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EEL-RUSSIAN RIVERS STREAMFLOW AUGMENTATION STUDIES



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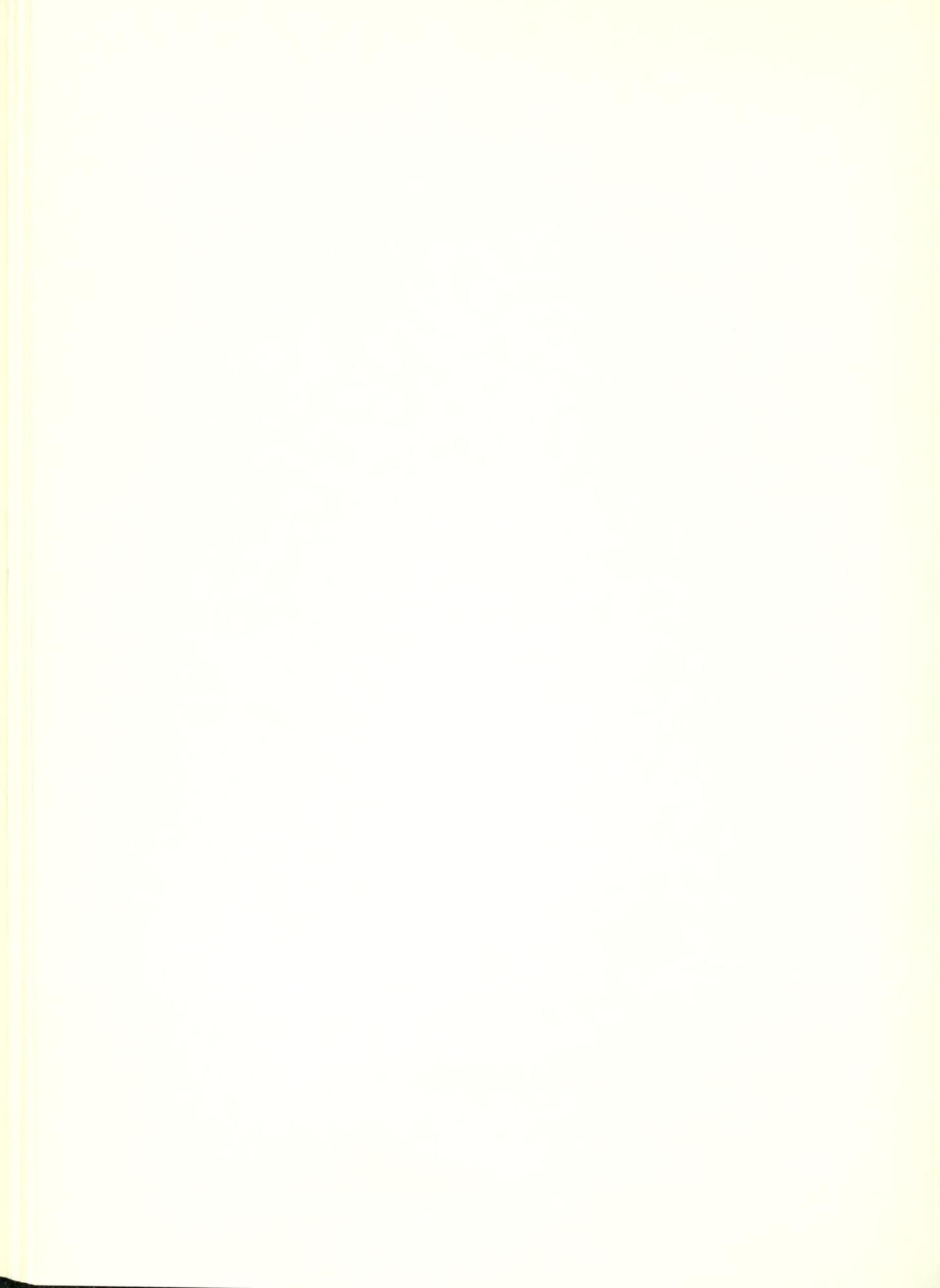


FEBRUARY 1976

CLAIRE T. DEDRICK
Secretary for Resources
The Resources Agency

EDMUND G. BROWN JR.
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RONALD B. ROBIE
Director
Department of Water Resources



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EEL-RUSSIAN RIVERS STREAMFLOW
AUGMENTATION STUDIES

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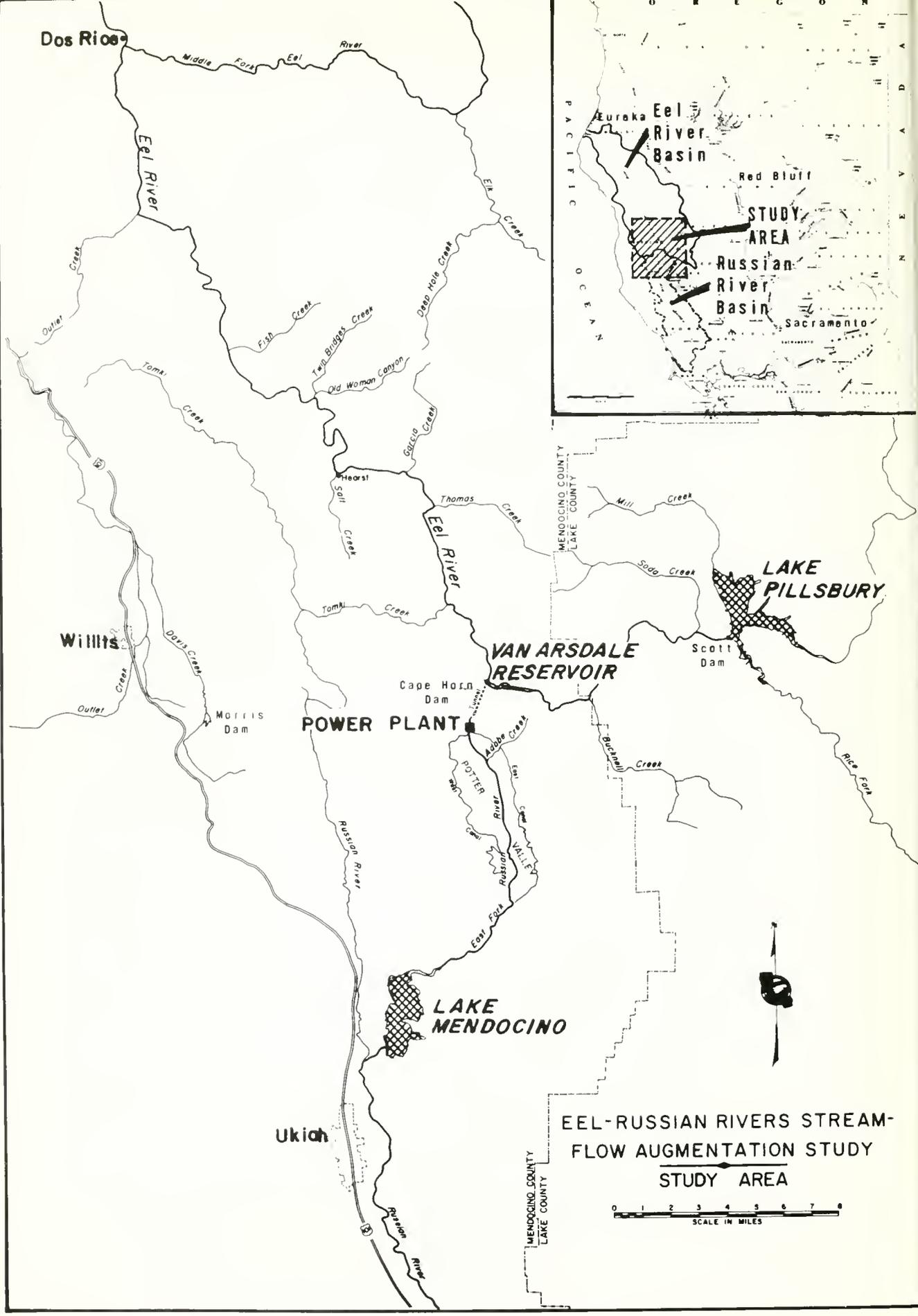
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Eel River Water Council Henry Spomer, Jerry Butchert
Humboldt County Ray Peart, Supervisor; John Winzler
Lake County Willard Hansen
Mendocino County Ernest F. Banker, Supervisor
Sonoma County Water Agency Gordon Miller, Richard Norton
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Fish and Game Jack C. Fraser, L. Frank Goodson
U. S. Bureau of Reclamation James Wiley, Ernest Sasaki
U. S. Army Corps of Engineers Charles E. Elmore
Mendocino County Russian River Flood Control
and Water Conservation Improvement District Christopher Keiffer
North Marin County Water District Gene Churchill, John O. Nelson

FIGURE 1



INTRODUCTION

In April 1972, the Federal Power Commission issued a 50-year license for the Potter Valley Project. As the April 1972 expiration date of that license approached, the California Department of Fish and Game, Humboldt County, and others expressed interest in modifying the project operation to overcome problems in the Eel River Basin. At the August 1972 meeting of the California Water Commission in Eureka, representatives of Humboldt County and the Eel River Water Council requested the Commission's assistance in initiating an in-depth study of ways to improve Eel River fisheries and recreation through a modified operation of Lake Pillsbury. In response to the Commission's request, the Department of Water Resources agreed to participate in a study aimed at finding solutions to some of the problems.

One of the biggest problems in a study such as this is that any suggestion for revising the existing system would run counter to the interest of one or more of the many agencies involved. To assure that all interests would be fairly considered, the Department joined with the Eel River Water Council ^{1/} in organizing an interagency study committee to oversee the conduct of the study. This study committee was comprised of representatives from the Eel River Water Council, Humboldt County, Lake County, Mendocino County, Sonoma County Water Agency, Mendocino County-Russian River Flood Control and Water Conservation Improvement District, North Marin County Water District, Pacific Gas and Electric Company, Department of Fish and Game, Department of Water Resources, U. S. Army Corps of Engineers, U. S. Bureau of Reclamation, U. S. Bureau of Sport Fisheries and Wildlife, and the U. S. Forest Service. Major effort on the study was performed by a technical subcommittee made up of the Department of Water Resources, the Department of Fish and Game, and the Corps of Engineers. The location of the study area is shown in Figure 1 on the opposite page.

Related Reports

In addition to this report, there are three other reports by member agencies of the technical subcommittee that document work done during the study. These reports are published by the responsible agency and copies can be obtained as noted below.

Engineering studies within the Russian River Basin were done by the Corps of Engineers. Those studies are documented in a report titled "Eel-Russian Rivers Streamflow Augmentation Study, Humboldt, Mendocino, Sonoma, Lake, and Marin Counties, California", published in December 1974. This report can be obtained from the Corps of Engineers, San Francisco District, 100 McAllister Street, San Francisco, California 94102.

^{1/} The duties of the Eel River Water Council relating to this study have since been taken over by the North Coast County Supervisors Association.

Fisheries evaluations by the Department of Fish and Game are documented in a report titled "Eel-Russian Rivers Streamflow Augmentation Study: Reconnaissance Fisheries Evaluation", published in February 1975. This report can be obtained from the Department of Fish and Game, Region 3, P. O. Box 47, Yountville, California 94599.

The third report, presently being prepared by personnel of the Department of Fish and Game, will provide complete documentation of data obtained in the summer flow evaluation discussed later herein. When it is completed, that report can be obtained from the Department of Fish and Game, 1416 Ninth Street, Sacramento, California 95814.

THE POTTER VALLEY PROJECT

About 100 miles north of San Francisco Bay, in Lake and Mendocino Counties, a hydroelectric project impounds and diverts water from the Eel River Basin into the Russian River Basin. This project, which derived its name from Potter Valley where the power plant is located, was first begun in 1905, interrupted by the 1906 earthquake, and began operation in 1908. The Potter Valley Project was planned and constructed by the Snow Mountain Water and Power Company and was acquired by Pacific Gas and Electric Company in August 1931.

Background

Initial features of the project were Cape Horn Dam (Van Arsdale Reservoir) on the upper Eel River, a diversion tunnel to Potter Valley in the Russian River Basin, and a 4,000 kilowatt (kw) power plant. Over the years the power plant has been modernized and expanded to a present installed capacity of 9,040 kw and generates about 61,000,000 kilowatt-hours (kwh) of energy annually.

Prior to construction of Scott Dam (Lake Pillsbury) the system operated on a run-of-the-river basis, diverting the entire flow of the Eel River, up to the capacity of the tunnel, except for a minimum release of 2 cubic feet per second (cfs) for downstream water users. Scott Dam was added to the system in 1921, and now provides 86,800 acre-feet of storage capacity to sustain the power diversion through the dry summer months. This amount of storage is inadequate to maintain the diversion at full capacity. Historically, the project has operated at about two-thirds capacity in August and September.

During the 48-year period evaluated in this study, from October 1922 to September 1970, an average of 154,700 acre-feet per year has been diverted from the Eel River into the Russian River Basin. Actual historical diversions have ranged from a low of 71,000 acre-feet in 1924 to a high of 221,000 acre-feet in 1967. In 1950 the tunnel was enlarged to its present capacity of 345 cfs. Adjustments of the historical diversions to account for the increased capacity derived a base diversion of 184,000 acre-feet per year for this study. The historical operation of the system, and adjustments of the historical diversions, are described in detail as Alternative 1 later in this report.

In 1959 the Corps of Engineers constructed Coyote Dam (Lake Mendocino) on the East Fork Russian River. Most of the water stored in Lake Mendocino is supplied by diversions from the Eel River. The existing reservoir, which was constructed to a capacity of 122,900 acre-feet, provides a firm yield of 65,000 acre-feet per year.

Lake Mendocino is the first feature of a three-phase water development program for the Russian River Basin. The second phase, Warm Springs Reservoir on Dry Creek, is currently under construction. The third phase would be enlargement of Coyote Dam and Lake Mendocino. Coyote Dam was designed to provide for future enlargement to a storage of 199,000 acre-feet and a total yield of 113,000 acre-feet per year. The existing project stores and regulates only about half the water diverted from the Eel River. Under the present operation, surplus water that would be developed by enlarging Lake Mendocino spills from the reservoir and flows down the Russian River to the ocean.

Accomplishments

The Potter Valley Project has been a boon to the Russian River Basin. Eel River water, regulated in Lake Mendocino, provides a firm base for municipal, industrial, and agricultural water use in the Russian River Basin. This water supply has had a positive influence on economic development throughout the Russian River Basin, from the Potter Valley Irrigation District in Mendocino County to the Santa Rosa Plain in southern Sonoma County. The influence actually extends outside the Russian River Basin, since the North Marin County Water District obtains part of its water supply from the lower Russian River.

Releases from Lake Mendocino maintain a minimum flow of 125 cfs in the Russian River at Guerneville. This sustained flow has supported the development of a summer recreation industry in the lower basin that attracts over 2 million visitor-days of use each year. Winter and spring flows, although frequently too turbid for fishing, have historically supported fish populations that have given the Russian River wide repute as a prime producer of salmon, steelhead, and American shad.

The Potter Valley Project also provides some benefits within the Eel River Basin. Lake Pillsbury and Van Arsdale Reservoir support about 170,000 visitor-days of recreation use each year. Also, the 12-mile reach of river between Scott and Van Arsdale Dams supports a trout fishery and provides spawning and nursery areas for steelhead and a few king salmon. Due to releases from Lake Pillsbury, this 12-mile reach is the only part of the upper Eel River stream system with relatively high sustained flows throughout the summer months.

The Potter Valley Project also contributes to the local economy. Pacific Gas and Electric Company's application to the Federal Power Commission for a new license states that in 1970 the project paid \$180,000 in local taxes, divided \$103,000 to Lake County and \$77,000 to Mendocino County. The project also contributes a substantial payroll to the area, and its 61 million kwh of energy generation provides a significant part of the local energy requirements, although the 9,040 kw power plant represents



Cape Horn Dam - Van Arsdale Reservoir

Photo courtesy of PGandE



Potter Valley Powerhouse

DWR Photo



Coyote Dam - Lake Mendocino

Photo courtesy of U.S. Army Corps of Engineers

less than one-tenth of 1 percent of the company's 1970 total installed capacity of 9,471,900 kw.

Problems

Operation of the Potter Valley Project has created several problems in both the Eel River and Russian River Basins. The principal problem is the adverse effect on anadromous fish in the Eel River. During early storms each fall, adult fish are attracted into the upper Eel River to spawn. However, once these storms subside, all available runoff is used for refilling Lake Pillsbury and for diversion to the Potter Valley Powerhouse, except for a minimum release of 2 cfs. This results in a section of the river below Cape Horn Dam being essentially dewatered between storms. Eggs deposited by spawning fish during the high water periods are lost, and fish may be trapped by the intervening low flows and die without spawning.

Another problem is inadequate summer flows in the Eel River. During the summer months a release of only 2 cfs is made at Cape Horn Dam for downstream water rights. This release is barely enough to maintain a flowing stream. It provides very limited habitat for anadromous fish and maintains only minimal esthetic appeal for recreation users of the river.

A third problem is water turbidity in the Eel and Russian Rivers. This turbidity is caused by extremely fine sediment particles in the upper Eel River watershed, which remain suspended in the water for prolonged periods of time. After the first major storm of the winter season, water stored in Lake Pillsbury becomes highly turbid. Flows in the Eel River and diversions to the Russian River remain turbid until the spring months, when the fine sediment in Lake Pillsbury finally settles out. At times, sustained turbidity severely limits winter fishing on both the Eel and Russian Rivers. However, during periods when these rivers are fishable, they provide some of the best salmon and steelhead fishing in California's north coastal area.

CONFLICTS AND CONSIDERATIONS

Most of the agencies represented on the study committee have a direct interest in some aspect of the operation of the Potter Valley Project. Several of these interests are in direct conflict. The following paragraphs describe the more significant conflicts.

Anadromous fish runs and recreation use in the Eel River have been damaged by operation of the Potter Valley Project. Consequently, Humboldt County, northern Mendocino County, and the Department of Fish and Game are interested in obtaining increased flows to improve conditions in the Eel River. However, using Lake Pillsbury storage or reducing diversions to provide these increased flows could have an adverse effect on recreation use at Lake Pillsbury, on power generation at Potter Valley Powerhouse and on recreation use and water supply in the Russian River Basin.

The Pacific Gas and Electric Company operates the project to maximize power production at the Potter Valley Powerhouse, which adversely affects flows in the Eel River and recreation use at Lake Pillsbury. However, the company's application (page 2 of Exhibit H) to the Federal Power Commission for a new license states:

"The water surface at Lake Pillsbury will be maintained as high as possible during the recreation season consistent with operational demands and irrigation requirements."

The Sonoma County Water Agency, North Marin County Water District, and Mendocino County-Russian River Flood Control and Water Conservation Improvement District have jointly purchased storage rights in Lake Mendocino and want to maintain firm water supplies to their service areas. In years of below-normal runoff, these agencies want to maximize the diversions from the Eel River, which adversely affect anadromous fish runs and recreation in the Eel River and recreation use at Lake Pillsbury.

The U. S. Forest Service, which operates recreation facilities at Lake Pillsbury, is interested in maintaining the lake as full as possible during summer months for recreation use. However, holding the water in storage during the recreation season would result in a reduction in power production, reduction of streamflows in the Eel and Russian Rivers, reduced recreation use at Lake Mendocino, and a reduction in water supply to the Russian River Basin.

The Corps of Engineers is interested in maintaining summer reservoir levels in Lake Mendocino as high as possible to provide for maximum recreation use. A reduction of summer diversion from the Eel River could cause the lake levels to be lowered.

Obviously, any plan involving modified operation of the Potter Valley Project would infringe somewhat upon the interest of one or more of the agencies who are concerned with use of the waters of the Eel and Russian Rivers.

WATER RIGHTS AND HYDROLOGY

To the extent possible, this study used information and basic data from previous studies within the Eel and Russian River Basins. The following sections discuss several areas of information pertinent to the study.

Water Rights

Established rights for use of waters originating within the Eel River Basin above Cape Horn Dam include approximately 2 cfs that is required for release to water right owners in the Eel River watershed downstream from the dam, water rights granted for operation of the Potter Valley Project for power purposes, and irrigation water rights for the Potter Valley Irrigation District.

Rights to the use of waters of the Eel River pertaining to the Potter Valley Project are described in Exhibit E of the Pacific Gas and Electric Company's application for a new license as follows:

"The water rights, both storage and direct diversion, which are used by Licensee in the operation of its Potter Valley Project include rights based on original appropriations and beneficial use prior to the enactment of the State of California Water Commission Act of 1913, and rights granted by permits and confirmed by licenses issued by the State of California.

"a) Storage Rights Are:

"1. Lake Pillsbury

"102,366 acre-feet per annum to be collected from November 1 to June 1 for power purposes under License 1424 pertaining to Application 1719, Permit 781, with priority of March 12, 1920, and 4,500 acre-feet per annum to be collected from November 1 to April 30 for irrigation use within the Potter Valley Irrigation District under License 1199 pertaining to Application 5661, Permit 2954, with priority of August 15, 1927, and 4,908 acre-feet per annum to be collected from November 1 to June 1 for irrigation use within the Potter Valley Irrigation District under License 5545 pertaining to Application 6594, Permit 3635, with priority of March 11, 1930.

"b) Direct Diversion Rights Are:

"1. Van Arsdale Reservoir at Intake

"20,000 miners inches direct diversion the year around under original appropriation with a priority date of July 25, 1905, and 800 acre-feet per annum under original appropriation with a priority date of 1907.

"2. Van Arsdale Reservoir at Intake

"40 cubic feet per second from May 1 to October 15 of each year under License 5545 pertaining to Application 6594, Permit 3635, with priority of March 11, 1930."

The Sonoma County Water Agency and the Mendocino County Flood Control and Water Conservation Improvement District have been granted direct diversion and storage permits for waters of the East Branch Russian River and the Russian River. At the present time, the Mendocino County Flood Control and Water Conservation Improvement District has a permit from the State Water Resources Control Board to use up to 8,000 acre-feet annually from the Russian River. The Sonoma County Water Agency has established water rights for a diversion of 37,544 acre-feet annually at Wohler and Mirabel Park on the Russian River, part of which has been contracted for use in Marin County. Permits for an additional 10,000 acre-feet of Sonoma County Water Agency project water from Lake Mendocino will

be granted by the State Board directly to individual diverters from the Russian River. The Sonoma County Water Agency has recently petitioned the Board to have the 37,544 acre-feet entitlement increased to 75,000 acre-feet. The Sonoma County petition has been protested by several individuals and agencies, including Mendocino County and various environmental groups.

In 1959 the Sonoma County Water Agency and the Mendocino County Russian River Flood Control and Water Conservation Improvement District applied for water right permits to cover the water diverted from the Eel River by the Potter Valley Project. These applications were made to insure the continuation of the diversion in the event the Federal Power Commission should reject the application for a new license for the project. Their applications were denied by the State Board in 1972. The Board's decision D1403 concluded:

". . .that the filing of Applications 18785 and 18786 was premature and they should be denied for lack of unappropriated water without prejudice to the refiling at some future date should Pacific Gas and Electric Company be unsuccessful in securing renewal of the power license."

Should the power license not be granted, it would appear that the water presently appropriated for power purposes would become subject to appropriation by any agency that could put it to beneficial use. Allocating that water among conflicting applications would then be within the jurisdiction of the State Water Resources Control Board. It therefore appears that continued operation of the Potter Valley Project is the principal assurance Russian River Basin interests have for continued use of water originating within the Eel River Basin.

The Department of Water Resources is presently conducting a planning investigation within the Russian River Basin. A more extensive discussion of water rights pertaining to Mendocino, Sonoma, and Marin Counties will be contained in the report on that investigation, which is scheduled for completion in 1976.

A complete determination of rights to the use of water from the upper Eel River would involve complex legal issues. Such a determination was not within the purview of this study. However, it appears that settlement of water rights questions by an adversary proceeding in the courts would almost certainly be a lengthy and costly process. A compromise solution would appear to be to the advantage of all interests involved.

Hydrology

Data on diversions from the Eel River by the Potter Valley Project and on related streamflows in the Eel and Russian River Basins were derived from several sources. Streamflows in the Eel River Basin were obtained from a California State-Federal Interagency Group report titled "Eel and Mad River Basins Master Plan - Hydrology", August 1969. Historical diversions to the Russian River, adjusted to account for a 1950 enlargement in tunnel capacity, were taken from previous planning

studies of the English Ridge Project. Streamflows in the Russian River Basin were obtained from previous planning studies for Coyote Dam (Lake Mendocino) conducted by the Corps of Engineers.

Since storage in Lake Pillsbury started in November 1921, hydrologic data directly related to operation of the Potter Valley Project were adjusted to a 48-year base period of October 1, 1922-September 30, 1970 for this study. These data are presented in Appendix B at the end of this report. Streamflow and diversion data shown in Appendix B were used in operation studies to evaluate the effects of various possible revisions in operation of the Potter Valley Project.

Summer Flow Evaluation

In evaluating the results of reservoir operation studies, the technical subcommittee concluded that it was vital to the study to obtain some measure of the effect of various summer flows on the Eel River. Therefore, the Pacific Gas and Electric Company was asked to make special flow releases from Lake Pillsbury to the Eel River. The Departments of Water Resources and Fish and Game agreed to monitor and evaluate the effects of these releases. The Pacific Gas and Electric Company agreed to provide a block of water totaling 1,200 acre-feet for the flow evaluation on a schedule to be determined jointly by the Department of Water Resources and the Department of Fish and Game.

The flow evaluation was conducted between July 26 and August 6, 1973, with streamflows being varied between 10 and 83 cfs. Results of the evaluation are presented in detail in an administrative report now being prepared by the Department of Fish and Game.

Included in the flow evaluation were measures of several habitat parameters for fish, such as water temperature, depth-velocity ratio, and spawning area availability. These studies documented the phenomenon of water temperature stratification within deep pools, with relatively cool water at the bottom of pools even when surface temperatures become very warm. This fact has been noted in earlier studies within the Eel River Basin, but has not previously been studied in detail or documented in any known reference publication. Probably the most important result of the flow evaluation was documentation of the effect of various flows on thermal stratification. Larger flows reduce the amount of cool water, and flows of sufficient magnitude will eliminate the cool water zone and lose the benefits of thermal stratification.

Understanding the importance of thermal stratification to anadromous fish populations requires a knowledge of the water temperature pattern in the Eel River and the life cycle of salmon and steelhead. These items are discussed in the following paragraphs.

The temperature of water released from Lake Pillsbury (river-mile 168.5) 1/ is usually about 58°-60° F. during the summer. At Van Arsdale Dam (river-mile 156.8) maximum temperatures are usually

1/ River mileage, from an index by the Federal Power Commission, measures the length of stream channel upstream from the mouth of the river.

about 70°-72° F. In the reach of the river from Van Arsdale to about the mouth of the South Fork (river-mile 40.6), maximum temperatures are normally about 85°-87° F. The highest water temperature of record, 91° F., was recorded at Fort Seward (river-mile 64.5) in 1969, when maximum air temperatures in the area exceeded 100° F. for a period of 6 days. Temperatures in the lower Eel River are strongly influenced by the ocean climate. At Scotia (river-mile 20.7), maximum water temperatures during the summer are about 72°-74° F. At its mouth, the river is subject to both the ocean climate and tidal mixing and cools to the ocean temperature, usually 50°-55° F.

Steelhead trout are anadromous; that is, they spawn in fresh water, but live most of their lives in the ocean. Juvenile steelhead normally remain in the stream from 1 to 3 years before migrating to the ocean. They must therefore have suitable year-round habitat to survive. These juvenile fish prefer water temperatures below 60° F., but can survive fairly well in temperatures up to the low 70's. Sustained water temperatures higher than about 78° F. are lethal.

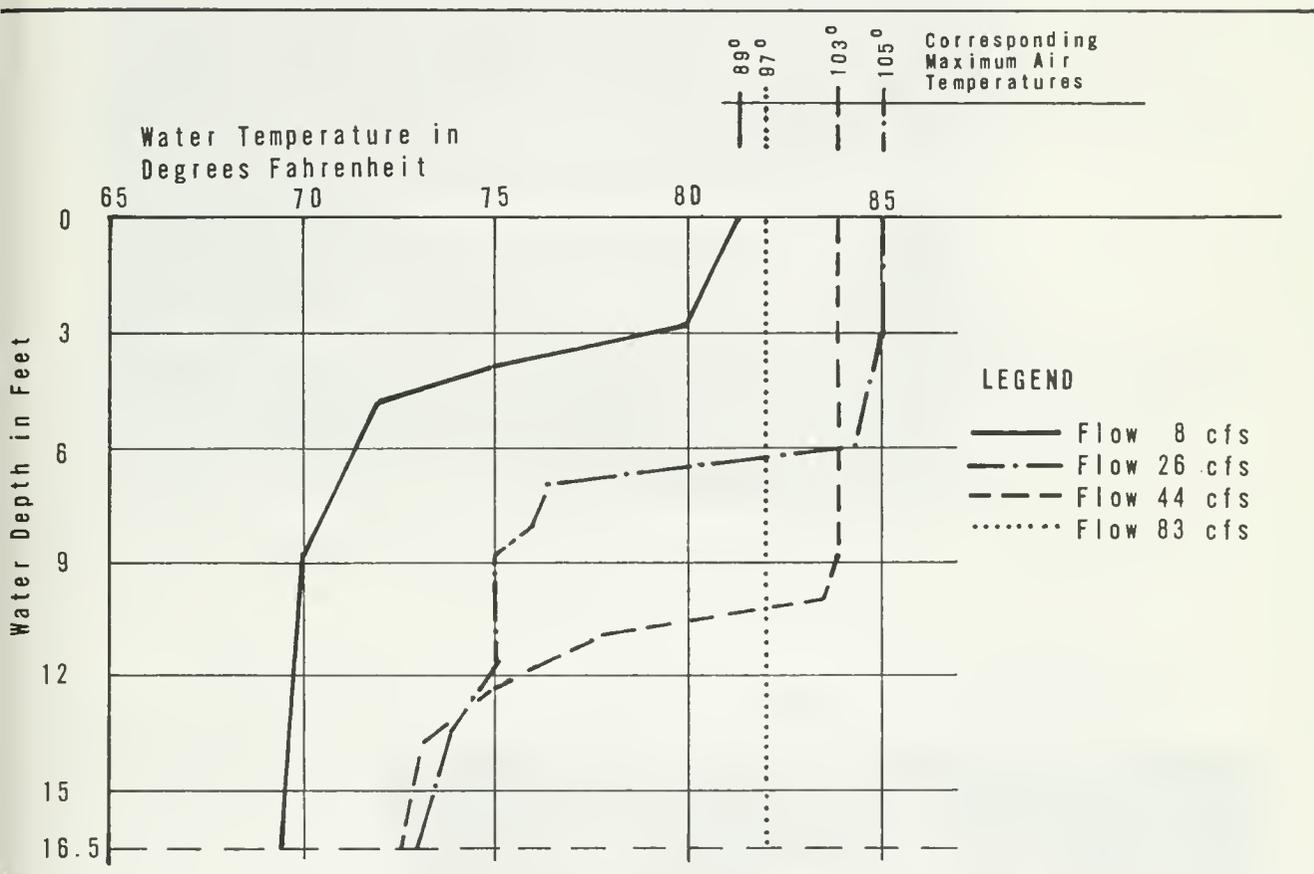
Observations of the Eel River during the summer flow evaluation indicate that pools are formed wherever there is obstruction to flow, such as bedrock outcrop on the streambank or large boulders deposited in the channel by landslide activity or bank erosion. Typical configuration of the river is a series of pools with gravel bars and riffles between them. This configuration changes from year to year as gravels are transported by high flows during the winter months. Pools inspected during the summer flow evaluation ranged from 9 to 16 feet in depth, averaging about 11 feet.

