STATE OF CALIFORNIA

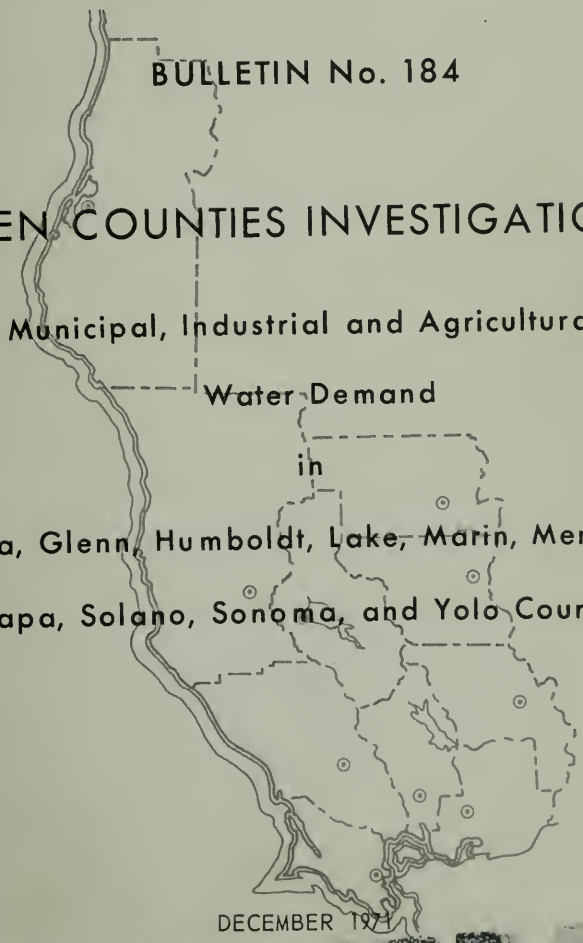
The Resources Agency

Department of Water Resources

BULLETIN No. 184

TEN COUNTIES INVESTIGATION

Municipal, Industrial and Agricultural Water Demand in Colusa, Glenn, Humboldt, Lake, Marin, Mendocino, Napa, Solano, Sonoma, and Yolo Counties



DECEMBER 1971

NORMAN B. LIVERMORE, JR.
Secretary for Resources
The Resources Agency

RONALD REAGAN
Governor
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WILLIAM R. GIANELLI
Director
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DEPARTMENT OF WATER RESOURCES

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FOREWORD

The principal objective of the Ten Counties Investigation is to provide up-to-date projections of future water demands for municipal, industrial, and agricultural purposes in the counties involved, and to appraise the need for new water supplies which may be needed from possible Eel River developments or other sources. These additional water demands are an important consideration for the eventual selection of the configuration of possible Eel River developments.

The Ten Counties Investigation is an outgrowth of the original Nine Counties Investigation which was undertaken in response to the first portion of Senate Concurrent Resolution No. 76, adopted by the 1968 Session of the Legislature, requesting the Department of Water Resources to "...make additional studies of the water demands and allocation of cost of water to meet these demands in the North Bay area, including the counties of Marin, Solano, Napa, Sonoma, Lake, Mendocino, Yolo, Colusa and Glenn..." The Resolution also requested the Department to study the quality of the waters of Clear Lake, and to report its recommendations relating to the extent to which further studies with respect to the routing of water from the Eel River should be undertaken. These other requests are also under study and will be reported on in subsequent publications.

The original Nine Counties Investigation culminated in a draft report dated February 1970, which was provided to the counties concerned. About that time, it became apparent that the original projections of future water demands might not be valid because of the lower trends in population indicated by the 1970 census. In November 1970, the Eel River Water Council asked the Department of Water Resources to review and revise the projected water demands in the Nine Counties Study and to include Humboldt County. The result is this report on ten counties.

This report does not include appraisals of future water demands and related services which may be required for such purposes as stabilization of existing reservoirs for recreational enhancement, flood control, water quality control, fisheries and wildlife enhancement, or water-oriented recreation which can be provided by new reservoir development.

Consideration has been given to the factors which underlie economic growth in preparation of the water demand projections, and possible future sources of water supply to accommodate this growth were identified. The sources of additional water supply considered include ground water development, surface water development on local streams, and alternative configurations of a future development on the Upper Eel River.

The studies described in this report were conducted in cooperation with the counties concerned. Valuable assistance and cooperation have been provided by technical staffs and consultants from each of the ten counties; the Eel River Water Council, particularly the Engineering Committee; the U. S. Bureau of Reclamation; and the U. S. Soil Conservation Service. The Department of Water Resources wishes to express its appreciation for this assistance and for the spirit of cooperation in which it was provided.

William R. Gianelli

William R. Gianelli, Director
Department of Water Resources
The Resources Agency
State of California
December 17, 1971

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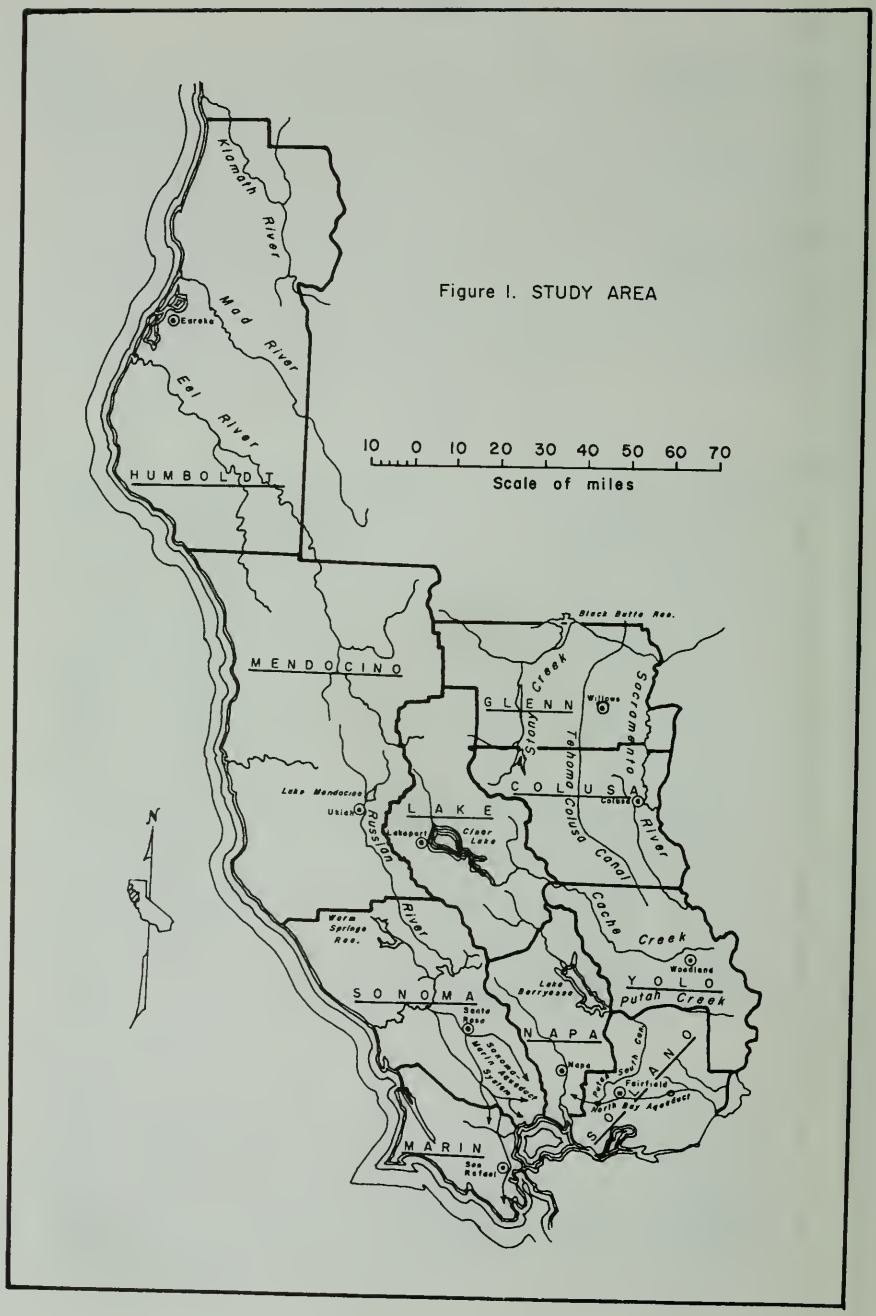


Figure 1. STUDY AREA

Chapter I. SUMMARY

After the publication of Bulletin No. 171, "Upper Eel River Development: Investigation of Alternative Conveyance Routes" (August 1967), considerable interest was generated in the North Bay counties for further studies of a southerly route for conveying water from the Eel River to the Sacramento-San Joaquin Delta. Many people in these counties felt that addition of benefits due to local water service in those counties from a southerly routing to the Delta would favor a southerly over an easterly routing. Senate Concurrent Resolution No. 76 (1968 Legislative Session) constitutes a formal request that the Department make additional studies and review previous studies bearing on recommendations regarding the extent to which further routing studies should be made.

As a result, the Nine Counties Investigation was begun in 1968, culminating in a draft report dated February 1970. About that time the original projections of future water demands based on earlier estimates of population growth appeared invalid, in view of the new trends indicated by the 1970 Census. The new lower trends were incorporated into Bulletin No. 160-70, "Water for California, the California Water Plan, Outlook in 1970". In November 1970, the Eel River Water Council requested the Department of Water Resources to review and revise the projected water demands in the Nine Counties Study and to include Humboldt County. As a result, this document is a report on a Ten Counties Study (Figure 1).

The Ten Counties Investigation provides an important input to further studies of possible Eel River developments, including routing studies. The information presented in this report will provide a sound basis for evaluation of the benefits and costs of water service in the North Bay counties. Hopefully, the projections will also prove helpful to each of the ten counties as a framework for more detailed county planning.

Water service area requirements for agricultural and municipal-industrial water were determined and are presented as economic water demands. Economic water demand is defined as the water quantities of suitable quality which can be marketed at a given price during a given time period. Supplemental water demands are defined as the need for future water supplies, considering time and price factors, in addition to the dependable water supplies presently developed or for which development facilities are under construction. The Tehama-Colusa Canal Unit of the Central Valley Project, which will provide water service for Glenn and Colusa Counties; the Warm Springs Project (Lake Sonoma) within the Russian River Basin; and the North Bay Aqueduct of the State Water Project, which will deliver water to Napa and Solano Counties, are examples of projects under construction.

This report does not include appraisals of future water demands and related services which may be required for such purposes as stabilization of

existing reservoirs for recreational enhancement, flood control, water quality control, fisheries and wildlife habitat enhancement, or water-oriented recreation which can be provided by new reservoir development. In many of the ten counties the nonconsumptive demands (including instream flow) for recreation and other purposes could be large in comparison to municipal, industrial, and agricultural water demands. This report does not evaluate the possible effect, if any of the recent State Water Resources Control Board decision on water quality in the Delta with respect to proposed water service from the Central Valley Project and State Water Project in the ten-county region.

Chapter I of this report provides a summary of conclusions, a summary of future supplemental water demands, and a discussion of potential water deficiencies by individual service areas within the ten-county region. Chapter II describes general study procedures and criteria; and Chapters III through XII present detailed discussions of the service areas and findings for each of the ten counties.

Conclusions

The following general conclusions are made on the basis of the water demand projections considering the probable cost of alternative water development possibilities.

1. Service areas within each of the ten counties will require augmentation of their presently available dependable water supplies and those for which construction is in progress to meet economic water demands by the year 2020.

2. The economic demands for supplemental agricultural water supplies in certain service areas would be significantly influenced by the pricing policies of the responsible water marketing agencies which may include federal, state, and local water agencies.

3. The additional water supplies needed in the ten-county area in year 2020 to satisfy demands for municipal-industrial water and agricultural water at prices similar to those currently prevailing within the various service areas would amount to about 990,000 acre-feet annually.

4. Provisions for serving supplemental water supplies to the North Bay counties in and adjacent to the Eel River Basin should be carefully considered in future plans for development of Eel River water supplies to meet State Water Project and Central Valley Project demands.

5. English Ridge Dam and Reservoir on the Upper Main Eel River should be given careful consideration as a source of supplemental water supply for Lake and Napa County service areas, as presently proposed by the U. S. Bureau of Reclamation, and also for service areas within the counties of Mendocino, Sonoma, and Marin.

6. The proposed West Sacramento Canals Unit of the Central Valley Project should be authorized and construction started at an early date to provide supplemental water service as needed for service areas within the counties of Yolo and Solano; and to provide water supplies via exchange as may be appropriate to facilitate development of the Middletown and Lakeport Projects in Lake County.

7. Local interests and agencies should periodically assess their needs for supplemental water supplies and other water services and fully review their options and alternatives for obtaining these services. They should provide the Department and the federal water agencies with this information and should indicate their views as to the timing of need for services, those developments they consider to be most beneficial, and their willingness to contract for repayment of reimbursable costs which will be associated with both federal and state projects.

Supplemental Water Demand

Future supplemental water demands within each of the ten counties for 1990 and 2020 are set forth in Table 1. The supplemental irrigation water demands in each table reflect both current prices and a price of $20 per acre-foot. These are assumed to represent an upper and lower range in values, representing the limits of the probable future pricing range. Price is measured at the farm headgate in the case of agricultural supplies and at the distribution system headworks prior to treatment for the municipal-industrial supplies.

Table 1: SUPPLEMENTAL WATER DEMAND in 1,000 Acre-feet per Year

County	Water Priced at Current Rates						Water Priced at $20 per Acre-foot					
	Demand in 1990			Demand in 2020			Demand in 1990			Demand in 2020		
	Agricultural	M & I*	Total	Agricultural	M & I*	Total	Agricultural	M & I*	Total	Agricultural	M & I*	Total
Colusa	0	0	0	27	0	27	0	0	0	2	0	2
Glenn	0	0	0	20	0	20	0	0	0	4	0	4
Humboldt	0	46	46	0	53	53	0	46	46	0	53	53
Lake	39	4	43	61	10	71	27	4	31	46	10	56
Marin	0	0	0	0	22	22	0	0	0	0	22	22
Mendocino	10	6	16	13	56	69	7	6	13	8	56	64
Napa	26	2	28	37	31	68	21	2	23	31	31	62
Solano	80	5	85	96	203	299	23	5	28	27	203	230
Sonoma	0	4	4	28	101	129	0	4	4	13	101	114
Yolo	117	21	138	173	59	232	15	21	36	23	59	82
TOTAL	272	88	360	455	535	990	93	88	181	154	535	689

* Municipal and Industrial

Table 1 indicates the sensitivity of supplemental agricultural demands to price. While agricultural water demands are influenced by a number of physical and economic factors, such as physical and climatological suitability of the land resources, unit water use requirements, crop payment capacities, and regional crop market patterns, the price of water has a most profound influence. On the other hand, municipal and industrial demands are primarily a function of population and industry type, and are not considered to be affected by water price over the price range considered.

In the Ten Counties Investigation each county was divided into identifiable service areas or subunits. Those areas which are expected to require significant quantities of supplemental water by 2020, or in the foreseeable future, are discussed in this section.

Colusa County

The firm water supply available in Colusa County will amount to 1,250,000 acre-feet per year upon completion of Tehama-Colusa Canal construction. It is composed of diversions from the Sacramento River, Butte Creek, and limited ground water pumping. Allowing for accretions from tail water and for reuse, the present water supplies would be equivalent to 1,369,000 acre-feet applied water requirements in Colusa County. Water demands are predicted to increase from 1,092,000 acre-feet in 1970 to 1,396,000 acre-feet per year in 2020. The supplemental irrigation water demands would amount to 27,000 acre-feet per year, if priced at about $3.50 per acre-foot at the farm headgate. These additional demands would be west of the Sacramento River on lands outside Glenn-Colusa Irrigation District and outside the Tehama-Colusa Canal service area.

Future supplemental demands for irrigation water in Colusa County probably would be served by diversion of Central Valley Project water supplies from the Sacramento River and from the Tehama-Colusa Canal.

Glenn County

The present firm water supply available to Glenn County is made up of Sacramento River diversions, Butte Creek diversions, Orland Project, and Western Canal deliveries and ground water pumping. When the Tehama-Colusa Canal of the Central Valley Project becomes operational, the area will have a total firm supply of 1,050,000 acre-feet per year. A portion of this supply is recaptured and reused in the County. This study indicates that in 2020 the present water supplies would provide 1,085,000 acre-feet of the County's applied water requirement. The demands for water in Glenn County, which were about 814,000 acre-feet per year in 1970, are expected to increase to 1,105,000 acre-feet per year by 2020. The supplemental demand at that date would be 20,000 acre-feet per year of irrigation water at a price of up to $3.50 per acre-foot at the farm headgate. The supplemental demand would be in the portion of the county

west of the Sacramento River outside Glenn-Colusa Irrigation District and the Tehama-Colusa Canal service area.

The future supplemental agricultural water demands in Glenn County probably will be served by diversion of Central Valley Project water supplies from the Sacramento River. The U. S. Bureau of Reclamation is conducting studies of sources of supplemental water supply for the long-range demands of areas served by the Central Valley Project. These sources include developments in the Sacramento Valley, such as the Paskenta-Newville Reservoir, and in the North Coastal area.

Humboldt County

Mad River Area. This area of Humboldt County consists of the Mad River drainage basin and the coastal areas conveniently adjacent to it. It includes the cities of Eureka and Arcata and the Samoa Peninsula with its pulp mills. Countywide population was estimated to be a little over 99,000 in 1967 and is projected to increase to 170,000 in 2020. About 71,000 people lived in the Mad River service area in 1967; this number should increase to about 121,500 in 2020. In addition, expansion of the pulp mills is expected to double the industrial use of water. The projected 2020 water demand in the Mad River service area is about 155,000 acre-feet. The municipal and industrial portion is about 142,000 acre-feet, of which 120,000 acre-feet is for the pulp industry.

Estimated firm water supply available from present sources would be about 102,000 acre-feet, leaving a projected deficit of 53,000 acre-feet. The authorized Butler Valley Project, now in advanced engineering design by the U. S. Corps of Engineers, would provide an ample supply for projected 2020 needs, with a reserve for further expansion of demands or a more rapid buildup than that projected in this report.

Lake County

Clear Lake Basin. This area includes all of Lake County outside the Eel River and Putah Creek drainage basins. The present demands in the area already exceed the supply which is available on a firm basis from ground water and riparian diversions from Clear Lake. By 2020, the annual deficiency, at current prices, would amount to about 52,000 acre-feet per year of irrigation water and 9,000 acre-feet for municipal-industrial use.

Lakeport Dam and Reservoir on Scotts Creek, authorized for construction by the U. S. Corps of Engineers, would supply a portion of the supplemental water demand of Clear Lake Basin. The remaining demands could be served from:

1. The Dos Rios-English Ridge-Clear Lake Complex; or

2. The proposed English Ridge Unit of the federal Central Valley Project; or

3. A storage project on Cache Creek by exchange; or

4. Carryover storage at local reservoirs, such as Kelseyville or Hunter Point; or

5. Exchange water imports into lower Cache Creek via the West Sacramento Canal Unit of the Central Valley Project, to facilitate upstream diversions in Lake County. In the exchange plans, a supplemental water supply for the Clear Lake Basin would be pumped from Clear Lake.

Under the historical and present mode of Clear Lake operation, the Lake storage is used for annual regulation purposes to provide downstream water users with nonfirm irrigation water supplies, which have exceeded 100,000 acre-feet in many years. Very little, if any, firm water supplies are developed through this mode of operation. While Clear Lake could theoretically be operated to develop a firm irrigation supply of up to about 35,000 acre-feet per year maximum, such operation would require use of essentially all of the Lake's storage space for long term critical period carryover and would preclude the nonfirm supplies presently being utilized in the downstream service areas.

Middletown and Coyote Valley Area. This area in southern Lake County is currently deficient in its water supplies and is expected to need about 10,000 acre-feet per year of supplemental water by 2020. Of that amount, 9,000 acre-feet would be for agriculture.

The Department of Water Resources has endorsed the U. S. Bureau of Reclamation proposal to provide 7,600 acre-feet per year of firm water supply for the Middletown area from the West Sacramento Canal Unit of the Central Valley Project. Their plan includes the construction of Middletown Reservoir on the Dry Creek tributary of Putah Creek, distribution facilities, and replacement water supplies delivered to lower Putah Creek by the West Sacramento Canal.

Coyote Valley lies within the service area proposed by the U. S. Bureau of Reclamation for English Ridge Reservoir. Assuming Middletown Reservoir is built, approximately 2,000 acre-feet per year of agricultural water would be needed from the English Ridge Project in year 2020.

Marin County

The population of Marin County, which was estimated to be 196,000 in 1967, is expected to reach 550,000 by 2020. The total annual water requirement in Marin County in 2020 would be almost entirely for municipal-industrial use and would amount to 112,000 acre-feet. Upon completion of construction of Warm Springs Reservoir and enlargement of the Sonoma-Marin Aqueduct (in the early 1970s), the county should have a total available supply of about 90,000 acre-feet per year.

The annual deficiency of 22,000 acre-feet in 2020 could be met from several sources. Walker Creek Dam and Reservoir would be a possible source to supply up to 25,000 acre-feet per year in the Tomales-Bodega Bay region of the County. According to county water district officials, however, the cost of distribution systems from Walker Creek Reservoir to

major areas of population in the eastern and southern portions of the County would preclude that possible project as a source of municipal-industrial water supply in those areas. Most of the supplemental water demand in Marin County in 2020 probably would be imported into Marin County via the Sonoma-Marin Aqueduct system from the Russian River. That water supply could be provided in the Russian River from enlarged Lake Mendocino, Knights Valley Reservoir, or English Ridge Reservoir. Marin County officials state that they anticipate an allocation of 30,000 acre-feet per year from the enlargement of Lake Mendocino.

Mendocino County

Coastal Area. This area along the coastline of Mendocino County is projected to experience an increase in population from 17,000 in 1967 to about 47,000 in 2020. A pulp mill, requiring a firm water supply of 40,000 acre-feet per year has been proposed for construction in the vicinity of Fort Bragg. Prospects of the mill's construction seem rather distant at this time, so it was not assumed to be in operation until after 1990. Presently developed water supplies, including ground water, will require augmentation to meet the area's future need for municipal and industrial water. The supplemental demand, including water for the proposed pulp mill, would amount to about 55,000 acre-feet per year by 2020.

Several possible local water projects in the Mendocino Coast area could develop the required supply at a cost considerably less than any import system from the Eel River. It is therefore concluded that the Mendocino Coast would not be in the service area of any proposed Eel River plan of development, and water demands in that area would not be a factor in the question of routing Eel River water to the Sacramento-San Joaquin Delta.

Redwood Valley Area. This valley, located at the north end of the Russian River in Mendocino County, will need approximately 3,000 acre-feet per year of supplemental water for municipal and industrial needs by 2020 and about an equal amount of irrigation water for agricultural development. The valley's total supplemental demand in 2020 is estimated at about 6,000 acre-feet per year. At this juncture one should remember that long-range forecasts of water demand in relatively small areas such as Redwood Valley are subject to major changes.

A promising source of supply is existing Lake Mendocino. This plan would require pump and pipeline facilities with seasonal storage in the Redwood Valley area.

Russian River Area. This is the remaining portion of the Russian River drainage in Mendocino County, including Potter Valley. Supplemental demands are expected to be modest in 2020, amounting to around 1,000 acre-feet for agriculture and about 7,000 acre-feet for municipal and industrial needs for a total of 8,000 acre-feet.

Alternatives to supply the Russian River area and Redwood Valley include the enlargement of Lake Mendocino or English Ridge Reservoirs.

Napa County

Napa Valley Area. Napa Valley currently has a firm annual water supply of about 50,000 acre-feet, including the supply of 25,000 acre-feet per year to be delivered by the North Bay Aqueduct. By 2020, the total water demand in the valley is expected to be 107,000 acre-feet per year. The portion of the valley below Yountville would require 20,000 acre-feet of supplemental water for municipal-industrial use. The upper valley will need additional annual supplies of 26,000 acre-feet of agricultural water (including water for frost protection), and 11,000 acre-feet for municipal-industrial use.

The Knights Valley Project, authorized for construction by the U. S. Corps of Engineers, could be a source of water supply for the Napa Valley. An alternative to the Knights Valley Project would be the Dos Rios-English Ridge-Clear Lake Complex. The water would be diverted into the Putah Creek Basin from Clear Lake and delivered to the Napa Valley via a gravity flow pipeline and tunnel.

Upper Putah Creek Area. This area includes the portion of the Putah Creek drainage basin within Napa County.

Napa County is entitled to purchase a supply of 7,500 acre-feet annually from the Solano Project (Lake Berryessa). This supply should be ample to meet the municipal-industrial demands in the vicinity of the Lake beyond 2020. A small water deficiency occurs presently in the upper area of the basin which includes Pope and Chiles Valleys. By 2020, the projected deficiency would be slightly over 10,000 acre-feet per year. However, the supplemental water demand would decrease to about 6,000 acre-feet per year for the 4,000 acres of vineyards and orchards projected in the upper area, if water costs should be $20 per acre-foot.

Local reservoir construction, as proposed in Department of Water Resources Bulletin No. 99* seems to offer the most economical source of additional water supply for the upper Putah Creek area in Napa County. The most promising developments include James Reservoir on James Creek, Walter Springs Reservoir on Pope Creek, and Goodings Reservoir on Maxwell Creek. Development at these reservoir sites would be governed by terms of the water rights decision on the Solano Project.

Solano County

Present firm water entitlements for Solano County from the North Bay Aqueduct of the State Water Project, the Solano Project, diversions from the Sacramento River and from ground water supplies amount to 505,000 acre-feet per year of applied water. Demands for municipal-industrial water and for agricultural water in Solano County are estimated to total 804,000 acre-feet in 2020. The deficit at that time of 299,000 acre-feet per year would be primarily due to needs for agricultural water outside the Solano Irrigation District, industrial water

* "Reconnaissance Report on Upper Putah Creek Basin Investigation", March 1962.

in the Collinsville vicinity, and municipal water for anticipated urban development in conjunction with the proposed Collinsville industrial complex. The preceding water demands do not include the requirements of the Suisun marshlands.

The West Sacramento Canal Unit of the Central Valley Project is planned to deliver 137,000 acre-feet per year of additional supply. This quantity of water appears to be enough for the total annual water demands until 2020 in Solano County, except for the Collinsville area.

The National Steel Company is actively planning a major steel mill at Collinsville. County representatives report that the mill and its associated facilities will require about 20,000 acre-feet per year initially and that its requirements will increase to 165,000 acre-feet annually under full operation. A logical source of the Collinsville steel mill would be a second barrel of the North Bay Aqueduct of the State Water Project.

Sonoma County

Santa Rosa and Petaluma Area. This area includes all of Sonoma County, except for the coastal drainage north of the Russian River. The population of the area is expected to increase from 189,000 in 1967 to 710,000 in 2020. By that date, the area would require supplemental municipal and industrial water supplies totaling 101,000 acre-feet per year and about 28,000 acre-feet annually of irrigation water (at current water prices). These amounts would be in addition to the supplies available from the existing Lake Mendocino and Warm Springs Reservoir, which is in the initial phase of construction.

Potential sources of supplemental water supply for the Santa Rosa-Petaluma subarea include enlarged Lake Mendocino, Knights Valley Project, English Ridge Reservoir on the Eel River, and treated waste water in the Laguna area.

Yolo County

The demands for additional supplemental water in Yolo County are expected to occur primarily within the Yolo County Flood Control and Water Conservation District. The District presently applies about 357,000 acre-feet per year, of which 334,000 is for agriculture and 23,000 for urban use. By 2020, the total annual water demands of the District are estimated to be 423,000 acre-feet for agriculture (at current water prices) and 78,000 for urban development. Firm supplies presently available from Cache Creek diversions (regulated at Clear Lake), the Solano Project, ground water, from recapture and reuse of irrigation drain water, and from Indian Valley Reservoir, now under construction, would provide about 284,000 acre-feet of the applied water requirement in year 2020. The shortage at present is made up from nonfirm surface water and ground water overdrafts.

