State of California

THE RESOURCES AGENCY

Department of Water Resources

BULLETIN No. 143-2

CLEAR LAKE WATER QUALITY INVESTIGATION

MARCH 1966

HUGO FISHER
Administrator
The Resources Agency

EDMUND G. BROWN
Governor
State of California

WILLIAM E. WARNE
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FOREWORD

Section 229 of the State of California Water Code directs the Department of Water Resources to

> "...investigate conditions of the quality of all waters within the State ... and report thereon to the Legislature and to the appropriate regional water pollution control board annually, and may recommend any steps which might be taken to improve or protect the quality of such waters."

Under this authorization, the Department of Water Resources, in cooperation with a number of other agencies and organizations, has established a comprehensive surveillance program of all the State's surface waters. Two of the monitoring stations established in this program are located in the Clear Lake drainage basin, one on Clear Lake itself at the city pier in Lakeport, the other immediately below the Clear Lake dam on Cache Creek, the outlet of Clear Lake. These stations have been in operation since 1951, and analyses of the samples, especially the station on the outlet of Clear Lake, have shown consistently high concentrations of boron, a chemical that can be harmful to plant life if present in irrigation waters in more than trace amounts.

As the waters released from Clear Lake are used almost entirely for irrigation, the high boron content, together with other water quality problems, gave the impetus for the start of the investigation.

In initiating the study, meetings were held with local officials and other interested parties. On June 12, 1963 the Lake County Board of Supervisors passed Resolution No. 63-82, requesting that this Department conduct a study of the chemical quality of the waters of Clear Lake and possible contamination of the lake waters by present sewage disposal practices.

A study of the causes and possible control of the undesirable algae concentrations that occur periodically throughout the lake was included in the resolution.

A study of this magnitude is beyond the intent of the authorization and assistance was therefore obtained in those phases of the study in which this Department did not have a primary interest.

To obtain this help and to allow other interested agencies to participate, a meeting was held in August 1963, with representatives of the State of California Department of Fish and Game, Bureau of Sanitary Engineering, Central Valley Regional Water Quality Control Board No. 5, and the Department of Water Resources.

As a result of this meeting an investigative program was developed that consisted of three parts and required the participation of three agencies.

The first part, to be completed by the end of 1963, was undertaken by the Bureau of Sanitary Engineering. This consisted of listing all major beneficial users of water located within the Clear Lake drainage basin and, in cooperation with this Department, determining coliform bacteria concentrations throughout the lake.

The second part, to be conducted by the Department of Water Resources, consisted of establishing and identifying present water quality problems in Clear Lake and possibly recommending a solution. This phase was to be completed by June 1965.

The third phase, under the direction of the Central Valley Regional Water Quality Control Board No. 5, was to make an inventory of and evaluate all sources of waste discharges in the Clear Lake drainage basin. Budgeting procedures did not allow this phase of the work to be started until July 1965, with completion slated for June 1966.

To coordinate these activities, to direct the course of the investigation, and to keep all other interested agencies informed of the progress of the investigation, five interagency meetings were held from October 1963 to January 1965. Representatives from the U. S. Bureau of Reclamation, U. S. Army Corps of Engineers, U. S. Soil Conservation Service, State of California Department of Fish and Game; Department of Public Health, Bureau of Sanitary Engineering; Central Valley Regional Water Quality Control Board No. 5; Lake County Health Department; Lake County Flood Control and Water Conservation District, and the Lake County Mosquito Abatement District, and other interested agencies attended these meetings.

The start of the Clear Lake Water Quality Investigation in July 1963, coincided with the start of an intensive planning study of the Upper Eel River development by the Department of Water Resources in cooperation with the U. S. Bureau of Reclamation, U. S. Corps of Engineers, and U. S. Soil Conservation Service. The initial objective of the Department's program was to determine whether project water from the Middle Fork Eel River should be routed to the Sacramento Valley via Clear Lake or via Thomes and Stony Creeks in Tehama and Glenn Counties. The results of the water quality investigation presented in this Bulletin are being used as a basis for evaluating the effects of routing Eel River water through Clear Lake. The results of these evaluations will be included in the Department's Upper Eel River route selection report, scheduled for completion in June 1967.

Regardless of the routing of the Middle Fork Eel River, if the proposed English Ridge Reservoir on the Upper Main Eel River is constructed, its waters will be routed through Clear Lake. The U. S. Bureau of Reclamation's feasibility report on the English Ridge Project is scheduled for completion in July 1966.

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OF CALIFORNIA—RESOURCES AGENCY WILLIAM E. WARNE, Director

ARTMENT OF WATER RESOURCES
BOX 388
MENTO

December 20, 1965

Honorable Edmund G. Brown, Governor
and Members of the Legislature
of the State of California

Gentlemen:

I have the honor to transmit Bulletin No. 142-2, "Clear Lake Water Quality Investigation".

This investigation was undertaken in cooperation with other state and local agencies to identify and evaluate water quality problems affecting the waters of Clear Lake, one of California's most valuable recreational assets. This report discusses the problems of the lake -- algae, sewage disposal and boron -- together with the environmental conditions relating to them.

The report recommends that three steps be taken:

1. Lake County should implement the algae abatement functions of the Lake County Mosquito Abatement District to undertake further work in the field of algae control.

2. A long-range planning program should be adopted and implemented to ensure the orderly development of adequate sewage treatment facilities as they are needed.

3. All water development agencies give detailed consideration to the possible water quality benefits and detriments which may result from the routing of additional water through Clear Lake.

The data collected during this investigation will be extremely valuable in the future to compare the results of corrective programs and to evaluate the effects of water development projects on the waters of Clear Lake.

Sincerely yours,

William E. Warne

Director

State of California
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DEPARTMENT OF WATER RESOURCES

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This Department would like to express its gratitude not only to them, but also to the Board of Directors of the Lake County Mosquito Abatement District for gratuitously providing office and laboratory space and whose personnel assisted in many phases of this investigation.

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Mr. Arnold Camp, Manager, Lake County Mosquito Abatement District
Mr. Willard D. Hansen, Manager, Lake County Flood Control and Water Conservation District

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State of California Central Valley Regional Water Quality Control Board (No. 5)

State of California Department of Fish and Game

United States Bureau of Reclamation

United States Army Corps of Engineers

United States Soil Conservation Service

Lake County Health Department

CHAPTER I. THE LAKE AND ITS ENVIRONS

Clear Lake, from which Lake County derives its name, is the largest body of fresh water within the borders of the State. Since 1861, it has been a mecca for fishermen, boaters, vacationers, and those who love scenic beauty. Those weary of the roar and bustle of the city come to the shores of the lake for peace and quiet.

On the shore of the lake, the Pomo Indians once lived well. Before the white man cleared the land for his farming operations, the watershed contained most of the sediments, so that the water flowing into the lake was clear. With the forest cover gone, however, the sediments flowing into the lake increased in rate and volume, carrying with them additional nutrients. The nutrients which washed into the lake stimulated the growth of planktonic algae, which today is so abundant as to make the lake appear almost solid at points. The sediments now flowing into the lake are kept in constant suspension by the waves and currents created by winds. At these times, Clear Lake belies its name.

Location

Clear Lake lies some 100 miles from San Francisco and about 80 miles from Sacramento--two major urban centers. A network of high speed freeways (Plate 1) puts the lake within easy driving distance from either city. A first class, two lane highway parallels the perimeter of the lake. Secondary roads radiate into the surrounding countryside.

Three airports about five miles southwest of Lower Lake, near the southeast tip of the lake, and about four miles south of Lakeport, provide easy access by private planes. The area is not served by a scheduled air flight.

Formation

Some millions of years ago a divide existed in the area now occupied by Clear Lake. Waters drained to the east through Cache Creek and flowed to the Sacramento River. West of the divide the waters flowed into Cold Creek and thence into the Russian River. These conditions were changed by a lava flow which blocked the Cache Creek drainage at a point less than a mile northeast of the present village of Lower Lake. Water ponded behind this lava to form a lake. In time, the original divide was breached and the whole area became tributary to Cold Creek on the west. Later, perhaps "some tens of centuries ago", a landslide blocked Cold Creek at the western end. A basin was thus formed between a landslide and a lava flow. In time the lava flow was breached and the ponded waters once again flowed into Cache Creek.

Drainage Basin

The surface area of the lake is 68.5 square miles (U. S. Geological Survey maps). The total drainage area tributary to the lake is about 457 square miles, excluding the lake surface.

The Clear Lake watershed is characterized by northwestward trending ridges and valleys. The area is generally mountainous with several large valleys suitable for cultivation varying from elevations of the surface of the lake (1,318 feet at zero on the Rumsey gage) to 3,924 feet at Cow Mountain in the Mayacmas Mountains which form the west side of the drainage area, and High Glade Lookout at an elevation of 4,840 feet in the Bartlett Mountains to the east of the lake. Most of the valley areas are adjacent to the lake, though some mountains rise abruptly from the lakeshore.

More than 70 percent of the drainage basin has less than 18 inches of soil mantle overlying impermeable formations; the shallowest (0-6 inches) soil mantles occur in the upper reaches of the watershed, where the heaviest precipitation is measured. Runoff starts as soon as this mantle becomes saturated, which is probably after three to four inches of precipitation. According to Department of Water Resources Bulletin No. 14, surface outflow to the valley area nearly equals surface inflow. Because of the shallow soil mantle and the intense precipitation on the upper reaches of the watershed, there is no retention of water by the soil and flooding occurs quite often in Cache Creek, the outlet of Clear Lake.

Climate

Since recreation and agriculture are the two dominant features in the economic life of the Clear Lake area, climate and weather are very important considerations in this investigation. The climate of the Clear Lake Basin is generally characterized by dry summers with high daytime temperatures and wet winters with moderate temperatures. Temperatures are influenced by the prevailing air masses which generally cover the area. In the summer a continual tropical air mass prevails, resulting in the hot daytime temperatures with moderate cooling at night. A marine air mass occupies the area in the winter and as a rule keeps the temperature from dropping below 20 degrees. The rainy season extends for about seven months, from October through April, with approximately 85 percent of the seasonal precipitation occurring during the five month period from November through March with July and August receiving precipitation only in trace amounts.

The Clear Lake area lies on the southern fringe of storms that periodically sweep inland from the Pacific Ocean during the winter. Precipitation consists almost entirely of rainfall although snowfall of insufficient quantity to form a snowpack does occur at the higher elevations. The wet period is by no means a season of continuous precipitation, as the "Pacific High" may assert itself causing many periods of clear, relatively pleasant weather. The mean seasonal precipitation ranges from 23 inches near Kelseyville and 22 inches at Clearlake Park, to as high as 45 inches in the Bartlett Mountains to the east and the Mayacmas Mountains to the west, and 65 inches on Cobb Mountain nine miles south of Clear Lake.

Table 1 shows the mean monthly distribution or precipitation at three selected stations throughout the area.

TABLE 1

MEAN MONTHLY DISTRIBUTION OF
PRECIPITATION AT THREE SELECTED STATIONS
1954 to 1964

Month	Upper Lake		Lakeport		Clearlake Park	
	Precipitation (Inches)	Percent of Seasonal Total	Precipitation (Inches)	Percent of Seasonal Total	Precipitation (Inches)	Percent of Seasonal Total
July	0.08	0.2	0.03	0.1	0.02	0.1
Aug.	0.26	0.7	0.11	0.4	0.12	0.5
Sept.	0.65	1.9	0.47	1.7	0.58	2.4
Oct.	2.34	6.8	2.20	7.9	1.74	7.3
Nov.	3.93	11.3	2.80	10.0	2.58	10.8
Dec.	4.36	12.7	4.35	15.5	3.84	16.0
Jan.	7.78	22.6	5.94	21.2	4.85	20.3
Feb.	6.79	19.7	5.61	20.1	5.19	21.6
March	4.34	12.4	3.13	11.2	2.29	9.6
April	2.65	7.6	2.38	8.5	2.02	8.5
May	1.23	3.6	0.80	2.9	0.54	2.4
June	0.19	0.5	0.15	0.5	0.12	0.5
Total	34.60		27.97		23.89	

Temperatures are considered moderate in winter, although an extreme low of 7° F has occurred at Clearlake Park, with extreme lows of 14° F at Lakeport and 17° F at Upper Lake. The growing period is fairly long, with a range around the lake from about 195 days in the Lower Lake and Big Valley areas to 217 days at Upper Lake. Extreme high temperatures recorded in the basin are around 110° F.

Average maximum temperatures during January are 52.3° F at Lakeport and Clearlake Park, and 54.3° F at Upper Lake. Average maximum temperatures usually occur during July with 93.8° F at Lakeport, 94.3° F at Clearlake Park, and 93.2° F at Upper Lake.

The average annual temperatures for three stations around the lake are shown in the following tabulation. The temperatures presented are the arithmetic averages of the daily minimum and maximum.

Station	Mean Temperature Maximum	Mean Temperature Minimum	Extreme Temperature Maximum	Extreme Temperature Minimum
Upper Lake	93.2	32.2	111	13
Lakeport	93.8	30.4	110	14
Clearlake Park	94.3	31.8	108	7

Mornings at Clear Lake are usually calm, and the afternoons breezy. Prevailing winds are from the west, with velocities during January, February, and March tending to be higher than during the remainder of the year. Because of the long reach of the lake, such winds cause waves to "pile up" sufficiently to be a hazard to small craft in the late afternoon. As will be shown in Chapter II, these winds play an important part in the human and biological life of Clear Lake.

Economic History

The Pomo tribe of Indians that inhabited the Clear Lake area before the coming of the White Man were the first people to establish a primitive economic base in the area.

This tribe, compared to others in California, was most fortunate. They lived in an area that abounded in game and fish and had an apparently inexhaustible supply of obsidian, or lava glass, with which to make weapons and tools. The climate was ideal, lacking the severity of the winters in the Sierras and Cascades, and being high enough in elevation to be protected against the rainy season floods of the lower valleys.

An added benefit was the numerous hot springs in the area that supposedly provided relief for many of their physical aches and pains. Undoubtedly, because of these advantages, a great deal of commerce was carried on between them and other tribes of California.

The first known contact these people had with White Men was with the hunters and trappers of the Russo-American Fur Company around 1811. By 1836, General Vallejo was using the large valleys around the south, west, and North sides of the Upper Arm for grazing cattle.

The discovery of gold in California signalled the end of the Indian era in the Clear Lake area. In 1861, Lake County was created out of Napa County. The early economy of Lake County was based on agriculture and mining with livestock and grain as the earliest farm products. Following the occupation of valley lands, the dairy industry began to assume importance. Barley and corn were produced to feed the cattle. Because of the difficulty of transporting the bulky and perishable dairy products, cheese making became one of the first industries.

Land under cultivation increased from 9,000 acres in 1868 to almost 15,000 acres in 1880 with most of the acreage devoted to wheat. Several flour mills were built and wheat was milled for both local consumption and outside sales. The fruit industry began to assume some importance as early as 1868. Bartlett pears, for which the Clear Lake area is famous, were first grown about 1885.

The Clear Lake area became a well developed vacation and recreation area before the turn of the century. Large resorts were usually built up around the numerous mineral and hot springs of the area. These became popular as convalescent as well as vacation spots. Though the lake itself has always been popular for boating and fishing, development of resort areas around its perimeter did not take place to any extent until the advent of good automobiles and good road systems.

Mineral production, though declining in statewide importance, has continued to be of importance to the local economy. Production of crushed stone, sand, and gravel have replaced mercury as the major mining product. In 1961, the production of sand and gravel was valued at $384,000, while the production of all other minerals was valued at less than $190,000. 1/

The timber industry compares to that of the mining industry. The need for timber for shoring in the mines created a large demand while the mines were in operation, but as the mining dwindled, the need for timber also dwindled. The timber industry no longer exists in the Clear Lake drainage area as adequate supplies to support such an industry have been depleted. The present economy of the Clear Lake area is derived mainly from agriculture and recreation.

In 1960, over half of the 40,000 acres under cultivation in Lake County were devoted to orchards, the main crops being pears and walnuts, with about twice as much acreage being devoted to walnuts as pears. These two crops account for 80 percent of the total agriculture economy. 1/

The agricultural shift to tree crops has brought about a few changes in economy of the area. No longer is there a need for flour mills or cheese factories. These have been replaced by the packing and processing plants for the fruits and nuts.

The orchard harvest starts in August. As the pear season nears its end, the harvesting of walnuts begins. Harvesting and packing provides seasonal employment for a great number of residents and itinerant help. Work

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1/ U. S. Bureau of the Census

in the orchards, such as irrigating, spraying and pruning provides a great deal of off-season employment and is usually done by local people.

Recreation, especially water-associated recreation, and its related activities contribute a great deal toward the economy of the area. Wilsey and Ham, in their study of the Cache Creek Basin in 1958, estimated a gross expenditure by recreationists in the area of over 15 million dollars annually. The development of much of the shoreline area for resorts and summer homes has been going on at an accelerating rate since modern highways have made the area more easily accessible. The demand for frontage on the lake for resorts has become so great that developers are finding it feasible to fill in low lying swamp lands to make more building spaces available.

During the tourist season many local residents of high school and college age work at the motels and resorts in the area.

Land Use

Most of the urban sites at Clear Lake are near the shoreline. Many of the houses, in both high and low density areas, are occupied during only a part of the year, or portions of the week throughout the year. The high density areas are not sharply divided by legal boundaries, but tend to merge into one another. Progressively around the lake clockwise these areas are Lakeport, Nice, Lucerne, Glenhaven, Clearlake Oaks, Clearlake Highlands, Jago Bay, Konocti Bay, Buckingham Park, and Soda Bay. Lakeport, the county seat, is the only incorporated city in the area.

Other communities that have developed within the area, but away from the lake are Upper Lake, Lower Lake, Finley, and Kelseyville. These communities have no water associated recreation industry. They exist largely to serve the agricultural interests of the area.

Although less densely populated, the irrigated valleys surrounding Clear Lake are intensively used. Irrigated agriculture utilizes some 28 square miles around the lake. (4) The principal crops grown are pears, pasture, alfalfa, walnuts, and grapes. In 1951, approximately 70 percent of the total agricultural lands in production were devoted to pears and walnuts, which accounted for 80 percent of the area's total income from agriculture. (1)

The livestock industry is important to Lake County, but most of the cattle raising occurs in areas outside the Clear Lake drainage basin, with approximately 5,000 cattle being marketed in 1959. 1/

Industry

There is little industry in the Clear Lake drainage basin. What there is, is associated with sorting and packing the pear and walnut crops for export. Some mining occurs largely for earth materials for decorative purposes, such as colored rock. Clear Lake has the distinction of being the only lake in California supporting a commercial fishing business.

Clear Lake has approximately 71 miles of shoreline, of which about 39 miles is developed for water associated recreation and permanent or summer homes. A recreation study of the Cache Creek area, made in 1958, showed that in 1950, there were more than 1,000 seasonal dwellings around the perimeter of the lake. (5)

About half the lake's edge is highly developed with boat marinas, swimming beaches, and parks. The longest stretch of undeveloped shoreline is between Lakeport and Soda Bay, where only the Lake County Park and Clear Lake State Park provide access to the water.

1/ U. S. Bureau of the Census

Many of the commercial establishments operate only during "the season", from about Memorial Day to Labor Day. Accommodations are available to handle 6,850 persons per night in a wide range of hotels, motels, cabins, trailer and tent camps. There are approximately 135 piers or docks, 40 boat ramps, 15 beaches, 7 boat repair shops, and 26 marine supply houses. (5)

Population

The exact population within the Clear Lake areas is not known. The population of Lake County rose from 5,402 in 1920 to 13,786 in 1960, the date of the last census. 1/ The percentage increase is less than that for the State as a whole. The population density of the County is lower than that of any neighboring county.

Population growth throughout the County has been relatively slow. In 1960, the permanent population living around the periphery of Clear Lake was estimated at 8,300. There were about 5,500 persons residing in Lake County outside the lake area. In 1963, the Department of Finance estimated the permanent population of Lake County at 15,300.

The population is a mature one. A comparison of the age distribution in Lake County and California in 1950 and 1960 is shown in the tabulation below.

	1950 (Percent)		1960 (Percent)	
Age Group	Lake County	State	Lake County	State
0 - 14	23.3	24.6	23.8	30.2
15 - 64	62.0	66.9	56.4	61.2
65 & over	14.7	8.5	19.8	8.6

1/ U. S. Bureau of the Census

It is throught that the high percentage of those in the "65 & over" age group is primarily due to the influx of retired persons. This hypothesis is supported by the low percentage of people in the area in the labor force. The ratio of persons not in the labor force (including children under 14) to persons in the labor force is 1.91 to 1, as compared to the State average of 1.44 to 1.

The Lake

Clear Lake is the largest natural lake entirely within California. The length along its long axis, from Rodman Slough Bridge to its outlet at Cache Creek, is approximately 18 miles. It is eight miles wide at its widest part. When the lake is at a level of 7.5 feet on the Rumsey gage the total area of the lake is 68.5 square miles, with a shoreline approximately 71 miles long and an average depth of 26 feet. The maximum depth of 60 feet occurs in the Oaks and Lower Arms.

The lake is not fed by perennial streams, thus its level is determined by runoff from precipitation. The lake's elevation, therefore, follows the same seasonal pattern as the precipitation. The level of the lake is now controlled by an impounding dam that was constructed on the Cache Creek outlet in 1915 by the Yolo Water and Power Company. The purpose of the dam is to retain winter runoff for release during the irrigation season. The dam is operated under a court decree that allows the lake to fluctuate between zero and seven and one-half feet in elevation based on an established reference plane referred to as the "Rumsey Gage". This fluctuation occurs mostly during the irrigation season, starting out at the maximum seven and one-half feet at the beginning of the season and dropping to near zero at the end of the growing season in September, before the winter rains begin. The natural level of the lake is controlled by a natural barrier in the Cache Creek outlet called the Grigsby Riffle. This riffle is approximately three and one-half feet below zero on the Rumsey gage. Unless otherwise stated, all surface areas and depths cited in this report will be referenced to seven and one-half feet on the Rumsey gage.

Clear Lake consists of three bodies of water. Each arm can be treated limnologically as a separate lake, with the Upper Arm being separated from the Oaks Arm (east arm) and the Lower Arm by a natural constriction called the "Narrows". For purposes of this report, the Upper Arm is defined as that portion of the lake north of an east-west line drawn between the eastern tip of Buckingham Point and the southern tip of Glenhaven Point (see Plate No. 1). The Oaks Arm is defined as that part of the lake east of a north-south line drawn from the southern tip of Glenhaven Point to the western tip of Sulphur Bank Point. The Lower Arm is the remainder of the lake to the outlet of Cache Creek near Indian Island.

The Upper Arm, the largest of the three arms, is approximately circular having an extreme length of ten miles and an extreme width of eight miles. It has a water surface area of approximately 31,500 acres (49 square miles), about 72 percent of the total area of the lake. The average depth of the Upper Arm at this lake level is a little more than 23 feet, with a total storage capacity of more than 730,450 acre feet of water. 1/ This is approximately 63 percent of the total volume of the lake. These figures are summarized in Table No. 2. The 35 miles of shoreline around this arm make up approximately 50 percent of the total shoreline of the lake and is more varied in character than elsewhere around the lake. This character varies from the gently sloping

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1/ Obtained by planimetering contours from U. S. Coast and Geodetic Survey hydrographic map of Clear Lake dated January 1949.

flat lands of Big Valley on the southwest side to the abruptly rising foothills of Pine Mountain and Pepperwood Cove on the east and Mount Konocti at Soda Bay. Except for the Clearlake Highlands area on the Lower Arm, and the Clearlake Oaks area on the Oaks Arm, the Upper Arm has the only terrain suitable for development into large densely populated urban areas.

The Oaks Arm is the smallest of the three arms and has the smallest drainage area surrounding it. Trending in an east-west direction, it is approximately four miles long and a mile and one-half wide at its widest point. It has a water surface area of approximately 3,100 acres or seven percent of the total area of the lake. Though it has a much smaller area than the other two arms, it is deeper, having an average depth of approximately 36 feet. The total volume of the Oaks Arm is approximately 11,400 acre feet, or ten percent of the total lake.

With seven percent of the area and ten percent of the volume, the Oaks Arm contains approximately 17 percent (12 miles) of the total shoreline of the lake. The entire shoreline, except for the east end, is characterized by abruptly rising hills with narrow terraces of land near the shore which allow some permanent home and summer home development to take place.

The eastern end of this arm is a large, gently sloping area that was once a tule bog. The community of Clearlake Oaks is being built on this land, now being reclaimed by importing fill material. The famed Sulphur Bank Mine is located on the southeastern shore of this arm and can easily be recognized by the large mounds of tailing wastes that surround it, or by the smell of sulphur that sometimes pervades the air. On cold mornings, plumes of steam rise in the air from the hot water or steam wells that have been drilled on the property.

The Lower Arm is the outlet for Clear Lake, being drained by Cache Creek which starts just south of Indian Island. This arm is irregular with the axis of the arm trending in a northwest-southeast direction. It is approximately eight and one-half miles long and at its widest point, between Konocti Bay and Pirates Cove, approximately two and one-half miles wide. It has about 9,200 acres of surface area, which is 21 percent of the total area of the lake, with an average depth of approximately 34 feet. The north end of this arm is deepest, sloping upward to the shallow outlet at Cache Creek. The total storage in the arm is approximately 311,200 acre feet, or 27 percent of the total volume of the lake.

The Lower Arm has a shoreline of approximately 24 miles, or 33 percent of the total lake shoreline. It is varied, going from the steep shoreline caused by volcanic action from Mount Konocti to alluvial plain or valley in the Burns Valley area where the Clearlake Highlands community has developed. Cache Creek outlet has been formed by natural filling in on part of the old lakebed.

TABLE 2

Summary of Surface Area, Volume, Average Depth, and Shoreline of Each Arm of Clear Lake

	Upper Arm	Oaks Arm	Lower Arm
Surface Area in Acres	31,500	3,100	9,200
Percent of Total Area of Lake	72	7	21
Total Volume of Water in Acre Feet	730,450	111,400	311,200
Percent of Total Volume of Lake	63	10	27
Average Depth in Feet	23.2	36.5	33.8
Total Length of Shoreline in Miles	35	12	24
Percent of Total Shoreline of Lake	50	17	33

CHAPTER II. HYDROLOGY, WATER QUALITY, AND BIOLOGY

A water quality study of a lake should include consideration of all factors that could influence the quality characteristics of the lake. This includes a study of all inflowing waters, a study of water as it remains in the lake and a study of waters leaving the lake.

Evaluations should be made of the effect that nature and man have on these waters. This chapter deals with these studies and evaluations.

Water Inflow to the Lake

There are three sources of inflow to Clear Lake; (1) runoff from precipitation, (2) subsurface flow from ground water, and (3) irrigation return flow.

Runoff from precipitation is the only significant source of inflow.

Though there are some extensive geologic formations surrounding the lake that contain ground water, there is no evidence to show that water from these formations feeds the lake. Either the aquifers do not extend under the lake, or the thickness of the sediments of the lake bottom prevents any large scale interchange.

Soda Bay is the only known area where springs flow to or within the lake. The water coming from these springs is warm and highly mineralized. The locations of these springs are shown on Plate 1. In numerous places throughout the lake, springs appear to be bubbling up; but they are actually gas vents that do not bring water into the lake.

Reclamation districts which have been created near the Upper Lake area to reclaim low lying land adjacent to Rodman Slough pump all of their irrigation return flow and drainage water to the lake. These return waters are of minor importance in the total inflow to the lake. No measurable flows have been observed in drainage from Big Valley and Scott Valley.

The estimated average yearly inflow to Clear Lake from runoff has been estimated at 445,000 acre feet. (1) More than 70 percent of the total drainage area contributing this volume of inflow is tributary to the Upper Arm of the lake and is drained by six major streams: Kelsey Creek, Adobe Creek, Highlands Creek, Scott Creek, Middle Creek, and Clover Creek. Gaging stations have been established on all of these.

These gaging stations measure the runoff from approximately 155 square miles of drainage area (30 percent of the total drainage area) which contributes approximately 45 to 50 percent of the total inflow to the lake. (2)

Quality of Inflowing Water

Water quality may be defined in various ways. To the agriculturist, good quality water means water that does not contain high enough concentrations of dissolved minerals to be harmful to his plants. The farmer is not usually concerned about the physical and biological characteristics of water. The recreationist is usually not too concerned about the chemical characteristics of water, but does demand water that is pleasing to the sight, smell, and touch, and free from disease carriers.

Usually when we discuss the quality of water we are considering its physical properties, its dissolved mineral content, and its biological characteristics. When we talk of good quality water we must state the use to which the water will be put. The criteria against which water is rated is included at the end of this report.

Physical Quality

The physical properties of the lake water that were determined during this investigation were the thermal and optical properties of the water such as temperature, turbidity, and transparency.

Temperature. Many of the chemical and biological properties of water are functions of the temperature of the water. The growth of all organisms in water is limited by the range of temperature of the water and practically ceases at temperatures below 35° F and above 90° F.

Temperature changes in bodies of water may result from natural climatic conditions or from the introduction of industrial wastes such as cooling waters. Temperature has an effect on the viscosity of water. Raising the temperature of water reduces its viscosity the same way that heating of honey makes it easier to pour. This is important in Clear Lake as the water is more easily moved about by currents during the warm summer months, allowing better circulation of dissolved minerals and nutrients.

The temperature also has an effect on the ability of water to absorb gases such as oxygen and carbon dioxide. The warmer the water, the less gas it can absorb.

At the start of the rainy season the temperature of the water of inflowing streams is lower than that of the lake. However, as the winter season progresses, the cooler inflowing waters and the cool winter air absorb the heat from the lake's waters until the temperature of the lake and the temperature of the inflowing water equal each other. This equalization usually occurs within a period of approximately one month after inflow begins.

Temperature measurements of inflowing water immediately following the storm of mid-November 1964, from Scott, Middle, and Clover Creeks that enter Clear Lake through Rodman Slough indicated that thermal stratification of the colder inflowing water did not occur.

The temperatures of the springs in Soda Bay remain relatively high (87° F) throughout the year. The amount of water moving in from these springs is so small it does not effect the temperature of the surrounding water.

Sediment Loads. Sediment load studies were not considered in this investigation. However, a report by the U. S. Department of Agriculture Soil Conservation Service (9) estimated that the annual sediment production rate above Clear Lake is about three-tenths of an acre-foot per year per square mil of catchment area. The lake, as a whole, has approximately 457 square miles of drainage area. It would thus take approximately 320 years to deposit silt to a depth of one foot at the bottom of the entire lake. With an average depth of 18 feet, assuming that the sedimentation rate is correct and that all other factors remain constant, the lake will be filled to an elevation of zero on the Rumsey gage by the year 7700.

Chemical Quality

Natural waters are never completely pure. During their passage over or through the ground, they acquire a wide variety of dissolved chemicals or impurities. These impurities are seldom in large concentrations in the ordinary chemical sense, nonetheless, they can modify the chemical behavior or usefulness of the water's intended purpose.

The dissolved chemicals range from gases like oxygen through the numerous inorganic materials such as calcium and magnesium to the complex organic compounds that are characteristic of sewage or other water borne wastes.

Many tests are employed in the examination of water samples for very different and definite purposes, the essential purpose being to determine the fitness of the water for the use it is to serve. Some of these tests give direct information and some are inferential.

Determinations of the hydrogen-ion concentration (pH), dissolved oxygen (DO), hardness, electrical conductivity (EC), dissolved solids, nutrients, and organic constituents were made during this investigation.

The chemical quality of inflow is typical of all streams flowing from the North Coast Mountain Range of California. The chemical constituents are in low concentrations during the heavy flows in the rainy season and gradually increase in concentration as the flow diminishes. This increase is relatively minor. Almost all the water entering the lake is of excellent quality; however, one stream, Seigler Creek, can contribute water to the lake having high boron concentrations (2-3 ppm) during periods of extremely low flow. This stream does not enter the lake proper but discharges into Cache Creek approximately three miles upstream from the Clear Lake Dam. During irrigation season, inflow from Seigler Creek mixes with the water in Cache Creek and leaves the area with the water being withdrawn for irrigation downstream. When water is not being withdrawn from Clear Lake through Cache Creek, waters from Seigler Creek can migrate to Clear Lake. It is doubtful that the high boron concentration in Seigler Creek waters has any noticeable effect on the waters of Clear Lake.

Quality of Lake Water

To determine the quality of the water in Clear Lake, many tests were made; not only for the dissolved chemical and biological constituents, but also for its physical properties.

At the start of the investigation 31 sampling stations were established in Clear Lake. Their locations are shown on Plate 2. Their selection was based on adequate coverage of the lake and on ability to be referenced to prominent landmarks for revisitation.

Stations 5, 9, and 16 were located near the major inflows from streams. Station 15 was located at a site established by the Lake County Mosquito Abatement District prior to this investigation. Since not all stations could be visited in one working day, the 16 stations in the Upper Arm were visited on the same day and the remaining 15 were visited on the following day.

As the investigation progressed, a high degree of correlation was noted among most of the stations and it was possible to reduce the number visited to nine and still maintain adequate coverage for the purpose of this study.

Five of these stations (4, 6, 12, 13, and 15) are located in the Upper Arm, one (22) is in the Oaks Arm, and the remainder (24, 28, and 30) are in the Lower Arm. This reduction in number of stations made it possible to visit all stations on the same day.

Data collected at each station included: transparency (by Secchi Disk), surface to bottom temperature, and specific conductance profiles, and the pH and dissolved oxygen (DO) near the surface and bottom of the lake. Turbidity, ortho phosphate (PO_4), ammonia (NH_4), nitrate (NO_3), sulfate (SO_4), and boron (B) analyses were made at a field laboratory in Lakeport. Additional analyses were made from time to time for nitrite (NO_2), copper (Cu), total and soluble iron (Fe), and manganese (Mn). The values of the above determinations are presented in Tables 3 and 4.

Additional samples were submitted to the Department's chemical laboratory to be analyzed for calcium, magnesium, potassium, alkalinity, chloride, hardness, organic nitrogen, total and organic phosphate and total dissolved solids. These data are presented in Tables 5 and 6.

Except where otherwise noted, all values of determinations are reported in parts per million by weight (ppm).

Physical Quality

The physical properties of the lake water determined during this investigation were temperature, turbidity, and Secchi Disk transparency.

Temperature. A temperature profile from surface to bottom was made at each station using a portable thermistor unit, with each station being visited at least once monthly.

The temperature of the lake follows the same general cycle as the seasons with the lowest surface temperature occurring during February (39°F to 42°F). As solar radiation increases, the lake warms; by July or August the temperature reaches its maximum of 80°F to 84°F. The lake surface begins to cool by September, and as the winter season approaches colder air temperatures and colder runoff water cause the lake to cool toward the February minimum. Figure 1 shows the variation in average water temperature of the lake at Lakeport over a ten year period.

Surface temperatures throughout the lake vary due to the warming effect of ambient air temperature and the absorbance of solar energy by the turbid waters, or the cooling effect of inflowing streams or local wind action. Figure 2 shows the surface temperatures at five representative stations from the summer of 1964 to the summer of 1965. Station 4 is influenced

Figure 1. Seasonal variations of the temperature of Clear Lake measured on a monthly basis at the Lakeport City Pier from 1956 to 1965. Releases from the lake through the Clear Lake Water Company Dam and

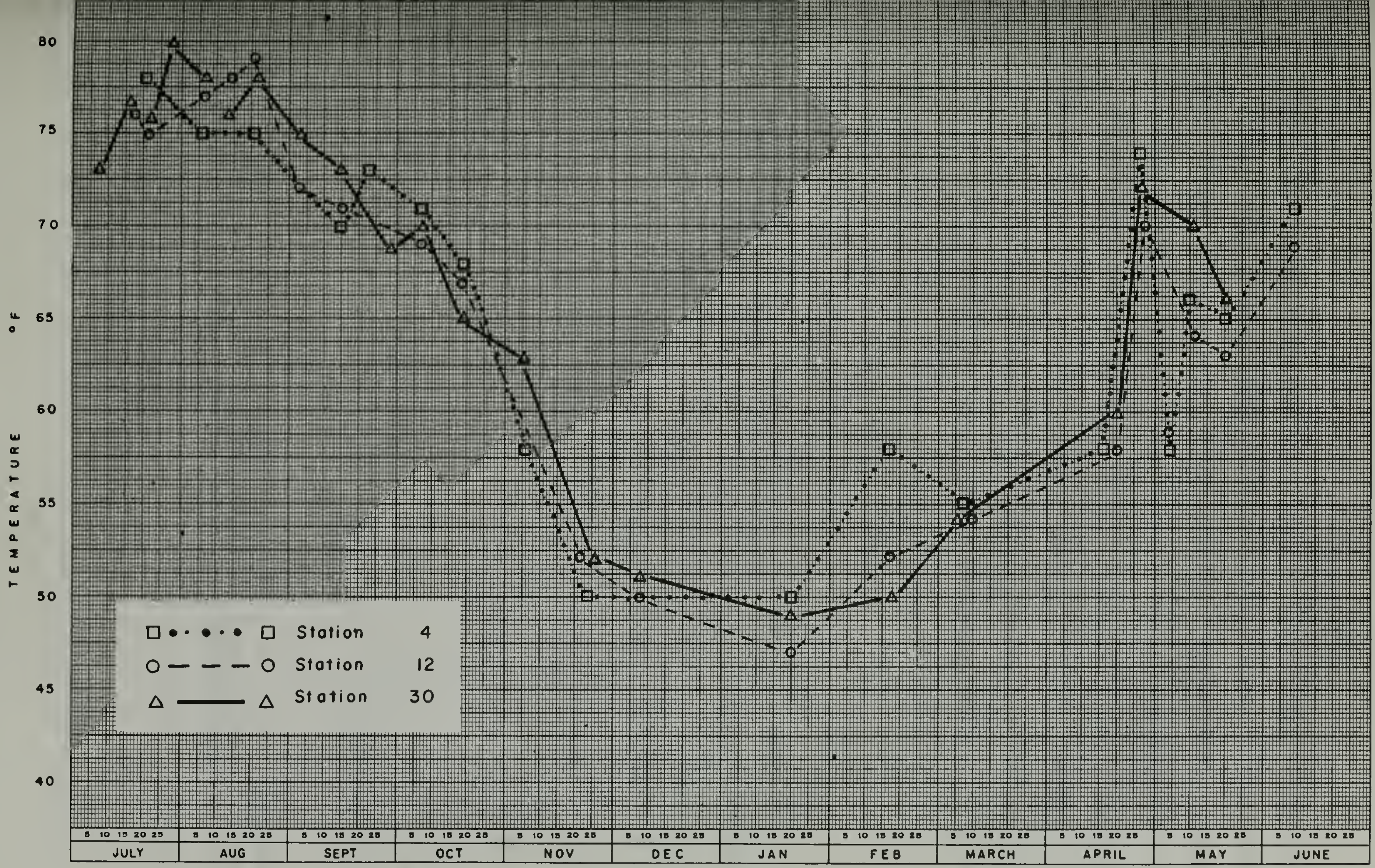


Figure 2. A comparison of the variation of the lake's surface temperature at three representative stations from July 1964 to June 1965.

in the winter months by the inflow of runoff through Rodman Slough. Station 13 is usually more turbid than the others and Station 22 is usually affected by high wind.