In the summer months, surface water temperatures in the Eel River fluctuate on a diurnal cycle of about 12 or 13 degrees in response to climatic influences that cause a daily air temperature range of about 40 or 45 degrees. At the low point in this cycle, in the early morning, the entire river cools to a uniform temperature. However, as the water warms in shallow riffle areas during the day, the less dense, warmer water flows across the top of the pools, leaving cooler water at the bottom.

Figure 2 shows typical maximum temperature profiles in a deep pool during the late afternoon when the stratification effect is fully established. These temperature profiles indicate that the stratification effect maintains a marginal habitat for fish within the lower levels of the pools, even on the hottest summer days. Figure 2 also shows that the amount of cool water is decreased as flows increase. At a flow of 8 cfs, the thermocline is at a depth of 4 to 5 feet. Increasing the flow to 26 cfs lowers the thermocline to a depth of 6 to 7 feet. At 44 cfs, the depth is 10 to 12 feet, and at 83 cfs, the stratification effect is eliminated.

FIGURE 2

TYPICAL DAILY MAXIMUM TEMPERATURE PROFILES
 IN THE EEL RIVER AT FISH CREEK
 (River Mile 134.2)



Previous studies within the Eel River Basin have shown that very few juvenile anadromous fish are found in the main channel of the Eel River between Van Arsdale Dam and the South Fork during the summer months. According to the Department of Fish and Game, this reach of the river is used principally as a migratory route to tributaries and areas farther upstream. Observations by the Department of Fish and Game during the summer flow evaluation in the reach between Van Arsdale Dam and Outlet Creek indicate that the few juvenile anadromous fish inhabiting this reach may depend upon the cool water zones at the bottom of pools to survive periods of extremely high temperature during the summer months. Recent studies by the Department of Fish and Game indicate that juvenile steelhead also occupy the riffle areas between pools during the summer. It is possible that destratification of the pools would not have as much effect on steelhead populations as previously supposed. Increased summer flows would deepen the riffle areas and might improve these areas for steelhead. Although not documented, the same situation probably exists in the Eel River between Outlet Creek and the South Fork.

EEL RIVER AT FISH CREEK



Looking upstream - riffle in foreground is at inlet to the pool shown below.



Looking downstream - this pool is over 16 feet deep near the large boulder at left center. Fish Creek enters the Eel River from right in the left background.

More information is needed on thermal stratification, effects of various flows, and fish populations before any firm conclusions can be reached. Until more information is available, the Department of Fish and Game believes that if the available water supply is very limited, most of the water should be released between November and April during the upstream and downstream migration periods. The temperature profiles in Figure 2 indicate that a summer flow of up to 25 cfs would maintain the stratification in pools more than about 7 feet in depth. This flow would also provide a significant improvement in the appearance and recreation potential of the Eel River, and increased rearing habitat immediately below Cape Horn Dam and in the lower 50 miles of the river.

THE ALTERNATIVES

At its first meeting in October 1972, the study committee defined the alternatives to be evaluated and assigned responsibilities for conduct of the study. All engineering studies within the Eel River Basin were assigned to the Department of Water Resources. Similar responsibilities in the Russian River Basin were assigned to the Corps of Engineers. Recreation evaluations in the Eel and Russian River Basins were assigned to the Department of Water Resources and the Corps of Engineers, respectively. Fisheries evaluations in both river basins were to be done jointly by the Department of Fish and Game and the U. S. Fish and Wildlife Service.

The Department of Water Resources and the Corps of Engineers allocated funds specifically for this investigation. The Department of Fish and Game assigned personnel from Region 3 (Yountville) to do the required fisheries studies. The Bureau of Sport Fisheries and Wildlife also contributed in response to an interagency request from the Corps for a fisheries evaluation in the Russian River Basin, and the Bureau of Reclamation provided some design and cost data.

Initially, the study committee defined six alternatives to be evaluated, ranging from continuing the historical operation of the system with no change, to complete shutdown of the power diversion. As the work progressed, the number and scope of alternatives were modified to fit available funds and manpower. Evaluation of two alternatives was expanded to consider various levels of flow, two alternatives were limited to a cursory evaluation, and one was dropped from consideration entirely.

Following is a list of the alternatives considered:

1. Evaluation of leaving the existing system and operation "as is".
2. Reoperation of the existing Lake Pillsbury-Potter Valley-Lake Mendocino complex to augment flows in the Eel River without substantially adversely affecting beneficial uses within the Russian River Basin.
3. Reoperation of existing Lake Pillsbury and enlarged Lake Mendocino to provide increased streamflow for fisheries enhancement and summer recreation in the Eel River without necessitating severe restriction in output of the Potter Valley Powerhouse.

4. Reoperation of Lake Pillsbury, enlarged Lake Mendocino, and an enlarged Potter Valley tunnel, and abandonment of the Potter Valley Powerhouse, to provide enhancement of the fishery and summer recreation in the Eel River, while meeting present and future recreation and consumptive water needs in the Russian River Basin.
5. Reoperation of the existing Lake Pillsbury-Lake Mendocino system with abandonment of the Potter Valley Powerhouse to provide the minimum diversion to the Russian River that is necessary to maintain present beneficial uses and streamflow requirements and provide increased flows for fisheries enhancement and summer recreation in the Eel River.
6. Evaluation of the impact on both the Eel and Russian River Basins of closing off the diversion tunnel.

Another alternative that was considered briefly was the possibility of providing increased storage in the Eel River Basin. This would relieve the primary fault of the existing system -- inadequate storage in Lake Pillsbury. The study committee abandoned this possibility because it could not be fully evaluated within the limited funding available.

Evaluation Procedure

Determining the effect of these alternatives on the Eel and Russian River Basins consisted of defining the operation of Lake Pillsbury, releases to the Eel River, diversions from the Eel River to the Russian River, and operation of Lake Mendocino in the Russian River Basin. Operation studies for Lake Pillsbury and Van Arsdale Reservoir and studies of diversions from the Eel River were done by the Department of Water Resources. Output from these studies, consisting of modified diversions to the Russian River Basin, were provided to the Corps of Engineers for use in its operation studies of Lake Mendocino.

Operation studies of the Eel River portion of the existing system used the following criteria:

1. Maintain operating levels of Lake Pillsbury at or near historical level to minimize adverse effects on recreation use at the lake, and maintain a minimum pool of 20,000 acre-feet except in extremely dry years such as 1924.
2. Make releases to the Eel River at Van Arsdale Dam on various schedules provided by the Department of Fish and Game. (These schedules are shown in Table 1 in the following section.)
3. Modify historical diversions to the Potter Valley Powerhouse as necessary to meet criteria 1 and 2, and to maximize the diversion during the winter months when Lake Pillsbury is full.
4. In years when the available water supply is inadequate to meet all demands (generally when runoff is less than 45 percent of normal), reduce releases to the Eel River by 50 percent.

5. In extremely dry years such as 1924, if the summer release schedule under criterion 2 is 50 cfs or more, reduce releases to the Eel River by 75 percent.

Modified diversions to the Russian River Basin as defined by these operation studies were used by the Corps of Engineers for similar operation studies of both existing and enlarged Lake Mendocino. Criteria for the Russian River operation studies included:

1. Depleting inflows to Lake Mendocino to allow for use of water by the Potter Valley Irrigation District.
2. Maintaining a minimum flow of 150 cfs at the confluence of the Russian River and the East Fork Russian River.
3. Maintaining a minimum flow of 125 cfs in the lower Russian River from Guerneville to the mouth.
4. Maintaining firm releases for prior downstream water rights.

The Corps' studies determined the effect various changes in Eel River diversions would have on the operation of Lake Mendocino and on water supply yield in the Russian River Basin. One difference in criteria between the Corps' and the Department of Water Resources' studies should be noted. Studies within the Eel River Basin included a dry year deficiency based on cumulative inflow to Lake Pillsbury. When this inflow fell below specified levels, a 50 percent reduction was imposed on releases down the Eel River. This resulted in reduced spring and summer releases in 8 years of the 48-year study period -- 1924, 1929, 1931, 1933, 1939, 1944, 1955, and 1964. Under the Corps of Engineers planning criteria, studies within the Russian River Basin did not include a dry year deficiency schedule for water supply yields, nor did it provide for reduced releases for stream-flow maintenance. Thus, the entire effect of modified Eel River diversions on the Corps' operation studies within the Russian River Basin are reflected as reduced water supply yield of Lake Mendocino for all alternatives. If a deficiency criteria were applied to the streamflow maintenance releases for extremely dry years, it would eliminate the adverse impact on estimated "yield".

Alternative 1

Continued operation of the existing system "as is"

This alternative defines the historical operation of the Potter Valley power development for the period October 1922 to September 1970. Historical diversions through the powerhouse are not representative of conditions that can be expected in the future. A restriction in the diversion tunnel was removed in 1950, increasing the capacity to the present maximum of 345 cfs. Therefore, the historical diversions were adjusted to account for the increased diversion capacity for the period 1923-1950. Diversions were also increased to the maximum capacity for months when Lake Pillsbury was spilling. These adjustments increased the average annual diversion from 155,000 to 184,000 acre-feet per year, the maximum that can reasonably be expected with the existing project facilities.



Main Stem Eel River - typical channel configuration between the Middle Fork (river mile 119.3) and the North Fork (river mile 96.5)

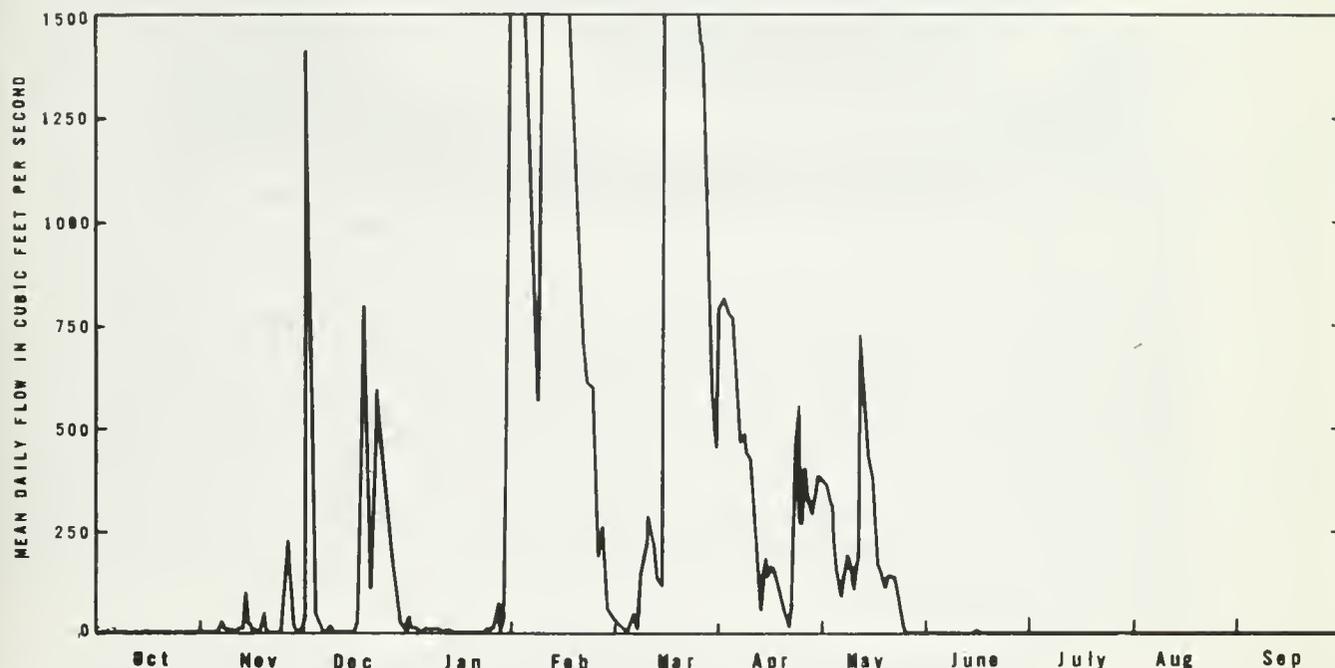
Historical and adjusted diversions are presented in Tables B-1 and B-2 in Appendix B. The adjusted diversions were used in this study as a base for comparing the effects of the alternatives evaluated.

During the 48-year study period, flow in the Eel River at Van Arsdale Dam averaged 468,000 acre-feet annually. Of this amount, an average of 184,000 acre-feet was diverted to the Russian River Basin. Thus, on the average, 284,000 acre-feet, or 61 percent of the flow, remains in the Eel River. However, this flow occurs primarily during winter storms, not during the summer or during fall and winter fish migrations when it is needed.

The effect of this flow variation for a typical year (1960-61) is shown in Figure 3. Due to the operation of the power project, flows are reduced to near zero several times during the peak migration and spawning months for salmon and steelhead from November through March.

FIGURE 3

RECORDED FLOW IN THE EEL RIVER BELOW CAPE HORN DAM
OCTOBER 1, 1960 TO SEPTEMBER 30, 1961



During the fall of 1960, storms occurring in late November and early December increased the runoff below Cape Horn Dam to several hundred cubic feet per second. These flows were sufficient to attract adult salmon and steelhead into the upper reaches of the river to spawn. However, as soon as these storms subsided, the entire flow of the river (except for 2 cfs) was again diverted to Potter Valley, leaving the river with essentially no flowing water for almost the entire month of January 1961.

A similar pattern of flows occurs in most years under the present operation of the Potter Valley Project.

In the spring, when the flow recedes to less than the diversion tunnel capacity, releases from Van Arsdale Dam are cut to the required 2 cfs and are maintained at that level until the first storm of the following winter. This occurred on May 25, 1961 (Figure 3). However, the reduction to 2 cfs can occur as early as March in dry years.

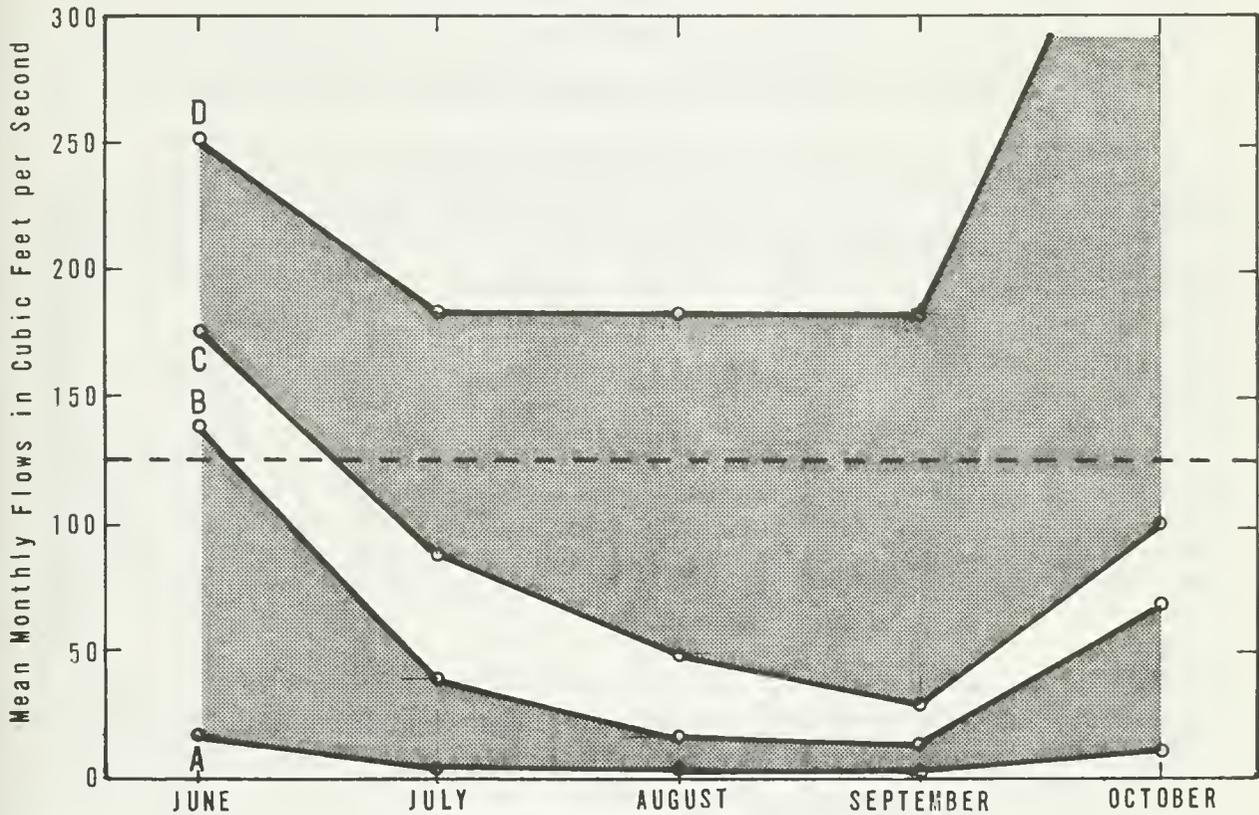
The extreme variability in Eel River runoff can also have a restrictive effect on operation of the power project. In some years, storm patterns are such that no significant runoff occurs until after January 1. In other years, storms occur in November and December, but very little precipitation occurs after February 1. On rare occasions very few significant storms enter the upper Eel River Basin during an entire winter season. The most notable year was in 1924 when the total runoff at Van Arsdale Dam was only about 13 percent of normal (see Table B-4, Appendix B). In years such as these, the limited storage in Lake Pillsbury is not sufficient to meet full demands for the power diversion. However, despite the variability of precipitation and runoff, the diversion to Potter Valley Powerhouse has been reduced by more than 15 percent of average in only 5 of 48 years (1924, 1929, 1931, 1939, and 1964; see Table B-1, Appendix B).

Effects of the Potter Valley Powerhouse operation on summer flows in the Eel and Russian Rivers are demonstrated by Figure 4. This figure compares the mean monthly summer flows in the Eel and Russian River under natural and historic operations; that is, with and without the power diversion. There are two significant comparisons in this figure. The first is between lines A and B, which compare the historical (project) flow in the Eel River with natural flows (what the flow would have been without the power diversion or Lake Pillsbury in operation). The area between lines A and B represents the average reduction in summer flows in the upper Eel River due to the power development. The second comparison is between lines C and D, which compare the historical (project) flows in the lower Russian River with what the flow would have been without the operation of Lake Mendocino or augmentation by water diverted from the Eel River. The area between lines C and D represents the average improvement in summer flows in the lower Russian River. The dashed line represents the specified minimum flow of 125 cfs in the lower Russian River. Average summer flows in the lower Russian River have substantially exceeded the specified minimum since Lake Mendocino went into operation. The flow comparisons shown in Figure 4 weighed heavily in formulating the conclusions presented later in this report.

Possible alternative modifications of the historical Potter Valley Project operation are discussed briefly in the following paragraphs. Effects of these modifications are compared in detail in the next section of this report.

FIGURE 4

COMPARATIVE MEAN SUMMER FLOWS
IN THE EEL AND RUSSIAN RIVERS



- A. Historical flow in the Eel River below Van Arsdale Dam, 1923-70, from Table B-3
- B. Unimpaired flow in the Eel River below Van Arsdale Dam, 1923-70 average without Potter Valley Diversions or Lake Pillsbury from Table B-4
- C. Unimpaired flow in the Russian River at Guerneville 1911-60 average without Lake Mendocino and without Eel River Diversions, from Table B-8
- D. Historical flow in the Russian River at Guerneville 1959-72 average from Table B-9. The specified minimum for this flow is 125 cfs, as is represented by the dashed line

Alternative 2

Reoperation of existing Lake Pillsbury-Potter Valley-Lake Mendocino complex to augment flows in the Eel River without substantially adversely affecting beneficial uses within the Russian River Basin

Most of the effort of this study was concentrated on this alternative and was directed at determining what could be done to overcome the problems of the present method of operation, using the existing facilities. A wide range of revisions in project operations was considered under this alternative. This range was based on proposed release schedules to the

Eel River prepared by the Department of Fish and Game. These varying schedules are differentiated by letter designation under Alternatives 2 and 3. Eel River release schedules are shown in Table 1.

TABLE 1
STREAMFLOW AUGMENTATION RELEASES FROM VAN ARSDALE DAM

Month	DFG Schedule Number						
	1*	2	3	4	5	6	7
(DWR Alter- native No.)	Flow in cubic feet per second						
(2A-3A)	(2B-3B)	(2C-3C)	(2D-3D)				(4)
October	2	25	50	75	50	50	100
November	100	100	100	100	100	100	100
December	100	100	100	100	100	200	200
January	100	100	100	100	100	200	200
February	100	100	100	100	100	200	200
March	100	100	100	100	100	200	200
April	100	100	100	100	200	200	200
May	100	100	100	100	200	200	200
June 1-15	2	25	50	75	100	100	100
June 16-30	2	25	50	75	50	50	100
July	2	25	50	75	50	50	100
August	2	25	50	75	50	50	100
September	2	25	50	75	50	50	100
AF/yr.	43,000	49,900	57,700	65,600	71,400	95,600	109,400

*Schedule recommended by Department of Fish and Game to Federal Power Commission, April 1972.

Alternative 2A

This alternative evaluated Schedule No. 1 shown in Table 1. Operation studies by the Department of Water Resources showed that the historical operation of Potter Valley Powerhouse would be essentially unchanged with Schedule No. 1 of releases to the Eel River, provided the previously described dry year deficiencies were included in the operation. This schedule would provide a minimum flow of 100 cfs in the Eel River during the winter months. This would result in an estimated increase in the fishery resources of the Eel River of about 7,000 king salmon and 4,700 steelhead. Average annual energy production at the Potter Valley Powerhouse would be reduced by about 1,000,000 kwh, or less than 2 percent. Water supply and recreation use in the Russian River Basin would not be significantly affected. In the Eel River Basin, recreation use would increase by about 8,000 recreation days per year due to improved operation of Lake Pillsbury.

However, Alternative 2A would provide no increase in summer flows and would therefore do nothing to improve recreation or aesthetics along the Eel River.

Alternative 2B

This alternative evaluated Schedule No. 2 shown in Table 1. This schedule would provide minimum fishery flows of 100 cfs in the Eel River during the winter months and would increase summer flows to 25 cfs. These releases would provide for an increase in the fishery resources of the Eel River of about 7,000 king salmon and 4,700 steelhead. Recreation use in the Eel River would increase by about 29,000 recreation days per year.

Within the Russian River Basin this schedule of releases would cause a reduction of about 3,100,000 kwh (5 percent) in average annual energy production at the Potter Valley Powerhouse. In the driest year of record the 65,000 acre-feet of firm yield from Lake Mendocino would be reduced by about 11,000 acre-feet.

Alternative 2C

This alternative evaluated Schedule No. 3 shown in Table 1. This schedule would provide the same 100 cfs minimum flow during the winter months, but would provide minimum summer flows of 50 cfs. The increase in fishery resources in the Eel River would be the same as with Alternatives 2A and 2B -- 7,000 king salmon and 4,700 steelhead. The greater summer flows would increase present recreation use by 55,000 recreation days per year.

Within the Russian River Basin this schedule would cause a reduction of about 5,500,000 kwh (9 percent) in average annual energy production at the Potter Valley Powerhouse. In the driest year of record, the firm yield of Lake Mendocino would be reduced by about 18,000 acre-feet.

Alternative 2D

This alternative evaluated Schedule No. 4 shown in Table 1. This schedule would provide the same minimum flow of 100 cfs during the winter months, but would increase summer flows to 75 cfs. The increase in fishery resources in the Eel River Basin would be the same as Alternatives 2A, 2B, and 2C -- 7,000 king salmon and 4,700 steelhead. The greater summer flow would support an increase in existing recreation use of about 78,000 recreation days per year.

Within the Russian River Basin this schedule of releases would cause a reduction of about 8,000,000 kwh (12 percent) in average annual energy production at the Potter Valley Powerhouse. In the driest year of record, the firm yield of Lake Mendocino would be reduced by about 27,000 acre-feet.

Accomplishments and Costs

Alternative 2 would provide a minimum flow of 100 cfs in the Eel River during the winter months, which would support increased fish runs of about 7,000 king salmon and 4,700 steelhead. Various summer flows would provide increases in recreation use ranging from 8,000 to 78,000 recreation days per year. Reductions in annual power generation would range from

1,000,000 kwh (less than 2 percent) to 8,000,000 kwh (over 12 percent). Reductions in the water supply available from Lake Mendocino would range from a negligible change under Alternative 2A to 27,000 acre-feet under Alternative 2D.

There would be no capital cost associated with Alternative 2 since it involves reoperation of the existing facilities. However, there would be an operational cost associated with the losses in energy production and water supply.

Alternative 3

Reoperation of existing Lake Pillsbury and enlarged Lake Mendocino to provide increased streamflow for fisheries enhancement and summer recreation in the Eel River without necessitating severe restriction in output of Potter Valley Powerhouse

This alternative evaluated the same four schedules as Alternative 2 but provided increased storage in enlarged Lake Mendocino to offset any decrease in water supply in the Russian River Basin. Existing Lake Mendocino, with a storage of 122,900 acre-feet, provides a firm water supply yield of 65,000 acre-feet per year for use within the Russian River Basin.

Coyote Dam, which impounds Lake Mendocino, was designed to be increased in height by 36 feet at some future date. This would increase the total storage to 197,800 acre-feet and would provide for an increase of 48,000 acre-feet per year of firm water supply yield. Studies by the Corps of Engineers determined lesser increases in the height of Coyote Dam that could maintain the present water supply in the Russian River Basin under each of the flow schedules considered. The Corps also determined the incremental yield that could be obtained with each flow schedule by enlarging Coyote Dam to its maximum height of 196 feet.

Accomplishments and Costs

Alternative 3 would have the same effect on Eel River fisheries and recreation and on power generation as shown for Alternative 2. There would be a reduction in future recreation use potential of about 200,000 recreation days per year at Lake Mendocino, due to inundation of some developable recreation lands. Fishing in the river below Lake Mendocino could be enhanced by increased control of the turbidity and temperature of releases by means of a multiple-level outlet. Enlarged Lake Mendocino would provide an increase in water supply to the Russian River Basin ranging from 22,000 to 48,000 acre-feet per year.

The Corps of Engineers estimates that enlarging Lake Mendocino to its maximum capacity would cost about \$33,000,000.

Alternative 4

Reoperation of Lake Pillsbury, enlarged Lake Mendocino, an enlarged Potter Valley tunnel, and abandonment of the Potter Valley Powerhouse to provide enhancement of the fishery and summer recreation in the Eel River while meeting present and future recreation and consumptive water needs in the Russian River Basin

This alternative would provide flows in the Eel River under Schedule No. 7 shown in Table 1. The power function would be eliminated and diversions to the Russian River would continue, but through an enlarged tunnel and only during the winter. Summer diversions would be limited to meeting water uses and streamflow requirements above Lake Mendocino. Storage in Lake Pillsbury would be used to augment summer and fall flows in the Eel River.

Accomplishments and Costs

Alternative 4 would support increased fish runs in the Eel River of about 12,500 king salmon and 7,200 steelhead, and increased recreation use of about 112,000 recreation days per year. Within the Russian River Basin, enlarged Lake Mendocino would cause a reduction of about 200,000 recreation days per year in recreation use, and would provide a net increase of 10,000 acre-feet per year in firm dry-year water supply.

Cost estimates by the Bureau of Reclamation indicate that enlarging the diversion tunnel would cost between \$4,400,000 at a capacity of 500 cfs and \$7,000,000 at a capacity of 1,000 cfs. The Corps of Engineers estimates that enlarging Lake Mendocino to its maximum capacity would cost about \$33,000,000. Acquisition of the Potter Valley power development would cost an additional \$5-10 million 1/.

Overall, this alternative would provide about twice the enhancement of Eel River fisheries and recreation that could be obtained with the existing system, and would cost a total of about \$45-50 million.

1/ This is an approximation and is not an estimate of the value of the power development. The actual cost of acquisition would be determined by negotiation with the owner of the development.

Alternative 5

Reoperation of the existing Lake Pillsbury-Lake Mendocino system with abandonment of the Potter Valley Powerhouse to provide the minimum diversion to the Russian River that is necessary to maintain present beneficial uses and streamflow requirements and provide increased flows for fisheries enhancement and summer recreation in the Eel River

This alternative would operate essentially the same as Alternative 4, but diversions to the Russian River would be reduced to the minimum required to maintain present water uses and streamflow requirements.

Accomplishments and Costs

Under Alternatives 4 and 5, streamflow enhancement in the Eel River is limited by the available storage in Lake Pillsbury. Alternative 5 would provide the same increases in Eel River fishery resources and recreation use as Alternative 4. Detriments to the Russian River Basin would be even greater than with Alternative 4 due to the limited winter diversions. Costs associated with this alternative would include elimination of the Potter Plant and enlargement of the diversion tunnel. On the basis of the small increment of enhancement for Eel River fisheries and recreation, and the potential losses to the Russian River, analysis of Alternative 5 was terminated early in the study.

Alternative 6

Evaluation of the impact on both the Eel and Russian River Basins of closing off the diversion tunnel

This alternative was initially proposed to define the upper limit of adverse effects on the Russian River Basin that could result from modifying the operation of the Potter Valley Powerhouse. It is apparent that completely shutting down the diversion is not practical. It would eliminate power production, infringe on existing water rights in Potter Valley, and adversely affect recreation, agricultural, and municipal water uses throughout the Russian River Basin. Therefore, the study committee dropped this alternative from consideration early in the study and no significant effort was expended on it.

EFFECTS OF PROJECT MODIFICATION

This section compares the effects of the possible modified operations of the Potter Valley Project. These comparisons include a schedule of operation that was developed after analysis of the six original alternatives was completed. This additional schedule, identified as Alternative 2E, is discussed below, followed by discussions of the effects that project modification would have on power generation, water supply within the Russian River Basin, recreation use, fishery resources, and water turbidity.

Additional Study - Alternative 2E

Table 1 presents a series of release schedules developed by the Department of Fish and Game for analysis of the possible variations of Alternatives 2 and 3. After completing an analysis of the original alternatives, the Department of Fish and Game recommended a schedule of minimum releases to the Eel River that was not included in Table 1. That schedule, based only on fisheries considerations, proposed minimum flows of 150 cfs from November to March, a schedule varying from 250 cfs to 10 cfs through May to facilitate downstream migration of juvenile fish, and 10 cfs from June through October.

The Department of Water Resources ran additional operation studies of project facilities within the Eel River Basin, and developed criteria that provide a balanced operation of the system using the winter and spring flows recommended by the Department of Fish and Game and summer flows of 20 cfs. The increased summer flow will provide greater stream esthetics and recreation use, and may also increase the capability of the Eel River to rear juvenile steelhead.

Operation of the existing system under the modified schedule described above, designated as Alternative 2E, is described in detail in Appendix C of this report. The results of that operation are included in the following discussions of the various effects of project modification.

Effects on Power Generation

Modifying the operation of Lake Pillsbury and the Potter Valley Powerhouse to make releases to the Eel River would have a varying effect on the output of the Potter Valley Powerhouse, depending upon the amount of water released to the Eel River. All the water diverted from the Eel River passes through the powerhouse. Therefore, changes in average power output under the various alternative operations were estimated on the basis of the change in average annual diversion. The base for comparison is the 61,000,000 kwh per year average generation shown in Exhibit I of Pacific Gas and Electric Company's application for new license, adjusted to correspond to the previously described adjustments of historical diversions. The estimated effect of the alternatives on generation at the Potter Valley Powerhouse is summarized in Table 2.