The Department of Water Resources endorses the authorization and construction of the West Sacramento Canal Unit of the Central Valley Project. As

currently planned, the canal would convey 163,000 acre-feet per year into Yolo County, of which 126,000 acre-feet would be delivered to the Yolo County Flood Control and Water Conservation District. The remaining supplemental water supply needed in the District by 2020 would amount to about 91,000 acre-feet per year for municipal-industrial and agricultural uses. Possible sources include additional Central Valley Project diversions from the Sacramento River, the proposed English Ridge Project, storage on Cache Creek, Middle Fork Eel River developments, and perhaps 30,000 acre-feet by conjunctive operation of ground water and nonfirm Cache Creek supplies. A deficit of around 15,000 acre-feet in the Cacne Creek North subunit of the county would be taken care of by proposed West Sacramento Canal service.

Chapter II. STUDY PROCEDURES

The interrelationships of a number of factors, both physical and economic, must be considered in the projection of water demands. These factors include: basic land suitability for development, population growth, urban expansion, industrial development types, unit water use values, crop marketing prospects, areal allocations of crop acreage, payment capacity limitations, and information on presently developed and utilized water supplies.

The methodology for this investigation of water demands and supply sources is consistent with the conventional analytical techniques which have been applied by the Department for service area studies in other regions of the State, including water supply contractors for the State Water Project. The methodology also has been adopted in large measure for general use in the federal Comprehensive Framework Study embracing the entire State.

This chapter describes and discusses the study approaches, factors considered, and particular findings associated with this analysis of supplemental water demands in the ten-county region.

Definition of Study Areas

Each of the ten counties was divided geographically into study areas to represent as nearly as possible homogeneous water service areas, either from the standpoint of probable future water supply sources or from the types of service to be required. The boundaries of presently organized water districts were adopted wherever possible. Table 2 lists the study areas delineated within each of the ten counties.

Table 2: STUDY AREAS

County	Study Area
Colusa	Glenn-Colusa Irrigation District
	Sacramento West Side Service Area
	Other Areas West of Sacramento River
	East of Sacramento River
Glenn	Glenn-Colusa Irrigation District
	Sacramento West Side Service Area
	Other Areas West of Sacramento River
	East of Sacramento River
Humboldt	Mattole-Bear River
	Eel River
	Mad River
	North Humboldt
Lake	Clear Lake Basin
	Middletown-Coyote Valley
	Upper Eel River
Marin	Entire County
Mendocino	Little Lake Valley
	Upper Eel River
	Mendocino Coast
	Redwood Valley
	Russian River
Napa	Upper Napa Valley
	Lower Napa Valley
	Upper Putah Creek
Solano	Delta Service Area
	Solano Irrigation District
	North Bay
	Other Areas
Sonoma	Santa Rosa - Petaluma
	Gualala River
Yolo	Cache Creek North
	Yolo County Flood Control and Water Conservation District
	Yolo Bypass
	Delta Service Area

Projections of Municipal-Industrial Water Demands

Forecasts of municipal-industrial water demands have been developed as a function of population growth, industrial development, and unit water use values. They are discussed in the following paragraphs.

Population

Forecasts of population growth were summarized by counties and study areas. These projections out to 2020 are based upon projections made by the Department of Finance in late July 1971 (preliminary data)*, which incorporated the findings of the final 1970 Census. Although the statewide projections for 2020 were down about 5 percent from those used in DWR Bulletin No. 160-70, "Water for California, the California Water Plan, Outlook in 1970", the 2020 projections for the ten-county region as a whole were up about 20 percent, primarily in the North Bay counties. The latest projections, which were used in this report, are based on Series D birthrates and an assumed average annual net migration (after 1980) of 150,000 people into California. This net migration is considerably less than the estimate of 300,000 persons per year which for so many years was typical of California. For comparison, over the past ten years the estimated annual civilian net migration fell from an average of 299,000 during 1960-65 to an average of 138,000 for the 1965-70 period. In fact, the last year reported, as of this date, showed a rate of only 26,000 people for 1970-71 but that reduction is regarded as only temporary by the Department of Finance demographers; these demographers project a gradual return to the 150,000 level during the next decade.

The historical and projected distribution of population for the ten counties, the State of California, and the United States for years 1940, 1960, 1967, 1970, 1990, and 2020 is shown in Table 3. The projections of future population set California growth rates at considerably higher levels than the national rates, reflecting a continued high net migration to this State.

Generally speaking, in the ten county area, the southern counties will be increasing in population at a faster rate than the State as a whole while the northern counties will be increasing at a slower rate.

Municipal and Industrial Unit Water Use.

The method used for determining per capita municipal and industrial water requirements was to relate total water delivery, as determined from

* The final Department of Finance projections were released in September 1971 and are slightly different in several counties from the figures used in this report. The only significant change between the preliminary and final projection was a reduction of about 20,000 people in the projected 2020 Mendocino County population. The changes came too late to be incorporated in the Ten Counties Investigation and are of little consequence in the overall water demand picture.

Table 3: POPULATION DISTRIBUTION

Area	Population Distribution, in 1,000's							Percent of Increase, by Period		
	1940	1960	1967a/	1970b/	1990c/	2020d/	2070e/	1940-1970	1960-1990	1990-2020
County										
Colusa	9.8	12.1	12	12.4	13	20	40	26	7	54
Glenn	12.2	17.2	17	17.5	18	20	40	44	5	11
Humboldt	45.8	104.9	99	99.7	118	170	300	118	13	44
Lake	8.1	13.8	18	19.5	34	60	150	140	146	76
Marin	52.9	146.8	196	206.0	335	550	900	290	128	64
Mendocino	27.9	51.1	51	51.1	74	130	300	83	45	76
Napa	28.5	65.9	75	79.1	146	290	600	178	122	97
Solano	49.1	134.6	162	170.8	302	750	2,000	248	124	148
Sonoma	69.1	147.4	191	204.9	367	720	1,500	196	149	96
Yolo	27.2	65.7	87	91.8	155	290	600	237	136	87
TOTAL	330.6	759.5	908	952.8	1,562	3,000	6,430	188	106	92
California	6,907.0	15,717.0	19,100	19,958	28,000	42,700	-	189	78	53
United States	132,288	180,007	-	204,265	255,000	336,000	-	54	42	32

a/ Estimated by the Department of Water Resources.

b/ 1970 census.

c/ Department of Finance preliminary (July 1971) projections.

d/ Extension of Department of Finance preliminary (July 1971) projections for 2000. The extension used assumptions and methods similar to those used in deriving the projections for 2000.

e/ Extrapolated by the Ten-County Investigation team.

Note: The above projections may diverge considerably from those made by the individual counties involved. Those shown for Humboldt County, for example, are much lower than those appearing in the Mid-County Water, Sewerage, and Drainage Study adopted by Humboldt County in 1971.

records of water service agencies, to population within the service area. Per capita water use values, so derived, were then adjusted to reflect anticipated changes in the densities of people on land, influx of recreationists visiting the area, and changing industrial requirements.

In order to improve the reliability of data on industrial water use, an industrial water use survey was initiated in 1960. Questionnaires were sent to about 27,000 manufacturing establishments throughout the State asking for information regarding water intake, kinds of use within the plant, sources of water, water treatment, recirculation and discharge, employment, and size of plant. The results of the study were presented in DWR Bulletin No.124, "Water Use by Manufacturing Industries in California, 1957-59", dated April 1964. The survey is one of a series of studies to refine municipal and industrial water use estimates by accounting separately for major components of urban water use. A new industrial water survey was underway in the summer of 1971 to update information, but results were not yet available.

Except for 165,000 acre-feet of water for an anticipated large industrial complex in Solano County, 40,000 acre-feet for a pulp mill in Mendocino

County, and 120,000 acre-feet for the pulp industry in Humboldt County, all municipal and industrial water demands within the study area were estimated on a per capita water use basis.

Industrial Development

The history of the ten-county area indicates that the people who first settled in this region were initially attracted by the potential for farming and lumbering. Although the basic physical resource consists mainly of over 2,000,000 acres of irrigable land, in recent years many new and diverse industries have located in this area.

Recent and anticipated economic trends which have been taken into consideration in the projections of water demand within the ten counties are summarized as follows:

1. The main resources of the coastal areas include timber, farm lands, and recreation areas. A large influx of retirement and second home development can be expected in this area.

2. Expansion of the pulp industry in the Eureka area to fully use raw wood materials under present forest practices in Humboldt and adjacent counties is expected. Also, in time, a large pulp mill located near Ft. Bragg in Mendocino County is anticipated.

3. Although agriculture has long been the mainstay of the north bay area, the proximity of the region to the San Francisco-Oakland industrial area and the continued improvement in access to this area should result in a considerable industrial development in the southern portion of this region.

4. A large industrial complex (steel and allied satellite industries) is expected to be built in Solano County.

5. Upper Napa and Lake Counties should continue to attract an increasing number of retired people as well as recreationists.

6. Glenn and Colusa Counties are expected to continue predominantly as agricultural areas. Agriculture will remain very important also in Yolo and Solano Counties.

7. The Port of Sacramento in Yolo County will stimulate the growth of industries having a need for deep water transportation at or near the plant site.

8. The expansion of the University of California at Davis will encourage University-associated companies to locate within the area.

9. A continuing "fill-in-type" of growth will occur along Highway 80 between Sacramento and Vallejo.

Projections of Agricultural Water Demands

Future agricultural water demands are influenced by the physical and climatological suitability of the land resources, cropping patterns as determined by overall regional needs for produce within the economic constraint of marketing probabilities, crop unit water requirements, crop payment capacities for water, and urban expansion on irrigable lands. These factors are discussed in the following paragrapns. Analysis of these factors by professional agriculturists in each of the counties form a major contribution to this study.

Land Use and Land Classification

In order to develop basic land use and classification data from which future land and water use might be predicted, the Department conducted field surveys during the period 1958 through 1962. Land classification data provided information on the location, extent, and quality of various types of lands available for future development, and placed a reasonable upper limit on the possible expansion of irrigation development. Land use survey information was used to indicate the location and magnitude of present land uses and the apparent amount of water being used thereon.

Climate

Crop adaptability is largely a function of the number of frost-free days, the temperature range, wind velocity during various times of the year, rainfall pattern, etc. Because of the diversity of climates between many of the individual subareas within the ten counties, considerable attention was given to this subject and its effect on future development.

Crop Market Outlook

A statewide analysis of crop marketing probabilities was completed by the Department prior to initiation of the present studies. The purpose of that analysis was to provide long-term projections of market demands for California crops to be used in the evaluation of water demands associated with the State Water Project, as well as a general guide in developing future crop patterns for other areas of the State. In general, the study included a historical review of United States production and consumption patterns, analysis of the impact of population and income on consumption patterns, and projections regarding California's probable share of the national market for each crop. It has provided an indication of future statewide demands for agricultural produce and serves as an "umbrella" to avoid the pitfall of projecting unduly large acreages of certain crops in specific service areas and underestimating others. This approach, previously adopted by the Department, has been employed by the federal agencies participating in the federal Comprehensive Framework Study.

From time to time, the crop market outlook has been revised. The most recent outlook was developed for DWR Bulletin No. 160-70 and shows a reduction from the previous outlook due to the lowered national population projections and a more pessimistic forecast on export prospects, especially for rice.

Table 4: URBAN LAND REQUIREMENTS

County	Population Density (People per acre)				Urban Land Requirements (1,000 acres)				Urban Growth on Irrigable Agricultural Lands (Percent)		
	1967	1990	2020	2070	1967	1990	2020	2070	1967 to 1990	1990 to 2020	2020 to 2070
Colusa	5.0	5.0	5.0	5.0	2.4	2.6	3.0	8.0	100	100	90
Glenn	5.5	5.5	5.5	5.5	3.1	3.3	3.6	7.3	100	100	90
Humboldt	4.4	4.5	5.0	6.0	22.4	26.2	34.0	50.0	90	90	80
Lake	5.0	5.5	6.0	6.5	3.6	6.2	10.0	23.1	80	70	70
Marin	7.5	8.8	10.0	11.0	26.0	38.1	55.0	81.8	60	50	50
Mendocino	3.4	4.0	5.0	6.0	15.1	18.5	26.0	50.0	95	90	80
Napa	4.2	6.0	8.0	10.0	18.0	24.3	36.3	60.0	90	90	80
Solano	9.8	10.0	11.0	11.0	16.5	30.2	68.2	181.8	90	90	90
Sonoma	4.8	7.0	8.5	10.0	40.0	52.4	84.7	150.0	95	95	90
Yolo	7.5	8.0	9.5	10.0	11.6	19.4	30.5	60.0	100	100	95

Note: See Table 3 for population projections.

Once the overall crop market was projected for the State, crop acreages were allocated to regions based upon local agricultural trends and variations in physical factors of climate and soils. The resulting agricultural estimates served as one of the guidelines for estimating the future irrigated agricultural development within the individual counties.

Urban Expansion on Agricultural Lands

As population and industries expand in the future a portion of the urban development will, in all probability, occur on lands which otherwise could be used for agricultural purposes. Therefore, estimates must be made of the extent to which this urban expansion will take place on the irrigable lands within each of the study areas.

Present population density patterns were used as basic guides for estimating future urban densities. Higher densities were assumed for the Bay portion of Marin County and Solano County where land limitations were adjudged to cause congested patterns of urban use. In the valley areas, however, the ample availability of land for expansion was assumed to allow somewhat lower densities. The 1967 and projected urban land areas and densities for the ten counties are summarized in Table 4. The densities shown include people living in rural farm and nonfarm residences.

Considerable judgment was necessary in forecasting the portion of urban growth expected to occur on irrigable lands. Table 4 also shows the percentage values by counties adopted for this investigation.

Unit Applied Agricultural Water Requirements

For planning purposes, unit water requirements are expressed as "applied" and "net". The applied water requirement is the quantity of water that must be made available at the actual place of use to provide for transpiration, evaporation, and losses associated with irrigation. The net water requirement is that quantity which must be delivered to the service area as a whole. The net water requirement is generally less than the applied requirement since it includes allowances for the possibilities

of recapture and reuse of some of the applied water. Unit requirements differ from area to area due to differences in soils, climate, and other factors. Unit water use values by crop categories by subareas within the ten counties are presented in Table 5.

Payment Capacity

The Department uses the term "payment capacity" as a measure of the ability to pay for irrigation water. It represents the maximum ability of the bulk of the irrigation users in a specific area to pay for water at their farm headgate for specific crops. Payment capacity represents the farm income available to pay for water after all other farm costs are paid, allowing for depreciation and interest on the farm investment, farm operator's labor, a 10 percent of gross income management allowance, and other contingencies.

Crop budgets for individual crops have been prepared with data supplied by the County Agricultural Extension Service and Agricultural Commissioners' Annual Reports. The Department has picked a base period of 1960-64 for the determination of average prices and average yields in the crop budget analysis used in long-term planning. It is recognized that, during the past several years, costs have risen more rapidly than prices received and, therefore, current crop payment capacity generally would be less than the 1960-64 base period, with the notable exception of north coastal wine grapes. However, the base period was chosen to reflect cost-price relationships over the long run, even though there may be interim short-term critical periods such as many farmers face today.

Table 5: UNIT APPLIED WATER REQUIREMENTS, in Acre-feet per Acre

Area	Crop								
	Vineyard[a]	Orchard (Deciduous)	Truck (Miscellaneous)	Tomatoes	Sugar Beets	Field (General)	Alfalfa	Rice	Pasture[b]
Colusa County[c]	3.0	2.9	1.6	2.4	3.0[e]	1.7	3.7	6.7[f]	4.3
Glenn County[c]	3.0	2.9	1.6	2.4	3.0[e]	1.7	3.7	6.7[f]	4.3
Humboldt County									
Coastal	-	-	1.0	-	-	1.0	1.5	-	1.7
Interior	-	-	1.5	-	-	1.5	2.8	-	3.4
Lake County	2.5	2.5[d]	1.9	-	-	1.9	3.5	-	3.8
Marin County	-	-	1.0	-	-	-	1.5	-	1.7
Mendocino County									
Coastal	1.2	2.0	1.0	-	-	1.0	1.5	-	1.7[g]
Upper Eel River	-	2.0	1.5	-	-	1.5	2.8	-	3.4
Russian River	1.5	2.0	1.7	-	-	1.7	3.1	-	3.4
Napa County	1.5	2.0	1.7	-	-	1.7	3.1	-	3.4
Solano County	1.5	2.9	1.6	2.4	3.0	1.7	3.7	-	4.3
Sonoma County	1.5	2.0	1.7	-	-	1.7	3.1	-	3.4
Yolo County	3.0	2.9	1.6	2.4	3.0[e]	1.7	3.7	6.7[f]	4.3
Glenn-Colusa Irrigation District	-	5.0	2.3	4.3	5.3	3.0	6.5	10.0	7.5

a/ Includes .5 acre-feet per acre for frost control
b/ 12 animal unit months
c/ Excepting Glenn-Colusa Irrigation District
d/ For walnuts; (for pears: 2.8); includes water for frost control
e/ 3.1 near the Sacramento River
f/ 8.3 near the Sacramento River
g/ 3.4 in Anderson Valley

Table 6: PAYMENT CAPACITY, in Dollars Per Acre

Crop	Income (Gross)*	Costs				Payment Capacity*
		Variable	Fixed	Management	Total*	
	(A)				(B)	(C)
Vineyard (Wine Grapes)	430	125	162	43	330	100
Orchard (Deciduous)						
Almonds	450	181	167	45	393	57
Apples	650	289	253	65	607	43
Peaches	806	484	191	81	756	50
Pears	825	453	211	83	747	78
Prunes	600	274	183	60	517	83
Walnuts	400	138	180	40	358	42
Truck (Miscellaneous)						
Potatoes	671	344	195	67	606	65
Tomatoes	475	232	140	47	419	56
Sugar Beets	270	130	76	27	233	37
Field (General)						
Corn	150	45	60	15	120	30
Grain Sorghum	112	34	58	11	103	9
Beans (Dry)	190	72	70	19	161	29
Alfalfa	175	52	76	17	145	30
Rice	250	90	90	25	205	45
Pasture	84	22	39	8	69	15

* A-B=C

Table 6 gives a summary of payment capacity data. The payment capacity per acre, when divided by the average unit use, yields the payment capacity per acre-foot of water. Generally speaking, in the individual county chapters, a single value for a county was used in all subunits; this value was based on the dominant agricultural area or an approximate county average.

The primary purpose of including payment capacity in this report is to provide an indication of the probable change in supplemental water demand, if the price of irrigation water is increased over current levels.

Other Factors

Factors other than payment capacity often seem to govern the expansion of irrigated lands, especially in areas where water is available at moderate cost. Such factors include (1) historic farming practices, (2) types of farming to which the area is best suited, (3) the interest and ability of the farmer himself, (4) availability of capital and other production inputs, (5) alternative opportunities available to the farm operator, (6) ability of the land to produce without irrigation, (7) land ownership patterns, and (8) the adequacy of marketing organizations.

Land Use and Water Requirements in 100 years.

In the Department's current statewide studies associated with the projections of water demands, 2020 has been adopted as the limit of the maximum time span for which forecasts have any reasonable degree of validity.

While the matter of validity in long-range forecasts was certainly recognized, representatives of the ten counties, nevertheless, expressed interest in having the Department prepare a general prognosis of the possible water needs beyond 2020. In discussions with the county representatives reference was made to the ultimate requirement concept previously embodied in the resource survey-type investigations conducted by the Department in the 1950s and early 1960s. Those investigations were reported in Bulletin No. 2, "Water Utilization and Requirements of California", 1955; and in certain of the Land and Water Use Reports of the Bulletin No. 94 series; and in Bulletin No. 58, "Northeastern Counties Investigation", 1960.

The Department and other water agencies once used the term "ultimate" to represent potential water needs at a point in time when all irrigable agricultural and habitable land has been used, believing that water use will then have reached a maximum and be in equilibrium between agricultural and municipal-industrial needs. That is, as urban development expands onto agricultural lands, the agricultural water use on those lands will merely have been substituted for urban use.

While this may represent a condition of ultimate land utilization, it will not necessarily be a condition which would reflect maximum water requirements. Water requirements are not only a function of land acreage, but also of the specific type of land use. Water use can increase dramatically through increases in the number of high water using industrial enterprises, such as steel and paper product mills, even after that time when all land resources will have been utilized.

With full recognition of the limitations of any forecast of conditions which might prevail beyond 2020, estimates of water requirements in the ten-county study area have been extended to 2070 pursuant to the expressed interests of representatives of those counties (Table 7).

Table 7: WATER REQUIREMENTS IN 2070

County	Unit Water Use (In Acre-feet)		Area (In 1,000 Acres)					Water Requirements in 2070 (In 1,000 Acre-feet)		
			Irrigable				Irrigated in 2070			
	Agricultural Applied Water[a] (Per Acre Per Year)	Municipal & Industrial (Per Capita Per Year)	Gross in 1960	Urban Encroachment from 1960	Gross in 2070	Net in 2070		Agricultural	Municipal & Industrial	Total
	(A)	(B)	(C)	(D)	(E)*	(F)	(G)	(H)	(I)	(J)
Colusa	5.0	0.30	373	5	368	294	294	1,470	12	1,482
Glenn	4.4	0.30	318	4	314	251	251	1,104	12	1,116
Humboldt	1.9	0.18	108	23	85	68	34	65	174[b]	239
Lake	2.8	0.22	98	14	84	67	44	123	33	156
Marin	1.9	0.20	46	32	14	11	1	2	180	182
Mendocino	2.1	0.25	155	29	126	101	30	63	115[c]	178
Napa	1.7	0.25	110	37	73	58	32	54	150	204
Solano	2.7	0.25	262	151	111	89	89	240	665[d]	905
Sonoma	2.3	0.26	271	107	164	131	70	161	390	551
Yolo	3.2	0.37	389	49	340	272	272	870	222	1,092

a/ Based on 2020
b/ Includes 120,000 acre-feet for pulp mills.
c/ Includes 40,000 acre-feet for pulp mill.
d/ Includes 165,000 acre-feet for Collinsville complex.

* E = C - D
H = A x G
I = B x (Population in 2070: Table 3)

The steps taken for estimating water needs to 2070 have generally involved extrapolations of population projections, estimates of development density, and evaluation of agricultural growth parameters previously described.

Developed Water Supplies

The present base of available water supply in each of the ten counties was established by estimating the annual dependable water yields from existing developments and from projects presently under construction. Authorized projects on which construction has not been started are excluded from this category.

The dependable water supplies include present ground water withdrawals which are within the limits of the safe yields of the ground water basins (i.e., the long-term average recharge to the basins). They also include the water supplies that can be sustained by surface water developments on a dependable yield basis during a critical drought period such as historically occurred for the seven years from 1928 through 1934. In accordance with current practice, deficiencies in agricultural water deliveries of up to 50 percent in any one year, but not exceeding 100 percent over a seven-year drought period, are considered allowable.

Summaries of the estimated presently developed water supplies available to each county are presented in detail in Chapters III through XII.

Estimates of Supplemental Water Demands

Supplemental water demands are measured as the difference between total water demands as a function of time and the dependable supplies presently available. The demand for supplemental water service begins for a particular service area at that point in time when full utilization of the supplies now available and currently being developed for that service area first occurs.

Municipal-industrial supplemental water demands were determined as the difference between the projected total future demand for a given time period and the present municipal and industrial supply. Price of the supplemental water supplies was not considered to be a factor in the projection of future municipal-industrial water demands for the ranges considered. The time periods of 1990 and 2020 were adopted to establish probable rates of growth in demand for both municipal-industrial and agricultural water service.

For agricultural water, the supplemental demands were determined for a range of possible water prices. Three price levels were tested for most of the agricultural service areas. The lower limit of this range assumed that current prices of water supplies (generally about $4 per acre-foot) would prevail in the future for all supplemental water service. The middle water price criterion was $10 per acre-foot. The upper limit assumed that all supplemental water supplies would be priced in the order of $20 per acre-foot at farm headgate.

The individual crops which were included in the projected crop patterns for 1990 and 2020 were arranged in descending order according to their ability to pay for water (the procedure for estimating payment capacities has been previously discussed in this chapter). Those crops with payment capacity less than $10 or $20 per acre-foot were then dropped out of the crop projection in 1990 and 2020, with the exception of those low payment capacity crops currently grown in the area with existing supplies.

Within a service area, the cropping patterns on lands which use existing irrigation water supplies would tend to intensify through time at the same rate as cropping patterns on the lands irrigated from new supplemental supplies. In many instances, portions of the existing water supply would be transferred from use on high water using crops such as pasture and alfalfa to orchards and vineyards which have lower water requirements. This trend is expected to occur, even if supplemental water is provided at a price within the payment capacity of pasture and alfalfa. In general, this intensification will result in increasing the amount of land acreage within a service area that would be irrigated from its existing water supply. Consequently, the estimates of supplemental water demands would be less under this assumption than if the existing water supplies was assumed static through time.

The projected cropping patterns and arrays of probable payment capacities for crops within each of the service areas of the ten-county region are presented in the tables accompanying Chapters III through XII of this report. Those tables also show the projected supplemental demands for both municipal-industrial and agricultural water supplies.

Estimates of Recreation Demands

As stated earlier in the section on municipal and industrial unit water use estimates, an attempt was made to reflect anticipated changes in urban unit use due to recreationists visiting the area. Since the computation of present unit use is generally based on dividing total water use by the number of permanent residents, it includes the recreation usage. In many areas, the recreation use of water is such a minor component of total use that it can be neglected or can be assumed to be increasing in proportion to the increase in service area population. In several of the ten counties with relatively small rates of projected population increase, projected urban unit uses were selected with a view to being adequate to account for future outdoor recreation use.

Forecasting future recreation demand and accompanying needs for water is a rather treacherous area filled with much uncertainty at this time. It is an area which the DWR plans to investigate further in the next several years with the hope of developing better methods. However, because of the desires of several of the ten counties, countywide estimates have been made for this report. These projections should be regarded as provisional and may be expected to change in the next several years as new trends develop and methodology is improved.

Table 8: RECREATION USE
in 1,000 Visitor-Days

County	Present			Future*	
	Day	Overnight	Total	1990	2020
Colusa	230	100	330	690	1,400
Glenn	200	20	220	460	900
Humboldt	1,790	370	2,160	4,540	9,300
Lake	730	2,320	3,050	6,400	13,100
Marin	3,750	90	3,840	8,060	16,500
Mendocino	2,690	420	3,110	6,530	13,400
Napa	3,440	810	4,250	8,930	18,300
Solano	1,430	60	1,490	3,120	6,400
Sonoma	3,670	620	4,290	9,010	18,400
Yolo	400	10	410	860	1,800
TOTAL	18,330	4,820	23,150	48,600	99,500

* Detailed study of potential recreational attractions may modify data for individual counties. Visitor-days for 1990 represent present visitor-days multiplied by a population-participation factor of 2.1; those for 2020, by one of 4.3.

The best picture of present base level recreation usage that can be assembled is presented on Table 8. The source of data is a Department of Parks and Recreation inventory of estimated 1969 recreation use at public facilities and a 1966 survey of private facility usage by the U. S. Soil Conservation Service. Probably some actual usage has not been counted; some day use also likely represents visits to more than one facility by the same people.

Statewide, the increase in leisure time and money and hence outdoor recreation demand away from home probably will be somewhat slower than forecasts of several years ago. For this report the per capita outdoor recreation usage was projected to increase by 50 percent in 1990 and to double in 2020. On top of the increase in per capita demand, the increase in the state's population will result in a 2020 estimate of recreation use about 4.3 times the present. The distribution of the increase among the state's counties is not likely to be proportional to present usage because of better transportation, availability of desirable recreation areas, public tastes on differing forms of recreation, and degree of crowding. Because of availability of desirable recreation lands and opportunities, the northern counties may well bear a greater portion of the new recreation use.

Regional increases are more likely to follow statewide trends because these factors would tend to balance out among the various counties. It was beyond the scope of this study to delve into all the factors which might have a bearing on future recreation in each individual county. Therefore, a constant factor for the region was multiplied by the existing use to give some approximate indication of the future recreation demand in the ten-county region. Results are shown on Table 8. Certainly, a prime factor in the specific location of future recreation usage will be the development of desirable new facilities and providing better access to existing choice areas.

Sources of Supplemental Water Supplies

The possible sources of future water supplies to meet supplemental demands in the ten-county area include further ground water development, reservoirs on local streams, imports via the proposed West Sacramento Canal, a second barrel of the North Bay Aqueduct, and the major developments within the Eel River Basin under investigation by the Department of Water Resources, U. S. Bureau of Reclamation, and U. S. Corps of Engineers. These latter developments include Eel River imports via alternative routing, either easterly or southerly.