Thermal stratification of the lake waters resulting from calm periods is generally infrequent and is usually short-lived. The frequent strong winds create wave action and currents that keep the lake thoroughly mixed. Figure 3 shows a number of temperature profiles from a selected station (28) and illustrates this short-lived stratification.

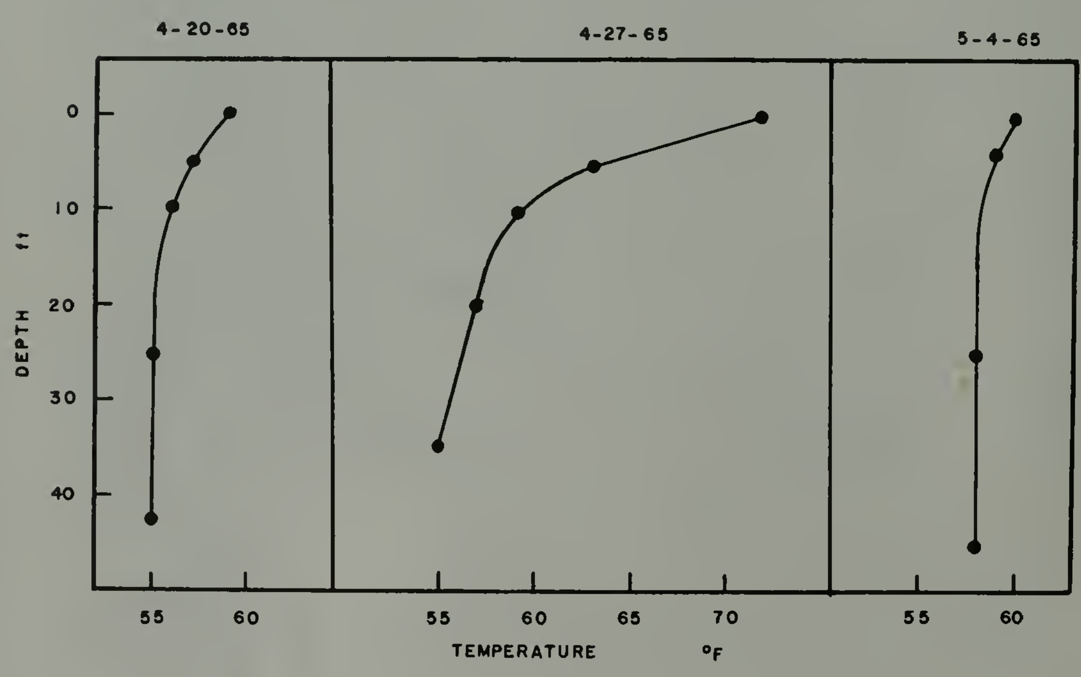


Figure 3. Temperature Profiles obtained on three successive weeks (April 20, 27, and May 4, 1965) at Station 28.

Turbidity. The turbidity of water is due to suspended clay, silt, finely divided organic matter, microscopic organisms, and similar substances. Turbidity is measured by comparing the interference of suspended matter to the passage of light through a known sample. All turbidity measurements were made on samples of water collected within two feet of the surface. The degree of turbidity was determined by comparing the percentage of light transmitted through a sample to that of a known sample using a photoelectric colorimeter that had been calibrated to read direct in Jackson Candle Units.

The effect of turbidity is to diminish the penetration of light, which can have a profound effect on aquatic life.

With a lesser penetration of light, photosynthesis is reduced, decreasing the primary productivity upon which the fish food organisms depend. As a consequence, fish production is diminished. High turbidity can also make it hard for fish to find food, even though smaller fish may be protected from predators. Extremely high concentrations of turbidity can also be directly lethal to fish and other aquatic life.

Turbidity can also modify the temperature structure of lakes by absorbing most of the solar energy at or near the surface; as a result, the bottom temperatures are lower.

A rise in turbidity in Clear Lake generally is the result of currents stirring up the sediments from the bottom of the lake or of sediments brought into the lake by inflowing waters and from biological growth.

The highest turbidity readings were found in the more shallow Upper Arm of the lake where the prevailing northwest winds have ample reach to cause wave action and currents. The largest concentrations of inflow also occur in this arm.

As the water moves from north to south through the lake toward the outlet, mixing causes a more uniform turbidity and when the waters reach the deeper, more wind-protected areas of the lake, some of the turbidity causing sediments drop out. As a result, the lowest turbidities are found in the Lower Arm. The highest turbidity recorded in the Lower Arm during the winter of 1964 was about one-fourth that of the Upper Arm (350 Jackson Candle Units at Station 12 in the Upper Arm compared to 95 Jackson Candle Units at Station 2 in the Lower Arm).

The highest turbidity readings in the lake (350 Jackson Candle Units) were measured at Station 12 in the Upper Arm in January 1965. This value had dropped to 25 Units when measured in May 1965.

The lowest turbidity measurements (5 Jackson Candle Units) were recorded at a number of different stations in the Lower and Oaks Arms at various times of the year, though mostly in the spring and late fall during periods of calm weather.

Figure 4 shows the turbidity readings from July 1964 to June 1965 at four selected stations in Clear Lake.

Another method for determining the transparency of lake waters, in a restricted sense, is by determining the depth to which objects may be seen by an observer. This measurement is made by lowering a horizontal white and black disk, 20 cm in diameter, called a Secchi Disk, until it disappears from view and then raising it until it reappears. The average of the two depths is taken as the Secchi Disk transparency. Though the measurement of transmission of light through water has been refined by the use of photosensitive instruments the simple procedure of measuring the transparency with the Secchi Disk still retains its value.

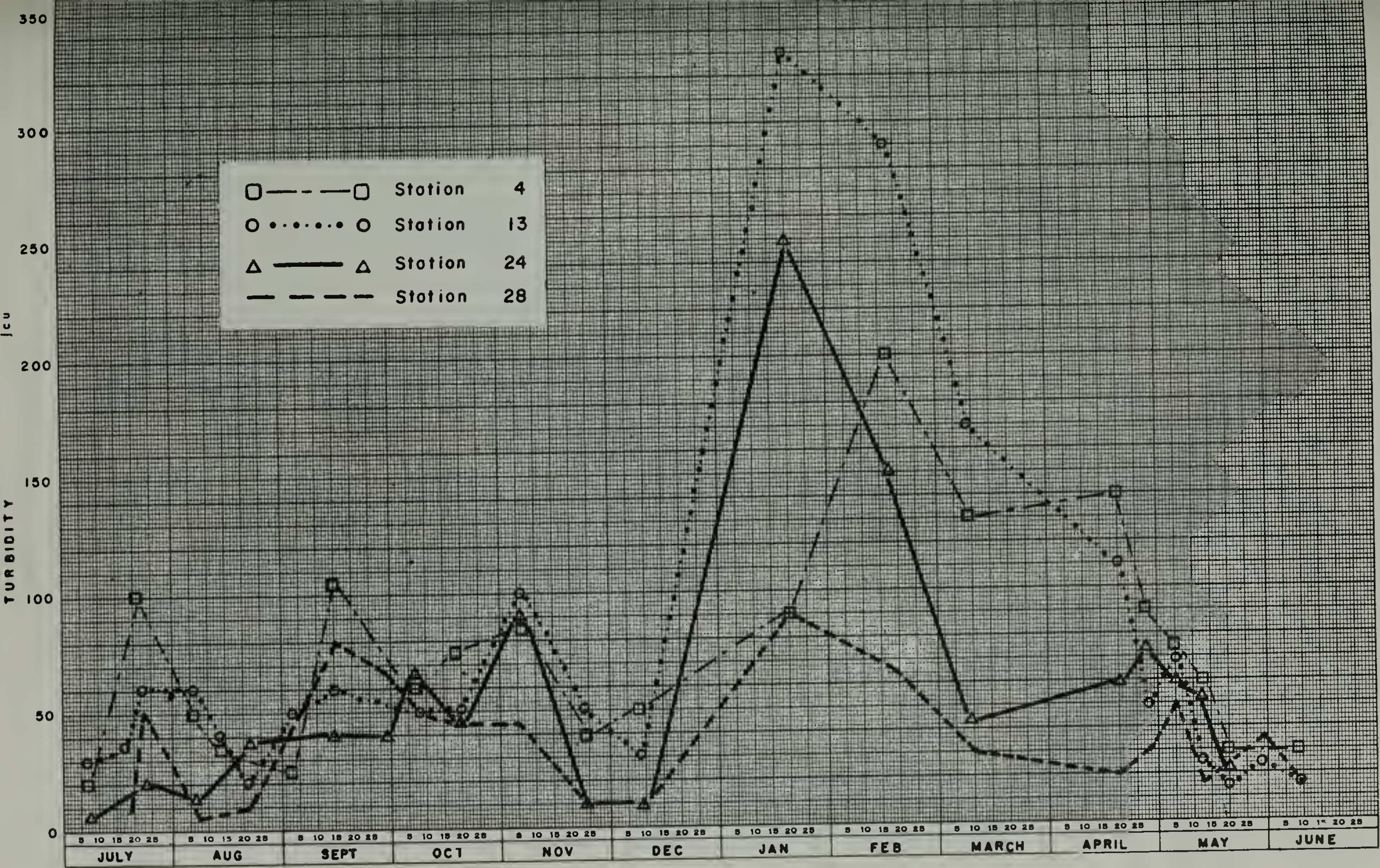


Figure 4. Comparison of turbidity value determinations at four stations from July 1964 to June 1965. Station 4 is influenced by runoff. Stations 13 and 24 are influenced by winds. Station 28 is a deep, wind protected area.

There is a general correlation between turbidity readings and Secchi Disk values. The Secchi Disk is observable at greater depths during the spring and summer, when turbidity values are low, than during the stormy winter months when turbidity values are high.

Because of the general high turbidities of the Upper Arm, Secchi Disk readings in this area were lower than in the Lower and Oaks Arm of the lake, generally averaging about 1.0 feet. The lowest reading in the Upper Arm (0.4 feet) was measured at all stations in the Upper Arm during January and February 1965 (Table 3).

The deepest observations recorded (5.5 to 7.0 feet) occurred in May 1965.

By comparison, the Oaks and Lower Arms readings generally average between one and two feet. The lowest value recorded in these two arms was 0.6 feet at stations 22 and 24 during February 1965. Stations 28 and 30, at the same time, had Secchi Disk readings of 1.1 and 1.2 feet.

The highest values in these two arms are comparable to the highest readings observed in the Upper Arm -- five to seven feet.

The Secchi Disk transparencies for four selected stations in the lake made from July 1964 to June 1965 are shown in Figure 5.

Dissolved Chemical Quality

Water samples collected from the lake for chemical analyses were obtained from within two feet of the surface and at the bottom using a 1200 cc Kemmerer type sampler.

Analyses for the dissolved oxygen, pH, and electrical conductivity were made immediately at the time of collection. All other samples were analyzed either in a field laboratory in Lakeport or were transported to

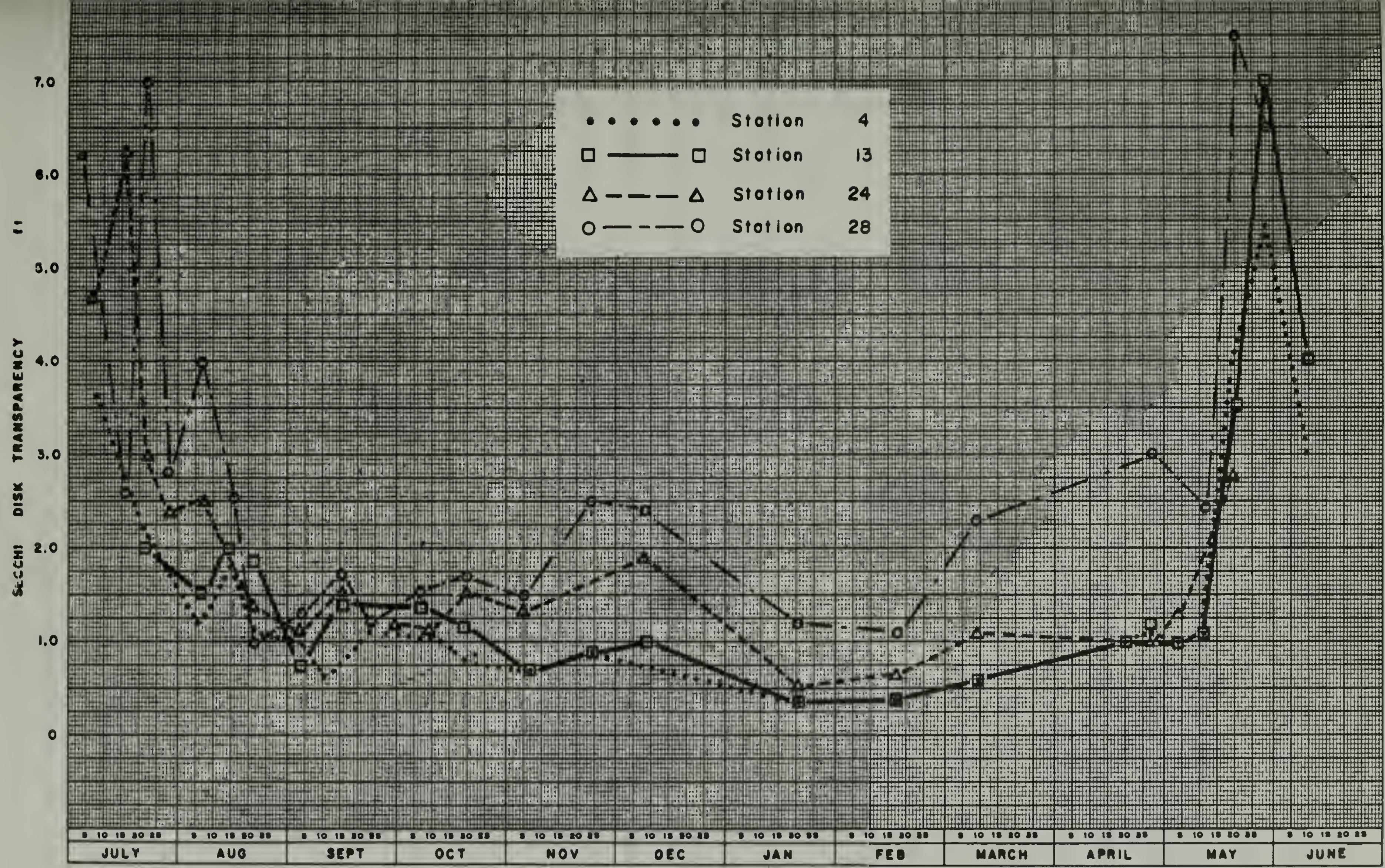


Figure 5. A comparison of Secchi disk transparency measurements at four selected stations from July 1964 to June 1965.

Sacramento for analyses in the Department of Water Resources chemical laboratory.

The waters of Clear Lake can be classified as a magnesium-calcium bicarbonate type, based on a system that classifies the water by the predominant cations and anions in the water. The magnesium and calcium content combined make up more than 80 percent of the reacting values of the cations with each being present in almost equal values.

Typical of many other fresh waters, the bicarbonate ion is the predominant anion and is responsible for more than 80 percent of the reacting values of the anions (Table 6).

The ionic composition of the water in Clear Lake is typical of all waters in the coastal range which are influenced by the inflows of winter rains, followed in summer by long periods of intense evaporation with little or no inflow. A comparison of the chemical constituents of the waters in Clear Lake is made with those from the Eel River and Lake Tahoe in the following tabulation. Electrical conductivity is in micromhos; mineral constituents are in parts per million.

TABLE 6

Mineral Constituents	Date	Clear Lake at Lakeport	Eel River near Dos Rios	Lake Tahoe at Tahoe City
Electrical Conductivity	5/60 9/60	235 276	169 228	93 93
Calcium	5/60 9/60	20 22	19 24	9.6 8.0
Magnesium	5/60 9/60	13 15	6.9 8.0	1.9 3.3
Sodium	5/60 9/60	7.8 11.0	5.3 10.0	5.4 6.3
Potassium	5/60 9/60	2.2 1.7	1.1 1.5	1.8 1.2
Bicarbonate	5/60 9/60	138 158	94 114	55 56
Sulfate	5/60 9/60	6.0 6.0	10.0 18.0	1.0 1.2
Chloride	5/60 9/60	4.9 6.8	3.5 5.5	1.2 1.4
Nitrate	5/60 9/60	0.9 4.6	0.2 0.1	0.0 0.1
Boron	5/60 9/60	1.2 0.8	0.2 0.5	0.0 0.0
Total Dissolved Solids	5/60 9/60	138 156	104 132	60 62
Hardness as Calcium Carbonate	5/60 9/60	103 118	76 93	32 33

pH. Generally speaking, the pH of a water describes its place on an alkalinity-acidity scale.

The pH is measured on a scale from 0.0 to 14.0 with 7.0 being considered the neutral point. A reading below 7.0 indicates acidic waters; a reading above that indicates alkaline water.

L. V. Wilcox in an article in the Sewage Works Journal (20:24-1948) states that waters with pH values over nine are unsuitable for irrigation purposes.

The permissible range of pH for fish depends on many other factors such as temperature, dissolved oxygen, prior acclimation and the concentrations of various cations and anions. It has been concluded that direct lethal effects of pH are not produced within a range of 5.0 to 9.5, but from the standpoint of productivity it is best to maintain the pH in a range of about 6.5 to 8.5.

The pH of each sample collected was determined by use of a portable pH meter immediately after the sample was collected. The samples were taken from the surface and bottom at all stations.

The pH of the waters of the lake is extremely variable. In some areas it correlated fairly well with algae production. When algae production was high, the pH values were high, and when algae production decreased, the pH values were lower. For the period measured, there were no pH values below 7.2 or higher than 9.7 (Tables 3 and 4). Generally, the values remained below 8.0 during the winter months. As algae production increased pH values increased to between 8.0 and 9.0. The measurements of the surface and bottom samples were very close, except when periods of stratification caused depletion of the dissolved oxygen in bottom waters. The pH of the bottom samples would then be noticeably lower.

The fluctuations in pH values at two typical stations in Clear Lake are shown in Figure 6.

Dissolved Oxygen. Dissolved oxygen in the water is necessary for the support of aquatic life. There is generally not too much concern about a surplus of dissolved oxygen, but rather with a deficiency or complete absence thereof. Inadequate dissolved oxygen in surface water may contribute to unfavorable environment for fish and other aquatic life and may give rise to odors originating from the anaerobic decomposition of organic wastes.

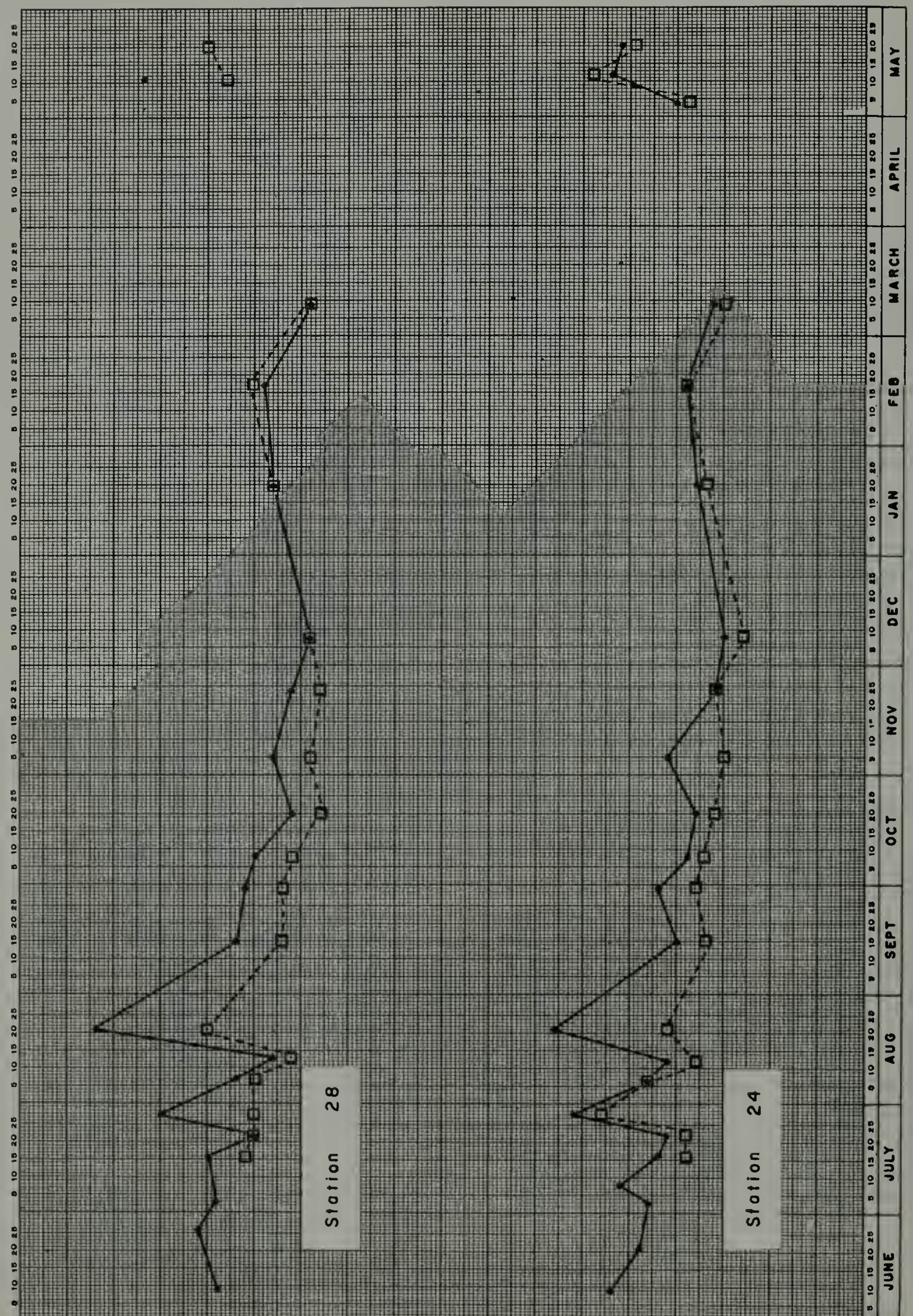
Though oxygen normally comprises approximately 20 percent of the atmosphere, the transfer of oxygen from the air into the water is extremely inefficient unless wave action occurs. The movement or distribution of oxygen throughout the water mass is not entirely dependent on molecular diffusion but involves water movement. One of the main sources of oxygen in quiescent bodies of water is from the photosynthesis process in algae production.

The presence of dissolved oxygen in domestic supplies of water increases the palatability of the water, but also increases the corrosion rate in metal pipes. Many industrial users take steps to reduce the dissolved oxygen concentrations.

The temperature affects not only the amount of oxygen available in the water but also the rate at which fish use it.

Fish can, within certain limits, adjust their rate of respiration to compensate for low concentration of dissolved oxygen, and it is generally agreed that fish like carp and pike can stand lower concentrations than the more active fish like trout and salmon.

At 20° C and with dissolved oxygen values below 2.0 ppm, response is very prompt with stress developing so quickly that some species of fish will usually not swim into the poorly oxygenated water. (6)



Station 28
Station 24
pH
pH
10
9
8
7
10
9
8
7
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MARCH
APRIL
MAY

The lethal effect of low concentrations appears to be increased by the presence of toxic substances such as ammonia, lead, copper, and zinc.

During daylight, algae production produces a surplus of oxygen; at night, respiration of the algae continues but photosynthesis does not and the available oxygen is depleted. Numerous fish mortalities have arisen from the diurnal oxygen demand of algae.

Oxygen can also vary with depth in lakes due to a number of chemical and biological factors, and for this reason fish may avoid certain areas of the environment.

The dissolved oxygen concentrations were determined on both surface and bottom samples at all stations immediately on collection, using the Alsterberg modification of the Winkler method for dissolved oxygen determination. The results of these analyses are presented in Tables 3 and 4.

In those areas where algae production was excessive, the water would become supersaturated with oxygen, containing from 10 to 15 ppm.

During those periods when high productivity of algae coincided with relatively calm periods, thermal stratification would be established and oxygen depletion in the lower stratas would occur, depleting the concentrations sometimes to less than one part per million. An instance of this occurred at Station 28 in July 1964, when the dissolved oxygen concentration at the surface contained 16 ppm and bottom concentrations were reduced to 0.3 ppm. This condition was relatively short lived and was relieved when wind-caused currents again mixed the waters. These conditions were noted only in the deeper portions of the lake and in those areas having low turbidity which allowed algae production.

Hardness. The term "hardness" refers to the soap neutralizing power of water. It is caused by any substance that will form an insoluble curd with soap, such as calcium, magnesium, iron, manganese, copper, lead, zinc, and other trace metals. The calcium and magnesium ions are the principal causes of hardness as the other elements are seldom present in appreciable quantities. Because of this, hardness is defined as a characteristic of water which represents the total concentration of calcium and magnesium ions expressed as calcium carbonate.

This is a matter of concern mostly in urban waters where it causes excessive soap consumption, scums and curds, shortens the wearing ability of fabrics, toughens cooked vegetables, and forms scale in boilers, pipes, hot water heaters, and utensils.

The major detrimental effect of hardness is economic. It has had no demonstrable harmful effects on the health of consumers.

Hardness can be removed only by chemical means and a large industry has been founded on the process of removing the hardness causing compounds from water. Hardness is reported in terms of calcium carbonate ($CaCO_3$).

A plot (Figure 7) of the hardness (calcium carbonate values) from samples collected monthly at the Lakeport City Pier since 1956, shows the hardness varying seasonally, ranging from a low of 82 ppm to a high of 158 ppm, with lowest values occurring in the winter and gradually increasing after inflow stops and concentration from evaporation begins.

The analyses show that hardness caused by the two principal cations of calcium and magnesium are approximately equal.

Dissolved Solids. The dissolved solids in natural waters are composed of all salts in solution. They consist mainly of sodium, potassium, magnesium,

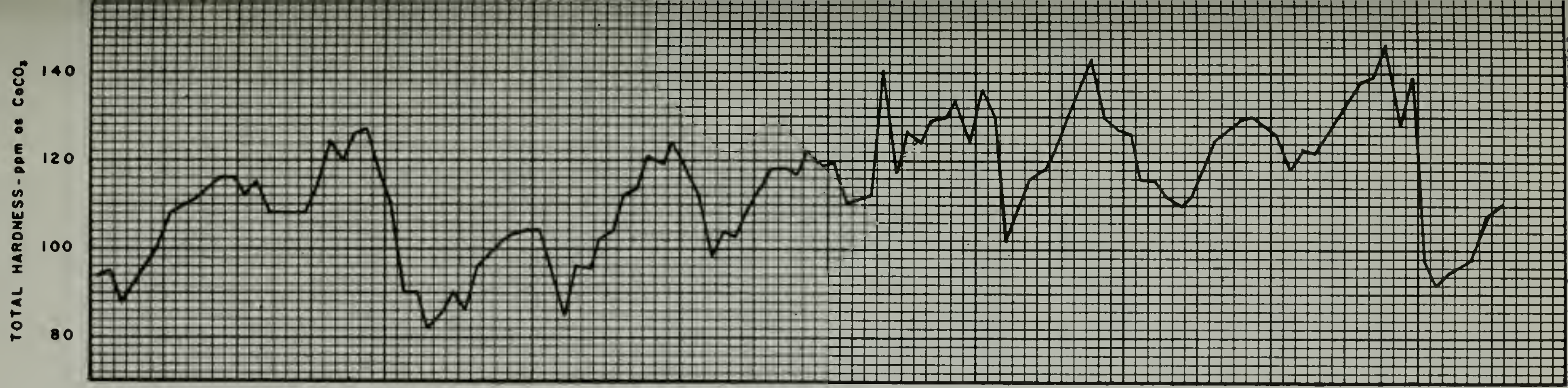


Figure 7. Monthly variations of hardness (as $CaCO_3$) values of Clear Lake as determined at the Lakeport City Pier from 1956 to 1965.

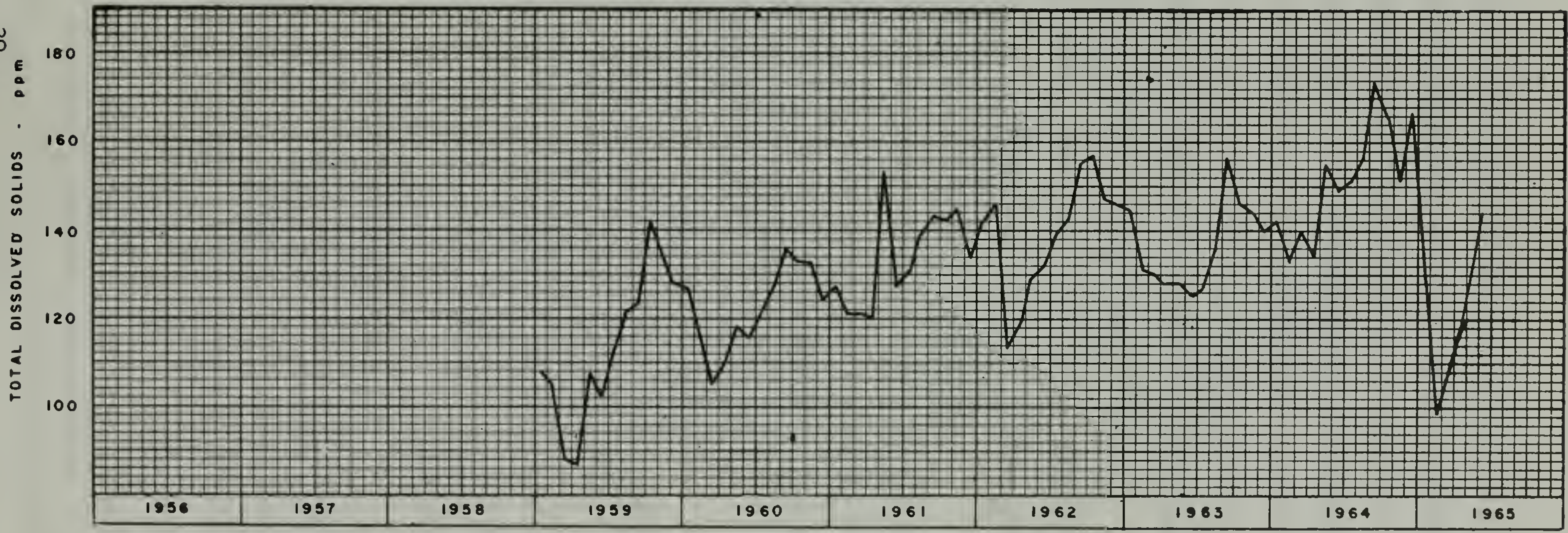


Figure 8. Monthly variations of the total dissolved solids of Clear Lake as determined at the Lakeport City Pier from 1959 to 1965.

calcium, chloride, bicarbonate and sulfate ions together with ammonia, nitrite, nitrate, nitrogen and other nitrogenous compounds. Minor constituents are iron, manganese, and other substances. These substances in solution can change the physical and chemical nature of water and collectively exert osmotic pressure on the organisms living in it. When this pressure is sufficiently high from the salts in solution, water may be drawn from gills or cells, or other delicate external organs with considerable damage.

It has been reported that among inland waters in the United States supporting a good mixed fish fauna, about 50 percent have a dissolved solids concentration under 169 ppm and about 95 percent under 400 ppm.

When used for irrigation, waters with high dissolved solids may be deleterious to the plants directly, or indirectly through the soil; however, this can depend on a number of factors such as the kind of crop, character of the soil, drainage conditions, climate, and composition of the water.

The 1962 U. S. Public Health Service drinking water standards specify that total dissolved solids should not exceed 500 ppm if more suitable supplies are available. Many communities though, use water containing 2,000 to 4,000 ppm of dissolved solids even though such waters may not usually be considered palatable, and can have a laxative effect on new users. Waters containing more than 4,000 ppm of total salts are generally considered unfit for human consumption.

The Department of Water Resources Surface Water Quality Monitoring Program has determined the dissolved solids of samples of lake water from the Lakeport City Pier on a monthly basis since January 1959. The concentrations of dissolved solids follow a seasonal cycle; values are low during the winter and spring when inflow occurs, and increase progressively through the summer and fall, until the inflowing waters of the next winter dilute and reduce their concentrations.

The seasonal variation is due, of course, to the dilution from inflowing waters having lower concentrations, and from concentrating of the dissolved solids by evaporation of the lake waters.

The overall yearly variations result from the net inflow and outflow from the lake. High inflow and outflow tend to lower the concentration of dissolved solids and vice versa.

Figure 8 shows a general yearly increase in concentration from the heavy runoff that occurred in the winter of 1958 through the relatively dry years until the heavy runoff winter of 1964.

Specific Electrical Conductance. Another method of estimating the concentration of dissolved solids in water is by measuring its specific electrical conductance.

Electrical conductance is the ability of a substance to conduct an electrical current, which depends upon the ion concentration of the substance.

Conductivity is reported as specific electrical conductance (EC). Technically, it is the reciprocal of resistance, in ohms, of a cube of a substance one centimater on a side at a temperature of 25° Centigrade. The substance may be solid, liquid, gaseous, pure, a mixture, or a solution.

Because conductance is the reciprocal of resistance, the unit of specific conductance is called the "mho", or "ohm" spelled backward. Natural waters have specific conductance values of much less than one mho; to avoid decimals data are reported in millionths of mhos, or micromhos. The conductance of a water rises as the temperature rises, and to make values comparable, all measurements are referred to the same temperature of 25° Centigrade.

The presence of dissociated ions in water makes it conductive but, as undissociated ions which are nonconductive are also present, there is no exact relationship between the total dissolved solids and the specific conductance. However, in Clear Lake, the relationship is close enough to be of value, with the dissolved solids in parts per million being between 55 and 60 percent of the conductance as reported in micromhos.

As it is easy to determine the specific conductance of a water, agriculturalists have used it in adopting criteria for the classification of irrigation waters. These criteria are presented in Appendix A.

The specific conductance (EC) of the waters in Clear Lake have been determined on a monthly basis since 1951. Figure 9 shows the values from samples collected at the Lakeport city pier since 1955.

These determinations show that the EC varies seasonally. The lower values occur during the winter when water flows into the lake from the winter rains. As the inflow dwindles the EC increases until it reaches its highest values just before inflow begins again. The specific conductance generally ranges between 200 and 300 micromhos, with 358 being the highest and 187 the lowest recorded.

During this investigation, numerous EC profiles of the lake were made at all stations. A portable temperature compensating conductivity bridge was used. The data obtained from these profiles are presented in Tables 3 and 4. They show the lake to be fairly uniform in specific conductance values at all depths. No data were obtained that would indicate that any significant amounts of water, with different conductivity values than the lake water, flow or move into the lake except from runoff.

The specific conductance values of four widely separated, representati stations (4, 12, 22, and 30) are presented in Figure 10.

These profiles show that the specific conductance did not increase or decrease evenly throughout all areas of the lake at the same time.

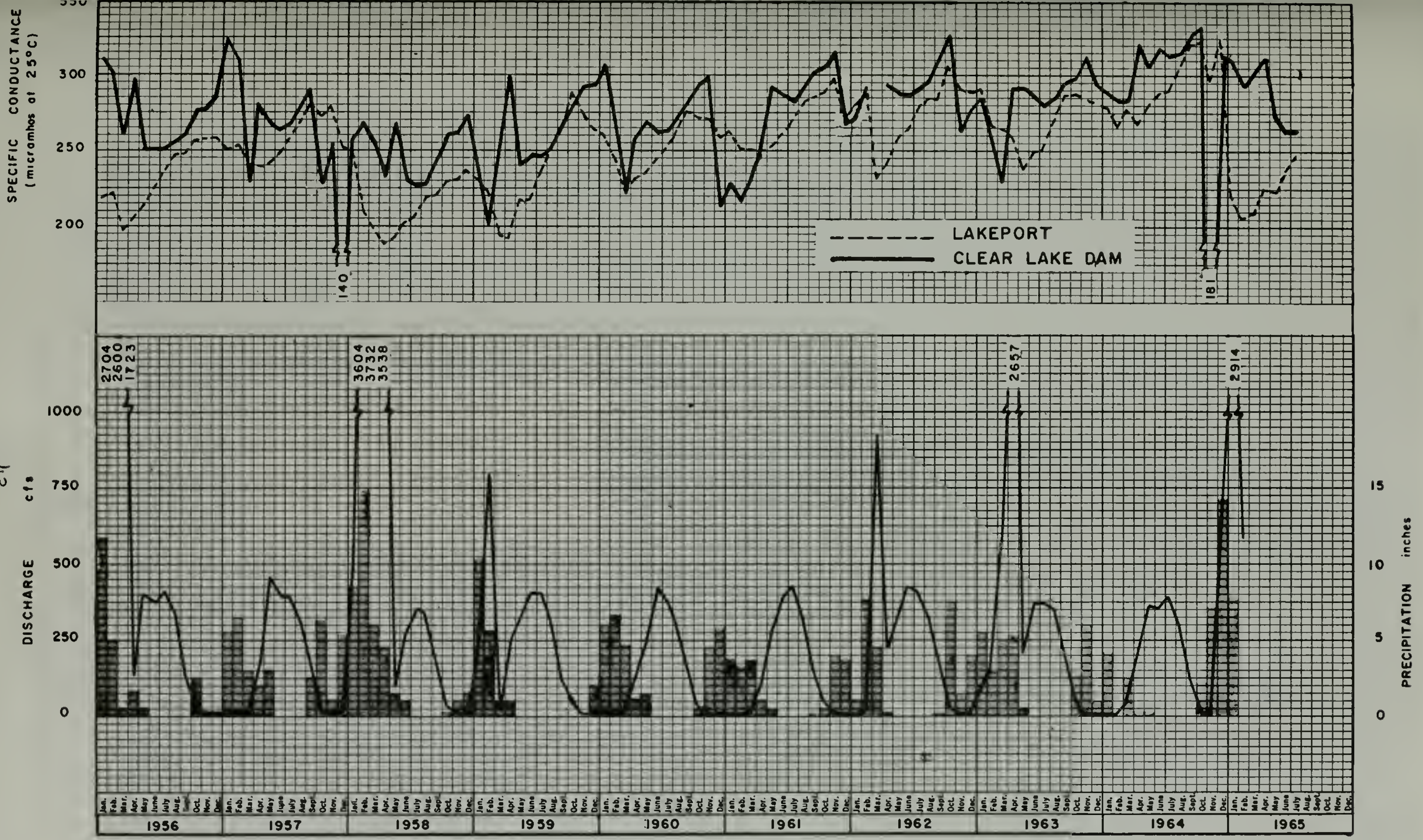


Figure 9. Monthly variations of the specific electrical conductance (EC) of Clear Lake as determined at the Lakeport City Pier and the Clear Lake Water Company Dam. Releases from the lake through the Clear Lake Water Company Dam and the precipitation as measured at Lakeport for the same time period is shown for comparison.