Generation of 61,000,000 kwh per year indicates that the Potter Valley Powerhouse operates at about a 76 percent annual capacity factor, which is above average for a hydroelectric plant. The Department of Water Resources estimates that revenues of the Potter Valley Powerhouse would exceed operating costs at a minimum monthly capacity factor of 40 percent between June 1 and September 30. This would require a minimum diversion of about 8,000 acre-feet per month during that period. Historically, and under Alternatives 2A and 3A, the project would unavoidably go below this minimum only three times in the 48-year period from 1923 to 1970. The minimum diversion of 8,000 acre-feet per month could not be maintained four times under Alternatives 2B-3B, five times under Alternatives 2C-3C, and twelve times under Alternatives 2D-3D. Under Alternative 2E, the 8,000 acre-foot minimum could not be maintained in 4 years.

TABLE 2

ESTIMATED EFFECT ON AVERAGE GENERATION
AT POTTER VALLEY POWERHOUSE, 1923-1970

Designation	Average Annual Diversion (1,000 acre-feet)	Average Annual Energy Produced (kilowatt-hours)	Decrease in Generation (percent)
Base ^{1/}	184	64,100,000	-
Alternatives 2A-3A	181	63,100,000	1.6
Alternatives 2B-3B	175	61,000,000	4.8
Alternatives 2C-3C	168	58,600,000	8.6
Alternatives 2D-3D	161	56,100,000	12.5
Alternatives 4, 5, 6	-	None	100.0
Alternative 2E	176	61,300,000	4.4

1/ Historical diversion adjusted to maximum when water is available, as was done in operation studies for Alternatives 2 to 6.

Effects on Water Supply

A large increase in minimum flows in the Eel River will cause a decrease in the water supply available to the Russian River Basin. However, since the water originates in the Eel River Basin, consideration should be given to problems caused by exporting water from that river. Conversely, much of this water has been beneficially used in the Russian River Basin, so there is also need to maintain the water supply needed for agricultural, municipal, and industrial uses in the Russian River Basin, and to maintain flows for fish and recreation. The following sections of this report present a general discussion of water supply considerations, a summary of the Corps of Engineers analysis of Russian River water supply, and an alternate approach to resolving water supply problems.

General Considerations

Sustaining present water uses in the Russian River Basin requires about 19,000 acre-feet to meet the annual needs of the Potter Valley Irrigation District, 65,000 acre-feet per year for firm yield from Lake Mendocino, and a variable amount of water to meet streamflow maintenance requirements in the lower Russian River. In most years, the available water supply exceeds present demands. Problems occur only in years of below-normal runoff. Table 3 presents the effect of the various alternatives on diversions to the Russian River in the critical dry year, 1924, and, for comparison, in the next 3 driest years. The firm yield of Lake Mendocino is defined by the water supply that could be obtained from the reservoir in the driest year of record, assuming that all prior water rights and the downstream flow maintenance requirements are being met in full.

Firm dry-year Russian River water supplies would be impaired only when the diversion from the Eel River is less than that minimum dry-year amount, i.e., 151,000 acre-feet in 1924.

TABLE 3

DRY-YEAR DIVERSIONS TO THE RUSSIAN RIVER
(1,000 acre-feet)

Water Year	Critical Period	Total Diversion under Alternative						
		1*	2A-3A	2B-3B	2C-3C	2D-3D	4	2E
1924	May 1, 1923-Oct. 31, 1924	151	151	137	128	111	91	140
1931	May 1, 1930-Nov. 30, 1931	190	179	155	146	130	86	162
1929	May 1, 1928-Nov. 30, 1929	220	201	183	169	155	121	194
1939	June 1, 1938-Nov. 30, 1939	229	219	204	191	178	130	211

*Adjusted historical diversions from Table B-1, Appendix B

Table 3 indicates that providing summer flows in the Eel River of 50 cfs or more (Alternatives 2C, 2D, 3C, 3D, and 4) will cause a substantial decrease in firm water supply in the Russian River. There would be no reduction in firm water supply under Alternatives 2A and 3A, which would continue the historical 2 cfs summer flow in the Eel River. Under Alternatives 2B, 3B, and 2E, the firm water supply in the Russian River Basin would be reduced only by a severe drought condition similar to that which occurred in 1924. The Department of Water Resources estimates the probability of recurrence of a dry year equivalent to 1924 as 0.005, or once in 200 years.

Corps of Engineers Analysis

As noted earlier, the Corps of Engineers in its evaluation of the alternatives used different criteria than the Department of Water Resources. The Corps' criteria do not permit deficiencies in any project function during dry years, with the result that their analysis of the alternatives showed the effect of modified diversions entirely as changes in the firm yield of Lake Mendocino.

In evaluating the alternatives, the Corps determined the effect on yield of the existing system and the amount of enlargement of Lake Mendocino that would be required to maintain the present yield of the system. The Corps also showed the water supply that could be obtained by maximum enlargement of Lake Mendocino. Table 4 summarizes the results of the Corps' analysis as presented in its separate report on the study.

TABLE 4

HYDROLOGIC ANALYSIS - LAKE MENDOCINO
(Taken from Tables 2 and 3 of the Corps of Engineers Report)

Alternative	Minimum Russian River Outflow (cfs)	Yield of Existing System (AF)	Water Supply Storage to Maintain Existing Yield (AF)	Total Reserve Storage Including Flood Cont. (AF)	Yield From Ultimate Water Supply Storage (AF/Yr) ^{a/}	Incremental Yield Available from Ultimate (AF/Yr)
1 (Hist.)	125	65,000	70,000	122,900	113,000	48,000
2A	125	66,000	70,000	122,900	-	-
2B	125	54,000	104,000	154,600	-	-
2C	125	50,000	110,000	160,600	-	-
2D	125	38,000 ^{b/}	121,000 ^{b/}	171,700	-	-
2E	125	56,000 ^{b/}	100,000 ^{b/}	-	-	-
3A	125	-	-	197,800	113,000	48,000
3B	125	-	-	197,800	101,000	36,000
3C	125	-	-	197,800	96,000	31,000
3D	125	-	-	197,800	87,000	22,000

^{a/} 147,000 acre-feet is ultimate water supply storage at ultimate spillway crest elevation of 800 feet m.s.l. and ultimate dam crest elevation of 820 feet m.s.l.

^{b/} Estimated by interpolation.

As expected, representatives of water users within the Russian River Basin within the study committee objected to the concept of reducing the yield of Lake Mendocino to provide low-flow augmentation in the Eel River. However, that concept is only the result of the criteria used in the analysis and is not an unavoidable result of modifying the historical diversion pattern. An alternative approach that can provide augmentation of low flows in the Eel River without impairing consumptive water uses in the Russian River Basin is described in the following paragraphs.

Department of Water Resources Analysis

Recognizing the extreme variability in annual runoff common to most California watersheds, the Department of Water Resources has for many years used the concept of taking deficiencies in water project releases during dry years. This concept was applied in all operation studies involving water releases in the Eel River Basin. The following analysis presents the effects of extending this concept to streamflow maintenance releases within the Russian River Basin.

To make an exact determination of the effect of including similar deficiencies in the Russian River Basin would require a complete new set of operation studies. Time and budget constraints precluded these studies. However, since the Corps' hydrologic analysis is based on the most critical dry year, the maximum deficiencies that would be necessary in flows in the Russian River can be determined. Other deficiencies of lesser amounts would be required in dry years that are not as critical as the extreme that occurred in 1924.

The primary consideration in this alternative method of analysis is to maintain the firm yield for municipal, industrial, and agricultural uses from Lake Mendocino with no deficiencies. Therefore, any dry-year reductions in flows would apply only to the streamflow maintenance releases made to the Russian River. Assuming that such deficiencies would be applied to the specified 125-cfs outflow from the lower Russian River for the 7-month period from April 1 to October 31, the maximum deficiencies necessary under Alternative 2 to maintain the present yield of 65,000 acre-feet per year would be as shown in Table 5.

TABLE 5
 MAXIMUM REDUCTIONS IN FLOW
 IN THE LOWER RUSSIAN RIVER
 TO MAINTAIN YIELD FROM LAKE MENDOCINO

Alternative	Firm Yield From Lake Mendocino (AF/Yr)	Maximum Deficiency in Summer Flow* (cfs)	Maximum Deficiency in Summer Flow* (Percent)	Minimum Russian River Outflow (cfs)
1 (Historical)	65,000	-	-	125
2A	65,000	0	0	125
2B	65,000	26	21	99
2C	65,000	35	28	90
2D	65,000	64	51	61
2E	65,000	21	17	104

*For the period from April 1 to October 31, 1924

Alternative 3, with an enlarged Lake Mendocino, would provide an increment of water supply in addition to the present yield of 65,000 acre-feet. Under the Corps of Engineers analysis (Table 4) the increment of yield would be reduced with summer releases of 25 cfs or more to the Eel River (Alternatives 3B, 3C, and 3D). Applying deficiencies similar to those shown in Table 5 to the streamflow maintenance releases from Lake Mendocino could offset that reduction and maintain the full water supply function of the enlarged reservoir.

Whether dry-year deficiencies resulting from increased flows in the Eel River would be applied to water supply or recreation uses in the Russian River Basin, or some combination of the two, would need to be determined. Further studies of this problem are being conducted by the Department of Water Resources within the Russian River Basin.

The Department of Water Resources believes that applying this deficiency concept to the operation of Lake Mendocino is a practical and workable means of providing low-flow augmentation in the Eel River without impairing the firm yield from existing Lake Mendocino. However, there would be some adverse effect on recreation use within the Russian River Basin during dry years. This is discussed in the following section.



Pillsbury Pines Resort
on Lake Pillsbury

Photo courtesy of PGandE



Swimming at Lake Mendocino

Photo courtesy of
U. S. Army Corps of Engineers

Effects on Recreation

Higher minimum flows in the Eel River would provide for an increase in recreation use. Appendix A of this report presents estimates of the increases provided by the alternatives studied. Table 6 summarizes the increases in recreation use in the Eel River Basin.

TABLE 6

SUMMARY OF EFFECTS OF ALTERNATIVE OPERATIONS ON RECREATION
IN THE EEL RIVER BASIN, 1970-1990

Alternative	Average Annual Recreation Days		
	Lake Pillsbury	Eel River	Estimated Increase
1 (Historic)	220,000	185,000	-
2A and 3A	228,000	185,000	8,000
2B and 3B	228,000	206,000	29,000
2C and 3C	228,000	232,000	55,000
2D and 3D	224,000	259,000	78,000
4	232,000	285,000	112,000

As noted before, Alternative 2E was developed after analysis of the original alternatives was completed. In comparison with Alternative 2B, Alternative 2E would provide summer flows of 20 cfs instead of 25 cfs, but would maintain higher average summer storage in Lake Pillsbury. Therefore, it is estimated that Alternative 2E would provide about the same increase in recreation use, or 29,000 recreation days per year.

It should be noted that the increases in recreation use shown in Table 6 are based on the present public access to the Eel River, which is severely limited in some reaches. If public access to the river is improved, recreation use could increase substantially over the projections shown above.

Criteria used by the Corps of Engineers in evaluating the various alternatives had very little effect on recreation use within the Russian River Basin. This was because the full streamflow releases from Lake Mendocino were maintained in all years, and the effect of the alternatives was shown as a reduction in the water supply. Under this method of operation, fluctuations of the water level in Lake Mendocino would be about the same as if the historical operation were continued and overall effects on recreation use in the Russian River Basin would be minimal.

Conversely, if Lake Mendocino is operated to maintain the full water supply function, there would be two effects on recreation use in the Russian River Basin. First, the flow maintenance releases from Lake Mendocino would be reduced in dry years. The dry-year diversions shown in Table 3 indicate that this would probably occur two or three times within

the 48-year study period. The maximum reduction under the alternatives studies, which would be required only in the driest year of record, is shown in Table 5. Secondly, the water levels in Lake Mendocino would fluctuate over a greater range than if the historical operation were continued.

The effect of potential changes in the water surface of Lake Mendocino and changes in streamflow in the Russian River on recreation use were not evaluated in this study. However, as noted in Appendix A, these areas support large amounts of recreation use and significant changes could have a major adverse effect on that use.

Any proposal for increasing flows in the Eel River should include a provision for monitoring the effect of reduced diversions on recreation use in the Russian River Basin and should provide for adjusting the diversion and the schedule of releases to the Eel River if major problems occur.

Effects on the Fishery

As noted before, the Department of Fish and Game was assigned responsibility for fish and wildlife evaluations in the study. Results of those evaluations are published in a separate report, "Eel-Russian Rivers Streamflow Augmentation Study: Reconnaissance Fisheries Evaluation", dated February 1975. The following discussions of impacts on the fisheries of the Eel and Russian Rivers are quoted from that report:

"Discussion in the foregoing chapters suggests the Eel River fisheries can be significantly rehabilitated by increasing streamflows and by decreasing water temperatures at key periods of the year. Most of the potential for improvement is in the upper Eel River where effects of the Potter Valley hydroelectric project have had their greatest impact. Because of the limited manpower available to conduct the study, however, it has not been possible to develop precise estimates of anadromous fish spawning escapement numbers which could be supported by various flow releases from the project.

"Increasing Winter (November-May) Flows

"The greatest immediate need for anadromous fisheries in the upper Eel River is to fill in water voids caused by the present operations. If more continuous (more natural) flows were to exist downstream from Van Arsdale Dam from November through May, winter run steelhead and fall run salmon could be benefited.

"Our present estimates of anadromous fish runs assuming different winter flows is summarized in Table 3. It should be emphasized that these estimates are reconnaissance level, though considered conservative. As additional information becomes available or when a feasibility level study is conducted these numbers can be refined.

TABLE 3

Reconnaissance Level Spawning Escapement Estimates of King Salmon, Silver Salmon, and Steelhead in the Eel River at Various Minimum Winter Flow Releases from Van Arsdale Reservoir ^{1/}

Minimum Flow Release	Scott Dam to Van Arsdale Reservoir :		Van Arsdale Reservoir to Outlet Creek :		Outlet Creek to McCann :			McCann to Mouth of Eel River		
	King Salmon	Steelhead	King Salmon	Steelhead	King Salmon	Silver Salmon	Steelhead	King Salmon	Silver Salmon	Steelhead
Present										
Operating Conditions ^{2/}	35	800	8,000	11,000	28,000	4,500	48,500	32,500	25,500	51,500
100 cfs ^{3/}	3,000	4,500	12,000	12,000	28,000	4,500	48,500	32,500	25,500	51,500
200 cfs ^{3/}	3,500	5,000	17,000	14,000	28,000	4,500	48,500	32,500	25,500	51,500
300 cfs ^{4/}	4,000	5,500	19,000	16,000	29,000	4,500	49,000	33,000	25,500	51,500
400 cfs ^{4/}	5,000	6,500	22,000	18,000	30,000	5,000	50,000	33,500	26,000	52,000

^{1/} Possible fish population increases resulting from augmentation of summer flows are not included. Steelhead and American shad numbers could increase significantly. Analysis of these possibilities should be included in the feasibility studies recommended in this report.

^{2/} Taken in part from California Department of Fish and Game, DWR Bulletin 136, North Coastal Area Investigation, Appendix C, Fish and Wildlife, 1965.

^{3/} During the period November 1 through February; and predicated on flow releases of 250 cfs from March 1 through March 15, and decreasing at a constant rate thereafter to 10 cfs by May 31.

^{4/} During the period November 1 through February; and predicated on flow releases decreasing at a constant rate thereafter to 10 cfs by May 31.

"Increasing Summer (June-October) Flows

"As indicated, previous studies show that low summer flows and high water temperatures frequently limit production of anadromous fish. Therefore, it would appear that Eel River fisheries could be improved by increasing summer flows downstream from Cape Horn Dam.

"However, as pointed out earlier, a flow increase of greater than 10 cfs during the summer (June through October) period would initiate the breakdown in thermal stratification in pools of the upper Eel River, thus decreasing the total nursery habitat available there. At the same time, however, once in the lower Eel River the water would cool off and the larger flows would increase the amount of nursery area. It appears that the net effect would be on the plus side provided the flows were sufficiently large. This amount has not been determined, but would probably be greater than 25 cfs.

"One aspect which we were not able to cover in this report is the potential improvement of American shad runs in the Eel River by increasing summer flows. The size of the shad run in the river could probably be improved with additional summer water.

"Within the scope of alternatives evaluated in this study, we have come to three conclusions regarding increase of summer flows:

"1. Steelhead fisheries could probably be improved.

"2. American shad fisheries could probably be improved.



Salmon-Steelhead fishermen
on the lower Eel River.



Fish on! An intrepid angler plays a Steelhead
on the upper Eel River.

"3. If only limited amounts of water are available for release in the Eel River, the best use of the water from a fisheries viewpoint would be to release it during the late fall and winter months to fill present water voids rather than to use it during the summer months to improve nursery area."

* * *

"Because of the limited scope and manpower available for the study, we have not conducted an in-depth evaluation of the impact on Russian River fisheries from increased Eel River flows. We conclude, however, that all alternatives except Number Six (closing off the diversion tunnel) will have very little impact on Russian River fisheries. The stipulations of the first five alternatives require that Russian River water interests be maintained. Alternative Six is discussed further in this report but only for academic reasons. It is not considered a suitable course of action."

Increases in the fishery resources of the Eel River Basin under the various alternatives are summarized in Table 7.

TABLE 7

SUMMARY OF INCREASES IN EEL RIVER FISH POPULATIONS

Alternative	King Salmon	Steelhead
1 (Historic)	0	0
2A-3A	7,000	4,700
2B-3B	7,000	4,700
2C-3C	7,000	4,700
2D-3D	7,000	4,700
4	12,500	7,200
2E	9,700	6,000

Additional increases in fisheries resources would occur in the lower reaches of the river due to improved rearing habitat for juvenile salmonids. It was not possible to estimate the amount of this improvement during the conduct of this study.

Effects on Turbidity

Within the Eel River Basin, none of the alternatives would have a significant effect on turbidity levels, since there would be no structural change in the existing facilities. Operational changes may have some minor effect on turbidity. In the fall, if releases from Lake Pillsbury are at lower turbidity levels than the inflow from downstream tributaries, there may be some improvement in conditions. Conversely, releases from Lake Pillsbury in the late winter and spring could at times be at higher turbidity levels than downstream flow accretions, causing some increase in overall turbidity.

In the Russian River, only the alternatives that include an enlarged Lake Mendocino, Alternatives 3, 4, and 5, could accomplish any improvement in turbidity. The Corps of Engineers' report states on page 22:

"Increasing Coyote Dam to its ultimate height would provide some enhancement to the Russian River fishery due to increased releases for the additional water supply and the regulation of temperature and turbidity of releases with a multiple-level outlet."

The Corps could not make a quantitative estimate of the enhancement due to turbidity control within the limited scope of this study.

Special Considerations

Any proposal for modifying the operation of the Potter Valley Project should give special consideration to the following four points:

1. The need to improve flow conditions in the Eel River. This can be considered in two parts. In the winter months, sufficient flow should be maintained to allow fish movement in the river. The Department of Fish and Game states that the minimum flow for this purpose is 100 cfs but has recommended a flow of 150 cfs for the spawning season and larger flows in the spring for downstream migration of juvenile fish. In the summer, the present flow of 2 cfs should be augmented as much as possible without impairing existing water uses.
2. The problem of maintaining existing water uses. Augmenting flows in the Eel River will necessitate some reduction in diversions to the Russian River Basin. Those diversions have maintained high summer flows in the Russian River and have provided a firm water supply for municipal and agricultural uses. A reduction, or dry-year deficiency concept, could be applied to consumptive water uses, or to streamflow maintenance releases, or to some combination of both.
3. The problem of inadequate storage. Lake Pillsbury, with only 86,800 acre-feet of storage capacity, cannot hold enough water in storage to meet all demands in a year of abnormally low runoff. There are two ways of compensating for this -- either by providing additional storage or by maximizing the use of

existing facilities by applying a dry-year deficiency to the scheduled releases. This report recommends a stringent deficiency criteria for releases to the Eel River in order to maintain existing municipal and agricultural uses of water during dry years.

Provision has already been made within the Russian River Basin for dry-year deficiencies in the operation of Lake Mendocino, within an agreement between the Department of Fish and Game and the Sonoma County Water Agency (formerly Sonoma County Flood Control and Water Conservation District). This agreement, signed on August 21, 1959, specifies that the agency shall operate the water conservation storage of Lake Mendocino to maintain minimum flows of:

- a. 25 cfs immediately below Coyote Dam.
- b. 150 cfs at the junction of the east and west forks of the Russian River.
- c. 125 cfs at Guerneville.

Section 2 of that agreement lists several conditions to the operation of Lake Mendocino, one of which states:

"E That reduction in District's commitment hereunder shall be allowed corresponding to any reduction in quantities and at times substantially as have existed since 1950 in Eel River water importation into the Russian River Basin to the extent that such reduction may affect District's ability to perform hereunder without encroachment upon beneficial uses other than sustained minimum flows for protection, preservation and enhancement of fish, wildlife, and recreational resources existing in and around Russian River."

This condition gives priority to consumptive uses of water by giving the Sonoma County Water Agency the authority to reduce streamflow releases rather than take a deficiency in consumptive water uses. However, it does not allow the Agency to increase its diversion allotment at the expense of streamflow releases.

4. The need for additional information. There are many unanswered questions left in connection with the Potter Valley Project. Also, the project's releases to the Eel River can be a laboratory for fishery and recreation studies that may be very valuable for future water management planning in the Eel River Basin. In combination, these factors present a need for continuing study of the project.

The Department of Fish and Game has recommended: (1) further study of Alternatives 4, 5, and 3; (2) the design and construction of a fish hatchery below Scott Dam; and (3) that the Federal Power Commission issue a new license for a term of 10 years so that positive results of the study can be implemented at the end of that term. The Department of Water Resources supports the

recommendation for further study, and feels that the study should also give careful consideration to the possibility of providing additional storage on the upper Eel River.

The California Wild and Scenic Rivers System includes the Eel River up to a point 100 yards below Van Arsdale Dam, but excludes everything upstream from that point. There are several possible sites in this upper area that could provide sufficient storage to meet all the demands presently made on existing Lake Pillsbury. It may be advantageous to increase the available on-stream storage within the Eel River Basin rather than provide additional off-stream storage by enlarging Lake Mendocino.

Further studies of the Potter Valley Project should also provide additional knowledge on such questions as:

- a. What effect will a change in project operation have on recreation use, in both the Russian and Eel River Basins?
- b. To what extent will higher summer flows in the Eel River enhance nursery areas for fish below Van Arsdale Dam and in the lower reach of the river?
- c. To what extent will higher summer flows improve the American shad runs in the Eel River?
- d. How many fish use the limited nursery area provided by riffle areas and temperature-stratified pools in the middle reach of the Eel River, from Van Arsdale Dam to the South Fork?

SUMMARY

The Potter Valley Power Development has been in operation since 1908 and diverts an adjusted average of 184,000 acre-feet of water per year from the upper Eel River into the Russian River Basin. The powerhouse annually generates about 64,000,000 kwh of energy and makes a significant contribution to the local economy. Lake Pillsbury provides 86,800 acre-feet of storage to sustain the diversion through the summer months. Lake Mendocino, on the East Fork Russian River, reregulates part of the diverted water to provide 65,000 acre-feet per year of firm water supply for agricultural, municipal, and industrial use, and maintains high sustained summer flows in the Russian River for recreational purposes.

Sustained flows in the Russian River have contributed greatly to the basin's development, ranging from irrigated agriculture in Potter Valley to urban development in southern Sonoma and northern Marin Counties. These flows are also a major factor in the extensive resort development on the lower Russian River.

On the other hand, the diversion has had an adverse effect on the Eel River Basin. Extremely low flows during the summer months and between

winter storms have limited the recreation potential and have been a contributing factor in the decline of anadromous fish populations.

There are a number of agencies with an interest in the operation of the Potter Valley Project, and several of these agencies have interests that are in direct conflict. Existing facilities are inadequate to meet the needs of all these agencies in dry years. Some compromise must be made to produce a balanced operation of the project.

The objective of this study was to evaluate various means of improving flow conditions in the Eel River without substantially adversely affecting beneficial uses of water in the Russian River Basin. The study evaluated alternative solutions ranging from continuing the historical operation of the project to extensive modification such as eliminating the powerhouse, enlarging the diversion tunnel, or increasing the storage capacity of Lake Mendocino.

Extensive modification of the project could provide greater fisheries and recreation benefits to the Eel River than could be obtained with the existing facilities. With an enlarged Lake Mendocino, increased water supply and fisheries enhancement benefits could also be obtained in the Russian River Basin. The increased water supply could more than offset losses in firm yield in the Russian River Basin associated with reducing imports from the Eel River. Such extensive modification could incur capital costs of about \$45-50 million. Further study is needed to determine if the potential benefits would justify such modification. Pending the completion of such studies, an interim solution to most of the problems associated with the project can be obtained by modifying the operation of the existing facilities.

Evaluation of the alternatives proposed in this study showed that any significant increase in releases to the Eel River causes a decrease in diversions into the Russian River. The study also showed that under average flow conditions there is surplus water within the Russian River Basin in most years, since the average summer outflow is 60 cfs greater than the specified minimum of 125 cfs at Guerneville (Figure 4, page 19). Modifying the operation of the existing facilities to provide a moderate increase in summer flows in the Eel River would not greatly impair present water uses if a dry-year deficiency is applied in the Russian River Basin (Table 3, page 27). However, it would cause a reduction in the average energy production of the project. Operation of the system to maintain summer flows of 20 cfs and winter fish releases of 150 cfs in the Eel River (Alternative 2E, Appendix C) would require a maximum dry-year deficiency of 21 cfs (17 percent) in Russian River flows and would reduce energy production by less than 5 percent.

Current recreation use in the Russian River Basin is 10 to 12 times greater than in the Eel River areas affected by releases from Van Arsdale Dam. The effect of modifying the Potter Valley Project operation should be monitored, and provision should be made for further modification if a major adverse effect is found on recreation use in the Russian River Basin.

Conclusions

From the evaluation of the various proposed alternative methods of reoperating the Potter Valley Project, the following conclusions were reached:

1. Present operation of the Potter Valley Project is detrimental to fish life and recreation in the Eel River. There is a need to maintain greater minimum flows for fish in the winter months and for fish, recreation, and esthetics in the summer months.
2. Present operation of the Potter Valley Project is beneficial to the Russian River Basin. Sustained flow in the Russian River supports extensive recreation development at Lake Mendocino and along the Russian River. It also provides a water supply for irrigation and for municipal and industrial uses within that basin and in southern Sonoma and northern Marin Counties.
3. Flows in the Eel River greater than about 25 cfs during the summer months will tend to destratify pools containing cool water, but will increase the shallow riffle areas. The net effect may be either beneficial or detrimental to juvenile steelhead and salmon in the area between Tomki Creek and the South Fork. Increased summer flows would be beneficial to these fish for a few miles below Van Arsdale Dam (above Tomki Creek) and throughout the lower reaches of the river.
4. Reductions in diversions from the Eel River as proposed under Alternatives 2E and 2B, which would maintain summer flows in the Eel River of 20 to 25 cfs, would cause only minor reductions in the water available to users in the Russian River Basin. These reductions could be offset by a maximum dry-year deficiency of about 20 percent in Russian River flows.
5. Increasing summer flows in the Eel River from the present release of 2 cfs to 20 cfs and maintaining a minimum winter flow of 150 cfs (Alternative 2E) could support increased annual fish runs of approximately 9,700 king salmon and 6,000 steelhead, and could support an increase in recreation use of about 29,000 recreation days per year. Maintaining these flows in the Eel River would result in a decrease of less than 5 percent in energy production at the Potter Valley Powerhouse and a decrease of about 9,000 acre-feet of firm water supply to the Russian River Basin during a critically dry year, such as 1924. The decrease in firm water supply could be accommodated by taking a deficiency in streamflow maintenance releases rather than reducing consumptive uses. The deficiency would amount to about 21 cfs (17 percent) in the most critical dry year, 1924.
6. Feasibility studies are needed to properly evaluate the potential accomplishments of various structural modifications of the existing Potter Valley Project. These studies should also evaluate the possibilities of providing increased storage to meet the needs of both the Eel and Russian River Basins.

7. If operation of the Potter Valley Project is modified to improve flow conditions in the Eel River, a program should be established to monitor the effect on the fishery resources of the Upper Eel River and on recreation use in the Russian River Basin. A 10-year monitoring period could be provided in a new license by the Federal Power Commission, and the license terms could be modified if significant adverse effects are found.

Recommendations

Based on the conclusions reached from evaluation of the various methods of reoperating the Potter Valley Project, it is recommended that:

1. The Federal Power Commission include in a new 10-year license for the Potter Valley Project conditions to provide for minimum releases to the Eel River, summer storage levels in Lake Pillsbury, and dry-year operating criteria as set forth in Appendix C of this report.
2. A monitoring program be established, designed to evaluate the effects of the revised project operation on fish, recreation, energy production, and water supply in the Eel and Russian River Basins.
3. A feasibility study be initiated to evaluate the potential accomplishments of extensive modification of the existing Potter Valley Project, with emphasis on the effects of providing increased streamflows and storage.

EEL-RUSSIAN RIVERS
STREAMFLOW AUGMENTATION STUDY

APPENDIX A

RECREATION

Prepared by

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October 1974

RECREATION

Introduction

The purpose of the Streamflow Augmentation Study was to determine how streamflow conditions in the Eel and Russian Rivers could be improved for fisheries and recreation through reoperation of Lake Pillsbury and Lake Mendocino. The proposed reoperation of these reservoirs and resulting changes in downstream flows would affect recreation use at Lake Pillsbury, Eel River below Lake Pillsbury, East Fork Russian River above Lake Mendocino, Lake Mendocino, and the Russian River below Lake Mendocino. This memorandum evaluates the effect of the proposed changes on recreation use at Lake Pillsbury and the Eel River. It discusses, in general terms, the effects on the East Fork Russian River, Lake Mendocino, and the Russian River below Lake Mendocino. Evaluation of the effects of the various alternatives on recreation use in the Russian River Basin was assigned to the U. S. Corps of Engineers.

Several possible operations of Lake Pillsbury were considered, but only the nine most favorable plans are discussed and compared with the historical operation. Four of the alternative operations of Lake Pillsbury could be coupled with either the existing Lake Mendocino or an enlarged Lake Mendocino; one operation would require an enlarged Lake Mendocino (Table A1).

TABLE A1
SUMMARY OF ALTERNATIVE OPERATIONS OF LAKE PILLSBURY,
RELEASES DOWN EEL RIVER, AND DIVERSIONS TO RUSSIAN RIVER

Alternative Operation	Minimum Flows in the Eel River Below Cape Horn Dam (cfs)		Average Diversion to Russian River (AF/Year)	Lake Mendocino Storage (AF)
	Summer	Winter		
	1 (Historic)	2	2	175,000
2a	2	100	181,000	122,200
2b	25	100	175,000	122,200
2c	50	100	168,000	122,200
2d	75	100	161,000	122,200
3a	2	100	181,000	199,000
3b	25	100	175,000	199,000
3c	50	100	168,000	199,000
3d	75	100	161,000	199,000
4	100	200	124,000	199,000

Lake Pillsbury and Van Arsdale Reservoir

Recreation use on the upper Eel River is concentrated at Lake Pillsbury and the Eel River downstream to Van Arsdale Reservoir. Lake Pillsbury, with a surface area of 2,280 acres, is the primary attraction and use is typically of several days duration. Recreation use at Van Arsdale Reservoir and along the Eel River upstream to Lake Pillsbury is more transient in nature, although overnight camping does occur.