A word of caution is necessary on the need for supplemental water supply in each of the subunit service areas. Many of the subunits are quite large. Even where the total supply appears adequate to meet projected water demands, local shortages may occur because of the location of available supply and distribution systems and the location of projected demand.

Table 9: COLUSA COUNTY: WATER DEMAND, SUPPLY, AND USE

Area	Water Demand, in 1,000 Acre-feet per Year									
	In 1967			In 1990			In 2020		
	Agricultural[a]	M & I[b]	Total	Agricultural	M & I[b]	Total	Agricultural	M & I[b]	Total
West of Sacramento River									
Glenn-Colusa Irrigation District	489.6	1.1	490.7	530.9	1.2	532.1	570.9	1.4	572.3
Sacramento West Side	81.7	0.4	82.1	127.8	0.4	128.2	162.1	1.0	163.1
Other Areas	400.9	2.1	403.0	458.1	2.2	460.3	513.3	3.4	516.7
East of Sacramento River	116.4	0.1	116.5	135.9	0.1	136.0	143.9	0.2	144.1
TOTAL	1,088.6	3.7	1,092.3	1,252.7	3.9	1,256.6	1,390.2	6.0	1,396.2

Area	Dependable Water Supply, in 1,000 Acre-feet per Year										
	Firm				Reuse		Applied	In 1990		In 2020	
	Surface	Ground	Accretions	Total	Percent	Amount	Equivalent	Surplus	Deficiency	Surplus	Deficiency
West of Sacramento River											
Glenn-Colusa Irrigation District	495	4	17	516	20	103	619	86.9	0	46.7	0
Sacramento West Side	156[c]	18	0	174	10	17	191	62.8	0	27.9	0
Other Areas	322[d]	7	79	408	20	82	490	29.7	0	0	26.7
East of Sacramento River	152[e]	0	0	152	10	15	167	31.0	0	22.9	0
TOTAL	1,125	29	96	1,250	-	217	1,467	210.4	0	97.5	26.7

Area	Population, in 1,000's			Municipal and Industrial Per Capita Water Use					
				Gallons per Day			Acre-feet per Year		
	1967	1990	2020	In 1967	In 1990	In 2020	In 1967	In 1990	In 2020
West of Sacramento River									
Glenn-Colusa Irrigation District	3.7	4.0	4.7	270	270	270	0.30	0.30	0.30
Sacramento West Side	1.2	1.4	3.3	"	"	"	"	"	"
Other Areas	7.0	7.4	11.5	"	"	"	"	"	"
East of Sacramento River	0.1	0.2	0.5	"	"	"	"	"	"
TOTAL	12.0	13.0	20.0	-	-	-	-	-	-

a/ Areas west of Sacramento River represent 1970 data.
b/ Municipal and Industrial.
c/ Source: Tehama Colusa Canal
d/ Sources (in 1,000 acre-feet): Private diversions from Sacramento River, 86; Provident Irrigation District, 5; Princeton-Codora-Glenn Irrigation District, 52; Maxwell Irrigation District, 24; Roberts Ditch Irrigation Company Inc., 5; Reclamation District No. 108, 150.
e/ Sources (in 1,000 acre-feet): Private diversions from Sacramento River, 115; Butte Creek, 37.

Table 10: COLUSA COUNTY: SUPPLEMENTAL WATER DEMAND
In 1,000 Acre-feet

Price, in Dollars per Acre-foot	In 1990			In 2020		
	Agricultural	M & I*	Total	Agricultural	M & I*	Total
@ $ 3.50	0	0	0	26.7	0	26.7
@ $ 10.00	0	0	0	7.4	0	7.4
@ $ 20.00	0	0	0	1.9	0	1.9

* Municipal & Industrial

Chapter III. COLUSA COUNTY

By 2020, Colusa County (Figure 2) will have a supplemental demand of about 27,000 acre-feet per year of agricultural water at current price levels (Table 9). The deficiency would occur mainly in the area lying between the Sacramento River and the Colusa trough. The agricultural water demand in the County will be quite responsive to water price; for example, the supplemental water demand in 2020 would drop to about 7,000 acre-feet per year if the price of new water supplies at the farm headgate were $10 per acre-foot (Table 10).

If the same rate of agricultural and municipal-industrial growth shown in 2020 were to continue to 2070 (100 years) the demand for supplemental water would approach 80,000 acre-feet per year for Colusa County. However, this long-range demand would change greatly if a large increase in rice acreage should occur.

In 1961, about 178,000 acres of land were irrigated in Colusa County. A reconnaissance survey conducted in 1967 showed that this irrigation use had increased to 189,000 acres, mostly on the basis of large increases in

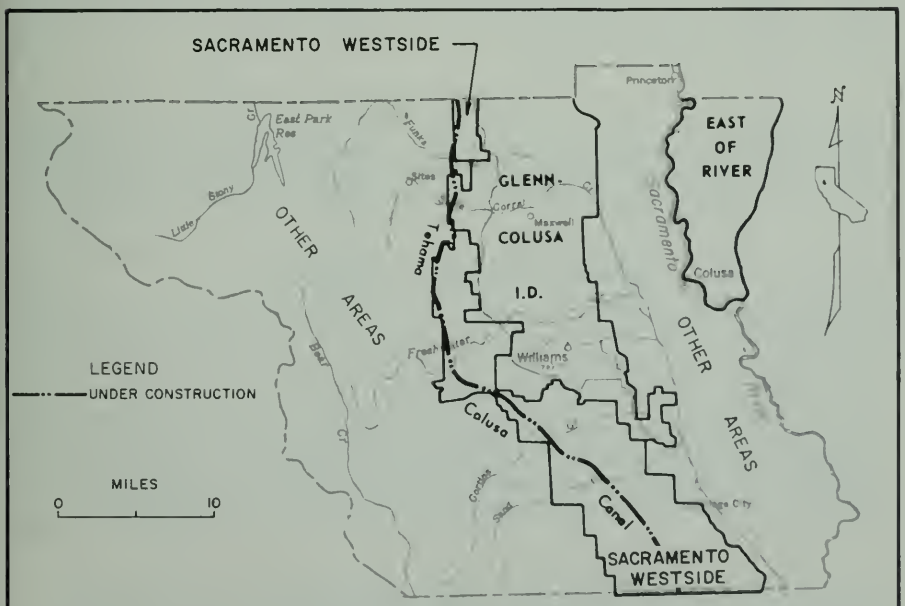


Figure 2: COLUSA COUNTY

rice allotments and decreases in irrigated pasture. But, in 1970, a new survey showed a small decline in irrigated acreage to 182,000 acres, mainly because of smaller rice allotments. Projections of future irrigated agriculture for Colusa County indicate an economic demand for the productivity from 235,000 acres in 1990 to about 280,000 acres by 2020 (Table 11).

The long-range demands for supplemental water in Colusa County probably will be served by diversion of Central Valley Project water supplies from the Sacramento River, and the Tehama-Colusa Canal. The total water supply available to the County in 2020 appears to be adequate to meet demands if the supply can be distributed. One likely solution which suggests itself is to use some of the water allotted to the Tehama-Colusa service area in other areas of the County where deficits are projected. The U. S. Bureau of Reclamation also is currently making studies of possible sources to augment the water yield of the Central Valley Project. These sources include developments in the Sacramento Valley such as the Paskenta-Newville Reservoir, and in the north coastal area.

Future water demand in Colusa County will be greatly influenced by rice, a crop controlled by government allotment. Rice acreage in Colusa County is expected to increase only slightly over the next 50 years. Inexpensive water, outstanding climate and soil conditions (high yields), and large land holdings give the County a definite advantage in rice growing if the overall market demand for California rice should increase over that projected. Major increases in sugar beet and field crop acreage are expected within the study period.

To relate future water needs within Colusa County to current or existing water supplies, the County was divided into four study areas. These areas were the Glenn-Colusa Irrigation District, the Sacramento West Side service area, "other" areas west of the Sacramento River, and the area east of the River. These four study areas are discussed individually below.

Glenn-Colusa Irrigation District

This large agricultural service area encompasses about 97,000 acres within Colusa County. In 1961 and in 1970, 57,000 acres or nearly 60 percent of the land area was irrigated. By the year 2020, irrigation within the District should increase to about 73,000 acres (excluding the wildlife refuge). The major increase will be in field crops--corn, milo, beans, and safflower. Only minor increases in rice acreage are forecast because of market constraints. The tight clay soils found in this old river basin area are somewhat restricting to the production of a very wide variety of crops. This area, on the other hand, is highly adapted to rice production.

The District has a dependable base water supply at present of 495,000 acre-feet per year of surface water and about 4,000 acre-feet of ground water (estimated present pumpage). In future years inflow of tail or drain water amounting to about 17,000 acre-feet per year is expected from the Sacramento West Side service area lying to the west. This annual water supply when applied, then partially reapplied through careful man-

Table 11: COLUSA COUNTY: CROPS

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1970	1990	2020	1970	1990	2020
Summary							
Vineyard	33.50	0	3.0	4.0	0	9.0	12.0
Orchard (Deciduous)	24.00	29.0	29.0	27.9	86.2	86.2	83.0
Truck (Miscellaneous)	35.00	4.8	6.3	7.0	8.3	10.8	11.9
Tomatoes	23.50	4.2	4.3	3.8	10.3	10.6	9.4
Sugar Beets	12.00	13.7	20.2	27.9	45.0	65.6	90.0
Field (General)	11.50	25.9	51.9	74.0	51.8	101.7	146.2
Alfalfa	8.00	10.0	14.4	20.6	43.4	58.8	81.9
Rice	5.50	89.0	93.0	93.0	807.4	843.5	841.9
Pasture	3.50	5.6	12.5	21.3	36.2	66.5	113.9
TOTAL	-	182.2	234.6	279.5	1,088.6	1,252.7	1,390.2
Glenn-Colusa Irrigation District							
Orchard (Deciduous)	24.00	1.0	1.0	1.0	5.0	5.0	5.0
Truck (Miscellaneous)	35.00	1.0	1.0	1.0	2.3	2.3	2.3
Tomatoes	23.50	0.1	0.1	0.1	0.4	0.4	0.4
Sugar Beets	12.00	1.4	1.7	2.0	7.4	9.0	10.6
Field (General)	11.50	5.9	10.4	15.7	17.7	31.2	47.1
Alfalfa	8.00	1.9	2.0	2.0	12.3	13.0	13.0
Rice	5.50	41.6	44.0	44.0	416.0	440.0	440.0
Pasture	3.50	3.8	4.0	7.0	28.5	30.0	52.5
TOTAL	-	56.7	64.2	72.8	489.6	530.9	570.9
Sacramento West Side							
Vineyard	33.50	0	1.0	1.0	0	3.0	3.0
Orchard (Deciduous)	24.00	15.2	15.0	15.0	44.1	43.5	43.5
Truck (Miscellaneous)	35.00	0.7	1.3	2.0	1.1	2.1	3.2
Tomatoes	23.50	1.4	1.4	1.4	3.4	3.4	3.4
Sugar Beets	12.00	4.2	5.1	6.0	12.6	15.3	18.0
Field (General)	11.50	1.4	11.0	16.0	2.4	18.7	27.2
Alfalfa	8.00	2.5	4.2	6.0	9.2	15.5	22.2
Rice	5.50	1.2	2.0	3.0	8.0	13.4	20.1
Pasture	3.50	0.2	3.0	5.0	0.9	12.9	21.5
TOTAL	-	26.8	44.0	55.4	81.7	127.8	162.1

agement of drain water, would be equivalent to 619,000 acre-feet of farm headgate supply. This supply when compared to a year 2020 total demand of 572,000 acre-feet indicates that the Glenn-Colusa Irrigation District within Colusa County should have an adequate supply of water to meet all needs far into the future.

Sacramento West Side

This study area, located west of the Glenn-Colusa Irrigation District, includes approximately 90,000 acres of irrigable land. At present 27,000 acres are irrigated, mainly from ground water sources and drainage water

Table 11: COLUSA COUNTY: CROPS (Continued)

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1970	1990	2020	1970	1990	2020
Other Areas West of Sacramento River							
Vineyard	33.50	0	2.0	3.0	0	6.0	9.0
Orchard (Deciduous)	24.00	8.4	8.5	7.4	24.3	24.6	21.4
Truck (Miscellaneous)	35.00	1.6	2.0	2.0	2.5	3.2	3.2
Tomatoes	23.50	2.1	1.8	1.3	5.1	4.4	3.2
Sugar Beets	12.00	8.0	11.4	15.9	24.7	35.1	49.0
Field (General)	11.50	12.8	22.5	33.3	21.8	38.2	56.6
Alfalfa	8.00	5.6	7.7	12.1	21.9	28.5	44.8
Rice	5.50	35.4	36.0	35.0	293.8	298.8	290.5
Pasture	3.50	1.6	4.5	8.3	6.8	19.3	35.6
TOTAL	-	75.5	96.4	118.3	400.9	458.1	513.3
East of Sacramento River							
Orchard (Deciduous)	24.00	4.4*	4.5	4.5	12.8*	13.1	13.1
Truck (Miscellaneous)	35.00	1.5*	2.0	2.0	2.4*	3.2	3.2
Tomatoes	23.50	0.6*	1.0	1.0	1.4*	2.4	2.4
Sugar Beets	12.00	0.1*	2.0	4.0	0.3*	6.2	12.4
Field (General)	11.50	5.8*	8.0	9.0	9.9*	13.6	15.3
Alfalfa	8.00	0*	0.5	0.5	0*	1.8	1.9
Rice	5.50	10.8*	11.0	11.0	89.6*	91.3	91.3
Pasture	3.50	0*	1.0	1.0	0*	4.3	4.3
TOTAL	-	23.2*	30.0	33.0	116.4*	135.9	143.9

* 1967 data

from other areas. The area currently has an overdraft on ground water and problems on water supply in the driest part of the year.

Surface water imports, via the Tehama-Colusa Canal, ground water and reuse of return flow waters within the area should provide about 191,000 acre-feet per year of dependable supply at the farm headgate. Department of Water Resources crop projections for this study area indicate a total annual demand for 163,000 acre-feet in 2020. These values would indicate a surplus of 28,000 acre-feet at that time.

Other Areas West of Sacramento River

This area includes all lands lying between the Glenn-Colusa Irrigation District and the Sacramento River plus those scattered parcels of land somewhat isolated from the Valley floor in western Colusa County. There are over 500,000 acres of land within this service area, much of which is rough watershed area. In 1970 over 75,000 acres were irrigated from the area's firm annual water supply of about 490,000 acre-feet.

By the year 2020 the applied water needed to irrigate about 118,000 acres of crops will amount to 513,300 acre-feet of water. Municipal-industrial demands of 3,400 acre-feet plus agricultural demands indicate a deficiency of nearly 27,000 acre-feet in this area by 2020. This deficiency will occur almost entirely east of the Colusa trough.

Future imports into Colusa County through the Tehama-Colusa Canal should provide some additional return flow water to this area that could meet predicted deficits. The extent to which these future return flows would be available on a dependable basis, however, is not known.

Part of the apparent 2020 surplus Tehama-Colusa allotment may possibly be used to meet the deficit in this area.

East of Sacramento River

Nearly 42,000 acres of land in Colusa County lie east of the Sacramento River. In 1967 about 23,000 acres were irrigated within this area, of which nearly half was in rice.

Surface supplies from the Sacramento River, the Feather River (Western Canal), Butte Creek, and drain recapture total over 167,000 acre-feet per year. Some additional supply may be available from ground water.

By 2020 agricultural plus municipal-industrial demands should total 144,000 acre-feet per year. No water supply deficits are predicted for this area.

Table 12: GLENN COUNTY: WATER DEMAND, SUPPLY, AND USE

Area	Water Demand, in 1,000 Acre-feet per Year								
	In 1967			In 1990			In 2020		
	Agricultural[a]	M & I[b]	Total	Agricultural	M & I[b]	Total	Agricultural	M & I[b]	Total
West of Sacramento River									
Glenn-Colusa Irrigation District	343.2	1.5	344.7	406.1	1.6	407.7	415.5	1.7	417.2
Sacramento West Side	114.0	0	114.0	189.7	0.1	189.8	250.5	0.2	250.7
Other Areas	264.3	3.5	267.8	294.7	3.6	298.3	319.9	3.9	323.8
East of Sacramento River	87.8	0.1	87.9	105.1	0.2	105.3	112.8	0.2	113.0
TOTAL	809.3	5.1	814.4	995.6	5.5	1,001.1	1,098.7	6.0	1,104.7

Area	Dependable Water Supply, in 1,000 Acre-feet per Year										
	Firm				Reuse		Applied	In 1990		In 2020	
	Surface	Ground	Accretions	Total	Percent	Amount	Equivalent	Surplus	Deficiency	Surplus	Deficiency
West of Sacramento River											
Glenn-Colusa Irrigation District	330[c]	1	29	360	20	72	432	24.3	0	14.8	0
Sacramento West Side	214[d]	74	0	288	10	29	317	127.2	0	66.3	0
Other Areas	189[d]	51	36	276	10	28	304	5.7	0	0	19.8
East of Sacramento River	108[e]	20	0	128	0	0	128	22.7	0	15.0	0
TOTAL	841	146	65	1,052	-	129	1,181	179.9	0	96.1	19.8

Area	Population, in 1,000's			Municipal and Industrial Per Capita Water Use					
				Gallons per Day			Acre-feet per Year		
	1967	1990	2020	In 1967	In 1990	In 2020	In 1967	In 1990	In 2020
West of Sacramento River									
Glenn-Colusa Irrigation District	5.0	5.2	5.7	270	270	270	0.30	0.30	0.30
Sacramento West Side	0.1	0.3	0.5	"	"	"	"	"	"
Other Areas	11.5	12.0	13.0	"	"	"	"	"	"
East of Sacramento River	0.4	0.5	0.8	"	"	"	"	"	"
TOTAL	17.0	18.0	20.0	-	-	-	-	-	-

a/ Areas west of Sacramento River represent 1970 data.
b/ Municipal and Industrial.
c/ Source: Tehama Colusa Canal
d/ Sources (in 1,000 acre-feet): Private Diversions from Sacramento River, 3; Orland Water Users Association, 108; Provident Irrigation District, 60; Princeton-Codora-Glenn Irrigation District, 18.
e/ Sources (in 1,000 Acre-feet); Private Diversions from Sacramento River, 4; Western Canal Company, 78; Butte Creek, 26.

Table 13: GLENN COUNTY: SUPPLEMENTAL WATER DEMAND
In 1,000 Acre-feet

Price of Water per Acre-foot	In 1990			In 2020		
	Agricultural	M & I*	Total	Agricultural	M & I*	Total
@ $ 3.50	0	0	0	19.8	0	19.8
@ $ 10.00	0	0	0	6.0	0	6.0
@ $ 20.00	0	0	0	3.5	0	3.5

* Municipal & Industrial

Chapter IV. GLENN COUNTY

This study shows that with the new water supplies to be delivered to Glenn County (Figure 3) through the U. S. Bureau of Reclamation's Tehama-Colusa Canal, only one area lying northwest of the Bureau's service area will be water-deficient by the year 2020 (Table 12). This deficiency would amount to about 20,000 acre-feet per year of agricultural water if priced on the order of $4 per acre-foot (Table 13). These long-range needs could be served from the Central Valley Project.

This history of Glenn County has been closely tied to agricultural development in California. Early day water supplies came mostly from diversions made directly from the Sacramento River. When the Tehama-Colusa Canal is completed, water will be available to nearly all the irrigable lands on the Valley floor, including those lying at some 100 feet in elevation above the Sacramento River.

In 1961, about 146,000 acres were irrigated in Glenn County. A land use survey conducted during the summer of 1967 indicated that this acreage had increased to 161,000 acres. However, a 1970 survey showed a small decline in acreage to around 154,000, largely due to a reduction in rice acreage. Projections of future irrigated acreage in Glenn County in 1990 and 2020 show approximately 210,000 and 248,000 acres, respectively. The 2020 projection represents nearly complete development of the available irrigable land.

If the same rate of agricultural and municipal-industrial growth shown for 2020 were to continue to 2070 (100 years) the demand for supplemental water would still be about 20,000 acre-feet for Glenn County per annum, assuming Tehama-Colusa Canal water cannot be distributed to other areas of the

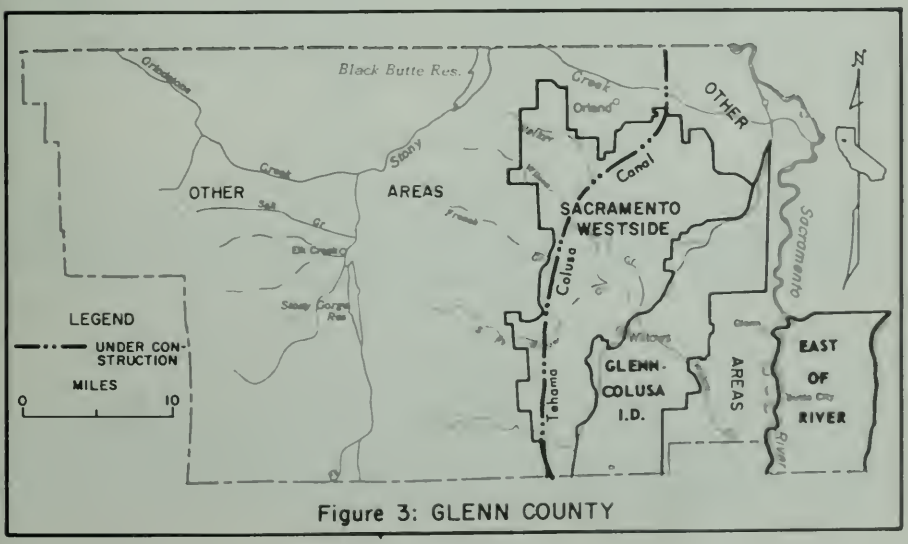


Figure 3: GLENN COUNTY

County west of the Sacramento River. As in Colusa County, the supplemental demand would be drastically changed if a large increase in rice acreage should occur.

Rice accounts for over half of the present demand for water. The rice acreage grown in California is closely associated with world market demand. Virtually all California rice is exported out of the country--the largest portion, about 50 percent, going to Puerto Rico. As worldwide population and consumption of rice increase, the extent to which California can compete in the world market with other rice-growing areas is uncertain. The expected increase in yields per acre would almost meet the projected increase in demand for California rice and only a small increase in future rice acreage was shown for Colusa and Glenn Counties. Rice yields were projected to increase to 7,000 and 8,000 pounds per acre in 1990 and 2020, respectively, compared to present yields of around 5,000 pounds. Glenn County has a very favorable environment for the continued production of rice. The advantages are inexpensive water, large land holdings, a strong rice history and highly favorable soil conditions.

Major increases are expected in the field crop category, a trend which will be helped by the arrival of Tehama-Colusa Canal water on the west side. A strong demand for sugar beets is expected to boost sugar beet acreage, a trend visible in recent years. Although increases in forage crops are projected from 1970, the 2020 acreage of these crops will still be a little less than that in 1961 (Table 14).

Urban land use and water needs within Glenn County are quite small. Municipal-industrial water uses are expected to increase from a present amount of 5,100 acre-feet annually to a future need of 6,000 acre-feet by the year 2020.

In order to relate present water supplies and water use to future water demand, Glenn County was divided into four distinct study areas. These areas are the Glenn-Colusa Irrigation District (GCID), the Sacramento West Side service area, other areas west of the Sacramento River, and areas east of the Sacramento River. Each of these areas is discussed below.

Glenn-Colusa Irrigation District

In 1970 the portion of this district within Glenn County contained nearly 43,000 acres of irrigated land. Over half, or 25,000 acres, was in high-water-using rice. By 2020 the irrigated acreage within the District is expected to amount to 56,000 acres. Rice will have increased to 27,000 acres or nearly 50 percent of the cropping pattern.

The present firm annual water supply in this County's portion of the District is estimated at 330,000 acre-feet of surface water and about 1,000 acre-feet of ground water (present pumpage). To this amount nearly 29,000 additional acre-feet per year of water would eventually become available on a firm basis from return flows from the Sacramento West Side service area to the west. Studies by the Glenn-Colusa Irrigation District indicate that around 25 percent of those waters diverted into the District are reused (reapplied). However, there is evidently some loss and "carriage"

Table 14: GLENN COUNTY: CROPS

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1970	1990	2020	1970	1990	2020
Summary							
Vineyard	33.50	0	5.9	8.7	0	17.7	26.1
Orchard (Deciduous)	24.00	25.5	26.2	26.2	77.8	79.8	79.8
Truck (Miscellaneous)	35.00	0.3	1.2	1.7	0.5	2.0	2.8
Tomatoes	23.50	0.2	0.3	0.3	0.4	0.6	0.6
Sugar Beets	12.00	3.4	12.0	17.5	11.4	41.1	58.3
Field (General)	11.50	27.8	53.6	71.2	56.9	107.2	138.6
Alfalfa	8.00	16.5	20.1	24.3	63.4	77.2	92.7
Rice	5.50	46.7	51.0	51.0	429.0	465.7	465.7
Pasture	3.50	34.0	40.2	46.7	169.9	204.3	234.1
TOTAL	-	154.4	210.5	247.6	809.3	995.6	1,098.7
Glenn-Colusa Irrigation District							
Orchard (Deciduous)	24.00	1.8	1.8	1.8	9.0	9.0	9.0
Truck (Miscellaneous)	35.00	0	0.1	0.1	0	0.2	0.2
Sugar Beets	12.00	0.5	2.2	2.5	2.7	11.7	13.3
Field (General)	11.50	7.4	12.4	13.5	22.2	37.2	40.5
Alfalfa	8.00	0.9	1.0	1.0	5.8	6.5	6.5
Rice	5.50	24.8	26.8	26.8	248.0	268.0	268.0
Pasture	3.50	7.4	9.8	10.4	55.5	73.5	78.0
TOTAL	-	42.8	54.1	56.1	343.2	406.1	415.5
Sacramento West Side							
Vineyard	33.50	0	3.0	5.0	0	9.0	15.0
Orchard (Deciduous)	24.00	4.4	5.3	5.3	12.8	15.4	15.4
Truck (Miscellaneous)	35.00	0	0.6	1.0	0	1.0	1.6
Tomatoes	23.50	0.1	0.1	0.1	0.2	0.2	0.2
Sugar Beets	12.00	1.8	5.7	9.0	5.4	17.1	27.0
Field (General)	11.50	8.6	23.3	32.7	14.6	39.6	55.6
Alfalfa	8.00	8.9	11.1	14.0	32.9	41.1	51.8
Rice	5.50	0.5	2.0	2.0	3.4	13.4	13.4
Pasture	3.50	10.4	12.3	16.4	44.7	52.9	70.5
TOTAL	-	34.7	63.4	85.5	114.0	189.7	250.5

water between river diversions and the farm. For this study, the firm water supplies were increased by a 20 percent reuse factor in calculating the farm headgate supply of 432,000 acre-feet per year which would be available to meet 2020 demands of 417,000 acre-feet.

Sacramento West Side

The Tehama-Colusa Canal, under construction, will provide water service to this 110,000-acre service area in Glenn County. At present 35,000 acres are irrigated within the service area. Our present studies indicate irrigation will increase in the Sacramento West Side service area to 63,000

Table 14: GLENN COUNTY: CROPS (Continued)

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1970	1990	2020	1970	1990	2020
Other Areas West of Sacramento River							
Vineyard	33.50	0	2.9	3.7	0	8.7	11.1
Orchard (Deciduous)	24.00	15.9	15.5	15.5	46.1	45.0	45.0
Truck (Miscellaneous)	35.00	0.3	0.5	0.6	0.5	0.8	1.0
Tomatoes	23.50	0.1	0.1	0.1	0.2	0.2	0.2
Sugar Beets	12.00	0.7	2.1	3.0	2.1	6.3	9.0
Field (General)	11.50	8.8	12.9	18.0	15.0	21.9	30.6
Alfalfa	8.00	5.5	6.8	8.1	20.3	25.2	30.0
Rice	5.50	13.3	13.2	13.2	110.4	109.6	109.6
Pasture	3.50	16.2	17.9	19.4	69.7	77.0	83.4
TOTAL	-	60.8	71.9	81.6	264.3	294.7	319.9
East of Sacramento River							
Orchard (Deciduous)	24.00	3.4*	3.6	3.6	9.9*	10.4	10.4
Tomatoes	23.50	0*	0.1	0.1	0*	0.2	0.2
Sugar Beets	12.00	0.4*	2.0	3.0	1.2*	6.0	9.0
Field (General)	11.50	3.0*	5.0	7.0	5.1*	8.5	11.9
Alfalfa	8.00	1.2*	1.2	1.2	4.4*	4.4	4.4
Rice	5.50	8.1*	9.0	9.0	67.2*	74.7	74.7
Pasture	3.50	0*	0.2	0.5	0*	0.9	2.2
TOTAL	-	16.1*	21.1	24.4	87.8*	105.1	112.8

* 1967 data

acres by 1990 and to nearly 86,000 acres by 2020. Present firm water supplies in this area are estimated at about 74,000 acre-feet per year, mostly from ground water sources. Partial irrigation from nonfirm surface sources and ground water overdrafts are currently supporting much of the irrigated acreage. A significant portion of the annual water imports of 214,000 acre-feet via the Tehama-Colusa Canal will be needed to meet current deficiencies.