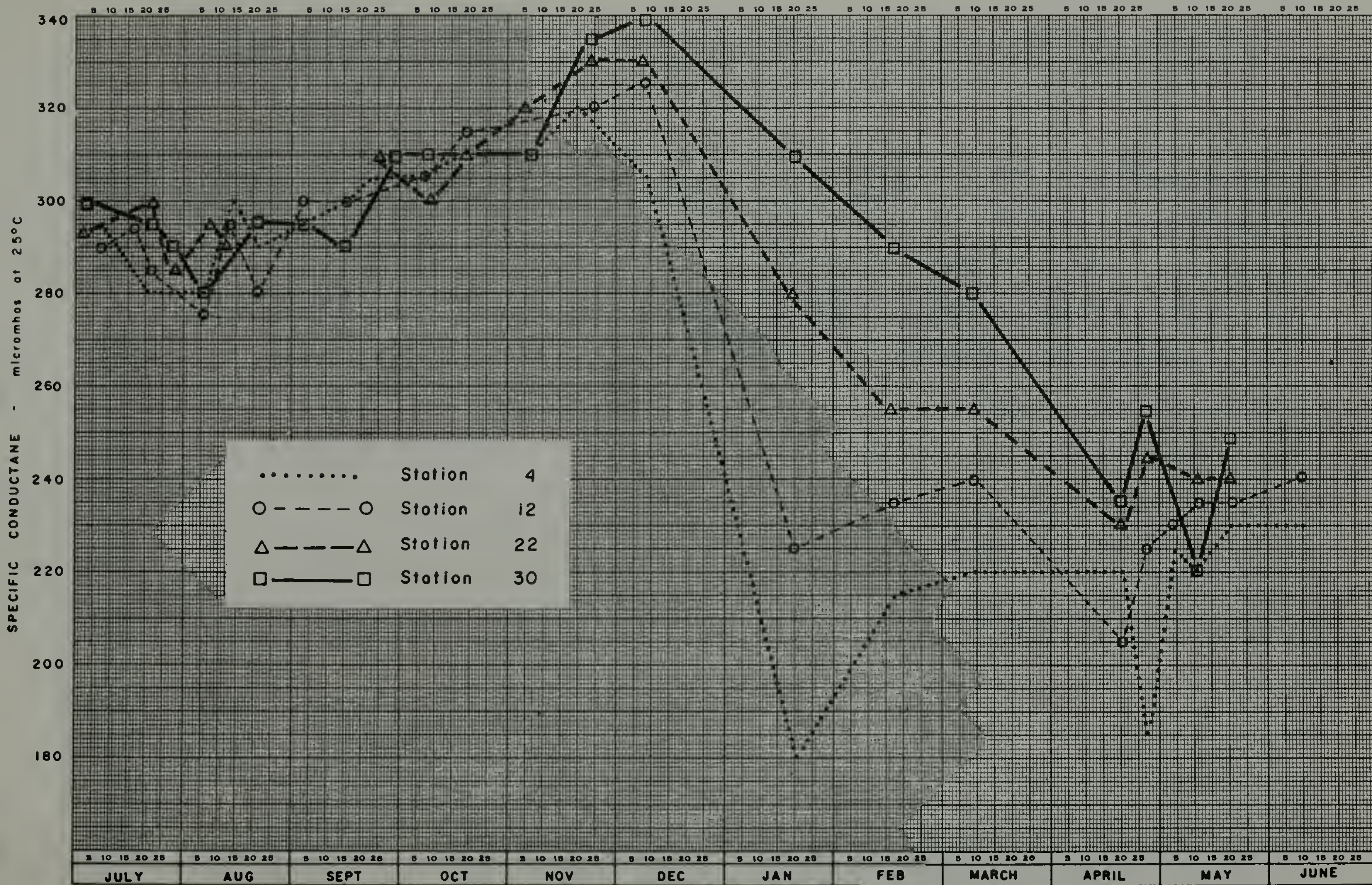


Figure 10. Specific Electrical Conductance (EC) values at four selected stations from July 1964 to June 1965. Station 4 is in the Upper Arm. Station 12 is in the Narrows. Station 22 i...

The large difference that occurred in December 1964, resulted from precipitation and runoff from a large storm that contributed approximately 500,000 acre feet of water to the lake within a short time; 300,000 acre feet remained in the lake, the remainder being allowed to flow out. The specific conductance of this inflow, measured at the peak of flow at Rodman Slough, was 74 micromhos.

Though all stations throughout the lake showed the same general value (325 micromhos) before the start of the runoff season, the Upper Arm quickly reflected the effect of inflow. At station 4, approximately one mile from the point of inflow from Rodman Slough, values decreased from 300 micromhos to 180 micromhos one month after the inflow started.

The specific conductance at the other station in the Upper Arm (Station 13) dropped from 320 micromhos to 220 micromhos during the same period.

At the same time, EC values in the Oaks Arm at station 22 showed a decrease from 330 micromhos to 280 micromhos. The inference was that little dilution had occurred because little inflow water had moved into the Oaks Arm at that time.

Data obtained during the same period of time from a station in the Lower Arm near the outlet (Station 30) showed that less inflow of diluting water had occurred in that arm, as the value decreased only slightly, from 340 to 310 micromhos.

It is significant that the inflow, which had EC values approximately one third those of the receiving water, did not channelize or stratify, but became thoroughly mixed with the lake water.

After inflow started, the EC values gradually equalized throughout the lake.

By June, the values at stations 4 and 12 had increased to 230 micromhos, while stations 22 and 30 had decreased to 240 micromhos and 250 micromhos respectively, showing that general mixing of the lake water was taking place.

Boron. Boron in drinking water is generally not regarded as a hazard to human beings. It is present in the ordinary human diet to the extent of 10-20 mg per day, with fruits and vegetables as the largest contributors. Boron in irrigation water though, is extremely important. It is an essential element in the nutrition of higher plants, yet if present from 0.5 to 1.0 ppm may be harmful to certain crops.

Crops such as sugar beets, alfalfa, onions, turnips, asparagus, cabbage, carrots, and lettuce can tolerate boron concentrations of 2.0 to 4.0 ppm; tomatoes, wheat, peas, corn, oats, potatoes, and lima beans can grow well at 1.0 to 2.0 ppm, but most orchard crops such as pears, plums, apples, pecans, cherries, peaches, oranges, avocadoes, grapefruit, lemons, and grapes are sensitive to boron and generally cannot tolerate water with concentrations of more than 0.5 to 1.0 ppm.

Criteria for the limits of boron concentrations in irrigation water have been developed by the Regional Salinity Laboratories of the United States Department of Agriculture and are presented in the criteria at the end of this chapter.

These criteria have limitations in actual practice. In many instances, a water may be unsuitable for irrigation under certain conditions of use, and yet be completely satisfactory under other circumstances.

The element boron is a minor constituent of rocks and of natural waters and may be present in volcanic emmisions. Boron is released to solution by the decomposition and weathering of rocks. It may also be liberated in volcanic gases or through the water of some hot springs, especially those springs occurring in areas where there has been recent volcanic activity.

Detection of relatively high boron concentrations of the outflow water from Clear Lake by the Department of Water Resources surface water monitoring program was instrumental in this Department initiating a water quality investigation of Clear Lake.

Samples have been collected and analyzed from the two monitoring stations in the Clear Lake drainage basin since 1951. A comparison of the monthly boron concentrations from these two stations show the boron concentration at the outlet of the lake being higher than those of the Upper Arm during the summer and lower during the winter (Figure 11).

Boron analyses of samples collected throughout the lake show an increase in the concentrations as the water moved from the Upper Arm towards the outlet (Figure 12).

Analyses show that water in streams flowing into the lake could not contribute enough boron to account for the high concentrations in the lake (Table 6). Other sources, within or adjacent to the lake, were then investigated.

Possible sources of boron adjacent to the lake exist in the areas of Sulfur Bank Mine, Big Borax Lake, and Little Borax Lake.

The boron concentrations of Big and Little Borax Lakes have long been known. Big Borax Lake, on the peninsula between the Oaks and Lower Arms of the lake, occupies a site that was at one time a part of the valley now occupied by Clear Lake. Centuries ago a flow of lava separated Big Borax Lake from Clear Lake. Big Borax Lake today has no visible outlet. A series of extinct volcanic gas vents, which are probably the source of the boron, now trend eastward across the closed margin of Big Borax Lake.

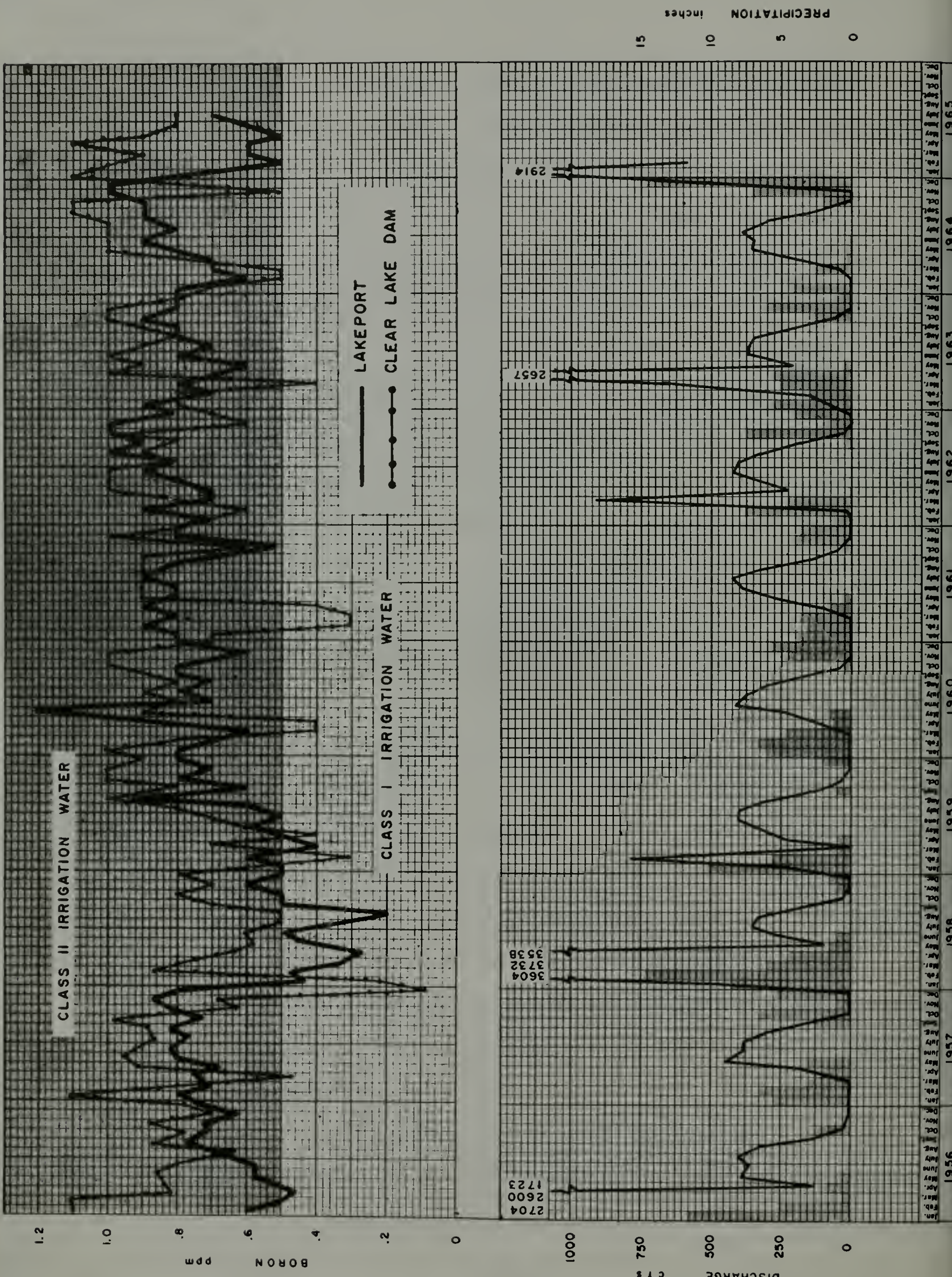

CLASS II IRRIGATION WATER
CLASS I IRRIGATION WATER
LAKEPORT
CLEAR LAKE DAM
BORON ppm
1.2
1.0
.8
.6
.4
.2
0
DISCHARGE cfs
1000
750
500
250
0
PRECIPITATION inches
15
10
5
0
2704
2600
1723
3604
3732
3538
2657
2914
1956
1957
1958
1959
1960
1961
1962
1963
1964
1965

Figure 12. Boron concentrations at various lake stations as determined on May 20, 1964.

After the lava flow the boron was embedded in the muds which formed in the lake bottom. Boron became so concentrated that at one time it was mined. For a short time, this was the major source of borax in the United States. The mining operations ceased when it became uneconomical to process the large amounts of mud necessary to extract the borax. The high concentrations of boron remaining in Big Borax Lake can be attributed to the boron which remained in the lake mud. Since there is no outflow of water from the lake, the action remains one of repeated solution and precipitation.

Little Borax Lake occupies a depression near the junction of Buckingham Point and the flank of Mount Konocti. The precise cause of this depression is not readily apparent; however, the scar on the northeast side of Mount Konocti, and the mass of rubble which constitutes Buckingham Point are indicative of landslide topography. The nature of the sediments filling the basin, and the lack of widespread fine ash materials and rubble indicative of volcanic explosions, argues against the possibility of the lake occupying an explosion crater.

The borax in this lake is disseminated throughout much of the mud deposited in the basin and in all probability precipitated from supersaturated brines. The water in the original lake could have acquired the boron from either a volcanic vent, as in Big Borax Lake, or by the solution of boron contained in the rocks through which the water moved. There are, however, no volcanic vents visible in the vicinity of Little Borax Lake as there are at Big Borax Lake, and if any are present they lie beneath the lake, or have been covered over by alluvium.

The area surrounding Little Borax Lake is presently developed into a golf course. The construction of this course necessitated the changing of a large portion of the natural surface features. The old lake was dredged so as to be larger and deeper, and top soil was imported to establish the grasses necessary for the course. The course is irrigated in the summer by pumping water from Clear Lake. Another pump is installed on Little Borax Lake so as to return any surplus water to Clear Lake.

An analysis of a sample collected from Little Borax Lake on March 26, 1965, showed the water to be a highly saline sodium carbonate type with 94 ppm of boron (Table 6). Little Borax Lake contributes some boron to Clear Lake when the excess waters are pumped into Clear Lake, though this occurs only in the winter.

One other apparent source of boron outside of the lake proper is the Sulfur Bank Mine area. This area is adjacent to the lake on the southwest of the Oaks Arm.

Sulfur Bank Mine is located in an area of volcanic vent activity. Faults in the area act as orifices for hot water and sulfur gases that still issue from vents in the area. These gaseous vapors are charged with carbon dioxide, hydrogen sulfide, methane gas, and nitrogen. Thermal waters and vapors deposit sulfur and cinnabar as incrustations along the walls of fissures from which they emanate. These incrustations are also found adhering to the surface of rocks and boulders buried in the alluvium.

Mining has changed many of the topographic features of this area. Large excavations have been made and tailing dumps extend over the area. Highly saline waters originating in this area are prevented from entering the lake by containment within the excavations.

Water Supply Paper 1473 (U. S. Geological Survey) reported that a sample of water taken from Sulfur Bank Spring showed 528 ppm. The date the sample was taken is not given. The spring is no longer in existence. In 1964, Department of Water Resources personnel collected a sample of steam condensate from another well in the Sulfur Bank Spring area. The sample contained 584 ppm of boron. Other minerals in the two samples showed considerably higher variation. The following tabulation shows a comparison of minerals in the two samples.

Mineral	Sulfur Bank Spring	Condensate from Geothermal Well at Sulfur Bank Mine
Silica	67	478
Calcium	56	< 1
Magnesium	57	
Sodium	1390	720
Potassium	68	65
Bicarbonate	1890	2312
Sulfate	1980	36
Chloride	489	954
Boron	528	584

An intensive boron sampling program was conducted in areas where boron might possibly be entering the lake from these three sources.

The highest boron concentrations were found on the west side of the Lower Arm near the base of Mount Konocti, with the highest value near Fraser Point just north of Konocti Bay (Figure 13, which appears after Plate 3). Here the surface sample had a concentration of 1.1 ppm, 0.3 ppm more than the bottom sample at that point and 0.2 ppm more than the samples collected on the opposite side of the lake, and 0.4 ppm more than those samples collected near the Sulfur Bank Mine area. The high boron concentration near Fraser Point prompted a boron survey in Konocti Bay. Waters in Konocti Bay proved to be lower in concentration varying only 0.1 ppm between values of 0.7 and 0.8 ppm.

These data would indicate that there is no concentrated discharge or inflow having a direct influence on the boron concentration in lake waters in this area. The high value of the surface sample (1.1 ppm) at Fraser Point indicates shallow ground waters migrating to the lake by percolation through volcanic formations.

The boron concentrations in the lake water appear to increase as the water moves toward the outlet, indicating a gradual accretion of boron rather than a concentrated single source.

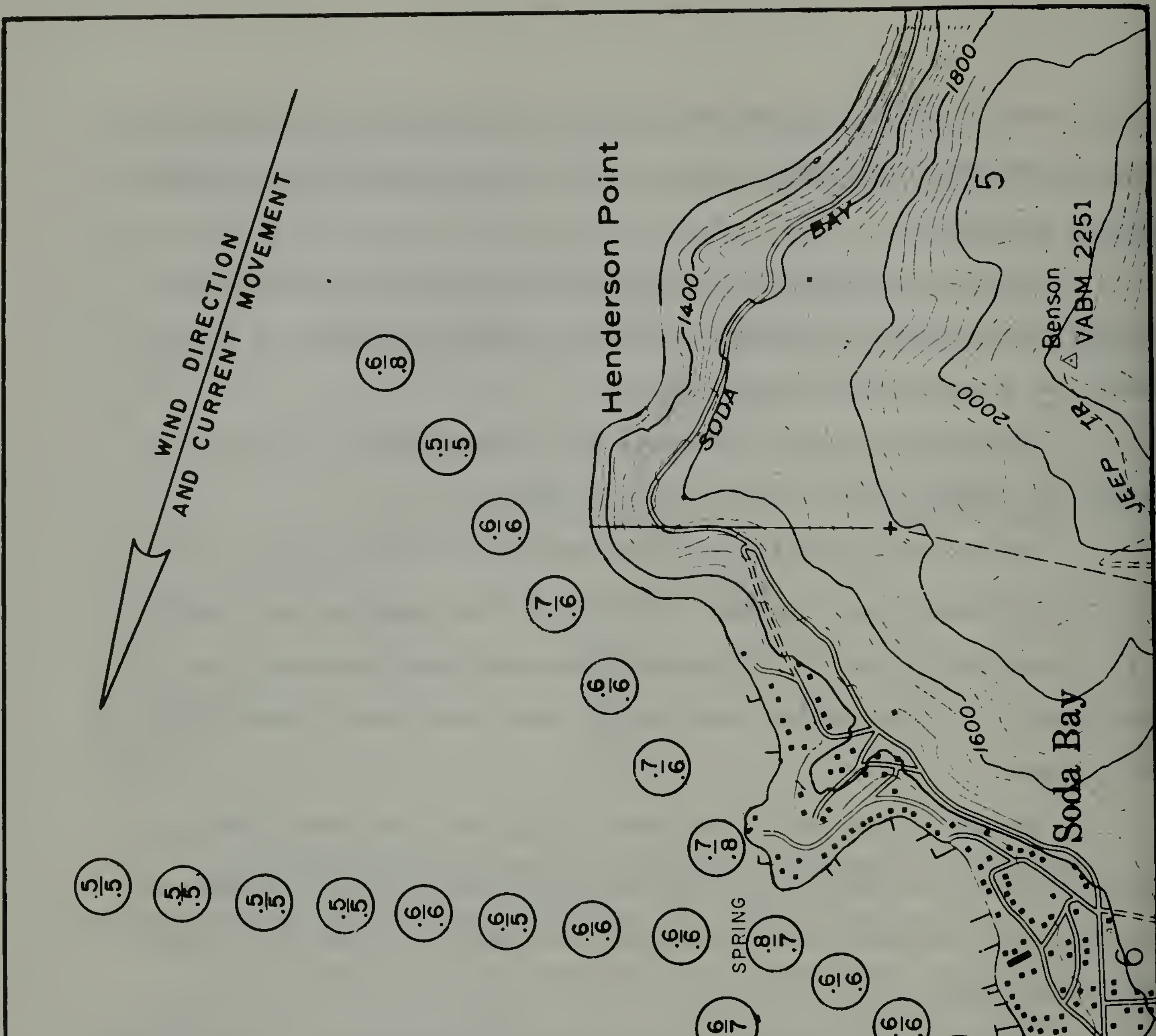
The only known direct source of high concentrations of boron to the lake is the thermal springs issuing forth in Soda Bay.

Two of these springs exist close together on the east side of the bay; a third smaller one is located northwest of these near the east shore of the State Park (Plate 2). The springs are easily found because of the orange rust color that appears on all of the rocks that come in contact with their waters.

Analyses of the water from these springs show the water contains relatively high concentrations of calcium (93 ppm) and chloride (66 ppm), and extremely high concentrations of total iron and boron -- 20 ppm and 15 ppm respectively (Table 6).

To ascertain the effects the high boron concentration in these spring waters have on the lake, a series of samples were collected from the lake in the vicinity of these springs. The analyses of these samples and the sample collection pattern are shown in Figure 14.

The highest concentrations (0.8 ppm) occur immediately adjacent to the springs and diminish to values of 0.6 and 0.5 ppm away from the source. Though some boron is added to the lake from these springs, it does not appear to be in amounts sufficient to account for any signifcant increase throughout the lake.


WIND DIRECTION
AND CURRENT MOVEMENT
Henderson Point
SODA BAY
Soda Bay
SPRING
Dorn Bay
ROAD
Benson
VABM 2251
JEEP TR
1400
1600
1800
2000
2075
5
6

The total flow from these springs is estimated to be less than 450 gallons per minute (1 cfs). With their present concentration of 15 ppm boron, these springs would have to flow at a rate of approximately 9,000 gallons per minute (20 cfs) to raise the boron concentration of the lake by 0.1 ppm.

What was once thought to be large springs discharging into the lake at a number of locations have been proved to be nothing more than escaping gas. These gas seeps are located in two areas at the lower end of the Upper Arm, about one mile west of Shag Rock (Plate 2).

The gas seeps are sometimes hard to find, especially when the surface of the lake is choppy, as they do not bubble constantly but tend to be cyclic, being only slightly active for a number of minutes and then showing increased activity for three or four minutes.

Though they have the appearance of springs, analyses of water taken in their vents is identical in chemical constituents and temperature to that of the lake water (Table 6).

Though the gas was not analyzed, it is believed to be methane. A sample of the gas trapped in an inverted bottle caused a mild explosion when ignited.

Methane is recognized as a by-product of the decay of organic matter and is easily related to the sedimentary rocks of the region which underlie the surficial volcanic rocks. The carbonaceous material in the older Cretaceous sediments is probably the prime source material.

These gas seeps have been noticed throughout the lake on a line coinciding with the alignment of two prominent faults which have been mapped. Plate 1 shows these faults and all gas seeps that have been located in the Clear Lake drainage basin. Similar seeps probably exist in the land areas around the lake but go unnoticed inasmuch as methane is odorless and mixes easily with air.

One of these gas seeps is located in Thurston Lake (Plate 1) and, though it is apparently isolated, it could be related to a fault or faults in strata which underlie the volcanic rocks.

Analyses of the water in Thurston Lake show boron in the amount of 0.01 ppm (Table 6), considerably below the average concentration in Clear Lake. If this seep in Thurston Lake, which boils constantly, were charged with boron, the concentration of boron in the lake would presumably be much higher.

The gas vents in these cases may not extend below the sedimentary section; on the other hand, the vents at Sulfur Bank undoubtedly extend deep enough to release magmatic gases.

Nutrients. Those organic and inorganic chemicals needed by primary organisms in the food chain to sustain and reproduce their species are considered nutrients.

Generally, those chemicals needed for biological growth that are required in more than trace amounts are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulfur, calcium, and magnesium. Micronutrients, nutrients needed only in trace amounts, include iron, manganese, cobalt, molybdenum, boron, zinc, and copper. Most of these nutrients are available, in one form or another, in plentiful supply in natural waters.

The principal nutrients needed by algae to produce new protoplasm and cellular material are nitrogen and phosphorus, which they take from solution during their growth.

The basic sources of nutrients are precipitation from the atmosphere, surface water, and interchange with bottom sediments.

Inorganic nitrogen compounds are present in small amounts in rainwater. These come from the atmosphere, in which they occur as products of terrestrial decomposition, volcanic eruptions, and lightening. Much of the inorganic nitrogen compounds in rainwater is left in the soil upon which it falls. During times of excessive runoff these nitrogen compounds provide a good source of nutrients to the lake.

Tributary streams are the major source of nutrients to the lake. No attempt was made to determine the total nutrient inflow from tributary streams; however, samples were collected from the six streams flowing into the lake during the initial seasonal runoff in October 1964. These data are presented in the following tabulation.

Stream	NH_4-N ppm	NO_3-N ppm	Organic N ppm	Total + Organic PO_4 ppm
Adobe	2.1	1.2	0.6	0.28
Kelsey	0.0	0.6	0.5	0.47
Manning	1.6	0.0	0.0	0.20
Scott	1.2	0.0	0.6	0.45
Middle	1.4	0.0	0.3	0.28
Schindler	0.7	0.4	0.8	0.97

Sewage effluent can be a prime source of nutrients. Lake County ordinances and a resolution by the Central Valley Water Quality Control Board prohibit the discharge of sewage to waters of Clear Lake. This policy has been supported by the State Department of Public Health. All sewage effluent in the Clear Lake drainage basin is disposed of to land through septic tanks, percolation and evaporation ponds or through sprinkler irrigation and any sewage migrating to the lake must first travel through soils and gravels.

The total yearly contribution of sewage effluent to the Clear Lake drainage basin, based on an estimated year round population of 13,000 1/ and an estimated 50 gallons of sewage effluent per capita per day, 2/ is approximately 750 acre feet, or less than one tenth of one percent of the total storage capacity of the lake.

Studies in Wisconsin on oxidation ponds which received only domestic sewage indicated an annual per capita contribution of four pounds of inorganic nitrogen. This was computed to be sufficient to fertilize five acre-feet of water and cause nuisance algae blooms during the summer. (15)

Using the above figures of population and the per capita contribution of inorganic nitrogen, the direct discharge of all sewage effluent to the lake would provide only six percent of the inorganic nitrogen needed, and it would take the direct sewage discharge from a population of approximately 200,000 people to fertilize Clear Lake to the extent of causing nuisance algae blooms during the summer if this were the only source of nutrients.

Land runoff from the drainage basin is the principal contributor of nutrients. Data collected by Sawyer, et al, on three lakes in Wisconsin, indicated that the annual contribution of inorganic nitrogen per square mile of drainage was 2,800, 3,100, and 4,100 pounds for each lake respectively. (15)

Using the previously mentioned figure of a contribution of four pounds of inorganic nitrogen per person per year and the minimum figure mentioned above, the yearly runoff from one square mile of land is equal to the yearly sewage contribution of 700 people in contributing inorganic nitrogen.

1/ Based on an estimated permanent population of 10,000 and a seasonal population of 9,000 for four months.

2/ From flow figures from the City of Lakeport Sewage Treatment Plant.

If this figure is projected to the Clear Lake drainage basin, with an area of 457 square miles, the inflow of inorganic nitrogen from land runoff is equal to the direct discharge of sewage effluent from approxomately 320,000 people, 25 times the present population.

Algae and other growth that occurs in the lake or is brought into the lake by inflowing waters, settle to the bottom as they die. Here they become subject to decomposition and a considerable part of their nutrient elements are rendered soluble and passed into solution in the waters above.

A portion of the available nutrients is derived from remineralization by bacterial action of the sediments in the lake. The nitrogen and phosphorus resulting from the bacterial action and the decomposition of organisms are recirculated from the bottom ooze or sediments by eddy diffusion and by thorough mixing of the lake waters by the wind caused currents.

This back feeding of nutrients from the bottom deposits would continue for some time even if further depositions were prevented. Lakes may require years to recover their former status after remedial action is taken to prevent further deposition (20).

Samples of the top half inch of bottom sediments were collected throughout the lake at 12 places and analyzed for nutrients. These data are presented in Table 7.

TABLE 7

ANALYSES OF SEDIMENTS IN CLEAR LAKE
(in ppm)

Station	Ammonia-N dry soil (NH_4)	Nitrite-N dry soil (NO_2)	Nitrate-N dry soil (NO_3)	Organic Nitrogen dry soil (N)	Total Plus Organic Phosphate dry soil (PO_4)	Total Plus Organic Phosphate extract (PO_4)
4	18	0.00	9.8	4600	5.9	0.2
7	40	0.00	13.0	3600	58.0	0.2
9	25	0.00	5.1	1600	1.8	0.4
10	104	0.00	20.0	6300	4790.0	2.0
12	60	0.00	20.0	8600	496.0	0.0
15	21	0.00	18.0	8900	49.0	0.2
19a	165	0.00	15.0	9800	3190.0	3.2
20	193	0.00	17.0	12000	934.0	3.8
24	119	0.00	18.0	12000	80.0	0.4
27	111	0.00	13.0	1600	0.0	1.2
29	150	0.00	17.0	12000	12.0	1.8
30	193	0.00	5.6	2300	6.8	3.3

Determinations of the nutrient concentrations in the water at nine stations were made during this investigation and are presented in Table 5. The ranges of the various nutrient values is shown in the following tabulation.

Ammonia as N (ppm)	Nitrate as N (ppm)	Organic Nitrogen as N (ppm)	Total plus Organic PO_4 (ppm)
0.01 - 0.32	0.1 - 5.8	0.2 - 1.5	0.10 - 0.54

Though the nutrient concentrations of Clear Lake are relatively low, the organic nitrogen is about 16 times greater and the nitrate about 90 times greater than the concentrations found in the waters of Lake Tahoe. A comparison of values is shown in the following tabulation.

Lake	Constituents in ppm		
	Ammonia-N	Nitrate-N	Organic-N
Tahoe	.002*	.008	.05
Clear Lake (average of analyses from Station 28)	.12	.7	.8

*Lowest detectable limit

Organics. Prior to the recent intensive development of petrochemical compounds, the main source of organics in water was from sewage or from the natural life cycle of the plant material or organisms in the water.

With the beginning of production of synthetic organics derived from petroleum or natural gas, many new sources of organics became available. These new types of organics include detergents, herbicides, insecticides, and other petrochemicals.

By one route or another, these chemicals or the waste products resulting from their manufacture and use may enter our waters and affect them adversely not only for the householder but even for further industrial use. Many of these contaminants are persistent and are resistant to the normal processes expected to remove or eliminate them. The best sewage treatment still leaves a residue of these organics. One synthetic chemical was followed downstream in the Mississippi River for a distance of 1,000 miles.

These organics are appearing more and more in our surface and ground waters in concentrations of not more than a few parts per million and often only in a few parts per billion.

These low concentrations are, on occasion, sufficient to cause water damage such as imparting taste and odor to drinking water. They can cause off-taste in the flesh of fish or worse yet, cause large fish kills. They can cause foaming, interfering with industrial and treatment processes, or interfere with the recreational use of water.

There is a great variety of organic compounds, many being extremely complex, and they usually occur in very low concentrations. Serious problems arise when attempts are made to identify them and measure their concentrations in water. Methods for concentrating, isolating, and identifying these materials have been under study by the U. S. Public Health Service at the Robert A. Taft Sanitary Engineering Center where, as a result of this study, the "Carbon Adsorption Method for Organics in Water", was developed. Activated carbon has unique adsorptive characteristics and can be used to recover organics from water and wastes. The organics can then be extracted from the carbon.

The organics that are extracted by chloroform are usually man made; whereas, the alcohol extractables usually occur naturally. The chloroform extractable group is separated into ether insolubles, water insolubles, amines, strong acids, weak acids, and neutrals. Since the neutral fraction usually contains the most important taste and odor producing compounds, this fraction is further separated into aliphatics, which are the petroleum type hydrocarbons, aromatics, which contain the insecticides and the oxygenates, which generally indicate the age of pollution.

The U. S. Public Health Service has set limits on the organic concentrations of drinking water and recommends that chloroform extractables not exceed 0.2 ppm.

In 1962, 1963, and 1964, the Department of Water Resources surface water quality monitoring program determined the organic concentration of the water leaving Clear Lake by using the carbon adsorption method.

Amounts were determined twice yearly; before and after the peak of the tourist season and use of the lake waters for recreation purposes. These amounts are shown in Table 8.

The analyses show not only the chloroform extractables but the alcohol extractables approximately doubling each year between spring and fall with their percentage of total extract remaining fairly constant. It would seem that both the man made and natural occurring organics are increasing almost equally.

The group separation of the neutrals shows that more than 90 percent are oxygenates, indicating that most of this group is not of recent origin.

The chloroform extractables exceeded the U. S. Public Health Service drinking water standards (200 ppb) on the samples collected in September 1962 and 1964.

Pesticides. Man has certainly reaped bountiful awards in the form of greater productivity, improved comfort and better health from the widespread use of pesticides. It has been estimated that in the first ten years

TABLE NO. 8

ORGANIC ANALYSES
CACHE CREEK AT CLEAR LAKE WATER COMPANY DAM

Constituent		6/4/62	9/21/62	5/13/63	9/13/63	6/5/64	9/24/64
Total Extract	ppb	259	622	245	433	389	707
Chloroform	ppb	92	235	83	165	146	255
Extractables	%	35.4	37.8	34.1	38.0	37.6	36.1
Alcohol	ppb	167	387	162	268	243	452
Extractables	%	64.6	62.2	65.9	62.0	62.4	63.9
Group Separation of Chloroform Extractables							
Ether	ppb	8	6	6	6	2	8
Insoluble	%	9.0	2.8	7.7	3.8	1.0	3.0
Water Soluble	ppb	32	73	25	54	49	92
	%	34.9	31.0	30.6	33.0	33.4	36.1
Amines	ppb	2	4	2	2	3	5
	%	1.9	1.8	2.3	1.3	2.1	2.0
Strong Acids	ppb	10	22	7	20	13	21
	%	11.3	9.3	8.8	12.1	9.0	8.2
Weak Acids	ppb	6	31	5	14	16	29
	%	7.0	13.1	6.0	8.6	10.8	11.1
Neutrals	ppb	14	30	19	30	48	71
(See Breakdown)	%	14.7	12.8	22.5	18.0	32.6	27.9
Total	ppb	72	166	64	126	131	226
	%	78.8	70.8	77.9	76.8	88.9	88.3
Loss	ppb	20	69	19	39	15	29
	%	21.2	29.2	22.1	23.2	11.1	11.7
Group Separation of Neutrals							
Aliphatics	ppb	0	2	0	0	5	12
	%	3.1		2.2	1.5	9.7	16.2
Aromatics	ppb	1	2	0	0	2	4
	%	4.6		2.2	1.5	4.0	5.4
Oxygenates	ppb	12	25	18	27	39	49
	%	84.7		93.6	92.5	81.5	69.3
Total	ppb	13	29	18	27	46	65
	%	92.4		98	95.5	95.2	90.9
Loss	ppb	1	1	1	3	2	6
	%	7.6		2.0	4.5	4.8	9.1

of broad scale use of pesticides, five million lives were saved and 100 million illnesses prevented (6).

Pesticides can be categorized into three groups, (a) inorganic, such as arsenicals, mercurials, borates, and fluorides, (b) natural organic, such as rotenone, pyrethrum, and nicotine, and (c) synthetic organic, which are the chlorinated hydrocarbons and organic phosphates and many other types.

In general, the inorganic pesticides have been supplanted largely by organics which can be adapted to a more selective use. The natural organics are somewhat limited in supply and popularity, and present day trends are towards the use of the powerful chlorinated hydrocarbons and organic phosphates of the synthetic organic groups.

Pesticides can gain access to ground and surface water through direct application, percolation, runoff from treated areas, and from drift of the application.

There are no simple analytical techniques for identifying and measuring these chemicals. Because the biological significance of trace quantities is not fully understood, there has been a hesitancy on the part of officials to set limits for organic pesticides in water.

Toxicity to fish can result when certain pesticides are present in water at approximately one part per billion (.001 part per million).