Lake Pillsbury supports fair fisheries for rainbow trout, green sunfish and bluegill. The Department of Fish and Game stocks about 15,000 catchable trout in Lake Pillsbury annually. In 1970, fishing at Lake Pillsbury totaled about 37,500 angler days, including 26,200 angler days for trout (Anderson, 1972).

Existing recreation developments in Lake Pillsbury include commercial resort facilities, summer homes, public campgrounds, and picnic areas. Most of the facilities at Pillsbury Pines Resort, including 21 camp, 7 trailer, and 4 cabin units, are on PG&E land on the east shore of the lake. Nineteen acres of PG&E land on the west shore of Lake Pillsbury are also managed as a camping area by this resort. Lake Pillsbury Resort, on National Forest land, has 31 camp, 7 trailer, and 7 cabin units. Both resorts provide marina facilities and supplies.

Seventy-two homes occupy the Lake Pillsbury Homesite Tract under permits issued by the Forest Service. The area is located on a wooded ridge on the east side of the lake. A few of the homes are permanent residences, but the majority are used primarily during weekends and summer vacation.

Pogie Point (39 camp units) and Sunset (54 camp units) are Forest Service campgrounds. The 30-unit Forest Service campground at Oak Flat is used primarily for overflow camping.

The area around Van Arsdale Reservoir and the reach of the Eel River above it does not contain developed facilities. However, existing roads make the reservoir and river accessible to fishermen and other recreationists.

Both PG&E and the Forest Service have plans for future development at Lake Pillsbury, Van Arsdale Reservoir, and the Eel River. These facilities will accommodate anticipated future recreation use.

The proposed revised operations of Lake Pillsbury would lower the water surface elevation during October through June but would hold the lake at higher elevations during the peak recreation-use months of July, August, and September (Table A2).

Although the proposed operations could have minor adverse effects on the spring fishing, they should generally improve recreation use at Lake Pillsbury. The higher lake levels should result in a small increase in recreation use during the summer months (Table A3).

TABLE A2
AVERAGE FIRST-OF-MONTH WATER SURFACE ELEVATION
AT LAKE PILLSBURY, 1923-1970

Alternative	Elevation in Feet Above Mean Sea Level				
	May	June	July	August	September
1 (historic)	1828	1826	1821	1813	1806
2a and 3a	1827	1825	1822	1817	1810
2b and 3b	1826	1824	1821	1816	1810
2c and 3c	1826	1824	1821	1816	1811
2d and 3d	1826	1824	1821	1816	1810
4	1826	1825	1823	1818	1814

TABLE A3
ESTIMATED RECREATION USE AT LAKE PILLSBURY, 1970-1990 ^{1/}
(in recreation days)

Year	Alternative			
	1 (Historic)	2a, 2b, 2c 3a, 3b, 3c	2d and 3d	4
1970	170,000	180,000	175,000	185,000
1975	190,000	200,000	195,000	205,000
1980	210,000	220,000	215,000	230,000
1985	260,000	270,000	265,000	270,000
1990	270,000	270,000	270,000	270,000
Average Annual Use	220,000	228,000	224,000	232,000

^{1/} The U. S. Forest Service reports recreation use at Lake Pillsbury in 12-hour visitor days which total about twice these estimates.

Eel River

The Eel River between Scott Dam and Cape Horn Dam is an excellent nursery area for steelhead spawned there, due to the controlled releases from Scott Dam. Most of the steelhead produced in the streams tributary to this reach also rear in the Eel River because the low summer flows in the tributaries limit their value for nursery habitat (Anderson, 1972).

Juvenile steelhead in the 11.7 miles of Eel River between the two dams support considerable angling pressure. A survey conducted jointly by the Departments of Fish and Game and Water Resources during 1973 revealed that about 7,000 anglers fished this reach. Recreation use between Scott Dam and Cape Horn Dam totaled about 43,000 recreation days, predominantly fishing, swimming, camping, and river touring. The proposed reregulation of Lake Pillsbury would reduce summer flows about 15 percent in this reach of the Eel River. Recreation use is not expected to change significantly (Table A4).

TABLE A4
ESTIMATED RECREATION USE OF EEL RIVER
BETWEEN SCOTT DAM AND CAPE HORN DAM, 1970-1990
(in recreation days)

<u>Year</u>	<u>Alternative</u>	
	<u>1 (Historic)</u>	<u>All Proposed Alternatives</u>
1970	40,000	40,000
1975	45,000	45,000
1980	50,000	50,000
1985	60,000	60,000
1990	70,000	70,000
Average Annual Use	53,000	53,000

In contrast to the reach above Cape Horn Dam, the Eel River downstream to Outlet Creek (about 30 miles) is poor nursery area for salmonids. Summer streamflows are very low (3 cfs or less) and maximum water temperatures are high. Large mats of filamentous algae form in summer which reduce the esthetic appeal of the river. Recreation use of this section of the Eel River is relatively light primarily due to the combination of these problems and limited access. Use is composed mostly of camping at private hunting camps with some swimming, fishing, and river touring at the few access points.

Improved streamflows below Cape Horn Dam could increase the number of salmon and steelhead produced in the Eel River by allowing fish to migrate over Cape Horn Dam to the good habitat upstream and by improving conditions for spawning fish below Cape Horn Dam. Nursery area for juvenile steelhead probably would be improved for a few miles below Cape Horn Dam. The increased runs would support an additional 9,400 angler days of salmon and steelhead fishing in the lower Eel River and ocean sport fisheries. The increased runs also would contribute to the ocean commercial salmon fishery (Lee and Baker, 1974).

Summer streamflows in the Cape Horn Dam to Outlet Creek reach would be substantially increased with Alternatives 2b, 2c, 2d, 3b, 3c, and 3d. This would improve the summer trout fishing in the upper part of this area and the appearance of the stream. A substantial increase in the recreation potential of this reach would occur; however, limited access would restrict the actual increase in use (Table A5).

TABLE A5
ESTIMATED RECREATION USE OF EEL RIVER
BETWEEN CAPE HORN DAM AND OUTLET CREEK, 1970-1990
(in recreation days)

Year	Alternative					
	1 (Historic)	2a and 3a	2b and 3b	2c and 3c	2d and 3d	4
1970	7,000	7,000	15,000	26,000	38,000	49,000
1975	8,000	8,000	18,000	30,000	43,000	56,000
1980	9,000	9,000	20,000	34,000	49,000	63,000
1985	11,000	11,000	24,000	42,000	59,000	77,000
1990	13,000	13,000	29,000	49,000	70,000	91,000
Average Annual Use	10,000	10,000	21,000	36,000	52,000	67,000

The Eel River from Outlet Creek to Dos Rios is paralleled by the Longvale-Covelo Road which provides access to the river for salmon and steelhead anglers during the fall and winter, and swimmers and sunbathers during the spring and summer. A limited amount of overnight camping also occurs along this reach. Summer streamflows are reduced by the diversion from Van Arsdale Reservoir. General recreation use would be increased by higher releases (Table A6).

TABLE A6
 ESTIMATED RECREATION USE OF EEL RIVER
 BETWEEN OUTLET CREEK AND DOS RIOS, 1970-1990
 (in recreation days)

Year	Alternative					
	1 (Historic)	2a and 3a	2b and 3b	2c and 3c	2d and 3d	4
1970	6,000	6,000	9,000	12,000	15,000	18,000
1975	7,000	7,000	10,000	14,000	18,000	21,000
1980	8,000	8,000	12,000	16,000	20,000	24,000
1985	9,000	9,000	14,000	18,000	23,000	27,000
1990	11,000	11,000	16,000	22,000	28,000	33,000
Average Annual Use	8,000	8,000	12,000	16,000	21,000	25,000

The 78-mile reach of the main Eel River between Dos Rios and the South Fork is generally inaccessible to the typical recreationist. The river is paralleled by the Northwestern Pacific Railroad, but passenger service is no longer provided. County roads reach the river at Alderpoint, Fort Seward, Eel Rock, and below Sequoia. Private roads approach the river at Spyrock, Island Mountain, and Kekawaka but are normally closed to public use. Consequently, recreation use of this reach of the Eel River is low. Use is concentrated near Alderpoint, Fort Seward, and the lower river below Sequoia. Streamflows in this reach are not affected by the Potter Valley diversion as much as upstream areas due to the flow contributions from the Middle Fork, North Fork, and many smaller tributaries. Recreation use in this reach is primarily swimming and camping at the access points, and river touring by raft, kayak, or canoe. Use would be increased only moderately by the increased summer flows (Table A7).

Below the South Fork, the Eel River is closely paralleled by the Redwood Highway (U.S. 101) and numerous county roads. Recreation use of the lower river is based primarily on fishing, particularly for salmon and steelhead. Many anglers fish near Fortuna and Fernbridge prior to the first major rains each fall when the fish are usually confined to the reach below the Van Duzen River. During the winter months when the river begins to clear following major storms, the fishery moves to upper river areas in the South Fork and near Dos Rios on the main river.

TABLE A7

ESTIMATED RECREATION USE OF EEL RIVER BETWEEN DOS RIOS
AND CONFLUENCE WITH SOUTH FORK EEL RIVER, 1970-1990
(in recreation days)

Year	Alternative					
	1 (Historic)	2a and 3a	2b and 3b	2c and 3c	2d and 3d	4
1970	18,000	18,000	20,000	20,000	24,000	26,000
1975	20,000	20,000	22,000	24,000	26,000	29,000
1980	22,000	22,000	24,000	27,000	29,000	32,000
1985	26,000	26,000	27,000	32,000	34,000	37,000
1990	31,000	31,000	34,000	38,000	41,000	44,000
Average Annual Use	23,000	23,000	25,000	28,000	31,000	34,000

Duck hunting occurs in the Eel River estuary during the winter months. A seasonal fishery for red-tailed surfperch near the mouth of the river extends from spring to late summer. A minor fishery develops in the lower river during late spring for American shad. Many anglers also seek "half-pounders" (a run of small steelhead) in late summer.

Other recreation activities observed along the lower river include swimming, boating, hiking, and bird-watching. Annual use along the river below the South Fork was estimated to total about 71,000 recreation days in 1970 (Table A8).

TABLE A8

ESTIMATED RECREATION USE OF EEL RIVER BETWEEN
CONFLUENCE WITH SOUTH FORK EEL RIVER AND MOUTH, 1970-1990
(in recreation days)

Year	Alternative					
	1 (Historic)	2a and 3a	2b and 3b	2c and 3c	2d and 3d	4
1970	71,000	71,000	74,000	77,000	79,000	82,000
1975	79,000	79,000	82,000	86,000	89,000	92,000
1980	88,000	88,000	92,000	95,000	98,000	102,000
1985	106,000	106,000	111,000	115,000	119,000	123,000
1990	125,000	125,000	130,000	135,000	140,000	145,000
Average Annual Use	94,000	94,000	98,000	102,000	105,000	109,000

East Fork Russian River

The East Fork Russian River above Lake Mendocino has been planted with about 30,000 catchable-sized rainbow trout each year since 1965. The Department of Fish and Game estimates that 5,300 angler days were spent fishing for catchable trout in this section of stream in 1970 (Anderson, 1972). This use is expected to increase to 6,600 angler days in 1975. The fishery is dependent on continued diversions from the Eel River.

Populations of wild rainbow trout, largemouth bass, and catfish are also found in the East Fork Russian River between the Potter Valley Powerhouse and Lake Mendocino. These populations have developed as a result of the imported water and are dependent on the flows. They support a small fishery. Irrigation canals of the Potter Valley Irrigation District also contain small populations of warmwater game fish and trout and support a minor local fishery.

Recreation use of the East Fork Russian River includes mostly fishing, camping, hiking, and sightseeing. These activities would be affected by the revised operations, since releasing more water down the Eel River would reduce the diversions to the East Fork Russian River and Lake Mendocino during the summer months.

Smaller summer diversions with alternatives 2b, 2c, 2d, 3c, and 3d would significantly reduce recreation use of the East Fork Russian River.

Lake Mendocino

Lake Mendocino is a 1,700 surface-acre reservoir constructed by the Corps of Engineers on the East Fork of the Russian River. The reservoir was first opened for public recreation use in June 1959. Initially, the Corps provided a boat launching ramp and parking area near the dam and subsequently developed additional facilities. State and local interests constructed a water supply system, picnic and camp sites, sanitary facilities, boat docking and launching ramps, parking areas, and trails along parts of the reservoir shoreline. Various problems with the operation and maintenance of the nonfederal facilities resulted in the Corps taking over operation of the entire recreation development in 1970.

Present facilities at Lake Mendocino include 2 boat ramps with adjacent parking, a swimming beach, 59 picnic sites, 76 campsites with

drinking water, an overflow camping area, 2 boat docks, and 4 parking areas with spaces for 189 cars.

Lake Mendocino supports a warmwater fishery for bluegill, black crappie, largemouth bass, and channel catfish. A few trout and other warmwater fish are also caught. Striped bass have been planted annually since 1967 to provide an additional sport fish and to help control a population of stunted bluegill. Angler use at Lake Mendocino was estimated at 125,000 angler days in 1969 (Anderson, 1972).

The proximity to U.S. Highway 101 and State Route 20, along with the moderate climate, aesthetic qualities of Lake Mendocino, and good recreation facilities, attract many recreationists from the San Francisco Bay area and tourists traveling the Redwood Highway each summer. Annual use of Lake Mendocino has increased substantially during the past 10 years and the Corps predicts that capacity use of 1,500,000 recreation days will be reached by 1975.

Alternative operations 2a, 2b, 2c, and 2d would change the operation of Lake Mendocino only slightly. Water surface elevations during the summer months would range from 0 to 4 feet lower than with the present operation, according to the Corps' operation studies. If Lake Mendocino is enlarged to a crest elevation of 820 feet, operations 3a, 3b, 3c, and 3d also would result in a similar operation of Lake Mendocino.

However, enlarging the reservoir would inundate some of the lands now developed for recreation and needed for future development. This would cause a 15 percent reduction in the recreation use capacity of the lake, according to the Corps of Engineers.

Enlarging Coyote Dam would provide an opportunity to install multiple-level outlets which would provide some control of water temperatures and the turbidity of the water released. If the turbidity is significantly reduced during the salmon and steelhead fishing season, fishing use on the lower Russian River would increase.

Russian River

Water diverted from the Eel River to the Russian River permits a wide variety of summer recreational uses that would not otherwise be possible and has been largely responsible for the extensive resort development along the Russian River.

The 30-mile reach from Healdsburg to the mouth at Jenner is a major year-around playground for residents of the San Francisco Bay area. The economy of many of the small communities bordering the river is dependent on recreational visitors.

Boating, canoeing, fishing, and swimming are the more popular water-related activities. Other activities include golfing, sunbathing, horseback riding, hiking, camping, picnicking, and driving for pleasure. In the winter months, the river offers fishing for steelhead trout in an easily accessible area. Angling for shad and smallmouth bass is also very popular during the spring and early summer months.

The community of Healdsburg has constructed a beach park along the river and two recreation districts provide a recreation beach and two temporary dams on the lower river for summer recreation. However, most of the water-associated public recreation areas in the basin are provided by private enterprise. Many are associated with the main stem Russian River. The lands along the river between the mouth and the Santa Rosa Valley include some of the most intensively developed and heavily used recreation lands in the State. There are also hundreds of summer homes; many are rented out during periods the owner is not there.

The Russian River supports runs of steelhead and salmon and is stocked with rainbow trout. At times during the year, the high turbidity of the imported water adversely affects the fishery in the upper reaches.

The Department of Fish and Game estimated angling use for salmon and steelhead at about 70,000 angler days annually (Anderson, 1972). The Department is concerned that the numbers of salmon and steelhead, and angling success in the Russian River may be declining. Total recreation use along the Russian River is estimated to be about 2,200,000 recreation days.

Existing agreements require that the streamflow of the Russian River be maintained at a minimum of 150 cfs at the confluence of the East and West Branches, and 125 cfs at Guerneville. The Corps of Engineers' operation studies assumed that smaller diversions from the Eel River would result in reduced water supplies in the Russian River Basin during dry years, but that summer flows in the river would not be affected. With this assumption there would be no change in recreation use along the Russian River with any of the alternatives being considered. However, if water needs are

met without dry year deficiencies (a more likely assumption), summer flows in the Russian River would be reduced during dry years such as occurred in 1924 and 1931.

Recreation use during such years would be adversely affected. The specific impact of reduced flows on Russian River recreation use was not evaluated, but would probably vary with each alternative.

In summary, the revised operations of Lake Pillsbury and the Potter Valley diversion would increase summer flows in the Eel River below Van Arsdale Dam. The water surface of Lake Pillsbury would be 4 to 5 feet higher on September 1 during an average water year. These changes would cause a net increase in recreation use in the Eel River Basin of 8,000 to 112,000 recreation days (Table A9).

Changes in the water surface of Lake Mendocino and changes in streamflow in the Russian River were not evaluated. However, Lake Mendocino and the Russian River support large amounts of recreation use, and reductions in water surface at Lake Mendocino or reduced streamflow in the river could have major adverse effects on recreation in the Russian River Basin.

To an unknown degree, increases in Eel River and Lake Pillsbury recreation would be offset by reductions in Russian River and Lake Mendocino recreation.

Lake Mendocino may eventually be enlarged to meet future water needs in the Russian River Basin. If it is enlarged, the ultimate recreation capacity of the reservoir would be reduced. However, fishing use on the lower Russian River would increase due to better control of the turbidity and temperature of the releases from the dam. This increase would at least partially offset losses in recreation use at the reservoir.

TABLE A9
SUMMARY OF EFFECTS OF ALTERNATIVE OPERATIONS ON RECREATION
IN THE EEL RIVER BASIN, 1970-1990

Alternative	Average Annual Recreation Days		
	Lake Pillsbury	Eel River	Estimated Increase
1 (Historic)	220,000	185,000	-
2a and 3a	228,000	185,000	8,000
2b and 3b	228,000	206,000	29,000
2c and 3c	228,000	232,000	55,000
2d and 3d	224,000	259,000	78,000
4	232,000	285,000	112,000

REFERENCES

- Anderson, Keith R. "Report to the California State Water Resources Control Board by the Department of Fish and Game regarding Water Application 18785 and 18786, Eel River, Lake and Mendocino Counties". April 1972.
- Department of Parks and Recreation. "Recreation". Appendix B to Department of Water Resources Bulletin No. 136, "North Coastal Area Investigation". March 1965.
- Federal Power Commission. "Evaluation Report, Water Resources Appraisal for Hydroelectric Licensing, Potter Valley Development, Project No. 77 owned by Pacific Gas and Electric Company, Eel and Russian River Basins, California". 1972.
- Lee, Dennis P. and Phillip H. Baker. "Eel-Russian Rivers Streamflow Augmentation Study: Reconnaissance Fisheries Evaluation". February 1975.
- Pacific Gas and Electric Company. "FPC Project No. 77, Report to the Federal Power Commission on the Potter Valley Hydroelectric Project". July 1968.
- . "Application of the Pacific Gas and Electric Company for New License Before the Federal Power Commission, Potter Valley Project - 77". April 1970.
- U. S. Corps of Engineers. "Master Plan for Public Recreation Development, Lake Mendocino, Russian River Reservoir (Coyote Dam)". Supplement - Part V. May 1970.
- U. S. Forest Service. "English Ridge Reservoir Impact Survey Report". March 1967.

EEL-RUSSIAN RIVERS
STREAMFLOW AUGMENTATION STUDY

APPENDIX B

HYDROLOGY

HYDROLOGY

This appendix presents in tabular form the hydrologic data used in the Eel-Russian Rivers Streamflow Augmentation Study. A brief description of each table cites the source of the data and discusses any adjustments or revisions of the data.

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Adjusted Historical Diversions
to Potter Valley Powerhouse

Actual diversions from the upper Eel River to Potter Valley Powerhouse for the study period 1923-1970 (Table B-2) averaged 154,700 acre-feet per year. However, past diversions would not be representative of what could be expected in the future, because the capacity of the diversion tunnel was increased in 1950.

Previous joint studies of the English Ridge Project by the Department of Water Resources and the Bureau of Reclamation had adjusted data for 1923-1950 to compensate for the tunnel enlargement. Data for 1961-1970 were taken from U. S. Geological Survey publications of water supply data for California. These data were further adjusted to provide an estimate of the maximum diversion that could be expected under the historical project operation. During months when spills to the Eel River below Van Arsdale Dam would exceed 2,000 acre-feet, the diversions were adjusted to the maximum rate of 345 cfs. These adjusted diversions, shown in Table B-1, were used as a base for all operation studies for the various alternatives evaluated in this study.

TABLE B-1

ADJUSTED HISTORICAL DIVERSIONS TO POTTER VALLEY POWERHOUSE
(1,000 Acre-Feet)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1923	16.0	17.0	19.0	21.2	19.1	13.0	20.5	18.0	15.0	12.0	11.0	6.0	187.8
1924	15.0	7.0	7.0	6.0	12.0	4.0	2.0	4.0	4.0	10.0	10.0	2.0	83.0
1925	6.0	8.0	19.0	19.0	19.1	21.2	20.5	21.2	17.0	13.0	11.0	15.0	190.0
1926	15.0	15.0	8.0	9.0	19.1	16.0	20.5	15.0	8.0	11.0	10.0	10.0	156.6
1927	15.0	18.0	21.2	21.2	19.1	21.2	20.5	21.2	14.0	12.0	11.0	15.0	209.4
1928	15.0	15.0	18.0	19.0	19.1	21.2	20.5	19.0	13.0	12.0	11.0	9.0	191.8
1929	15.0	10.0	13.0	16.0	12.0	16.0	6.0	6.0	7.0	12.0	11.0	12.0	136.0
1930	15.0	5.0	19.0	21.2	19.1	21.2	20.5	19.0	13.0	11.0	11.0	7.0	182.0
1931	15.0	7.0	6.0	11.0	6.0	11.0	14.0	5.0	4.0	11.0	10.0	6.0	106.0
1932	15.0	8.0	19.0	21.2	19.1	21.2	18.0	19.0	14.0	11.0	10.0	10.0	185.5
1933	15.0	6.0	9.0	10.0	14.0	21.2	20.5	21.2	18.0	13.0	11.0	14.0	172.0
1934	15.0	15.0	13.0	19.0	19.1	21.2	18.0	5.0	4.0	11.0	11.0	7.0	158.3
1935	15.0	12.0	19.0	19.0	19.1	21.2	20.5	19.0	14.0	12.0	11.0	12.0	193.8
1936	16.0	6.0	11.0	21.2	19.1	21.2	20.5	19.0	16.0	13.0	11.0	10.0	184.0
1937	15.0	5.0	7.0	4.0	17.0	21.2	20.5	19.0	15.0	12.0	11.0	15.0	161.7
1938	16.0	19.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	13.0	11.0	15.0	216.4
1939	16.0	16.0	15.0	16.0	11.0	19.0	19.0	6.0	5.0	11.0	10.0	7.0	151.0
1940	15.0	6.0	11.0	21.2	19.1	21.2	20.5	19.0	13.0	11.0	11.0	10.0	178.0
1941	15.0	7.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	14.0	11.0	15.0	204.4
1942	16.0	16.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	13.0	11.0	15.0	213.4
1943	15.0	18.0	19.0	21.2	19.1	21.2	20.5	19.0	15.0	12.0	11.0	12.0	203.0
1944	15.0	6.0	8.0	9.0	11.0	21.2	20.5	19.0	14.0	12.0	11.0	13.0	159.7
1945	15.0	13.0	19.0	19.0	19.1	21.2	20.5	19.0	13.0	12.0	11.0	10.0	191.8
1946	16.0	18.0	21.2	21.2	19.1	21.2	20.5	18.0	6.0	11.0	10.0	10.0	192.2
1947	15.0	10.0	18.0	19.0	15.0	21.2	20.5	14.0	6.0	12.0	11.0	12.0	173.7
1948	17.0	16.0	9.0	19.0	17.0	19.0	20.5	21.2	18.0	13.0	11.0	15.0	195.7
1949	15.0	16.0	11.0	9.0	17.0	21.2	20.5	18.0	8.0	11.0	11.0	15.0	172.7
1950	15.0	15.0	4.0	19.0	19.1	21.2	20.5	19.0	13.0	12.0	11.0	14.0	182.8
1951	19.0	19.0	21.2	21.2	19.1	21.2	18.0	19.0	14.0	12.0	11.0	13.0	207.7
1952	15.0	9.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	13.0	11.0	14.0	204.4
1953	14.0	7.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	15.0	13.0	14.0	205.4
1954	18.0	17.0	18.0	21.2	19.1	21.2	20.5	19.0	13.0	12.0	11.0	12.0	202.0
1955	15.0	9.0	19.0	19.0	17.0	16.0	18.0	19.0	14.0	12.0	11.0	15.0	184.0
1956	15.0	8.0	21.2	21.2	19.1	21.2	20.5	21.2	17.0	12.0	11.0	12.0	199.4
1957	15.0	14.0	4.0	12.0	19.1	21.2	20.5	21.2	18.0	13.0	11.0	13.0	182.0
1958	19.0	18.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	14.0	11.0	15.0	219.4
1959	14.0	14.0	5.0	21.2	19.1	21.2	19.0	14.0	5.0	11.0	10.0	12.0	165.5
1960	15.0	5.0	7.0	12.0	19.1	21.2	20.5	19.0	17.0	12.0	11.0	12.0	170.8
1961	16.0	18.0	19.0	18.0	19.1	21.2	20.5	21.2	12.0	8.0	8.0	19.0	200.0
1962	19.0	14.0	19.0	19.0	19.1	21.2	20.5	8.0	10.0	13.0	14.0	11.0	187.8
1963	18.0	18.0	21.2	21.2	19.1	21.2	20.5	21.2	13.0	13.0	13.0	12.0	211.4
1964	14.0	16.0	18.0	19.0	17.0	15.0	4.0	4.0	4.0	8.0	9.0	10.0	138.0
1965	17.0	18.0	21.2	21.2	19.1	21.2	20.5	19.0	12.0	13.0	14.0	17.0	213.2
1966	18.0	11.0	14.0	21.2	19.1	21.2	20.5	14.0	8.0	13.0	13.0	17.0	190.0
1967	19.0	17.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	19.0	19.0	19.0	235.4
1968	16.0	11.0	18.0	21.2	19.1	21.2	20.5	5.0	7.0	13.0	13.0	13.0	178.0
1969	17.0	18.0	18.0	21.2	19.1	21.2	20.5	21.2	15.0	13.0	13.0	17.0	214.2
1970	18.0	15.0	21.2	21.2	19.1	21.2	20.5	6.0	8.0	8.0	9.0	16.0	183.2
TOTAL	750.0	606.0	756.8	871.0	853.6	955.8	915.0	803.2	600.0	580.0	538.0	596.0	8825.4
AVG.	15.6	12.6	15.8	18.1	17.8	19.9	19.1	16.7	12.5	12.1	11.2	12.4	183.9

Actual Historical Diversions
to Potter Valley Powerhouse

Table B-2 shows the measured diversions from the upper Eel River to Potter Valley Powerhouse for the 48-year study period, from October 1922 through September 1970. These data are from U. S. Geological Survey publications of water supply data for California.

TABLE B-2

RUNOFF OF POTTER VALLEY P.H. TAILRACE NR POTTER VALLEY

(1,000 Acre-Feet)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1923	13.1	13.6	14.7	16.3	14.7	16.3	15.7	16.3	16.4	14.8	13.5	13.2	133.6
1924	14.9	13.1	7.1	4.7	7.1	4.3	3.5	3.8	3.6	3.5	3.5	1.7	70.8
1925	4.6	16.2	18.8	18.1	15.3	18.0	16.5	17.5	17.5	18.2	16.4	16.2	193.3
1926	15.3	14.8	15.3	13.2	13.1	15.5	14.6	15.3	14.9	15.2	16.0	15.2	178.9
1927	15.3	14.9	15.3	14.4	13.6	14.8	14.8	15.3	15.6	16.2	16.8	16.4	183.4
1928	14.8	14.5	15.3	15.4	14.3	15.2	15.1	16.0	16.4	17.1	17.8	16.1	188.0
1929	14.0	11.8	13.3	13.5	11.7	12.4	10.2	9.2	11.7	11.5	11.6	8.6	139.5
1930	5.6	4.7	9.3	16.2	12.6	12.4	13.9	14.3	10.9	11.7	12.8	9.2	133.6
1931	5.0	10.5	15.8	16.6	15.6	16.8	10.0	5.9	5.2	6.6	7.0	9.5	124.5
1932	13.8	16.1	9.5	16.9	15.4	8.1	10.8	13.5	5.4	6.8	6.7	6.4	129.4
1933	11.1	17.6	17.8	8.8	14.2	18.0	17.9	13.6	11.5	14.2	17.7	9.9	172.3
1934	1.4	.6	.2	4.4	8.5	3.3	3.9	7.5	9.2	10.4	10.8	10.8	71.0
1935	11.4	10.9	11.2	11.4	10.3	11.2	8.2	7.8	7.8	10.7	10.4	10.7	122.0
1936	4.7	7.9	11.1	11.2	10.4	11.1	8.8	10.0	10.5	12.3	11.7	9.8	119.5
1937	11.2	7.8	11.4	10.9	10.1	11.0	10.9	11.0	10.8	11.3	11.4	11.1	128.9
1938	11.5	7.8	9.9	9.9	9.8	4.6	9.4	11.3	11.1	11.8	11.4	10.9	119.4
1939	10.7	11.0	11.1	8.6	9.7	8.3	9.8	11.2	11.0	11.6	11.4	11.8	126.2
1940	12.2	9.2	10.1	12.0	10.6	10.8	11.6	8.9	6.8	9.3	8.6	10.9	121.0
1941	11.0	9.9	10.1	8.1	9.4	12.8	11.6	12.5	11.7	9.2	12.1	12.8	131.2
1942	11.7	12.7	13.0	13.1	11.8	13.2	12.8	13.1	12.3	9.1	8.4	8.4	139.6
1943	8.6	10.3	13.1	12.8	11.8	12.8	12.7	12.5	8.5	9.2	9.6	9.1	131.0
1944	9.4	12.6	3.1	.9	12.3	13.2	12.6	13.2	12.6	10.2	10.3	9.9	120.3
1945	10.0	12.8	13.4	13.4	12.1	13.4	13.1	13.1	10.2	10.2	11.1	12.0	144.8
1946	13.4	13.0	11.7	12.4	12.2	13.6	13.4	11.0	9.6	10.0	10.0	9.4	139.7
1947	10.3	10.0	13.2	11.3	9.7	13.3	12.9	5.5	6.5	8.0	9.2	11.4	121.3
1948	13.3	12.8	13.5	13.3	12.6	13.6	13.0	13.3	11.3	6.3	11.3	13.0	147.3
1949	11.0	11.6	10.8	13.4	12.1	13.2	13.0	12.2	5.1	8.7	9.9	9.4	130.4
1950	9.4	11.7	13.5	13.5	10.0	.0	9.5	16.3	4.9	12.3	10.8	13.3	125.2
1951	16.6	18.3	17.3	18.6	16.8	19.2	19.4	15.8	10.9	11.3	11.3	10.9	186.4
1952	12.5	15.4	18.7	18.8	16.3	19.2	19.2	20.2	17.1	14.0	19.2	15.0	205.6
1953	13.6	8.8	18.6	5.2	11.0	18.9	19.1	20.0	19.3	19.3	19.6	17.2	190.6
1954	17.1	18.1	18.6	18.0	14.2	16.4	18.5	19.5	12.2	12.5	13.5	17.8	196.4
1955	19.2	14.7	18.0	18.9	17.2	10.7	10.2	17.9	12.7	14.8	14.7	14.0	183.0
1956	14.5	12.6	8.4	16.6	16.6	19.7	19.1	19.4	12.3	14.6	15.3	15.3	134.4
1957	14.3	11.6	6.5	10.0	9.2	18.0	14.8	18.5	12.9	13.1	13.4	13.6	155.9
1958	14.6	18.0	18.4	18.1	14.8	18.2	17.6	15.8	13.8	13.2	13.0	15.9	191.4
1959	17.3	14.3	6.9	17.0	16.8	17.9	9.2	5.4	16.4	19.1	19.4	6.1	165.8
1960	.0	9.9	1.5	5.8	17.2	18.4	17.2	15.1	10.1	18.8	6.4	10.3	130.7
1961	16.4	18.2	18.7	18.3	16.4	18.6	18.2	18.4	12.2	7.8	7.8	18.6	189.6
1962	19.1	13.6	18.6	19.0	16.8	18.6	17.0	8.2	10.1	13.5	13.7	11.3	179.5
1963	17.5	18.5	18.5	18.5	16.8	16.2	17.9	18.2	13.0	12.6	13.3	12.4	193.4
1964	13.5	16.3	18.1	18.6	17.2	14.8	4.1	4.0	3.8	8.3	9.0	10.3	138.0
1965	17.1	18.3	15.6	18.6	16.9	9.4	17.7	18.6	12.3	13.5	13.9	17.0	188.9
1966	18.0	10.9	13.7	18.6	16.9	17.9	18.4	14.1	7.6	12.6	13.6	17.4	179.7
1967	19.4	17.5	18.9	18.9	17.0	17.9	18.1	18.8	17.9	18.8	19.0	18.7	220.9
1968	16.3	10.6	18.0	18.7	17.5	18.6	11.4	4.4	6.6	13.0	13.0	12.6	160.7
1969	17.2	17.8	18.0	17.8	16.1	17.9	17.2	18.4	14.9	13.1	13.2	17.2	193.8
1970	18.4	15.1	13.1	17.9	16.4	17.8	6.4	5.6	7.9	8.3	8.8	15.9	151.6
TOTAL	616.8	618.9	636.7	666.6	649.1	675.5	640.9	627.4	533.0	578.6	589.3	594.6	7427.4
AVG.	12.9	12.9	13.3	13.9	13.5	14.1	13.4	13.1	11.1	12.1	12.3	12.4	154.7

Recorded Runoff of the Eel River
at Van Arsdale Dam

Table B-3 summarizes the recorded flow in the Eel River below Van Arsdale Dam, as shown in U. S. Geological Survey reports on water supply data for California. These flows are impaired by storage in Lake Pillsbury and by export diversions to the Russian River Basin.

