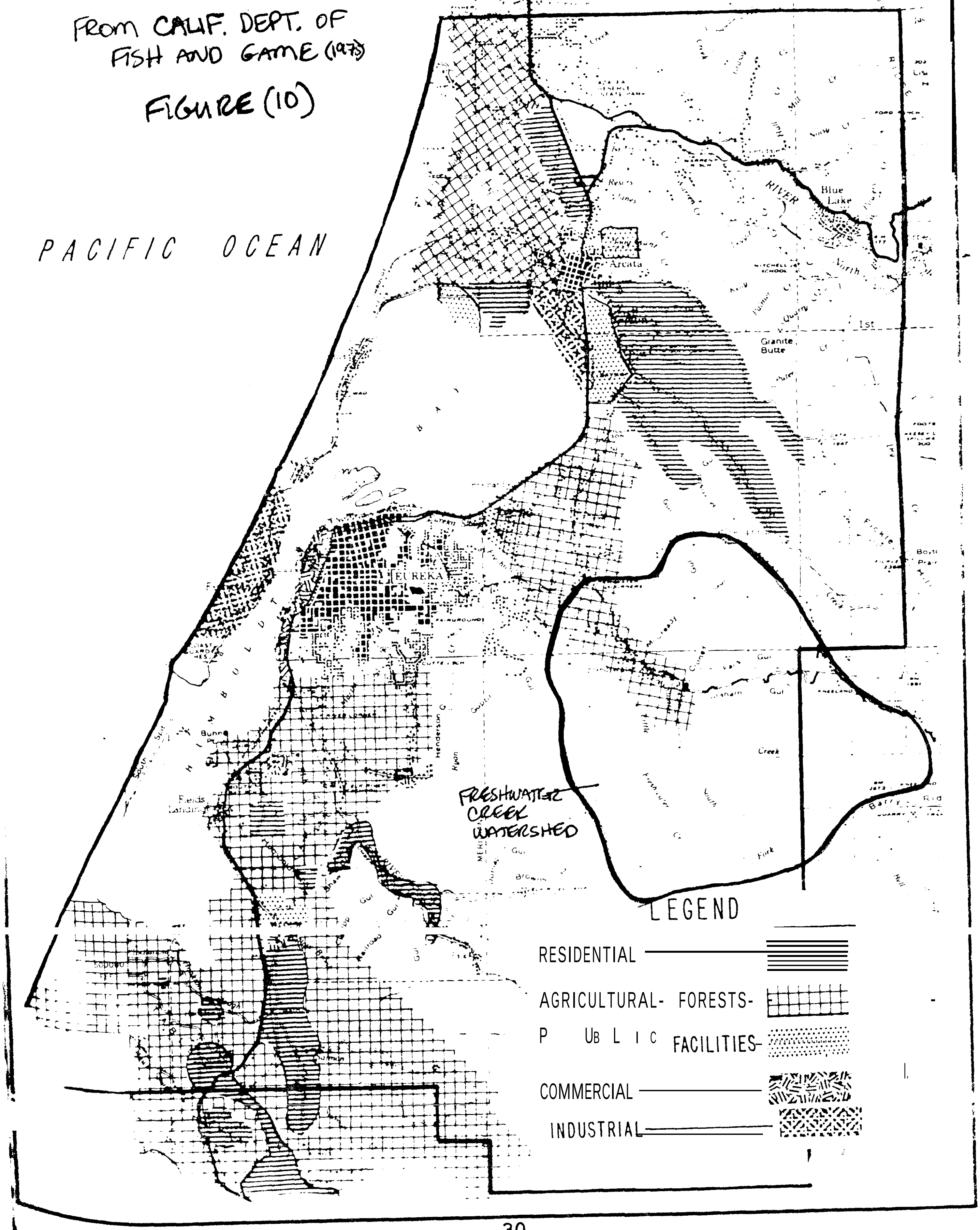
The forested areas of the basin are second growth redwood forests. Maps at the Timber Division of the Humboldt County Tax Assessor's office, show that most of the area was first logged in 18704890. Small areas have since been logged, but most of the area has not yet received a second harvesting. Harvests since 1976 are not recorded in the Assessor's office for the assessments are now made according to a yield tax method, so


KEY
URBAN LANDS
DRY FARMED LAND
FULL IRRIGATION
RECREATION LAND
NATURALLY IRRIGATED MEADOWLAND
FORESTED LANDS.
LAND USE (FIGURE 9)
FRESHWATER CREEK WATERSHED
1" = 1 mile
N
EUREKA
Freshwater Corners
Barry Ridge
Graham Gulch
Falls Gulch
Fickle Hill
Ridgewood Heights

GENERAL LAND USE MAP

FROM CALIF. DEPT. OF FISH AND GAME (1975)

FIGURE (10)



cutting dates are no longer monitored.