The people in the Clear Lake drainage basin are familiar with the use of pesticides as control of the Clear Lake gnat began in 1949, when the Lake County Mosquito Abatement District applied one of the new post World War II chlorinated hydrocarbon pesticides, DDD, a derivative of DDT, to Clear Lake waters.

This application of pesticide controlled the gnat for approximately four years. By the summer of 1954, the population of gnats had again risen to nuisance levels and the lake was again treated with the same pesticide. This period of control was of shorter duration and Clear Lake was treated again in 1957. This third treatment failed to control the gnat. It was then discovered that the pesticide used was extremely stable and was being assimilated by aquatic biota and passed up through the food chain where it was concentrated and stored in the tissues of the bodies of the fish and fish eating animals or birds. Studies made in 1958, by the Department of Fish and Game, on certain species of fish in Clear Lake showed DDD concentrations as high as 2,500 ppm in the fat surrounding their internal organs, and as high as 221 ppm in their edible flesh. (16)

The use of DDD was stopped and research begun immediately on alternative compounds for gnat control. An organic phosphate replacement compound, methyl parathion, was found in the summer of 1961, and successfully applied to the lake in the summer of 1962. This pesticide has many advantages over the chlorinated hydrocarbon, DDD. It deteriorates very rapidly, losing 50 percent of its toxicity in 48 hours, and 90 percent in one week, whereas DDD was still detected in the biological systems of the lake five years after the last application. (17) An infrared spectrum analysis of the aromatic fraction of a sample of organics in the lake collected at Nice in June 1962 indicates the probable presence of 0.2 ppb of DDD. The last application to the lake five years previously was in a concentration of 20 ppb.

Unlike many of the chlorinated hydrocarbon pesticides, methyl parathion can be metabolised by an organism and excreted rather than accumulated in the in the various tissues of the body. Methyl parathion can be applied in such low concentrations (3.3 ppb) that the dosage satisfies the safety factors required by those agencies charged with the protection of human and wildlife populations.

The aromatics of the neutral group of chloroform extractable organics, the group most likely to contain pesticides, do not exceed 4 ppb in any of the six samples collected (Table 8).

Samples were collected in 1964 of the initial flow from six of the major tributaries and analyzed for pesticides by the gas chromatographic method. The results of these analyses are presented in Table 9. They are reported in parts per trillion (.001 ppb).

TABLE 9

PESTICIDE ANALYSES OF SIX STREAMS FLOWING INTO CLEAR LAKE

Sampling	Date	BHC (ppt)	DDE (ppt)	DDT (ppt)	Dieldrin (ppt)	Lindane (ppt)
Kelsey Creek	11/12/64	1				1
Adobe Creek	11/12/64	2	15	15		2
Manning Creek	11/12/64	2			57	2
Middle Creek	11/12/64	2				
Scott Creek	11/12/64	4		15		3
Cole Creek	11/12/64	5	100	100	10	4

Detergents. A detergent is anything that cleanses, including bar soap, even though popular usage of the term usually limits it to those packaged cleaning products used in the household laundry which contain synthetic detergents.

One of the advantages synthetic detergents have over ordinary soap is that in hard water, which contains relatively large amounts of calcium and magnesium salts, detergents are less likely to precipitate the familiar hard water scum.

Detergents are effective removers of dirt and grease because they have ingredients that tend to lower the surface tension of water. These ingredients, sometimes called "surfactants", hold soil particles in suspension. Until 1965, the surfactant most commonly present in detergents, accounting for approximately 70 percent of total production, was alkyl benzene sulfonate (ABS).

Although detergents made with alkyl benzene sulfonate (ABS) have many advantages over common soap, they are quite resistant to biological attack and decomposition, and are responsible for lingering foaming properties in the waste discharge.

Alkyl benzene sulfonate (ABS), which sometimes causes foaming at one part per million, is found in sewage at concentrations in the order of 10 parts per million, while washing machine drainage can contain from 220-600 parts per million.

It is almost impossible to set definite limits on the ABS concentrations of water in regard to aquatic life as there are so many variables involved. For instance, experiments have shown that roach fish will normally die in waters containing 5.0 ppm of detergent, but that this fish may be acclimated to live in waters containing 20 ppm.

Because of the persistent foaming properties of ABS, water treatment plant operators and the general public, have raised such a clamor that the synthetic detergent manufacturers have been forced to look for a suitable substitute which is bio-degradable so that the foaming properties will be minimized within a short time.

These characteristics have been found in a "linear alkyl sulfonate" (LAS) and the detergent industry is now in the process of eliminating ABS in their products and substituting LAS.

The U. S. Public Health Service recommends that ABS in drinking water be limited to 0.5 ppm, as higher concentrations may cause water to foam or have a bad taste. More important though, is that as ABS is discharged through the sewer system with household wastes and other sewage, its presence in surface streams or ground water is indicative of sewage pollution.

A number of samples were analyzed for ABS concentrations during this investigation. The data are presented in Table 6.

In addition to these ABS analyses, the Lake County Health Department collected 35 samples in June 1964 for ABS determinations. The stations at which the samples were collected are presented in Figure 15.

The values shown in Table 10 indicate the ABS present in such low concentrations that it is doubtful that they indicate that sewage effluent is migrating to the lake.

Bacteriological Quality

The search for a specific disease carrier in water is too uneconomical, slow and unwieldy for routine sampling procedures. Instead, water is examined for the presence of coliform bacteria. These bacteria are generally associated with sewage, and when found, are presumed to indicate that the water is potentially dangerous.

Coliform Bacteria. Though the presence of coliform organisms in a water sample is regarded as evidence of sewage contamination, they are only indicative of certain bacterial contamination since coliform can originate not only from humans and animals but also from soils, and other non-fecal sources.

Two standard methods are now being used to determine the presence of coliform organisms in the water. One is by the multiple-tube fermentation

Figure 15. Map showing location of sampling points for ABS analyses made by the Lake County Health

TABLE 10

ABS ANALYSES OF SAMPLES COLLECTED BY
LAKE COUNTY HEALTH DEPARTMENT
JUNE 26, 1964
(ppm)

Station	ABS	Station	ABS
1	0.03	19	0.02
2	0.02	20	0.02
3	0.01	21	0.02
4	0.02	22	0.02
5	0.02	23	0.03
6	0.02	24	0.04
7	0.02	25	0.02
8	0.03	26	0.02
9	0.02	27	0.03
10	0.02	28	0.02
11	0.03	29	0.02
12	0.02	30	0.03
13	0.02	31	0.02
14	0.03	32	0.02
15	0.03	33	0.03
16	0.04	34	0.04
17	0.03	35	0.02
18	0.03		

procedure. In this test, a series of test tubes containing lactose broth are inoculated with different portions of sample water suspected of containing coliform bacteria and incubated at a specific temperature for a certain length of time. If coliform bacteria are present, they will ferment the lactose broth with the production of an acid and a gas. The results are reported as the most probable number (MPN) of coliform bacteria present. This method is merely an estimate of the number of coliform bacteria present and is not an actual enumeration of the coliform in any given volume of sample.

The other method for the detection of bacteria of the coliform group is called the membrane filter method. This method uses a cellulose-acetate membrane through which the water sample is filtered. The filter is then cultured and incubated in selective media that allow the bacteria to grow and form colonies. The coliform bacteria colonies are identified by the golden sheen produced by growth on these selective media.

This method of detection has a number of advantages. One is the short time required (24 hours) for growth of colonies. Another is that it permits a much larger sample of water to be examined than the previously mentioned multiple tube fermentation test providing that it does not contain much suspended solids. This method also permits the field filtration of the sample eliminating the need to transport the sample back to a laboratory before the test can be started. The results are reported as the number of coliform colonies identified from a 100 milliliter sample.

The Lake County Health Department, in cooperation with the State of California Department of Public Health made a large number of determinations of the coliform bacteria concentrations of the lake during August, September, and October 1964, using the multiple tub fermentation procedure. The location of the sampling points are shown in Figure 16 and the data are presented in Table 11.

Figure 16. Map showing location of sampling stations for coliform bacteria analyses collected by the Lake County Health Department.

TABLE 11

COLIFORM BACTERIA COUNTS IN SAMPLES COLLECTED BY
LAKE COUNTY HEALTH DEPARTMENT AND
DETERMINED BY
MULTIPLE TUBE FERMENTATION METHOD AND
REPORTED AS MPN PER 100 ml

Station	8/24/64	9/21/64	10/26/64	Station	8/24/64	9/21/64	10/26/64
1		>16	230	36	<2.2		2,300
2	<2.2	>16	620	37			290
3			620	38			620
4	>16	>16	23,000	39	<2.2	6,200	2,300
5			230	40	5.1		130
6	>16		23,000	41	<2.2	2,300	2,300
7	<2.2		60	42	5.1	620	2,300
8			2,300	43	9.2	6,200	2,300
9			620	44	<2.2		23,000
10	<2.2	>16	2,300	45	<2.2		240,000
11			2,300	46	>16	2,300	620
12			62,000	47	<2.2	2,300	620
13			6,200	48	>16	60	6,200
14			2,400,000	49	>16	23,000	230
15	>16		62,000	50	9.2	60	60
16	>16		620	51	>16		2,300
17	>16		620	52	>16		2,300
18			62,000	53	>16		23,000
19		>16	2,300	54	>16	2,300	62,000
20			230	55	<2.2		500
21			620	56	>16		700,000
22			6,200	57			700,000
23			13,000	58			700,000
24	>16		23,000	59			23,000
25	>16		6,200	60	>16		
26	>16	>16	2,100	61	>16		
27			6,200	62	>16		
28	>16	>16	620	63	>16		
29	<2.2	>16	2,300	64	>16		620
30	9.2		2,300	65	>16		
31			230	66	>16		
32	<2.2	>16	23,000	67	9.2		
33			230	68	>16		
34	5.1	>16	620	69	>16		
35	5.1	>16	620	70	>16		

TABLE 11, Continued

COLIFORM BACTERIA COUNTS IN SAMPLES COLLECTED BY
LAKE COUNTY HEALTH DEPARTMENT AND
DETERMINED BY
MULTIPLE TUBE FERMENTATION METHOD AND
REPORTED AS MPN PER 100 ml

Station	8/24/64	9/21/64	10/26/64	Station	8/24/64	9/21/64	10/26/64
71	>16		230	101			2,300
72			2,300	102	>16	>16	620
73			620	103	>16		620
74	>16		60	104			6,200
75			230	105	>16		2,300
76	>16		60	106	>16	>16	130
77			230	107	5.1	>16	2,300
78			230	108	>16	>16	6,200
79	>16		230	109	5.1		2,300
80			230	110			6,200
81	9.2	>16	60	111			2,300
82	9.2		230	112	>16		6,200
83	9.2		2,300	113	>16		23,000
84	9.2	>16	6,200	114	9.2		
85			2,300	115	>16		
86	5.1		120	116	>16		
87			240,000	117	>16		
88	>16	>16	23,000	118	>16		23,000
89	>16		6,200	119	>16	>16	700,000
90			2,300	120	>16		
91	>16	>16	230	121	>16		
92	>16		620	122	>16		
93			620	123	>16		2,300
94			2,300	124	>16		
95	>16	>16	6,200	125	>16		230
96			2,300	126	>16		
97	>16		240,000	127		>16	620
98			2,100	128	2.2	>16	13,000
99			620	129	2.2		
100	>16		13,000	130	2.2		2,300
				131	>16		
				132	>16	>16	62,000

It should be pointed out that the most probable number of coliform bacteria present in the samples collected in August and September are probably low, as the analyst used the procedure associated with a finished drinking water. When the bacteria production reached the level that drinking water would be rejected (16 coliform per 100 ml of water), the analyst made no further attempt to determine the most probable number of bacteria present.

Prior to these sampling runs, a number of determinations of the coliform bacteria concentrations were made by the Department of Water Resources using the membrane filter method. The location of these sampling points are shown in Figure 17 and the results of these determinations are presented in Table 12.

These data indicate the possibility of fecal contamination in Clear Lake at the time of sampling.

Currents

Winds are generally the source of most of the currents occurring in large bodies of water.

This is especially true in Clear Lake, although the release of water from the lake established a minor current. When the wind blows steadily from a single direction the currents in the lake can be correlated with the direction of the wind.

The prevailing winds in the Clear Lake area are westerlies. These winds have an overall affect on the lake, though it is less pronounced on the Lower Arm of the lake, which is protected on the west and south side by the surrounding hills. The Upper Arm, being exposed to the west and

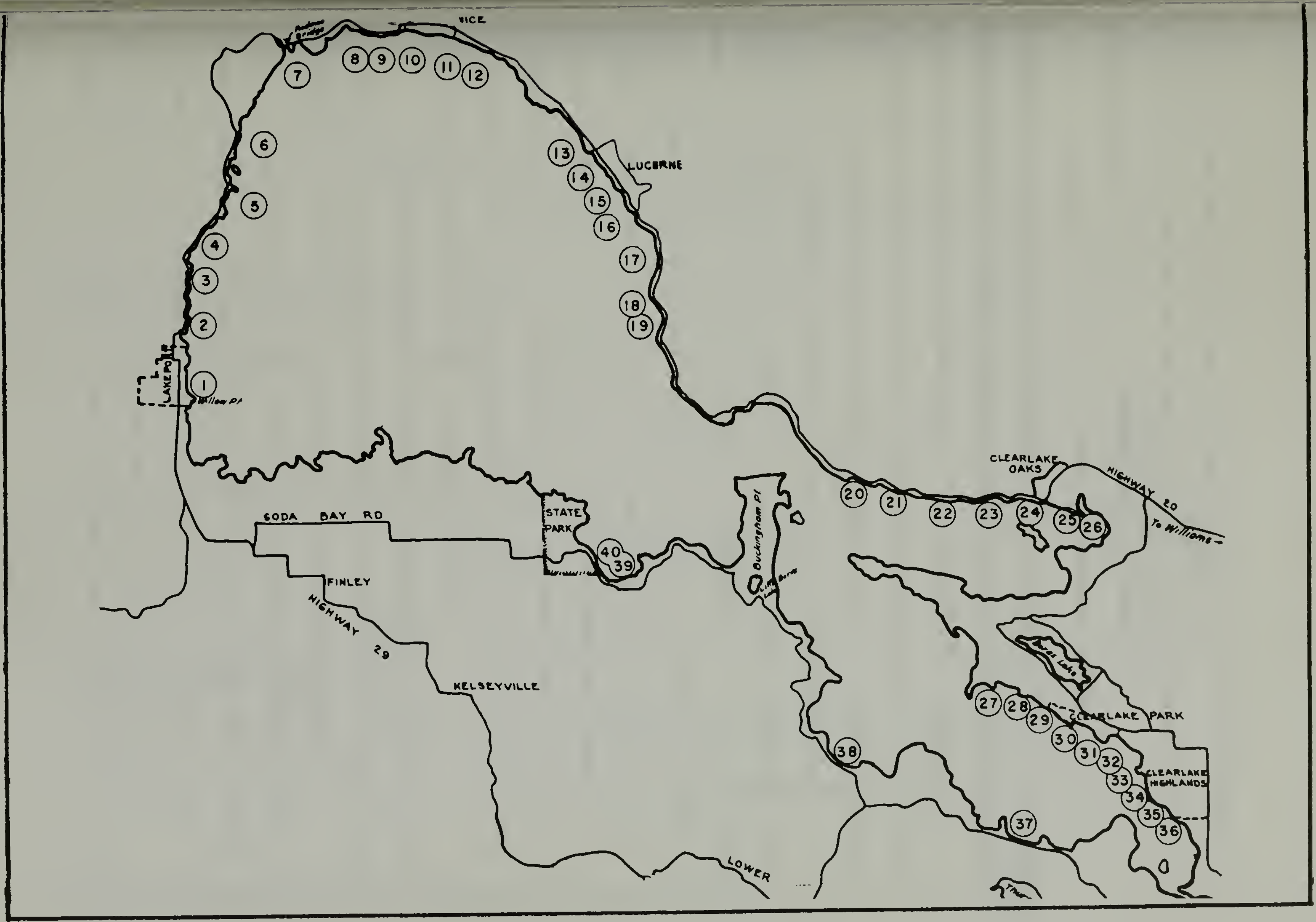


Figure 17. Map showing location of sampling station for coliform bacteria analyses collected by the Department of Water Resources.

TABLE 12

COLIFORM BACTERIA COUNTS BY
THE MEMBRANE FILTER METHOD
1964
(Colonies per 100 ml)

Station Number	6/25	7/1	7/8	7/9	7/14	7/15	7/23	7/24	7/27	7/28	8/4	8/5	8/11
1		19		6	21		0	120		0		10	1
2	3	36		3			15			7		5	4
3	1									0			1
4	2	1		1			3			4		0	15
5	3	1		0		0	2			2		0	0
6	1	2		1		0	0			1		5	0
7	1	2			2					0	1		4
8	2	1			17		4			2	0		40
9	0	3		0	16					60	0		4
10	0	0		0	10					2	1		0
11	1	0		0	26		12			1	1		1
12	0	0								1			
13		1		0	0		2			1	1		2
14		0		0	0		1			8	0		2
15		0		0	0		8			23	2		2
16		0		0	0					0	0		0
17		0		0	24			16		4	1		0
18				0	0					1	1		0
19				3	1					2	7		0
20					1					2	2		0
21										0			
22		1		0	1	0		75	0		6		
23		1		0	0	0		2	0		4		
24		1		0	0	32		80	3		40		
25		0		2	0	2			36		2		
26		3		0		0			0		2		
27		2		0		2			2		2		
28			0			0			0			0	
29			0			0			0			2	
30			0			2		0	0			0	
31			0			0		8	0			3	
32			1			0		20	0			1	
33			0			0		2	0			3	
34			1			3		2	8			0	
35			0			0		2	10			5	
36			1			0		3	0			0	
37			0			0			0			2	
38			4			0			0			3	
39			1			0			0			3	
40			3			1			1			2	

south, and the Oaks Arm with its long axis trending in a westerly direction, usually have wind caused wave action due to the prevailing westerlies, though there are periods of calm.

Mount Konocti has some influence on the winds in the area. This influence is noted mostly in the Narrows, where the three arms join just north of Mount Konocti. At numerous times the winds have caused relatively rough water in the Narrows and on down through the Oaks Arm while the Upper and Lower Arms, for a distance of two or three miles away, remain perfectly calm.

The currents in the lake were studied by the use of aluminum drogues designed and constructed by personnel assigned to this investigation. The drogues were made of aluminum vanes 18 inches by 18 inches attached to each other in the form of a cross which was then attached to a one and one-quarter inch diameter aluminum conduit. Each drogue floated by inserting a rubber stopper in each end of the conduit. A wooden dowel with an orange numbered flag was inserted in the upper stopper in order to track each drogue. To determine the currents at any specific depth, the vanes were attached to either three, six, or twelve foot lengths of conduit or were suspended from the conduit by lengths of wires to the desired depth.

The results of these studies show that currents exist in all parts of the lake and are caused almost exclusively by wind action. Travel of the drogues was almost always in the direction of the prevailing wind.

Small local breezes can start local currents and surface waves; however, when the winds become general, affecting the entire lake, currents are set up at depth, moving the water in the direction of the wind. This action piles the water up at the extreme reach of the lake, setting up a return flow in the opposite direction underneath the surface currents. This phenomena has been observed a number of times. Drogues set at five foot and ten foot depths will move in the direction of the wind. The drogues at 30 or 40 feet will move in the opposite, or upwind, direction from the surface floats.

One set of current measurements made by setting drogues at the surface and at five and ten foot depths, showed the drogues set at the surface travelling more than two miles in a four hour period. This is an average velocity of better than 0.4 mph. The drogues that were set at five foot depths were clocked for an additional 40 hours for a total of 48 hours, during which time they travelled 11 miles for an average velocity of less than 0.25 mph. The drogues set at a ten foot depth and clocked for the same length of time as the five foot drogues travelled approximately 7.5 miles, for an average velocity of 0.16 mph.

All of these measurements were made when the prevailing wind was from the northwest and west at an average velocity of more than 16 mph.

It has also been noticed that when the prevailing winds shift direction, waves or swells are created on top of and at varying angles to existing waves or swells. This phenomenon sometimes creates cross currents in the lake where floats set at the same depth some distance apart cross each other's line of travel.

The vertical currents set up by the prevailing winds disturb the loose sediments on the bottom of the lake, mixing them and placing them in suspension, thus raising the turbidity of the water, recirculating nutrients, and maintaining uniform dissolved oxygen concentrations throughout the lake.

The prevailing wind pattern for Clear Lake is generally calm in the morning, with breezes occurring in the afternoon. These breezes are sufficient to start currents moving in the lake.

When periods of calm existed for three or four days or longer no currents existed. The effects of this were to cause temperature stratification to develop. Absorption of solar energy and the ambient air temperature can cause water in the upper levels of the lake to become five to ten degrees warmer than the underlying water.

Such thermal stratification forms a barrier that prevents dissolved oxygen used by the organic material of the bottom sediments to be replaced, thus creating oxygen deficiencies in the lower levels for aquatic life such as fish.

Biota

Biological studies of Clear Lake have ranged from primary productivity (Goldman and Wetzel, 1963) to Western Grebe reproduction (Hunt and Bischoff, 1960). Major emphasis has concerned the fishery and the Clear Lake gnat. Aquatic weeds usually do not grow profusely in Clear Lake except for tules and a few other species that grow in the littoral or shallow shoreline areas that are periodically exposed by receding waters. Because of the constant turbidity of the lake, light necessary for photosynthesis cannot penetrate more than a few feet beneath the surface and aquatic plants or weeds cannot establish themselves, although the bottom sediments may be suitable for plant growth.

The turbidity then, may be a blessing in disguise, as evidenced by one instance that occurred in Soda Bay in 1959. During the spring of that year the turbidity of the water remained low enough for a species of aquatic plant to become established in the relatively shallow bay. It grew so profusely that the entire bay was choked with weeds for the entire summer. Residents reported that it was impossible to row a boat through the dense growth.

Fish

Many studies have been made of the fish of Clear Lake (16, 17, 18, 19). The first collection of fish was apparently made by Stone in 1874, though Jordan and Gilbert (1895) were the first to publish any data. Since that time, studies by Coleman, 1930; Lindquist, 1943, Murphy, 1951; Pintler, 1957; and Cook, et al, 1964, have been published. These reports indicate the change the fishery of Clear Lake has undergone.

Since these early studies, the lake itself has changed considerably, thereby affecting the fishery. Activities credited to man have speeded up eutrophication of the lake. These factors and the introduction of at least 12 different species of fish not native to the waters are the main reasons for these changes in the fishery.

The 1895 report of Jordan and Gilbert listed 13 species of fish native to this body of water. Murphy's report, published in the October 1951 issue of "California Fish and Game", lists 20 species of fish, 12 native and 8 introduced, as occurring in Clear Lake at the time of his study. These are listed in the following tabulation.

THE FISHES OF CLEAR LAKE (Murphy, 1951)

NATIVE	INTRODUCED
Rainbow Trout	Carp
Thicktail Chub	Brown Bullhead
Western Sucker	White Catfish
Greaser Blackfish	Mosquito Fish
Hitch	Large Mouth Black Bass
Sacramento Squawfish	Green Sunfish
Splittail	Bluegill
Western Roach	Black Crappie
Sacramento Perch	
Tule Perch	
Riffle Sculpin	
Three Spined Stickleback	

This report also states that at least six other species of fish have been introduced but have not established themselves.

The report by Cook, et al, 1964, states that since the time of Murphy's report, four additional species of fish have been introduced to Clear Lake and have established themselves. These are the Goldfish, Golden Shiner, Channel Catfish, and White Crappie.

Of all the species of fish in the lake, ten may be considered game fish, eight of them being introduced. The remainder are considered non-game species. Table 12 shows the relative abundance of fish taken during an intensive sampling period from 1961 through 1963 by Cook. These have been arranged according to game and non-game types.

TABLE 13

Adult Fish Taken or Previously Reported from Clear Lake
June 1961 - June 1963

Species	Number of Fish Taken	Type: Non-Game	Type: Game
Bluegill	2,861		x
Mosquito Fish	Many	x	
Hitch	1,729	x	
Blackfish	539	x	
Tule Perch	519	x	
White Catfish	339		x
White Crappie	267		x
Black Crappie	173		x
Brown Bullhead	158		x
Prickly Sculpin	140	x	
Carp	152	x	
Large Mouth Black Bass	45		x
Golden Shiner	38	x	
Splittail	27	x	
Green Sunfish	11		x
Channel Catfish	4		x
Sacramento Squawfish	0*	x	
Sacramento Perch	9		x
Western Sucker	3	x	
Rainbow Trout	1		x
Goldfish	0	x	
Western Roach	0	x	
Thicktailed Chub	0	x	
Three-Spined Stickleback	0	x	

*Several juveniles taken

The abundance of non-game fish in Clear Lake permits a commercial fishery to exist. The fish are first caught by seining and then transported live in tank cars to markets in Los Angeles and San Francisco. Only two types of fish are commercially marketable at this time, the Blackfish and Carp.

Cook states that perhaps over half a million adult Blackfish have been removed from the lake from 1955 to 1963 with no apparent decimating effects upon the population levels.

Murphy, in his 1951 report, gives the following amounts in pounds of fish removed from the lake annually from 1941 to 1949.

Year	Carp	Blackfish
1941	55,000	80,000
1942	80,000	160,000
1943	125,000	40,000
1944	165,000	40,000
1945	290,000	40,000
1946	295,000	20,000
1947	394,000	21,000
1948	321,000	3,000
1949	385,000	0

The latest figures from the Department of Fish and Game show that 218,712 pounds of Carp were removed from the lake in 1962, and 241,288 pounds in 1963.

Insects

One of the major concerns of any resort area is the aesthetic problems that arise from too many of the wrong kind of insects, especially those insects which reproduce rapidly and are extremely active. Throughout the world, some species of these insects have become the bane of man, who has gone to great lengths to rid himself of them or made attempts to at least control them. Such are the mosquito and gnat - two great pests in the Clear Lake area.

In 1948, the residents of Lake County formed a countywide, tax supported Mosquito Abatement District. Through this agency, the mosquitos have been controlled throughout the county by the use of chemicals and mosquito eating fish. Though the mosquito is a problem, it is not nearly so much of a problem as another flying insect, Chaoborus Astectopus, commonly referred to as the Clear Lake gnat.

The Clear Lake gnat is a nonbiting organism found throughout the State. Nowhere, however, has it attained the population densities found at Clear Lake.

The annoyance caused by these insects is due to their extreme abundance and attraction to light. In fact, the swarms of gnats around lights in the evening have, in the past, prevented maximum recreational use of shoreline areas.

The gnat lays its eggs in the lake where they hatch in one or two days either on the surface or, if the egg has sunk, on the bottom. If calm weather prevails, great drifts or islands of eggs are formed that are several yards wide and several hundred yards long. Estimates of the number of eggs in these drifts have ranged up to ten million per square foot in drifts as large as 200 acres. The larvae are free swimming and migrate to deep water where they enter the bottom muds, emerging at night to feed in the open water. After emergence from the larvae stage, the flying adult gnats move shoreward but are seldom found more than several miles from the lakeshore.

The gnat population survives the colder winter months as larvae buried in the bottom muds and emerge in late April or early May. By July, a second generation begins to appear and heavy flights then continue into October.

A series of tests over two years show the average seasonal emergence in the Upper Arm is about 712 billion gnats, or 356 tons.

The Clear Lake gnat has been controlled since 1961, when researchers of the Lake County Mosquito Abatement District found a non-persistent chemical that would selectively destroy the larvae of the gnat and could be applied to the waters of the lake in such small concentrations that the waters could safely be used for all purposes.

Another species of insects that is prevalent in the Clear Lake area is the aquatic midge of the family Chironomidae. These insects are also non-biting organisms that are widespread throughout the country and the world, though their populations do not reach densities in Clear Lake comparable to the Clear Lake gnat. As a result their impact on the recreational use of the shoreline areas is not as drastic as the Clear Lake gnat. The heaviest emergence of these midges occurs in the early spring and late fall instead of at the height of the tourist season in the summer.

Plankton

The community of unicellular, usually microscopic, animals and plants that live in bodies of water and are free floating or swimming are called plankton. There are two types; phytoplankton, which are the plant plankton such as algae, and zooplankton, which are animal plankton such as daphnia or water fleas.

Algae is to water what grass is to earth. Algae is often called the "grass of water". Wherever there is a body of water exposed to sunlight, there will also be algae of one type or another. More than 20,000 individual kinds of algae have been identified.

Whenever algae growths develop to the point that they become aquatic nuisances, they interfere with man's intended use of the water. Aquatic sports such as swimming, boating, fishing, and water skiing are either curtailed or eliminated. Picturesque areas of beauty may be impaired, property values may be lowered or resort trade may suffer.

The treatment of water for industrial and municipal uses could be hampered or made inefficient and, if certain species of algae are present, the water could be made unsafe for use because of the release of toxins from the algae to the water.

Algae are distinguished from other groups of small of microscopic organisms by a number of characteristics. One of these is that they possess an internal green pigment called chlorophyll, which is sometimes hidden or partially masked by other pigments. Chlorophyll enables algae, in the presence of sunlight, to combine water and carbon dioxide to form starch, or related substances, and release oxygen into the water. This process is called photosynthesis and is common to all types of green plants.

Algae make it possible for important chemical changes to take place in the water through their release of oxygen through the photosynthesis process during daylight hours. This oxygen is available for respiration by all types of animals from fish to the microscopic forms. The oxygen also helps to prevent foul or septic conditions from occurring by accelerating the decomposition of organic materials in the lake. The release of oxygen to the water by algae is the primary source for renewal of this essential element in most bodies of quiescent water.

Another important chemical effect of algae is the continual removal of carbon dioxide from the water during photosynthesis. This produces a change in the total hardness of the water. Vigorous algae growths have been known to reduce water hardness by as much as one third.

These changes in carbon dioxide change the p^H of the water, making it more alkaline, thus increasing the amounts of chemicals that would be needed to treat the water for use or for algae control.

Increasing attention is now being paid to algae that produce toxic organic substances. There are records of these toxins causing the deaths of many kinds of wild and domestic animals. Certain outbreaks of gastro-intestinal disorders among persons using a common water supply have been suspected of being caused by toxin producing algae. (14)

The principal factors affecting algae growth include nutrients, sunlight, water clarity, and temperature.

The growth and normal biochemistry of one algal group, the blue-green, require the availability of 20 elements, according to Eyster (1964). Those required in relatively large amounts are carbon, hydrogen, oxygen, nitrogen, phosphorus, sulfur, potassium, magnesium, and calcium. Elements required in trace amounts are iron, manganese, copper, zinc, molybdenum, vanadium, boron, chloride, cobalt, and silicon.

All nutritional studies of algae point to nitrogen in the inorganic form (ammonia, nitrite, nitrate) as being the largest nutrient requirement. The ultimate source of nitrogen is from the atmosphere. Nitrogen compounds usually result from fixation of the atmospheric nitrogen. It is an essential constituent of the protein of all living organisms.

Phosphorus is perhaps the element more likely to be deficient in lake water than any other major biological element. It is an essential nutrient for plant and animal growth and, like nitrogen, passes through cycles of decomposition and photosynthesis.

Phosphorus comes from decomposition of organic matter, the weathering of phosphatic rocks or from agricultural drainage. It is strongly tied up by the soil and is not easily leached by rainwater. Detergents are becoming an increasingly important source of phosphorus.

Carbon dioxide (CO_2) is another raw material that must be present for supporting algae growth. As with nitrogen, tremendous resources of this material exist in the atmosphere. The rate of replenishment of the supply removed from the water by plants containing chlorophyll is relatively slow except under conditions of extreme wave action. Generally, in surface waters, there is not enough free carbon dioxide present to support algae blooms; however, surface waters are generally high in bicarbonates (HCO_3) and algae can remove its CO_2 requirements from the bicarbonates, which is the reservoir of the available raw material.

The removal of CO_2 from HCO_3 makes the water more alkaline, thus raising its pH. Its CO_2 then becomes more readily dissolved from the air. The pH, or measure of acidity or alkalinity of the water, is considered to be one of the more important factors in governing the rate of algae growth.

The control of algae has been studied for years. Various methods could be employed in Clear Lake but practicality has to enter the picture. It is quite obvious that if the nutrients and light can be regulated, an effective control of the algae would be instituted. Different methods of such regulation have been proposed, but none have proved practical. To date, the only effective control of algae has been through the use of chemicals. A number of algicides have been compounded but generally are to expensive for for large scale use. Copper sulfate is the only algicide in common use at present. It is toxic to many algae at comparatively low concentrations, is ordinarily not lethal to fish at strengths recommended, and is relatively inexpensive.

With more extensive use of a lake surface by motor propelled boats and the accompanying demand for cleaner water for water contact sports, the urgency of the algae problem in Clear Lake has been brought into sharper focus. Prior to the popular outboard motorboat era, as long as the algae blooms occurred in the open waters away from resort areas and did not pile up on shore, there was no particular cause for concern or complaints.

No one knows exactly when excessive algae growth in Clear Lake first reached nuisance conditions. Comments from long time residents are varied, one stating that he knew that Clear Lake had algae problems in the late 1920's. He particularly remembered this from his first day at Clear Lake. His little white dog went to the lake to get a drink. When it returned, its fur was dyed green from algae, and it later became sick from the water it drank.

Goldman, in his study on the primary productivity of Clear Lake (1963) states that the productivity of the lake has undoubtedly increased during the past century due to the rapid development of the surrounding land for agriculture. He also states that the natural watershed drainage, together with improper land use, agricultural fertilization and some sewage inflow has contributed to the present high rate of sedimentation, turbidity, and algae productivity.

The productivity of the algae in Clear Lake is usually low in the winter and early spring with a small spring peak. Productivity increases progressively during the summer to a large autumn maximum before the rapid winter decline. Fluctuations of productivity during the various seasons is correlated with the amount of light reaching the lake and the turbidity and temperature of the water; productivity rates are higher when the water is clearer.

These algae can accumulate at times in such numbers as to form loose aggregations called "blooms", which may cover very large areas of the lake. These blooms usually occur during periods of calm, warm weather when the algae, which previously were distributed throughout the water, rise to the surface. The different colors appearing in these blooms is attributed to decomposition of the cells of the dead algae.

There is no known record of quantitative counts or of identification of all of the specific species of algae in Clear Lake; however, the Lake County Mosquito Abatement District, in conjunction with their research on the ecology of the Clear Lake gnat, sample a number of stations throughout the lake on a monthly basis. This sampling is for the total plankton present that can be trapped by use of a plankton net. The method of collection is to pull the net from five, ten, fifteen, and twenty foot depths to the surface and the resultant collection from each depth is then centrifuged.

A relative quantitative count of each group of organisms is then made by measuring the amounts separated in the centrifuge tube. In addition, identification is made of the predominant species.

In Clear Lake, the predominant types of algae have been identified as belonging to either the blue-green group or the flagellates. The blue-green algae derive their name from their blue-green color caused by a blue pigment being present within their cell structure in addition to the green chlorophyll. They have a comparatively simple form and structure and their cells are surrounded by a slimy coating. They are primarily floating and dependent upon the currents to move about. In nature they seem to grow best in waters having high organic matter and are notorious slime producers.

The flagellates have a more complicated form and structure than the blue-green algae. They possess a nuclei, a red eye spot, and have one or more flexible whip-like hairs known as flagella, extending from their cells. These flagella are whipped about spontaneously and tend to move the algae through the water, though their direction of movement in general is not controlled, but random. Flagellates vary in color from green to brown.

The blue-green algae identified in the order of their predominance are Aphanizomenon, Anacystis, and Anabaena.

Aphanizomenon is present in Clear Lake the year round and is the cause of most of the algae blooms in Clear Lake.

It is a colony dwelling algae and can be seen in the water by the naked eye. It appears similar to a small blade of new rye grass about one-eighth of an inch in length suspended in the water. Examination under a microscope would show each blade to be a colony of algae made of numbers of strings of green cells gathered together like a bundle of sticks. Aphanizomenon can withstand a wide range of temperatures. Blooms of this algae species have been observed in lakes with frozen surfaces and in waters as high as 84° F.

Anacystis is also a colonial dwelling algae that, under magnification, has the appearance of a group of green peas individually suspended in a clear gelatin with no apparent shape or pattern.

Anabaena is also a colony dwelling species. This algae, when enlarged, appears to be similar to a strand of miniature green beads.

Only one variety of flagellates has been identified as being a predominant algae in Clear Lake. This is Volvox. When viewed under a high power microscope, volvox is similar in appearance to a large snowball covered with little green dots, each of which has two little hairs protruding from it.

In Clear Lake *aphanizomenon* is the predominant algae until late summer, when climatic and other conditions become more favorable for *anacystis* or *anabaena* to reproduce in great abundance and become the dominant species. This predominance is rather short lived, usually not more than one or two weeks, when the conditions change and again become more favorable for *aphanizomenon*.

All three of the blue-green algae (*aphanizomenon*, *anacystis*, and *anabaena*) are capable of producing nuisance blooms and all three are present in Clear Lake. At any single time, however, usually only one predominates.

Volvox, a flagellate algae, has not been observed to reach concentrations of nuisance proportions, though it too is present at various times of the year.

All of these algae, whether singly or in combination, have been associated with numerous water supply problems throughout the world. Such problems as imparting taste, odor, color, causing corrosion of concrete, interfering with coagulation in water treatment or contributing toxic elements to water have been documented.

Water Outflow

The only outlet from Clear Lake is through Cache Creek. This creek begins at the southern end of the lake and flows generally southeastward through the mountains, through Capay Valley, and on into the Sacramento Valley north of Woodland where, during periods of heavy outflow, it joins the Sacramento River just south of Knights Landing. There is no flow in the lower reaches of this stream during the summer, as all water is diverted for irrigation.

Amount of Outflow

As mentioned previously, the flow of water in Cache Creek is controlled by a dam about five miles downstream from the outlet of the lake. This dam is used to impound runoff waters in Clear Lake for later release for irrigation downstram. As a result of this practice, there is usually more water flowing down Cache Creek in the summer than during the normal wet season.

Table 14 shows the monthly discharge in thousands of acre-feet leaving Clear Lake via Cache Creek for the years 1951 through 1964.