TABLE B-3

RECORDED RUNOFF OF THE EEL RIVER AT VAN ARSDALE DAM

(1,000 Acre-feet)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1923	1.6	1.8	17.7	14.0	23.9	4.1	34.1	.2	.1	.1	.1	.1	97.8
1924	.1	.1	.1	.1	2.0	.1	.1	.1	.1	.1	.1	.1	3.1
1925	.1	.1	3.3	.1	153.0	21.3	67.2	40.0	.1	.1	.1	.1	285.5
1926	.1	.1	.2	1.9	57.8	.6	29.8	.1	.1	.1	.1	.1	91.0
1927	.1	3.2	39.8	131.0	288.0	67.8	84.5	13.3	.1	.1	.1	.1	628.1
1928	2.8	1.3	4.4	5.9	34.5	142.0	65.5	4.0	.9	.7	.7	.9	263.6
1929	.7	.7	1.9	.8	2.7	.8	.4	.3	.4	.4	.4	.6	10.1
1930	.4	.4	6.3	49.2	48.8	53.2	18.5	1.2	.3	.3	.3	.2	179.1
1931	.2	.3	.5	3.2	1.1	1.6	.5	.2	.1	.1	.1	.1	8.0
1932	.3	.4	20.4	42.7	12.3	15.7	7.4	10.7	.2	.3	.2	.2	110.8
1933	.3	.2	.4	1.1	.5	34.7	13.7	18.6	2.7	.1	.2	.1	72.6
1934	.3	.5	31.4	43.0	16.4	22.6	11.5	2.2	.1	.1	.1	.1	128.3
1935	.1	1.6	1.2	50.4	33.5	62.2	115.3	7.8	.9	.1	.1	.1	273.3
1936	.1	.2	1.1	150.7	167.8	34.6	28.3	.8	2.6	.2	.1	.1	386.6
1937	.1	.1	.1	.8	13.9	58.6	52.7	15.0	.3	.1	.1	.1	141.9
1938	.1	58.0	177.4	63.1	238.2	274.4	84.2	29.8	5.5	.2	.2	.5	931.6
1939	.4	.9	6.4	6.3	13.1	28.4	1.0	.1	.2	.2	.1	.1	57.2
1940	.1	.3	1.2	104.3	259.2	150.8	37.0	6.5	.4	.2	.2	.2	560.4
1941	.3	.2	114.9	189.3	153.0	121.9	126.7	32.1	2.2	.4	.3	.2	741.5
1942	.4	.4	128.1	141.5	191.4	15.9	41.6	28.4	6.7	.3	.2	.2	555.1
1943	.2	1.7	58.3	185.9	56.6	37.1	25.8	6.3	.5	.5	.2	.2	373.3
1944	.2	.2	1.5	6.2	5.0	40.5	12.5	5.8	.4	.2	.3	.4	73.2
1945	.4	2.7	24.7	12.2	79.8	32.5	25.8	3.8	.3	.3	.3	.3	183.1
1946	.7	4.7	187.6	83.3	23.0	10.4	7.1	1.1	.5	.4	.5	.5	319.8
1947	.5	1.9	1.9	.5	8.8	57.6	13.7	.5	.4	.3	.2	.3	86.6
1948	.9	.8	.7	33.0	.8	24.3	131.5	37.3	5.2	.3	.3	.2	235.3
1949	.2	.3	.7	.8	19.8	109.1	23.1	5.7	.3	.3	.2	.2	160.7
1950	.2	.2	.4	18.2	72.5	64.2	29.4	3.7	.3	.3	.4	.2	190.0
1951	2.2	30.1	140.4	133.9	104.7	29.0	.7	.7	.2	.3	.2	.2	442.6
1952	.3	.6	126.6	107.1	191.9	81.1	38.5	8.4	.6	.2	.2	.1	555.6
1953	.1	.1	66.1	318.9	25.5	40.7	21.2	21.0	5.3	.2	.1	.2	499.4
1954	.6	2.9	2.6	109.1	101.6	62.9	61.3	2.0	.3	.3	.2	.2	344.0
1955	.2	1.6	6.1	4.9	2.1	2.2	7.1	10.8	.3	.2	.2	.1	35.8
1956	.1	.4	245.2	251.8	170.8	52.5	4.0	6.4	.2	.2	.3	.1	732.0
1957	.7	.5	.5	3.2	54.6	63.4	12.2	38.6	1.3	.3	.3	.4	176.0
1958	5.5	4.6	55.9	123.9	369.3	122.5	126.3	9.4	1.0	.3	.2	.2	819.1
1959	.3	.5	.4	23.6	87.0	19.6	.3	.3	.4	.3	.2	1.7	134.6
1960	1.7	.4	.3	5.9	126.0	101.4	10.6	6.3	.4	.3	.3	.2	253.8
1961	.2	1.8	12.4	14.7	103.8	66.9	20.4	10.6	.2	.2	.2	.2	231.6
1962	.2	.9	2.2	2.6	92.8	68.7	17.5	.1	.2	.2	.1	.2	185.7
1963	9.4	1.3	35.6	24.2	117.2	48.0	159.1	17.2	.2	.2	.1	.1	412.6
1964	.1	2.4	.6	33.6	8.7	.7	.2	.1	.1	.2	.1	.1	46.9
1965	.1	3.0	322.8	243.1	38.3	1.7	62.2	8.2	.2	.2	.1	.1	680.0
1966	1.2	6.4	6.9	114.9	43.5	43.8	22.4	.2	.2	.1	.1	.1	239.8
1967	.1	6.3	92.7	160.3	47.0	72.9	55.8	38.7	5.7	.2	.1	.1	479.9
1968	.5	.2	2.7	36.8	125.8	35.8	1.4	.1	.2	.3	.3	.2	204.3
1969	.2	.7	27.5	287.5	140.3	77.0	38.4	18.8	.3	.3	.3	.2	591.5
1970	.3	.3	46.8	387.1	68.1	31.8	.7	.3	.3	.3	.2	.2	536.4
TOTAL	35.9		2026.9		3996.4		1749.2		49.5		10.0		14749.2
		148.3		3726.6		2509.6		473.8		11.6		11.4	
AVG.	.7	3.1	42.2	77.6	83.3	52.3	36.4	9.9	1.0	.2	.2	.2	307.2

Unimpaired Runoff of the Eel River
at Van Arsdale Dam

Table B-4 summarizes the unimpaired flow of the Eel River at Van Arsdale Dam; that is, the runoff that would have occurred without Lake Pillsbury or the power diversion in operation.

Data for the years 1923-1967 are from a report by the California State-Federal Interagency Group, titled "Eel and Mad River Basins Master Plan - Hydrology", published in August 1969. Data for 1968-1970 are from U. S. Geological Survey reports on water supply data for California, adjusted to account for storage in and evaporation from Lake Pillsbury and for diversions to the Russian River Basin via the Potter Valley Powerhouse.

TABLE B-4

UNIMPAIRED RUNOFF OF THE EEL RIVER AT VAN ARSDALE DAM
(1,000 Acre-feet)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1923	5.2	12.6	72.1	58.4	38.9	17.8	63.4	12.8	7.0	2.0	.8	1.1	292.1
1924	1.8	4.2	2.2	9.5	28.7	3.9	3.3	2.9	1.1	.5	.3	.2	58.6
1925	4.9	20.1	55.1	32.0	203.2	41.6	85.7	55.4	15.9	4.0	1.3	2.2	521.4
1926	1.4	3.7	8.6	25.2	130.2	21.5	54.3	10.0	3.5	1.8	.4	.8	261.4
1927	1.7	64.5	82.5	149.5	300.2	85.0	99.6	28.0	9.0	3.0	1.1	.9	825.0
1928	2.8	20.1	20.7	62.7	72.9	154.4	83.8	17.2	5.4	2.7	1.1	.5	444.3
1929	.7	8.4	23.2	15.3	37.5	17.7	19.5	10.8	6.2	1.4	.7	.4	141.8
1930	.3	.7	83.8	73.7	65.8	71.4	33.2	15.2	4.8	1.4	.5	.3	351.1
1931	.3	2.2	2.1	40.1	16.7	34.7	8.9	3.5	2.6	.8	.5	.3	112.7
1932	1.3	6.0	96.3	64.4	32.2	35.7	23.6	24.9	4.6	1.0	.5	.3	290.8
1933	.2	1.3	9.3	20.4	28.7	88.5	33.1	33.3	12.0	2.9	1.0	.7	231.4
1934	2.6	1.9	58.1	42.0	39.9	30.9	16.5	8.7	3.1	.6	.6	.2	205.1
1935	1.6	27.2	17.1	77.3	48.4	77.4	125.4	24.2	6.1	2.7	.5	.5	408.4
1936	1.7	1.7	9.6	189.7	180.9	52.2	45.7	13.5	12.4	4.7	1.2	.3	513.6
1937	.6	.8	2.2	3.3	59.7	92.1	73.8	26.2	9.5	2.4	.9	1.0	272.5
1938	2.7	93.3	186.9	75.8	247.6	278.9	108.2	47.3	14.8	4.2	1.2	1.9	1062.8
1939	3.6	7.1	28.0	22.9	29.2	47.6	13.2	8.4	2.8	1.4	.6	.7	165.5
1940	1.7	1.3	29.1	156.8	277.1	163.7	62.1	17.7	5.8	.9	.5	.8	717.5
1941	1.4	3.9	155.7	197.6	167.3	143.9	144.2	45.5	14.8	5.3	1.7	1.3	882.6
1942	2.1	5.2	169.3	155.4	201.8	31.3	73.0	43.2	18.8	4.4	1.6	.8	706.9
1943	.9	21.4	75.8	199.7	66.5	68.2	39.9	21.0	8.7	2.5	1.0	.5	506.1
1944	.6	1.9	4.5	25.7	34.2	70.2	25.3	18.9	7.3	1.3	.6	.4	190.9
1945	.7	31.7	51.5	25.7	102.0	54.2	41.5	17.8	7.2	2.0	.9	.5	335.7
1946	7.1	42.6	204.3	93.0	36.6	37.0	28.5	11.2	3.7	1.1	.6	.3	466.0
1947	.3	18.9	23.5	4.6	49.1	85.1	27.0	6.2	7.3	1.9	.8	.4	225.1
1948	12.6	5.6	5.4	74.5	20.0	53.2	145.6	51.7	17.2	4.4	1.4	1.5	393.1
1949	1.7	5.3	16.3	14.7	49.8	131.0	48.5	18.5	5.1	1.0	.5	.3	292.7
1950	1.6	2.9	2.9	71.3	83.8	72.5	51.9	20.4	5.9	1.9	1.5	.7	317.3
1951	28.3	54.9	157.7	153.6	121.1	52.7	20.7	25.7	5.0	1.7	1.2	.6	623.2
1952	.6	35.6	167.5	127.4	205.8	100.9	67.7	38.8	12.0	4.5	1.7	.7	763.2
1953	.4	3.4	137.2	322.7	35.2	66.9	54.5	42.6	22.3	6.4	3.6	1.3	696.5
1954	1.8	17.7	19.6	180.2	114.4	85.1	94.4	18.2	7.8	2.2	1.5	1.3	544.2
1955	.3	19.7	52.4	30.0	20.7	23.1	36.2	32.2	5.6	2.2	.9	1.0	224.3
1956	.3	5.8	308.6	268.6	187.7	70.8	36.0	31.2	9.3	3.1	1.4	1.7	924.5
1957	2.4	3.0	3.1	30.9	103.2	94.6	33.5	58.1	12.1	2.8	1.2	2.7	347.6
1958	37.0	22.2	78.0	144.0	384.0	140.8	149.0	39.7	13.6	5.2	1.8	.8	1016.1
1959	.4	1.2	4.4	95.7	104.6	44.3	21.8	8.3	2.6	1.1	.6	1.3	286.3
1960	.6	.4	2.2	32.4	171.7	138.6	29.9	22.0	8.4	1.9	.7	.7	409.5
1961	1.1	12.7	71.4	38.3	116.7	104.3	39.6	29.7	8.0	2.3	1.5	.9	426.5
1962	1.2	14.2	33.3	22.6	133.4	87.9	48.3	15.1	5.4	2.0	.9	1.2	365.5
1963	45.9	13.2	64.3	52.7	124.4	82.5	177.9	38.3	9.8	3.2	1.1	1.0	614.3
1964	3.4	43.3	11.3	66.5	23.1	16.2	12.1	7.1	3.4	1.3	.6	.4	188.7
1965	1.9	29.2	370.7	261.4	54.1	25.0	86.1	26.7	6.1	2.2	1.8	.8	866.0
1966	2.2	34.9	32.5	152.6	60.1	70.4	51.4	15.7	4.1	1.7	1.0	1.3	427.9
1967	1.0	55.9	125.5	184.1	59.2	91.6	84.7	67.0	21.6	5.1	2.2	1.9	699.8
1968	2.8	3.6	32.2	99.6	143.2	62.6	20.6	9.3	3.4	.8	1.3	.7	380.1
1969	1.6	6.9	97.7	306.2	156.9	94.7	71.9	39.9	10.7	3.0	1.1	1.6	792.2
1970	2.4	1.8	117.4	406.6	83.4	49.9	15.0	8.6	3.3	.9	.1	.9	690.3
TOTAL	199.7		3383.1		5051.8		2730.0		397.1		50.5		22479.1
		796.1		4957.3		3564.5		1188.6		117.8		42.6	
AVERAGE	4.2	16.6	70.5	103.3	105.2	74.3	56.9	24.8	8.3	2.4	1.0	.9	468.3

Unimpaired Inflow to Lake Pillsbury

Table B-5 represents that portion of the flows shown in Table B-4 originating in the 290-square-mile drainage upstream from Scott Dam. To the extent possible, flows in Table B-5 were derived from records of storage in Lake Pillsbury and records of the gaging station "Eel River below Scott Dam". However, that combination would at times produce values for summer months that were greater than the corresponding flows in Table B-4, indicating a negative runoff for the 59-square-mile area between Scott and Van Arsdale Dams. In those instances, allowing the values in Table B-4 to control, the inflow to Lake Pillsbury was taken as equal to the runoff at Van Arsdale Dam, and the runoff of the area between the two dams was set at zero.

TABLE B-5

 UNIMPAIRED INFLOW TO LAKE PILLSBURY
 (1,000 Acre-feet)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1923	4.5	10.2	52.9	43.9	24.7	16.5	56.6	12.2	5.2	1.1	.4	.6	228.8
1924	1.6	4.0	1.8	8.2	23.3	3.7	3.1	2.8	1.1	.5	.3	.2	50.6
1925	3.7	16.4	42.2	25.4	181.9	36.4	67.5	44.9	15.9	3.8	1.3	2.2	441.6
1926	1.4	3.7	7.8	21.0	105.7	17.3	41.9	8.4	2.7	1.3	.2	.1	211.5
1927	1.6	57.2	61.3	82.2	210.6	71.3	83.6	23.7	9.0	3.0	1.1	.9	605.5
1928	2.8	19.4	17.7	51.9	62.7	121.2	66.9	15.6	5.4	2.7	1.1	.5	367.9
1929	.7	5.5	17.9	10.2	29.3	14.0	15.3	9.0	3.9	1.4	.7	.4	108.3
1930	.3	.2	71.0	55.7	50.7	59.0	28.5	14.3	4.5	.6	.5	.3	285.6
1931	.3	1.6	1.7	33.0	14.4	28.1	7.5	3.5	2.6	.4	.5	.3	93.9
1932	1.3	5.4	70.9	52.0	25.5	33.0	20.1	21.5	4.6	.7	.1	.3	235.4
1933	.2	1.3	7.9	15.3	21.3	70.6	29.2	27.8	11.1	1.9	.3	.2	187.1
1934	2.5	1.6	49.3	33.5	33.5	25.4	14.3	7.3	3.1	.6	.4	.2	171.7
1935	1.2	22.7	13.3	59.9	41.6	58.0	100.2	21.3	4.9	.7	.5	.5	324.8
1936	.8	.4	6.4	143.1	143.3	44.0	38.0	11.7	9.7	2.1	.1	.3	399.9
1937	.0	.2	1.3	2.1	45.8	73.9	60.6	24.1	7.8	1.3	.1	.1	217.3
1938	1.4	74.8	158.6	71.0	226.2	265.1	98.4	46.4	14.1	2.9	.7	1.9	961.5
1939	2.2	5.2	20.2	17.8	22.1	40.5	11.7	7.0	1.9	.7	.6	.7	130.6
1940	.6	.4	25.2	137.5	232.7	140.5	50.6	16.4	5.6	.9	.5	.6	611.5
1941	1.4	3.8	137.9	191.0	151.1	123.9	122.5	39.1	13.4	4.6	.9	.4	790.0
1942	1.2	3.5	145.4	137.0	172.6	26.7	64.7	38.4	16.4	4.2	1.2	.8	612.1
1943	.9	17.8	63.5	162.4	54.3	60.6	32.4	16.7	6.9	2.1	1.0	.5	419.1
1944	.6	1.3	3.9	20.7	27.1	59.3	24.0	18.0	6.7	1.3	.6	.4	163.9
1945	.7	26.0	44.8	19.9	90.7	43.5	34.4	15.2	6.7	1.6	.2	.5	284.2
1946	6.1	35.4	180.7	75.4	29.1	28.9	24.7	10.7	2.9	.7	.6	.3	395.5
1947	.3	15.8	19.8	3.6	40.9	70.8	22.1	5.1	5.8	.5	.8	.4	185.9
1948	10.2	4.2	3.9	61.7	14.7	41.1	125.3	45.3	15.4	3.2	.5	.6	326.1
1949	1.1	3.6	12.3	10.5	37.8	109.5	44.8	18.0	4.3	.9	.0	.3	243.1
1950	.7	2.2	1.9	56.5	75.3	66.7	46.6	19.3	5.9	1.2	.8	.7	277.8
1951	24.1	52.0	136.1	126.6	102.7	40.8	18.0	22.3	3.9	.5	.4	.4	527.8
1952	.3	34.1	131.2	97.4	165.7	84.1	67.3	32.8	11.5	3.3	.9	.7	629.3
1953	.4	3.4	110.4	274.9	31.1	55.0	48.8	34.3	17.9	5.9	3.5	1.3	586.9
1954	1.8	15.1	16.4	147.8	99.4	76.6	81.7	14.8	7.8	2.2	1.5	.4	465.5
1955	.3	17.5	45.0	23.0	16.9	19.2	29.9	28.6	5.2	1.8	.7	.5	188.6
1956	.3	4.8	265.8	253.4	172.6	66.4	32.5	28.0	9.3	3.1	.7	1.1	838.0
1957	2.0	2.9	2.4	23.9	94.0	83.2	29.1	51.4	10.5	2.4	1.2	2.7	305.7
1958	33.1	18.5	71.8	131.8	350.0	123.5	131.8	37.3	13.0	5.2	1.6	.8	918.4
1959	.4	1.2	3.8	82.6	84.3	39.4	19.3	7.3	2.6	1.1	.3	1.0	243.3
1960	.6	.4	2.1	25.0	140.7	112.6	25.6	19.5	8.4	1.9	.7	.7	338.2
1961	1.1	12.0	59.5	34.3	93.4	76.8	34.2	24.5	8.0	2.3	1.4	.9	348.4
1962	1.2	13.1	27.9	18.8	115.4	74.9	45.7	14.9	5.4	2.0	.9	1.2	321.4
1963	41.1	12.1	56.6	52.7	117.0	70.4	160.6	38.3	9.8	3.2	1.1	1.0	563.9
1964	3.4	37.8	11.2	59.6	23.1	13.8	10.6	6.7	3.2	.8	.6	.4	171.2
1965	1.9	23.9	336.3	223.8	46.8	22.4	78.1	22.9	6.1	2.2	1.8	.8	767.0
1966	1.5	26.2	23.1	132.5	54.6	60.4	44.6	14.1	4.1	1.7	1.0	1.3	365.1
1967	1.0	47.5	108.8	161.0	50.3	77.4	65.7	58.0	19.6	5.1	1.9	.3	596.6
1968	2.8	3.3	27.0	82.3	120.2	51.7	18.6	8.0	3.4	.8	1.3	.7	320.1
1969	1.6	6.3	76.7	268.4	133.7	82.0	66.9	39.9	10.7	3.0	1.1	1.6	691.9
1970	2.1	1.2	101.4	351.3	71.6	43.3	12.7	7.6	3.3	.9	.1	.9	596.4
TOTAL	171.3		2855.0		4272.4		2357.2		361.2		38.7		19114.9
		677.1		4173.5		3023.4		1054.9		96.3		33.9	
AVERAGE	3.6	14.1	59.5	86.9	89.0	63.0	49.1	22.0	7.5	2.0	.8	.7	398.2

Incremental Unimpaired Runoff -
Scott Dam to Van Arsdale Dam

Table B-6 represents that portion of the flows shown in Table B-4 originating in the 59-square-mile drainage between Scott and Van Arsdale Dams. Data in Table B-6 were derived by subtracting flows in Table B-5 from corresponding flows in Table B-4.

TABLE B-6

INCREMENTAL UNIMPAIRED RUNOFF-
SCOTT DAM TO VAN ARSDALE DAM
(1,000 Acre-feet)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1923	.7	2.4	19.2	14.5	14.2	1.3	6.8	.6	1.8	.9	.4	.5	63.3
1924	.2	.2	.4	1.3	5.4	.2	.2	.1	.0	.0	.0	.0	8.0
1925	1.2	3.7	12.9	6.6	21.3	5.2	18.2	10.5	.0	.2	.0	.0	79.8
1926	.0	.0	.8	4.2	24.5	4.2	12.4	1.6	.8	.5	.2	.7	49.9
1927	.1	7.3	21.2	67.3	89.6	13.7	16.0	4.3	.0	.0	.0	.0	219.5
1928	.0	.7	3.0	10.8	10.2	33.2	16.9	1.6	.0	.0	.0	.0	76.4
1929	.0	2.9	5.3	5.1	8.2	3.7	4.2	1.8	2.3	.0	.0	.0	33.5
1930	.0	.5	12.8	18.0	15.1	12.4	4.7	.9	.3	.8	.0	.0	65.5
1931	.0	.6	.4	7.1	2.3	6.6	1.4	.0	.0	.4	.0	.0	18.8
1932	.0	.6	25.4	12.4	6.7	2.7	3.5	3.4	.0	.3	.4	.0	55.4
1933	.0	.0	1.4	5.1	7.4	17.9	3.9	5.5	.9	1.0	.7	.5	44.3
1934	.1	.3	8.8	8.5	6.4	5.5	2.2	1.4	.0	.0	.2	.0	33.4
1935	.4	4.5	3.8	17.4	6.8	19.4	25.2	2.9	1.2	2.0	.0	.0	83.6
1936	.9	1.3	3.2	46.6	37.6	8.2	7.7	1.8	2.7	2.6	1.1	.0	113.7
1937	.6	.6	.9	1.2	13.9	18.2	13.2	2.1	1.7	1.1	.8	.9	55.2
1938	1.3	18.5	28.3	4.8	21.4	13.8	9.8	.9	.7	1.3	.5	.0	101.3
1939	1.4	1.9	7.8	5.1	7.1	7.1	1.5	1.4	.9	.7	.0	.0	34.9
1940	1.1	.9	3.9	19.3	44.4	23.2	11.5	1.3	.2	.0	.0	.2	106.0
1941	.0	.1	17.8	6.6	16.2	20.0	21.7	6.4	1.4	.7	.8	.9	92.6
1942	.9	1.7	23.9	18.4	29.2	4.6	8.3	4.8	2.4	.2	.4	.0	94.8
1943	.0	3.6	12.3	37.3	12.2	7.6	7.5	4.3	1.8	.4	.0	.0	87.0
1944	.0	.6	.6	5.0	7.1	10.9	1.3	.9	.6	.0	.0	.0	27.0
1945	.0	5.7	6.7	5.8	11.3	10.7	7.1	2.6	.5	.4	.7	.0	51.5
1946	1.0	7.2	23.6	17.6	7.5	8.1	3.8	.5	.8	.4	.0	.0	70.5
1947	.0	3.1	3.7	1.0	8.2	14.3	4.9	1.1	1.5	1.4	.0	.0	39.2
1948	2.4	1.4	1.5	12.8	5.3	12.1	20.3	6.4	1.8	1.2	.9	.9	67.0
1949	.6	1.7	4.0	4.2	12.0	21.5	3.7	.5	.8	.1	.5	.0	49.6
1950	.9	.7	1.0	14.8	8.5	5.8	5.3	1.1	.0	.7	.7	.0	39.5
1951	4.2	2.9	21.6	27.0	18.4	11.9	2.7	3.4	1.1	1.2	.8	.2	95.4
1952	.3	1.5	36.3	30.0	40.1	16.8	.4	6.0	.5	1.2	.8	.0	133.9
1953	.0	.0	26.8	47.8	4.1	11.9	5.7	8.3	4.4	.5	.1	.0	109.6
1954	.0	2.6	3.2	32.4	15.0	8.5	12.7	3.4	.0	.0	.0	.9	78.7
1955	.0	2.2	7.4	7.0	3.8	3.9	6.3	3.6	.4	.4	.2	.5	35.7
1956	.0	1.0	42.8	15.2	15.1	4.4	3.5	3.2	.0	.0	.7	.6	86.5
1957	.4	.1	.7	7.0	9.2	11.4	4.4	6.7	1.6	.4	.0	.0	41.9
1958	3.9	3.7	6.2	12.2	34.0	17.3	17.2	2.4	.6	.0	.2	.0	97.7
1959	.0	.0	.6	13.1	20.3	4.9	2.5	1.0	.0	.0	.3	.3	43.0
1960	.0	.0	.1	7.4	31.0	26.0	4.3	2.5	.0	.0	.0	.0	71.3
1961	.0	.7	11.9	4.0	23.3	27.5	5.4	5.2	.0	.0	.1	.0	78.1
1962	.0	1.1	5.4	3.8	18.0	13.0	2.6	.2	.0	.0	.0	.0	44.1
1963	4.8	1.1	7.7	.0	7.4	12.1	17.3	.0	.0	.0	.0	.0	50.4
1964	.0	5.5	.1	6.9	.0	2.4	1.5	.4	.2	.5	.0	.0	17.5
1965	.0	5.3	34.4	37.6	7.3	2.6	8.0	3.8	.0	.0	.0	.0	99.0
1966	.7	8.7	9.4	20.1	5.5	10.0	6.8	1.6	.0	.0	.0	.0	62.8
1967	.0	8.4	16.7	23.1	8.9	14.2	19.0	9.0	2.0	.0	.3	1.6	103.2
1968	.0	.3	5.2	17.3	23.0	10.9	2.0	1.3	.0	.0	.0	.0	60.0
1969	.0	.6	21.0	37.8	23.2	12.7	5.0	.0	.0	.0	.0	.0	100.3
1970	.3	.6	16.0	55.3	11.8	6.6	2.3	1.0	.0	.0	.0	.0	93.9
TOTAL	28.4	119.0	528.1	783.8	779.4	541.1	372.8	133.7	35.9	21.5	11.8	8.7	3364.2
AVERAGE	.6	2.5	11.0	16.3	16.2	11.3	7.8	2.8	.7	.4	.2	.2	70.1

Unimpaired Inflow to Lake Mendocino
(Runoff of the East Fork Russian River)

Table B-7 summarizes the unimpaired runoff of the East Fork Russian River from the 105-square-mile area tributary to Lake Mendocino. These data, supplied by the U. S. Army Corps of Engineers, do not include diversions from the Eel River.