The artificially- and naturally-irrigated land of the alluvial plain are used for raising livestock. The high prairie around Kneeland are also used for grazing. The recreation area shown on Figure 9 is a county facility, Freshwater Park. It is used for general recreation year-round, and in the summer as a swimming pool when Freshwater Creek is temporarily dammed, The barriers are removed in Fall to prevent flooding during the wet season

Watershed Conditions and Trends

Quantity and Control of Flow

Aside from the five surface diversions mentioned earlier and the temporary damming of the creek at Freshwater Park, there are no major diversions or blockages to flow in the drainage. A proposed permanent fish trapping facility on the mainstem will have to deal with its potential for stream blockage and subsequent flooding.

A planned and soon to be commenced widening of Myrtle Avenue-Old Arcata Road, the main north-south road crossing at Freshwater Corners, has considered potential flooding problems. Planned structures, including new dikes and bridges, are designed to improve existing conditions in the favor of better flood control (Humboldt County and Cal Trans, 1980). The new bridge spanning Freshwater Creek will be built above the 100 year flood level. The report states that "analysis indicated that the new Freshwater Creek bridge and approaches will have either no appreciable effect or reduce flood water levels at the structures," Water Quality

Freshwater Creek has an apparent high water quality, as evidenced by channel characteristics and the flourishing salmon returns, both from supplemental planting, and more importantly, natural reproduction,, The stream, like all north coast streams, has a high sediment transport load during the winter, or following any major rain event. This high sediment load is due to many factors including steep slopes in the upper watershed, erosion susceptibility of soils and 'geologic formations present, and areas of man-caused surface exposures, Some of these activities are road construction, logging activities and land development.

Future logging in the basin and housing development in the area are potential threats to water quality. Improved logging practices, with increased sensitivity by the timber industry to watershed susceptibility to damage, lessen this threat to the basin's water quality, The potential problem of increased rese-dential development of the area remains.

With increased housing construction and the increase in population come several potential problems. The increased use of water will need to be faced very soon, especially in the town of Freshwater, The present water supply system is already hard-pressed to satisfy current needs, According to the operator of water system, Milton Cole (1982), no further households can be added to the system load. As discussed earlier, wells in the area are *very* limited in production and require very deep drilling to reach water holding formations. New sources of water supply must be developed to handle any increased need, Use of water directly from the stream could threaten fish populations and down-stream migrations, especially during years of low rainfall,

Increased population in the basin also will bring potential problems from wastewater and sewage disposal. Currently, the area is on a septic tank and cess pool system, Way (1978) states that “septic tank leech fields are usually difficult to locate in flood plains owing to the associated high water table." Since most development thus far has been in the flood plain the associated terraces, any further development in this area could cause great problems in groundwater contamination,,

Trotter-Yoder Associates (1975) in their report of regional interceptor sewer routes for the Humboldt Bay Wastewater Authority projected population growth in the Freshwater area for 1985 and 1995 to be 912 and 1095 respectively. They also projected sewer output (in mgd) to increase from 0.21 to 0.26, respectively, over the same period. They cite development pressures from Arcata and Eureka for the tendency to push residential uses outward into rural areas, such as the Freshwater area. They recommend that "the need for urban limit lines is now a clear issue" and that expansion and growth into rural areas should be limited, or allowed with great concern for potential negative impacts,