Though Clear Lake is a natural lake created by a volcanic dike called the Grigsby Riffle, several dams have been built across the Cache Creek outlet to Clear Lake to utilize the surplus water from winter runoffs. These dams have been a source of lengthly litigation. One, constructed in 1866, was destroyed by residents along the lakeshore when rising waters inundated their lands. In 1915, the Yolo Water and Power Company, predecessor to the present owner, the Clear Lake Water Company, constructed the present impounding dam. This dam is capable of regulating water in the lake from an elevation of -3.5 to +10.3 feet on the Rumsey gage.

The regulation of the lake levels by this dam was contested by lakeshore property owners soon after the dam was placed in operation.

In 1919, the owners of the dam tried to improve the outflow conditions from the lake by deepening the outlet channel. Work had been completed for a distance of about two miles when it was stopped by an injunction initiated by the land owners around the lake. As a result of this injunction, a decree was entered in 1920, by the Superior Court of the State of California. The salient points of the decree, known as the Gopcevic Decree, are as follows:

TABLE 14

MONTHLY DISCHARGE FROM CLEAR LAKE DAM
(Thousands of acre-feet)
1951-1964

Water Year	October	November	December	January	February	March	April	May	June	July	August	September
1951	.2	.1	.2	37.1	49.7	21.8	9.3	21.3	33.9	31.4	28.0	11.8
1952	.3	.2	.2	117.7	126.3	68.3	16.2	29.0	27.8	30.3	30.4	14.3
1953	1.5	.2	.2	122.8	25.1	10.0	24.3	19.3	22.6	31.0	25.4	12.6
1954	.8	.2	.2	.2	.1	63.3	45.5	21.4	25.9	29.3	26.0	15.6
1955	2.1	.0	.0	.0	.0	.0	3.9	12.5	26.1	29.6	23.9	9.9
1956	.6	.0	18.9	166.3	149.6	106.0	7.2	23.9	21.7	25.3	20.7	8.8
1957	1.0	.1	.2	.1	.1	.1	10.0	27.8	22.7	23.9	19.6	9.4
1958	.1	.1	.1	29.0	200.2	229.4	210.5	4.8	15.1	22.5	20.6	9.2
1959	1.9	.1	.1	.0	43.3	.6	14.7	19.6	24.2	24.2	19.5	7.2
1960	2.4	.1	.1	.1	.2	.2	6.8	14.5	25.0	23.6	19.4	8.9
1961	2.2	.2	.1	.1	.1	.2	7.2	17.1	22.5	26.4	20.3	8.7
1962	2.6	.1	.1	.1	1.1	57.2	13.0	20.1	25.3	25.5	19.8	10.3
1963	1.7	.2	.2	3.8	8.0	35.1	148.1	12.3	22.2	23.0	20.0	11.0
1964	3.4	.2	.2	.2	.2	3.8	12.1	22.1	20.2	24.9	18.7	7.3

1. The owner and operator of the dam is perpetually enjoined from excavating the outlet of Clear Lake to any depth greater than four feet below zero on the Rumsey gage.

2. The owner and operator of the dam, in their operation of the dam, is perpetually enjoined from drawing the level of the lake below zero elevation on the Rumsey gage.

3. The owner and operator of the dam is perpetually enjoined in the operation of the dam from allowing the lake level to rise above 7.56 feet above zero on the Rumsey gage except during storms and floods, which period shall not exceed ten days, but in no event, over 9.0 feet above zero on the said gage.

4. If the injunction is violated, or if the owner ceases to operate the dam, the land owners around the lake are entitled to restore the natural rim of the lake (Grigsby Riffle) to either one or two feet above zero on the Rumsey gage, in accordance with certain specified conditions.

The water storage available between zero and 7.5 feet on the Rumsey gage is 314,000 acre-feet. The lake has been operated to make available this storage in accordance with the terms of this decree, so far as possible, since 1920, though flooding of lands around the lake has occurred.

The flooding is caused primarily by the restricted outlet channel which has an extreme flood discharge capacity of 5,000 second-feet. Historic flood flows to the lake have been measured in excess of 40,000 second-feet. With the restrictions on outflow and the large volumes of inflow, it is physically impossible to operate within the limits set by the Gopcevic Decree.

Records of water surface elevations in Clear Lake since 1920 show that elevation 7.56 feet has been exceeded 14 times and that elevation 9.0 feet has been exceeded 4 times.

In February, March, and April 1958, the elevation of Clear Lake reached a maximum of 10.88 feet, and exceeded 9.0 feet for a total of 44 days, even though the maximum possible release was being made from the lake.

In February 1938, the lake reached a maximum elevation of 10.25 feet, causing widespread flooding. Following this disaster, the Clear Lake Water Company joined with Lake County and the State of California Department of Public Works to enlarge or widen the outlet of Clear Lake. This would have allowed larger releases of water while conforming to the Gopcevic Decree. Work had not progressed far when downstream land owners, fearful of flood damage from increased releases to Cache Creek from Clear Lake, obtained an injunction and a decree from the courts that perpetually enjoins the defendants from widening, deepening, or enlarging the outlet of Clear Lake so as to increase the flow of water from Clear Lake into Cache Creek. This decision is known as the Bemmerly Decree.

The result of these decrees was to limit the amount of water available in Cache Creek below the dam and to limit the flow of this water to the present capacity of the outlet channel.

Quality of Outflow

The primary purpose of the dam on Cache Creek is to store waters in Clear Lake for later release and use for irrigation. The quality of this water leaving the lake must be suitable for this purpose.

These outflowing waters have been monitored on a monthly basis from a sampling station located immediately below the Clear Lake dam since 1951.

Physical Quality

The temperatures of the water leaving the lake have a yearly range of approximately 40 degrees, 40° F to 80° F. The minimum temperature on record is 39° F, the maximum is 84° F. These values correlate closely with the temperatures at the monitoring station at Lakeport, except during the colder months when seasonal inflow occurs. Then the temperature at the outflow is two to six degrees lower than at other monitoring stations.

Generally, the turbidity at the outflow is less than at the Lakeport station. This is as expected, since most of the turbidity causing sediments enter the lake in the Upper Arm and have settled out by the time the inflow water has reached the outlet. Readings of turbidity at the outflow station (expressed in Jackson Candle Units) seldom go above 20, although a reading as high as 340 has been recorded. All readings above 20 are associated with the seasonal inflow and generally last for less than one month. Figure 18 compares the turbidity values of the outflow to those at the Lakeport monitoring station.

Chemical Quality

The outflow water is generally of good chemical quality, meeting all of the requirements established by the U. S. Public Health Service for drinking water, but falls into Class II irrigation water because of boron concentrations.

Analyses of water collected since 1951 shows that during the summer the chemical constituents of the outflow water are slightly higher than water at the other stations in the lake; during the winter they are slightly lower.

This variation in chemical concentration is attributed to the fact that the water is held in storage in the lake for later release, subjecting

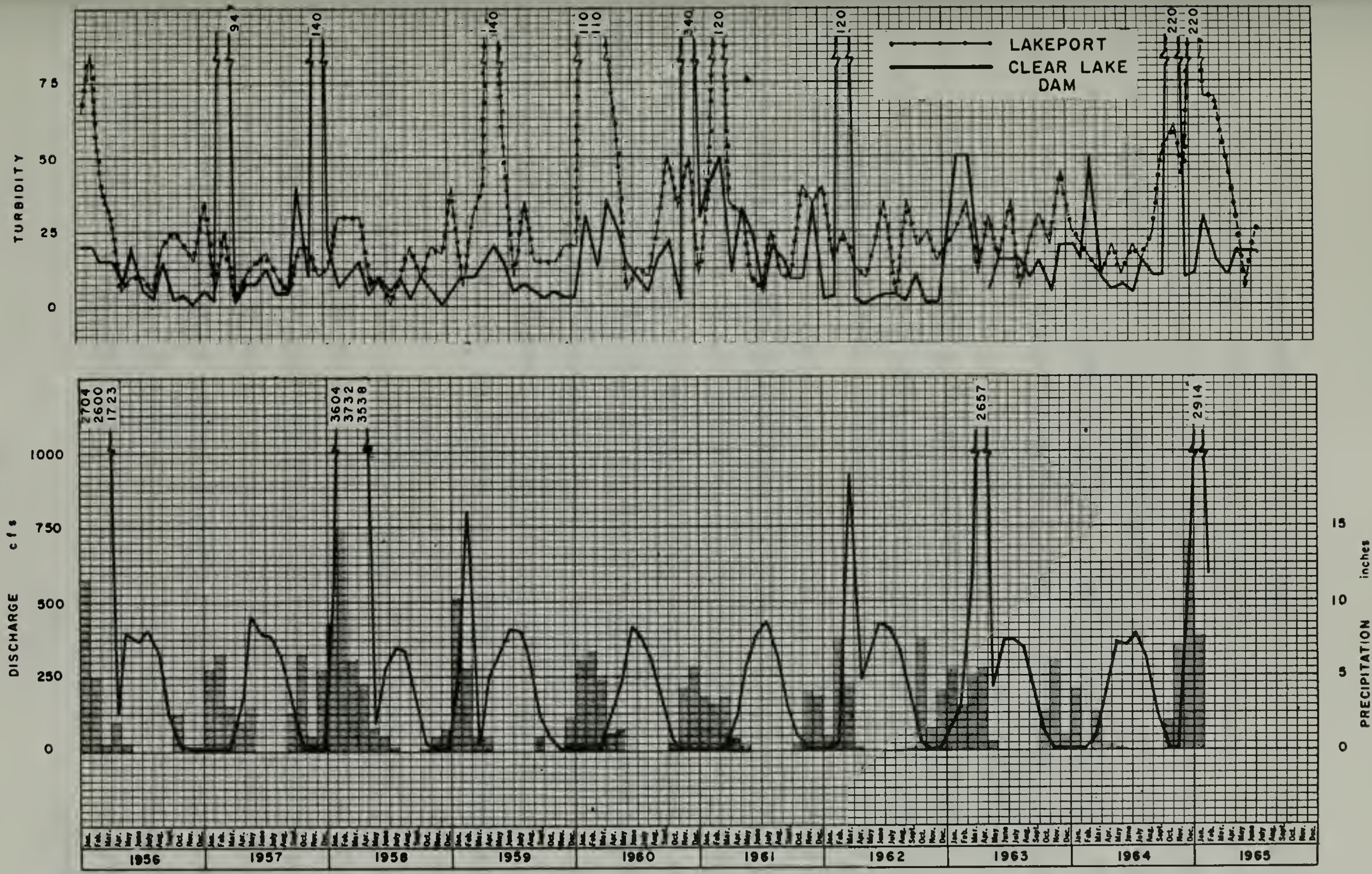


Figure 18. A comparison of turbidity values of Clear Lake determined monthly at the Lakeport City Pier and the Clear Lake Water Company Dam from 1956 to 1965.

it to evaporation. The evaporation tends to concentrate the chemical constituents. By the time the water has migrated to the outlet it is higher in mineral content. This is also noted in the EC values of the outflow water. EC values have been as high as 370 micromhos in the outflow water but only as high as 360 micromhos at Lakeport. Figure 9 shows the comparison of the EC values over a ten year period at the Lakeport monitoring station and the Clear Lake Dam station.

As noted earlier, the outflow water from Clear Lake falls into Class II irrigation water because of boron. Boron is an essential element needed for growth by plants, but if present in concentrations above 0.5 ppm, can be harmful.

Seldom since 1951, when the water quality monitoring station was established, has the boron concentration in the outflow water been below 0.5 ppm. Generally, the boron concentrations vary between 0.5 and 1.0 ppm with the maximum being 2.2. This magnitude was reached only once, during the winter of 1953. At no other time has the maximum exceeded 1.3 ppm (Figure 11).

It has been noted that at times, the concentration of minerals in the outflow water as monitored by the established monitoring station have been erratic.

An evaluation of the specific electrical conductance measurements (EC) made in November and December of 1952, show the EC values of the outflow water decreasing from 335 micromhos to 137 micromhos within a three week period of time. EC values at the monitoring station in Lakeport, during the same period of time, decreased from 310 micromhos to only 240 micromhos. This would lead to the assumption that larger amounts of inflowing water are entering the Lower Arm than the Upper Arm. Normally the magnitude of decreases are just the opposite.

Another instance of erratic values occurred during the winter of 1953, when EC values of the outflow were 316 micromhos in November. In December, these values increased to 447 micromhos and then to 490 micromhos in January, decreasing to 276 micromhos in February.

These variances from the normal values can be attributed to the influence on the sampling station of inflow from three streams that discharge to Cache Creek between the outlet of Clear Lake and the sampling station at the dam. These streams, Seigler Creek, Copsey Creek, and Herndon Creek, are annual streams flowing only during periods of precipitation and for short periods thereafter.

A review of the precipitation records and releases from the dam for the times mentioned in the previous examples tend to verify the influence of these streams.

In the first instance, 16 inches of precipitation had occurred during November and December 1952, causing large volumes of runoff to the lake.

The releases from the dam at that time were small, the dam's gates being closed to store the runoff to the lake. The large volume of inflow from the three streams replaced the small amount of water in Cache Creek between the outlet to the lake and the dam, and samples of water picked up at the monitoring station was not water leaving Clear Lake but runoff from these three streams.

Just the opposite occurred in the winter of 1953. Small amounts of precipitation caused the streams to flow early in the season with no appreciable runoff until late in January. The dam was not releasing water during this time, and the small amounts of inflow eventually replaced the waters in Cache Creek. These initial runoff waters picked up the minerals that had been deposited in the stream beds through evaporation and put them back in solution. These waters had become highly mineralized, which accounts for the increase in EC values in December and January.

Analyses of water collected from the outflow and the lake proper, show the following relations to a sample of water collected from Seigler Creek that was obtained under similar runoff conditions.

	Seigler Creek	Outflow	Lake
Date of Sample	2/20/64	1/17/54	1/17/54
Ca-Mg Ratio (ppm)	.66:1	.94:1	1.60:1
Na-Cl Ratio (ppm)	.73:1	.74:1	1.83:1
Percent Sodium	22	21	16
EC	522	490	283
Boron	2.0	2.1	0.9

Rather than being indicative of the concentrations of chemicals in the water leaving the lake, these measurements from this station at times appear to be indicative of the chemicals in the water flowing into Cache Creek from Seigler, Copsey, and Herndon Creeks.

CHAPTER III. WATER USE AND DISPOSAL

Man has placed many requirements on his limited supply of water. He needs it first of all to sustain his own life. He needs it to irrigate his food crop, flush away his wastes, keep him clean, keep him cool, put out his fires, help him in his manufacturing processes and after he is through using it for all of these and many other purposes, he wants it to be left clean so that he can use it for his own recreational purposes such as boating, swimming, and fishing.

Present Surface Water Use

In the Clear Lake Basin, water for all of the above mentioned uses has been developed from both surface and ground water. Surface water used today is supplied by direct diversion of the stream flow, from storage on streams tributary to Clear Lake or by pumping directly from the lake itself.

Development of surface water is limited, however, by the water rights controlling the use of Clear Lake as a storage reservoir for irrigation in Yolo County.

In 1960, there were over 160 listed diversions of surface water from Clear Lake or its tributaries for all purposes. Almost all of these are for irrigation.

The main diverter is the Clear Lake Water Company, which stores the water in Clear Lake for release and diversion for irrigation downstream in Yolo County.

The major surface diversions for use in the Clear Lake Basin itself are made from Clear Lake to serve the Helms and Edmonds Irrigation Districts in the Upper Lake area. These districts provide water for irrigation of land reclaimed from the lake by levees. Through a system of canals, the water is delivered to individually owned pumps which pump from the delivery canals. The districts operate drainage pumps which return excess winter water and return drainage to a slough that drains back into Clear Lake. More than 3,750 acres of land were irrigated by surface water in 1960. (4)

As the population of the Clear Lake Basin is centered around Clear Lake it is only natural that a large part of the urban water supply should be developed from the easily accessible waters in the lake. Six of the eight largest domestic water systems in the basin, each supplying 200 or more services, are directly or indirectly supplied from the lake. (12) Four obtain their supply directly from the lake. The fifth company is supplied indirectly with lake water through a shallow infiltration well situated at the edge of Clear Lake. The sixth company has an emergency intake located in the lake.

There are also four water supply systems having more than 25, but less than 200, service connections delivering water obtained from the lake. In addition to these suppliers, there are more than 50 resorts and private residences obtaining their domestic supply from water pumped from the lake.

Almost all of the recreation activity in the Clear Lake drainage basin is based on Clear Lake and the uses of its waters. However, small impoundments of water on tributary streams do provide some activity such as fishing, boating, and swimming. Two of these of note are Upper and Lower Blue Lake.

These two lakes, about five miles west of the community of Upper Lake, on State Highway 20, are natural fresh water spring-fed lakes with small resort areas built around them. Heavy recreation use is made of their waters.

Present Ground Water Use

Early settlers in Big Valley, Scott Valley, and the Upper Lake area found ground water easy to develop because of the high water tables in those areas. These areas are now fairly well developed and are the large agricultural areas of the basin, demanding large amounts of irrigation water.

Seventy-five percent of the irrigated land within the entire Clear Lake basin, over 10,400 acres, is irrigated with ground water. The municipal and domestic water supplies for these communities and areas away from the lake are obtained primarily from ground water. Four communities, Lakeport, Upper Lake, Kelseyville, and Lower Lake obtain their water supplies solely from this source. There are no figures available for the number of resorts and individual services that use ground water for their domestic purposes, but this is the only source of water available away from the lake or other surface storage.

Present Quantity of Surface Water Use

The largest user of surface water for irrigation, the Clear Lake Water Company, has used an average of 105,000 acre-feet of water per year since 1927. This seems to be a rather small amount since there is available in active storage in Clear Lake about 314,000 acre-feet; however, the Gopcevic and Bemmerly Decrees control the amount of water that can be released each month and maximum storage is not always attained. Loss of storage by evaporation has been estimated to be between 139,000 and 220,000 acre-feet annually.

Measurement of diversions of surface water, made in 1960, in the Clear Lake Basin showed that more than 6,000 acre-feet of water was applied to 3,750 acres. It is rather difficult to determine the amount of surface water diverted for urban use, but water used by the large water companies will give an estimate of the amount.

The following tabulation lists the large water supplying systems diverting water from Clear Lake, and the estimated amounts.

Supplier	Areas Served	Amount (in acre-feet)
Clearlake Oaks County Water District	Clearlake Oaks	50
Clearlake Park Water Company	Clearlake Park, Austins, and Pine Dale	80
Highlands Water Company	Clearlake Highlands	310
Lucerne Water Company	Lucerne	110
Buckingham Park Water Company	Buckingham Park	20
Manakee County Water District	Clearlake Highlands	20
Miscellaneous	-	50
	TOTAL	640 acre-feet

Negligible amounts of surface water are diverted for stock watering, recreation, industrial, and mining operations.

Present Quantity of Ground Water Use

The largest use of ground water in the basin is for irrigation of agricultural crops. Estimates of the amount used is difficult to arrive at as the discharges are not measured and agricultural irrigation practices differ. An idea of the magnitude of water pumped from the ground can be arrived at by taking the number of acres irrigated by ground water, 10,400 (4), and multiplying that by some figure relative to the amount applied to the largest percentage of crops irrigated; in this case, pears and walnuts.

Agronomists have estimated that 24 inches of water are applied seasonally to each irrigated acre of pears or walnuts. (1) If we multiply the 10,400 irrigated acres by two feet, we find that approximately 20,000 acre-feet of ground water is pumped annually for irrigation in the Clear Lake Basin.

This large amount of withdrawal lowers the water table each year, but the recharge areas are extremely porous and almost 100 percent replenishment of the withdrawn water is attained through the rapid infiltration and percolation of winter runoffs.

The only measurements available for the amount of ground water used for urban purposes is for the City of Lakeport and the Town of Kelseyville.

The water supply for Lakeport is obtained from two wells or filter galleries located in the bed of Scott Creek. These wells supply more than 135 million gallons of water yearly (about 410 acre-feet) and the demand is growing.

Kelseyville is served by the Kelseyville County Water District which maintains two wells on the east bank of Kelsey Creek near Kelseyville. It was estimated that in 1949, the production from these wells was 31 acre-feet. There has been little reason since that time to increase this estimate. The combined listing of all other water service agencies do not total the combined amount of the previous mentioned suppliers and it is doubtful that the total amount of ground water in the Clear Lake Basin that is used for urban use exceeds 1,000 acre-feet annually.

Industrial use of ground water is of little importance, the cannery near Upper Lake probably being the greatest user, and this during the canning season only.

Surface Water Treatment Practices

The two principal requirements of water supply are that it be adequate and that it be suitable for the use intended. The surface water in the Clear Lake Basin that is delivered for urban and domestic use by the large water companies is treated before it is released to the consumer. The following systems, having more than 200 service connections, treat water by the following methods.

The Clearlake Oaks County Water District obtains its supply by means of a suction line extending into Clear Lake. The water is filtered through a diatomaceous earth pressure-type filtering system. The filtered water is chlorinated and then held in a 30,000 gallon covered and screened water tank to provide chlorine contact time. The finished water is then delivered to the distribution system or to one of two 100,000 gallon storage tanks.

The Clearlake Park Water Company also derives its supply from Clear Lake. Two intake lines are located in the lake; one is located below Chamisa Gap and extends about 100 feet out into the lake; the other, near the Clearlake Park Post Office, extends about 200 feet into the lake. Each of these intakes supplies a filtration plant where the water is coagulated and sedimentation occurs. Activated carbon is then added to the water and it is run through a sand filter under pressure before chlorination.

The plant at Chamisa Gap has no chlorine contact storage. The treated water is pumped directly to the distribution system or to a 42,000 gallon covered tank. The plant near the Clearlake Park Post Office stores the finished water in a 3,000 gallon chlorine contact storage tank before it is pumped directly to the distribution system or stored in a series of covered tanks having a capacity of 230,000 gallons.

The Highlands Water Company obtains its supply of water from Clear Lake by an intake line extending 285 feet into the lake near Club Island.

Treatment consists of coagulation by the addition of alum. Activated carbon is then added and sedimentation allowed to take place before the water is pressure filtered through sand. The water is then chlorinated with chlorine contact time being maintained during a two hour period in the plant. The water is then aerated before storage in covered tanks having capacities of about 400,000 gallons or in a new 350,000 gallon terminal storage and distribution reservoir.

The Lucerne Water Company derives its water supply from Clear Lake through a single suction line extending 600 feet into the lake. All water supplied by the company is coagulated, settled, pressure filtered through sand and chlorinated. Chlorine contact is provided in an 18,000 gallon tank. Pumps deliver treated water to the distribution system and three storage tanks having a combined capacity of 700,000 gallons.

The Nice Mutual Water Company, which obtains its water supply from a well on the shore of Clear Lake, has an emergency source of supply through a suction line extending 200 feet into Clear Lake. All water supplied by this company is coagulated, filtered under pressure through sand and then chlorinated. No chlorine contact time is provided. Treated water is pumped to the distribution system and two 42,000 gallon covered tanks.

The Konocti County Water District obtains its supply of water from a shallow well situated at the edge of Clear Lake. Though, technically this source could be identified as from ground water, the shallow well acts like a filter gallery and obtains its water from the lake. The water is filtered through a pressure sand filter and chlorinated. Chlorine contact storage is provided by a 24,000 gallon tank before the water is delivered to the distribution system or stored in a covered 80,000 gallon tank.

Four other smaller water systems, serving an estimated population of 1,800 people, derive all or part of their supply from Clear Lake. These are listed in the following tabulation.

System	Area Served	Treatment
Crescent Bay Improvement Company	Crescent Bay Subdivision near Jago Bay	Chlorination
Manakee County Water District	Manakee and Woodland Tract in Clearlake Highlands	Filtration, chlorination
Pine Dell Mutual Water Company	Pine Dell	Chlorination
Konocti Harbor Development*	Plumbers Union near Konocti Bay	Coagulation, filtration

*Infiltration works similar to Konocti County Water District

Generally, surface water used for recreation is not treated except perhaps when it is used in swimming pools, which use is insignificant in the Clear Lake Basin. However, some surface water connected with the recreation business is treated. This is due to the algae blooms occurring near resorts, making the water aesthetically undesirable for water contact sports.

To gain limited clearing of the areas, a number of resort owners place copper sulfate in burlap bags and drag them behind a boat through the area to be cleared. Though this might give temporary relief, usually the wind caused currents move the algae in the untreated areas into the treated areas. It should also be pointed out that high concentrations of copper in water can be injurious to both fish and man, and information for its correct use should be obtained from both the State of California Department of Public Health and the Department of Fish and Game.

A more unique method of combating the algae nuisance is practiced by one enterprising resort owner. To keep the swimming area around his resort clear, he placed an electric submersible pump in the lake in water deep enough for algae growth to be inhibited by lack of light. He then pumps this relatively algae free water up onto his shore where it displaces the water having high algae concentrations.

Another method practiced by some of the resort owners, similar but not quite as successful, is the operation in the water of outboard motors attached to stationary piers. The currents set up by the operation of these motors gives some limited relief.

Ground Water Treatment Practices

Part of the rain that falls upon the surface of the earth percolates into the ground and becomes ground water. During its passage through the ground, the water comes in contact with many substances, some of which are readily soluble in water.

Generally, ground waters are clear, cold, colorless, and harder than most surface waters of the area. Percolation through the subsoil has acted as a filter, removing bacteria and other living organisms. Ground water is obtained either naturally through springs or artificially through wells. Two water service agencies in the Clear Lake Basin obtain their supply of water from ground water sources.

The City of Lakeport, the largest urban water service agency in the Clear Lake Basin, derives all of its supply from ground water. Two of the three wells that produce their water can be classified as infiltration galleries, as they are shallow wells in the bed of Scott Creek. The third well is a deep well located nearby.

There is no treatment of the water for urban use except chlorination. No chlorine contact storage tanks are provided and all water is pumped to covered reservoirs having a combined capacity of 700,000 gallons.

The Kelseyville County Water Works District No. 3 derives its supply from three wells located on the bank of Kelsey Creek. The water is chlorinated prior to its delivery to the distribution system, though no chlorine contact tanks are provided. The water is stored in a covered 50,000 gallon steel tank.

The following tabulation lists the small water service agencies (those having 25 to 200 service connections in April 1961) that derive their supply from wells or springs.

System	Area Served	Source	Treatment
Loch Lomond Mutual Water Company	Loch Lomond	Well	None
Anderson Springs Water Company	Anderson Springs	Springs	None
Bonanza Springs Water Company	Bonanza Springs	Spring	Chlorination
Pine Heights Water Company	Pine Heights	Well	None
Pine Grove	Pine Grove	Spring	None
Glenhaven Mutual Water Company	Glenhaven	Well	None
Lower Lake County W.W.D. No. 1	Lower Lake	Wells	None

Waste Water Treatment Practices

Generally, man's use of water creates a waste product or leaves an amount that has not been consumed. This water is almost always undesirable and presents a problem of disposal, as it can contain unwanted concentrations of chemicals, high concentrations of organic material, or ingredients that could be harmful.

A number of things can happen to water that has been applied to agricultural land. The runoff can contain large amounts of organic material; it could become colored from decaying matter, or it could contain large amounts of harmful insecticides, or fertilizers, or any combination of the three.

In the Clear Lake Basin, return irrigation waters occur only in the reclamation districts in the Upper Lake area. No problem has been noticed as yet, as the amount of return irrigation water concentrating in these areas is still relatively small.

The present practice for the treatment of this water is to dilute it with lake water by pumping the water back into the sloughs of Clear Lake. This practice causes some local effects on the receiving water, but its influence is not widespread.

The sanitary disposal of sewage must meet two requirements. The first is that it must be collected efficiently and inoffensively, and second, it must be disposed of safely.

In the Clear Lake drainage basin most of the household waste water is flushed into septic tanks. Several communities have constructed sewers and treatment plants.

The City of Lakeport treats sewage for approximately 3,500 permanent and 7,000 summer population by using primary and secondary clarifiers to remove settleable solids, primary and secondary trickling filters to convert the finer colloidal and dissolved matter into settleable solids and then primary and secondary digesters which allow the destruction of the organic matter by having it serve as food for bacteria. The resultant sludge is dewatered by air drying on a bed of sand.

The remaining sewage effluent, after the solids have been removed, is chlorinated and pumped to storage ponds, where it is used by farmers for furrow irrigation. The City of Lakeport has passed a bond issue to allow the construction of another sewage treatment plant that would ease the burden on the existing one and service more homes.

The Lakeshore Village Sewage Maintenance District south of Clear Lake Highlands collects sewage from that area and pumps it to a large septic tank that allows the settleable solids to drop out and be digested in the same tank. The effluent is then discharged into two large basins, where the air has a chance to oxidize the fine colloidal and dissolved matter. The effluent then evaporates or percolates to the ground. In 1964, the district asked for permission from the controlling agencies to bypass the septic tank and change the existing oxidation ponds to raw sewage lagoons.

The Clearlake Keys subdivision in Clearlake Oaks collects and disposes of its sewage effluent in a similar manner.

The Konocti Harbor Development, a recreation area located near Konocti Bay and owned by the United Association of Plumbers and Pipefitters Local Union 38 in San Francisco, provides treatment of sewage from its facilities by a rated aeration plant. This plant is a modification of the activated sludge process, in which biological slimes are produced within the sewage itself while it is gently stirred, either by mechanical means or by the introduction of air.

The effluent is chlorinated and discharged to a 480,000 gallon oxidation pond, from where it is pumped for irrigation of a walnut orchard.

The Kelseyville County Water Works District No. 3 has just completed a sewage collection and treatment system for the area it serves, mainly the community of Kelseyville. The sewage from their system will be treated by raw sewage stabilization ponds. This type of pond purifies sewage or other waste water by storage under climatic conditions that favor the growth of algae.

Bacterial decomposition of the waste matter releases carbon dioxide and heavy growths of algae develop that use up nutrients and develop high dissolved oxygen levels. A remarkable reduction in coliform organisms is observed when the sewage is held for three or four weeks at a depth of three or four feet. The effluent, at present, is disposed of by percolation and evaporation, though later it is planned to dispose of it by irrigation of adjoining pasture and orchard lands.

The State Division of Forestry Conservation Camp facilities to the south of Mount Konocti near State Highway 29 treats sewage in a large septic tank with the effluent discharged to evaporation ponds.

In addition to the above systems, the State Department of Public Health noted that in 1963, there were 150 motels and 95 trailer parks operating under permits issued by the local County Health Department.

CHAPTER IV. SUMMARY OF PROBLEMS

As has been said before, a lake is an entity which is born, matures, and dies. From its infancy and youth one can predict, within rather broad limits, what its old age and death will be like. Clear Lake is eutrophic, a dying lake, which in a geologic time scale cannot live much longer. Unless man intervenes, within less than 5,000 years the present body of water could become a swamp.

To a large extent this condition results from the volume of sediments being carried into the lake. The yearly inflow to the lake, from all sources, is generally insufficient to completely replace or flush all existing waters from the lake and a dead storage effect takes place. Obviously, no one molecule of water remains forever. Because of evaporation and mixing the waters do change. If man does nothing to change the physical features of the lake and its environs this condition will remain constant. Precipitation and runoff records indicate that the inflow will continue as it has in the historic past, neither raising nor lowering the lake level significantly.

Turbidity is a measure of the suspended sediments in the water. At present the lake is turbid, and unless steps are taken to change the physical features, will remain so. The high turbidity is generally found in the shallow Upper Arm of the lake. It is caused in part by the fine particulate organic and inorganic materials in the inflowing waters, and in part by circulation and suspension of the bottom sediments by the wind caused currents.

The turbidity tends to diminish as the water moves from the Upper Arm into the deeper more wind protected Lower Arm where the outlet to the lake is located.

The turbidity causing materials remain in suspension for great lengths of time. This produces an effect on the biota of the lake by either reflecting or absorbing the light or solar radiation entering the water and diminishing the biological activity through the restriction of light and by producing pronounced changes in the temperature of the water.

The reflection of light by the turbid waters restricts the depths at which biological activity takes place. In the turbid shallow Upper Arm this is sufficient to restrict the establishment of light demanding aquatic plants in the nutrient rich bottom sediments. This restriction of light also inhibits algae growth.

Though the high turbidity of the water is undesirable for domestic and industrial users of water, because it inhibits biological activity, it may be more desirable than the clear water which might permit aquatic plants to proliferate.

There are ways to alleviate or correct the twin problems of turbidity and sedimentation even though a partial solution to the turbidity problem would be costly and time consuming. Better land use practice and protection of the watershed through the prevention of forest and brush fires, coupled with the construction of reservoirs on the tributary streams to be used as sedimentation basins, would probably lower the quantity of sediments in the runoff water.

The outflow data show the boron concentrations in the lake to be sufficiently high to place the water in the "use with caution" Class II irrigation water. No one single source of inflow could be found that contributed boron in amounts sufficient to raise the overall levels in the lake water.

The high concentrations of boron in the outflow waters are suspected to result from gradual accretions from the volcanic formations that are exposed to the lake below the Narrows and from the concentrating of the minerals in the water as a result of evaporation.

It is doubtful that sealing off any one source of boron would have any significant effect on the overall quality of the lake. As was previously discussed, the one known source of inflowing waters having high concentrations is the springs in Soda Bay. The flow from these springs would need to be increased 20 times to increase the boron level significantly.

Treatment for minerals in solution usually consists of one of three methods. These are ion replacement (such as used in home water softeners), distillation (used to practically eliminate all minerals), and dilution with additional quantities of better quality water. The first method would not remove boron, and both methods are economically impractical since the tremendous volume of water contained in Clear Lake would require extensive facilities.

The only practical solution appears to be dilution with water from North Coastal streams. These waters have a lower boron concentration than the lake water. The degree of dilution would depend upon the amount of inflow, detention time, outflow rate, and other factors.

As was pointed out in Chapter II, there is no direct discharge of sewage effluent into the lake. The effluents are discharged to the ground and some may move laterally and find their way into the lake. Samples of water for bacterial analyses were collected around the lake. These samples indicated that sewage at times was reaching the lake, especially in those areas where there are no sewage collection of treatment facilities. In some areas of heavy population density the land now accepts its full charge of effluent -- it can accept no more. If populations continue to increase in these areas the problem might build up to the critical stage.

The solution to the problem is to plan for the timely development of adequate sewage collection and treatment facilities in anticipation of an increase in population.

The algae problem, discussed at some length in Chapter III, is of great concern to both water users and recreationists, and it is lakewide. Those areas in the lake with low turbidities which are relatively calm produce the heaviest algae blooms.

Even if inflow of nutrients were to be cut off, the algae would continue to bloom. The sediments of the lake contain high nutrient concentrations, and the wind caused currents throughout the lake keep these nutrients in circulation. There is also a recycling of the nutrients tied up by algae growths through natural decomposition of dead algae.

Three methods of control might be employed: mechanical, biological, and chemical.

Mechanical control by the use of some type of a harvesting machine would remove or strain the algae from the water. There are a number of factors connected with this method that must be resolved before it becomes practical. It is not known how effective mechanical treatment would be; that is, if the algae were removed from an area of the lake, how long it would be before algae populations in that area increased to nuisance proportions again.

The second means of controlling undesirable aquatic growth is by biological methods. The control of an undesirable plant or animal by the use of a natural predator or enemy is not new. We see it in the use of "Lady Bugs" to control aphis, or the use of the mosquito fish to control mosquitoes. The Lake County Mosquito Abatement District is presently engaged in research on biologic control of the Clear Lake gnat by two methods; one method is to find a selective disease causing virus that will attack only the gnat; the second is to introduce a natural predator (fish in this case) that will keep the gnat under control by natural means.

A great deal of research and investigation into the total biological communities and their environment (ecologies) needs to be made before biological controls can be initiated, but this means of control should not be overlooked or discarded without full consideration.

The third method of control of algae is through chemistry. The application of chemical techniques for temporary control of algae appears at this time to be the only feasible method available for control in the near future. Chemicals offering general control over aquatic plants have been successfully used for many years. The application of copper sulfate for temporary control of algae has been in use since the early part of the twentieth century and is the only algicide in common use at present. Although other algicides are available they are quite costly. Research is now being conducted to find a more selective algicide that will be within economic reach.

Because of algae's need for light to carry on photosynthesis, the process by which it makes its food, researchers have tried to control the algae by controlling the amount of light available. This has been done on a small scale by placing a cover over the water or by the addition of light inhibiting dyes or chemicals. Placing a cover over the water is not practical on large bodies of water, and the addition of dyes or chemicals could make the water aesthetically undesirable. Limited algae control by light inhibition already occurs to a limited extent because of the high turbidity in the lake.

Much research would be needed to find the most effective algicide that would be the least harmful to the lake's ecology.

Another method of chemical control is the removal, rather than the addition of chemicals. Such a method would be designed to remove the nutrients available to the algae. It would not be necessary to remove all the algal nutrients, only the essential ones.

Of all the nutrients, the three needed in the greatest amounts are carbon, nitrates, and phosphorus. Carbon is obtained from the air, and from the dissolved carbonates in the water, which it holds in plentiful supply.

Practically all nitrogen compounds are the result of the fixation of atmospheric nitrogen. Removal of this nutrient from the inflowing water would not necessarily rule out the growth of algae, as some of the blue-green algae in Clear Lake can utilize the atmospheric nitrogen that has dissolved at the surface of the lake.

Phosphorus then, is the major essential element that could possibly be removed to control the algae. Phosphorus is contributed to the lake by the highly turbid inflowing streams and as feedback from the bottom sediments.

Prevention or reduction of these contributions might be effected by the same method as that which might be used to reduce turbidity; that is by the use of sedimentation dams on all inflowing streams. There is also the possibility of placing some type of cover over the bottom sediments, to prevent recycling.

There are several chemicals needed in minute quantities by algae. These are called micro-nutrients and any in short supply could inhibit or limit algae growth. The literature in this field is scant and research is needed.

All of these methods of algae control have been tried on a limited basis. If they are to be perfected and adapted for use in Clear Lake, a great deal of research will have to be done, with no possible method of control overlooked.

As a solution to the algae problem is most pressing, the State Department of Water Resources recommended during this study that it might be advisable for the people of Lake County to solve this problem on a local level by establishing a local tax supported district specifically for the study and control of algae.