The firm water supplies in this area will total 288,000 acre-feet per year with the Tehama-Colusa Canal in full operation. With internal district reuse of 10 percent, the firm annual base supply will be equivalent to a farm headgate supply of 317,000 acre-feet. Demands for 1990 and 2020 will total 190,000 and 251,000 acre-feet, respectively. No deficiencies are expected within this area by 2020.

Other Areas West of Sacramento River

This service area includes a narrow strip of land located between the Sacramento River and the Glenn-Colusa Irrigation District plus those irrigable lands within Glenn County lying above the Sacramento West Side service area. Current firm supplies of about 304,000 acre-feet per year are adequate to meet current demands with the exception of certain more isolated areas lying to the west.

In 1970 there were 61,000 acres irrigated within the service area. By 1990 and 2020 this acreage should increase to 72,000 and 82,000 acres, respectively. Water demands, including small amounts for municipal and industrial use, will be 298,000 and 324,000 acre-feet per year respectively. This study indicates that a relatively small deficit in water supply of about 20,000 acre-feet per year at current water costs should occur by year 2020 in the more westerly portions of the area.

The supplemental water demands for future agricultural needs in Glenn County probably will be served by diversion of Central Valley Project water supplies from the Sacramento River perhaps via the Tehama-Colusa Canal. The U. S. Bureau of Reclamation is conducting studies of supplemental water supply for the long-range demands of areas served by the Central Valley Project.

East of Sacramento River

This service area includes all lands in Glenn County lying east of the Sacramento River. In 1970 about 16,000 acres of land were under irrigation. These lands required about 88,000 acre-feet of water annually. Land use projections to years 1990 and 2020 indicate a total annual need for 105,000 and 113,000 acre-feet, respectively.

Present supplies, total 128,000 acre-feet per year originating primarily from the Sacramento River, Butte Creek, and the Feather River. These supplies indicate that no deficiencies would exist even in 2020.

Table 15: HUMBOLDT COUNTY: WATER DEMAND, SUPPLY, AND USE

Area	Water Demand, in 1,000 Acre-feet per Year								
	In 1967			In 1990			In 2020		
	Agricultural	M & I[a]	Total	Agricultural	M & I[a]	Total	Agricultural	M & I[a]	Total
Mattole-Bear River	1.4	0.1	1.5	2.0	0.1	2.1	2.6	0.2	2.8
Eel River	25.7	3.8	29.5	32.0	4.5	36.5	37.9	6.5	44.4
Mad River	11.3	69.9[b]	81.2	12.6	133.4[c]	146.0	13.5	141.9[d]	155.4
North Humboldt	1.9	1.0	2.9	1.9	1.1	3.0	1.9	1.5	3.4
TOTAL	40.3	74.8	115.1	48.5	139.1	187.6	55.9	150.1	206.0

Area	Dependable Water Supply, in 1,000 Acre-feet per Year							
	Firm				In 1990		In 2020	
	1990	2020			Surplus	Deficiency	Surplus	Deficiency
		Surface	Ground	Total				
Mattole-Bear River	2.1	2.8	0	2.8	0	0	0	0
Eel River	36.5	6.3	38.1	44.4	0	0	0	0
Mad River	100.2	89.4[e]	12.7	102.1	0	45.8	0	53.3
North Humboldt	3.0	2.4	1.0	3.4	0	0	0	0
TOTAL	141.8	100.9	51.8	152.7	0	45.8	0	53.3

Area	Population			Municipal and Industrial per Capita Water Use					
				Gallons per day			Acre-feet per Year		
	1967	1990	2020	In 1967	In 1990	In 2020	In 1967	In 1990	In 2020
Mattole-Bear River	0.3	0.6	0.8	180	180	180	0.20	0.20	0.20
Eel River	23.5	28.4	40.8	140	140	140	0.16	0.16	0.16
Mad River[f]	70.9	84.0	121.5	130	140	160	0.14	0.16	0.18
North Humboldt	4.6	5.0	6.9	200	200	200	0.22	0.22	0.22
TOTAL	99.3	118.0	170.0	-	-	-	-	-	-

a/ Municipal and Industrial
b/ Comprised of 9.9 for municipal water and 60.0 for pulp and paper water (@ 55,000 gallons per ton per day)
c/ Comprised of 13.4 for municipal water, and 120.0 for pulp and paper water (@ 55,000 gallons per ton per day)
d/ Comprised of 21.9 for municipal water, and 120.0 for pulp and paper water (@ 55,000 galloos per ton per day)
e/ Excludes 160,000 acre-feet yield of Butler Valley Project
f/ Per capita water use data excludes pulp mills

Table 16: HUMBOLDT COUNTY: SUPPLEMENTAL WATER DEMAND In 1,000 Acre-feet

Price of Water per Acre-foot	In 1990			In 2020		
	Agricultural	M & I*	Total	Agricultural	M & I*	Total
@ $6, $10, $20	0	45.8	45.8	0	53.3	53.3

* Municipal & Industrial

Chapter V. HUMBOLDT COUNTY

The estimated population within Humboldt County in 1967 was 99,300 persons (Table 15). The official 1970 United States Bureau of the Census figures of 99,692 persons tend to confirm this base figure. According to the new Department of Water Resources forecasts for Humboldt County, 118,000 and 170,000 persons will live within the county by 1990 and 2020 respectively. This population increase will produce an increase in municipal water demand from about 15,000 acre-feet in 1967 to about 30,000 by 2020. Industrial demands for the Samoa Pulp Mills will probably double from a present use of 60,000 acre-feet to 120,000 acre-feet by 1990. Under present forest practices employed in Humboldt and other adjacent counties, the availability of raw wood materials could prove to be the limiting factor in the expansion of this industry. Table 16 reports supplemental demand for water.

Agriculture should experience a slow but steady increase in irrigated acreage with special emphasis on those crops such as potatoes, broccoli, artichokes, and nursery stock that do well in Humboldt County's cool maritime climate. At present 21,900 acres are irrigated within Humboldt County (Table 17). This acreage should increase to about 30,000 acres by 2020. Present applied water use was estimated at about 40,000 acre-feet; this is expected to increase to nearly 56,000 acre-feet by 2020. The three main agricultural areas within the county are the lower Van Duzen fan, the Eel River Delta, and the Korbel-Arcata Bottoms area. Due to urban growth some displacement and reestablishment of irrigated land parcels should occur in the area between McKinleyville and Arcata.

If the same rate of agricultural and urban growth shown at year 2020 were to continue to 2070 (100 years) the total water demand would be nearly 240,000 acre-feet per year. The corresponding supplemental water demands, which could not be provided from present water sources, would be about 90,000 acre-feet.

For this study Humboldt County has been divided into four major hydrographic provinces (Figure 4). These are the Mattole-Bear River subunit, the Eel River subunit, the Mad River subunit, and the North Humboldt subunit which includes Redwood Creek and portions of the Trinity and Klamath Rivers.

Mattole-Bear River

This area is the rugged western section of Humboldt County, lying between the Eel River drainage and the ocean. Major streams are the Mattole River, whose average runoff at the mouth is about 1,000,000 acre-feet, and the smaller Bear River draining the area north of the Mattole River. This area is sparsely populated and has little agricultural acreage at present with only minor expansion expected in the future. The economic future of this area would appear to be closely tied to recreation, primarily fishing for salmon and steelhead, hunting, and "whitewater" activities. Public access to both the Mattole and Bear Rivers will have to improve markedly if the outstanding recreation potential of this region is to be realized.

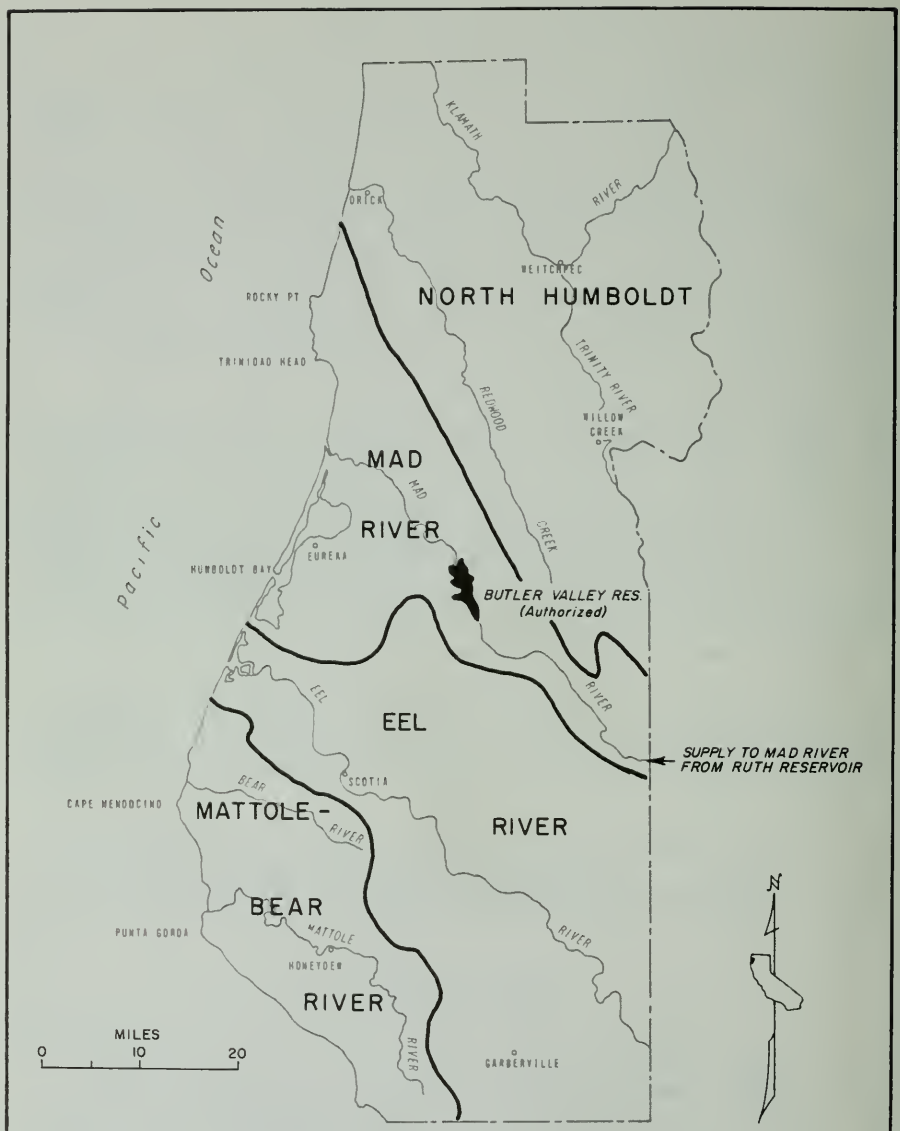


Figure 4: HUMBOLDT COUNTY

Existing water supplies consist mainly of small streams, wells, and springs which are developed only to the extent of current usage. Thorn Dam and Reservoir has been proposed in Bulletin 3 for the upper Mattole River drainage. If built, its main function would be to improve low flow conditions, resulting in improved conditions for fish and recreation on a 55-mile reach of the river.

Eel River

About one-third of the total area of Humboldt County lies within the Eel River Basin, including the tributary Van Duzen River Catchment. The Basin includes the Eel River Delta, the major farming area of Humboldt County. Irrigated pasture is the main agricultural crop grown in the area and is closely tied to the extensive dairy and beef industry of the region. Although not irrigated at this time, several thousand acres of potatoes, grown exclusively for the potato chip industry, have been planted in this area in recent years. This is envisioned as the beginning of a fairly extensive expansion of the truck crop industry in this region. Total irrigated acreage in the Eel River subunit is expected to increase from the 13,900 acres found today to over 20,000 by 2020.

Municipal demands will increase only moderately in the future. The estimated 1967 population of 23,500 persons is expected to increase to 40,500 by 2020. With a low current per capita water use of 140 gallons per day, this population increase amounts to a water need increase of only 2,700 acre-feet. Present per capita use includes present recreational visitation but may be somewhat low if the needs of expected large numbers of future recreation visitors were to be included.

The redwood forests, the potentially outstanding anadromous fishery, and the whitewater attraction of the Eel River should continue to be the major recreational attraction of the Eel River subunit.

Present water usage is comprised of 4,000 acre-feet from surface sources plus 25,500 acre-feet of estimated ground water extraction. Ground water extraction is expected to increase to 38,100 acre-feet by 2020 while diversions from surface sources rise to 6,300 acre-feet per year. Most of the ground water pumping occurs in the alluvial formations of the lower Eel River and Van Duzen Valleys.

The estimated safe yields are:

Eel River Delta	50,000 acre-feet
Yager-Van Duzen	10,000
Total	60,000 acre-feet

The total supply appears adequate to meet projected demands. However, local shortages may occur because of the location of available supply and projected demand. Many small communities have had difficulty in maintaining an adequate domestic supply during dry months.

Several relatively small projects have been proposed for local use in the Eel River Basin. On the South Fork, Cahto (in Mendocino County) and

Table 17: HUMBOLDT COUNTY: CROPS

Crop	Payment Capacity in Dollars per Acre-foot*	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1967	1990	2020	1967	1990	2020
Summary							
Truck (Miscellaneous)	52.00	0.4	1.4	2.4	0.4	1.4	2.6
Field (General)	24.00	0.2	0.5	0.6	0.2	0.6	0.7
Alfalfa	14.00	1.5	2.7	3.7	2.6	5.3	7.8
Pasture	6.00	19.8	21.7	23.3	37.1	41.2	44.8
TOTAL	-	21.9	26.3	30.0	40.3	48.5	55.9
Mattole-Bear River							
Alfalfa	14.00	0	0.1	0.2	0	0.3	0.6
Pasture	6.00	0.4	0.5	0.6	1.4	1.7	2.0
TOTAL	-	0.4	0.6	0.8	1.4	2.0	2.6
Eel River							
Truck (Miscellaneous)	52.00	0.1	1.0	1.8	0.1	1.0	2.0
Field (General)	24.00	0.1	0.3	0.4	0.1	0.4	0.5
Alfalfa	14.00	1.4	2.5	3.4	2.3	4.7	6.9
Pasture	6.00	12.3	13.5	14.6	23.2	25.9	28.5
TOTAL	-	13.9	17.3	20.2	25.7	32.0	37.9
Mad River							
Truck (Miscellaneous)	52.00	0.3	0.4	0.6	0.3	0.4	0.6
Field (General)	24.00	0.1	0.2	0.2	0.1	0.2	0.2
Pasture	6.00	6.4	7.0	7.4	10.9	12.0	12.7
TOTAL	-	6.8	7.6	8.2	11.3	12.6	13.5
North Humboldt							
Alfalfa	14.0	0.1	0.1	0.1	0.3	0.3	0.3
Pasture	6.0	0.7	0.7	0.7	1.6	1.6	1.6
TOTAL	-	0.8	0.8	0.8	1.9	1.9	1.9

* Based upon average of coastal and interior water use.

Panther Reservoirs have been proposed. Their primary justification would be recreation and stream-fishery enhancement. The Cahto Project would consist of a dam and 95,000-acre-foot reservoir on Ten Mile Creek about six miles north of Laytonville. It would yield an estimated 18,000 acre-feet of water.

Proposed Panther Dam and Reservoir would be located on the east branch of the South Fork Eel River about one mile above its confluence with the South Fork near Garberville. The Dam would impound about 80,000 acre-feet and would make possible a firm yield slightly over 60,000 acre-feet.

Mad River

This area comprises the drainage from Rocky Point near Trinidad on the north to Table Bluff at the southern end of Humboldt Bay. The Mad River is the major stream. The major urban centers of Eureka and Arcata are located in this area, and also included are the two Samoa Pulp Mills which currently use about 60,000 acre-feet per annum.

Municipal-industrial water demands are expected to increase quite markedly over the next 50-year period. The present population of 70,900 persons is expected to climb to about 121,500 by 2020. This will mean an increase in municipal water use of from 9,900 acre-feet today to 21,900 acre-feet by 2020. An additional 60,000 acre-feet of pulp industry water will also be needed sometime before 1990. Agriculture, on the other hand, should exhibit only modest increases in water demand. At present 6,800 acres of land are under irrigation. This acreage is expected to increase to 8,200 acres by 2020 with a net increase in water demand of 2,200 acre-feet.

Current firm water supplies in the Mad River subunit were estimated at 8,600 acre-feet from ground water and 88,900 acre-feet from surface sources. Future water supplies, without the Butler Valley Project, would amount to about 102,000 acre-feet, leaving a supplemental 2020 water demand of 53,000 acre-feet. This future supply includes modest increases in ground water extraction and some increases in the use of minor tributary streams. The projected supplemental water demands could easily be provided from the authorized Butler Valley Reservoir on the Mad River, which is currently under advanced engineering design by the U. S. Corps of Engineers.

The new fish hatchery on the lower Mad River near Blue Lake will undoubtedly enhance the anadromous fish runs on the lower Mad River which in turn should increase the sports fishery use many fold, providing public access and turbidity problems can be resolved.

North Humboldt

The North Humboldt subunit comprises all or portions of the Klamath and Trinity River Basins as well as Redwood Creek and several other small coastal streams. This subunit is an area of low population numbering some 4,600 persons today. The principle areas of habitation are the Hoopa Valley-Willow Creek area on the Trinity River and the town of Orick near the mouth of Redwood Creek. Population is expected to increase to 7,000 persons by 2020.

Agriculture in this mountainous region is restricted at present to about 800 acres of various forage crops grown adjacent to the main tributary streams. No increases in irrigated acreage are expected in the future. Recreational tourism could, however, play an important role in the economy of this region. With many miles of scenic waterways suitable for fishing, rafting, or other recreational pursuits, and the new national Redwood Park, tourism could become as important as lumbering in the area.

The water supplies presently available in the North Humboldt subunit seem adequate with little foreseeable need for expansion in the future.

Table 18: LAKE COUNTY: WATER DEMAND, SUPPLY, AND USE

Area	Water Demand, in 1,000 Acre-feet per year								
	In 1967			In 1990			In 2020		
	Agricultural	M & I[a]	Total	Agricultural	M & I[a]	Total	Agricultural	M & I[a]	Total
Clear Lake Basin	37.9	3.7	41.6	63.8	6.7	70.5	84.1	11.9	96.0
Middletown-Coyote Valley	6.7	0.3	7.0	13.3	0.7	14.0	14.8	1.2	16.0
Upper Eel River	0	0	0	0.4	0.1	0.5	0.8	0.1	0.9
TOTAL	44.6	4.0	48.6	77.5	7.5	85.0	99.7	13.2	112.9

Area	Dependable Water Supply, in 1,000 Acre-feet per Year										
	Firm			Reuse		Applied Equivalent		In 1990		In 2020	
	Surface	Ground	Total	Percent	Amount	1990	2020	Surplus	Deficiency	Surplus	Deficiency
Clear Lake Basin	3.3[b]	27.3	30.6	15	4.6	35.2	35.2	0	35.3	0	60.8
Middletown-Coyote Valley	3.0[c]	3.0	6.0	0	0	6.0	6.0	0	8.0	0	10.0
Upper Eel River	0	1.0	1.0	0	0	1.0	1.0	0.5	0	0.1	0
TOTAL	6.3	31.3	37.6	-	4.6	42.2	42.2	0.5	43.3	0.1	70.8

Area	Population in 1,000's			Municipal and Industrial Per Capita Water Use					
				Gallons per Day			Acre-feet per Year		
	1967	1990	2020	In 1967	In 1990	In 2020	In 1967	In 1990	In 2020
Clear Lake Basin	16.6	30.6	54.0	200	200	200	0.22	0.22	0.22
Middletown-Coyote Valley	1.3	3.1	5.5	"	"	"	"	"	"
Upper Eel River	0.1	0.3	0.5	"	"	"	"	"	"
TOTAL	18.0	34.0	60.0	-	-	-	-	-	-

a/ Municipal and Industrial.
b/ From Clear Lake.
c/ From Detert and McCreary Reservoirs.

Table 19: LAKE COUNTY: SUPPLEMENTAL WATER DEMAND
In 1,000 Acre-feet

Price of Water per Acre-foot (by Area)	In 1990			In 2020		
	Agricultural	M & I*	Total	Agricultural	M & I*	Total
Agricultural Water @ $4						
Clear Lake Basin	31.7	3.6	35.3	52.0	8.8	60.8
Middletown-Coyote Valley	7.6	0.4	8.0	9.1	0.9	10.0
County	39.3	4.0	43.3	61.1	9.7	70.8
Agricultural Water @ $10						
Clear Lake Basin	23.6	3.6	27.2	42.5	8.8	51.3
Middletown-Coyote Valley	4.0	0.4	4.4	4.9	0.9	5.8
County	27.6	4.0	31.6	47.4	9.7	57.1
Agricultural Water @ $20						
Clear Lake Basin	22.9	3.6	26.5	42.0	8.8	50.8
Middletown-Coyote Valley	3.8	0.4	4.2	4.7	0.9	5.6
County	26.7	4.0	30.7	46.7	9.7	56.4

* Municipal and Industrial

Chapter VI. LAKE COUNTY

In 1967, the 16,300 acres of irrigated land in Lake County (Figure 5) required about 45,000 acre-feet per year of applied water (Table 18). This study shows that agricultural water needs will increase to about 100,000 acre-feet per year by 2020. Municipal and industrial annual demands will increase from a present use of 4,000 acre-feet to 13,000 by 2020. Total county demands will approach 113,000 acre-feet per year by 2020. Table 19 reports supplemental demand for water.

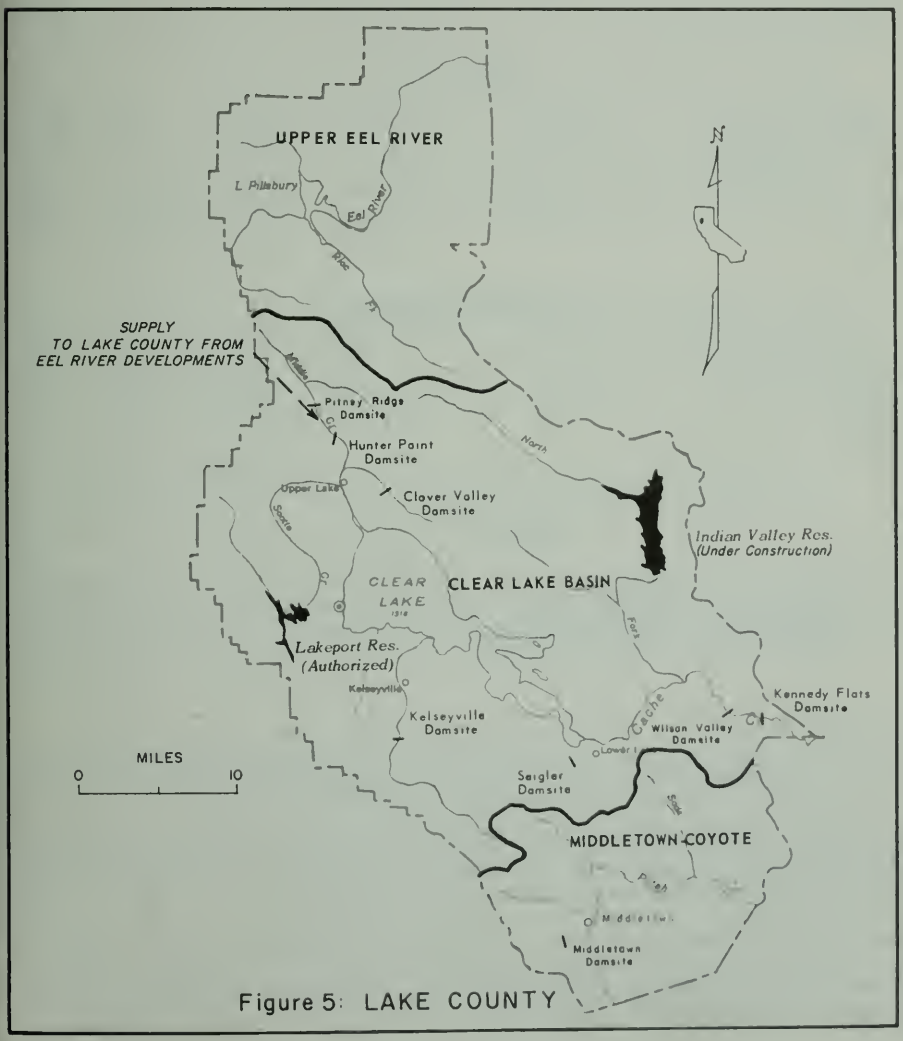


Figure 5: LAKE COUNTY

Table 20: LAKE COUNTY: CROPS

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1967	1990	2020	1967	1990	2020
Summary							
Vineyard	40.00	0	4.9	9.8	0	12.2	24.5
Orchard (Deciduous)	24.00*	9.0	15.0	18.5	18.5	40.1	49.6
Truck (Miscellaneous)	29.50	0.1	0.2	0.2	0.2	0.4	0.4
Field (General)	10.00	0.5	0.9	0.9	0.9	1.7	1.7
Alfalfa	8.50	1.2	1.5	1.6	4.2	5.2	5.6
Pasture	4.00	5.5	4.7	4.7	20.8	17.9	17.9
TOTAL	-	16.3	27.2	35.7	44.6	77.5	99.7
Clear Lake Basin							
Vineyard	40.00	0	2.9	7.6	0	7.2	19.0
Orchard (Deciduous)	24.00*	8.7	14.4	17.7	18.0	38.5	47.4
Truck (Miscellaneous)	29.50	0.1	0.2	0.2	0.2	0.4	0.4
Field (General)	10.00	0.5	0.7	0.7	0.9	1.3	1.3
Alfalfa	8.50	1.0	1.2	1.2	3.6	4.2	4.2
Pasture	4.00	4.0	3.2	3.1	15.2	12.2	11.8
TOTAL	-	14.3	22.6	30.5	37.9	63.8	84.1
Middletown-Coyote Valley							
Vineyard	40.00	0	2.0	2.2	0	5.0	5.5
Orchard (Deciduous)	24.00*	0.3	0.6	0.8	0.5	1.6	2.2
Field (General)	10.00	0	0.2	0.2	0	0.4	0.4
Alfalfa	8.50	0.2	0.3	0.4	0.6	1.0	1.4
Pasture	4.00	1.5	1.4	1.4	5.6	5.3	5.3
TOTAL	-	2.0	4.5	5.0	6.7	13.3	14.8
Upper Eel River							
Pasture	4.00	0	0.1	0.2	0	0.4	0.8
TOTAL	-	0	0.1	0.2	0	0.4	0.8

* Based on walnuts (1/3) and pears (2/3).

Estimated current firm supplies when adjusted for some reuse total about 42,000 acre-feet per year. Future demands when compared to supplies indicate an annual deficit by 2020 of about 71,000 acre-feet for agricultural, municipal and industrial water. Table 20 reports crop data.

If the same rate of agricultural, municipal and industrial growth shown in 2020 were to continue to 2070 (100 years) the annual demand for supplemental water would approach 110,000 acre-feet for Lake County.