TABLE B-7

UNIMPAIRED INFLOW TO LAKE MENDOCINO

(1,000 Acre-feet)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1923	.6	2.3	25.6	14.0	7.1	3.1	8.9	1.2	.6	.2	.1	.1	63.8
1924	.2	.4	.3	1.8	7.4	.9	.4	.2	.1	.1	.1	.0	11.9
1925	.4	2.6	9.7	5.2	49.4	7.9	10.6	5.4	1.3	.4	.2	.1	93.2
1926	.3	.6	1.3	7.9	35.4	4.5	16.9	1.3	.3	.2	.1	.1	68.9
1927	.2	11.7	13.6	23.5	59.9	13.3	19.0	2.3	.7	.3	.3	.1	144.9
1928	.3	4.5	5.8	10.8	16.0	28.4	12.2	1.7	.4	.2	.1	.1	80.5
1929	.1	.8	4.4	2.6	8.3	3.0	1.9	.8	.3	.2	.1	.1	22.6
1930	.1	.1	22.7	17.6	13.0	14.6	4.0	1.3	.3	.2	.1	.1	74.1
1931	.1	.2	.2	6.5	2.1	4.7	.9	.2	.1	.1	.1	.1	15.3
1932	.1	.4	24.3	12.2	7.4	4.2	2.2	1.7	.4	.2	.1	.0	53.2
1933	.0	.1	1.0	9.0	4.5	11.5	3.6	2.0	.6	.3	1.7	.1	34.4
1934	.2	.2	11.5	9.0	9.2	5.0	1.8	.7	.2	.1	.1	.0	38.0
1935	.1	2.9	2.7	25.5	7.6	22.7	18.6	2.6	.6	.3	.1	.1	83.8
1936	.1	.2	.9	23.1	45.7	8.5	6.8	1.2	.9	.3	.2	.1	93.0
1937	.0	.1	.3	1.3	24.5	21.9	9.9	2.5	.9	.4	.2	.2	62.2
1938	.3	9.9	38.2	14.5	69.7	55.9	14.6	4.2	1.1	.6	.2	.2	209.4
1939	.3	.6	3.0	3.6	4.0	6.6	1.3	.6	.2	.2	.1	.1	20.6
1940	.1	.0	.9	29.7	53.3	30.4	12.4	1.9	.4	.2	.0	.0	129.3
1941	.1	.6	39.5	53.4	40.8	29.5	33.4	3.8	1.0	.4	.2	.1	202.8
1942	.2	.4	33.1	30.8	47.9	8.7	16.6	4.4	1.3	.6	.3	.1	144.4
1943	.1	1.9	11.3	41.4	11.2	11.5	4.6	2.3	.9	.3	.2	.1	85.8
1944	.1	.2	.7	4.8	15.4	16.2	1.9	1.0	.3	.1	.1	.0	40.8
1945	.0	3.7	9.5	5.0	25.7	13.5	4.4	1.6	.7	.3	.1	.1	64.6
1946	.9	6.0	49.7	18.1	6.7	5.0	3.4	.9	.3	.2	.0	.1	91.3
1947	.1	1.5	3.9	.8	9.5	14.5	4.4	.7	.4	.2	.1	.0	36.1
1948	.8	.8	.8	8.2	2.3	10.4	26.0	7.1	1.3	.6	.2	.0	58.5
1949	.2	.1	2.7	3.4	10.5	41.4	3.4	1.0	.4	.1	.2	.1	63.5
1950	.1	.0	.7	15.2	23.1	8.7	4.6	1.1	.4	.1	.1	.0	54.1
1951	1.9	11.3	35.7	30.3	19.1	8.9	1.9	3.1	.4	.3	.2	.2	113.3
1952	.1	2.5	41.4	52.9	24.2	20.5	4.0	1.5	.3	.6	.2	.2	148.4
1953	.2	.2	33.5	54.3	3.7	9.3	4.8	3.0	.9	.3	.2	.2	110.6
1954	.2	2.7	2.2	28.1	19.8	16.6	14.4	2.2	.7	.3	.1	.2	87.5
1955	.3	3.7	12.3	9.9	3.4	2.7	6.4	2.7	.4	.4	.2	.1	42.5
1956	.3	.3	70.0	66.3	43.3	9.5	2.8	2.0	.9	.7	.4	.3	196.8
1957	.1	.7	.3	5.7	20.0	17.4	4.9	7.3	1.6	.4	.3	.0	58.7
1958	6.9	2.6	11.4	25.4	94.3	33.3	37.6	2.5	1.1	.7	.6	.3	216.7
1959	.4	.3	.3	20.5	29.9	3.9	1.6	.6	.3	.6	.3	.2	58.9
1960	.3	.4	.3	4.7	35.1	19.1	3.1	1.5	.6	.7	.4	.3	66.5
1961	.1	.7	12.7	7.4	24.5	16.4	3.7	1.5	1.0	1.3	1.3	.4	71.0
1962	.1	1.6	5.8	2.9	44.8	23.5	1.9	1.0	.6	.3	.3	.2	83.0
1963	9.0	1.5	13.1	9.0	34.7	14.0	33.8	4.9	1.6	.7	.3	1.0	123.6
1964	.3	10.4	2.1	18.8	4.1	2.7	1.6	.7	1.0	.9	.7	.3	43.6
1965	.0	5.2	50.6	49.4	5.7	2.5	14.6	2.3	1.2	.7	.7	.1	133.0
1966	.1	9.7	11.1	40.2	20.0	8.2	2.7	1.2	.9	.7	.4	.0	95.2
1967	.1	8.0	25.0	39.0	13.4	19.9	22.3	5.2	2.3	.8	.6	.4	137.0
1968	.7	.4	3.5	21.8	23.8	14.4	2.7	1.0	1.0	.7	.6	.2	70.8
1969	.0	.3	25.1	73.3	49.7	16.9	3.9	1.9	1.0	.9	.8	.0	173.8
1970	.0	.4	29.4	100.6	21.8	12.7	2.1	.8	1.1	1.1	1.0	.0	171.0
TOTAL	27.2		704.1		1152.9		419.5		35.3		15.0		4342.9
		115.7		1064.4		678.9		102.6		20.5		6.8	
AVERAGE	.6	2.4	14.7	22.2	24.0	14.1	8.7	2.1	.7	.4	.3	.1	90.5

Unimpaired Runoff of the
Russian River at Guerneville

Table B-8 summarizes the unimpaired runoff from the 1,340-square-mile area upstream of the gaging station on the Russian River at Guerneville, as it would be if unaltered by upstream diversion, storage, imports of Eel River water, or consumptive uses by human development. Table B-8 is taken from Department of Water Resources Bulletin 142-1, "Water Resources and Future Water Requirements, North Coastal Hydrographic Area".

TABLE B-8

 UNIMPAIRED RUNOFF OF THE RUSSIAN RIVER AT GUERNEVILLE
 (1,000 Acre-feet)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1911	1.9	8.2	35.6	275.8	234.9	354.0	177.4	48.8	22.8	7.5	3.6	2.9	1173.4
1912	3.7	5.8	11.4	164.2	92.7	158.3	97.3	118.7	26.9	10.3	4.7	11.2	705.2
1913	3.6	67.7	114.2	376.4	149.8	97.9	123.3	35.3	11.9	7.4	4.7	1.3	993.5
1914	1.6	23.5	399.8	1427.5	609.0	297.6	134.4	34.0	15.5	8.1	3.5	2.5	2957.0
1915	4.8	4.5	44.9	349.8	906.2	319.8	188.5	130.5	41.3	14.5	7.6	2.3	2014.7
1916	2.2	7.9	195.0	495.8	581.6	318.7	73.5	23.4	8.6	7.0	4.0	2.3	1720.0
1917	2.1	6.8	66.7	91.8	456.6	180.3	174.5	47.9	13.7	5.0	4.2	2.1	1051.7
1918	2.3	4.5	41.4	29.5	190.7	248.2	101.1	17.8	4.3	2.7	2.8	3.2	648.5
1919	2.1	10.1	22.0	206.8	435.9	261.9	96.0	25.5	5.4	3.1	2.3	1.7	1072.8
1920	2.9	4.3	64.1	21.5	14.1	121.3	304.7	30.9	5.8	3.4	1.8	1.6	576.4
1921	3.0	204.0	434.4	503.0	417.6	220.3	75.3	26.6	11.7	4.8	2.5	1.9	1905.1
1922	.8	6.2	53.6	46.0	329.4	163.4	132.9	46.6	12.9	7.4	4.0	1.8	805.0
1923	10.7	25.7	225.9	184.1	128.0	51.8	143.6	17.8	8.0	4.8	2.9	2.0	805.3
1924	9.5	25.2	20.9	87.7	273.7	32.0	19.9	10.3	3.9	3.5	2.9	1.7	491.2
1925	9.1	37.3	158.8	92.6	614.3	111.1	179.0	74.3	18.2	6.4	3.9	1.6	1306.6
1926	4.1	8.5	27.0	79.4	428.3	62.5	122.9	13.7	3.4	2.4	1.6	1.2	755.0
1927	3.2	136.8	271.7	494.5	1037.0	259.4	238.0	42.3	11.1	5.5	3.1	1.5	2504.1
1928	4.8	36.8	59.2	179.1	217.4	406.2	172.7	22.0	5.4	3.7	2.4	1.1	1110.8
1929	1.6	25.6	109.9	72.8	186.8	77.7	65.7	22.7	10.9	6.5	3.9	1.7	585.8
1930	.5	1.3	234.0	206.4	192.4	184.2	66.3	19.0	4.4	3.0	1.8	1.0	914.3
1931	1.4	7.5	11.2	214.1	93.3	171.4	32.7	7.6	4.1	3.2	2.2	1.5	550.2
1932	2.4	11.8	293.5	197.1	102.9	100.5	51.2	34.6	6.5	3.0	1.9	1.1	806.5
1933	.5	5.0	34.5	76.3	111.2	304.5	88.0	56.2	17.5	8.8	4.6	2.0	709.1
1934	5.1	4.3	203.4	147.7	146.5	100.3	40.6	12.9	3.0	2.4	1.8	1.0	669.0
1935	2.6	52.7	51.8	233.9	152.7	215.8	273.8	33.2	6.4	3.7	2.5	1.1	1030.2
1936	2.2	3.1	25.3	503.4	500.7	127.7	87.1	15.7	12.6	7.1	3.3	1.5	1289.7
1937	.7	1.8	7.5	11.3	213.4	290.8	181.8	40.7	12.7	6.7	3.9	1.5	772.8
1938	5.4	259.6	813.2	331.0	1129.0	1124.7	341.8	95.5	25.7	9.9	6.3	2.4	4144.5
1939	8.7	19.3	116.4	95.6	127.2	183.3	38.2	14.9	4.3	3.2	2.2	1.1	614.4
1940	.9	.2	14.1	451.5	808.4	461.5	188.6	29.3	7.6	3.1	.8	.4	1966.4
1941	2.4	8.3	599.7	810.7	619.0	447.0	507.1	57.3	16.1	6.9	2.6	2.0	3079.1
1942	3.0	7.3	502.2	467.8	727.1	132.5	251.9	66.9	20.2	8.5	5.0	2.4	2194.8
1943	2.4	29.3	170.5	629.4	169.0	174.5	69.5	36.1	13.5	4.3	3.2	1.6	1303.3
1944	1.9	3.1	10.8	73.2	233.1	246.0	29.2	16.1	5.8	2.5	1.5	.6	623.8
1945	.2	55.5	144.3	75.9	389.4	205.5	66.9	23.1	9.9	4.3	1.7	1.2	977.9
1946	13.1	91.5	754.5	275.4	101.9	76.5	51.5	13.3	5.7	3.2	1.6	1.5	1389.7
1947	1.4	21.6	59.2	11.3	144.7	219.8	65.6	10.9	7.6	2.7	1.2	.1	546.1
1948	11.8	11.4	11.6	123.8	36.4	156.8	394.4	108.4	19.8	8.4	2.6	1.5	886.9
1949	3.3	1.3	40.7	51.5	159.3	628.0	51.3	14.7	6.5	2.4	2.7	1.4	963.1
1950	2.2	.6	10.8	230.9	351.4	132.1	69.6	17.3	6.5	1.5	1.9	.6	825.4
1951	28.3	170.4	543.1	458.9	289.9	136.1	29.6	47.7	7.4	5.1	3.2	2.7	1722.4
1952	1.6	37.2	629.3	803.6	367.5	311.6	61.0	21.2	5.5	8.5	2.9	3.0	2252.9
1953	3.9	3.4	509.2	823.4	56.3	140.7	73.0	45.5	14.2	4.4	3.5	4.0	1681.5
1954	3.6	40.1	33.1	427.9	300.2	253.3	218.3	33.6	10.0	5.7	1.3	4.0	1331.1
1955	4.7	56.5	186.0	150.3	50.2	41.1	96.3	40.0	6.6	7.1	3.7	2.0	644.5
1956	4.4	5.1	1062.6	1006.4	657.3	144.2	41.6	29.8	13.2	9.8	6.0	4.5	2984.9
1957	1.0	11.0	5.8	86.2	303.5	263.9	75.0	109.4	23.4	7.4	5.6	.7	892.9
1958	104.9	39.4	173.6	384.9	1430.2	504.6	571.3	36.9	17.4	11.0	9.0	4.9	3288.1
1959	6.1	5.2	4.8	311.7	454.9	58.6	23.9	8.7	5.3	8.3	5.7	2.9	896.1
1960	5.6	7.6	5.7	70.5	532.8	289.7	47.8	22.6	9.1	9.4	7.1	5.2	1013.1
TOTAL	310.2	10276.2	18434.5	5630.6	524.2	150.7	66146.8						
	1621.8	15673.5	11432.8	1733.4	267.7	91.2							
AVERAGE	6.2	32.4	205.5	313.5	368.7	228.6	112.6	34.7	10.5	5.4	3.0	1.8	1322.9

Recorded Flow in the
Russian River at Guerneville

Table B-9 summarizes historical flows in the Russian River at Guerneville since Lake Mendocino began operation in November 1958. These flows include diversions from the Eel River, regulated by Lake Mendocino and depleted by in-basin diversions and consumptive uses. Data in Table B-9 are from U. S. Geological Survey reports on water supply data for California.

TABLE B-9

RECORDED FLOW IN THE RUSSIAN RIVER AT GUERNEVILLE
(1,000 Acre-feet)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1959	15.8	15.8	10.2	298.0	436.9	73.2	32.2	12.8	7.5	9.8	10.1	13.6	935.9
1960	17.9	18.0	17.0	72.0	510.1	308.9	75.4	35.8	15.3	10.3	9.4	13.1	1103.2
1961	14.3	28.2	213.6	130.3	389.9	269.2	70.5	37.3	18.8	16.6	18.9	20.5	1228.1
1962	17.6	38.0	109.2	63.8	700.0	377.1	43.6	18.8	7.5	7.5	9.3	9.8	1402.2
1963	154.7	42.0	218.4	159.0	543.7	229.0	534.0	88.1	25.2	12.3	8.9	12.4	2027.7
1964	16.8	176.1	49.6	301.6	78.2	53.5	25.1	10.4	8.3	9.7	9.3	9.7	748.3
1965	12.2	101.0	789.8	766.5	101.4	46.8	237.8	47.8	19.5	13.2	14.7	13.5	2164.2
1966	14.9	156.5	180.4	629.8	317.5	140.5	55.3	26.6	9.1	9.9	10.8	12.0	1563.3
1967	13.7	137.7	402.6	613.9	219.9	319.7	356.2	91.8	40.5	15.3	13.4	17.2	2241.9
1968	20.9	17.1	72.0	349.4	377.3	236.0	48.3	13.8	9.0	10.3	11.8	9.2	1175.1
1969	12.3	20.1	399.1	1123.0	761.4	271.0	73.9	40.1	17.9	12.0	11.6	10.0	2752.4
1970	14.4	19.7	464.2	1550.0	349.5	211.3	34.6	12.1	11.3	11.6	12.2	9.2	2700.1
1971	11.1	128.8	721.0	465.5	59.8	222.2	97.1	38.9	17.9	10.0	11.1	10.4	1793.8
1972	12.0	12.0	85.0	99.4	133.2	95.9	56.7	23.6	9.9	9.8	11.0	11.3	559.8
TOTAL	348.6		3732.1		4350.2		1684.4		212.1		157.9		22396.0
		911.0		7733.1		2480.5		474.9		158.5		152.7	
AVERAGE	24.9	65.1	266.6	552.4	310.7	177.2	120.3	33.9	15.1	11.3	11.3	10.9	1599.7

EEL-RUSSIAN RIVERS
STREAMFLOW AUGMENTATION STUDY

APPENDIX C

OPERATION OF THE POTTER VALLEY PROJECT
UNDER ALTERNATIVE 2E

OPERATION OF THE POTTER VALLEY PROJECT
UNDER ALTERNATIVE 2E

Based on the initial analysis of the alternatives presented in this report, the Department of Water Resources concluded that the most balanced operation of the existing Potter Valley Project would be obtained by implementing Alternative 2B.

After that conclusion was reached, the Department of Fish and Game published a report of findings in February 1975 recommending a different schedule of releases to the Eel River. In response to that report, the Department of Water Resources conducted additional operation studies and analyses to determine the impact of the Fish and Game recommendations. From those additional studies an improved operation plan for the existing system was developed. This revised operation, designated as Alternative 2E, is recommended for adoption by the Federal Power Commission as the best response to the problems associated with existing project operation.

Criteria

Operating criteria for Alternative 2E were developed from the special considerations discussed on page 36 of this report, with allowance for the extreme variability of runoff. The basic premise of these criteria is to provide a substantial augmentation of Eel River flows when water is available, a reduced augmentation in years of low runoff, and little or no augmentation in critically dry years. The complexity of the many considerations requires that the operating criteria be based on two controlling factors. Releases to the Eel River are determined by the total runoff of the Eel River above Van Arsdale Dam. Diversions through Potter Valley Powerhouse to the Russian River are regulated according to the storage levels in Lake Pillsbury.

Releases to the Eel River

Criteria for Eel River releases are considered in three parts: winter flows (November 1-February 28), spring flows (March 1-May 31), and summer flows (June 1-October 31).

The Department of Fish and Game would like a minimum flow of 150 cfs beginning on November 1 each year. However, in years of low precipitation during November and December, that starting date for the release would deplete Lake Pillsbury storage and adversely affect the diversion capability. Therefore, the start of higher releases for the recommended operating criteria is conditioned upon the first occurrence after November 1 of a storm that would cause an unregulated spill of 100 cfs or more below Van Arsdale Dam.

It is possible that early storms can generate flows in excess of 100 cfs in the Eel River below Tomki Creek prior to the time that a 100-cfs spill would occur at Van Arsdale. This flow could attract

migrating fish into the upper Eel River before the start of higher releases. It may therefore be necessary to base the initiation of higher winter releases on flows at the gaging station "Eel River near Dos Rios", above Outlet Creek, or on a new gaging station below Tomki Creek. This possibility could be evaluated as part of the recommended monitoring program.

Historically, the starting dates for winter fish releases based on spills at Van Arsdale Dam would be as follows:

<u>Water Year</u>	<u>Start Date</u>	<u>Water Year</u>	<u>Start Date</u>
1923	November 10, 1922	1947	November 22, 1946
1924	January 22, 1924	1948	January 2, 1948
1925	December 8, 1924	1949	January 1, 1949
1926	December 2, 1925	1950	January 10, 1950
1927	December 1, 1926	1951	November 16, 1950
1928	December 7, 1927	1952	December 1, 1951
1929	December 25, 1928	1953	December 5, 1952
1930	December 10, 1929	1954	November 14, 1953
1931	January 2, 1931	1955	November 15, 1954
1932	November 17, 1931	1956	December 5, 1955
1933	January 27, 1933	1957	January 12, 1957
1934	December 12, 1933	1958	November 13, 1957
1935	November 18, 1934	1959	January 5, 1959
1936	December 12, 1935	1960	January 25, 1960
1937	January 29, 1937	1961	November 13, 1960
1938	November 16, 1937	1962	November 30, 1961
1939	November 30, 1938	1963	November 26, 1962
1940	December 31, 1939	1964	November 14, 1963
1941	December 18, 1940	1965	November 9, 1964
1942	December 2, 1941	1966	November 4, 1965
1943	November 17, 1942	1967	November 15, 1966
1944	December 20, 1943	1968	December 3, 1967
1945	November 3, 1944	1969	November 18, 1968
1946	November 16, 1945	1970	December 12, 1969

Beginning on February 1 of each year, Eel River releases would be reduced 50 percent if the total runoff is below 40 percent of normal, and minimized to 5 cfs if total runoff is below 20 percent of normal. As part of the present project operation, Pacific Gas and Electric Company collects records of the storage in Lake Pillsbury and of the flow below Scott Dam, below Van Arsdale Dam, and through the diversion tunnel to the Potter Valley Powerhouse. These data can be combined to measure the total unimpaired runoff at Van Arsdale Dam on a daily basis. Comparing the accumulated seasonal runoff after February 1 of each year to the long-term average runoff will determine if a deficiency schedule should be imposed on Eel River releases. Deficiency levels were initially proposed to start on January 1 at 50 percent and 25 percent of normal runoff. However, under that proposal releases to the Eel River would be at deficiency levels about 33 percent of the time in the 48-year study period. With the recommended February 1 starting date and deficiency levels of 40 and 20 percent of normal runoff, releases would be at reduced levels about 21 percent of the time.

During the summer months, Eel River releases would be at the full schedule of 20 cfs or reduced by 50 or 75 percent depending upon the accumulated seasonal runoff. The recommended schedule of Eel River releases is summarized in the following tabulation:

Time Period	Release in cfs when the cumulative runoff of the Eel River at Van Arsdale Dam is:		
	More than 40 percent of normal ^{a/}	Between 20 and 40 percent of normal	Less than 20 percent of normal
February	150	75	5
March 1-15	250	75	5
March 16-31	250-205 ^{b/}	75	5
April	205-114 ^{b/}	75	5
May	114- 20 ^{b/}	75- 10 ^{b/}	5
June	20	10	5
July	20	10	5
August	20	10	5
September	20	10	5
October	20	10	5
November	20-150 ^{c/}	10-150 ^{c/}	5-150 ^{c/}
December	20-150	10-150	5-150
January	20-150	10-150	5-150

^{a/} Long-term unimpaired runoff as shown in Table B-4, Appendix B.

^{b/} Flow to decrease in uniform increments from the higher to the lower value through the indicated time period.

^{c/} Increase in releases to be initiated on or after November 1 when spills from Van Arsdale Dam cause the mean daily flow at the gaging station below Van Arsdale Dam to exceed 100 cfs.

Diversions to the Russian River

In conjunction with the above releases to the Eel River, diversions to the Russian River are to be maintained as high as possible after giving consideration to maintaining high storage levels in Lake Pillsbury during the recreation season. With these requirements, the criteria for diversions are based on the storage levels in Lake Pillsbury, as follows:

1. Between November 1 and January 31, maximize diversions while maintaining a minimum storage in Lake Pillsbury of 20,000 acre-feet. Maintain a minimum power diversion of 4,000 acre-feet per month even if it becomes necessary to draw Lake Pillsbury below 20,000 acre-feet.
2. Between February 1 and April 30, if in a dry year and making deficient releases to the Eel River, reduce diversions to maximize storage in Lake Pillsbury.

3. Between May 1 and October 31, limit diversions to maintain storage in Lake Pillsbury of:
 - a. 86,800 acre-feet on June 1
 - b. 78,000 acre-feet on July 1
 - c. 70,000 acre-feet on August 1
 - d. 61,500 acre-feet on September 1 (recommended by U. S. Forest Service)
 - e. 45,000 acre-feet on October 1
 - f. 30,000 acre-feet on November 1

Maintain a minimum diversion of 8,000 acre-feet per month, even if the above storage cannot be maintained, unless storage in Lake Pillsbury is reduced to 20,000 acre-feet. Maintain a minimum diversion to 4,000 acre-feet per month if storage in Lake Pillsbury falls below 20,000 acre-feet.

Operation of Alternative 2E

Although the above criteria are somewhat different from the criteria used in the analysis of the other alternatives presented in this report, the results of operating the existing Potter Valley Project under these criteria are comparable to the other alternatives. All operation studies were made using the same basic hydrologic data and the effects on diversions to the Russian River derived from the adjusted historical diversions shown in Table B-1, Appendix B.

Table C-1 shows the minimum flows that would be maintained in the Eel River below Van Arsdale Dam under Alternative 2E. In addition to the flows shown in Table C-1, there would be substantial spills down the Eel River in the winter months of most years.

Table C-2 shows adjusted diversions to the Russian River Basin under Alternative 2E. Comparison of this table with Table B-1 in Appendix B will show the reduction in historical diversions required to meet the recommended schedule of releases to the Eel River. On the average, diversions to the Russian River would be reduced by 8,000 acre-feet per year, or about 4 percent.

Accomplishments of Alternative 2E

Reoperation of the Potter Valley Project under the criteria listed above would provide a substantial improvement to conditions on the Eel River without substantially adversely affecting beneficial uses within the Russian River Basin. During the 48-year study period, this reoperation would:

1. Eliminate the problem of extremely low flows between winter storms in the upper Eel River.
2. Provide high flows in March and April to facilitate the downstream migration of juvenile fish in 39 of 48 years.
3. Maintain summer flows of 20 cfs in the upper Eel River in 44 of 48 years.
4. Maintain an average September 1 water surface elevation in Lake Pillsbury of 1,812 feet above sea level, or about 6 feet higher than the adjusted historical operation.

Adverse Impacts of Alternative 2E

Reoperation of the Potter Valley Project under the recommended criteria would have some adverse effects within the Russian River Basin, as follows:

1. The total diversion during a critical dry year such as 1924 would be reduced by about 11,000 acre-feet. This would require a deficiency of about 17 percent in summer flow in the Russian River to prevent any impairment of the water supply function of Lake Mendocino.
2. Average generation of electric energy at the Potter Valley Powerhouse would be reduced by about 4 percent.
3. The average summer water level in Lake Mendocino would be lowered to some extent. Evaluation of this effect is one of the reasons for the monitoring program recommended in this report.
4. The present average summer outflow of 185 cfs from the Russian River would be reduced by about 10 percent.

Implementation

The Federal Power Commission can implement the modified operation of the Potter Valley Project recommended herein by including the schedule of minimum releases to the Eel River as a condition in a new license for the project.

TABLE C-1

ALTERNATIVE 2E
MINIMUM RELEASES TO THE EEL RIVER AT VAN ARSDALE DAM
 (1,000 acre-feet)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1923	1.2	6.7	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	67.3
1924	1.2	1.2	1.2	3.6	.3	.3	.3	.3	.3	.3	.3	.3	9.6
1925	.3	.3	6.7	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	57.5
1926	1.2	1.2	8.9	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	61.5
1927	1.2	1.2	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	61.8
1928	1.2	1.2	6.4	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	59.0
1929	1.2	1.2	2.8	9.2	4.1	4.7	4.5	1.9	.6	.6	.6	.6	32.0
1930	.6	.6	6.5	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	57.9
1931	1.2	1.2	1.2	8.9	4.1	4.7	4.5	1.9	.6	.6	.6	.6	30.1
1932	.6	4.2	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	64.2
1933	1.2	1.2	1.2	2.1	4.1	4.7	4.5	4.0	1.2	1.2	1.2	1.2	27.8
1934	1.2	1.2	6.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	58.8
1935	1.2	4.3	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	64.9
1936	1.2	1.2	6.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	58.8
1937	1.2	1.2	1.2	1.7	4.1	14.5	9.4	4.0	1.2	1.2	1.2	1.2	42.1
1938	1.2	4.6	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	65.2
1939	1.2	1.2	9.2	9.2	4.1	4.7	4.5	1.9	.6	.6	.6	.6	38.4
1940	.6	.6	.6	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	52.0
1941	1.2	1.2	4.6	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	57.2
1942	1.2	1.2	8.9	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	61.5
1943	1.2	4.2	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	64.8
1944	1.2	1.2	5.1	9.2	4.1	4.7	4.5	1.9	1.2	1.2	1.2	1.2	36.7
1945	1.2	8.1	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	68.7
1946	1.2	4.6	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	65.2
1947	1.2	3.3	9.2	9.2	4.1	7.3	9.4	4.0	1.2	1.2	1.2	1.2	52.5
1948	1.2	1.2	1.2	8.6	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	53.2
1949	1.2	1.2	1.2	9.2	4.1	4.7	9.4	4.0	1.2	1.2	1.2	1.2	39.8
1950	1.2	1.2	1.2	6.7	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	51.3
1951	1.2	4.6	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	65.2
1952	1.2	1.2	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	61.8
1953	1.2	1.2	8.0	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	60.6
1954	1.2	5.1	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	65.7
1955	1.2	4.8	9.2	9.2	8.3	7.3	9.4	4.0	1.2	1.2	1.2	1.2	58.3
1956	1.2	1.2	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	61.8
1957	1.2	1.2	1.2	6.1	4.1	14.5	9.4	4.0	1.2	1.2	1.2	1.2	46.5
1958	1.2	5.4	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	66.6
1959	1.2	1.2	1.2	8.0	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	52.6
1960	1.2	1.2	1.2	2.8	4.1	14.5	9.4	4.0	1.2	1.2	1.2	1.2	43.3
1961	1.2	5.4	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	66.6
1962	1.2	1.2	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	61.8
1963	1.2	2.3	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	62.9
1964	1.2	5.1	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	65.7
1965	1.2	7.0	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	67.6
1966	1.2	7.8	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	68.4
1967	1.2	4.8	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	65.4
1968	1.2	1.2	8.6	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	61.3
1969	1.2	4.3	9.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	64.9
1970	1.2	1.2	6.2	9.2	8.3	14.5	9.4	4.0	1.2	1.2	1.2	1.2	58.8
TOTAL	54.9	129.3	318.5	407.3	348.4	608.6	417.6	179.9	54.9	54.9	54.9	54.9	2684.4
AVG.	1.1	2.7	6.6	8.5	7.3	12.7	8.7	3.7	1.1	1.1	1.1	1.1	55.0

TABLE C-2

ALTERNATIVE 2E
 MODIFIED DIVERSIONS TO POTTER VALLEY POWERHOUSE
 (1,000 acre-feet)