The Lake County Mosquito Abatement District, a local tax supported agency, is conducting some research along the lines that would be needed for algae research. This agency already has manpower and equipment that could be utilized. The formation of a new district would essentially duplicate the existing district efforts and would be an undue burden on the people of Lake County.

As a result of the Clear Lake investigation, Senator Peterson introduced a bill (drafted by the Department of Water Resources) extending the authority of Mosquito Abatement Districts to study and control algae. This amendment was permissive, not mandatory.

With the concurrence of the Lake County Mosquito Abatement District Board of Directors, Senator Peterson introduced this amendment (SB 1205) on April 20, 1965, which was passed and signed by the Governor on July 17, 1965, and is now law.

If the economy of Clear Lake is to grow, the area must continue to lure vacationists. To do this the algae problem must be solved. The solution need not be on a year-round basis, nor a lakewide basis, although such overall solutions would be most desirable.

CHAPTER V. SUMMARY

The only significant source of inflow to Clear Lake is from runoff of precipitation. There is some supply from ground water inflow and from irrigation return but these are almost negligible compared to surface runoff.

The largest amount of inflow enters the Upper Arm of the lake from major tributary streams of the Upper Arm.

There is seldom enough yearly inflow to the lake to completely flush the existing waters in the lake. During periods of low runoff, inflowing water can remain in the lake for as long as three years. There is a general yearly buildup of concentrations of dissolved minerals during successive years of low inflow until a "wet" year supplies ample runoff for flushing and dilution.

Dilution of all of the water in the lake due to runoff does not occur at the time of inflow but is extended over a period of time as mixing takes place.

Wind induced lake currents prevail most of the time and cirulate the water throughout the lake. These currents keep bottom sediments in suspension causing turbidity and also prevent extended periods of thermal stratification.

Channelization or stratification in the lake from inflowing waters does not take place due to the thorough mixing action of the wind induced currents.

The inflowing water is of good quality, reflecting the quality of precipitation, although it carries a great deal of turbidity causing sediments.

The dissolved mineral concentrations of the water in the lake reflect the influence of dilution by runoff during the winter and spring and the influence of concentration by evaporation during the summer and fall.

The overall mineral quality of the water in the lake is good except for slightly excessive hardness-causing minerals and excessive amounts of boron.

No single source of inflowing waters is responsible for the high boron concentrations; they apparently result from a general contribution over an extended area.

The primary biological productivity of the lake is cyclic, being high in the summer and fall and low in the winter and spring.

The primary source of nutrients for biological productivity is from tributary streams and the back feeding of nutrients from the bottom sediments, and not from sewage effluent.

The detergent concentrations were below reliable detection limits. The only evidence that sewage effluent is migrating to the lake comes from the high coliform concentrations present in the lake's water.

The chloroform extractable organic concentrations of the lake water collected by the carbon filter method exceeded the U. S. Public Health Service recommendations for drinking water in two out of six samples analyzed.

It is not known for what length of time algae has been a nuisance in Clear Lake; however, the algae problem is acute and evidence points toward increased concentrations and problems.

CHAPTER VI. RECOMMENDATIONS

It is recommended that:

1. Officials of Lake County expedite the formation of the algae abatement functions of the Lake County Mosquito Abatement District authorized by Senate Bill 1205 of the 1965 Legislative session. Personnel should be recruited at the earliest possible date to initiate the following programs relating to algae:

a. Obtain information regarding the possibility of grants and technical assistance from governmental agencies or private research foundations for the identification and control of algae.

b. Initiate a periodic and regularly scheduled monitoring program to determine algae populations and types throughout the lake.

c. Implement an experimental algae control program using biological, mechanical, and chemical methods to control algae along the shoreline in coves and recreational beaches. The effectiveness, cost, and duration of control programs should be reported and made available to the public.

d. The experience gained from the shoreline program should form the basis for expanding algae control to larger sections of the lake, if feasible.

2. Lake County officials undertake a long-range basin-wide planning program which will consider future sewage needs and define particular areas where sewage disposal problems require correction. This plan should provide for the timely construction of sewage collection, treatment, and land disposal facilities as the need arises. Consideration should be given to provide the necessary funding to construct the recommended facilities to ensure that local overflows of sewage will not create shoreline contamination problems in Clear Lake.

3. All water development agencies give detailed consideration to the possible water quality benefits and detriments which may result from the routing of additional water through Clear Lake.

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PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]								
											Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
3	5/21/64		surf.	65	260			8.1			0.1	0.0	7.0	15	0.5	0.1				
4			surf.	65	260			8.2			0.4	0.0	3.5	12	1.1	0.2				
7			surf.	65	260			8.3			0.6	0.0	4.5	20	0.5	0.3				
8			surf.	70	305			8.3			0.8	0.0	3.8	17	0.6	0.3				
10			surf.	68	300			8.3			0.8	0.0	4.0	15	1.5	0.3				
11			surf.	65	260			8.3			0.3	0.0	4.6	15	0.8	0.2				
13			surf.	68	260			8.1			0.3	0.0	3.2	15	0.8	0.1				
14			surf.	68	285			8.3			0.8	0.0	4.0	17	1.2	0.2				
16			surf.	68	280			8.3			0.5	0.0	3.0	20	1.0	0.3				
17			surf.	65	260			8.3			0.4	0.0	3.2	17	1.3	0.2				
18			surf.	64	285			8.2			0.0	0.0	4.5	18	1.3	0.2				
20			surf.	65	290			8.3			0.5	0.0	4.5	19	1.5	0.3				
21			surf.	66	280			8.1			0.8	0.0	3.7	20	1.3	0.2				
22			surf.	65	285			8.2			0.0	0.0	5.5	18	1.5	0.35				
28			surf.	64	295			8.1			0.0	0.0	5.5	19	1.4	0.22				
31			surf.	67	295			8.0			0.9	0.0	4.5	20	1.8	0.5				
1	6/3/64		surf.								0.5	0.0	1.7	21		0.15	0.00			
2			surf.								0.1	0.0	4.5	17		0.15	0.00			
3			surf.								0.1	0.0	3.8	19		0.20	0.00			
4			surf.								0.3	0.0	5.0	17		0.20	0.00			
5			surf.								0.4	0.4	3.5	21		0.25	0.00			
6			surf.								0.1	0.0	3.0	21		0.20	0.1			
7			surf.								0.2	0.4	3.5	25		0.25	0.00			
8			surf.								0.1	0.0	1.2	20		0.20	0.00			
9			surf.								0.3	1.3	3.6	25		0.30	0.00			

a Analyses made using Hach reagents and calorimeter

TABLE 3 (cont.)
PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million: Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
10	6/3/65		surf.								0.3	0.0	2.6	18		0.25	0.00			
11			surf.								0.1	0.4	1.6	18		0.30	0.00			
12			surf.								0.3	2.2	1.5	25		0.30	0.00			
13			surf.								0.1	0.4	2.2	25		0.30	0.00			
14			surf.								0.3	0.4	1.7	35		0.30	0.00			
16			surf.								0.5	1.3	2.9	25		0.30	0.00			
18	6/5/64		surf.								0.4	0.4	1.5	18		0.15	0.00			
20			surf.								0.9	0.9	2.7	20		0.20	0.00			
21			surf.								1.9	0.3	1.9	27		0.20	0.00			Algae blooms
22			surf.								2.6	0.4	2.0	30		0.30	0.00			Algae blooms
24			surf.								0.4	0.9	2.1	33		0.15	0.00			
27			surf.								0.6	0.0	1.7	23		0.15	0.00			
29			surf.								0.3	0.0	2.0	25		0.20	0.00			
30			surf.								0.9	0.0	3.5	20		0.20	0.00			
31			surf.								1.5	0.0	5.6	20		0.15	0.00			
1	6/9/64		surf.	64	300	1.5		8.0	6.7	78	0.6	0.0	4.6	15	0.9	0.10	0.00		0.15	
2			surf.	64	315	3.3		8.2	7.3	83	0.1	0.0	4.8	15	1.0	0.10	0.00		0.05	
3			surf.	64	315	2.0		8.3	7.0	80	0.5	0.0	4.0	15	0.4	0.10	0.00		0.10	
4			surf.	63	305	1.5		8.3	6.7	75	0.5	0.0	6.0	17	1.0	0.10	0.00		0.10	
5			surf.	63	290	1.2		8.1	6.0	67	0.6	0.0	5.0	17	0.5	0.10	0.00		0.05	
6			surf.	62	300	2.0		8.2	7.0	77	0.5	2.2	3.8	18	1.0	0.20	0.00		0.10	
7			surf.	62	300	1.6		8.3	7.1	79	0.4	1.8	3.8	17	0.3	0.10	0.00		0.10	
8			surf.	62	280	1.4		8.3	7.8	87	0.5	1.8	4.2	19	0.7	0.10	0.00		0.10	
9			surf.	64	310	1.5		8.1	8.0	91	2.3	1.8	2.2	40	1.9	0.05	0.10		0.05	
10			surf.	66	290	1.5		8.0	7.1	82	0.9	1.8	4.5	19	0.7	0.20	0.00		0.10	

PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million: Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
11	6/9/64		surf.	66	290	1.5		8.9	8.8	102	0.4	1.6	3.0	15	0.5	0.10	0.00		0.05	
12			surf.	65	280	3.0		8.6	8.4	96	0.4	1.8	4.4	13	0.5	0.10	0.00		0.05	
13			surf.	67	280	1.5		8.9	9.4	110	0.4	1.3	4.2	16	0.3	0.15	0.00		0.05	
14			surf.	68	280	1.2		8.9	9.3	111	0.5	1.8	4.6	15	0.5	0.15	0.12		0.05	
15			surf.	69	280	2.5		8.9	9.0	108	0.3	1.8	3.6	16	0.1	0.12	0.00		0.05	
16			surf.	70	290	1.5		8.6	8.0	98	0.5	1.5	3.0	15	0.3	0.12	0.00		0.10	
17			surf.	67	280	2.1		8.8	9.5	111	0.3	2.2	3.5	15	0.5	0.12	0.00		0.05	
18			surf.	67	280	5.0		8.5	7.8	91	0.3	1.8	3.3	13	1.0	0.09	0.		0.05	
19			surf.	65	290	2.0		8.3	8.7	100	0.0	1.3	2.1	15	1.0	0.12	0.00		0.05	
20			surf.	67	300	1.0		8.4	8.6	101	1.0	1.3	3.8	15	0.3	0.15	0.10		0.10	
21			surf.	67	300	2.2		8.3	7.6	89	1.2	1.8	3.9	16	0.6	0.15	0.00		0.08	
22			surf.	67	280	4.0		8.2	7.1	83	1.3	1.8	5.0	18	0.9	0.12	0.00		0.10	
23			surf.	65	280	5.0		8.1	6.2	71	0.5	1.8	3.6	18	1.1	0.15	0.00		0.11	
24			surf.	67	290	4.3		8.7	8.6	101	0.4	1.8	4.6	18	0.9	0.12	0.10		0.08	
25			surf.	65	300	5.0		8.1	7.1	82	0.6	0.9	1.8	17	0.8	0.10	0.05		0.08	
26			surf.	66	300	7.5		8.4	6.7	78	0.5	0.9	5.8	16	1.0	0.12	0.00		0.08	
27			surf.	67	300	4.0		8.7	8.2	96	0.5	1.8	5.5	15	1.1	0.10	0.15		0.08	
28			surf.	66	300	3.4		8.4	8.2	95	0.8	1.8	3.2	16	1.3	0.12	0.00		0.08	
29			surf.	68	300	4.0		8.6	9.5	113	0.8	2.2	6.8	16	0.7	0.15	0.00		0.10	
30			surf.	67	320	2.5		8.1	7.8	91	1.3	1.8	3.4	16	1.1	0.14	0.00		0.08	
31			surf.	68	300	2.0		7.8	3.4	40	3.6	1.8	4.5	15	0.3	0.13	0.00		0.10	
1	6/23/64	0800	surf.	75	285	4.1		8.0	8.7	110	0.3	1.3	1.85	14	0.7	0.10	0.00		0.05	
2		0820	surf.	75	280	3.5		8.4	11.7	150	0.3	1.8	2.55	12	0.4	0.10	0.02		0.08	
3		0840	surf.	75	280	4.7		8.1	11.7	150	0.4	0.9	5.9	11	0.6	0.12	0.00		0.03	
4		0900	surf.	75	280	3.9		7.7	8.7	110	0.2	1.3	4.2	13	0.4	0.14	0.00		0.05	

o Analyses made using Hach reagents and colorimeter.

TABLE 3 (cont.)
PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million: Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
5	6/23/6[illegible]	0920	surf.	74	270	2.1		7.2	5.9	75	0.6	1.3	8.0	12	0.5	0.14	0.00		0.06	
6		0945	surf.	76	275	5.3		7.9	10.0	129	0.0	0.9	4.9	11	0.8	0.11	0.00		0.04	
7		1000	surf.	79	280	5.2		7.9	10.7	142	0.0	0.4	3.4	13	0.2	0.12	0.02		0.06	
8		1020	surf.	77	270	6.7		8.1	11.5	150	0.0	1.3	2.35	11	0.2	0.13	0.04		0.05	
9		1100	surf.	78	280	3.0		7.9	9.6	74	0.5	2.6	4.8	12	0.4	0.14	0.04		0.06	
10		1120	surf.	78	275	6.5		7.3	10.5	139	0.0	2.6	6.3	11	0.2	0.10	0.00		0.02	
11		1140	surf.	77	270	1.8		8.3	15.6	204	0.6	3.1	3.85	15	1.1	0.10	0.00		0.09	Algae bloom
12	6/25/64	0900	surf.	74	280	4.6		8.2	10.7	136	0.3	0.9	3.2	13	1.3	0.05	0.02		0.07	Windy
13		0930	surf.	74	275	4.7		8.5	11.2	142	0.2	0.4	6.6	13	0.3	0.06	0.02		0.06	Windy
14		0950	surf.	75	270	3.4		8.7	11.6	149	0.1	0.9	3.9	14	0.3	0.04	0.04		0.05	Calm - algae
15		1015	surf.	75	270	4.8		8.7	11.5	147	0.3	0.4	4.0	13	0.9	0.10	0.02		0.07	
16		1030	surf.	75	285	3.8		8.4	8.8	113	0.1	1.3	2.7	13	1.1	0.09	0.03		0.06	
17	6/26/64	0830	surf.	75	290	6.7		8.0	11.5	147	0.0	0.9	5.0	15	0.8	0.10	0.03		0.06	
18		0840	surf.	74	290	6.1		7.9	10.6	134	0.0	0.0	4.7	13		0.08	0.02		0.06	Algae
19		0900	surf.	76	285	2.6		8.2	14.9	190	0.0	0.9	3.9	15	0.5	0.12	0.01		0.10	Algae
20		0900	surf.	76	285	2.6		8.3	15.7	201	0.0	1.3	5.9	13	0.8	0.15	0.00		0.09	Algae
21		0930	surf.	76	290	3.1		8.4	15.0	192	0.0	1.3	5.2	14	0.5	0.20	0.02			Algae
22		0940	surf.	76	285	4.8		8.3	14.8	189	0.0	0.0	2.8	13	0.5	0.08	0.04			Algae
23		0955	surf.	75	280	5.0		8.4	12.7	162	0.0	0.0	5.0	15	0.7	0.10	0.00			
24		1005	surf.	75	280	3.9		8.4	12.4	158	0.0	0.0	5.1	12	0.5	0.06	0.02			Algae
25		1020	surf.	73	290	4.5		8.3	11.6	145	0.0	0.0			0.4	0.11	0.03			
26		1030	surf.	73	290	5.0		8.3	11.9	149	0.0	0.0	2.95	13	0.4	0.12	0.00			
27		1040	surf.	75	280	5.2		8.6	14.0	179	0.0	0.0			0.6	0.10	0.05			
28		1050	surf.	76	290	3.6		8.6	15.5	203	0.4	0.0	2.6	13	0.2	0.08	0.03			
29		1110	surf.	77	285	5.4		8.6	16.6	219	0.3	0.0			0.8	0.12	0.03			

PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million: Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
30	6/26/64	1125	surf.	78	290	5.5		8.7	17.4	230	0.3	0 .0	3.8	12	0.2	0.12	0.01			
31		1140	surf.	79	300	1.6		8.6	13.5	180	1.4	0 .0	3.7	12	0.7	0.18	0.07			
17	7/3/64	0830	surf.	68	290	4.5		8.5	7.9	94	0.1	0 .0	3.3	13	0.5	0.12	0.05			Heavy algae concentrations noted at all stations sampled this dat
18		0845	surf.	71	300	3.7		8.5	7.1	87	0.3	0 .0	3.4	13	0.2	0.12	0.08			
24		0900	surf.	70	295	4.7		8.3	7.3	89	0.1	0.4	4.6	13	0.5	0.15	0.09			
25		0915	surf.	70	300	4.3		8.3	8.4	101	0.3	0.4	5.8	13	0.3	0.18	0.09			
26		0930	surf.	70	300	5.2		8.6	8.1	99		0.9	6.4	13	0.5	0.15	0.09			
27		0945	surf.	71	300	1.5		8.4	9.1	112		0. 0	3.0	13	0.5	0.12	0.07			
28		1000	surf.	72	300	6.2		8.4	7.9	97		0.4	4.0	12	0.5	0.13	0.08			
29		1025	surf.	73	300	2.7		8.7	10.9	136		0.0	4.6	13	0.5	0.16	0.08			
30		1045	surf.	73	300	2.0		8.6	10.1	126		0.4	3.8	15	0.4	0.23	0.13			
31		1100	surf.	75	305	1.0		8.5	8.4	107		0.7	2.6	12	0.5	0.12	0.08			
1	7/7/64	0745	surf.	72	290	3.2	20	8.4	6.5	81	0.1	0.9	4.7	16	0.0	0		0.25	0.09	Heavy algae concentrations noted at all stations sampled this dat
2		0800	surf.	72	295	4.2	26	8.2	7.7	95	0.0	0.4	5.8	18	0.6	0.10		0.25	0.09	
3		0815	surf.	73	295	3.4	27	8.4	8.1	99		0.4	2.5	15	0.5	0.08		0.40	0.09	
4		0830	surf.	72	295	3.7	22	8.4	7.4	92		0.9	4.0	18	0.6	0.08		0.10	0.12	
5		0845	surf.	73	300	1.4	48	8.2	4.3	54	0.5	0.9	2.8	21	0.5	0.18		2.10	0.19	
6		0900	surf.	73	290	5.2	29	8.5	8.1	101	0.1	0.4	2.6	14	0.4	0.10		0.30	0.10	
7		0915	surf.	74	295	4.8	29	8.6	8.8	112		0.4	2.7	17	0.4	0.09		0.25	0.11	
8		0930	surf.	74	290	5.2	30	8.7	8.8	112		0.7	5.8	15	0.4	0.09		0.25	0.11	
9		0945	surf.	73	300	4.8	39	8.4	7.6	95	0.4	0.7	4.4	14	0.4	0.10		0.75	0.11	
10		1000	surf.	75	280	4.4	31	7.9	8.1	104	0.1	0.4	3.2	15	0.2	0.05		0.50	0.10	
11		1015	surf.	75	285	3.6	30	9.0	10.2	80		0	3.9	18	0.45	0.05		0.25	0.07	
12		1030	surf.	75	290	4.7	20	8.6	9.8	126		0	6.1	17	0.7	0.10		0.25	0.08	
13		1045	surf.	75	270	4.1	25	8.7	10.1	129		0.4	4.4	32	0.4	0.10		0.40	0.09	

a Analyses made using Hach reagents and colorimeter.

TABLE 3 (cont.)
PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micramhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million: Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
14			surf.	73	285	2.3	140	8.1	7.0	88	0.1	0.4	4.3	25	0.5	0.08		0.40	0.15	
15			surf.	73	265	3.3	20	8.3	8.0	100		0.4	1.5	23	0.5	0.10		0.30	0.10	
16			surf.	75	285	1.7	70	8.1	7.3	93	0.1	1.3	1.7	28	0.4	0.10		0.40	0.15	
18	7/8/64	0840	surf.	71	310	4.0	5	8.3	7.3	90		2.6	3.9	28	0.6	0.09		0.30	0.07	Algae
24		0845	surf.	71	310	4.8	5	8.6	7.6	93			1.9	16	0.4	0.07		0.40	0.08	Algae
25		0900	surf.	71	310	5.1	7	8.4	7.6	93		0.9	1.3	14	0.5	0.10		0.70	0.07	Algae
17	7/16/64		surf. 35	75 73	290	4.2	5	8.1 7.7	6.8 3.1	87 39	0.1	0.4	4.4	17	0.1	0.05	0.00	0.20		
18			surf. 25	74 73	300	5.2	9	8.2 8.1	6.8 5.6	86 70	0.2	0.2	5.0	25	0.5	0.06	0.00	0.10		
19			surf. 37	75 75	295	4.0	10	8.6 8.2	7.5 5.2	95 65	0.2	0.4	2.4	32	0.3	0.06	0.00	0.10		
20			surf. 26	76 75	300	3.9	10	8.6 8.4	7.1 4.8	92 61	0.6	0.7	2.5	20	0.1	0.12	0.05	0.25		
21			surf. 9	75 76	300	2.6	10	8.8 8.6	8.1 6.0	104 77	0.3	0.7	1.9	16	0.4	0.11	0.03	0.30		
22			surf. 18	76 75	295	3.0	10	8.7 8.2	7.4 3.5	95 45	0.2	0.7	3.1	18	0.4	0.10	0.02	0.25		
23			surf. 42	75 75	275	5.9	10	8.5 8.5	7.4 3.5	95 45	0.3	0.4	3.7	15	0.2	0.10	0.05	0.40		
24			surf. 39	75 73	280	6.3	10	8.2 7.9	7.4 5.1	95 64	0.3	0.7	2.8	18	0.5	0.08	0.00	0.25		
25			surf. 38	75 73	300	6.4	11	8.0 7.9	6.4 4.1	82 51	0.3	0.9	3.9	15	0.50	0.12	0.04	0.30		
26			surf. 43	74 73	300	5.8	10	8.1 7.8			0.3	0.4	2.3	22	0.50	0.10	0.00	0.50		
28			surf. 39	76 75	295	2.6	10	8.5 8.1			0.2	0.4	6.0	18	0.2	0.15	0.00	0.70		
30			surf. 15	77 77	305	2.8		8.1 8.0			0.9	0.0	3.7	18	0.2	0.12	0.00	1.25		
31			surf.	79	320	7.3		7.8			1.4	0.0	3.0	15	0.65	0.10	0.00	0.25		

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million: Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
1	7/17/64	0800	surf.	74	315	1.4	25	7.8	6.3	80	0.2	0.0	5.7	24	0.3	0.18	0.00	0.75		
7		1025	surf. 12	76 75	280	1.9	30	8.5 8.4	8.5 7.8	110 100		0.0	0.4	21	0.6	0.15	0.00	0.50		
8		1010	surf. 27	75 74	280	2.9	45	8.4 8.1	7.8 3.3	100 42		0.0	6.0	18	0.4	0.23	0.05	0.30		
9		0955	surf.	79	285	2.0	30	8.5				0.4	5.8	18	0.5	0.15	0.05	0.50		
10		0940	surf. 15	79 77	305	3.0	15	8.2 7.8	8.9 1.5	118 20	0.4	2.0	6.5	20	0.8	0.14	0.00	0.40		
11		0930	surf. 32	77 75	300	2.9	30	8.6 8.0	10.0 3.0	131 64		0.4	4.5	21	0.6	0.08	0.00	0.25		
12		0920	surf. 27	76 74	295	2.5	30	8.4 8.0	9.2 5.0	119 64	0.1	0.2	2.4	14	0.9	0.08	0.00	0.25		
13		0905	surf. 36	76 75	310	5.5	35	8.6 8.3	9.0 6.0	116 78		0.7	6.5	14	0.6	0.08	0.01	0.15		
14		0850	surf. 40	76 73	310	2.9	40	8.5 7.8	8.3 3.1	101 39		0.4	4.6	16	0.3	0.13	0.02	0.45		
15		0820	surf. 15	74 72	295	2.2	40	8.4 7.8	7.8 2.1	99 26		0.0	2.8	18	0.35	0.12	0.06	0.50		
1	7/21/64	1325	surf. 8	78 77	280	1.3	70	8.5 7.9	11.6 10.0	153 131	0.4	0.9	4.7	13	0.40	0.07	0.04			
2		1335	surf. 16	77 70	290	2.6	50	8.3 8.1	8.4 6.5	110 79	0.3	1.3	3.6	14	0.30	0.10	0.02			
3		1350	surf. 20	77 75	280	1.9	20	8.3 7.9	9.0 4.0	119 51	0.3	0.9	4.3	14	0.30	0.11	0.05			
4		1400	surf. 17	78 75	280 280	1.2	100	8.2 7.8	7.5 3.4	99 44	0.4	1.5	2.8	16	0.2	0.14	0.05			
5		1410	surf. 10	78 75	290	1.2	100	8.1 7.8	8.0 3.3	119 74	0.5	1.5	4.0	14	0.6	0.16	0.10			
6		1450	surf. 18	78 75	260	1.7	100	8.3 8.0	9.0 5.8	119 74	0.4	1.7	4.6	15	0.6	0.01	0.01			
7		1505	surf. 12	80 81	270	1.3	100	8.6 8.1	11.2 6.1	151 84	0.4	1.1	4.1	15	0.7	0.03	0.02			

a Analyses made using Hach reagents and colorimeter.

TABLE 3 (cont.)

PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
8		1515	surf. 28	77 75	270	1.5	100	8.5 8.2	9.6 5.4	126 69	0.4	1.8	5.5	12	0.6	0.04	0.02			
9		1110	surf.	78	275	2.0	100	8.5	11.2	148	0.6	1.5	3.9	13	0.4	0	0.01			
10		1055	surf. 12	78 77	275	2.3	100	8.3 7.6	8.5 5.0	112 66	0.6	2.6	1.5	13	0.4	0.05	0.00			
11		1045	surf. 25	76 75	290	2.7	50	8.6 8.2	9.9 6.3	1128 81	0.4	0.9	3.1	14	0.5	0.05	0.06			
12		1015	surf. 25	75 74	285	2.3	40	8.0 7.8	7.1 5.9	91 75	0.3	2.3	5.9	14	0.4	0.07	0.01			
13		1035	surf. 25	76 75	280	2.0	60	8.4 8.4	7.9 7.4	102 95	0.4	1.4	3.7	14	0.4	0.07	0.03			
14		1125	surf. 23	76 75	275	2.0	30	8.3 8.2	7.3 4.8	94 61	0.3	1.8	5.2	15	0.3	0.08	0.03			
15		1138	surf. 16	76 75	255	1.7	60	8.1 8.0	7.2 5.5	93 70	0.3	1.8	3.3	12	0.1	0.12	0.00			
16		1150	surf. 11	76 74	275	1.8	100	8.3 8.1	8.6 6.2	111 79	0.4	1.0	1.5	12	0.5	0.12	0.08			
17	7/22/64	0825	surf. 34	74 74	300	2.5	14	8.0 7.8	6.6 4.3	84 55	0.1	0.7	7.8	18	0.5	0.08	0.10	0.50		
18		0845	surf. 27	74 72	300	3.3	18	8.0 7.9	6.0 4.9	76 61	0.3	0.6	7.0	18	0.4	0.07	0.00	0.50		
19		0855	surf. 37	74 73	305	4.8	19	8.1 8.0	6.6 4.2	84 52	0.3	0.9	4.6	16	0.5	0.10	0.12	0.60		
20		0910	surf. 28	74 74	315	2.2	62	8.6 8.1	8.4 5.6	107 71	0.6	1.3	5.5	25	0.5	0.35	0.02	1.50		
21		0920	surf. 9	75 75	300	0.8	105	8.8 8.6	9.5 7.8	122 100	0.4	1.3	5.2	31	0.5	0.26	0.00	1.30		
22		0930	surf. 20	75 75	300	2.9	40	8.7 8.2	8.5 3.3	109 42	0.3	0.9	5.0	23	0.6	0.16	0.04	1.00		
23		0945	surf. 42	74 74	290	3.1	30	8.2 8.1	6.5 3.8	83 48	0.3	0.8	2.7	24	0.4	0.07	0.00	0.80		
24		0955	surf. 35	74 74	280	3.0	20	8.1 7.9	6.4 5.8	81 74	0.4	0.6	7.4	20	0.6	0.08	0.09	0.90		

PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
25		1005	surf. 38	75 75	305	5.0	25	8.1 8.0	7.5 6.0	96 76	0.3	4.0	5.2	21	0.6	0.10	0.10	0.85		
26		1020	surf. 47	75 74	310	4.0	20	8.0 7.9	6.9 4.0	88 51	0.3	3.5	4.8	22	0.9	0.10	0.00	0.95		
27		1055	surf. 23	76 77	300	2.4	72	8.0 7.7	6.4 4.0	83 52	0.8	0.0	1.6	17	0.6	0.30	0.12	0.30		
28		1110	surf. 30	77 75	310	7.0	50	8.0 8.0	6.9 4.8	90 61	0.5	0.2	1.9	14	0.6	0.26	0.00	0.00		
29		1120	surf. 31	76 75	305	4.2	56	7.7 7.5	7.6 3.9	98 50	0.6	0.3	1.1	16	0.6	0.24	0.14	0.00		
30		1135	surf. 15	76 75	315	2.4	75	8.0 8.0	8.7 7.0	112 90	1.2	0.9	2.6	17	0.6	0.29	0.00	0.05		
31		1145	surf.	77	300	1.7	100	8.0	12.8	168	0.9	1.5	2.1	23	0.6	0.32	0.15	0.20		
17	7/28/64	0845	surf. 29	79 75	305	3.4		8.5 7.3	11.2 0.1	149 1	0.1	0.7	4.5	14	0.6	0.10				
18		0855	surf. 21	79 78	295	3.4	12	8.8 8.7	10.4 9.0	138 119	0.1	1.0	5.2	17	0.1	0.10				
19		0910	surf. 35	79 74	295	3.6	20	8.7 7.9	11.0 0.2	147 3	0.1	0.8	4.2	15	0.8	0.10				
20		0920	surf. 24	79 76	290	2.8	10	8.9 7.6	12.1 0.5	161 7	0.2	0.9	4.0	17	0.8	0.15				
21		0930	surf. 15	81 79	295	3.4	12	8.8 8.7	10.9 7.9	150 105	0.3	1.0	5.0	14	0.6	0.07				
22		0940	surf. 20	80 78	285	2.9	15	8.7 8.2	12.3 3.3	167 44	0.1	1.1	3.4	15	0.6	0.10				
23		0950	surf. 40	78 76	265	4.5	15	8.7 7.9	11.5 1.5	152 19	0.1	0.8	4.6	17	0.7	0.10				
24		1005	surf. 26	80 78	275	2.4	45	9.1 8.8	11.8 8.3	160 109	0.2	1.3	4.1	15	0.7	0.11				
25		1045	surf. 38	79 75	285	3.0	40	8.8 8.0	13.2 0.2	176 3	0.1	1.8	4.0	16	0.6	0.11				
26		1055	surf. 48	80 76	295	2.9	20	9.2 8.2	15.5 0.7	210 9	0.0	0.9	5.4	17	1.0	0.09				

a Analyses made using Hach reagents and colorimeter.

TABLE 3 (cont.)
PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
27	7/28/64	1100	surf. 35	81 76	285	2.8		9.1 8.1	16.0 0.2	220 3	0.2	0.2	5.5	13	0.7	0.10				
28		1115	surf. 30	80 76	285	2.8		9.0 8.0	16.0 0.3	216 4	0.3	0.2	7.5	14	0.8	0.15				
29		1125	surf. 42	81 78	290	1.8	10	9.1 8.8	17.2	236	0.4	0.4	4.2	15	1.0	0.18				
30		1140	surf. 16	80 78	290	3.2	15	8.7 8.3	11.5 5.3	150 70	0.4	0	4.1	15	0.9	0.15				
31		1145	surf.	80	310	1.6	10	8.7	12.0	162	0.8	1.1	4.3	14	1.0	0.18				
1	8/6/64	0930	surf.	75	290	1.2	100	8.3	4.0	51	0.8	4.0	6.0	17	1.0	0.13				
2		0940	surf. 14	75 75	285 285	1.9	40	8.3 8.4	7.6 1.6	97 21	0.4	0.9	5.4	19	1.2	0.10				
3		0955	surf. 18	76 75	285 285	1.9	45	8.2 8.4	8.6 3.2	111 41	0.5	1.1	5.3	19	1.3	0.10				
4		1005	surf. 15	75 75	280 290	1.2	50	8.2 8.4	5.9 4.5	75 58	0.4	1.5	7.2	17	1.2	0.12				
5		1015	surf. 9	76 75	290 290	1.0	70	8.3 8.3	6.9 3.0	89 38	0.7	1.3	5.9	17	1.1	0.11				
6		1030	surf. 22	75 75	290 270	1.3	50	8.4 8.3	6.0 3.0	77 38	0.5	1.3	3.8	18	1.1	0.12				
7		1045	surf. 12	75 75	275 290	1.0	80	8.0 7.9	5.4 4.7	69 60	0.6	1.3	4.3	21	1.2	0.18				
8		1055	surf. 29	76 75	280 280	1.5	40	8.6 8.5	6.6 2.5	85 32	0.5	1.1	2.6	14	1.2	0.10				
9		1110	surf. 7	78 78	280 300	1.5	55	8.5 8.3	11.7 9.9	155 131	0.6	1.5	5.4	16	1.1	0.09				
10		1120	surf. 13	80 80	285 285	1.3	55	8.6 8.6	14.0 12.9	189 174	0.6	1.5	5.4	18	1.0	0.05				
11		1130	surf. 31	78 75	280 285	1.5	40	8.3 8.3	10.9 4.5	144 58	0.4	0.7	5.6	19	0.5	0.07				
12		1140	surf. 28	77 75	275 280	1.5	50	8.5 8.0	10.5 4.3	138 55	0.4	0.9	5.6	16	0.8	0.08				

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
13	8/6/64	1150	surf. 27	77 75	280 280	1.5	60	8.3 8.3	9.4 4.6	123 59	0.4	0.7	7.0	19	1.0	0.11				
14		1205	surf. 17	78 75	280 280	1.6	50	8.5 8.1	9.1 4.0	120 51	0.4	0.9	5.6	21	1.0	0.16				
15		1220	surf. 15	77 75	300 275	1.5	45	8.4 8.5	9.1 2.0	119 26	0.4	0.4	3.8	17	0.6	0.12				
16		1230	surf. 9	80 77	285 280	1.4	70	8.7 8.5	9.7 7.5	131 98	0.5	0.7	2.6	17	0.6	0.11				
17	8/7/64	1000	surf. 34	74 74	275 285	2.2	10	8.3 8.3	6.6 4.0	84 51	0.5	0.9		15	0.5	0.03				
18		1005	surf. 24	73 73	280 280	2.4	20	8.0 8.1	6.5 5.8	81 72	0.5	0.4		23	0.6	0.03				
19		1015	surf. 38	74 74	275 280	3.0	20	8.3 8.3	7.7 2.8	98 36	0.4	0.9		50	0.6	0.02				
20		1025	surf. 28	76 75	280 285	3.0	50	8.6 8.1	10.0 6.2	129 79	0.4	0.9		27	0.6	0.03				
22		1123	surf. 19	78 77	295 280	4.5	25	8.6 8.4	9.3 7.8	123 102	0.4	0.9		22	0.4	0.05				
23		1130	surf. 42	75 74	280 280	3.0	20	8.4 8.5	8.8 4.6	113 58	0.4	0.5		20	0.5	0.05				
24		1140	surf. 32	74 74	290 300	2.5	15	8.3 8.3	10.5 4.5	133 57	0.6	0.7		18	0.4	0.08				
25		1150	surf. 38	75 74	305 300	4.4	5	8.2 8.3	5.6	72	0.4	0.8		15	0.3	0.03				
26		1200	surf. 41	75 75	305 300	4.5		7.8 7.8	6.2	80	0.6	0.4		16	0.5	0.05				
27		1205	surf. 32	76 75	300 305	2.7	20	8.8 7.6	13.5 3.1	174 40	0.4	0.9		12	0.4	0.06				
28		1215	surf. 32	76 76	300 300	4.0	5	8.2 8.0	8.7 5.6	112 72	0.1	0.9		16	0.3	0.00				
30		1230	surf. 16	78 78	280 280	1.5	40	8.8 8.8	12.5 11.8	165 156	0.3	1.8		15	0.5	0.08				
31		1237	surf.	79	300	1.1	40	8.8	12.6	168	0.4	2.0		13	0.4	0.09				

a Analyses made using Hach reagents and colorimeter.