Lake County is divided by nature into three major watershed areas: the Clear Lake-Cache Creek Basin draining easterly into Yolo County, the Putah Creek Basin which drains southerly into Napa County and the Upper Main Eel River Basin which drains northwesterly into Mendocino County. For this

study the water service areas within those basins are designated the Clear Lake Basin, the Middletown-Coyote Valley area, and the Upper Eel River Basin respectively.

Clear Lake Basin

This study area includes the Clear Lake drainage basin plus the portion of Cache Creek drainage area within Lake County.

Clear Lake has been used for many years as a reservoir for storage of water for irrigation in Yolo County. The lake is also used extensively for recreation purposes. In 1958, Wilsey and Ham estimated the recreation use was 2,300,000 visitor-days in their "Cache Creek Basin Recreation Study". A current estimate for all of Lake County was 3,050,000 visitor-days (Chapter 2). The Department of Water Resources is currently studying Clear Lake and obtaining data and technical information relating to recreation use, water quality, and seasonal fluctuation of the water surface. The source and quantities of supplemental water that might be needed to effect lake stabilization and control quality are not yet defined by the Department and are therefore not included in this study as demands for water. This study was restricted to estimating future needs for agricultural, municipal and industrial water.

The Clear Lake Basin has three distinct agricultural areas which are Big Valley, the Upper Lake area including Scotts Valley and Bachelor Valley, and the Lower Lake area. Pears and walnuts are grown extensively in the Big Valley and Upper Lake areas. This industry appears very firm and should show considerable expansion, closely correlated to demands created by statewide and national population growth.

Although the planting of varietal grapes has not been extensive in this area to date, those familiar with the soil and climatic requirements of this crop are optimistic. For this reason, 7,600 acres of vineyard was predicted for the Clear Lake Basin by year 2020.

In recent years experimentation in other areas has proven that adequate spring frost control can be obtained for vineyard and pears through the use of fine-mist water sprinklers. A water requirement of 0.5 feet per acre per year above normal summer irrigation requirements was used for these crops in this study.

The firm water yield of the ground water basins in the Clear Lake Basin is estimated to be about 27,000 acre-feet per year. Pump diversions from Clear Lake by local residents with riparian water rights amount to about 3,000 acre-feet per year of additional firm supply. Some of the presently applied water returns to the ground water basin or Clear Lake and is reuseable. The total effective firm supply of water presently available for irrigation use at the farm headgate, and for municipal and industrial use, amounts to about 35,000 acre-feet per year in the Clear Lake Basin.

Demands in the Clear Lake Basin for water at current prices are expected to be about 96,000 acre-feet per year in 2020, with a corresponding supple-

mental demand of nearly 61,000 acre-feet per year. The amount of demand would be reduced to about 86,000 acre-feet per year, however, if the price of supplemental water exceeds the payment capacity of pasture and alfalfa. The annual quantities of supplemental supply needed in 2020 would be 9,000 acre-feet per year of municipal and industrial water, and 42,000 acre-feet of agricultural water priced at $10 per acre-foot at the farm headgate.

The Department of Water Resources has endorsed the construction of Lakeport Dam and Reservoir, which is authorized for construction by the U. S. Corps of Engineers. The multipurpose project on Scotts Creek would have storage capacity of 55,000 acre-feet and a capital cost of about $12,800,000 at 1969 prices. The U. S. Corps of Engineers has estimated that the Reservoir would annually supply 8,400 acre-feet of municipal water for the city of Lakeport and 9,200 acre-feet for agriculture in the Clear Lake Basin. The proposed development includes levee and channel improvements on Scotts Creek. A firm water supply would have to be imported into lower Cache Creek in exchange for the water utilized in the Clear Lake Basin from Scotts Creek that is in excess of the firm yield of Lakeport Reservoir.

The remaining water demands in 2020 of 43,000 acre-feet per year (at current prices) could be served from the Dos Rios-English Ridge-Clear Lake complex. If the Dos Rios Reservoir water development is deleted or routed easterly the supplemental water demands in the Clear Lake Basin would be served from:

1. The proposed English Ridge unit of the federal Central Valley Project; or

2. A new storage project, on Cache Creek by exchange; or

3. Exchange water imports into lower Cache Creek via the West Sacramento Canal unit of the Central Valley Project, to facilitate upstream diversions in Lake County; or

4. Carryover storage provided at additional local reservoirs such as Kelseyville or Hunter Point.

In plans 2 and 3 above a supplemental water supply for the Clear Lake Basin service area would be pumped from Clear Lake. Under the historical and present mode of operation of Clear Lake, the Lake storage is used for annual regulation purposes to provide downstream water users with nonfirm irrigation water supplies, which have exceeded 100,000 acre-feet in many years. Very little, if any, firm water supplies are developed through this mode of operation. While Clear Lake could theoretically be operated to develop a firm irrigation water supply of up to about 35,000 acre-feet per year maximum, such operation would require use of essentially all of the Lake's storage space (about 310,000 acre-feet) for long term critical period carry over purposes and would preclude the nonfirm supplies presently being used in the downstream service areas.

Middletown-Coyote Valley

The present firm supply of water in the Middletown-Coyote Valley area, from ground water and from Detert and McCreary Reservoirs, amounts to about 6,000 acre-feet per year. This supply is not quite adequate to meet the area's present need which is predominately for irrigation water on 1,500 acres of pasture. The proximity of the Middletown area to the wine-producing regions of Napa County gives credence to the opinion that wine production will become important in that area also. Some 2000 acres of wine grapes are projected for the area in year 2020, in this study. Total water demands projected in year 2020 would amount to about 16,000 acre-feet per year, of which 14,800 would be irrigation water at current prices and 1,200 would be municipal and industrial water. The annual supplemental demands in year 2020 in the Middletown-Coyote Valley service area for water priced at $4 per acre-foot at the farm headgate would be about 9,100 acre-feet of agricultural water and 900 acre feet of municipal and industrial water.

The U. S. Bureau of Reclamation proposes to supply 7,600 acre-feet per year into the area near Middletown from the Central Valley Project. That supply would include 1,600 acre-feet for municipal and industrial use. Their plan, which is endorsed by the Department of Water Resources, includes the construction of Middletown Reservoir on the Dry Creek tributary of Putah Creek, distribution facilities, and replacement water supplies delivered to lower Putah Creek via the West Sacramento Canal.

Coyote Valley lies within the service area proposed by the U. S. Bureau of Reclamation for English Ridge Reservoir. This study indicates the supplemental demand in Coyote Valley from that source in year 2020 would be for about 2,000 acre-feet per year of agricultural water. If Eel River supplies are not conveyed into the Putah Creek Basin, the demands in Coyote Valley could be served from a possible reservoir on Coyote Creek as oulined in DWR Bulletin No. 99 "Upper Putah Creek Basin Investigation".

Upper Eel River

This area in northern Lake County includes all of the Eel River drainage basin within the County. Due to its extreme seasonal fluctuation, the Eel River does not offer a significant firm water supply for the area. Water demands in the area, however, are minimal and additional development of surface supplies probably will not be required to supplement present spring and ground water supplies.

Lake Pillsbury owned by the Pacific Gas and Electric Company is operated to provide some regulation of Eel River flows at the Van Arsdale Diversion Dam and Potter Valley Powerhouse.

The potential for recreational visitation within this area appears to be quite high if access could be improved. Water demands for recreation, however, are generally quite low and of a nonconsumptive nature.

Table 21: MARIN COUNTY WATER

Item	Year			Payment Capacity, in $1 per Acre-foot
	1967	1990	2020	
Population, in 1,000's	196.0	335.0	550.0	-
Water Use (Per Capita):				
Municipal and Industrial				
Gallons per Day	150	180	180	-
Acre-feet per Year	0.17	0.20	0.20	-
Acres Irrigated, in 1,000's				
Truck and Nursery	0.2	0.3	0.3	-
Alfalfa	0	0.1	0.1	-
Pasture	0.8	0.5	0.4	-
TOTAL	1.0	0.9	0.8	-
Water Demand, in 1,000 Acre-feet				
Agricultural				
Truck (Miscellaneous)	0.4	0.6	0.6	56.00
Alfalfa	0	0.2	0.2	8.50
Pasture	1.3	0.8	0.7	9.00
Subtotal	1.7	1.6	1.5	-
Municipal and Industrial	33.3	67.0	110.0	-
TOTAL	35.0	68.6	111.5	-
Water Supply, in 1,000 Acre-feet				
Surface				
Stafford Lake	-	2.0	2.0	-
Lagunitas Reservoir	-	0.4	0.4	-
Bon Tempe Reservoir	-	1.0	1.0	-
Alpine Reservoir	-	5.6	5.6	-
Kent Reservoir	-	8.0	8.0	-
Nicasio Reservoir	-	15.0	15.0	-
Sonoma-Marin Aqueduct				
Warm Springs Reservoir	-	47.0	47.0	-
Lake Mendocino	-	10.0	10.0	-
Subtotal	-	89.0	89.0	-
Ground	-	1.0	1.0	-
TOTAL	-	90.0	90.0	-
Water Surplus or Deficiency, in 1,000 Acre-feet	-	21.4	-21.5	-
Supplemental Water Demand, in 1,000 Acre-feet, @ $8.50, $10, & $20				
Agricultural	0	0	0	-
Municipal and Industrial	0	0	21.5	-
TOTAL	0	0	21.5	-

Chapter VII. MARIN COUNTY

Marin County (Figure 6) should experience a continuation of the rapid growth in population that has occurred over the past two decades. The estimated 1967 population of 196,000 persons is expected to nearly triple to 550,000 by 2020. Most of the more readily developed habitable land will be used at that time, especially on the side draining to San Francisco Bay. The planning effort to construct roads and develop water and power distribution systems on steep terrain will be challenging.

Water Supply and Demands

The water needs of Marin County will be restricted basically to those of a residential community (Table 21). Internal home use for bathing and cleaning will be about equal to outside residential use for the watering

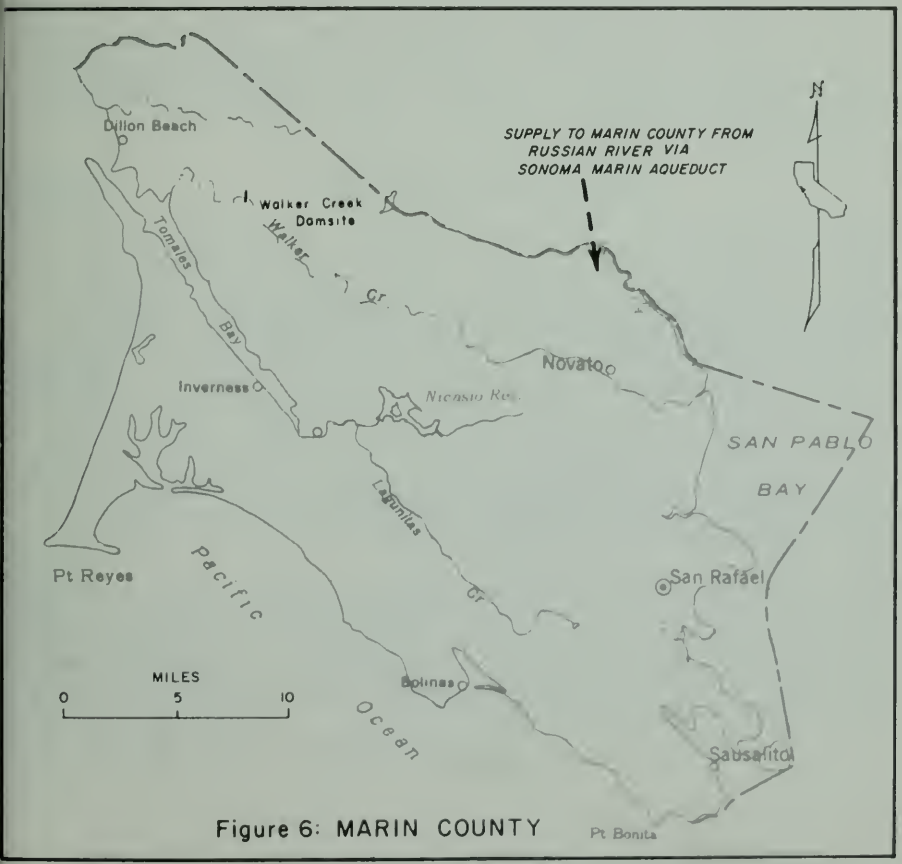


Figure 6: MARIN COUNTY

of shrubs, lawns and other forms of vegetation. The relatively low per capita demands today of 150 gallons per day are expected to climb to 180 gallons per day by 1990 and then level off as the density of population increases. The estimated municipal use of 33,000 acre-feet in 1967 will increase to about 110,000 acre-feet per year by 2020.

The County has a present dependable annual water supply of 43,000 acre-feet, excluding a new water supply of 47,000 acre-feet per year from Warm Springs Reservoir, now under construction in Sonoma County. The present supply would fully meet County needs only until the mid-1970s. The inclusion of the Warm Springs Reservoir supply should enable Marin County to meet all needs until about 2000. By 2020, however, a demand for an additional 22,000 acre-feet per year is expected to occur.

Future demands for agricultural water appear to be minimal. The continued irrigation of a few acres of pasture used in conjunction with the dairy industry and a small amount of truck and nursery crops will probably constitute the County's agricultural water needs.

If the same rate of municipal and industrial growth shown in 2020 were to continue to 2070 (100 years), the demand for water would be about 180,000 acre-feet per year for Marin County, and the supplemental demand would be 90,000 acre-feet per year.

Sources of Supplemental Supply

Possible sources of supplemental water supply to meet water needs in Marin County include the enlargement of Lake Mendocino, English Ridge Reservoir (via Potter Valley and the Russian River) either singly or in combination with a Dos Rios Reservoir and a southerly route conveyance system, the Knights Valley Project, a Dos Rios-Stony Creek complex (via North Bay Aqueduct), Walker Creek Reservoir, and waste water reclamation. The Marin County allocation of the additional water yield due to enlargement of Lake Mendocino is anticipated to be 30,000 acre-feet per year which would meet the projected 2020 needs of the County. Walker Creek Dam and Reservoir in western Marin County could supply up to 25,000 acre-feet per year to the Tomales-Bodega Bay region if constructed. According to county water district officials, however, the cost of a distribution system would be excessive from Walker Creek Reservoir to the major urban areas in eastern and southern Marin County.

The water supply from English Ridge Reservoir or from a southerly routing of Dos Rios Reservoir water would be diverted into the Russian River Basin through a second Potter Valley Tunnel. The supply for Marin County would be conveyed from the Russian River via enlargement of the Sonoma County Flood Control and Water Conservation District's distribution system which serves Sonoma and Marin Counties.

Chapter VIII. MENDOCINO COUNTY

Mendocino County should experience an increase in population from 51,000 persons today to 130,000 by year 2020. This increase in population will mean an increase in municipal-industrial water use of an additional 58,000 acre-feet per year of water of which 40,000 would be for a pulp paper mill proposed in the coastal area (Table 22). Table 23 shows supplemental demand.

Agricultural demands in the County should increase from a present estimated use of almost 41,000 acre-feet to about 57,000 acre-feet by year 2020. The cropping trend for Mendocino County generally follows that of all of the

Table 22: MENDOCINO COUNTY: WATER DEMAND, SUPPLY, AND USE

Area	Water Demand, in 1,000 Acre-feet per Year								
	In 1967			In 1990			In 2020		
	Agricultural	M & I[a/]	Total	Agricultural	M & I[a/]	Total	Agricultural	M & I[a/]	Total
Little Lake Valley	1.0	1.1	2.1	1.7	1.7	3.4	2.7	2.9	5.6
Upper Eel River	6.3	0.5	6.8	8.0	0.6	8.6	8.2	1.0	9.2
Mendocino Coast	3.7	3.4	7.1	7.7	5.2	12.9	10.6	49.4[b/]	60.0
Redwood Valley	1.0	1.4	2.4	3.9	2.0	5.9	3.3	3.0	6.3
Russian River	28.7	7.1	35.8	32.6	9.2	41.8	32.3	15.0	47.3
TOTAL	40.7	13.5	54.2	53.9	18.7	72.6	57.1	71.3	128.4

Area	Dependable Water Supply, in 1,000 Acre-feet per Year						
	Firm			In 1990		In 2020	
	Surface	Ground	Total	Surplus	Deficiency	Surplus	Deficiency
Little Lake Valley	0.5[c/]	15.0	15.5	12.1	0	9.9	0
Upper Eel River	0	23.0[d/]	23.0	14.4	0	13.8	0
Mendocino Coast	4.0	1.0	5.0	0	7.9	0	55.0
Redwood Valley	0	0.5	0.5	0	5.4	0	3.8
Russian River	24.0[e/]	15.0	39.0	0	2.8	0	8.3
TOTAL	28.5	54.5	83.0	26.5	16.1	23.7	69.1

Area	Population in 1,000's			Municipal and Industrial Per Capita Water Use					
				Gallons per Day			Acre-feet per Year		
	1967	1990	2020	In 1967	In 1990	In 2020	In 1967	In 1990	In 2020
Little Lake Valley	6.0	9.0	15.0	170[f/]	170	170	0.19[g/]	0.19	0.19
Upper Eel River	4.0	5.0	8.0	110[g/]	110	110	0.12[g/]	0.12	0.12
Mendocino Coast	16.8	26.0	47.0	180[h/]	180	180	0.20[h/]	0.20	0.20
Redwood Valley	4.1	6.0	10.0	310	290	270	0.35	0.33	0.30
Russian River	20.2	28.0	50.0	310	290	270	0.35	0.33	0.30
TOTAL	51.1	74.0	130.0	-	-	-	-	-	-

a/ Municipal and Industrial
b/ Includes 40,000 acre-feet for pulp mill
c/ From Morris Reservoir
d/ 15,000 acre-feet in Laytonville area; 8,000 acre-feet in Round Valley
e/ 16,000 acre-feet from Eel River in Potter Valley; 8,000 acre-feet from Lake Mendocino
f/ Based on 1966-1970 data for Willits.
g/ Based on 1962-64 data for Garberville, See DWR Bulletin No. 166-1, "Municipal and Industrial Water Use", August 1968.
h/ Based on 1968 and 1969 data for Fort Bragg and includes some lumber mill water.

Russian River Basin counties which shows a substantial increase in the use of irrigation water on vineyard and orchard. Conversely, urban encroachmen and the availability of high-quality agricultural land are serious constraints on agricultural development (Table 24).

If the same rate of agricultural and municipal-industrial growth shown for 2020 were to continue to 2070 (100 years), the demand for supplemental water would approach 110,000 acre-feet for Mendocino County per annum.

Mendocino County is comprised of three major stream systems--the Mendocino coastal streams (north of Gualala), the Russian River Basin, and the Upper Eel River Basin (Figure 7). Those stream systems form the study areas used in this demand study for the County, except Redwood Valley and Little Lake Valley, which were separated from the Russian and Eel River Basins, respectively. Each of these study areas is described below.

Little Lake Valley

Future agricultural water use in this Valley is conditioned on local interest to improve surface drainage and develop local ground water supplies Climatically, Little Lake Valley is quite similar to Round Valley. Future agricultural expansion of any magnitude will be closely tied to the cattle industry and the production of forage.

The Pacific Gas and Electric Company's Morris Dam and Reservoir provides about 500 acre-feet per year of dependable water supply for Little Lake Valley. Additional demands at present of about 2,000 acre-feet per year are met from ground water. Further development and distribution of the

Table 23: MENDOCINO COUNTY: SUPPLEMENTAL WATER DEMAND
In 1,000 Acre-feet

Price of Water per Acre-foot (by Area)	In 1990			In 2020		
	Agricultural	M & I*	Total	Agricultural	M & I*	Total
@ $ 4.50						
Mendocino Coast	5.1	2.8	7.9	8.0	47.0	55.0
Redwood Valley	3.7	1.7	5.4	3.1	2.7	5.8
Russian River	1.8	1.0	2.8	1.5	6.8	8.3
County	10.6	5.5	16.1	12.6	56.5	69.1
@ $10.00						
Mendocino Coast	2.6	2.8	5.4	3.9	47.0	50.9
Redwood Valley	3.7	1.7	5.4	3.1	2.7	5.8
Russian River	1.0	1.0	2.0	1.0	6.8	7.8
County	7.3	5.5	12.8	8.0	56.5	64.5
@ $20.00						
Mendocino Coast	2.6	2.8	5.4	3.9	47.0	50.9
Redwood Valley	3.7	1.7	5.4	3.1	2.7	5.8
Russian River	1.0	1.0	2.0	0.9	6.8	7.7
County	7.3	5.5	12.8	7.9	56.5	64.4

* Municipal and Industrial

Table 24: MENDOCINO COUNTY: CROPS

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1967	1990	2020	1967	1990	2020
Summary							
Vineyard	66.50	0.4	7.2	7.9	0.6	10.6	11.6
Orchard (Deciduous)	39.00	5.2	7.9	8.9	10.4	15.8	17.8
Truck (Miscellaneous)	65.00	0.2	0.6	0.6	0.2	0.6	0.6
Field (General)	11.50	0.8	0.7	0.7	1.3	1.1	1.1
Alfalfa	9.50	0.8	0.7	0.7	2.5	2.0	2.0
Pasture	4.50	8.1	7.8	8.2	25.7	23.8	24.0
TOTAL	-	15.5	24.9	27.0	40.7	53.9	57.1
Little Lake Valley							
Pasture	4.50	0.3	0.5	0.8	1.0	1.7	2.7
TOTAL	-	0.3	0.5	0.8	1.0	1.7	2.7
Upper Eel River							
Orchard (Deciduous)	21.00*	0.3	0.5	0.6	0.6	1.0	1.2
Field (General)	11.50	0.2	0.5	0.5	0.3	0.8	0.8
Alfalfa	9.50	0.2	0.5	0.5	0.6	1.4	1.4
Pasture	4.50	1.4	1.4	1.4	4.8	4.8	4.8
TOTAL	-	2.1	2.9	3.0	6.3	8.0	8.2
Mendocino Coast							
Vineyard	83.50	0	0.5	0.6	0	0.6	0.7
Orchard (Deciduous)	21.50	0.3	1.4	2.0	0.6	2.8	4.0
Truck (Miscellaneous)	65.00	0.2	0.6	0.6	0.2	0.6	0.6
Pasture	7.50	1.4	1.9	2.7	2.9	3.7	5.3
TOTAL	-	1.9	4.4	5.9	3.7	7.7	10.6
Redwood Valley							
Vineyard	66.50	0.2	2.2	1.8	0.3	3.3	2.7
Orchard (Deciduous)	39.00	0.2	0.3	0.3	0.4	0.6	0.6
Pasture	4.50	0.1	0	0	0.3	0	0
TOTAL	-	0.5	2.5	2.1	1.0	3.9	3.3
Russian River							
Vineyard	66.50	0.2	4.5	5.5	0.3	6.7	8.2
Orchard (Deciduous)	39.00	4.4	5.7	6.0	8.8	11.4	12.0
Field (General)	11.50	0.6	0.2	0.2	1.0	0.3	0.3
Alfalfa	9.50	0.6	0.2	0.2	1.9	0.6	0.6
Pasture	4.50	4.9	4.0	3.3	16.7	13.6	11.2
TOTAL	-	10.7	14.6	15.2	28.7	32.6	32.3

* Based on Walnuts

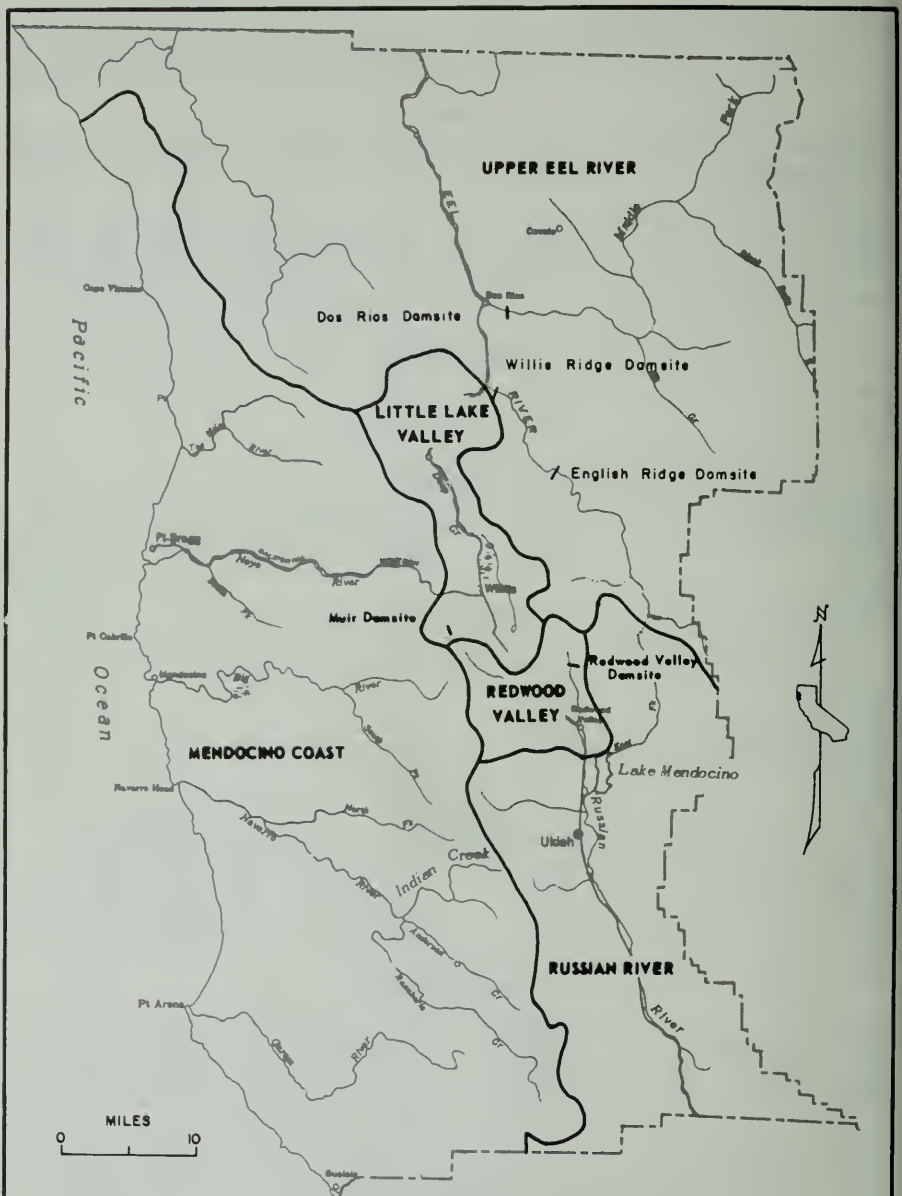


Figure 7: MENDOCINO COUNTY

ground water resources, which is currently under study by the Federal Soil Conservation Service, appears to be the best method of serving the Valley's future demands. The potential safe yield of the ground water basin in Little Lake Valley is estimated to be around 15,000 acre-feet per year.

Water from proposed Eel River developments could be conveyed into the Valley from English Ridge Reservoir via a proposed tunnel having a length of 2.2 miles, or a 15,000-foot pump and pipeline system. The conveyance and distribution costs for the relatively small deliveries of Eel River water to meet the demands projected for Little Lake Valley would far exceed the costs of water service from local ground water sources, however.

Upper Eel River

The major agricultural areas within the Upper Eel River Basin are the Laytonville area and Round Valley, with Round Valley having the greater agricultural potential. Presently about 1,700 acres are irrigated within Round Valley. Walnuts, pears and pasture are the principal crops. Future expansion of agriculture may be contingent on the development of a limited ground water resource. Recent estimates indicate that ground water within 200 feet of the surface in Round Valley would provide about 8,000 acre-feet of safe yield per year. This water is not considered to be a dependable supply over all parts of Round Valley, but is restricted mainly to the more northerly and easterly portions. A distribution system may be needed, therefore, to transfer water into the western portion of Round Valley. The area in the vicinity of Laytonville has abundant ground water supplies and should not experience water deficiencies during the foreseeable future.

Mendocino Coast

Mendocino coastal area water use is comprised mainly of wood-products-oriented industrial use, recreation use and limited agricultural use. The rate of water demand for the lumber industry has shown a down-trend since 1960, as lumber processing diminished. The bottom probably has been reached and further decline is not expected. Water use may change upward markedly sometime after 1990 if a proposed pulp paper mill becomes operable along the coast, possibly near Fort Bragg. Water demand for this single industry would approach 40,000 acre-feet per annum. The pulp mill is not certain, however, as alternative uses of the available raw wood materials are possible, for example, particle board manufacture.