The County of Humboldt has forseen many of these potential problems. In their Open Space Conservation Element of the General Plan (1973), they have set down guidelines for future development in the county, Among these is consideration of negative impacts of development on water resources, They have viewed water quality as being central to ecology, especialy in this county, "'This ecological chain becomes integrated with recreation and economic relationships when we note that fish and wildlife are even more important to the county beyond their self-importance% man enjoys fishing for recreation--many county residents operate businesses which depend on the availability of fish and wildlife? From this philosophy they have determined that "to protect and promote significant wildlife, fish, and marine areas, development should be prohibited that will have significant adverse effect upon upon rivers, creeks, sloughs, estuaries, lagoons. . Buffer zones may be established near or around certain rivers, creeks, sloughs, estuaries, lagoons..,. to maintain the quality of water and prevent contamination, pollution or alteration of the quality of the water." Also, future construction sites in the county are to be considered under the guideline that "steeply sloping land, flood plains, . s9 present hazards to public safety and are unsuitable for urbanization," In areas of the study basin, this guideline would eliminate future residential construction,

Projections and Recommendations

Due to extreme retardation of the construction industry nation-wide, and economic recession, in general, the lumber industry has suffered great cutbacks, Therefore, any future logging in the watershed will be quite limited, at least in the short term. Any potential impacts in the watershed from logging will, consequently be minimal in the near future,

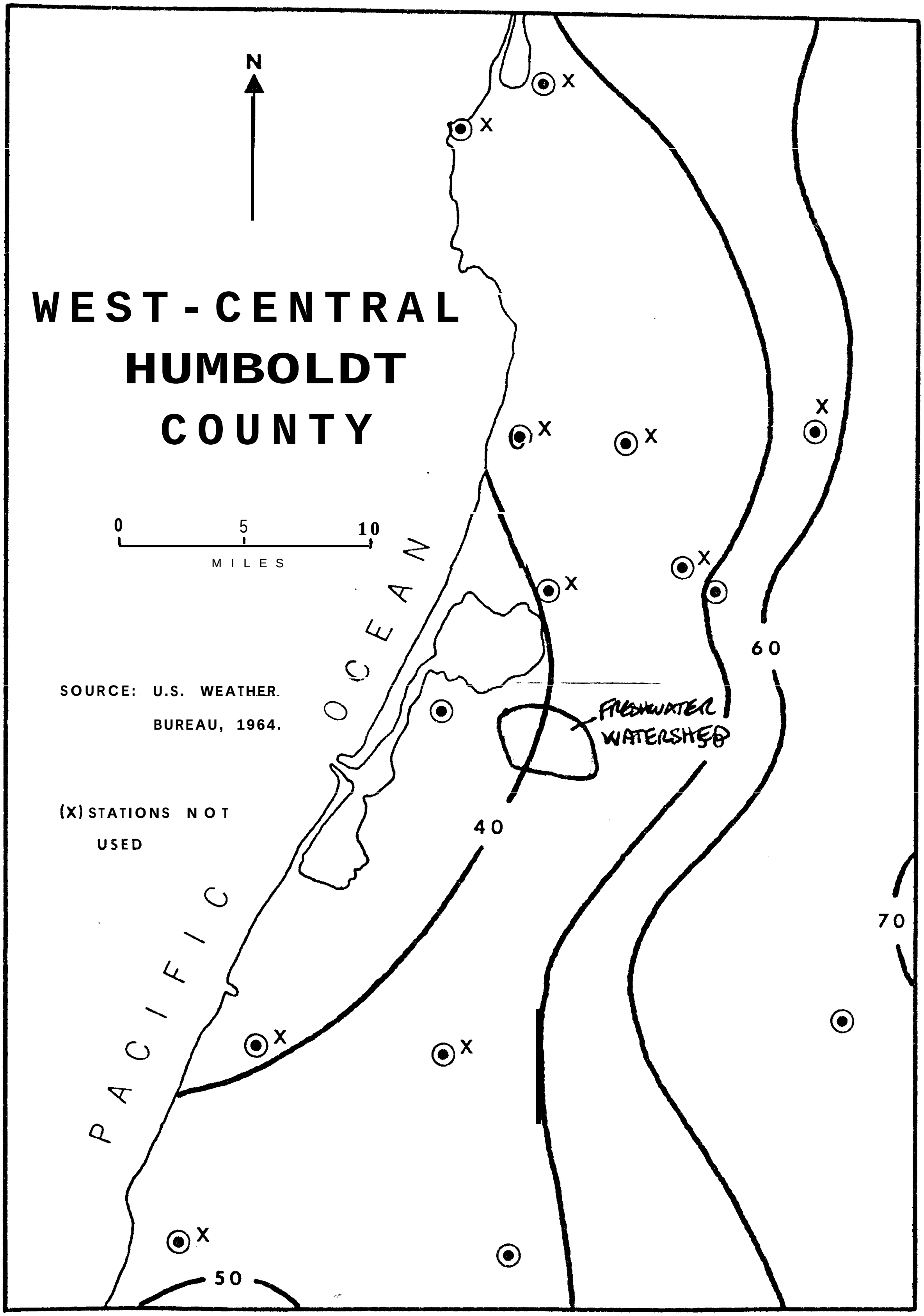
While water supply and use are not at a critical state currently, they are at a maximum level and could become a problem with any future growth in the area's population. New supply sources must be found or developed. This limited supply of drinking quality water will limit potential growth in this area.