TABLE 3 (cont.)
PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
17	8/13/64	0920	surf.	75	290	3.2		8.0	6.3	81	0.1	2.6		19	0.8	0.08				
			16	74	290			8.0	6.0	76										
			32	74	290			7.7	6.0	76										
19		0940	surf.	75	280	2.3		8.3	7.0	104	0.1	2.6		22	0.9	0.10				
			18	75	280			8.3	6.5	83										
			36	74	285			8.2	6.1	77										
20		1000	surf.	76	290	2.0		8.5	8.1	105	0	2.6		21	0.9	0.07				
			14	76	290			8.4	7.3	94										
			27	75	290			8.3	6.6	84										
22		1015	surf.	77	290	1.8	15	8.6	9.4	123	0.2	3.1		22	1.0	0.10				
			13	77	280			8.5	8.0	105										
			26	76	280			8.5	7.6	99										
23		1030	surf.	75	295	2.7		8.2	7.4	95	0.1	2.6		20	1.1	0.13				
			21	75	295			8.4	6.9	88										
			42	75	290			8.1	5.4	69										
24		1100	surf.	76	290	1.8		8.1	6.7	86	0.1	2.2		18	1.1	0.18				
			16	75	290			7.8	5.6	72										
			32	74	290			7.8	4.3	55										
25		1120	surf.	76	290	3.4		8.1	6.9	89	0.1	2.0		17	0.7	0.05				
			20	75	290			7.7	5.3	68										
			40	75	290			7.7	5.7	73										
26		1130	surf.	76	295	3.6		7.8	5.5	71	0.1	2.2		16	0.3	0.02				
			25	75	295			7.8	5.5	70										
			49	75	295			7.7	5.5	70										
28		1145	surf.	76	295	3.4		7.8	5.6	72	0.1	2.0		15	0.2	0.08				
			20	75	295			7.8	5.3	68										
			39	75	295			7.6	4.5	58										
30		1200	surf.	76	295	4.7	5	7.9	7.8	101	0.1	1.8		15	0.8	0.05				
			16	76	290			8.0	7.1	92										
31		1215	surf.	78	290	2.0	11.9	8.8	11.9	157	0.3			20	0.1	0.12				
1	8/14/64	0930	surf.	74	305	3.3	105	7.6	4.7	60	0.5	2.6	5.9	37	0.5	0.20				
			9	75	280			7.8	4.3	55										
3		1000	surf.	76	305	3.0	15	8.1	6.3	81	0	1.3	4.5	18	0.5	0.10				
			18	74	300			7.6	2.7	34										
4		1020	surf.	76	300	1.8	35	7.9	4.4	57	0.2	2.2	2.1	22	0.8	0.17				
			14	74	295			7.7	4.1	52										

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
5	8/14/64	1030	surf.	75	305	1.4	50	7.7	5.1	65	0.2	1.8	4.9	24	1.1	0.28				
6		1045	surf. 22	76 75	300 295	1.6	30	7.8 7.6	5.7 3.8	73 49	0.2	2.9	3.1	20	0.7	0.16				
7		1100	surf. 11	76 74	300 245	1.5	35	8.1 7.8	7.2 5.5	93 70	0.1	2.2	3.8	23	0.7	0.19				
8		1140	surf. 29	76 75	300 300	2.0	30	7.8 7.6	5.2 3.4	67 43	0.1	2.6	5.5	20	0.9	0.15				
9		1200	surf.	77	300	0.8	90	8.2	9.0	119	0.3	3.3	2.9	25	1.0	0.18				
10		1210	surf. 12	79 77	305 305	1.0	130	8.4 7.2	13.1 3.4	174 44	0.3	3.8	3.5	28	0.5	0.19				
11		1220	surf. 29	78 75	280 300	2.3	40	8.0 7.4	8.2 2.5	108 32	0.4	2.6	1.4	23	0.9	0.11				
12		1230	surf. 28	78 74	295 300	2.1	50	8.4 7.4	11.0 3.2	145 41	0.3	1.3	3.5	20	0.6	0.11				
13		1245	surf. 27	78 75	300 260	2.0	40	7.9 7.4	6.2 2.3	82 29	0.5	2.6	5.4	19	0.7	0.11				
14		1300	surf. 18	78 76	300 300	1.8	32	8.2 7.9	9.0 3.5	119 45	0.3	2.6	3.8	29	0.7	0.13				
15		1340	surf. 18	75 75	295 295	2.7	45	7.8 7.3	5.6 1.8	72 23	0.4	2.6	3.5	18	0.4	0.13				
16		1400	surf. 10	77 76	300 260	2.1	58	7.8 7.8	6.4 5.8	84 75	0.4	2.6	6.5	21	0.7	0.13				
4	8/21/64	0915	surf. 13	75 75	290 295	1.1		8.0 7.8	3.6 3.0	46 38	0.3	1.5	7.6	8	1.3	0.18				
5		0925	surf.	76	290	0.6	10	8.1	2.6	34	0.2	2.4	3.1	12	1.3	0.06				
7		0945	surf. 11	80 79	280 285	1.3	15	9.5 9.3	12.6 11.0	170 146	2.2	2.0	4.0	12	1.7	0.12				
8		1000	surf. 28	78 75	275 290	2.5	10	9.2 8.5	11.6 2.1	153 27	0.1	1.5	1.8	9	1.5	0.13				
10		1015	surf. 10	77 77	300 295	1.3	20	8.2 7.9	8.4 4.1	110 54	0.3	3.3	5.5	11	1.5	0.11				
12		1035	surf. 26	79 79	280 280	2.4	10	9.1 9.0	10.5 9.2	140 122	0.0	1.3	3.2	10	1.4	0.30				

a Analyses made using Hach reagents and colorimeter.

TABLE 3 (cont.)
PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
13	8/21/64	1315	surf. 26	80 77	285 270	1.9	20	9.3 8.6	13.6 3.5	184 46	0.2	1.1	1.4	11	1.1	0.11				
15		1230	surf. 17	80 76	280 295	1.7	10	9.2 8.4	11.7 2.6	158 34	0.2	2.4	1.0	11	0.8	0.08				
19		1050	surf. 35	77 76	285 280	2.2	20	8.9 8.6	6.7 3.4	88 44	1.5	2.2	3.9	11	1.0	0.08				
20		1100	surf. 26	77 77	285 280	1.8	20	9.2 8.5	8.6 3.4	113 45	3.0	0.9	2.6	13	0.7	0.10				
23		1116	surf. 39	78 76	280 295	0.8	10	9.2 8.5	9.7 2.1	128 27	0.0	1.3	4.5	12	0.3	0.00				
24		1140	surf. 29	75 76	290 295	1.4	40	9.3 8.1	13.1 3.0	168 39	3.9	0.9	6.0	15	0.6	0.12				
26		1200	surf. 47	76 76	295 300	1.0	10	9.4 8.2	14.3 2.0	185 26	0.1	0.9	4.6	14	0.6	0.05				
28		1212	surf. 31	81 76	295 295	1.0	10	9.7 8.5	18.7 2.7	257 35		2.6	5.2	32	0.6	0.12				
30		1230	surf. 16	77 77	295 295	1.6	10	9.3 9.1	11.0 7.7	144 101	0.0	1.3	3.6	12	0.3	0.00				
31		1240	surf.	79	295	1.3	5	9.6	13.2	176		1.8		26	0.4	0.05				
4	9/3/64	0925	surf. 12	72 72	295 275	1.0	25		6.0 5.5	76 68	0.8	0.0	4.9	14	0.4	0.20				
5		0940	surf. 9	70 68	300 310	0.8	50		10.4 8.6	126 102	0.3	0.4	3.2	17	0.6	0.30				
7		1000	surf. 11	72 72	300 295	1.0	20		5.9 5.8	73 72	0.3	0.2	7.5	13	0.4	0.31				
8		1015	surf. 28	72 71	300 295	0.9	32		5.8 5.8	72 71	0.4	0.2	3.5	16	0.5	0.20				
10		1030	surf. 10	73 72	305 305	1.1	32		5.2 1.0	65 12	1.0	0.0	5.4	14	0.4	0.23				
11		1035	surf. 28	73 72	295 300	1.0	38		5.6 3.0	70 37	0.4	0.0	8.0	12	0.1	0.21				
12		1045	surf. 25	72 71	300 300	0.9	35		6.0 5.0	74 62	0.4	0.0	3.2	15	0.5	0.25				

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
13	9/3/64	1315	surf. 26	74 72	285 285	0.7	50		5.4 5.3	68 66	0.6		6.5	17	0.4	0.31				
15		1335	surf. 16	73 72	290 295	1.0	42		7.4 5.5	93 68	0.4	0.0	8.5	14	0.5	0.26				
19		1110	surf. 35	73 72	295 300	1.9	22		4.3 4.0	54 50	0.8	0.0	2.7	16	0.8	0.15				
20		1115	surf. 26	74 73	300 295	2.1			5.2 4.8	66 60	1.0	0.9	7.4	12	0.7	0.26				
23		1125	surf. 37	74 73	295 300	1.5			5.6 4.2	71 52	0.8	0.9	3.4	15	1.0	0.28				
24		1140	surf. 22	74 73	300 300	1.1			5.6 4.9	70 61	0.6	0.7	2.9	12	0.7	0.37				
26		1150	surf. 43	75 73	285 205	2.2			6.0 3.0	77 37	0.5	0.4	3.1	13	0.8	0.32				
28		1200	surf. 35	75 73	295 300	1.3			7.0 4.1	90 51	0.1	0.7	2.7	13	0.9	0.35				
30		1215	surf. 16	75 73	295 295	1.2			9.4 6.4	120 80	0.3	0.4	3.7	12	1.0	0.51				
31		1225	surf.	74	280	0.8			9.5	121	0.4	1.1	5.6	14	1.4	0.54				
4	9/15/64	0950	surf. 13	70 70	300 300	0.6	105	8.1 8.1	5.4 4.6	66 56	0.9	0.7	4.5	15		0.48				
5		0935	surf. 8	70 70	300 300	0.4	120	8.3 8.1	6.3 4.9	77 60	1.4	0.5	1.8	23		0.58				
7		1005	surf. 9	72 70	300 300	1.2	70	7.8 8.4	8.3 3.8	152 46	0.8	2.0	3.8	18		0.32				
8		1025	surf. 26	70 70	300 300	1.5	70	8.1 7.8	6.4 3.9	78 48	0.4	1.6	3.6	18		0.28				
10		1050	surf. 11	73 72	300 300	1.2	60	7.4 7.2	8.9 5.2	111 64	0.6	2.4	4.4	20	0.9	0.28				
11		1105	surf. 28	73 71	295 290	1.7	45	8.1 7.7	8.3 5.6	104 69	0.3	2.0	3.7	19		0.20				
12		1120	surf. 28	71 70	300 295	1.5	70	7.7 7.7	5.7 5.0	70 61	0.5	3.7	5.5	21	1.2	0.24				Interface between turbid and clear water - temp. 72 - 73 pH 8.0- 8.4

a Analyses made using Hach reagents and colorimeter.

b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 3 (cont.)
PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
13	9/15/64	1400	surf. 26	73 71	310 310	1.7	60	8.2 7.5	8.5 4.0	106 49	0.4	2.9	3.1	22		0.22				
15		1430	surf. 16	76 70	280 295	1.1	50	8.2 8.0			0.4	2.9	3.7	20	1.0	0.22				
19		1135	surf. 36	72 71	300 300	2.2	50	8.2 7.7	8.5 4.7	105 58	0.6	2.0	4.1	18	1.0	0.15				Algae
20		1150	surf. 27	72 72	290 295	1.5	50	8.3 8.1	11.8 8.5	147 105	0.1		2.8	21	0.3	0.20				Algae
23		1215	surf. 42	71 71	300 300	1.9	50	8.0 7.8	6.6 5.2	82 65	1.4	2.0	2.6	17	0.4	0.14				
24		1230	surf. 33	71 70	300 300	1.6	40	8.0 7.7	6.6 4.5	82 55	0.7	1.4	3.4	20	0.4	0.16				
26		1245	surf. 44	73 71	300 305	1.5	40	7.8 7.7	7.3 5.5	91 68	0.4	0.2	2.4	18	0.5	0.15				
28		1255	surf. 29	72 71	305 305	1.7	80	8.2 7.7	11.4 5.9	141 69	0.4	1.1	3.4	18	1.2	0.22				Algae
30		1315	surf. 16	73 72	290 295	1.2	80	8.8 8.7	14.5 11.5	181 143	0.2	2.4	3.1	20	1.3	0.25				Algae
31		1330	surf.	75	285		100	9.1	18.9	242	0.3		1.5	22	0.3	0.45				Algae
4	9/23/64	1230	surf. 13	73 72	305 300	1.1		8.6 8.6	10.0 5.0	125 62	0.6	2.8	1.6	15	0.6	0.05				
7		1145	surf. 10	73 69	295 295	1.7		8.4 8.2	8.3 5.7	104 68	0.5	1.9	2.7	16	0.9	0.20				
8		1115	surf. 27	72 69	300 300	1.3		8.3 8.0	7.1 4.4	88 53	0.5	0.5	2.7	15	1.3	0.10				
10		1030	surf. 27	69 69	305 300	1.1		7.5 7.6	5.4 5.0	65 60	0.4	2.5	5.0	15	0.8	0.15				
11		1100	surf. 25	70 70	300 300	1.3		7.8 7.8	5.2 4.3	63 52	0.7	3.7	2.7	13	0.3	0.20				
13		1000	surf. 26	69 69	305 305	1.2		7.9 8.0	5.2 3.4	62 41	0.3	0.5	4.0	15	0.1	0.20				
15		0930	surf. 15	70 70	305 305	1.1		7.9 7.6	4.8 4.2	59 51	0.3	0.7	3.1	15	1.4	0.25				

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
19	9/30/64	1600	surf. 37	69 69	310 305	1.0	55	8.1 7.5	8.1 4.7	97 56	0.5	22	2.9	14	0.10	0.50				
20		1545	surf. 27	69 69	305 305	1.3	50	8.4 8.0	6.8 7.5	82 90	0.4		1.5	12	0.75	0.00				
22		1530	surf. 15	71 71	310 310	1.0	65	8.5 8.4	9.6 7.0	108 86	0.5		3.5 2.0	15 18	0.35	0.10				
23		1505	surf. 42	69 69	310 310	1.2	50	8.1 7.9	8.6 6.3	103 76	0.5	0.3	4.0	15	0.90	0.00				
24		1450	surf. 31	68 68	305 285	1.2	40	8.2 7.8	7.5 6.6	89 79	0.4	0.7	4.3	13	0.40	0.20				
26		1435	surf. 45	68 68	310 305	1.6	30	7.9 7.8	8.6 6.4	102 76	0.3	1.0	3.4	15	0.8	0.60				
28		1415	surf. 29	69 69	305 305	1.2	65	8.1 7.7	8.6 5.6	103 67	0.5	1.7	3.2	14	0.1	0				
30		1330	surf. 16	69 69	310 315	1.2	70	8.3 8.3	11.2 10.2	134 122	0.5	0.3	1.9	15	1.0	0.00				Clumps of algae
4	10/7/64	1635	surf. 12	71 69	305 305	1.0	60	8.4 7.8	9.6 5.6	117 67	0.4	1.0	3.0	22		0.20				
7		1610	surf. 8	71 70	300 300	1.4	20	8.4 7.8	12.8 5.3	158 65	0.3	0.5	4.8	19	1.0	0.15				
8		1548	surf. 26	71 68	305 305	1.5	30	8.4 7.6	14.0 5.4	172 64	0.3	2.5	4.2	18	1.1	0.10				
10		1500	surf. 8	71 71	305 305	1.3	30	7.6 7.4	9.4 7.9	116 97	0.3	2.4	2.5	17	0.8	0.15				
11		1445	surf. 25	71 70	300 300	1.3	20	8.3 7.8	10.9 4.4	134 54	0.3	1.3	4.3	16	1.1	0.15				
12		1430	surf. 24	69 69	305 305	1.5	70	8.0 7.9	8.3 6.4	100 78	0.3	1.7	3.4	18	0.9	0.15				
13		1400	surf. 24	69 68	310 305	1.4	50	8.2 7.4	9.9 4.6	119 55	0.1	1.3	2.2	19	1.5	0.10				
15		1330	surf. 13	68 67	305 305	1.2	100	8.2 7.5	8.1 0.4	96 5	0.3	1.3	6.0	17	1.2	0.20				
19	10/8/64	1025	surf. 36	69 69	305 305	1.3	70	7.8 7.4	6.3 6.3	76 76	0.3	0.8	4.5	18	1.2	0.25				

a Analyses made using Hach reagents and colorimeter.
b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 3 (cont.)
PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
22	10/8/64	1045	surf. 19	70 70	300 300	0.6		8.6 8.5	10.3 8.6	126 105										Clumps of algae
23		2000	surf. 43	69 68	300 305	1.4	70	7.9 7.7	7.1 6.8	85 81	0.3	2.9	5.5	17	1.3	0.20				
24		1115	surf. 33	68 68	300 300	1.1	70	7.9 7.7	6.6 7.2	78 86	0.3	0.0	2.4	18	1.2	0.15				
26		1130	surf. 44	70 69	300 300	1.2	50	7.9 7.6	9.0 6.3	110 76	0.3	0.5	4.7	16	1.3	0.15				Clumps of algae
28		1150	surf. 30	70 69	310 300	1.5	50	8.0 7.6	9.0 5.6	110 67	0.5	1.2	6.0	15	0.4	0.20				
30		1205	surf. 16	70 69	310 310	1.5	50	8.0 7.8	9.0 8.0	110 96	0.3	0.8	5.5	15	1.0	0.20				Clumps of algae
4	10/10/64	1530	surf. 9	68 65	310 315	0.8	75	7.8 7.9	6.0 4.8	71 55	0.3	1.3	5.7	15	1.1	0.40				
6		1515	surf. 20	69 65	310 310	0.9	100	7.8 7.8	5.7 5.0	68 57	0.1	1.2	6.6	12	1.0	0.55				
8		1445	surf. 21	70 67	315 315	1.0	70	7.9 7.7	7.0 4.7	85 55	0.1	0.8	4.0	13	0.8	0.38				
10		1335	surf. 9	67 66	315 315	0.9	75	7.3 7.3	4.9 3.9	57 45	0.1	2.8	6.5	12	0.9	0.50				
11		1315	surf. 24	69 66	305 305	1.0	65	8.0 7.7	6.9 5.5	83 64	0.1	1.8	6.1	10	1.0	0.32				
12		1215	surf. 24	67 66	315 315	0.9	80	7.7 7.7	6.9 5.8	80 67	0.1	2.2	5.5	11	1.0	0.45				
13		1145	surf. 24	66 66	305 315	1.2	50	7.9 7.8	6.8 6.1	79 71	0.1	1.2	5.7	12	0.7	0.25				
15		1115	surf. 10	65 64	310 315	0.8	60	7.6 7.4	5.6 5.0	64 58	0.1	1.2	4.5	10	0.7	0.32				
19	10/20/64	1145	surf. 30	67 67	310 310		30		9.7 5.4	113 63	0.0	3.7	3.1	15	0.4	0.20				Algae
22		1125	surf. 15	67 67	310 310	2.2	30	8.0 7.6	7.6 4.6	89 54	0.1	0.8	6.0	22	1.2	0.20				Algae
23		1110	surf.	66	310	2.0	30	7.7	6.0	70	0.1	0.5	5.5	14	1.5	0.21				Algae

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
24	10/20/64	1100	surf. 31	66 66	310 310	1.6	45	7.8 7.6	5.9 4.6	68 53	0.1	0.4	4.8	14	0.3	0.25				
26		1045	surf. 41	67 66	315 315	2.8	35	8.0 7.4	9.9 3.9	116 45	0.1	0.2	5.2	13	1.0	0.20				Clumps of algae
28		1020	surf. 39	66 65	315 315	1.7	45	7.6 7.3	6.8 4.3	79 49	0.1	0.2	5.4	13	1.1	0.25				Clumps of algae
30		1000	surf. 10	65 65	310 310	1.8	40	7.8 8.2	10.0 9.6	115 110	0.1	0.8	6.2	10	1.6	0.21				Clumps of algae
17	11/5/64	1300	surf. 27	63 63	300 300	1.2	65	7.9 7.9	11.0 6.9	123 77	0.4	0.7	3.3	18	1.3	0.25				
19		1315	surf. 31	65 62	300 300	1.5	80	7.6 7.6	7.1 6.3	82 70		1.2	4.2	13	0.3	0.20				
22		1330	surf. 23	64 62	320 315	1.4	80	7.4 7.3	5.7 5.3	65 59		1.5	4.1	13	0.5	0.22				
23		1340	surf. 36	65 61	310 320	1.3	85	7.6 7.5	7.1 6.0	82 66	0.3	1.2	3.6	13	0.3	0.22				
24		1350	surf. 35	65 60	310 310	1.4	90	8.1 7.5	10.6 6.3	122 69	0.4	0.7	2.9	13	1.5	0.25				Clumps of algae
26		1400	surf. 8	65 63	315 320	1.6	70	7.7 7.3	8.1 6.7	93 75		1.2	4.5	13	0.7	0.19				
28		1412	surf. 38	64 62	300 310	1.5	95	7.8 7.4	9.1 7.2	104 80	0.3	0.2	1.9	15		0.25				
30		1428	surf. 13	63 60	310 315	1.8	80	7.2 7.2	6.4 4.6	72 50	0.3	0.7	2.4	14	1.7	0.26				Clumps of algae
4	11/6/64	0830	surf. 10	58 58	310 310	0.7	85	7.8 7.6	8.0 7.7	85 82	0.1	0.2	2.8	13	0.4	0.40				Precipitation occurred sufficie to cause stream flow.
6		0850	surf. 21	59 59	305 305	0.7	140	7.8 7.8	8.3 7.7	89 82	0.1	0.0	3.0	15	0.7	0.60				
8		0910	surf. 24	59 59	305 305	0.9	100	8.0 7.8	8.4 7.6	90 81	0.1	0.2	4.8	15	0.4	0.40				
10		0930	surf. 5	59 59	310 310	0.8	85	7.3 7.2	8.6 7.5	92 75	0.1	1.2	2.0	13	1.2	0.35				Algae
11		0950	surf. 24	59 59	305 305	0.8	105	7.7 7.5	7.9 7.7	84 82	0.1	1.2	3.6	13	0.7	0.45				

a Analyses made using Hach reagents and colorimeter.
b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 3 (cont.)

PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
13	11/6/64	1030	surf.	59	305	0.7	100	7.9	8.2	88	0.1	0.8	3.9	17	1.0	0.50				
			23	59	300			7.8	8.1	87										
15		1050	surf.	59	300	0.8	100	7.8	8.3	89	0.1	1.5	4.1	18	0.9	0.42				
			11	58	300			7.8	8.6	92										
4	11/24/64	0915	surf.	50	320	0.9	40	7.7	9.4	90	0.5	1.4	5.5							
			2	50	320															
			5	50	320															
			9	49	320			7.6	8.9	85	0.6	2.0	3.9							
6		0935	surf.	50	320	0.9	50	7.7	9.1	87	0.4	1.7	2.6							
			5	50	320															
			15	50	320															
			24	50	320			7.7	8.6	82	0.6	2.2	2.9							
12		1020	surf.	52	320	1.1	20	7.8	9.2	91	0.4	2.0	3.2							
			5	52	320															
			15	51	320															
			26	50	320			7.7	8.5	81	0.6	2.2	3.8							
13		1005	surf.	51	320	0.9	50	8.0	9.6	94	0.5	1.4	2.8							
			5	50	320															
			15	49	320															
			26	49	320			7.8	8.7	83	0.6	1.4	5.5							
15		1230	surf.	51	320	1.0	40	7.8	9.3	91	0.6	1.4	6.8							
			5	50	320															
			17	50	320			7.7	8.8	84	0.6	1.4	3.5							
22		1100	surf.	53	330	1.7	20	7.3	7.6	76	0.4	1.4	4.1							
			5	53	330															
			10	53	330															
			15	53	330															
			20	53	330			7.3	6.5	65	0.3	2.3	4.3							
24		1105	surf.	53	335	1.7	10	7.6	8.6	86	0.5	1.4	3.3							
			5	53	335															
			15	52	330															
			33	51	330			7.6	8.4	83	0.6	1.7	3.1							
28		1130	surf.	54	340	2.5	10	7.6	8.7	87	0.4	1.0	1.6							
			15	53	340															
			20	53	335															
			35	52	335			7.3	6.4	63	0.8	1.2	3.0							
30		1145	surf.	52	335	3.0	10	7.3	7.9	79	0.7	1.7	2.4							
			5	52	335															
			13	51	335			7.3	7.9	68	0.9	1.4	2.5							

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
4	12/8/64	1230	surf.	50	305	0.8	50	7.8	9.2	88	0.6	1.6	3.7		1.0					
			5	49	305															
			11	49	295			7.7	9.0	85	0.6	1.6	3.1		0.5					
6		1245	surf.	51	315	1.0	35	7.8	9.3	91	0.5	1.6	2.4		2.0					Small concentrations of algae
			5	50	320															
			15	50	320															
			25	50	320			7.7	9.1	87	0.5	1.2	2.1		1.2					
12		1320	surf.	50	325	1.1	30	7.7	9.3	89	0.4	1.6	3.4		1.3					
			5	50	325															
			15	50	320															
			26	50	320			7.7	9.2	88	0.5	1.6	2.6		1.8					
13		1310	surf.	51	320	1.0	30	7.7	9.2	90	0.5	0.9	2.2		2.2					
			5	50	320															
			15	50	320															
			25	50	320			7.6	9.1	87	0.4	1.0	3.0		1.1					
15		1530	surf.	51	320	1.0	35	7.7	9.4	90	0.4	0.9	1.9		0.3					Small concentrations of algae
			5	50	320															
			19	50	320			7.6	9.7	93	0.5	1.0	2.6		0.5					
22		1345	surf.	52	330	1.6	35	7.4	9.1	90	0.5	1.2	1.9		1.8					
			5	52	330															
			16	52	330			7.3	8.2	81	0.4	0.6	2.3		1.2					
24		1405	surf.	52	335	1.9	10	7.5	9.1	90	0.5	1.2	1.9		1.6					Small concentrations of algae
			5	52	335															
			10	51	330															
			15	51	330															
			35	51	330			7.3	8.3	81	0.5	1.0	2.3		0.9					
28		1420	surf.	52	335	2.4	10	7.4	9.2	91	0.4	0.9	4.0		2.0					
			5	52	335															
			10	51	335															
			38	51	335			7.4	8.1	79	0.5	0.6	3.2		0.8					
30		1440	surf.	51	340	3.0	5	7.3	8.1	80	0.7	1.2	2.0		1.5					
			5	50	340															
			12	50	340			7.3	7.9	76	1.0	0.8	1.9		1.8					
4	1/20/64	1025	surf.	50	180	0.4	90	7.6	9.5	91	0.4	0.6	5.6		1.5					
			5	48	190															
			12	47	200			7.7	9.2	85	0.5	0.6	4.1		2.0					
6		1045	surf.	47	215	0.4	330	7.8	10.5	97	0.4	0.6	1.3		1.7					
			5	47	215															
			15	47	230															
			29	47	220			7.8	10.3	95	0.6	1.0	4.9		2.1					

a Analyses made using Hach reagents and colorimeter.

b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 3 (cont.)

PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
12	1/20/65	1120	surf.	47	225	0.4	330	7.8	10.3	95	0.4	0.6	3.3		1.0					
			5	47	225															
			15	47	230															
			28	47	230			7.8	9.9	91	0.6	2.0	4.8		2.5					
13		1105	surf.	47	220	0.4	330	7.8	10.7	98	0.5	0.6	4.2							
			5	47	220															
			15	47	220															
			29	48	220			7.8	9.9	93	0.4	0.6	1.8							
15		1020	surf.	48	215	0.4	300	7.8	10.7	100	0.4	0.6	2.6		0.6					
			5	48	220															
			22	47	230			7.8	9.9	91	0.4	0.6	4.2		2.4					
22		1145	surf.	48	280	1.0	110	7.8	10.6	100	0.4	0.6	4.5		0.6					
			5	48	280															
			15	48	280															
			20	48	280			7.6	9.9	93	0.4	0.6	3.5		0.7					
24		1205	surf.	47	250	0.5	250	7.8	10.6	97	0.4	2.5	1.7		1.1					
			5	47	250															
			15	47	250															
			36	47	250			7.7	9.7	89	0.4	0.6	1.7							
28		1220	surf	48	290	1.2	90	7.8	10.0	94	0.5	0.6	1.1		1.1					
			5	48	290															
			15	48	290															
			25	48	300															
			42	48	300			7.8	8.8	83	0.3	0.6	2.1		2.1					
30		1240	surf	49	310	2.0	45	7.7	10.7	101	0.3	0.6	4.2		1.7					
			5	49	310															
			19	48	310			7.8	8.9	84	0.4	0.7	1.7		3.8					
4	2/17/65	1610	surf	58	215	0.4	200	7.8	10.5	111	0.4	2.0	6.5							
			2	50	215															
			5	48	215															
			15	48	215			7.7	10.0	94	0.6	2.0	1.9							
6		1630	surf	55	215	0.4	240	8.2	9.5	97	0.1	2.0	2.7							
			2	49	215															
			5	49	215															
			15	48	215															
			30	48	315			7.7	9.4	88	0.3	2.5	3.7							
12		1525	surf	52	235	0.4	230	8.0	10.0	99	0.1	2.5	3.5							
			2	49	235															
			5	49	230															
			15	48	225															

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
13	2/17/65	1535	surf.	55	220	0.4	290	7.9	10.0	102	0.1	2.5	2.5							
			2	48	220															
			5	48	220															
			15	48	220															
			32	48	220			7.7	9.4	88	0.3	2.5	3.7							
15		1600	surf.	52	220	0.4	320	8.0	9.5	94	0.1	2.0	1.2							
			2	48	220															
			5	48	220															
			15	48	220															
			23	48	220			7.8	8.0	75	0.4	2.0	1.2							
22		1445	surf.	54	255	0.6	125	7.9	9.4	95	0.4	0.5	4.4							
			2	51	255															
			5	49	255															
			15	48	250															
			30	48	250			7.5	8.4	79	0.3	0.7	3.9							
24		1330	surf.	53	250	0.6	150	7.9	10.8	108	0.4	0.5	3.1							
			2	50	260															
			5	49	265															
			15	49	260															
			25	48	255															
			40	48	245			7.9	10.0	94	0.4	0.5	4.0							
28		1345	surf.	51	285	1.1	65	7.9	10.2	101	0.4	1.0	7.0							
			2	50	285															
			5	48	280															
			15	48	280															
			25	48	280															
			41	48	275			8.0	9.8	92	0.5	1.2	7.0							
30		1410	surf.	50	290	1.2	50	7.2	9.2	88	0.4	0.5	2.2							
			2	49	290															
			5	49	290															
			15	49	290															
			19	48	290			7.5	9.1	85	0.5	1.0	3.9							
4	3/9/64	1645	surf.	55	220	0.6	130	8.0	10.8	110		1.0	4.2							
			2	54	220															
			5	53	220															
			10	52	220															
			17	51	220			7.8	8.6	85		3.0	7.0							
6		1700	surf.	54	220	0.6	150	7.9	9.0	91		2.0	2.5							
			5	51	220															
			15	51	220															
			33	50	220			7.7	8.1	78		2.3	5.7							

a Analyses made using Hach reagents and colorimeter.

b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 3 (cont.)
PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
12	3/9/64	1545	surf.	54	240	0.8	85	7.6	9.6	97		1.3	3.9							
			5	52	235															
			15	52	235															
			35	51	230			7.5	8.0	78		2.3	10.0							
13		1610	surf.	54	220	0.6	170	7.9	9.3	94		1.3	4.4							
			5	52	220															
			15	52	220															
			33	50	225			7.5	9.0	86		3.0	1.6							
15		1625	surf.	56	225	0.6	120	7.9	10.0	104		1.3	0.4							
			5	51	220															
			15	51	220															
			28	50	220			7.7	8.6	82		3.3	1.2							
22		1515	surf.	52	255	0.8	70	7.6	9.6	95		1.7	5.5							
			5	51	255															
			15	50	255															
			28	50	255			7.4	8.6	83		2.6	2.7							
24		1345	surf.	52	270	1.1	45	7.6	9.7	96		2.6	6.6							
			5	52	270															
			15	51	270															
			30	51	270			7.5	9.0	88		3.3	9.0							
28		1415	surf.	54	280	2.3	30	7.4	9.5	96		2.3	4.9							
			5	52	275															
			15	51	280															
			42	50	280			7.4	8.5	82		2.3	5.4							
30		1440	surf.	54	280	1.7	25	7.9	9.4	95		2.3	4.9							
			5	53	280															
			18	50	280			7.6	7.7	74		3.3	0.6							
4	4/20/65	1600	surf.	58	220	1.0	140		8.4	89										
			5	55	220															
			10	54	220															
			18	53	220				9.2	92										
6		1530	surf.	58	220	1.0	130		9.2	98										
			5	54	220															
			10	54	225															
			25	53	225				7.0	70										
			35	53	225															
12		1430	surf.	58	205	1.0	100		8.4	89										
			5	57	205															
			10	56	210															
			32	55	210				8.1	83										

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
13	4/20/65	1500	surf.	58	220	1.0	110		9.4	100										
			5	56	220															
			10	55	225															
			32	53	225				8.1	81										
15		1630	surf.	57	220	1.0	150		8.5	89										
			5	54	220															
			10	54	220															
			25	53	220				8.0	80										
22		1300	surf.	59	230	1.5	60		7.0	75										
			5	58	220															
			10	57	220															
			32	56	220				8.8	92										
24		1230	surf.	59	205	1.0	60		9.4	100										
			5	56	210															
			10	56	210															
			25	55	230															
			44	55	230				8.6	88										
28		1130	surf.	59	215	2.9	20		10.4	111										
			5	57	230															
			10	56	240															
			25	55	240															
			43	55	240				9.0	92										
30		1200	surf.	60	235	3.4			9.6	105										
			5	59	235															
			10	59	240															
			20	57	240				8.8	92										
4	4/27/65	1215	surf.	74	185	1.0	90		9.8	124										
			5	58	185															
			10	55	185															
			15	55	185				8.9	91										
6		1230	surf.	68	190	1.0	80		10.5	125										
			5	60	190															
			10	58	190															
			20	57	185															
			35	54	185				8.0	81										
12		1300	surf.	70	225	1.0	70		9.8	120										
			2	67	225															
			5	62	225															
			10	58	230															
			20	55	230															
			31	54	230				7.6	77										

a Analyses made using Hach reagents and colorimeter.

b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 3 (cont.)
PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
13	4/27/65	1245	surf.	68	215	1.1	50		9.6	114										
			5	62	215															
			10	57	215															
			20	55	215															
			33	54	215				8.7	89										
15		1200	surf.	72	185	1.1	90		10.7	132										
			5	66	185															
			10	59	185															
			22	54	185				8.1	82										
22		1320	surf.	70	245	1.5	40		8.9	108										
			2	67	245															
			5	62	240															
			10	58	245															
			20	56	245															
			32	56	245				4.8	50										
24		1445	surf.	70	230	1.0	75		12.5	152										Small concentrations of algae
			5	66	240															
			10	60	240															
			15	57	250															
			20	56	260															
			37	55	260				8.5	87										
28		1515	surf.	72	250	3.0	30		16.6	206										Algae bloom - first of year observed
			5	63	250															
			10	59	260															
			20	57	270															
			35	55	270				8.7	89										
30		1545	surf.	72	265	1.7	15		16.0	198										Algae
			2	66	265															
			5	61	265															
			10	58	260															
			20	57	260				10.0	105										
4	5/4/65	1100	surf.	58	225	1.2	65		9.5	101										
			5	58	225															
			10	58	225															
			18	58	225				9.0	95										
6		1130	surf.	58	225	1.2	75	8.1	9.3	99										
			10	58	225															
			20	57	225															
			30	57	225															
			35	57	225			8.0	9.0	95										

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
12	5/4/65	1230	surf.	59	230	1.2	110	7.9	9.2	98										
			5	58	230															
			15	58	230															
			25	58	225															
			35	58	225			8.0	8.7	92										
13		1200	surf.	61	225	1.0	70	7.9	9.7	107										
			10	60	225															
			20	57	225															
			30	57	225															
			40	57	225			7.7	9.3	98										
15		1030	surf.	58	225	1.0	110		9.0	95										
			5	58	225															
			10	58	225															
			15	58	225															
			21	58	225				8.8	93										
24		1300	surf.	59	240	1.3	70	8.0	9.2	98										
			5	59	240															
			15	58	240															
			25	58	230															
			37	58	235			7.9	9.1	96										
28		1330	surf.	60	250		50		9.6	105										
			5	59	250															
			25	58	250															
			45	58	260				9.2	98										
4	5/11/65	1630	surf.	66	220	1.4	60	9.2	12.7	148										
			5	66	220															
			10	66	220															
			15	59	220															
			17	58	220			8.3	7.6	80										
6		1610	surf.	63	225	1.2	70	9.0	10.8	121										
			5	63	225															
			15	60	230															
			32	57	225			8.4	8.8	92										
12		1545	surf.	64	235	1.0	40	8.8	9.5	108										
			5	63	235															
			15	61	235															
			25	60	235															
			32	60	240			8.2	7.7	84										
13		1545	surf.	64	225	1.1	25	9.0	12.6	143										
			5	63	225															
			15	58	225															
			32	57	225			8.3	7.7	81										

a Analyses made using Hach reagents and colorimeter

b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 3 (cont.)

PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
15	5/11/65	1700	surf.	64	225	1.2	50	9.0	12.0	137										
			5	63	225															
			10	61	225															
			15	58	225															
			22	58	225			8.4	7.0	74										
22		1450	surf.	62	240	1.0	30	8.0	7.8	87										
			5	60	240															
			15	58	240															
			30	58	240			8.1	7.8	83										
24		1430	surf.	65	240	1.5	55	8.6	11.8	136										
			5	62	240															
			15	61	240															
			25	59	250															
			37	59	240			9.2	8.0	86										
28		1410	surf.	66	250	2.4	15	9.2	15.0	174										Heavy algae concentrations
			5	64	255															
			15	60	255															
			25	59	260															
			40	59	260			8.3	8.6	92										Heavy algae concentrations
30		1345	surf.	70	220	2.8	15	9.2	14.6	178										
			20	70	220			8.2	8.6	105										
4	5/20/65	1340	surf.	65	230	4.0	30		8.9	102										
			5	64	230															
			10	62	230															
			18	59	240				7.0	75										
6		1320	surf.	64	235	3.5	30		8.6	98										
			10	63	235															
			20	61	235															
			32	59	240				6.6	71										
12		1230	surf.	63	235	3.5	25		8.9	100										
			10	63	235															
			20	63	235															
			38	63	235				8.6	96										
13		1300	surf.	65	235	3.5	15		8.6	99										
			10	63	235															
			20	62	235															
			33	62	235				8.1	90										
15		1400	surf.	66	235	3.5	20		8.9	103										
			5	64	235															
			10	63	235															
			20	58	235				4.5	48										

PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY
CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[o] Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
22	5/20/65	1130	surf.	65	240		35		9.9	114										
			10	64	240															
			24	64	240				9.6	110										
24		0910	surf.	64	240	2.8	25	8.6	9.2	105										
			10	62	240															
			25	62	240															
			37	62	240			8.4	9.2	102										
28		0940	surf.	62	250		25		9.2	102										
			10	62	250															
			20	62	250															
			35	62	250			8.5	8.8	98										
30		1015	surf.	66	250	2.2	35		11.0	127										
			10	66	255															
			20	65	255				8.1	93										Heavy concentrations of algae
4	5/28/65		surf.			5.5	25													
6			surf.			6.5	30													
12			surf.			6.0	25													
13			surf.			7.0	25													
15			surf.			6.5	25													
28			surf.				35													
4	6/9/65	1515	surf.	71	230	3.0	28		9.7	119										
			5	70	230															
			12	69	230				6.8	82										
6		1500	surf.	70	230	4.5	30		9.1	111										
			5	69	230															
			10	68	235															
			20	68	235															
			36	61	240				3.5	37										
12		1330	surf.	69	240	5.0	15		9.5	114										
			5	69	240															
			10	69	240															
			20	68	240															
			30	68	250				8.7	105										

o Analyses made using Hach reagents and colorimeter.
b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 3 (cont.)