Present estimated firm water supplies are comprised of 4,000 and 1,000 acre-feet per year from developed surface and ground water sources, respectively. The future total demand in 2020 of about 60,000 acre-feet per year indicates an apparent deficit of 55,000 acre-feet at that time.

The Mendocino coastal streams which include Noyo River, Ten Mile River, Big River, Rancheria Creek, Indian Creek, North Fork Navarro River, Garcia River and Gualala River offer a logical source of supply to meet the long-range demand for supplemental water along the Mendocino Coast. Preliminary studies by the Department of Water Resources in the North Coastal area investigation in 1969, indicated that firm water supplies can be provided from reservoir construction on those streams at a unit cost in the order

of $20 per acre-foot of yield at or below the reservoir. The unit cost of water purchased from an Eel River development and conveyed into the Mendocino coastal area would far exceed the cost from local developments.

The major portion of the supplemental demand would be associated with a proposed future pulp paper mill. If the mill is built, the firm constructing the mill could choose to develop its own reservoir water supply at private expense.

Redwood Valley

Redwood Valley, located at the upper end of the Russian River watershed, has historically been a dry-farm grape-growing area. Like many of the potential varietal grape-growing areas of California, this valley is experiencing an increasing rate of urban growth typified by the small residential farm development. Future irrigation demands will depend on the amount of presently dry-farmed grape acreage brought under irrigation and could be affected by the arrival time of new water supplies. New project water service at an early date may tend to slow the conversion of the better farmlands to urban uses.

Present water supplies are derived from wells, a number of small private reservoirs, and by direct diversions of streamflow when water is available. The firm yield (in critically dry years) of surface sources was assumed to be negligible in this report. Local ground water supplies are spotty and undependable; many wells reportably go dry during the late summer months. Year 2020 water demands are expected to be slightly over 6000 acre-feet per year and supplemental supplies of about this amount will have to be developed to meet expected deficiencies.

One very promising source of additional water for Redwood Valley is existing Lake Mendocino, making use of part of Mendocino County's share of the yield of that project. Pump and pipeline facilities would be required to convey the water into Redwood Valley. The intake would be located in Lake Mendocino a couple of miles north of the dam. Enough seasonal storage to meet urban water demands during extremely dry years would be a necessary part of the project. Additional water supplies in the future, if needed, for the Redwood Valley diversion could be provided by additional Russian River system developments, including the enlargement of Lake Mendocino, as proposed by the U. S. Corps of Engineers.

Other proposed Russian River Basin projects, which could serve Redwood Valley, include Redwood Valley Reservoir on the headwaters of the Russian River, and Forsythe Creek Reservoir on Forsythe Creek. The estimated yield of an 89,500 acre-foot capacity Redwood Valley Reservoir would be 7,400 acre-feet per year. About the same yield, but at higher cost, could be developed by a 71,000 acre-foot-capacity Forsythe Reservoir. The Eel River could be another alternative source of water for Redwood Valley if English Ridge Reservoir were constructed, either from English Ridge directly, or Middle Fork water from Dos Rios Reservoir conveyed through English Ridge Reservoir on a southerly routing.

Russian River

Agricultural income from the main Russian River Valley in the past as well as far into the future will provide much of the economic base for Mendocino County. The present total agricultural water demand of about 29,000 acre-feet per year will increase to almost 33,000 acre-feet in 1990, then essentially level off. However, intensification of the cropping pattern toward the production of high-value varietal grapes will greatly increase the future gross agricultural return. Due to the projected mild decrease in irrigated pasture acreage and a lower per-acre water requirement for vineyard than for other crops, the increase in the irrigated grape acreage will only cause a relatively modest increase in total agricultural water demand over 1967 levels.

The population of this service area is estimated to increase from 20,200 in 1967 to about 50,000 by 2020. Approximately 8,000 acre-feet per year of supplemental supply would be needed from the enlargement of Lake Mendocino to serve the agricultural and municipal-industrial demands at that time in the Russian River subarea of Mendocino County.

Recreational Water Demands

Chapter 2 contains the estimated future outdoor recreation demands for Mendocino County. Present usage was estimated at 2,690,000 visitor days of day use and about 420,000 days of overnight use. The 2020 projections were for 11,600,000 visitor-days of day use and 1,800,000 visitor-days of overnight use for a total of 13,400,000 assuming ratios of day and overnight use similar to the present. The corresponding water usage would be about 800 acre-feet, based on 15 gallons per person for day use and 40 gallons per person for overnight use.

Visitor Days Per Year, in 1,000's		Water Requirement in 1,000 Acre-feet per year
Day Use	Overnight	
27,000[a]	66,000[a]	10.7[a]
18,800[b]	38,200[b]	5.6[b][c]

a/ Derived from data in: "Comprehensive Soil and Water Plan Appendix", Mendocino County Soil Conservation District, and Bulletin No. 142-1, "Water Resources and Future Water Requirements in the North Coastal Hydrographic Area", California Department of Water Resources.

b/ Source: California Department of Water Resources, 1962-1963

c/ Based on 15 gallons per person per day for day use, and 40 gallons per person per day for overnight use.

These estimates are much less than earlier estimates, presumably founded on greater rates of population growth for the State and Nation. Two independent estimates of future (2020) recreational water needs for Mendocino County are presented in the adjacent tabulation. Both estimates are premised on applying a daily per capita water use to an estimate of day and overnight visitation.

Chapter IX. NAPA COUNTY

Napa County has two major watershed areas--the Upper Putah Creek and Napa River Basins. For this study the Putah Creek Basin in Napa County was studied as a whole while the Napa River Basin was divided into upper and lower service areas. The Upper Napa Valley is expected to maintain its agricultural characteristics through time while the Lower Napa Valley will continue to become more heavily urbanized (Figure 8).

Upper Napa Valley

The Upper Napa Valley, extending from where the valley narrows near Yountville to the vicinity of Calistoga, is one of the State's more valuable assets from both an esthetic and economic standpoint. The future of the premium table wine industry in this picturesque valley will be dependent on the ability of the local governmental entities to establish those constraints that will allow the valley to resist urbanization.

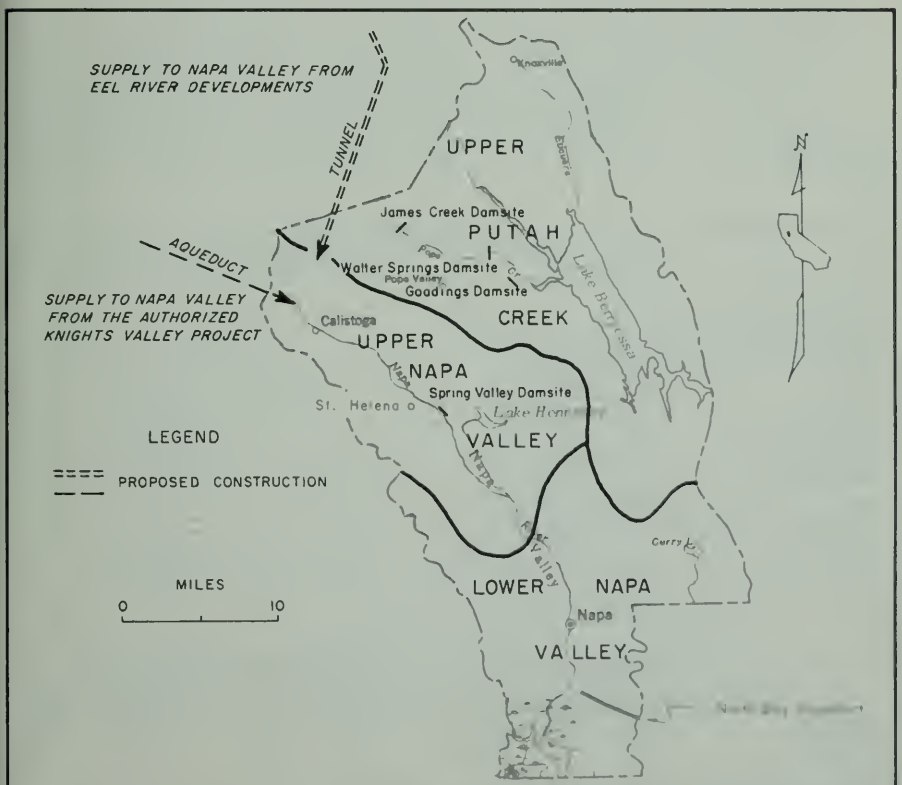


Figure 8: NAPA COUNTY

At present the Upper Napa Valley area is water deficient. It has a total firm water supply of about 11,300 acre-feet (Table 25). In Bulletin No. 110, "North Bay Aqueduct," the Department of Water Resources estimated the entire Napa Valley had a safe annual ground water yield of only 5,500 acre-feet. Of this, 3,000 acre-feet was considered in this study to be in the Upper Napa River watershed. The balance of the present firm supply originates from small surface reservoirs. Planning studies by the U. S. Bureau of Reclamation indicate that the 1967 levels of ground water pumping in the Napa Valley were in excess of 10,000 acre-feet per year and may have been more than the safe yield of the ground water basin. The Napa County Flood Control and Water Conservation District is currently having a study made by the U. S. Geological Survey on ground water resources in the Upper Napa Valley in order to firm up the extent of this resource.

Table 25: NAPA COUNTY: WATER DEMAND, SUPPLY, AND USE

Area	Water Demand, in 1,000 Acre-feet per Year								
	In 1967			In 1990			In 2020		
	Agricultural	M & I[a]	Total	Agricultural	M & I[a]	Total	Agricultural	M & I[a]	Total
Upper Napa Valley	11.0	3.6	14.6	27.3	7.2	34.5	32.7	15.6	48.3
Lower Napa Valley	6.6	10.6	17.2	4.5	24.2	28.7	4.5	54.0	58.5
Upper Putah Creek	2.7	0.4	3.1	5.9	0.7	6.6	11.5	1.8	13.3
TOTAL	20.3	14.6	34.9	37.7	32.1	69.8	48.7	71.4	120.1

Area	Dependable Water Supply, in 1,000 Acre-feet per Year						
	Firm			In 1990		In 2020	
	Surface	Ground	Total	Surplus	Deficiency	Surplus	Deficiency
Upper Napa Valley							
Conn Creek Tributaries	.2	-	-	-	-	-	-
Rector Reservoir	3.0	-	-	-	-	-	-
Kimball Creek Reservoir	.4	-	-	-	-	-	-
Bell Canyon & St. Helena Reservoirs	1.6	-	-	-	-	-	-
Small Reservoirs	.9	-	-	-	-	-	-
Lake Hennessey	2.2	-	-	-	-	-	-
Total	8.3	3.0	11.3	0	23.2	0	37.0
Lower Napa Valley							
North Bay Aqueduct	25.0	-	-	-	-	-	-
Lake Hennessey	8.8	-	-	-	-	-	-
Milliken Reservoir	1.6	-	-	-	-	-	-
Rector Reservoir	.2	-	-	-	-	-	-
Total	35.6	2.5	38.1	9.4	0	0	20.4
Upper Putah Creek			8.5				
Lake Berryessa	7.5	-	-	-	-	-	-
Small Farm Reservoirs	1.0	-	-	-	-	-	-
Total	8.5[b]	0	8.5	0	4.9	0	10.5
TOTAL	52.4	5.5	57.9	9.4	28.1	0	67.9

Area	Population in 1,000's			Municipal and Industrial Per Capita Water Use					
				Gallons per Day			Acre-feet per Year		
	1967	1990	2020	In 1967	In 1990	In 2020	In 1967	In 1990	In 2020
Upper Napa Valley	15.0	29.0	60.0	210	220	230	0.24	0.25	0.26
Lower Napa Valley	59.0	115.0	225.0	160	190	210	0.18	0.21	0.24
Upper Putah Creek	1.0	2.0	5.0	330	330	330	0.37	0.37	0.37
TOTAL	75.0	146.0	290.0	-	-	-	-	-	-

a/ Municipal and Industrial
b/ Only an estimated 1,000 acre-feet of present supply can be used for agriculture due to location of service area.

Table 26: NAPA COUNTY: SUPPLEMENTAL WATER DEMAND
In 1,000 Acre-feet

Price of Water per Acre-foot (by Area)	In 1990			In 2020		
	Agricultural	M & I*	Total	Agricultural	M & I*	Total
@ $ 4.50						
Upper Napa Valley	21.0	2.2	23.2	26.4	10.6	37.0
Lower Napa Valley	0	0	0	0	20.4	20.4
Upper Putah Creek	4.9	0	4.9	10.5	0	10.5
County	25.9	2.2	28.1	36.9	31.0	67.9
@ $ 10.00 and @ $20.00						
Upper Napa Valley	18.4	2.2	20.6	25.0	10.6	35.6
Lower Napa Valley	0	0	0	0	20.4	20.4
Upper Putah Creek	2.1	0	2.1	6.2	0	6.2
County	20.5	2.2	22.7	31.2	31.0	62.2

* Municipal and Industrial

Future demands totaling 34,000 acre-feet by 1990 and 48,000 acre-feet by 2020 for both agricultural and municipal and industrial needs indicate deficiencies in 1990 and 2020 of about 23,000 and 37,000 acre-feet respectively. Since the agricultural demands in this area are primarily for high-payment-capacity vineyard the demand for supplemental water shown in this study is not very responsive to water price (Table 26). With new irrigation on previously dry-farmed vineyard and the use of fine-mist sprinklers to reduce spring frost damage, the grape yields in Napa Valley are expected to more than double (Table 27).

The possible sources of water supply for the Upper Napa Valley (Figure 9) consist of the following works:

Dos Rios-English Ridge Complex, via Clear Lake and Table Mountain Tunnel

- Dos Rios Dam and Reservoir
- Elk Creek Pumping Plant and Tunnel
- English Ridge Dam and Reservoir
- Garrett Tunnel
- Clear Lake Outlet Improvement
- Soda Creek Tunnel
- Putah Creek Basin Conveyance Works
- Table Mountain Tunnel

Dos Rios-English Ridge Complex via Pipeline from the Russian River

- Dos Rios Dam and Reservoir
- Elk Creek Pumping Plant and Tunnel
- English Ridge Dam and Reservoir
- Potter Valley Tunnel No. 2
- Pump and Pipeline from Russian River to Napa Valley

Dos Rios-Stony Creek Complex, via North Bay Aqueduct

- Dos Rios Dam and Reservoir
- Grindstone Tunnel
- Rancheria Reservoir
- North Bay Aqueduct

English Ridge Dam and Reservoir, via Clear Lake and Table Mountain Tunnel

- English Ridge Dam and Reservoir
- Garrett Tunnel
- Soda Creek Tunnel
- Putah Creek Basin Conveyance Works
- Table Mountain Tunnel

English Ridge Dam and Reservoir, via Pipeline from the Russian River

- English Ridge Dam and Reservoir
- Potter Valley Tunnel No. 2
- Pump and Pipeline from Russian River to Napa Valley

Knights Valley Project, Stages 1 and 2

- Knights Valley Dam and Reservoir
- Russian River Pump Diversion Works
- Conveyance Works to Napa Valley

Spring Valley Pump-Storage Project

- Spring Valley Dam and Reservoir (7,000 AF capacity)
- Napa River Diversion and Pumping Facilities

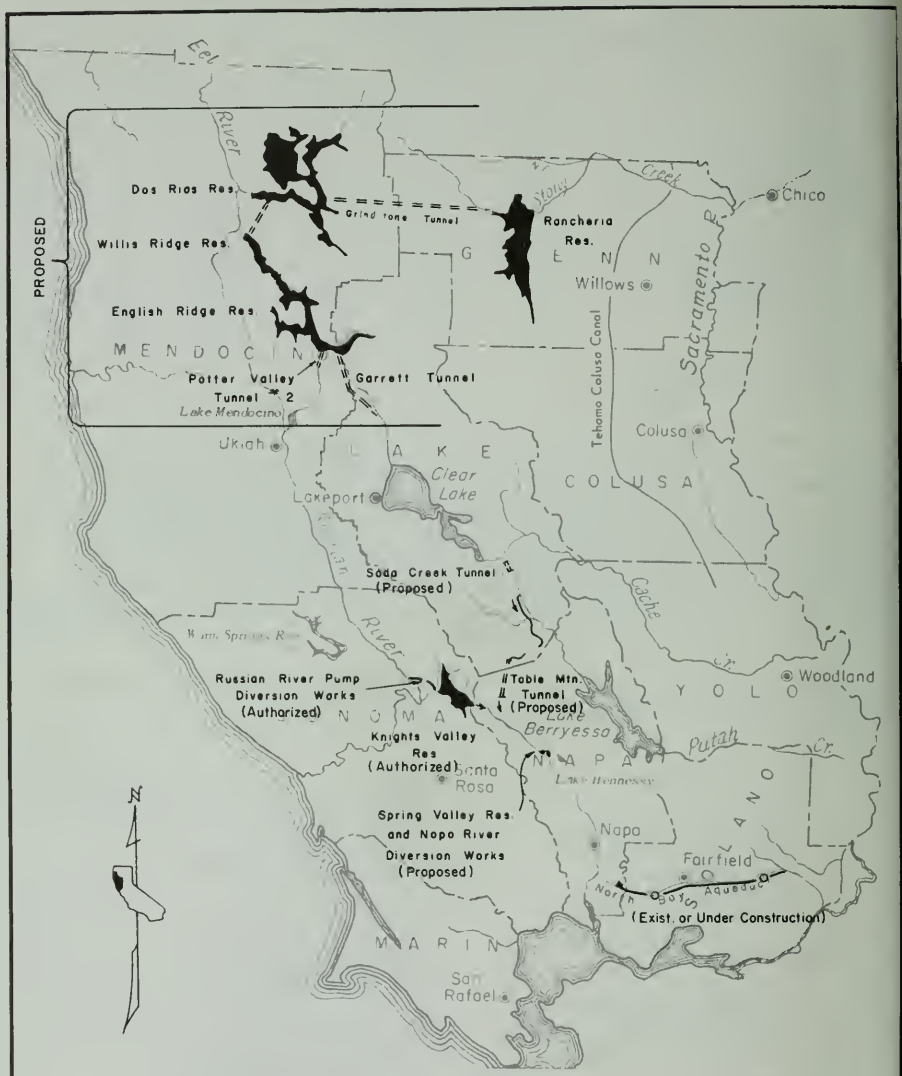


Figure 9:
POSSIBLE WATER SUPPLY SOURCES FOR NAPA VALLEY

The unit cost of water supply would be high from all of the alternative plans for service to the Upper Napa Valley, particularly for agricultural purposes. An Eel River development, which includes English Ridge Reservoir, should be given careful consideration as a source of water supply for that area.

A possible interim alternative for a portion of the Upper Valley may be an exchange of Lake Hennessy yield for North Bay Aqueduct water. North Bay Aqueduct capacity apparently will exceed Lower Napa Valley urban demands until slightly after 1990. Such an arrangement would require agreement by all parties having rights to Lake Hennessy water.

Table 27: NAPA COUNTY: CROPS

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1967	1990	2020	1967	1990	2020
Summary							
Vineyard	66.50	0.2	19.0	25.6	0.4	28.5	38.4
Orchard (Deciduous)	41.50	1.9	1.2	1.9	3.8	2.4	3.8
Truck (Miscellaneous)	33.00	0.5	0	0	0.8	0	0
Field (General)	11.50	0.8	0	0	1.4	0	0
Pasture	4.50	4.1	2.0	1.9	13.9	6.8	6.5
TOTAL	-	7.5	22.2	29.4	20.3	37.7	48.7
Upper Napa Valley							
Vineyard	66.50	0.1	15.0	20.0	0.2	22.5	30.0
Orchard (Deciduous)	41.50	0.9	0.7	0.5	1.8	1.4	1.0
Truck (Miscellaneous)	33.00	0.2	0	0	0.3	0	0
Field (General)	11.50	0.5	0	0	0.9	0	0
Pasture	4.50	2.3	1.0	0.5	7.8	3.4	1.7
TOTAL	-	4.0	16.7	21.0	11.0	27.3	32.7
Lower Napa Valley							
Vineyard	66.50	0	3.0	3.0	0	4.5	4.5
Orchard (Deciduous)	41.50	0.9	0	0	1.8	0	0
Truck (Miscellaneous)	33.00	0.3	0	0	0.5	0	0
Field (General)	11.50	0.1	0	0	0.2	0	0
Pasture	4.50	1.2	0	0	4.1	0	0
TOTAL	-	2.5	3.0	3.0	6.6	4.5	4.5
Upper Putah Creek							
Vineyard	66.50	0.1	1.0	2.6	0.2	1.5	3.9
Orchard (Deciduous)	41.50	0.1	0.5	1.4	0.2	1.0	2.8
Field (General)	11.50	0.2	0	0	0.3	0	0
Pasture	4.50	0.6	1.0	1.4	2.0	3.4	4.8
TOTAL	-	1.0	2.5	5.4	2.7	5.9	11.5

Napa County officials state that there is some interest in reclaiming waste water to help meet water demands in the Upper Napa Valley. No definite plans for that action exist now, but a demonstration type project for utilization of reclaimed waste water in the St. Helena area is being investigated.

Lower Napa Valley

Lower Napa Valley has experienced rapid urban growth during the past 20 years. The estimate 1967 population was 59,000 persons. Population is expected to grow to 115,000 by 1990 and to 225,000 by 2020. Urban land use, totaling about 13,500 acres in 1960 should climb to nearly 30,000 acres by 2020.

Agricultural land requirements are expected to remain minimal due to urban encroachment. By 2020, it is anticipated that 3,000 acres of vineyard, principally in the Carneros region will comprise essentially all of the irrigated agriculture in Lower Napa Valley. Agricultural water requirements for 4,500 acre-feet in 2020 would be small in comparison to the municipal and industrial demands for 54,000 acre-feet in that year. It is assumed in this report that the agriculture demands would be met partly from ground water and partly from North Bay Aqueduct water which would be in excess of the urban demand for quite a while during the buildup period.

Firm water supplies to Lower Napa Valley total 38,100 acre-feet. When compared to 2020 demands, an annual deficit of about 20,000 acre-feet for municipal and industrial uses is shown.

The sources of supply which were presented on page 61 for the Upper Napa Valley would also be valid for the Lower Napa Valley. Except for the plan using the North Bay Aqueduct, there would be the additional cost of conveyance from the upper end of the Valley. It is not apparent from this study which of the proposed alternative plans would be best suited for the Lower Napa Valley area. However, the area will need an additional water supply of about 20,000 acre-feet per year by 2020 and the selection of the source will be affected by the plan of development selected for the Upper Napa Valley, and that selected for the Eel River.

Upper Putah Creek

This portion of Napa County is separated from the Bay Area by a low range of mountains that create a marked climate change. The Upper Putah Creek Basin does not have the maritime influence found in the Napa Valley but is typified by hot summer days and warm nights. Pope Valley, which is the main agricultural area within this Basin, has a recognized potential for the production of fruit, nut, and vineyard crops.

Irrigated agriculture in the Upper Putah Creek area has been restricted by the lack of a firm water supply which is estimated to amount to only about 1,000 acre-feet per year. This study shows that agriculture could increase from the present 1,000 acres irrigated today to about 5,400 acres by 2020. The 5,400 acres of land would create a demand for 10,500 acre-fet per year of supplemental water. (For simplicity, unit uses in the area were assumed to be the same as the remainder of Napa County; because of

ıe warmer summer climate, agricultural water demands may be a little
gher than shown, especially for pasture.)

ricultural water demand in the area, however, will be quite responsive
water price. If the price were to increase to $10 or $20/AF, the
mand for supplemental water in 2020 would drop from 10,500 to about 6,000
re-feet per year.

ıe recreationally oriented land uses around Lake Berryessa currently have
7,500 acre-foot firm water supply. This supply was made available
rough contractual agreement between the Napa County Flood Control and
ıter Conservation District and the U. S. Bureau of Reclamation. The
ıter supply is available in Lake Berryessa and the rate of use will be
function of the recreational-residential buildup on those lands surround-
ıg the Lake. The present rate of permanent residential-type development
ppears to be moderate.

Bulletin No. 99 (Reconnaissance Report on Upper Putah Creek Basin
vestigation, March 1962) the Department of Water Resources concluded
at the most promising sources for an additional water supply for Pope
lley would be from locally constructed reservoirs, including Walter
rings Reservoir on Pope Creek, Goodings Reservoir on Maxwell Creek, and
mes Creek Reservoir on James Creek. Each reservoir could be sized to
oduce a firm water supply of 10,000 acre-feet per year at an annual unit
st of about $25 per acre-foot, at 1969 prices.

e right to develop firm water supplies in the Upper Putah Creek Basin
contingent upon that development occurring prior to the time when the
ailable supply would be put to beneficial use within the Solano Project
rvice area. Item 14 of State Water Rights Board Decision No. 869, issued
bruary 7, 1957, reads:

> "14. The permits and all rights acquired or to be acquired thereunder are and shall remain subject to depletion of stream-flow above Monticello Reservoir not to exceed 33,000 acre-feet of water annually, by future appropriations of water for reasonable beneficial use within the watershed of Putah Creek above said reservoir; provided such future appropriations shall be initiated and consummated pursuant to law prior to full beneficial use of water within the project service area under these permits."

other option would be service from the Central Valley Project, possibly
mbined with the West Sacramento Canal. One or more of the Upper Putah
sin reservoirs listed previously could be built to serve water to the
ea with exchanges from the West Sacramento Canal, if needed, to satisfy
wnstream water rights.

southerly route system for the Dos Rios-English Ridge complex integrated
to the State Water Project and Central Valley Project is a possible source
supply for the Putah Creek Basin. The gravity flow conveyance system
om Clear Lake considered for service to Napa Valley, could be extended
Pope Valley and Chiles Valley areas of the Upper Putah Creek Basin.

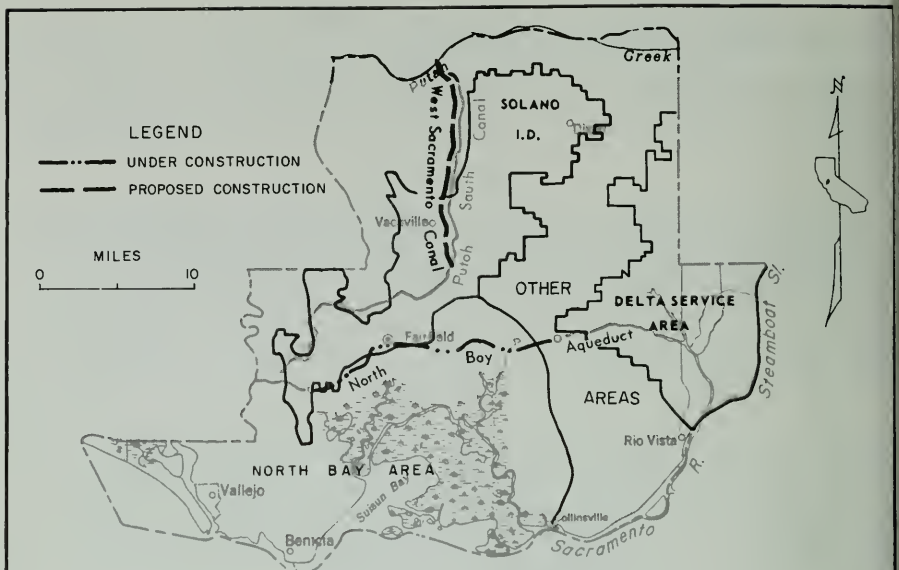


Figure 10: SOLANO COUNTY

Chapter X. SOLANO COUNTY

This study indicates that Solano County (Figure 10) will require major augmentation of its water supplies by 2020. Presently developed water supplies, with allowances for reuse, will supply 505,000 acre-feet per year of the County's needs. The water demand in the County is expected to increase to 804,000 acre-feet per year by 2020, leaving an annual deficit of 299,000 acre-feet at that time (Table 28). Table 29 indicates supplemental demand.

If the same rate of growth estimated for Solano County in 2020 were to be extended for another 50 years, i.e, 100 years from the present, the demand for supplemental water could approach 400,000 acre-feet annually.