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
1923	16.0	17.0	19.0	21.2	19.1	18.0	20.5	8.0	13.0	8.0	8.0	14.0	181.8
1924	16.0	13.0	4.0	4.0	8.0	8.0	8.0	8.0	4.0	4.0	4.0	4.0	85.0
1925	4.0	7.0	19.0	19.0	19.1	21.2	20.5	21.2	17.0	13.0	9.0	15.0	185.0
1926	15.0	8.0	6.0	16.0	19.1	19.0	20.5	8.0	8.0	8.0	8.0	13.0	148.6
1927	15.0	19.0	21.2	21.2	19.1	21.2	20.5	21.2	14.0	10.0	8.0	15.0	205.4
1928	16.0	18.0	19.0	19.0	19.1	21.2	20.5	15.0	9.0	8.0	8.0	15.0	187.8
1929	14.0	17.0	19.0	8.0	17.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	131.0
1930	4.0	4.0	19.0	21.2	19.1	21.2	20.5	11.0	10.0	8.0	8.0	13.0	159.0
1931	14.0	8.0	4.0	18.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	4.0	104.0
1932	4.0	4.0	19.0	21.2	19.1	21.2	18.0	16.0	10.0	8.0	8.0	13.0	161.5
1933	13.0	10.0	8.0	18.0	19.0	21.2	20.5	21.2	18.0	8.0	8.0	15.0	179.9
1934	16.0	11.0	18.0	19.0	17.0	19.0	18.0	8.0	8.0	8.0	8.0	8.0	158.0
1935	8.0	18.0	14.0	19.0	19.1	21.2	20.5	19.0	12.0	8.0	8.0	14.0	180.8
1936	16.0	10.0	4.0	21.2	19.1	21.2	20.5	9.0	18.0	10.0	8.0	15.0	172.0
1937	14.0	9.0	4.0	4.0	17.0	21.2	20.5	21.2	15.0	8.0	8.0	15.0	156.9
1938	17.0	20.5	21.2	21.2	19.1	21.2	20.5	21.2	18.0	12.0	9.0	15.0	215.9
1939	15.0	18.0	19.0	14.0	17.0	19.0	10.0	8.0	8.0	8.0	8.0	5.0	149.0
1940	4.0	4.0	18.0	21.2	19.1	21.2	20.5	13.0	12.0	8.0	8.0	12.0	161.0
1941	15.0	13.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	14.0	8.0	16.0	208.4
1942	15.0	14.0	21.2	21.2	19.1	19.0	20.5	21.2	18.0	17.0	8.0	15.0	209.2
1943	14.0	18.0	19.0	21.2	19.1	21.2	20.5	17.0	14.0	8.0	8.0	14.0	194.0
1944	14.0	11.0	4.0	12.0	17.0	19.0	18.0	12.0	13.0	8.0	8.0	13.0	149.0
1945	14.0	18.0	19.0	19.0	19.1	21.2	20.5	14.0	12.0	8.0	8.0	14.0	186.8
1946	18.0	18.0	21.2	21.2	19.1	21.2	19.0	8.0	8.0	8.0	8.0	12.0	181.7
1947	14.0	18.0	18.0	4.0	17.0	21.2	19.0	8.0	8.0	8.0	8.0	10.0	153.2
1948	19.0	18.0	8.0	19.0	17.0	19.0	20.5	21.2	18.0	15.0	8.0	16.0	198.7
1949	15.0	14.0	15.0	6.0	17.0	21.2	20.5	14.0	11.0	8.0	8.0	12.0	161.7
1950	15.0	12.0	4.0	19.0	19.1	21.2	20.5	16.0	11.0	8.0	8.0	15.0	168.8
1951	19.0	19.0	21.2	21.2	19.1	21.2	18.0	14.0	11.0	8.0	8.0	14.0	193.7
1952	14.0	18.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	10.0	8.0	15.0	207.4
1953	14.0	12.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	18.0	12.0	16.0	214.4
1954	15.0	18.0	15.0	21.2	19.1	21.2	20.5	14.0	13.0	8.0	8.0	16.0	189.0
1955	14.0	18.0	19.0	19.0	17.0	16.0	12.0	8.0	8.0	8.0	8.0	13.0	160.0
1956	14.0	15.0	21.2	21.2	19.1	21.2	20.5	21.2	15.0	9.0	8.0	16.0	201.4
1957	16.0	12.0	4.0	19.0	19.1	21.2	20.5	21.2	18.0	8.0	8.0	17.0	184.0
1958	19.0	18.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	12.0	9.0	15.0	215.4
1959	15.0	9.0	4.0	19.0	19.1	21.2	19.0	8.0	8.0	8.0	8.0	8.0	146.3
1960	9.0	9.0	4.0	19.0	19.1	21.2	18.0	18.0	13.0	8.0	8.0	14.0	160.3
1961	15.0	17.0	19.0	18.0	19.1	21.2	20.5	21.2	14.0	8.0	8.0	15.0	196.0
1962	15.0	18.0	19.0	19.0	19.1	21.2	20.5	11.0	11.0	8.0	8.0	15.0	184.8
1963	18.0	18.0	21.2	21.2	19.1	21.2	20.5	21.2	15.0	9.0	8.0	16.0	208.4
1964	16.0	18.0	18.0	19.0	17.0	12.0	8.0	8.0	8.0	8.0	8.0	4.0	144.0
1965	4.0	18.0	21.2	21.2	19.1	19.0	20.5	21.2	12.0	8.0	8.0	15.0	187.2
1966	16.0	18.0	19.0	21.2	19.1	21.2	20.5	11.0	10.0	8.0	8.0	14.0	186.0
1967	15.0	18.0	21.2	21.2	19.1	21.2	20.5	21.2	18.0	19.0	9.0	16.0	219.4
1968	16.0	13.0	18.0	19.0	19.1	21.2	11.0	8.0	8.0	8.0	8.0	11.0	160.3
1969	15.0	13.0	18.0	21.2	19.1	21.2	20.5	21.2	17.0	12.0	8.0	16.0	202.2
1970	16.0	10.0	21.2	21.2	19.1	21.2	8.0	8.0	8.0	8.0	8.0	16.0	164.7
TOTAL	669.0	678.5	753.8	875.6	873.5	945.0	876.0	717.6	602.0	448.0	388.0	632.0	8459.0
AVG.	13.9	14.1	15.7	18.2	18.2	19.7	18.3	15.0	12.5	9.3	8.1	13.2	176.2

EEL-RUSSIAN RIVERS
STREAMFLOW AUGMENTATION STUDY

APPENDIX D

COMMENTS FROM STUDY COMMITTEE
AND OTHER AGENCIES

<u>Agency</u>	<u>Page</u>
California Department of Fish and Game	D- 3
California Trout	D- 5
County of Humboldt	D- 7
County of Lake	D- 9
County of Mendocino	D-11
Mendocino County Russian River Flood Control and Water Conservation Improvement District	D-17
Pacific Gas and Electric Company	D-21
Sierra Club	D-25
Sonoma County Water Agency	D-27
U. S. Forest Service - Mendocino National Forest	D-37

em o r a n d u m

: Albert J. Dolcini, Chief
Northern District
Department of Water Resources
P. O. Box 607
Red Bluff, California 96080

Date: October 7, 1975

: Department of Fish and Game - Region 3

ect: Eel-Russian Rivers Streamflow Augmentation Study, Draft Report

We have reviewed the text and Appendix C of your subject report, transmitted to us on September 18, 1975.

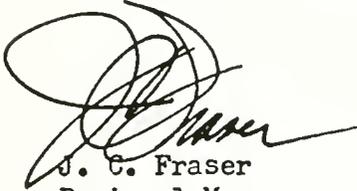
We accept the report including the recommended interim flow schedule and dry-year clauses provided that recommendation be made in the final report for an FPC license of limited duration, not to exceed 10 years. This limited license period will allow time for the necessary feasibility studies to be conducted.

Several problems were noted in the flow schedule presented; however, these can be, and should be, resolved during the feasibility studies. As pointed out in previous correspondence, the criteria proposed for triggering increased flow releases in the fall into the Eel River below Van Arsdale is based on impaired flows. It is recognized that in many years precipitation will create adequate fish transportation flows below Tomki Creek without causing spills over Van Arsdale Dam. We recommend that this problem be fully evaluated during the interim license period with the objective of developing improved "triggering" criteria. DWR in cooperation with PG&E and DF&G should make the necessary studies and develop appropriate recommendations. These points should be made in your report.

Additionally, provisions for guaranteed flows immediately below Lake Pillsbury were omitted from the report and should also be fully evaluated in the feasibility studies during the interim license period.

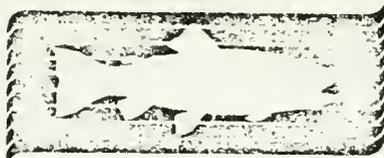
The remaining conclusions and recommendations appear to agree with those presented in our "Reconnaissance Fisheries Evaluation" report, dated February 1975, with the exception of our recommendation for the design and construction of a salmon and steelhead hatchery during the interim license period. We recognize that such a recommendation is beyond your purview. However, we would appreciate it if your report would make reference to the possible need for such an installation by noting that the Department of Fish and Game has made a recommendation to this effect in its report.

If you have any questions or comments, please contact the office. Thank you for the opportunity to comment on this draft.

A handwritten signature in black ink, appearing to read "J. C. Fraser". The signature is stylized with large, overlapping loops and a long horizontal tail.

J. C. Fraser
Regional Manager
Region 3

CALIFORNIA TROUT



KEEPER OF THE STREAMS

July 29, 1975

Mr. Albert J. Dolcini, Chief
Northern District
Dept. of Water Resources
Red Bluff, California

Dear Mr. Dolcini:

California Trout appreciates the opportunity to comment on your District's review draft of the "Eel-Russian Streamflow Augmentation Study." I am enclosing our comments, delivered by Dr. George Stewart at the June 19 meeting in Ukiah, for the record.

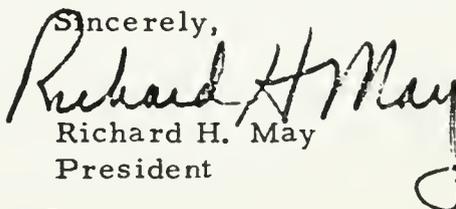
As you know, our organization long has recognized the problems discussed in this report and we have taken a variety of actions to attain our goals (including intervention in the relicensing of FPC #77). These goals are:

1. Increasing flows in the Eel River below Van Arsdale at critical times of the year to restore steelhead habitat and the fishery.
2. Mitigation of fish habitat losses caused by construction of major dams on the Eel and Russian Rivers (Scott and Coyote dams).
3. Resolution of the turbidity problem in the Russian River caused by Eel water transfers.

As you know, we are opposed to construction of Warm Springs Dam and we favor enlargement of Lake Mendocino (enlarged Coyote Dam). The latter offers several opportunities to attain our goals outlined above.

California Trout asks that DWR work with DFG to implement interim flows below Van Arsdale which are optimal for the Eel's decimated fish populations; we ask that DWR request from FPC a short-term relicensing of project #77 for a term of five years; we ask that DWR co-operate with DFG in the latter's recommended feasibility studies of Alternatives Three, Four, and Five; and finally we ask that DWR withhold support of Warm Springs Dam until the foregoing is completed and evaluated.

Sincerely,


Richard H. May
President

RHM:cc

Enc.

cc: Dir., DWR

D-5



BOARD OF SUPERVISORS
COUNTY OF HUMBOLDT
EUREKA, CALIFORNIA 95501 PHONE (707) 445-7266

July 29, 1975

Mr. Albert J. Dolcini
Chief, Northern District
Department of Water Resources
P.O. Box 607
Red Bluff, California 96080

Attention: Mr. Ed Barnes, Chief
Environmental Studies Section

Gentlemen:

Subject: Comments on Draft Report: Eel-Russian River Stream-flow Augmentation Study

The Humboldt County Board of Supervisors reviewed your draft report, and the report prepared by the Department of Fish and Game and noted that the recommendations contained in both reports were similar and in agreement.

After reviewing both reports, the Board initially decided to support the recommendations of the Department of Fish and Game, as noted in the Board letter of July 22, 1975. This was not to imply that the Board disagreed with the recommendations of the Department of Water Resources.

Upon reconsideration, the Board has decided to support the recommendations of both reports with the exception that the minimum flow release schedule recommended by the Department of Fish and Game be superceded by the new minimum flow release schedule recommended by the Department of Water Resources in their memorandum dated June 27, 1975. The reason is that the Department of Water Resources flow schedule provides low summer flows not only for fish and wildlife, but also for recreation and aesthetic purposes.

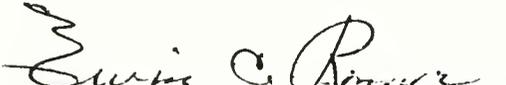
The Board has continually sought a plan that would provide environmental water below Van Arsdale throughout the year without causing a significant adverse effect on present water users in the Russian River Basin.

Mr. Albert J. Dolcini
Page Two

The Board believes that the recommendations of your plan and those of Fish and Game represent a bonafide effort towards that goal.

The Board commends you and your staff for preparing an objective and informative report.

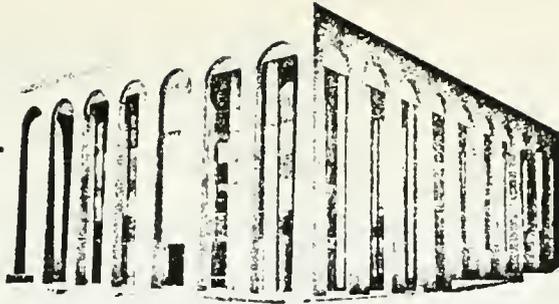
Very truly yours,


ERVIN C. RENNER, CHAIRMAN

Humboldt County Board of Supervisors



COUNTY OF LAKE



BOARD OF SUPERVISORS

COURTHOUSE - 255 N. Forbes St.
LAKEPORT, CALIFORNIA 95453
TELEPHONE: 707 263-5461

ly 28, 1975

Albert J. Dolcini
Department of Water Resources
Post Office Box 607
Eureka, California 96080

Subject: DWR Bulletin No. 105-5 Eel-Russian Rivers Streamflow Augmentation Study

Dear Mr. Dolcini:

We have again reviewed the alternative operations of the most recent report above, dated July 1975. The information contained in the report is a valuable addition to recorded data for the Russian-Eel System placing together this data for easy access. The report will also enable many to further understand the rather static overall relationship of water use limitations from the present systems without providing additional storage to make more water available. This impediment placed a tremendous burden upon those in charge of preparing such a report and such was pointed out in the introduction of the Bulletin.

A section on water rights was added to the report. We agree with the substance of the statement of March 1972, from Mendocino County, particularly with the importance of the water rights matter in this case. Although the May 1975 draft of the DWR report included a section on water rights, the June 20, 1975 meeting was the occasion of enough discussion to raise questionable doubts concerning the understanding of the respective rights of the parties involved. Although Lake County presumes no knowledge of the respective rights of other counties and other agencies, it has previously submitted a Resolution, numbered 105-55, regarding this matter. The people of Lake County feel strongly that water is a crucial item and any plans, studies, proposals or applications which might effect that water or future water will be viewed with care by the County of Lake. A mere engineering study of the mechanics of the water transfer is only a small part of the problem. We have legal and historic interests in the water and do not intend to give any part of them without a complete justification for doing so. We would stand on any statutory rights and by any precedents established in this case including a decision of the State Water Resources Control Board on an application by Sonoma County and settlement with the County of Lake.

Although the operating criteria appears to be very well thought out, it is obvious that fifty years of operation of this project has established the rights, economics and other factors such that any change in operation of the system would be detrimental to some. After two years of meetings have made it quite apparent that, to accomplish any meaningful improvement to any sector in this system, additional water would need to be made available and brought into the system either by import or by additional storage.

It should be noted here that the forward of the "Report" states that, "It is expected that the information developed herein would serve as input to the Federal Power Commission's

July 28, 1975

deliberations regarding relicensing the Potter Valley Project". Should there be any question of such relicensing, Lake County was permitted to intervene by the Federal Power Commission. This action was sparked by another agency's petition for such intervention. The specific interests of Lake County are in the continuation of the recreational potential in the Pillsbury area and in the continuation of the power development and facilities of the Pacific Gas and Electric Company.

The recreational potential is the optimum elevation of the surface of Lake Pillsbury. It is understood from the report that the Lake will have higher average levels for some of the summer months. We hope that a review of the year by year levels will also show consistent higher or equal levels into the Fall months without striking differences in some years.

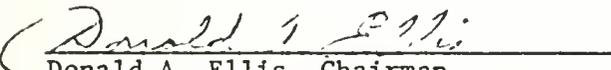
The power production is significant from several viewpoints. We believe that the production of power should not be decreased. The shortages of power and agricultural products in these days of shortages should be recognized in this case by no proposed decrease in power production at the Potter Valley Plant. The income to Lake County from this source is significant and would create an economic hardship to the County if any part of this were to be decreased for purposes of a questionable enhancement of a fish program, accruing mostly in counties other than Lake County.

On the other hand, if further investigative work of a more comprehensive nature should be commenced in this area, such investigation should be one of vital positive concern to the entire area, one that would be of a nature that all the counties could receive benefits such as have been successfully completed in other areas of the State but so sadly lacking in the North Coast Area.

The following recommendations should be considered:

1. The license to Pacific Gas and Electric Company be granted by the Federal Power Commission, at least for a short term.
2. The operation of the Potter Valley Project be continued without decrease in historical power production.

Sincerely,


Donald A. Ellis, Chairman
BOARD OF SUPERVISORS
COUNTY OF LAKE

DAE:WDH:ps



TELEPHONE
462-4731
EXT. 235

COUNTY OF MENDOCINO

BOARD OF SUPERVISORS
COURTHOUSE
UKIAH, CALIFORNIA 95482

August 1, 1975

Mr. Albert J. Dolcini
District Engineer
Northern District
Department of Water Resources
P. O. Box 607
Red Bluff, California 96080

Dear Mr. Dolcini:

This letter constitutes the comments of the Mendocino County Board of Supervisors on the May, 1975 Review Draft of the Eel-Russian River Stream Flow Augmentation Study.

Mendocino County objects to the report's recommendations. It is also the position of this county that the report is seriously deficient in several important respects and is an inadequate basis upon which to found recommendations or make decisions. It is the position of this county:

(1) Until the Warm Springs project is completed, or at least until all legal obstacles to its completion have been removed and the project is nearing completion, no plans should be approved that would result in diminishing the flow of water into the Russian River from the Eel River.

(2) When the Warm Springs project is completed, or nearing completion, it would be appropriate to study the feasibility of augmenting the flow of the Eel River pursuant to a plan that meets the following terms and conditions:

- Present and reasonable predictable beneficial uses of water in Mendocino County are provided for.
- The recreational value of Lake Mendocino and the Russian River within Mendocino County are protected. Recreational values include fishing, boating, swimming and scenic enjoyment.
- Environmental damage resulting from extreme fluctuations in the level of Lake Mendocino is avoided, and

-Adverse socio-economic effects in Mendocino County resulting from decreased energy or increased energy costs are avoided.

In the following paragraphs I have summarized the key points that have lead the Board of Supervisors of Mendocino County to the conclusions and positions stated above. I have not attempted to make detailed comments on minor errors in the Draft Report because other interested parties have made such comments and because I assume that they will be corrected in the report that is published

The Recommendations:

The study makes the following recommendations:

1. The FPC grant a short-term license to PG&E for the Potter Valley project.
2. Diversions from the Eel River, through the Potter Valley Project, to the Russian River be reduced by an amount sufficient to assure stable flows in the Eel River of 100 cubic feet per second from November to February, 200 cubic feet persecond during the first part of March and then reducing at a constant rate down to 20 cubic feet per second, which is reached at the end of May, and maintained until the end of October.
3. The effects of this operation on fish, recreation and water supply in the Eel and Russian Rivers be studied.
4. A study be conducted of the prospects of enlarging Lake Mendocino, or increasing storage on the upper Eel River, to provide increased water for the Russian River system.

Mendocino County objects to these recommendations for the following reasons:

- a. As revealed in the December, 1974 comments on this study by the Corps of Engineers, under present circumstances there is no substantial excess of water supply in the Russian River system over demand. At

present, in order to meet demand during the summer months the level of Lake Mendocino is reduced substantially. If inflow into Lake Mendocino is reduced during the summer, as a result of increasing the flow in the Eel, downstream demand in the Russian River can be met only, if at all, by greatly increasing the fluctuation of the level of Lake Mendocino. This would have obvious adverse environmental and recreational impact:

- As reported by the United States Fish and Wildlife Service, "greater reservoir fluctuation would likely reduce fish productivity in the Lake."
- The Corps' report of 1974 highlights the adverse recreation impacts on users of Lake Mendocino and upon the economic value of existing recreational facilities.
- Rotting plantlife on the Lake bottom would create serious environmental problems in the vicinity of Lake Mendocino.

b. Problems listed in a. above are exacerbated by the fact that the Sonoma County Water Agency has pending before the State Water Resources Control Board petitions that would, if granted; allow it to double the amount of water it takes from Lake Mendocino during summer months. If these petitions are granted it will be impossible to satisfy water uses in the Russian River without almost draining Lake Mendocino each summer and without greatly reducing the volume of water which flows past Guerneville to the Pacific Ocean. The result would destroy recreation not only at Lake Mendocino but also in the lower Russian River and would likely have serious adverse impact on the fish and wildlife in both the Lake and the River.

c. Realization of the agricultural potential and future controlled development in Mendocino County would be jeopardized or thwarted. As an example, the Redwood Water District presently plans to put to beneficial use approximately 6,000 acre feet per year in Redwood Valley. The water will come from Lake Mendocino. The project has been approved by the federal government; but, it is doubtful that sufficient water would be available if the flow into Lake Mendocino is reduced by augmentation of flow in the Eel. Certainly the combination of the Redwood Valley District and the Eel augmentation flow would result in greater fluctuation of Lake Mendocino, with resulting harms listed above.

d. Until the Warm Springs Project is built there simply is not enough water available to meet existing, and reliably predictable, uses of water in the Russian River system and augment flow in the Eel. Even increasing the storage capacity of Lake Mendocino will not solve this obvious problem; and, as appears from the December, 1974 report of the Corps of Engineers, it is extremely doubtful that the money could be obtained from the Congress for this project in view of the limited benefits it would afford.

e. It is in the economic interests of Mendocino County that the Potter Valley Project continue to operate at capacity because this protects the water supply to the Russian River and avoids the possibility of that project closing down, thereby reducing the tax base of the county. It is in the national interest, including the interest of Mendocino County that hydroelectric sources of energy be maximized, not diminished, in view of the energy deficient status of the United States.

f. The benefits that will result from increasing the flow of water in the Eel River are minimum when compared to the harm that will result from decreasing the water available in the Russian River system.

THE REPORT:

The report is deficient in three major respects:

1. Although it emphasizes the benefits to the Eel River Fishery that would come from augmenting Eel River flow, it does not contain any reliable analysis of the adverse effects on the fishery in Lake Mendocino and the Russian River that would result from diminished water in the Russian River system.

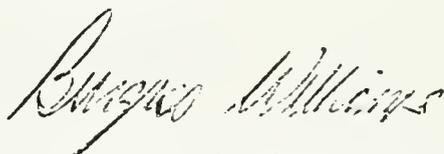
2. While the Report discusses the benefits to recreation on the Eel River that would result from augmenting its flow, it does not discuss the adverse impacts upon recreation at Lake Mendocino and in the Russian River that would result from diminishing flow in the Russian River. This is a particularly serious deficiency in view of the facts that current usage of the lower Russian River is estimated at about 2,200,000 annual recreation days and that about a million and half members of the public are estimated to visit Lake Mendocino each year. Even the estimates in the Report, which have been criticized by other parties' comments, estimate only an increase of 29,000 average annual recreation days on the Eel if the recommendations are approved.

Mr. Dolcini
Page 5
August 1, 1975

3. The environmental effect of increased fluctuation of water level in Lake Mendocino is not studied. Not only is this a serious shortcoming, but this deficiency must be remedied before any decisions are made or those decisions will be subject to attack under the California Environmental Quality Act.

We regret we have not been able to keep our comments to two pages, as requested in Mr. Barnes' memo of June 27, 1975. However, this subject is extremely important to Mendocino County and we expect that our comments will be taken seriously by those who review and act upon the Report.

Sincerely,



Burgess Williams, Chairman
Mendocino County Board of
Supervisors

JC/BW/jf

cc - Jared Carter
Admr. Beltrami
Tudor Engineering, Attn: Joe Carson

NORTH COUNTIES ENGINEERING COMPANY

CONSULTING CIVIL ENGINEERS

410 EAST PERKINS STREET • UKIAH, CALIFORNIA 95482 • 707-462-1961

GARY L. AKERSTROM, P.E.

July 28, 1975

Mr. Ed Barnes
State Department of
Water Resources
P. O. Box 607
Red Bluff, California 96080

RE: Eel River Water
Diversion

Dear Mr. Barnes:

Enclosed is a copy of the Resolution of the Board of Trustees of the Mendocino County Russian River Flood Control & Water Conservation Improvement District to be included as the Districts' position on diversion of water down the Eel River.

Very truly yours,



Gary L. Akerstrom
District Engineer
MCRRFC & WCID

GLA:mb

Enclosure (1)

RESOLUTION OF THE BOARD OF TRUSTEES OF THE
MENDOCINO COUNTY RUSSIAN RIVER FLOOD CONTROL
AND WATER CONSERVATION IMPROVEMENT DISTRICT
SETTING FORTH ITS POSITION WITH RESPECT TO
PROPOSED DIVERSION OF EEL RIVER WATER.

WHEREAS, the MENDOCINO COUNTY RUSSIAN RIVER FLOOD CONTROL AND WATER CONSERVATION IMPROVEMENT DISTRICT is a participant in the Russian River Project, specifically the COYOTE VALLEY DAM AND RESERVOIR, and

WHEREAS, the future of Ukiah Valley and Southern Mendocino County depends upon the continued and expanding use of Russian River water, both natural flow and stored water which has historically been diverted from the Eel River, and

WHEREAS, proposals are now being made by the various County, State and Federal agencies to decrease the amount of Eel River water released to the Russian River valley, and

WHEREAS, this District deplores and protests any reduction in the amount of Eel River water flowing into the Russian River Project, and believes that said proposals, if carried through, will greatly damage the economy, both present and future, of the area within the boundaries of the District, to the detriment of the inhabitants thereof,

NOW, THEREFORE, the District declares its position with respect to such proposals as follows:

- a) 1. Releases down the Eel River as recommended by the California Department of Fish & Game's February 1975 Report are not based on quantitative data that has been correlated with actual flow characteristics of the Eel River. Also, no attempt has been made to evaluate pre-project conditions or establish quantitative fish-run goals. In general, the "Reconnaissance Fisheries Evaluation" does not meet qualifications of an objective technical report.
2. Any proposal to raise Coyote Dam to facilitate increased flow in the Eel River is contrary to the intended purpose of meeting future water supply requirements in the Russian River Basin. Utilizing this potential future storage to maintain a status-quo condition on the Russian River will work an economic hardship on Mendocino County to replace this capacity at a future date.
3. No mention is made of who will bear the cost of raising Coyote Dam for the purpose of added recreation in the Eel River and decreased recreation in the Russian River.

This cost is now estimated at \$33 million and could escalate to \$50 - \$70 million by the time construction is started (10-15 years). Also, no mention is made of the \$912,000 already invested in the project to provide for increased future water supply storage.

4. The California Department of Fish & Game's attempt to tie the nebulous cost of construction and maintenance of a fish hatchery to the licensee, or any subsequent owner of the Potter Valley Power Project, places an onerous condition on the economic operation of the subject project.

This Board further declares that in its opinion no attempt has been made to evaluate the economic consequences to the Russian River Basin of any change in the Eel River diversion flows that have been in existence since 1908.

BE IT FURTHER RESOLVED, that this resolution constitutes the position of the District, and that copies hereof be forwarded to the Board of Supervisors of the County of Mendocino, the U. S. Corps of Engineers, Senators Cranston and Tunney, Congressman Don Claussen and all interested parties.

The foregoing resolution was introduced by Trustee Chas. Shimmin who moved for its adoption, seconded by Trustee W. S. Hildreth and passed and adopted this 13th day of May, 1975, by the following vote of the Board of Trustees of the Mendocino County Russian River Flood Control and Water Conservation Improvement District of Mendocino County, California.

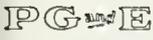
AYES: Charles Shimmin, W. S. Hildreth, Robert V. Knudsen and
NOES: None Christopher Keiffer
ABSENT: Frank Milone

WHEREUPON, the President declared the above and foregoing resolution adopted and SO ORDERED.

President of the Board

ATTEST: (Signed by Elma L. Rawles)
Secretary of the Board.

PACIFIC GAS AND ELECTRIC COMPANY



77 BEALE STREET • SAN FRANCISCO, CALIFORNIA 94106 • (415) 781-4211 • TWX 910-372-6587

ELMER E. HALL
CHIEF SITING ENGINEER

July 30, 1975

Mr. Edwin J. Barnes
Chief, Environmental Studies Section
Northern District
Department of Water Resources
P. O. Box 607
Red Bluff, CA 96080

DWR's June 27, 1975 Eel-Russian Rivers
Streamflow Augmentation Study

Dear Mr. Barnes:

Thank you for your letter of June 27, 1975 and Mr. Dolcini's letter of July 11, 1975 on the Eel-Russian Rivers Streamflow Augmentation Study (Study). The following comments are in addition to those we sent you on June 19:

PGandE and DWR Study Results

Our analysis shows differences between PGandE and DWR theoretical operation study results. The following tabulation summarizes and compares PGandE and DWR results based on your May 30 and June 27, 1975 recommendations.

<u>Alternative</u>	<u>Average Annual Diversion to Russian River (x 1000 AF)</u>		<u>Decrease in Amount of Water Diverted to Russian River (x 1000 AF)</u>	
	<u>PGandE</u>	<u>DWR</u>	<u>PGandE</u>	<u>DWR</u>
Base Case	193	184	-	-
DWR Recommendations				
May 30, 1975	170	?	23	-
June 27, 1975	157	176	36	8

The differences between PGandE and DWR results can be attributed to the study criteria used. PGandE's analysis initiates the 150 cfs fish water release to the Eel River on November 1 of each year (per February 1975 Fish and Game recommendations). If we were to use DWR's criteria of waiting for a spill from Cape Horn Dam to cause the mean daily flow at the gaging station below the dam to exceed 100 cfs to trigger the increase in fish water releases, it would be possible to increase PGandE's average annual Russian River diversion figure by approximately 8,000 acre-feet (AF) from 157,000 AF to 165,000 AF.

Our review of DWR's June 27 operation study indicates that Lake Pillsbury's storage was allowed to reach 86,800 AF during the first three months of the calendar year whenever water was available. This differs from the actual operational criteria used by PGandE. Exhibit H of our FPC license application shows Lake Pillsbury's actual operation criteria now being followed. These same criteria are also used in PGandE's base case, in our analysis of the Study Alternatives and in our analysis of DWR's recommended project operation alternatives. These criteria, which are also proposed for the future are:

During the fall and winter, the lake will be allowed to fill to spillway elevation (1,818.3 feet, 65,400 AF). The gates will be open generally between November 1 and April 1 to allow adequate spillway capacity during the winter storm period. Normally the gates will be closed after April 1 and the reservoir allowed to fill to elevation 1,828.3 feet (86,800 AF), as authorized by the State Division of Dam Safety. The water surface at Lake Pillsbury will be maintained as high as possible during the recreation season consistent with operational demands and irrigation requirements.

DWR Dry Year Criteria

The State and other agencies have generally accepted a dry year criteria based upon 50 percent or less of normal runoff. Such a criteria has been accepted by the FPC, the State, and PGandE for other projects. DWR's revised dry year criteria (40 percent or less of cumulative runoff of the Eel River at Cape Horn Dam) would reduce the number of dry years for the project from 10 to 4. Previously 1924, 29, 31, 33, 34, 39, 44, 47, 55, and 64 were designated dry years. Under your revised criteria, years 1924, 29, 31, and 39 would be desig-

nated as dry years. This proposed change, reducing the number of dry years from 10 to 4 for the study period, reduces the average annual diversion to the Russian River by approximately 13,000 AF.

In its June 27 study, DWR indicated that the effects on firm water supply in the Russian River Basin are best measured by the total diversion during the critical dry period: May 1, 1923 through October 31, 1924. The following tabulation compares PGandE and DWR study results for this period and the May 1930 through November 1931 period.

<u>Alternative</u>	<u>Diversion to Russian River</u>			
	<u>May 1923 to Oct. 1924</u>		<u>May 1930 to Nov. 1931</u>	
	<u>PGandE</u>	<u>DWR</u>	<u>PGandE</u>	<u>DWR</u>
Base Case	147	151	197	190
6/27/75 DWR Recommendation	<u>122</u>	<u>140</u>	<u>152</u>	<u>162</u>
Difference	25	11	45	28

DWR Storage Criteria for Lake Pillsbury

DWR's reservoir criteria attempts to maintain 61,500 AF in Lake Pillsbury on September 1. Based on our analysis, we find it impossible to maintain 61,500 AF in Lake Pillsbury by September 1 and to make the flows to the Eel River, as recommended by DWR.