Recreational use of the watershed is currently limited by reduced or nonexistent access on much of the private property within the basin. Through the efforts of the Humboldt Fish Action Council, the fishery in Freshwater Creek has been greatly improved., With the construction of the permanent fish trapping facility on the creek, this resource will be even further improved. Development of recreational use of this available resource should be considered by such agencies as the California Department of Fish and Game, and the Humboldt County Supervisors. This would require improved access to the stream over private or purchased lands and increased public awareness of the availability of the fish in this watershed. Regulation of the fishery by California Department of Fish and Game should also be examined to insure protection and preservation of this important anadramous stream.

The widening of Myrtle Avenue-Old Arcata Road and its resultant bridge construction will increase preventation of potential flooding. Problems of debris buildup along the channel and on the bridge support structures will continue to present potential flooding problems. Because of the size of the drainage, past logging activities and normal leaf and litter buildup, high amounts of debris being washed into the streams cannot be prevented. This year a Y.A.C.C. crew has removed much of the riparian vegetation which tended to catch this debris and cause blockages, This kind of preventative action will have to be continued to head off potential flood events,

Livestock grazing often has negative impacts on watersheds due to streambank erosion and organic nutrient load increases.

In the study basin most of the livestock grazing occurs around the lower reaches of the watershed, thus mitigating any potential direct hazard to humans from animal waste input. The wastes do enter Humboldt Bay through Eureka Slough, however,._and thus coliform levels should be monitored near the discharge site of the slough into the Bay. Sediment input in the bottom lands is increased by livestock trampling the dikes lining the lower stream, but this impact is small on the quality of the water in the stream and should be allowed to continue. Future changes in water use might demand further consideration of this situation.



Mean annual precipitation (Inches). (AFTER BACA)

APPENDIX 2

WATERSHED PARAMETERS

Basin-altitude index = 825 ft; 251 meters

Main channel slope index = 198.8 ft/mi. or 3.8%

Main channel mean slope = 38 m/km, or 20.1 ft/mi.

Stream length by order:

Stream order	Length	
1	23.0mi	37km
2	12.0mi	19.3km
3	5.8mi	9.3km

There are 29 miles of intermittent streams and 11.8 miles of year-round flowing streams for a total of **40.8** miles of streams in the basin

Drainage density $(D_d) = \frac{L}{A} = \frac{65.6 \text{ km}}{80.1 \text{ km}^2} = 0.82$

Mean slope of the watershed $(S) = \frac{100DL}{A} = 19.0\%$

Form factor $= \frac{\text{Basin Area}}{\text{Axial length}^2} = \frac{50.9}{(8.5)^2}$ 0.43

Basin Circularity $= \frac{\text{Area of Basin}}{\text{Area of Circle with same Perimeter}} = \frac{12.57A}{P^2} = 0.70$

Relief ratio $= \frac{\text{total relief}}{\text{basin length}} = \frac{3050 \text{ ft}}{44,853 \text{ ft}} = 0.068$

Compactness coefficient $(K_c) = \frac{P}{2\sqrt{A\pi}} = 0.28\frac{P}{\sqrt{A}} = 0.28(4.225) =$

$$K_c = 1.18$$

The compactness coefficient describes the ratio of watershed perimeter to the amount of area encompassed, High values K_c (1.4-2.0) show that there is comparatively little area in comparison to length of the perimeter. Conversely, low values of K_c (1.0-1.4) show high values of enclosed area for the given perimeter, or an approximately circular-shaped basin. In this case where K_c = 1.18, the basin is circular.

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