Table 28: SOLANO COUNTY: WATER DEMAND, SUPPLY, AND USE

Area	Water Demand, in 1,000 Acre-feet per Year								
	In 1967			In 1990			In 2020		
	Agricultural	M & I[a]	Total	Agricultural	M & I[a]	Total	Agricultural	M & I[a]	Total
Delta Service	110.2	0.6	110.8	115.9	0.8	116.7	119.8	1.1	120.9
Solano Irrigation District	115.7	5.0	120.7	132.5	21.6	154.1	116.9	60.5	177.4
North Bay	15.1	20.6	35.7[b]	20.5	33.2	53.7[b]	16.9	76.0	92.9[b]
Collinsville Complex	0	0	0	0	60.0	60.0	0	165.0	165.0
Other Areas	155.4	5.5	160.9	188.6	13.2	201.8	205.5	42.0	247.5
TOTAL	396.4	31.7	428.1	457.5	128.8	586.3	459.1	344.6	803.7

Area	Dependable Water Supply, in 1,000 Acre-feet per Year										
	Firm, in 2020			Reuse, in 2020		Applied Water Equivalent		In 1990		In 2020	
	Surface	Ground	Total	Percent	Amount	1990	2020	Surplus	Deficiency	Surplus	Deficiency
Delta Service	120.9[c]	0	120.9	0	0	116.7	120.9	0	0	0	0
Solano Irrigation District	142.2[d]	10.0[e]	152.2	15	22.8	175.0	175.0	20.9	0	0	2.4
North Bay	92.4[f]	1.0[g]	93.4	0	0	93.4	93.4	0	20.3	0	164.5
Other Areas	20.6[h]	80.0[i]	100.6	15	15.1	115.7	115.7	0	86.1	0	131.8
TOTAL	376.1	91.0	467.1	-	37.9	500.8	505.0	20.9	106.4	0	298.7

Area	Population in 1,000's			Municipal and Industrial Per Capita Water Use					
				Gallons per Day			Acre-feet per Year		
	1967	1990	2020	In 1967	In 1990	In 2020	In 1967	In 1990	In 2020
Delta Service	2.2	3.0	4.0	240	250	250	0.27	0.28	0.28
Solano Irrigation District	18.4	77.0	216.0	240	250	250	0.27	0.28	0.28
North Bay[j]	121.0	175.0	380.0	150	170	180	0.17	0.19	0.20
Other Areas	20.4	47.0	150.0	240	250	250	0.27	0.28	0.28
TOTAL	162.0	302.0	750.0	-	-	-	-	-	-

a/ Municipal and Industrial.
b/ Does not include Suisun Marsh requirements.
c/ Sacramento River plus a small amount of ground water.
d/ Source (in 1,000 acre-feet): Solano Project: the agricultural entitlement is 141.0; the California Medical Facility entitlement is 1.2.
e/ Sources (in 1,000 acre-feet): Solano Project, 25.6: (Vallejo, 14.8) (Benicia, 3.0) (Fairfield and Suisun City, 7.8); Cache Slough Pipeline, 21.5 ; State Water Project:(North Bay Aqueduct, 42.0); Local Reservoirs, 3.3.
f/ Sources (in 1,000 acre-feet): Solano Project, 20.6: (Maine Prairie Water District, 15.0) (Vacaville, 5.6).
g/ Reference Table 21, Appendix to Solano County Report, by Stoddard and Karrer, 1962.
h/ With Solano Project downstream release of 25,000 acre-feet per year.
i/ Per capita water use data excludes Collinsville Complex.

Table 29: SOLANO COUNTY: SUPPLEMENTAL WATER DEMAND
In 1,000 Acre-feet

Price of Water per Acre-foot (by Area)	In 1990			In 2020		
	Agricultural	M & I*	Total	Agricultural	M & I*	Tota
@ $3.50						
Solano Irrigation District	0	0	0	0	2.4	2.
North Bay	1.4	18.9	20.3	0	164.5	164.
Other Areas	78.9	7.2	86.1	95.8	36.0	131.
County	80.3	5.2**	85.5**	95.8	202.9	298.
@ $10.00						
Solano Irrigation District	0	0	0	0	2.4	2.4
North Bay	0.2	18.9	19.1	0	164.5	164.5
Other Areas	43.0	7.2	50.2	53.1	36.0	89.1
County	43.2	5.2**	48.4**	53.1	202.9	256.0
@ $20.00						
Solano Irrigation District	0	0	0	0	2.4	2.4
North Bay	0.1	18.9	19.0	0	164.5	164.5
Other Areas	22.3	7.2	29.5	27.2	36.0	63.2
County	22.4	5.2**	27.6**	27.2	202.9	230.1

* Municipal and Industrial

** Assumes that surplus supply in Solano Irrigation District would be transferred to a deficient area within the county.

The quantities of water demand indicated above do not include any additional amounts which may be needed for preservation of fish and wildlife in Solano County. Studies by the California Department of Fish and Game indicate that the present water supply for the Suisun marshlands may be jeopardized by increased Delta diversions. The 54,000-acre waterfowl area requires some 200,000 acre-feet per year of brackish water supply to sustain the natural vegetation needed by its waterfowl. The net supplemental fresh water requirement for that purpose may be less than that amount, however, as some mixing of fresh water and saline water (or irrigation tail water) would be permissible. The U. S. Bureau of Reclamation is conducting a reconnaissance study of the Montezuma Hills area, including marshlands water requirements and plans to serve water there.

Historically, the population centers of the County have been in the Vallejo-Fairfield area. Due to the limited availability of land and improved highway facilities, urban growth in the future is expected to occur in an easterly direction along Interstate 80 and, later, between Fairfield and Rio Vista as industry moves into the Collinsville area. The rise in population and increased job opportunities afforded by an industrial complex such as that proposed for Collinsville could greatly affect urban expansion in Solano County. Urban expansion onto irrigated agricultural lands is expected to increase causing some relocation of irrigated acreage to other areas of the County after 1990. By 2020, almost all of the remaining irrigable land is projected to be developed (Table 30).

;ricultural growth in Solano County is confronted by two major problems. ıe first is competition with urban growth for the better-quality lands ;oils) lying adjacent to Interstate 80. The second problem is land quality. ıe crop adaptability of much of the land (soil) located south of Inter-;ate 80 is restricted by salinity, heavy texture, or drainage deficiencies. ıe suitability of these lands for growing other than shallow-rooted, high-ıter-using, low-payment-capacity forage crops is questionable.

ɔr this study Solano County was divided into four subareas: the Delta ervice area, the Solano Irrigation District, the North Bay area, and ıe balance of the County. Water supplies and future water demands are escribed below for each of these study areas.

Delta Service Area

ıis area, located in the eastern portion of Solano County, has a very ɛregular western boundary that was originally described to encompass all ınds that receive a water supply from the Delta channels, even though ıe supply was obtained by pump lift. (This area should not be confused ith the "legal" Delta service area, which has been defined by the State ɔr water rights purposes.) The westerly boundary of the Delta service ɛea begins on the north edge of Rio Vista and extends in a northwesterly irection to include Lindsey and Cache Sloughs, then turns northeast until ; intersects the County line. The rich agricultural islands to the north ? Rio Vista, with water supplies furnished from the Delta channels, com-rise most of the 41,700 acres of presently irrigated land.

Table 30: SOLANO COUNTY: CROPS

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1967	1990	2020	1967	1990	2020
Summary							
Vineyard	66.50	0.6	1.2	2.8	0.9	1.7	4.1
Orchard (Deciduous)	27.00	20.1	21.8	21.6	58.4	63.3	62.7
Truck (Miscellaneous)	35.00	10.0	12.1	12.7	16.1	19.4	20.3
Tomatoes	23.50	19.6	21.3	21.0	47.0	51.1	50.4
Sugar Beets	12.50	11.0	14.5	15.0	33.0	43.5	45.0
Field (General)	11.50	39.5	43.2	45.2	67.1	73.5	76.9
Alfalfa	8.00	12.2	16.2	16.5	45.2	60.1	61.2
Pasture	3.50	29.9	33.7	32.2	128.7	144.9	138.5
TOTAL	-	142.9	164.0	167.0	396.4	457.5	459.1
Delta Service							
Orchard (Deciduous)	27.00	0.2	0.2	0.2	0.6	0.6	0.6
Truck (Miscellaneous)	35.00	1.8	2.0	2.5	3.0	3.2	4.0
Tomatoes	23.50	6.3	6.3	6.5	15.0	15.1	15.6
Sugar Beets	12.50	0	0.5	1.0	0	1.5	3.0
Field (General)	11.50	19.7	20.0	20.0	33.4	34.0	34.0
Alfalfa	8.00	1.2	1.5	1.8	4.4	5.6	6.7
Pasture	3.50	12.5	13.0	13.0	53.8	55.9	55.9
TOTAL	-	41.7	43.5	45.0	110.2	115.9	119.8

Table 30: SOLANO COUNTY: CROPS (Continued)

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1967	1990	2020	1967	1990	2020
Solano Irrigation District							
Vineyard	66.50	0.4	0.7	1.0	0.6	1.0	1.5
Orchard (Deciduous)	27.00	12.2	13.0	12.0	35.4	37.7	34.8
Truck (Miscellaneous)	35.00	4.8	6.0	5.5	7.7	9.6	8.8
Tomatoes	23.50	5.4	5.5	5.0	13.0	13.2	12.0
Sugar Beets	12.50	5.0	6.0	6.0	15.0	18.0	18.0
Field (General)	11.50	7.8	7.5	5.7	13.3	12.8	9.7
Alfalfa	8.00	4.8	6.8	6.1	17.8	25.2	22.6
Pasture	3.50	3.0	3.5	2.2	12.9	15.0	9.5
TOTAL	-	43.4	49.0	43.5	115.7	132.5	116.9
North Bay							
Vineyard	66.50	0.1	0.2	0.3	0.1	0.3	0.4
Orchard (Deciduous)	27.00	0.4	0.4	0.4	1.2	1.2	1.2
Truck (Miscellaneous)	35.00	0	0.1	0.2	0	0.2	0.3
Field (General)	11.50	0	0.7	1.0	0	1.2	1.7
Alfalfa	8.00	0	0.1	0.1	0	0.4	0.4
Pasture	3.50	3.2	4.0	3.0	13.8	17.2	12.9
TOTAL	-	3.7	5.5	5.0	15.1	20.5	16.9
Other Areas							
Vineyard	66.50	0.1	0.3	1.5	0.2	0.4	2.2
Orchard (Deciduous)	27.00	7.3	8.2	9.0	21.2	23.8	26.1
Truck (Miscellaneous)	35.00	3.4	4.0	4.5	5.4	6.4	7.2
Tomatoes	23.50	7.9	9.5	9.5	19.0	22.8	22.8
Sugar Beets	12.50	6.0	8.0	8.0	18.0	24.0	24.0
Field (General)	11.50	12.0	15.0	18.5	20.4	25.5	31.5
Alfalfa	8.00	6.2	7.8	8.5	23.0	28.9	31.5
Pasture	3.50	11.2	13.2	14.0	48.2	56.8	60.2
TOTAL	-	54.1	66.0	73.5	155.4	188.6	205.5

On the basis of findings in this study, a small increase is anticipated in the present use of about 110,000 acre-feet of agricultural water. Actual needs vary some from year to year depending on the crop mix. Municipal and industrial demands will increase slightly above present need. No deficiencies in water supply are foreseen because the area has rights to all the water needed from adjacent channels.

Solano Irrigation District

This District, which totals about 75,000 acres, receives its water service from the Putah South Canal of the Solano Project. The service area begins slightly south of Putah Creek and extends generally in a southwesterly direction on both sides of Interstate 80 nearly tc the town of Cordelia.

esent use of surface water supplies has created a ground water mounding oblem within certain areas of the District, Plans to correct this prob- n by limiting the amount and frequency of present water application in nsort with ground water pumping have been initiated.

2020 about 15,000 additional acres of urban land use should develop thin the present boundaries of this District. Much of this encroach- nt will occur on the more valued fruit tree lands around Cordelia, Fair- eld, and Vacaville, reducing projected agricultural acreage from a figure 49,000 acres in 1990 to 43,500 acres by 2020. Total water demand for l needs during this period will increase from a figure of 121,000 acre- et in 1967 to about 177,000 acre-feet per year in 2020. A small defi- ency in water supply, slightly over 2,000 acre-feet is anticipated for is District by then. Quite likely this could be met by some additional ound water pumping.

North Bay

is service area is composed of the portion of Solano County which drains to the San Pablo and Suisun Bays, beginning at the town of Collinsville; d it includes the Benicia-Vallejo-Mare Island urban complex, the Suisun rsh waterfowl area and the planned Collinsville industrial complex. It so includes the City of Fairfield.

pulation studies show that in 1967 about 121,000 people were living thin this region. By 2020 the population will increase to some 380,000 rsons. Municipal and industrial water demands will climb from the modest timated use in 1967 of slightly under 21,000 acre-feet to about 241,000 re-feet in 2020. Over two-thirds of this 2020 demand is assigned to et the needs of a large steel mill and satellite industries at the Collins- lle industrial site. County representatives report that the proposed mill d its associated facilities could require about 20,000 acre-feet per year itially about the mid 1970s, and its requirements could increase to 165,000 re-feet annually by 2020. Actual timing and final amounts of water quired are uncertain at this date, however, and may change as more defi- te plans are made. Since 1967, Humble Oil Company has built a refinery Benicia which now requires nearly 5,000 acre-feet per year. The uncer- inty in the Collinsville complex requirements is such that no separate counting of an additional refinery amount was felt warranted.

gricultural water use in the North Bay service area amounted to only about),000 acre-feet in 1960. The demand in 1990 is expected to increase to ound 20,000 acre-feet then decline to around 17,000 acre-feet in 2020 due urban expansion.

ater use annually for both agriculture and municipal and industrial needs 1967 totaled about 36,000 acre-feet, and the total demand for those rposes will amount to 258,000 acre-feet in 2020. Present water supplies, cluding the County's entitlement of 42,000 acre-feet per year from the rth Bay Aqueduct, amount to about 93,000 acre-feet per year. Within e County water structure, surplus water in the Solano Irrigation District rvice area can be transferred to the North Bay service area via the Putah

South Canal in 1990. But in 2020 no surplus is indicated and the North Bay area faces deficits of about 165,000 acre-feet per year. The primary location of need appears to be the Collinsville industrial complex. Additional water supplies may be needed also to preserve the Suisun Marsh waterfowl habitat; however, it was not in the scope of this investigation to define that quantity.

The additional annual supply of 165,000 acre-feet needed by 2020 for the North Bay service area in Solano County could be served from the State Water Project. The supply would be released to the Sacramento Delta from sources in Northern California which are presently under study. An additional low-head pumping plant would be needed to transport the augmented supply of 131,000 acre-feet per year to Collinsville.

Another alternative would be service from the Central Valley Project via the Montezuma Hills Unit proposed by the U. S. Bureau of Reclamation. This unit would provide water to the Montezuma Hills area (both in the North Bay and other areas of study) for urban municipal and industrial and agricultural purposes, as well as providing fresh water to the Suisun Marsh area. A reconnaissance report on the unit is scheduled for late 1971.

When water rights were granted for the Solano Project (Decision No. 869, in February 1957), 33,000 acre-feet were reserved for appropriation for beneficial use within the Upper Putah Creek watershed. However, this reservation was conditional and required that the water be used in the upper basin before it is used in the Solano Project service area. The reservation is set forth in Item 14 of Decision No. 869.

> "14. The permits and all rights acquired or to be acquired thereunder are and shall remain subject to depletion of stream-flow above Monticello Reservoir not to exceed 33,000 acre-feet of water annually, by future appropriations of water for reasonable beneficial use within the watershed of Putah Creek above said reservoir; provided such future appropriations shall be initiated and consummated pursuant to law prior to full beneficial use of water within the project service area under these permits."

Thus, the future Solano Project water supply may be a little more or a little less than the supply assumed in this report, which corresponds to an upstream depletion of about half of the 33,000 acre-foot conditional reservation.

Other Areas

This service area includes all lands in Solano County not within the three service areas described above. It consists mainly of a strip of land with an average width of about 5 miles, extending northwesterly from the Sacramento River at Rio Vista to Barker Slough, and then extending northeasterly adjacent to the Solano Irrigation District; it also includes the area in Solano County lying north of Solano Irrigation District and the mountainous area to the west of the District. It includes the City of Vacaville.

ıe area is deficient in water supply at present and the deficiency is xpected to amount to about 132,000 acre-feet per year in 2020. In 1967 ıe area had an estimated population of around 20,000 people and 54,000 :res of irrigated crops. By 2020 the population is projected to be 50,000 people and the area of irrigated crops is expected to increase to ome 73,500 acres if the relative price of additional agricultural water upplies remains at the current level. A new urban center is envisioned idway between Rio Vista and Fairfield in connection with the Collinsville ndustrial complex.

ne planned West Sacramento Canal Unit of the Central Valley Project would rovide 137,000 acre-feet per year of firm water supply to Solano County. hat supply would be sufficient to take care of the estimated supplemental emand in 2020 in this service area.

Table 31: SONOMA COUNTY: WATER DEMAND, SUPPLY, AND USE

Area	Water Demand, in 1,000 Acre-feet per Year								
	In 1967			In 1990			In 2020		
	Agricultural	M & I[a/]	Total	Agricultural	M & I[a/]	Total	Agricultural	M & I[a/]	Total
Santa Rosa-Petaluma	74.2	39.8	114.0	93.3	87.1	180.4	120.7	184.6	305.
Gualala River	0	0.2	0.2	0.3	0.4	0.7	0.7	1.1	1.
TOTAL	74.2	40.0	114.2	93.6	87.5	181.1	121.4	185.7	307.

Area	Depeodable Water Supply, in 1,000 Acre-feet per Year									
	Firm			Reuse		Applied	In 1990		In 2020	
	Surface	Ground	Total	Percent	Amount	Equivalent	Surplus	Deficieocy	Surplus	Deficie
Santa Rosa-Petaluma										
Lake Mendocino (East Fork Russian River)	42.0	-	-	-	-	-	-	-	-	-
Warm Springs Reservoir (Dry Creek)	66.5	-	-	-	-	-	-	-	-	-
Miscellaneous	15.0	-	-	-	-	-	-	-	-	-
Total	123.5	30.0	153.5	15	23.0	176.5	0	3.9	0	128.8
Gualala River	1.8	0	1.8	0	0	1.8	1.1	0	0	0
TOTAL	125.3	30.0	155.3	-	23.0	178.3	1.1	3.9	0	128.8

Area	Populatioo in 1,000's			Municipal and Industrial per Capita Water Use					
				Galloos per Day			Acre-feet per Year		
	1967	1990	2020	In 1967	In 1990	Io 2020	In 1967	In 1990	Io 202
Sante Rosa-Petaluma	189.4	363.0	710.0	190	210	230	0.21	0.24	0.26
Gualala River	1.6	4.0	10.0	100	100	100	0.11	0.11	0.11
TOTAL	191.0	367.0	720.0	-	-	-	-	-	-

a/ Municipal and Industrial

Table 32: SONOMA COUNTY: SUPPLEMENTAL WATER DEMAND In 1,000 Acre-feet

Price of Water per Acre-foot	In 1990			In 2020		
	Agricultural	M & I*	Total	Agricultural	M & I*	Tota
@ $4.50	0.3	3.6	3.9	27.7	101.1	128.8
@ $10.00	0.1	3.6	3.7	13.1	101.1	114.2
@ $20.00	0.1	3.6	3.7	12.9	101.1	114.0

* Municipal and Industrial

nicipal and industrial demands in Sonoma County will have increased from annual use of 40,000 acre-feet in 1967 to about 186,000 acre-feet in 20. Total water demand in 2020 will be about 307,000 acre-feet (Table 31).

e firm water supply potential of present sources to meet this large 2020 mand is estimated at 178,000 acre-feet per year. This annual supply uld be comprised of 125,000 acre-feet from surface sources existing or der construction, including 66,500 acre-feet from Warm Springs Reservoir, ,000 acre-feet from ground water, and an estimated 23,000 acre-feet of cidental reuse. About 35,000 acre-feet of the additional supplemental ed of 129,000 acre-feet per year could be supplied from an enlarged ke Mendocino development. The remaining 94,000 acre-feet would be sup- ied from the Eel River, waste water reclamation, or other suitable alter- tive developments.

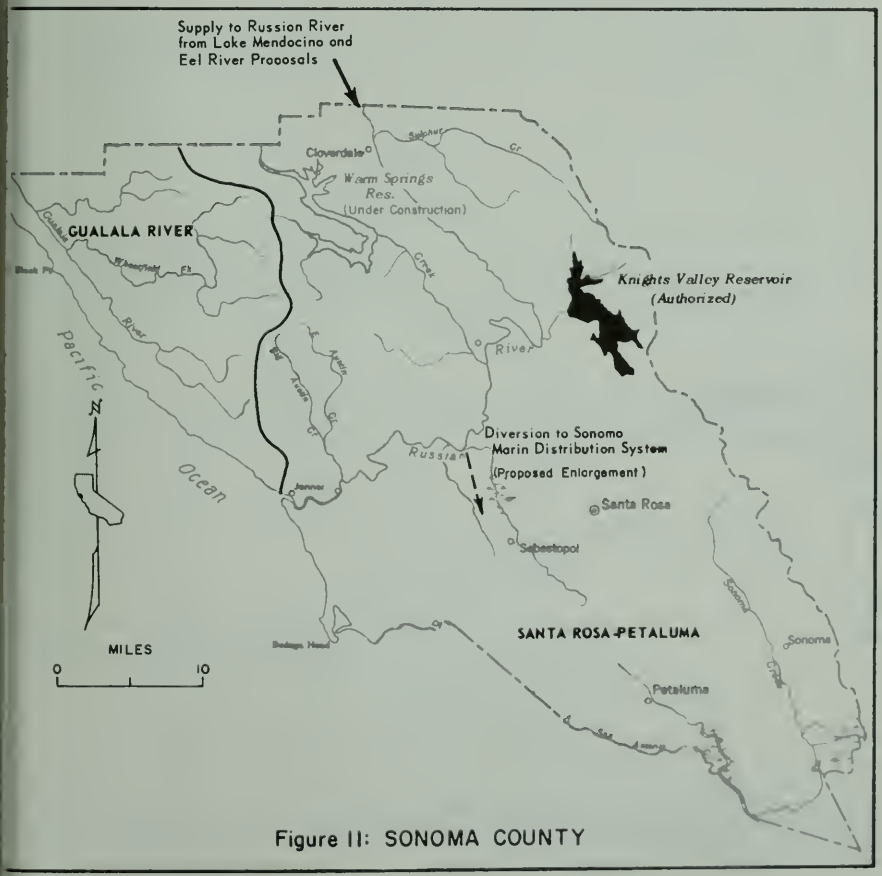


Figure II: SONOMA COUNTY

Table 32 lists supplemental demand. If the same rate of agricultural and municipal-industrial growth shown for 2020 were to continue to 2070 (100 years) Sonoma County would have a total water requirement of 550,000 acre-feet per year and a supplemental requirement of about 370,000 acre-feet pe year. In 1967, an estimated 29,000 acres were irrigated in Sonoma County. By 1990 this acreage is expected to increase to about 38,000 acres requiring almost 94,000 acre-feet of applied water annually. In 2020 agriculture should increase to 52,000 acres countywide with an applied water requirement of 121,000 acre-feet per year (Table 33).

Sonoma County can expect a continuation of the rapid urban land use expansion experienced in the past two decades. The population of the County is projected to increase from 191,000 in 1967 to 720,000 in 2020. Current urban land use acreage totaled slightly less than 35,000 acres in 1960. This use is expected to increase to around 52,000 acres by 1990 and to almost 85,000 by 2020. The need for an additional 50,000 net acres for urban expansion could require a gross acreage of around 70,000 acres due to the effect of urban spotting and entrapment of agricultural parcels.

For this study, Sonoma County has been divided into two study areas (Figure 11). The major portion of the County is referred to as the Santa Rosa-Petaluma subarea. That area is geographically suited to receive water supplies originating from reservoirs in the Russian or Eel River Basins. The Gualala River subarea which lies within the coastal drainage

Table 33: SONOMA COUNTY: CROPS

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1967	1990	2020	1967	1990	2020
Summary							
Vineyard	66.50	2.4	8.0	17.0	2.4*	12.0	25.5
Orchard (Deciduous)	41.50	10.0	12.5	15.0	20.0	25.0	30.0
Truck (Miscellaneous)	33.00	0.9	0.5	0.5	1.5	0.8	0.8
Field (General)	11.50	1.4	1.0	0.5	2.4	1.7	0.8
Alfalfa	9.50	1.2	1.0	1.0	3.7	3.1	3.1
Pasture	4.50	13.0	15.0	18.0	44.2	51.0	61.2
TOTAL	-	28.9	38.0	52.0	74.2	93.6	121.4
Santa Rosa-Petaluma**							
Pasture	4.50	13.0	14.9	17.8	44.2	50.7	60.5
TOTAL	-	28.9	37.9	51.8	74.2	93.3	120.7
Gualala River							
Pasture	4.50	0	0.1	0.2	0	0.3	0.7
TOTAL	-	0	0.1	0.2	0	0.3	0.7

* 1.0 acre-foot per acre used in 1967 calculation
** All data (excepting entries for "Pasture" and "Total") is the same as that reported under "Summary"

area north of the Russian River is not geographically situated for water service from those sources. The present and future water supplies and demands for these two service areas are discussed below.

Santa Rosa-Petaluma

This area includes all of Sonoma County except for the Gualala subarea. It consists of the Russian River watershed, those portions of Sonoma County that drain toward San Francisco Bay, Valley of the Moon, and the coastal areas of Sonoma County in the vicinity of Bodega Bay.

Upon completion of construction of Warm Springs Reservoir and enlargement of the Sonoma-Marin Aqueduct system, the area will have available a firm water supply of about 176,500 acre-feet per year. In 1967 the area's estimated total applied water usage was about 114,000 acre-feet; however, this study indicates the area will require further augmentation of its water supply beginning about 1990. By 2020 the demand for supplemental water at current prices will increase to 129,000 acre-feet per year of which 101,000 acre-feet would be needed for municipal and industrial demands and 28,000 acre-feet for agriculture.

Agriculture is projected to increase from the present 29,000 acres of irrigated land (1967) to about 52,000 acres by 2020. This projection shows an increase of about 5,000 acres in irrigated pasture with an additional water requirement somewhat over 15,000 acre-feet. This increase in irrigated pasture was premised on the reuse of treated sewage waste water expected to be available in the Laguna area and possibly other areas of the County. Since the water payment capacity for irrigated pasture is only $4.50 per acre-foot, sewage waste would seem to offer the only feasible source of supplemental water available for this crop.

This would mean that the probable supplemental demand for agricultural water in 2020 from new sources of supply would be 13,000 acre-feet per year, primarily for high-payment-capacity orchard and vineyard crops.

Possible sources of additional water supply for the Santa Rosa-Petaluma subarea follow:

1. Enlargement of Lake Mendocino
2. Dos Rios-English Ridge Complex via Potter Valley
3. English Ridge Reservoir via Potter Valley
4. Knights Valley Project, 1st and 2nd stages
5. Dos Rios-Stony Creek Complex via North Bay Aqueduct
6. Local Russian River tributary reservoirs
7. Walker Reservoir in Marin County (Bodega Bay area)

The enlargement of Lake Mendocino, as proposed by the U. S. Corps of Engineers, offers an attractive source for about 35,000 acre-feet of additional annual supply. Although the reservoir enlargement is expected to

yield about 75,000 acre-feet per year, this study assumed that 10,000 acre-feet of yield from that development would be allocated to Mendocino County and 30,000 acre-feet to Marin County.

With 35,000 acre-feet per year of new supply from enlarged Lake Mendocino and a reuse of 15,000 acre-feet annually of treated sewage waste water, the 2020 supplemental water demand of 129,000 acre-feet in the Santa Rosa Petaluma subarea would be reduced to 79,000 acre-feet, mostly for municipal industrial needs. Any of the other alternatives listed in the previous paragraph may provide the additional supply.

Gualala River

This study area includes the portion of the drainage of the Gualala River within Sonoma County and the numerous small coastal watersheds lying north of Jenner at the mouth of the Russian River.