Mr. Dolcini's July 11 letter indicates that DWR derived its "base case" by adjusting the historical diversions to the Russian River to maximum whenever Lake Pillsbury was spilling. However, DWR's base case gave no consideration to Lake Pillsbury operation by using a storage rule curve to minimize spill to optimize project yield. Such a procedure would increase DWR's base case results. It is noted that DWR's June 27 project operation study did utilize a storage rule curve to manipulate Lake Pillsbury storage to obtain an average annual diversion of 176,000 AF to the Russian River.

Mr. Dolcini's July 11 letter also suggests that PGandE uses a criterion in its studies which reduces the diversions to the Russian River. It is pointed out that we follow a criterion

July 30, 1975

in our studies which maximizes the diversion whenever possible. For each of the Study Alternatives, we establish a monthly critical storage on Lake Pillsbury which must not be violated in order to maintain a minimum pool of 15,000 AF and so that there is enough water to carry over the dry cycle. Our studies only reduce the diversion whenever the monthly critical storages are approached.

If there is any additional information you may need, please call me.

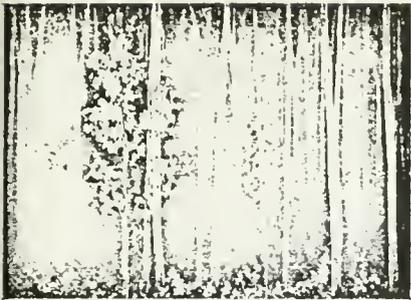
We appreciate the cooperation that you and your staff have extended to us during the course of this Study.

Sincerely,

W. Tom CE/for

A. P. KILROY
Senior Civil Engineer
Siting Department

cc: Study Committee Members



by Ansel Adams in *This Is the American Earth*

SIERRA CLUB

Mills Tower, San Francisco 94104

NORTHERN CALIFORNIA REGIONAL CONSERVATION COMMITTEE

Water Resources Division

Reply to:
1176 Emerson Street
Palo Alto, Ca. 94301

31 July 1975

Mr. A.J. Dolcini
Chief, Northern Division
California Department of Water Resources
P.O. Box 607
Red Bluff, California 96080

Dear Mr. Dolcini:

Eel-Russian Rivers Streamflow Augmentation Study

The Sierra Club appreciates the opportunity to comment on the Draft Eel-Russian Rivers Streamflow Augmentation Study. We agree that the time to modify the Eel diversion is in the relicensing of the Pacific Gas & Electric Company's power plant at Potter Valley, on which the diversion depends. Conditions should be written into the new license to allow the best solution to the fisheries and water supply problems upon completion of reregulation studies of the Eel-Russian Rivers system by the Department of Water Resources, the Department of Fish and Game, and the Corps of Engineers. Diversion of water through the PG & E power plant should not be solely for the purpose of power generation but should also include several beneficial purposes in the Russian River Basin, both in-stream and off-stream.

Anadromous fisheries have seriously declined in both the Eel and Russian Rivers from dam construction and poor land use. We therefore suggest the following three objectives to compensate for these losses and to protect and restore the fisheries:

- 1) Increased flow releases in the Eel as determined to be optimal for the fishery by the Department of Fish and Game

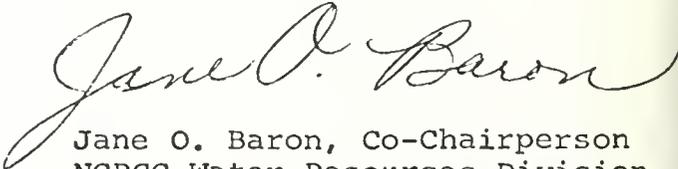
2) Reduced turbidity in the Russian resulting from the Potter Valley diversion. Multi-level outlets on Coyote Valley Dam and a sediment control basin should be studied for feasibility.

3) Construction and operation of steelhead hatcheries below Coyote Valley Dam and on the Eel where best suited--either below Van Arsdale or Scott Dam.

As for water development, the Sierra Club is opposed to further dams on that portion of the Eel River covered by the Wild and Scenic Rivers Act (Behr Bill). We also oppose further dams on the Russian River, except for a Greater Coyote Valley Dam with modifications as outlined above. Further water supplies should come from conjunctive use of groundwater, reuse of reclaimed water, recharge of aquifers, and conservation of water. We favor flood plain zoning and acquisition over structural means of flood protection. We agree with the Department of Water Resources' concept of permitting a water deficiency in the most critically dry years, with recreation taking the deficiency if conservation measures are insufficient.

Thank you for your consideration of the above.

Yours very truly,



Jane O. Baron, Co-Chairperson
NCRCC Water Resources Divisior

cc: California Department of Fish and Game
U.S. Army Corps of Engineers
Federal Power Commission

SONOMA COUNTY WATER AGENCY

(Formerly Sonoma County Flood Control & Water Conservation District)

SONOMA COUNTY ADMINISTRATION BLDG. SANTA ROSA, CALIFORNIA 95401
PHONE (707) 527-2211 *2555 Mendocino Avenue* GORDON W. MILLER
August 8, 1975 Chief Engineer

FILE: 40-0-25 Eel/Russian River
Streamflow Aug. Committee

Mr. Albert J. Dolcini, Chief
Northern District Office
State Department of Water Resources
P. O. Box 607
Red Bluff, CA 96080

Dear Mr. Dolcini:

As agreed at the June 19th meeting of the Eel/Russian River Streamflow Augmentation Committee, following are comments on your review draft report on that subject. We regret that our comments have been delayed because of problems with yield analysis as discussed later.

During the course of the Agency's Water Rights hearings on the Coyote Dam project, the Water Rights Board indicated the desirability of filing for water rights in the Eel for the Potter Valley diversion because of the dependence of the diversions to sustain the Coyote project benefits. Since the principal objector to the granting of such water rights was the Dept. of Fish and Game, the Agency retained the services of Dr. Ridenhour to investigate the fisheries associated with the Potter Valley project and to provide expert testimony at the water rights hearings. The essence of Dr. Ridenhour's testimony at the hearing held in October, 1968 was that the overall fishery in the Eel had been enhanced by the Potter Valley project; that the steelhead fishery probably had been enhanced by the project; that the declines in fishery at Van Arsdale (which Fish and Game attributed to the project) could not be blamed on the project because of its proven ability to sustain a large fishery over a long number of years of operation and that, in fact, the same decline in fishery was noted at Benbow and other fish counting stations; and that the decline in fishery was a general rather than a specific problem associated with this one installation. Based upon evidence produced at the hearing, the State Water Resources Control Board issued Decision 1345 granting, in part, the requested water rights.

The Dept. of Fish and Game appealed Decision 1345 and in April 1972, recommended to the Board wet season releases which had been statistically arrived at such as not to impair the diversions from the Eel into the Russian River system. In

Mr. Albert J. Dolcini
Department of Water Resources

August 8, 1975

October of 1972, the Board rescinded its earlier decision on the premise that the hydroelectric diversions were continuing in a historic manner and that new water rights were not required as long as such diversions were maintained.

Subsequent to publication of Fish and Game's recommendations for wet season releases, Humboldt County interests petitioned the Eel River Water Council for a study to see if operational changes of Potter Valley project could be made which would not adversely affect diversions to the Russian River and at the same time provide additional releases over and above Fish and Game's recommendations for the benefit of the Eel River system. A study committee of interested agencies was formed with the principal workload falling on your office. After some three years of study, it appears that the original study purpose has been forgotten or modified by your department in that the review draft presents recommendations which would have severe adverse impacts in the Russian River system while providing only nominal benefits to the Eel River system. This bias in the report may be largely explained by the comments of Ed Barnes of your office who indicated at the June meeting that it was his personal conviction that additional water supplies from the project should be routed down the Eel River, even if such routing was harmful to the Russian River system. At the same meeting, the Humboldt County representative reiterated the original position that it was not their intent to harm the Russian River system and most of the other committee members were quite concerned as to possible losses in power generation, water supply, tax base, etc., which would arise if the recommendations of the review draft were followed.

Of further interest was Mr. Barnes statement at the meeting that he felt sure the Federal Power Commission would examine the relicensing of the Potter Valley project based upon the presumption that this was a new project. If this is the case, and if the Department intends to forward the report to the FPC for their consideration as to project relicensing, it is necessary to start with "no project under existing conditions" so as to evaluate the project impacts. With the mass of actual streamflow measurements available in both the Eel and Russian River watersheds, hypothication of existing conditions without the project are relatively simple. Obviously unimpaired flow would not exist, because the various streams are affected by logging operations, ranching, recreation use, etc. In the Eel River drainage, Tomki Creek is generally dry during the period July through October, while Outlet Creek with a somewhat larger watershed has a regression in flow to about 1 cfs as a minimum. Flow at Van Arsdale under existing conditions without the project could, therefore, be anticipated in the 2 to 5 cfs range during the summer and fall period. Steelhead production would, therefore, be limited primarily to the smaller tributary streams with a cooler environment than the mainstem of the Eel with the loss of probably the best nursery habitat (Eel River between Van Arsdale and Lake Pillsbury) for steelhead in the north coastal area. Without the project there would be no fishery and recreation benefits associated with Lake Pillsbury. Without the project steelhead rather

Mr. Albert J. Dolcini
Department of Water Resources

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than trout would inhabit the cooler pools in the tributaries above Scott Dam. Lost also without the project would be the relatively inexpensive hydro-electric power generation which benefits all customers in the P.G. & E. system.

Moving into the Russian River basin, the picture would be much more bleak, not only for fisheries and recreation but for the agricultural enterprise throughout the river basin. Current uses in the basin (exclusive of this Agency's diversions) would cause the river in the Guerneville area to be normally dry in the period from June through the advent of the winter rains in October. Without the project the deficiency in use is so great that substantial areas of the basin which are now irrigated would be dryland farmed. The lack of river streamflow would place even more pressure than now exists on the small tributary streams to the Russian with a probable further degradation in fishery habitat in the tributaries than exists today.

Undoubtedly Sonoma County together with Marin would have joined the State Water Project rather than taking supply from the Russian River and it is doubtful that Coyote reservoir would have been constructed. Without project flow to the estuary of the river, the mouth would be closed from spring through fall instead of being generally open as it is now. Without the project, it can be safely assumed that agricultural income in the Russian River basin would be substantially impaired, that the current recreation use of millions of visitor-days would be essentially non-existent, that the warm water fishery which now exists would be essentially non-existent, that anadromous fish generally would be at a lower level than now, and that the water supply alternatives available to Mendocino, Sonoma, and to Marin Counties would be substantially more expensive.

When no project is compared with the project as historically operated, it is quite obvious why Dr. Ridenhour indicated that he felt that there had been a net benefit to the fishery by reason of the project. His point about the ability of the project to rear large numbers of steelhead and that there is nothing in the record of project operations which would account for the recent decline in their numbers is borne out by the available fish counts and flow records of the project. The generating capacity of the project has remained essentially unchanged since 1917 (9,000 kw then vs. 9,200 kw now) and flow past Van Arsdale has in general not exceeded 2 sec/ft. except during those periods when streamflow exceeds the combined diversion to storage and to the hydroelectric plant. As a norm, 2 sec/ft. are released past Van Arsdale commencing in May and extending through October. During October and November, diversion is maximized to take advantage of remaining storage in Lake Pillsbury and since the project is not continuously manned, occasional rains cause higher spills over Van Arsdale until project releases are readjusted. Once Pillsbury is refilled and the watershed is saturated, flow past Van Arsdale is generally fairly high until the following spring when the reservoir level is raised and the dry season again commences. While fish counts are unavailable in the early years of project operation, from the period 1933 to 1960 under the historic mode of operation only two years had less than 1,000 steelhead returning up the ladder at Van Arsdale and the average number of fish returning per year was almost 4,000.

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Department of Water Resources

August 8, 1975

This production record was accomplished in spite of the continuing extraction of eggs at the Snow Mountain egg collecting station and the diversion of some fish into the Russian River system through the Potter Valley powerhouse. During the entire period, the returning runs fluctuated considerably but there was no consistent pattern of a decline in the fishery. In fact, toward the end of the period (1955 through 1960) the average return was approximately 4,100 fish per year. Commencing in 1960 through the present, there have only been five years when the run has exceeded 1,000 fish with the average annual run at approximately 950. Since there has been no significant change in project operation since inception, let alone since 1960, it is statistically impossible to conclude that the project operation has adversely affected the fish run of recent years. When the fish counts at Benbow are compared with those at Van Arsdale and the same general pattern of decline is noted at that station, it is even more illogical to blame the project operations for a general decline in the fishery.

Except for three isolated years, salmon counts were not taken at the Snow Mountain egg taking station until 1956. It is, therefore, uncertain as to the ability of the area above Van Arsdale to sustain a salmon run either under preproject or project conditions. If the upper Russian River watershed is any indicator, there probably is very small potential for salmon in the project area. Despite repeated plants by Fish and Game of kings, there is a negligible salmon run in the Russian River system. This is particularly interesting when it is noted that the Russian River has a sustained flow at or above the magnitude recommended for release down the Eel. Since the upper Russian and Eel River systems experience the same general type of storm pattern and associated debris loading, and since the king salmon's reproductive cycle requires that its redds, eggs and alevins be subjected to winter storms (whereas the much more variable reproductive cycle of the steelhead allows "working around" the area's weather cycle) it is quite conceivable that steelhead may do quite well in the area and that the king salmon are incapable of sustaining a run in either the Russian or upper Eel.

There further appears to be no valid reason to require the project to release the flows as recommended in the review draft or the amendments thereto in order to enhance the fishery. The study of summer temperatures in the pools downstream of Scott Dam vs. flow rate verify that an increase in flow over that which has been historically released from the project will damage the downstream nursery area. Steelhead are capable of holing up between high water periods to continue their upstream migration. Intermittent flows rather than continuous flows, therefore accommodate the steelhead migration. The history of fish migrations through the Van Arsdale ladder indicate that the steelhead seem to prefer slightly higher flows than minimum release but are capable of making the

Mr. Albert J. Dolcini
Department of Water Resources

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migration even under low release schedules. As an example, during the spring of 1965 when the release schedule was maintained at 2 cfs, approximately half of the fish counted for the entire season passed through the ladder. While the record on king salmon is extremely spotty there are indications that these fish also are able to migrate through the fish ladder at minimum flow conditions. In fact, in the two largest years of recorded runs the flows passed through Van Arsdale generally were in the 10 cfs range from October through December and 100 cfs or more was recorded only for 2 days during that period in 1948 and 5 days during 1947. The 1946-47 run is also of interest because it is the only year of king salmon record when there was a significant run of fish and the return run of 4 years later is recorded. The flow at Van Arsdale was moderate for the entire winter season of 1947 and conditions for reproduction would appear to be excellent. Four years later, relatively high flows persisted from the end of October through March yet only 55 kings passed Van Arsdale in 1951. If the project area is able to sustain a large run of kings, why under these favorable conditions was it unable to do so?

The turbid winter and spring releases from Lake Pillsbury are such that they do not materially affect fish but do adversely affect fishing effort. As a consequence, these sustained flows are re-regulated by Coyote Dam to provide periods in the Russian River system during the steelhead season when the turbid water is held back in Lake Mendocino. Such an opportunity does not exist in the Eel River and if the flows as recommended in your report were to be initiated it is quite certain that the decline in steelhead angling will be proportional to the increase in howls of the fishermen.

The Agency's computer analysis of the Russian River system depends upon input of unimpaired data for various points in the Russian River system, input of releases from the Potter Valley project, consumptive use of water in the entire Russian River watershed tributary to Guerneville which impairs streamflow, and the operational criteria of the Coyote Project including minimum flow releases at the Forks and minimum flow at Guerneville, and surcharge capability of the reservoir during the non-flood season. We, therefore, updated our estimates of consumptive use within the watershed and attempted to run through the computer the various alternative flows from Potter Valley as provided by DWR and P.G. & E. and found these runs and those previously computed by the Corps of Engineers to differ substantially. Analysis of the unimpaired data indicated that the material for unimpaired flow published in Bulletin 142-1 (Preliminary) is inconsistent within itself. We found that the Corps had previously reported this to the State but since the bulletin has not been finalized apparently the State has not updated the preliminary data in Bulletin 142-1. Since the Corps data was consistent within itself, we utilized their projections of unimpaired flow and reran the program attempting to compare DWR and P.G. & E. projected releases from Potter Valley. Again we found substantial disparity between P.G. & E. and DWR figures. The conclusion that we reached was that DWR in its figures ran the various alternates at a theoretical 100% efficient diversion but did not modify the base case to provide for the same 100% efficiency assuming no releases down the Eel.

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Department of Water Resources

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We understand that Lake Pillsbury, for safety purposes, is not normally filled above approximately 66,000 AF until the danger of flood flows has passed, at which time storage can be increased to approximately 86,000 AF assuming there is a late season runoff. The DWR computer had insufficient capacity to limit maximum storage at Pillsbury at the 66,000 AF allowable level but instead assuming a full reservoir of 86,000 AF at any time when runoff so provided. As a result, it is impossible to assess the impact of DWR releases by comparing the historic operations with the theoretical modified release schedule.

P.G.& E.'s base case, on the other hand, was apparently run to maximize the diversion for hydroelectric purposes by substantially drawing down the recreation pool in the summertime instead of maintaining it at approximately 55,000 AF through Labor Day. We are concerned with our inability to reconcile DWR figures with historic, and P.G.& E. figures with DWR. We therefore find it necessary to calculate a base case based on historic operation and superimpose on this case the fish flows as suggested by DWR. The mode of operation was obtained from USGS surface water records of the last several years which show a fairly consistent pattern of operation. The "normal" mode of operation is to maintain 55,000+ AF in Pillsbury as of the 1st of September; start maximal releases soon after Labor Day; continue these releases through the winter period with lake surcharge above 66,000 AF commencing in March. In the event of a drought in the fall, the lake level is pulled down to approximately 10,000 AF at which time releases diminish to 60 cfs. In the event of a drought in spring, releases are diminished to achieve some surcharge in the lake so that with reduced releases on a consistent basis through the summertime, there is still some water in Pillsbury for recreation.

Admittedly, the Agency's mode of operation is less complicated than either P.G.& E.'s or DWR's, and necessarily so because we were forced to run our analysis by hand. It is, however, consistent between mode of operation with and without fish releases which is not the case of the DWR analysis. It, therefore, serves the purpose of comparing the effects of fish releases on Pillsbury and the Russian River system. Our comparison shows that the water level in Pillsbury through the recreation season would in general be slightly lower with DWR releases than without and that the summertime releases between Lake Pillsbury and Van Arsdale would also be slightly lower. These differentials in lake level and flows are quite small and probably would not have a severe adverse impact on the recreation or fish potential of the area. Our comparison analysis shows the additional releases down the Eel River would reduce diversion for power by 17,000 AF. Our analysis also shows the recreation pool in Coyote reservoir would be lower on the average by 1,000 AF in April and May, 2,000 AF in June, 3,000 AF in July, 6,000 AF in August and 5,000 AF in September. In the drier years the effects would be much more severe.

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The average reduction in yield of the Coyote project as measured by the low pool level with and without fish flow releases down the Eel would be approximately 5,000 AF per year. Our computer run of the effects on the Russian shows a much different story on dry year yields. A comparative computer run for the year 1924 shows the existing deficit of approximately 21,000 AF to remain the same either with or without the fish releases as recommended. In 1931 (the second driest year) the current surplus of approximately 9,000 AF without additional releases down the Eel shrinks to a deficit of over 19,000 AF for a net drop in yield in that year of over 28,000 AF. In the third driest year of record the yield would drop over 17,000 AF, and through the 10 driest years of record the average decline in yield would be 13,500 AF. It can, therefore, be seen that the recommended releases to the Eel River impact on the Russian River to the greatest extent in the dry years when water is in most critical supply in the Russian River system. Our computer analysis does not purport to establish the firm yield of the Russian River system but only analyzes on a theoretical basis the period from 1923 through 1963 (assuming 100% efficiency in operation) the yields which might be achieved with and without DWR's recommendation. As a practical matter, we cannot operate the Russian River system at 100% efficiency because of the variable use of water between Guerneville and the dam. To maintain a minimum of 125 cfs flow at Guerneville, we find it necessary to make releases in the magnitude of 150 cfs on the average. On both the Russian River and the Eel River sides the incremental flows tabulated in the computer run are presumed to be usable throughout the month. In many instances these flows either occur at such a high rate as to be unusable or occur toward the end of the month with quite a different effect in operation than is presumed in the computer run. Intervening flow between Pillsbury and Van Arsdale is, in general, unusable because of intermittent manning of the plant by P.G. & E. and the cyclical nature of much of this flow.

In addition, P.G. & E. has not historically operated the Potter Valley complex at a 345 cfs maximum rate of diversion as assumed in comparative runs but rather a little over 300 sec/ft. We have plotted the adjusted historic flow against our base case and find that except for the dry year of record, which is fairly comparable, there is a slippage on the average of between 25,000 and 30,000 AF. Reduction of theoretical base to historic base suggests that severe shortages would exist under present use in a year like 1924, a somewhat lesser shortage in a year like 1931, with excess of supply in the next and succeeding critical dry years.

Imposition of DWR recommendations would probably not affect yield in a dry year like 1924, would reduce 1931 to a drier or more critical condition than 1924, and would cause deficient supply in the next two most critical years. As water use from the river by agriculture and municipalities increases, the effect of these DWR flow release recommendations would extend to successive critical years. This

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increase in water use is a most important point which the DWR study overlooks. The study presumes that the impact on the Russian River system is limited to present use only while, in fact, water use for agricultural, industrial and municipal purposes from the river and tributaries is expanding. Many of the permits and licenses for water rights along the river system are for larger quantities than currently being used. As an example, this Agency's water rights permits for the Coyote project allow for diversion of several thousand acre feet more water than we are presently diverting. It certainly seems to be a major oversight to make recommendations for reregulation of the river systems without considering the fact that existing uses exceed safe yield and considering the impact on future use.

I think it is quite evident that if Mendocino and Sonoma Counties had not been farsighted enough to have invested in the Coyote project, severe and continuing water shortages would exist through the Russian River system today and the present study would not have been undertaken. The report, therefore, contemplates borrowing from storage capacity in Coyote reservoir to satisfy downstream diversions to the Eel. Sonoma County bought the water supply features of the Coyote project by issuance of general obligation bonds to insure not only a new water supply but enhancement of recreation and fishery resources by guaranteed flow of 125 cfs in the river. To reduce this recreation and fish flow as an alternative to reducing safe yield of the Coyote project would be contrary to the purpose of the project and the Counties' investment.

In conclusion, I would like to return to the original theme of the study and consider procedures which might enhance the fishery without damage to the Russian River system. We believe that records show quite conclusively that the malaise in the fishery runs at Van Arsdale is not attributable to historic project operation but to some other cause. Apparently activities of man which would pollute or degrade the nursery area have been minimal in the watershed above Van Arsdale. This leads to the conclusion that the decline in fishery is primarily attributable to a factor which prohibits the return of fish to Van Arsdale and since the decline in fishery is widespread, probably the same factor which contributes to the decline elsewhere. In all probability this constant factor is man, not as a builder or polluter but as a predator. Ample data exists to support this conclusion. From 1936 to 1970, the California trout catch increased from 12 million to 37 million while the number of fishing licenses increased from approximately 300,000 to 2 million. The recreation salmon fishery increased from 5,000 fish in 1947 to 199,000 fish by 1955. The fishing effort for king salmon has become so intense that, as witnessed by the study committee at the Red Bluff facility, a major portion of the returning fish bear evidence of having previously been hooked. It is also interesting to note that the largest returns of both king salmon and steelhead occurred in the immediate post World War 2 period. These large returns could well be attributed to reduced fishing pressure in the Eel River area due to gas rationing, etc., during World War 2.

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If the above analysis is even close to being correct, then most of the tools for increasing the productivity of the Potter Valley project must be employed by Fish and Game and not by P.G.& E. nor by reregulation of diversions into the Russian River. The following minor operational changes might be studied and tested to determine whether or not the fishery resources can be increased to or above historic levels.

1. Since the historic operation of the project requires a level of approximately 55,000 AF in Pillsbury as of the beginning of September, and winter storms normally occur prior to being able to completely empty the reservoir for hydroelectric purposes, an increase of historical discharge of 2 cfs after the first significant winter rains to a preferred flow of approximately 10 cfs would not impact significantly either the yield of the Russian River or the hydroelectric project. Such an increase should be subject to modification downward in the event of a drought condition and eliminated at the time of surcharge of Pillsbury in the spring.
2. The fish ladder at Van Arsdale be screened off so that downstream migrants cannot enter the river at a time in the spring when conditions are such that they can no longer make the full trip to the cooler waters in the lower Eel.
3. "Trout" fishing in the nursery area above Van Arsdale should be eliminated or regulated to insure a maximum return of steelhead in subsequent years. Noting that larger "trout" preying on young steelheads might surpress the fishery with the fish counting facilities and limited area above Van Arsdale, Fish and Game have a unique area for study and experimentation on "trout" take vs. steelhead production.
4. Fish and Game should experiment by supplemental feeding or enrichment of the nursery areas above Van Arsdale to see if an additional increment of survival and vigor can be attained over that naturally occurring.
5. Currently Fish and Game has a program of planting catchable trout in the East Fork of the Russian River above Coyote Dam. It would appear that if P.G.& E. were not required to replace the fish screen over the diversion inlet, that these diverted fish should become resident trout in the East Fork and thereby diminish the necessity for fish plants. The magnitude of diversion of fish is quite small compared to the total production in the Van Arsdale to Pillsbury area.



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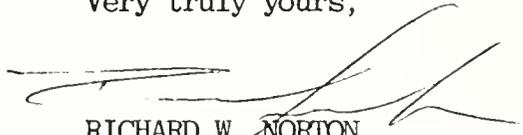
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Department of Water Resources

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6. It would appear that the take of steelhead and salmon should be regulated to insure a return of a sufficient number of spawners to maximize production. Such regulation should be variable depending on the size, timing and location of fish runs.

I would be pleased to meet with your staff to explain or expand upon the commentary made herein.

Very truly yours,



RICHARD W. NORTON
Sonoma County Committee Member

RWN/ph
Encl.

cc: G. Kulstad, Humboldt County Flood Control District
Willard Hansen, Lake County Flood Control
Ernie Banker, Mendocino County Board of Supervisors
Joseph E. Carson, Tudor Engineering Co.
John O. Nelson, North Marin County Water District
A. P. Kilroy, P.G.& E.
Charles Elmore, Corps of Engineers

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Mendocino National Forest
Willows, California 95988

2770
July 29, 1975



Edwin Barnes
California Department of Water Resources
2440 Main
Red Bluff, California 96080

Dear Ed:

Thank you for the opportunity to assist in the development and review of the "Eel-Russian Rivers Streamflow Augmentation Study". Following are brief comments on the proposed release schedule.

The final proposed release schedule should result in definite beneficial impacts on Eel River fisheries. The Forest Service favors improvement of these fisheries; provided, it is not gained at a cost of significant reductions in either Lake Pillsbury recreation use or Potter Valley power capabilities.

The proposed release schedule almost accomplishes all the desired goals. Additional reductions of summer flows in the Eel, when flow is not critical, would also help achieve these goals.

One problem in the report is the apparent discrepancy between results of the proposed release schedule and schedules developed by Pacific Gas and Electric Company. Using the same basic data, significantly different results have been obtained. These differences need to be explored further and a release schedule that depicts anticipated conditions should be developed. Copies of PG&E data should be included in the appendix of the report.

Thank you again for the opportunity to assist in the development and review of this report.

Sincerely,

For BLAINE L. CORNELL
Forest Supervisor

EEL-RUSSIAN RIVERS
STREAMFLOW AUGMENTATION STUDY

APPENDIX E

BIBLIOGRAPHY

BIBLIOGRAPHY

- Anderson, Keith R. "Report to the California State Water Resources Control Board by the Department of Fish and Game regarding Water Application 18785 and 18786, Eel River, Lake and Mendocino Counties". April 1972.
- California Department of Fish and Game. "Study of Downstream Migration at Cape Horn Dam". Administrative Report No. 68-4.
- California Department of Water Resources. Bulletin No. 94-8. "Land and Water Use in the Eel River Hydrographic Unit". August 1965.
- . Bulletin No. 94-11. "Land and Water Use in the Russian River Hydrographic Unit". November 1964.
- . Bulletin No. 142-1.1. "Water Resources and Future Water Requirements - North Coastal Hydrographic Area, Volume I: Southern Portion". April 1965.
- . Bulletin No. 184. "Ten Counties Investigation". December 1971.
- California State-Federal Interagency Group. "Eel and Mad River Basins Master Plan - Hydrology". August 1969.
- Federal Power Commission. "Evaluation Report, Water Resources Appraisal for Hydroelectric Licensing, Potter Valley Development, Project No. 77 owned by Pacific Gas and Electric Company, Eel and Russian River Basins, California". 1972.
- Lee, Dennis P. and Phillip H. Baker. "Eel-Russian Rivers Streamflow Augmentation Study: Reconnaissance Fisheries Evaluation". California Department of Fish and Game. February 1975.
- Pacific Gas and Electric Company. "FPC Project No. 77, Report to the Federal Power Commission on the Potter Valley Hydroelectric Project". July 1968.
- . "Application of the Pacific Gas and Electric Company for New License Before the Federal Power Commission, Potter Valley Project - 77". April 1970.
- U. S. Army Corps of Engineers. "Eel-Russian Rivers Streamflow Augmentation Study". San Francisco District Office Report. December 1974.
- . Design Memorandum Number Four. "General Design Memorandum, Russian River Reservoir (Coyote Valley)". October 1955.

EEL-RUSSIAN RIVERS
STREAMFLOW AUGMENTATION STUDY

APPENDIX F

ENGLISH-METRIC CONVERSION FACTORS

CONVERSION FACTORS

English to Metric System of Measurement

<u>Quantity</u>	<u>English unit</u>	<u>Multiply by</u>	<u>To get metric equivalent</u>
Length	inches (in)	25.4	millimetres (mm)
		.0254	metres (m)
	feet (ft)	.3048	metres (m)
	miles (mi)	1.6093	kilometres (km)
Area	square inches (in ²)	6.4516×10^{-4}	square metres (m ²)
	square feet (ft ²)	.092903	square metres (m ²)
	acres	4046.9	square metres (m ²)
		.40469	hectares (ha)
		.40469	square hectometres (hm ²)
		.0040469	square kilometres (km ²)
	square miles (mi ²)	2.590	square kilometres (km ²)
Volume	gallons (gal)	3.7854	litres (l)
		.0037854	cubic metres (m ³)
	million gallons (10 ⁶ gal)	3785.4	cubic metres (m ³)
	cubic feet (ft ³)	.028317	cubic metres (m ³)
	cubic yards (yd ³)	.76455	cubic metres (m ³)
	acre-feet (ac-ft)	1233.5	cubic metres (m ³)
		.0012335	cubic hectometres (hm ³)
		1.233×10^{-6}	cubic kilometres (km ³)
Volume/Time (Flow)	cubic feet per second (ft ³ /s)	28.317	litres per second (l/s)
		.028317	cubic metres per second (m ³ /s)
	gallons per minute (gal/min)	.06309	litres per second (l/s)
		6.309×10^{-5}	cubic metres per second (m ³ /s)
			cubic metres per second (m ³ /s)
Mass	pounds (lb)	.45359	kilograms (kg)
	tons (short, 2,000 lb)	.90718	tonne (t)
		907.18	kilograms (kg)
Power	horsepower (hp)	0.7460	kilowatts (kW)
Pressure	pounds per square inch (psi)	6894.8	pascal (Pa)
Temperature	Degrees Fahrenheit (°F)	$\frac{t_F - 32}{1.8} = t_C$	Degrees Celsius (°C)

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