Although present and future water demands will be relatively small in relation to the needs of other portions of the county the major water problem appears to be one of distribution of existing supplies. Since the resident and the large recreation population are expected to require water along the entire 40-mile Gualala coastline, local deficiencies can be expected. The Neese Ridge Reservoir on the Gualala River was proposed as a possible source of water supply by the Department of Water Resources in Bulletin No. 136. The reservoir would have a gross capacity of 10,000 acre-feet and a water yield of 15,000 acre-feet per year. Water supplies from proposed Eel River developments probably would not be required to meet local deficiencies along the Gualala coastal area.

Chapter XII. YOLO COUNTY

Yolo County is expected to show a population increase from 87,000 in 1967 to 155,000 by 1990 and 290,000 by 2020. Urban land use which amounted to approximately 10,000 acres in 1960 will increase to about 30,000 acres by the year 2020. The conversion of agricultural land to urban use will force expansion of irrigated agriculture onto remaining irrigable lands, but by 2020 essentially all of the available land will be developed and further urban expansion would result in a reduction of irrigated agriculture, mainly within the Yolo County Flood Control and Water Conservation District where the cities of Davis and Woodland are located.

Annual demands for municipal and industrial water and agricultural water for the County can be expected to increase from 837,000 acre-feet by 1967 to 927,000 acre-feet by 1990 and to about 1,030,000 acre-feet by 2020 (Table 34). The demands for supplemental water at current prices will be

Table 34: YOLO COUNTY: WATER DEMAND, SUPPLY, AND USE

Area	Water Demand, in 1,000 Acre-feet per Year								
	In 1967			In 1990			In 2020		
	Agricultural	M & I[a]	Total	Agricultural	M & I[a]	Total	Agricultural	M & I[a]	Total
Cache Creek North	221.5	1.1	222.6	236.5	1.1	237.6	251.5	1.4	252.9
Yolo County F.C. & W.C.D.[b]	334.4	23.0	357.4	382.7	39.0	421.7	423.7	77.7	501.4
Yolo Bypass	96.9	3.2	100.1	104.0	6.1	110.1	104.0	10.8	114.8
Delta Service	150.3	6.8	157.1	144.8	12.6	157.4	144.4	16.6	161.0
TOTAL	803.1	34.1	837.2	868.0	58.8	926.8	923.6	106.5	1,030.1

Area	Dependable Water Supply, 1,000 Acre-feet per Year										
	Firm, in 2020			Reuse in 2020		Applied Equivalent		In 1990		In 2020	
	Surface	Ground	Total	Percent	Amount	1990	2020	Surplus	Deficiency	Surplus	Deficiency
Cache Creek North	156.0[c]	82.0	238.0	0	0	237.6	238.0	0	0	0	14.9
Yolo County F.C. & W.C.D.[b]	104.0[d]	160.0	264.0	7.5	20.0	284.0	284.0	0	137.7	0	217.4
Yolo Bypass	104.8[e]	10.0	114.8	0	0	110.1	114.8	0	0	0	0
Delta Service	161.0[f]	0	161.0	0	0	157.4	161.0	0	0	0	0
TOTAL	525.8	252.0	777.8	-	20.0	789.1	797.8	0	137.7	0	232.3

Area	Population in 1,000's			Municipal and Industrial per Capita Water Use					
				Gallons per Day			Acre-feet per Year		
	1967	1990	2020	In 1967	In 1990	In 2020	In 1967	In 1990	In 2020
Cache Creek North	3.0	3.0	4.0	320	320	320	0.36	0.36	0.36
Yolo County F.C. & W.C.D.[b]	56.0	100.0	210.0	370	350	330	0.41	0.39	0.37
Yolo Bypass	9.0	17.0	30.0	320	320	320	0.36	0.36	0.36
Delta Service	19.0	35.0	46.0	320	320	320	0.36	0.36	0.36
TOTAL	87.0	155.0	290.0	-	-	-	-	-	-

a/ Municipal and Industrial.
b/ Flood Control and Water Conservation District.
c/ Sources (in 1,000 acre-feet): Tehama-Colusa Canal (Dunnigan Water District), 19; Sacramento River, 105; Sacramento River (Colusa Basin Drain and Knights Landing Ridge Cut), 32.
d/ Sources (in 1,000 acre-feet): Clear Lake-Cache Creek Supply, 40; Indian Valley Reservoir, 60; Solano Project (University of California at Davis), 4.
e/ Source: Sacramento River.
f/ Source: Sacramento River plus some ground water.

Table 35: YOLO COUNTY: SUPPLEMENTAL WATER DEMAND In 1,000 Acre-feet

Price of Water per Acre-foot (by Area)	In 1990			In 2020		
	Agricultural	M & I*	Total	Agricultural	M & I*	Total
@ $3.50						
Cache Creek North	0	0	0	14.9	0	14.9
Yolo County Flood Control & WCD**	117.0	20.7	137.7	158.0	59.4	217.4
County	117.0	20.7	137.7	172.9	59.4	232.3
@ $10.00						
Cache Creek North	0	0	0	4.3	0	4.3
Yolo County Flood Control & WCD**	64.8	20.7	85.5	93.2	59.4	152.6
County	64.8	20.7	85.5	97.5	59.4	156.9
@ $20.00						
Cache Creek North	0	0	0	1.3	0	1.3
Yolo County Flood Control & WCD	15.6	20.7	36.3	21.4	59.4	80.8
County	15.6	20.7	36.3	22.7	59.4	82.1

* Municipal and Industrial

** Water Conservation District

about 138,000 acre-feet per year by 1990 and 232,000 acre-feet by 2020. (Table 35). Table 36 presents crop data.

If the same rate of agricultural and municipal and industrial growth show at year 2020 were to continue to the year 2070 (100 years) the annual demand for supplemental water would approach 300,000 acre-feet for Yolo County.

For this study, Yolo County was divided into four subareas--Cache Creek North, the Yolo County Flood Control and Water Conservation District, Yolo Bypass, and the Delta Service Area (Figure 12).

Cache Creek North

This area includes all of Yolo County which lies north of Cache Creek except for the portions of the Yolo County Flood Control and Water Conservation District that also lie north of Cache Creek in the Hungry Hollow area.

The present firm annual water supply is composed of 82,000 acre-feet of ground water and 137,000 acre-feet of surface diversions. The Tehama-Colusa Canal, presently under construction, will deliver an additional 19,000 acre-feet annually and will increase the area's firm water supply to 238,000 acre-feet per year. Tehama Colusa Canal service, however, would only be available to the Dunnigan Water District under current plans.

Irrigated agriculture is expected to increase from 50,000 acres in 1967 to 61,000 acres by 2020 with an accompanying increase in annual water requirements from 223,000 acre-feet to 253,000 acre-feet. Municipal and industrial water demands are expected to change little.

is analysis shows a deficit of about 15,000 acre-feet per year in the ubunit by 2020, which would occur in the westerly portion (Dunnigan d Yolo-Zamora Water Districts). The U. S. Bureau of Reclamation pre-ently plans to provide water to those areas from the West Sacramento nal Unit of the Central Valley Project.

Yolo County Flood Control and Water Conservation District

or the purpose of the present study, this district is defined as all eas within Yolo County not included in the other three subunits. The ountainous area west of Winters and Capay were included within the acre-ge control even though they are not actually within the Flood Control istrict.

ne present firm water supply adjusted for reuse is estimated at about 34,000 acre-feet per year. A conservative estimate of the yield of the round water basin is about 160,000 acre-feet per year based on records or the base period of 1914-58 (DWR Bulletin No. 90, 1961); when Indian

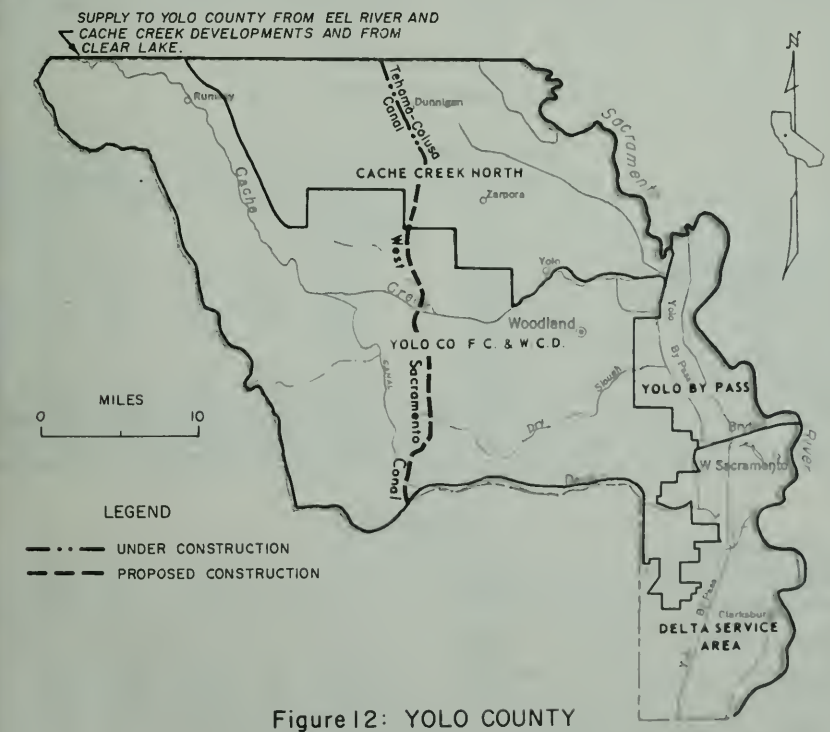


Figure 12: YOLO COUNTY

Valley Reservoir (under construction) is completed, about 100,000 acre-fe of firm supply can be provided annually from Cache Creek diversions (re ulated by Clear Lake and Indian Valley Reservoir); about 20,000 acre-fe per year is available from recapture and reuse of the present supplies; and about 4,000 acre-feet is diverted annually from the Solano Project the University of California at Davis. Present use is estimated at 357 acre-feet per year. The difference between present use and supply is comprised of nonfirm surface supplies and ground water overdraft.

The District should experience an increase in its annual water demand f 357,000 acre-feet at present to 422,000 acre-feet by 1990 and about 501 acre-feet by 2020. Without additional supplies the current water defic would increase to about 138,000 acre-feet in 1990 and to 217,000 acre-fe in 2020.

The U. S. Bureau of Reclamation plans to deliver 126,000 acre-feet per year for the Yolo County Flood Control and Water Conservation District f the West Sacramento Canal. The remaining supplemental supply needed in the District by 2020 would amount to about 90,000 acre-feet per year, m for urban use. That supply could be developed from a reservoir constru on Cache Creek such as the proposed Blue Ridge damsite or some other loc tion. (Alternative damsites will be discussed in the forthcoming Depart of Water Resources Bulletin 175). Another source could be the Eel Rive

Table 36: YOLO COUNTY: CROPS

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-fe		
		1967	1990	2020	1967	1990	2
Summary							
Vineyard	66.50	0	1.0	1.5	0	3.0	
Orchard (Deciduous)	19.50	22.7	25.1	27.3	65.8	72.8	7
Truck (Miscellaneous)	35.00	6.7	9.3	9.5	10.7	14.9	1
Tomatoes	23.50	31.0	34.8	37.4	74.4	83.6	8
Sugar Beets	12.50	21.6	36.8	47.0	64.8	110.4	14
Field (General)	11.50	70.4	63.4	63.4	119.6	107.8	10
Alfalfa	8.00	50.7	62.0	66.0	187.7	229.4	24
Rice	6.00	25.3	23.1	23.1	190.7	176.1	17
Pasture	3.50	20.8	16.3	15.3	89.4	70.0	6
TOTAL	-	249.2	271.8	290.5	803.1	868.0	92
Cache Creek North							
Orchard (Deciduous)	19.50	3.4	3.8	4.0	9.8	11.0	1
Truck (Miscellaneous)	35.00	2.3	2.8	3.0	3.7	4.5	1
Tomatoes	23.50	5.8	6.4	7.0	13.9	15.4	1
Sugar Beets	12.50	3.9	6.8	8.0	11.7	20.4	2
Field (General)	11.50	7.9	8.0	9.0	13.4	13.6	1
Alfalfa	8.00	9.1	10.0	12.0	33.7	37.0	4
Rice	6.00	15.1	15.0	15.0	122.4	121.7	12
Pasture	3.50	3.0	3.0	3.0	12.9	12.9	1
TOTAL	-	50.5	55.8	61.0	221.5	236.5	25

Table 36: YOLO COUNTY: CROPS (Continued)

Crop	Payment Capacity in Dollars per Acre-foot	Acres, in 1,000's			Water Demand, in 1,000 Acre-feet		
		1967	1990	2020	1967	1990	2020
Yolo County Flood Control and Water Conservation District							
Vineyard	66.50	0	1.0	1.5	0	3.0	4.5
Orchard (Deciduous)	19.50	16.2	18.0	20.0	47.0	52.2	58.0
Truck (Miscellaneous)	35.00	1.5	3.0	3.0	2.4	4.8	4.8
Tomatoes	23.50	16.0	18.0	20.0	38.4	43.2	48.0
Sugar Beets	12.50	10.4	21.0	29.0	31.2	63.0	87.0
Field (General)	11.50	26.2	27.0	28.0	44.5	45.9	47.6
Alfalfa	8.00	31.4	37.0	39.0	116.2	136.9	144.3
Rice	6.00	2.0	1.5	1.5	13.4	10.1	10.1
Pasture	3.50	9.6	5.5	4.5	41.3	23.6	19.4
TOTAL	-	113.3	132.0	146.5	334.4	382.7	423.7
Yolo Bypass							
Orchard (Deciduous)	19.50	2.7	3.0	3.0	7.8	8.7	8.7
Truck (Miscellaneous)	35.00	0.5	1.0	1.0	0.8	1.6	1.6
Tomatoes	23.50	3.0	4.0	4.0	7.2	9.6	9.6
Sugar Beets	12.50	2.0	3.0	3.0	6.0	9.0	9.0
Field (General)	11.50	15.2	10.0	10.0	25.8	17.0	17.0
Alfalfa	8.00	1.1	4.0	4.0	4.1	14.8	14.8
Rice	6.00	6.5	5.5	5.5	43.5	36.9	36.9
Pasture	3.50	0.4	1.5	1.5	1.7	6.4	6.4
TOTAL	-	31.4	32.0	32.0	96.9	104.0	104.0
Delta Service							
Orchard (Deciduous)	19.50	0.4	0.3	0.3	1.2	0.9	0.9
Truck (Miscellaneous)	35.00	2.4	2.5	2.5	3.8	4.0	4.0
Tomatoes	23.50	6.2	6.4	6.4	14.9	15.4	15.4
Sugar Beets	12.50	5.3	6.0	7.0	15.9	18.0	21.0
Field (General)	11.50	21.1	18.4	16.4	35.9	31.3	27.9
Alfalfa	8.00	9.1	11.0	11.0	33.7	40.7	40.7
Rice	6.00	1.7	1.1	1.1	11.4	7.4	7.4
Pasture	3.50	7.8	6.3	6.3	33.5	27.1	27.1
TOTAL	-	54.0	52.0	51.0	150.3	144.8	144.4

From English Ridge Reservoir or a southerly routing of Middle Fork Eel River water. Another option is conjunctive operation of ground water and confirm Cache Creek supplies which could yield perhaps 30,000 acre-feet.

Yolo Bypass

These are lands that lie north of the Southern Pacific Railroad (near Interstate 80) but east of the west boundary of Investment Operating Corporation (Woodland Farms) lands served from the Sacramento River.

The principal source of water supply to this area is by direct diversion from the Sacramento River, from return flows from the Knights Landing Ridge Cut, and some seasonal ground water. A number of wells are operated primarily in July and August for peak irrigation demands. The yield is

not exactly known; but a figure of 10,000 acre-feet per year has been assumed for this report.

The use of water for agriculture is expected to remain fairly constant about 104,000 acre-feet per year. Municipal and industrial water use is expected to increase from about 3,000 acre-feet per year in 1967 to near 11,000 acre-feet per year by 2020. This would be brought about by an anticipated 230 percent population increase in the area of the County adjacent to the city of Sacramento.

No water deficiencies are expected to occur in this subunit of Yolo County within the foreseeable future.

Delta Service Area

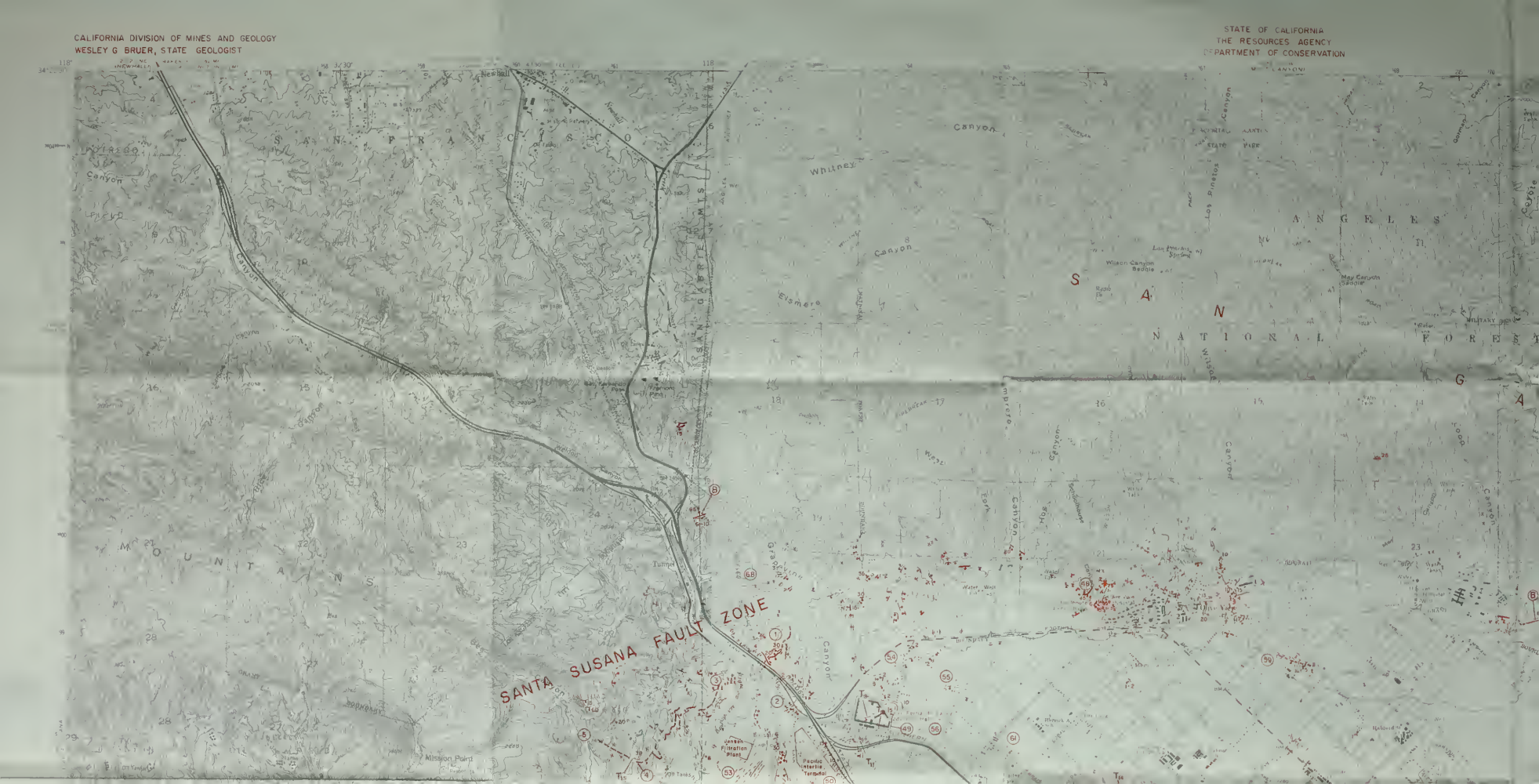
This study area lies in the southeasterly portion of Yolo County south of the Southern Pacific Railroad near Interstate 80. The area has a very irregular westerly boundary that was originally described to encompass all lands that receive a water supply from the Delta channels even though the supply was obtained by pump lift.

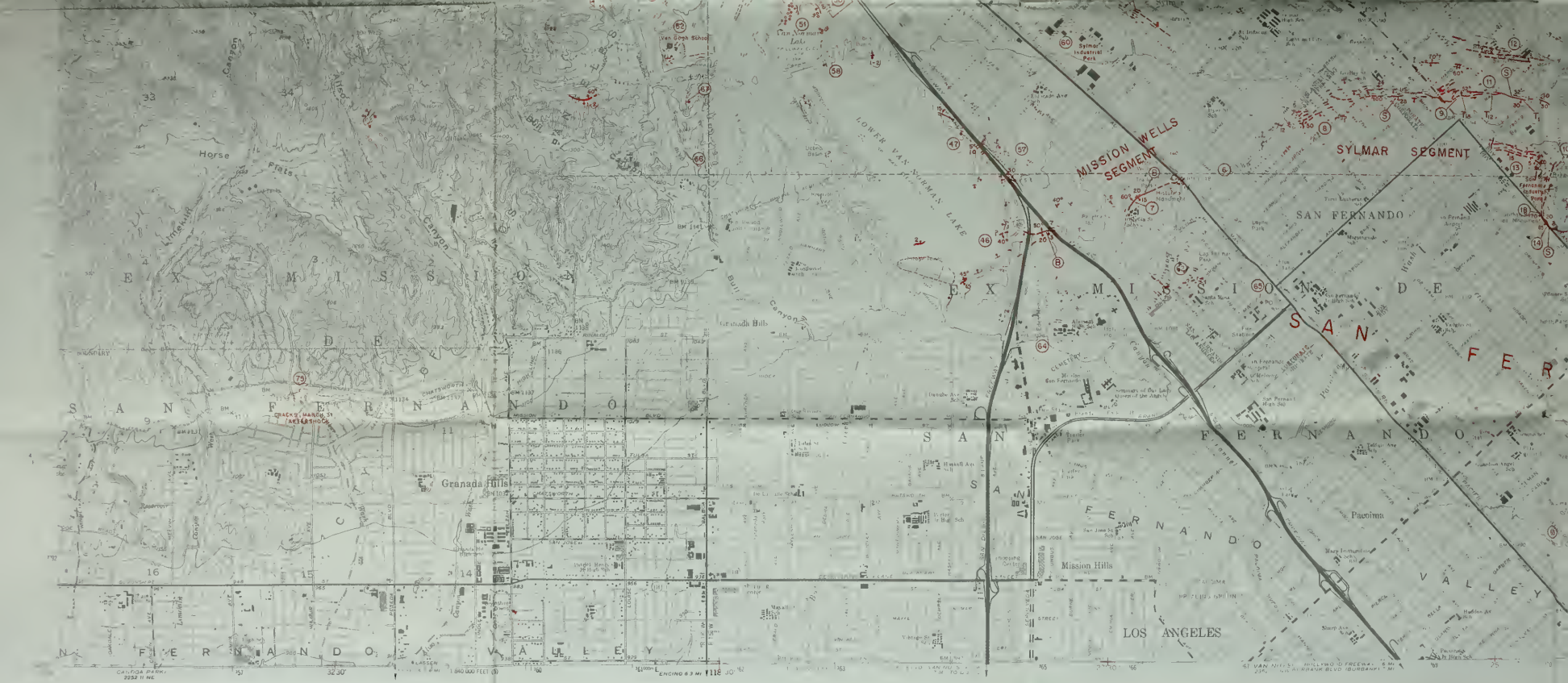
Only minor changes are anticipated in total water demand in this subunit. An increase in municipal and industrial demands from about 7,000 acre-feet to 17,000 acre-feet per year will be offset by a small decrease in irrigated acreage and agricultural water demands.

No water deficiencies are expected in this subunit within the foreseeable future.

CALIFORNIA DIVISION OF MINES AND GEOLOGY
WESLEY G BRUER, STATE GEOLOGIST

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF CONSERVATION





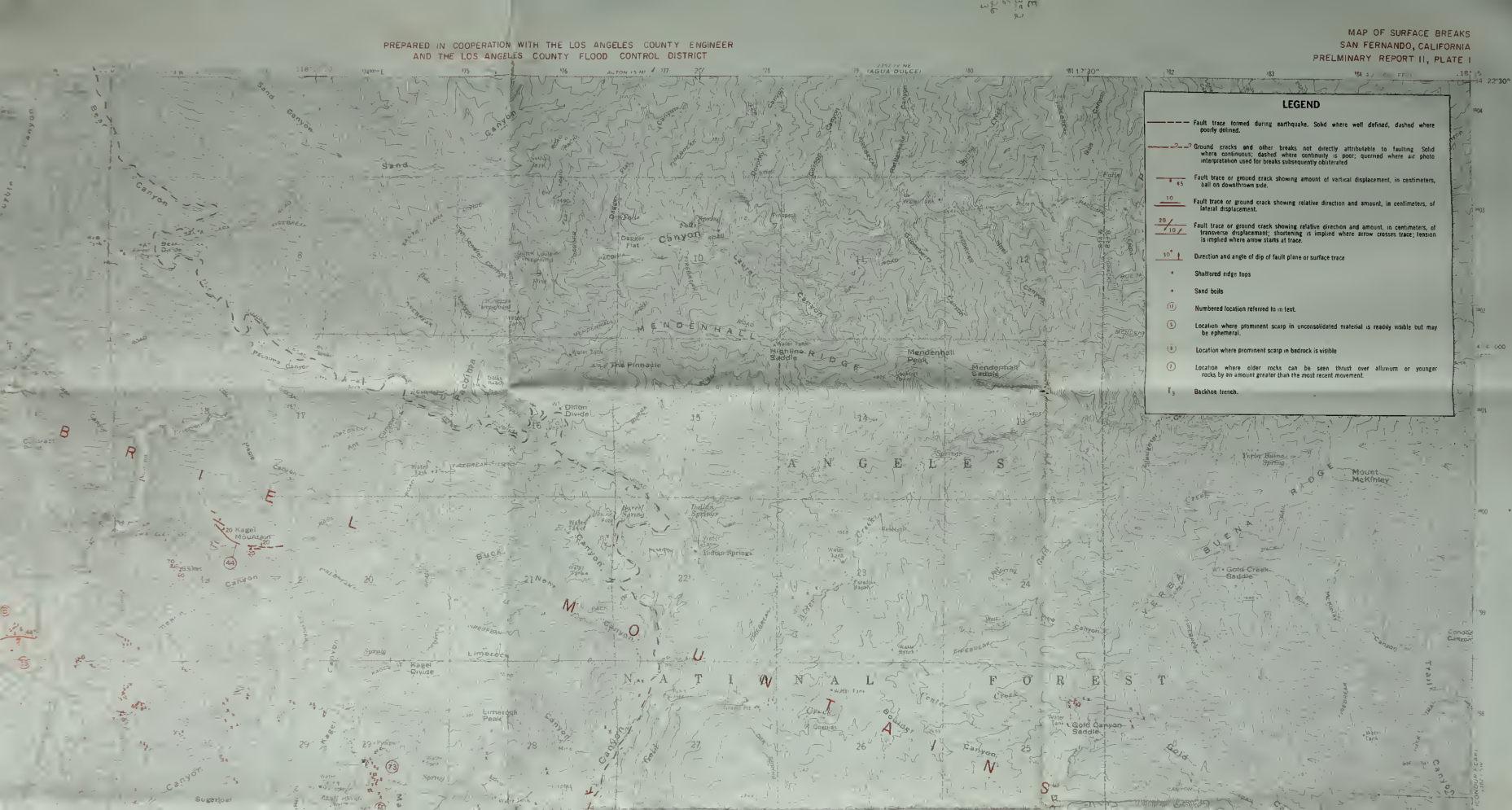
TOPOGRAPHIC BASE MAP BY U.S.G.S

MAP OF SURFACE BREAKS RESULTING FROM THE SA

A.G. BARROWS, J.E. KA
CALIFORNIA DIVIS

PREPARED IN COOPERATION WITH THE LOS ANGELES COUNTY ENGINEER
AND THE LOS ANGELES COUNTY FLOOD CONTROL DISTRICT

MAP OF SURFACE BREAKS
SAN FERNANDO, CALIFORNIA
PRELMINARY REPORT II, PLATE I



N FERNANDO, CALIFORNIA, EARTHQUAKE OF FEBRUARY 9, 1971

BY

HLE, F.H.WEBER, JR, AND R.B.SAUL

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1971

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National Oceanic and Atmospheric Administration
1973

UTM GRID AND 1969 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

DRAFTED BY A. ENG