PHYSICAL AND CHEMICAL DATA CHRONOLOGICALLY

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]										Remarks
											Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)		
13	6/9/65	1445	surf.	70	230	4.0	15		11.4	139											
			10	68	230																
			20	67	230																
			32	66	240				3.0	35											
15		1545	surf.	71	230	3.0	30		11.0	135											
			5	69	230																
			10	68	230																
			20	65	235				4.9	56											
28		1300	surf.				15														

CLEAR LAKE WATER QUALITY INVESTIGATION

STATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million [a]: Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1964																			
4	4/29		surf.	62	260			8.2	10.5	120										
	5/21		surf.	65	260			8.2			0.4		3.5	12	1.1	0.20				
	6/3		surf.								0.3	0.0	5.0	17		0.20	0.0			
	6/9		surf.	63	305	1.5		8.3	6.7	75	0.5	0.0	6.0	17	1.0	0.10	0.0		0.10	
	6/25		surf.	75	280	3.9		7.7	8.7	110	0.2	1.3	4.2	13	0.4	0.14	0.0		0.05	
	7/7		surf.	72	295	3.7	20	8.4	7.4	92		0.9	4.0	18	0.6	0.08		0.10	0.12	Heavy concentrations of algae
	7/21	1400	surf.	78	280	1.2	100	8.2	7.5	99	0.4	1.5	2.8	16	0.2	0.14	0.5			
			17	75	280			7.8	3.4	44										
	8/6	1005	surf.	75	280	1.2	50	8.2	5.9	75	0.4	1.5	7.2	17	1.2	0.12				
			15	75	290			8.4	4.5	58										
	8/14	1020	surf.	76	300	1.8	35	7.9	4.4	57	0.2	2.2	2.1	22	0.8	0.17				
			14	74	295			7.7	4.1	52										
	8/21	0915	surf.	75	290	1.1		8.0	3.6	46	0.3	1.5	7.6	8	1.3	0.18				
			13	75	295			7.8	3.0	38										
	9/3	0925	surf.	72	295	1.0	25		6.0	76	0.8	0.0	4.9	14	0.4	0.20				
			12	72	275				5.5	68										
	9/15	0950	surf.	70	300	0.6	105	8.1	5.4	66	0.9	3.1	4.5	15		0.48				
			13	70	300			8.1	4.6	56										
	9/23	1230	surf.	73	305	1.1		8.6	10.0	125	0.6	2.8	1.6	15	0.6	0.05				
			13	72	300			8.6	5.0	62										
	10/7	1635	surf.	71	305	1.0	60	8.4	9.6	117	0.4	1.0	3.0	22		0.20				
			12	69	305			7.8	5.6	67										
	10/19	1530	surf.	68	310	0.8	75	7.8	6.0	71	0.3	1.3	5.7	15	1.1	0.40				
			9	65	315			7.9	4.8	55										
	11/6	0830	surf.	58	310	0.7	85	7.8	8.0	85	0.1	0.2	2.8	13	0.4	0.40				
			10	58	310			7.6	7.7	82										Precipitation occurred thi date sufficient to cause streams to flow.
	11/24	0915	surf.	50	320	0.9	40	7.7	9.4	90	0.5	1.4	5.5							
			2	50	320															
			5	50	320															
			9	49	320			7.6	8.9	85	0.6	2.0	3.9							

a Analyses made using Hach reagents and colorimeter.
b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 4 (cont.)

PHYSICAL AND CHEMICAL DATA BY STATION

CLEAR LAKE WATER QUALITY INVESTIGATION

STATION 4

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1964																			
4	12/8	1230	surf.	50	305	0.8	50	7.8	9.3	88	0.6	1.6	3.7		1.0					
			5	49	305															
			11	49	295			7.7	9.0	85	0.6	1.6	3.1		0.5					
	1965																			
	1/20	1025	surf.	50	180	0.4	90	7.6	9.5	91	0.4	0.6	5.6		1.5					
			5	48	190															
			12	47	200			7.7	9.2	85	0.5	0.6	4.1		2.0					
	2/17	1610	surf.	58	215	0.4	200	7.8	10.5	111	0.4	2.0	6.5							
			2	50	215															
			5	48	215															
			15	48	215			7.7	10.0	94	8.6	2.0	1.9							
	3/9	1645	surf.	55	220	0.6	130	8.0	10.8	110		1.0	4.2							
			2	54	220															
			5	53	220															
			10	52	220															
			17	51	220			7.8	8.6	85		3.0	7.0							
	4/20	1600	surf.	58	220	1.0	140		8.4	89										
			5	55	220															
			10	54	220															
			18	53	220				9.2	92										
	4/27	1215	surf.	74	185	1.0	90		9.8	124										
			5	58	185															
			10	55	185															
			15	55	185				8.9	91										
	5/4	1100	surf.	58	225	1.2	65		9.5	101										
			5	58	225															
			10	58	225															
			18	58	225				9.0	95										
	5/11	1630	surf.	66	220	1.4	60	9.2	12.7	148										
			5	66	220															
			10	66	220															
			15	59	220															
			17	58	220			8.3	7.6	80										
	5/20	1340	surf.	65	230	4.0	30		8.9	102										
			5	64	230															
			10	62	230															
			18	59	230				7.0	75										
	5/28					5.5	25													

STATION

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million									Remarks
											Ammonium (NH_4)	Nitrate (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
	1965																			
4	6/9	1515	surf.	71	230	3.0	28		9.7	119										
			5	70	230															
			12	69	230				6.8	82										

a Analyses made using Hach reagents and calorimeter.
b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 4 (cont.)

PHYSICAL AND CHEMICAL DATA BY STATION

CLEAR LAKE WATER QUALITY INVESTIGATION

STATION 6

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
	1964																			
6	4/29		surf.	64	260				8.5	97	0.6	0.0				0.50				
	6/3		surf.								0.1	0.0	3.0	21		0.20	0.10			
	6/9		surf.	62	300	2.0		8.2	7.0	77	0.5	2.2	3.8	18	1.0	0.20	0.00		0.10	
	6/23		surf.	76	275	5.3		7.9	10.0	129	0.0	0.9	4.9	11	0.8	0.11	0.00		0.04	
	7/7		surf.	73	290	5.2	29	8.5	8.1	101	0.1	0.4	2.6	14	0.4	0.10		0.30	0.10	Heavy concentrations of algae
	7/21	1450	surf.	78	260	1.7	100	8.3	9.0	119	0.4	1.7	4.6	15	0.6	0.01	0.01			
			18	75				8.0	5.8	74										
	8/6	1030	surf.	75	290	1.3	50	8.4	6.0	77	0.5	1.3	3.8	18	1.1	0.12				
			22	75	270			8.3	3.0	38										
	8/14	1045	surf.	76	300	1.6	30	7.8	5.7	73	0.2	2.9	3.1	20	0.7	0.16				
			22	75	295			7.6	3.8	49										
	10/9	1415	surf.	69	310	0.9		7.8	5.7	68	0.1	1.2	6.6	12	1.0	0.55				
			20	65	310			7.8	5.0	57										
	11/6	0850	surf.	59	305	0.7	140	7.8	8.3	89	0.1	0.	3.0	15	0.7	0.60				
			21	59	305			7.8	7.7	82										
	11/24	0935	surf.	50	320	0.9	50	7.7	9.1	87	0.4	1.7	2.6							
			5	50	320															
			15	50	320															
			24	50	320			7.7	8.6	82	0.6	2.2	2.9							
	12/8	1245	surf.	51	315	1.0	35	7.8	9.3	91	0.5	1.6	2.4		2.0					
			5	50	320															Some Algae
			15	50	320															
			25	50	320			7.7	9.1	87	0.5	1.2	2.1		1.2					
	1965																			
	1/20	1045	surf.	47	215	0.4	330	7.8	10.5	97	0.4	0.6	1.3		1.7					
			5	47	215															
			15	47	230															
			29	47	220			7.8	10.3	95	0.6	1.0	4.9		2.1					
	2/17	1630	surf.	55	215	0.4	240	8.2	9.5	97	0.1	2.0	2.7							
			2	49	215															
			5	49	215															
			15	48	215															
			30	48	215			7.7	9.4	88	0.3	2.5	3.7							

STATION 6

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
	1965																			
6	3/9	1700	surf.	54	220	0.6	150	7.9	9.0	91		2.0	2.5							
			5	51	220															
			15	51	220															
			33	50	220			7.7	8.1	78		2.3	5.7							
	4/20	1530	surf.	58	220	1.0	130		9.2	98										
			5	54	220															
			10	54	225															
			25	53	225															
			35	53	225				7.0	70										
	4/27	1230	surf.	68	190	1.0	80		10.5	125										
			5	60	190															
			10	58	190															
			20	57	185															
			35	54	185				8.0	81										
	5/4	1130	surf.	58	225	1.2	75	8.1	9.3	99										Very windy previous week
			10	58	225															
			20	57	225															
			30	57	225															
			35	57	225			8.0	9.0	95										
	5/11	1610	surf.	63	225	1.2	70	9.0	10.8	121										
			5	63	225															
			15	60	230															
			32	57	225			8.4	8.8	92										
	5/20	1320	surf.	64	235	3.5	30		8.6	98										
			10	63	235															
			20	61	235															
			32	59	240				6.6	71										
	5/28		surf.			6.5	30													
	6/9	1500	surf.	70	230	4.5	30		9.1	111										
			5	69	230															
			10	68	235															
			20	68	235															
			36	61	240				3.5	37										

a Analyses made using Hach reagents and colorimeter.
b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 4 (cont.)
PHYSICAL AND CHEMICAL DATA BY STATION
CLEAR LAKE WATER QUALITY INVESTIGATION
STATION 12

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
	1964																			
12	6/3		surf.								0.3	2.2	1.5	25		0.30	0.00			
	6/9		surf.	65	280	3.0		8.6	8.4	96	0.4	1.8	4.4	13	0.5	0.10	0.00		0.05	
	6/26		surf.	74	280	4.6		8.2	10.7	136	0.3	0.9	3.2	13	1.3	0.05	0.02		0.07	
	7/7		surf.	75	290	4.7	20	8.6	9.8	126		0.0	6.1	17	0.7	0.10		0.25	0.08	Heavy concentrations of algae
	7/17	0920	surf.	76	295	2.5	31	8.4	9.2	119	0.1	0.2	2.4	14	0.9	0.08	0.00	0.25		
			27	74				8.0	5.0	64										
	7/21	1015	surf.	75	285	2.3	40	8.0	7.1	91	0.3	2.3	5.9	14	0.4	0.07	0.01			
			25	74				7.8	5.9	75										
	8/6	1140	surf.	77	275	1.5	50	8.5	10.5	138	0.4	0.9	5.6	16	0.8	0.08				
			28	75	280			8.0	4.3	55										
	8/14	1230	surf.	78	295	2.1	50	8.4	11.0	145	0.3	1.3	3.5	20	0.6	0.11				
			28	74	300			7.4	3.2	41										
	8/21	1035	surf.	79	280	2.4	10	9.1	10.5	140	0.0	1.3	3.2	10	1.4	0.30				
			26	79	280			9.0	9.2	122										
	9/3	1045	surf.	72	300	0.9	35		6.0	74	0.4	0.0	3.2	15	0.5	0.25				
			25	71	300				5.0	62										
	9/15	1120	surf.	71	300	1.5	70	7.7	5.7	70	0.5	3.7	5.5	21	1.2	0.24				
			28	70	295			7.7	5.0	61										
	10/7	1330	surf.	69	305	1.5	70	8.0	8.3	100	0.3	1.7	3.4	18	0.9	0.15				
			24	69	305			7.9	6.4	78										
	10/19	1215	surf.	67	315	0.9	80	7.7	6.9	80	0.1	2.2	5.5	11	1.0	0.45				
			24	66	315			7.7	5.8	67										
	11/24	1020	surf.	52	320	1.1	20	7.8	9.2	91	0.4	2.0	3.2							
			5	52	320															
			15	51	320															
			26	50	320			7.7	8.5	81	0.6	2.2	3.8							
	12/8	1320	surf.	50	325	1.1	30	7.7	9.3	89	0.4	1.6	3.4		1.3					
			5	50	325															
			15	50	320															
			26	50	320			7.7	9.2	88	0.5	1.6	2.6		1.8					
	1965																			
	1/20	1120	surf.	47	225	0.4	350	7.8	10.3	95	0.4	0.6	3.3		1.0					
			5	47	225															

STATION 12

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1965																			
12	2/17	1525	surf.	52	235	0.4	230	8.0	10.0	99	0.1	2.5	3.5							
			2	49	235															
			5	49	230															
			15	48	225															
			31	48	225			7.7	8.0	75	0.1	2.5	5.7							
	3/9	1545	surf.	54	240	0.8	85	7.6	9.6	97		1.3	3.9							
			5	52	235															
			15	52	235															
			35	51	230			7.5	8.0	78		2.3	10.0							
	4/20	1430	surf.	58	205	1.0	100		8.4	89										
			5	57	205															
			10	56	210															
			32	55	210				8.1	83										
	4/27	1300	surf.	70	225	1.0	70		9.8	120										
			2	67	225															
			5	62	225															
			10	58	230															
			20	55	230															
			31	54	230				7.6	77										
	5/4	1230	surf.	59	230	1.2	110	7.9	9.7	98										Very windy previous week
			5	58	230															
			15	58	230															
			25	58	225															
			35	58	225			8.0	8.7	92										
	5/11	1545	surf.	64	235	1.0	40	8.8	9.5	108										
			5	63	235															
			15	61	235															
			25	60	235															
			32	60	240			8.2	7.7	84										
	5/20	1230	surf.	63	235	3.5	25		8.9	100										
			10	63	235															
			20	63	235															
			38	63	235				8.6	96										
	5/28					6.0	25													
	6/9	1330	surf.	69	240	5.0	15		9.5	114										
			5	69	240															
			10	69	240															
			20	68	240															
			30	68	250				8.7	105										

a Analyses made using Hach reagents and colorimeter

b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 4 (cont.)

PHYSICAL AND CHEMICAL DATA BY STATION

CLEAR LAKE WATER QUALITY INVESTIGATION

STATION 13

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1964																			
13	5/21		surf.	68	260			8.1			0.3		3.2	15	0.8	0.10				
	6/3		surf.								0.1	0.4	2.2	25		0.30	0.00			
	6/9		surf.	67	280	1.5		8.9	9.4	110	0.4	1.3	4.2	16	0.3	0.15	0 .00		0.05	
	6/26		surf.	74	275	4.7		8.5	11.2	142	0.2	0.4	6.6	13	0.3	0.06	0.02		0.06	
	7/7		surf.	75	270	4.1	25	8.7	10.1	129		0.4	4.4	32	0.4	0.10		0.40	0.09	Heavy concentrations of algae
	7/17	0905	surf.	76	310	5.5	35	8.6	9.0	116	0.7	6.5	14	0.6	0.08	0.01	0.15			
			36	75				8.3	6.0	78										
	7/21	1035	surf.	76	280	2.0	60	8.4	7.9	102	0.4	1.4	3.7	14	0.4	0.07	0.03			
			25	75				8.4	7.4	95										
	8/6	1150	surf.	77	270	1.5	60	8.3	9.4	123	0.4	0.7	7.0	19	1.0	0.11				
			27	75	280			8.3	4.6	59										
	8/14	1245	surf.	78	300	2.0	40	7.9	6.2	82	0.5	2.6	5.4	19	0.7	0.11				
			27	75	260			7.4	2.3	29										
	8/21	1315	surf.	80	285	1.9	20	9.3	13.6	184	0.2	1.1	1.4	11	1.1	0.11				
			26	77	270			8.6	3.5	46										
	9/3	1315	surf.	74	285	0.7	50		5.4	68	0.6		6.5	17	0.4	0.31				
			26	72	285				5.3	66										
	9/15	1400	surf.	73	310	1.7	60	8.2	8.5	106	0.4	2.9	3.1	22	1.2	0.22				
			26	71	310			7.5	4.0	49										
	9/23	1000	surf.	69	305	1.2		7.9	5.2	62	0.3	0.5	4.0	15	0.1	0.20				
			26	69	305			8.0	3.4	41										
	10/7	1400	surf.	69	310	1.4	50	8.2	9.9	119	0.1	1.3	2.2	19	1.5	0.10				
			24	68	305			7.4	4.6	55										
	10/19	1145	surf.	66	305	1.2	50	7.9	6.8	79	0.1	1.2	5.7	12	0.7	0.25				
			24	66	315			7.8	6.1	71										
	11/6	1030	surf.	59	305	0.7	100	7.9	8.2	88	0.1	0.8	3.9	17	1.0	0.50				
			23	59	300			7.8	8.1	87										
	11/24	1005	surf.	51	320	0.9	50	8.0	9.6	94	0.5	1.4	2.8							
			5	50	320															
			15	49	320															
			24	49	320			7.3	6.5	83	0.6	5.5	5.5							

STATION 13

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1964																			
13	12/8	1310	surf.	51	320	1.0	30	7.7	9.2	94	0.5	0.9	2.2		2.2					
			5	50	320															
			15	50	320															
			25	50	320			7.6	9.1	87	0.4	1.0	3.0		1.1					
	1965																			
	1/20	1105	surf.	47	220	0.4	330	7.8	10.7	98	0.5	0.6	4.2							
			5	47	220															
			15	48	220															
			29	48	200			7.8	9.9	93	0.4	0.6	1.8							
	2/17	1535	surf.	55	220	0.4	290	7.9	10.0	102	0.1	2.5	2.5							
			2	48	220															
			5	48	220															
			15	48	220															
			32	48	220			7.7	9.4	88	0.3	2.5	3.7							
	3/9	1610	surf.	54	220	0.6	170	7.9	9.3	94		1.3	4.4							
			5	52	220															
			15	52	220															
			33	50	225			7.5	9.0	86		3.0	1.6							
	4/20	1500	surf.	58	220	1.0	110		9.4	100										
			5	56	220															
			10	55	225															
			32	53	225				8.1	81										
	4/27	1245	surf.	68	215	1.1	50		9.6	114										
			5	62	215															
			10	57	215															
			20	55	215															
			33	54	215				8.7	89										
	5/4	1200	surf.	61	225	1.0	70	7.9	9.7	107										
			10	60	225															
			20	57	225															
			30	57	225															
			40	57	225			7.7	9.3	98										
	5/11	1545	surf.	64	225	1.1	25	9.0	12.6	143										
			5	63	225															
			15	58	225															
			32	57	225			8.3	7.7	81										
	5/20	1300	surf.	65	235	3.5	15		8.6	99										
			10	63	235															
			20	62	235															
			33	62	235				8.1	90										

a Analyses made using Hach reagents and colorimeter

b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 4 (cont.)

PHYSICAL AND CHEMICAL DATA BY STATION

CLEAR LAKE WATER QUALITY INVESTIGATION

STATION 13

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]										Remarks
											Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)		
	1965																				
13	5/28					7.0	25														
	6/9	1445	surf.	70	230	4.0	15		11.4	139											
			10	68	230																
			20	67	230																
			32	66	240				3.0	35											

STATION 15

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1964																			
15	6/9		surf.	69	280	2.5		8.9	9.0	108	0.3	1.8	3.6	16	0.1	0.12	0.00		0.05	
	6/2		surf.	75	270	4.8		8.7	11.5	147	0.3	0.4	4.0	13	0.9	0.10	0.02		0.07	Algae
	7/7		surf.	73	265	3.3	20	8.3	8.0	100		0.4	1.5	23	0.5	0.10		0.30	0.10	Heavy concentrations of algae
	7/17	0820	surf. 15	74 72	295	2.2	40	8.4 7.8	7.8 2.1	98 26			2.8	18	0.4	0.12	0.06	0.50		
	7/21	1138	surf. 16	76 75	255	1.7	60	8.1 8.0	7.2 5.5	93 70	0.3	1.8	3.3	12	0.1	0.12	0.00			
	8/6	1220	surf. 15	77 75	300 275	1.5	45	8.4 8.5	9.1 2.0	119 26	0.4	0.4	3.8	17	0.6	0.12				
	8/14	1340	surf. 18	75 75	295 295	2.7	45	7.8 7.3	5.6 1.8	72 23	0.4	2.6	3.5	18	0.4	0.13				
	8/21	1330	surf. 17	80 76	280 295	1.7	10	9.2 8.4	11.7 2.6	158 34	0.2	2.4	1.0	11	0.8	0.08				
	9/3	1335	surf. 16	73 72	290 295	1.0	40		7.4 5.5	92 68	0.4		8.5	14	0.5	0.26				
	9/15	1430	surf. 16	76 70	280 295	1.1	50	8.2 8.0			0.4	2.9	3.7	20	1.0	0.22				
	9/23	0930	surf. 15	70 70	305 305	1.1		7.9 7.6	4.8 4.2	59 51	0.3	0.7	3.1	15	1.4	0.25				
	10/7	1330	surf. 13	68 67	305 305	1.2	100	8.2 7.5	8.1 0.4	96 5	0.3	1.3	6.0	17	1.2	0.20				
	10/19	1115	surf. 10	65 64	310 315	0.8	60	7.6 7.4	5.6 5.0	64 58	0.1	1.2	4.5	10	0.7	0.32				
	11/6	1050	surf. 11	59 58	300 300	0.8	100	7.8 7.8	8.3 8.6	89 92	0.1	1.5	4.1	18	0.9	0.42				
	11/24	1230	surf. 5 17	51 50 50	320 320 320	1.0	40	7.8 7.7	9.3 8.8	91 84	0.6 0.6	1.4 1.4	6.8 3.5							
	12/8	1530	surf. 5 19	51 50 50	320 320 320	1.0	35	7.7 7.6	9.4 9.7	90 93	0.4 0.5	0.8 1.0	1.9 2.6		0.3 0.5					Some algae on the surface

a Analyses made using Hach reagents and colorimeter.
b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 4 (cont.)

PHYSICAL AND CHEMICAL DATA BY STATION

CLEAR LAKE WATER QUALITY INVESTIGATION

STATION 15

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1965																			
15	1/20	1020	surf.	48	215	0.4	300	7.8	10.7	100	0.4	0.6	2.6		0.6					
			5	48	220															
			22	47	230			7.8	9.9	91	0.4	0.6	4.2		2.4					
	2/17	1600	surf.	52	220	0.4	320	8.0	9.5	94	0.1	2.0	1.2							
			2	48	220															
			5	48	220															
			15	48	220															
			23	48	220			7.8	8.0	75	0.4	2.0	3.6							
	3/9	1625	surf.	56	225	0.6	120	7.9	10.0	104		1.3	0.4							
			5	51	220															
			15	51	220															
			28	50	220			7.7	8.6	82		3.3	1.2							
	4/20	1630	surf.	57	220	1.0	150		8.5	89										
			5	54	220															
			10	54	220															
			25	53	220				8.0	80										
	4/27	1200	surf.	72	185	1.1	90		10.7	132										
			5	66	185															
			10	59	185															
			22	54	185				8.1	82										
	5/4	1030	surf.	58	225	1.0	110		9.0	95										
			5	58	225															
			10	58	225															
			15	58	225															
			21	58	225				8.8	93										
	5/11	1700	surf.	64	225	1.2	50	9.0	12.0	137										
			5	63	225															
			10	61	225															
			15	58	225															
			22	58	225			8.4	7.0	74										
	5/20	1400	surf.	66	235	3.5	20		8.9	103										
			5	64	235															
			10	63	235															
			20	58	235				4.5	48										
	5/28		surf.			6.5	25													
	6/9	1545	surf.	71	230	3.0	30		11.0	135										
			5	69	230															
			10	68	230															
			20	65	235				4.9	56										

STATION 22

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
22	1964 5/21		surf.	65	285			8.2			0.0	0.0	5.5	18	1.5	0.35				
	6/5		surf.								2.6	0.4	2.0	30		0.30				Algae bloom
	6/9		surf.	67	280	4.0		8.2	7.1	83	1.3	1.8	5.0	18	0.9	0.12	0		0.10	
	6/25		surf.	76	285	4.8		8.3	14.8	189	0.0	0.0	2.8	13	0.5	0.08	0.04			Algae,
	7/16		surf. 18	76 75	295	3.0	10	8.7 8.2	7.4 3.5	95 45	0.2	0.7	3.1	18	0.4	0.10	0.02	0.25		
	7/22	0930	surf. 20	75 75	300	2.9	40	8.7 8.2	8.5 3.3	109 42	0.3	0.9	5.0	23	0.6	0.16	0.04	1.00		
	7/28	1040	surf. 20	80 78	285	2.9	15	8.8 8.2	12.3 3.3	167 44	0.1	1.1	3.4	15	0.6	0.10				
	8/7	1123	surf. 19	78 77	295 280	4.5	25	8.6 8.4	9.3 7.8	123 102	0.4	0.9		22	0.4	0.05				
	8/13	1015	surf. 13 25	77 77 76	290 280 280	1.8	15	8.6 8.5 8.5	9.4 8.0 7.6	123 105 99	0.2	3.1		22	1.0	0.10				
	9/30	1530	surf. 15	71 71	310 310	1.0	65	8.5 8.4	9.6 7.0	108 86	0.5		3.5 2.0	15 18	0.4	0.10				
	10/8	1045	surf. 19	70 70	300 300	0.6		8.6 8.5	10.3 8.6	126 105										Algae clumps
	10/20	1125	surf. 15	67 67	310 310	2.2	30	8.0 7.6	7.6 4.6	89 54	0.1	0.8	6.0	22	1.2	0.20				Algae
	11/5	1330	surf. 23	64 62	320 315	1.4	80	7.4 7.3	5.7 5.3	65 59		1.5	4.1	13	0.5	0.22				
	11/24	1100	surf. 5 10 15 20	53 53 53 53 53	330 330 330 330 330	1.7	20	7.3 7.3	7.6 6.5	76 65	0.4 0.3	1.4 2.3	4.1 4.3							
	12/8	1345	surf. 5 16	52 52 52	330 330 330	1.6	35	7.4 7.3	9.1 8.2	90 82	0.5 0.4	1.2 0.6	1.9 2.3		1.8 1.2					

a Analyses made using Hach reagents and calorimeter.

b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 4 (cont.)

PHYSICAL AND CHEMICAL DATA, BY STATION
CLEAR LAKE WATER QUALITY INVESTIGATION
STATION 22

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1965																			
22	1/20	1145	surf.	48	280	1.0	110	7.8	10.6	100	0.4	0.6	4.5		0.6					
			5	48	280															
			15	48	280															
			20	48	280			7.6	9.9	93	0.4	0.6	3.5		0.7					
	2/17	1445	surf.	54	255	0.6	125	7.9	9.4	95	0.4	0.5	4.4							
			2	51	255															
			5	49	255															
			15	48	250															
			30	48	250			7.5	8.4	79	0.3	0.7	3.9							
	3/9	1515	surf.	52	255	0.8	70	7.6	9.6	95		1.7	5.5							
			5	51	255															
			15	50	255															
			28	50	255			7.4	8.6	83		2.6	2.7							
	4/20	1300	surf.	59	230	1.5	60		7.0	75										
			5	58	220															
			10	57	220															
			32	56	220				8.8	92										
	4/27	1320	surf.	70	245	1.5	40		8.9	108										
			2	67	245															
			5	62	240															
			10	58	245															
			20	56	245															
			32	56	245				4.8	50										
	5/11	1450	surf.	62	240	1.0	30	8.0	7.8	87										
			5	60	240															
			15	58	240															
			30	58	240			8.1	7.8	83										
	5/20	1130	surf.	65	240		35		9.9	114										Very windy
			10	64	240															
			24	64	240				9.6	110										

STATION 24

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1964																			
24	6/5		surf.								0.4	0.9	2.1	33		0.15	0.00			
	6/9		surf.	67	290	4.3		8.7	8.6	101	0.4	1.8	4.6	18	0.9	0.12	0.10		0.08	
	6/26		surf.	75	280	3.9		8.4	12.4	158	0.0	0.0	5.1	12	0.5	0.06	0.02			Algae, cool, clear, windy
	7/3		surf.	70	295	4.7		8.3	7.3	89	0.1	0.0	4.6	13	0.5	0.15	0.09			Heavy concentrations of algae
	7/8	0845	surf.	71	310	4.8	5	8.6	7.6	93			1.9	16	0.4	0.07		0.40	0.08	Algae
	7/16		surf. 39	75 73	280	6.3	10	8.2 7.9	7.4 5.1	95 64	0.3	0.7	2.8	18	0.5	0.08	0.00	0.25		
	7/22	0955	surf. 35	74 74	280	3.0	20	8.1 7.9	6.4 5.8	81 74	0.4	0.6	7.4	20	0.6	0.08	0.09	0.90		
	7/28	1005	surf. 26	80 78	275	2.4	45	9.1 8.8	11.8 8.3	160 109	0.2	1.3	4.1	15	0.7	0.11				
	8/7	1140	surf. 32	74 74	290 300	2.5	15	8.3 8.3	10.5 4.5	133 57	0.6	0.7		18	0.4	0.08				
	8/13	1100	surf. 16 32	76 75 74	290 290 290	1.8		8.1 7.8 7.8	6.7 5.6 4.3	86 72 55	0.1	2.2		18	1.1	0.18				
	8/21	1140	surf. 29	75 76	290 295	1.4	40	9.3 8.1	13.1 3.0	168 39	3.9	0.9	6.0	15	0.6	0.12				
	9/3	1140	surf. 22	74 73	300 300	1.1			5.6 4.9	70 61	0.6	0.7	2.9	12	0.7	0.37				
	9/15	1230	surf. 33	71 70	300 300	1.6	40	8.0 7.7	6.6 4.5	82 55	0.7	1.4	3.4	20	0.4	0.16				
	9/30	1350	surf. 31	68 68	305 285	1.2	40	8.2 7.8	7.5 6.6	89 79	0.4	0.7	4.3	13	0.4	0.20				
	10/8	1115	surf. 33	68 68	300 300	1.1	70	7.9 7.7	6.6 7.2	78 86	0.3	0	2.4	18	1.2	0.15				
	10/20	1100	surf. 31	66 66	310 310	1.6	45	7.8 7.6	5.9 4.6	68 53	0.1	0.4	4.8	14	0.3	0.25				
	11/5	1350	surf. 35	65 60	310 310	1.4	90	8.1 7.5	10.6 6.3	122 69	0.4	0.7	2.9	13	1.5	0.25				Clumps of algae

a Analyses made using Hach reagents and colorimeter

b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 4 (cont.)

PHYSICAL AND CHEMICAL DATA BY STATION

CLEAR LAKE WATER QUALITY INVESTIGATION

STATION 24

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
	1964																			
24	11/24	1105	surf.	53	335	1.7	10	7.6	8.6	86	0.5	1.4	3.3							
			5	53	335															
			15	52	330															
			33	51	330			7.6	8.4	83	0.6	1.7	3.1							
	12/8	1405	surf.	52	335	1.9	10	7.5	9.1	90	0.5	1.2	1.9		1.6					
			5	52	335															
			10	51	330															Some algae
			15	51	330															
			35	51	330			7.3	8.3	81	0.5	1.0	2.3		0.9					
	1965																			
	1/20	1205	surf.	47	250	0.5	250	7.8	10.6	97	0.4	2.5	1.7		1.1					
			5	47	250															
			15	47	250															
			36	47	250			7.7	9.7	89	0.4	0.6	1.7							
	2/17	1330	surf.	53	250	0.6	150	7.9	10.8	108	0.4	0.5	3.1							
			2	50	260															
			5	49	265															
			15	49	260															
			25	48	255															
			40	48	245			7.9	10.0	94	0.4	0.5	4.0							
	3/9	1345	surf.	52	270	1.1	45	7.6	9.7	96		2.6	6.6							
			5	52	270															
			15	51	270															
			30	51	270			7.5	9.0	88		3.3	9.0							
	4/20	1230	surf.	59	205	1.0	60		9.4	100										
			5	56	210															
			10	56	210															
			25	55	230															
			44	55	230				8.6	88										
	4/27	1445	surf.	70	230	1.0	75		12.5	152										Some algae
			5	66	240															
			10	60	240															
			15	57	250															
			20	56	260															
			37	55	260				8.5	87										
	5/4	1300	surf.	59	240	1.3	70	8.0	9.2	98										
			5	59	240															
			15	58	230															
			25	58	230															
			37	58	235			7.9	9.1	96										

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
	1965																			
24	5/11	1430	surf.	65	240	1.5	55	8.7	11.8	136										
			5	62	240															
			15	61	240															
			25	59	250															
			37	59	240			8.9	8.0	86										
	5/20	0910	surf.	64	240	2.8	25	8.6	9.2	105										
			10	62	240															
			25	62	240															
			37	62	245			8.4	9.2	102										

a Analyses made using Hach reagents and colorimeter

b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 4 (cont.)

PHYSICAL AND CHEMICAL DATA BY STATION

CLEAR LAKE WATER QUALITY INVESTIGATION

STATION 28

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (jcu.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1964																			
28	5/21		surf.	64	295			8.1			0.0	0.0	5.5	19	1.4	0.22				
	6/9		surf.	66	300	3.4		8.4	8.2	95	0.8	1.8	3.2	16	1.3	0.12	0.00		0.08	
	6/26		surf.	76	290	3.6		8.6	15.5	203	0.4	0.0	2.6	13	0.2	0.08	0.03			Clear, cool, windy
	7/3		surf.	72	300	6.2		8.4	7.9	97		0.4	4.0	12	0.5	0.13	0.08			Heavy concentrations of algae
	7/16		surf.	76	295	2.6	10	8.5			0.2	0.4	6.0	18	0.2	0.15	0.00	0.70		
			39	75				8.1												
	7/22	1110	surf.	77	310	7.0	50	8.0	6.9	90	0.5	0.2	1.9	14	0.6	0.26	0.00	0.00		
			30	75				8.0	4.8	61										
	7/28	1115	surf.	80	285	2.8		9.0	16.0	216	0.3	0.2	7.5	14	0.8	0.15				
			30	76				8.0	0.3	4										
	8/7	1215	surf.	76	300	4.0	5	8.2	8.7	112	0.1	0.9		16	0.4	0.00				
			32	76	300			8.0	5.6	72										
	8/13	1145	surf.	76	295	3.4		7.8	5.6	72	0.1	2.0		15	0.2	0.08				
			20	75	295			7.8	5.3	68										
			39	75	295			7.6	4.5	57										
	8/21	1312	surf.	81	295	1.0	10	9.7	18.7	257		2.6	5.2	32	0.6	0.12				
			31	76	295			8.5	2.7	35										
	9/3	1200	surf.	75	295	1.3			7.0	90	0.1	0.7	2.7	13	0.9	0.35				
			35	73	300				4.1	51										
	9/15	1255	surf.[c]	72	305	1.7	80	8.2	11.4	141	0.4	1.1	3.4	18	1.2	0.22				
			29	71	305			7.7	5.9	72										
	9/30	1415	surf.	69	305	1.2	65	8.1	8.6	103	0.5	1.7	3.2	14	0.1	0.00				
			29	69	305			7.7	5.6	67										
	10/8	1150	surf.	70	310	1.5	50	8.0	9.0	110	0.5	1.2	6.0	15	0.4	0.20				Algae
			30	69	300			7.6	5.6	67										
	10/20	1020	surf.	66	315	1.7	45	7.6	6.8	79	0.1	0.2	5.4	13	1.1	0.25				First stage of algae clumping
			39	65	315			7.3	4.3	49										
	11/5	1412	surf.	64	300	1.5	95	7.8	9.1	104	0.3	0.2	1.9	15		0.25				
			38	62	310			7.4	7.2	80										
	11/24	1130	surf.	54	340	2.5	10	7.6	8.7	87	0.4	1.0	1.6							
			15	53	340															
			20	53	335															
			35	52	335			7.3	6.4	63	0.8	1.2	3.0							

STATION 28

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (jcu)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a] Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho-Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1964																			
28	12/8	1420	surf.	52	335	2.4	10	7.4	9.2	91	0.4	0.9	4.0		2.0					
			5	52	335															
			10	51	335															
			38	51	335			7.4	8.1	79	0.5	0.6	3.2		0.8					
	1965																			
	1/20	1220	surf.	48	290	1.2	90	7.8	10.0	94	0.5	0.6	1.1		1.1					
			5	48	290															
			15	48	290															
			25	48	300															
			42	48	300			7.8	8.8	83	0.3	0.6	2.1		2.1					
	2/17	1345	surf.	51	285	1.1	65	7.9	10.2	101	0.4	1.0	7.0							
			2	50	285															
			5	48	280															
			15	48	280															
			25	48	280															
			41	48	275			8.0	9.8	92	0.5	1.2	7.0							
	3/9	1415	surf.	54	280	2.3	30	7.4	9.5	96		2.3	4.9							
			5	52	280															
			15	51	280															
			42	50	280			7.4	8.5	82		2.3	5.4							
	4/20	1130	surf.	59	215	2.9	20		10.4	111										
			5	57	230															
			10	56	240															
			25	55	240															
			43	55	240				9.0	92										
	4/27	1515	surf.	72	250	3.0	30		16.6	206										
			5	63	250															First algae bloom of the year
			10	59	260															
			20	57	270															
			35	55	270				8.7	89										
	5/4	1330	surf.	60	250		50		9.6	105										
			5	59	250															
			25	58	250															
			45	58	260				9.2	98										
	5/11	1410	surf.	66	250	2.4	15	9.2	15.0	174										Algae, but not blooming
			5	64	255															
			15	60	255															
			25	59	260															
			40	59	260			8.3	8.6	92										

a Analyses made using Hach reagents and colorimeter
b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 4 (cont.)

PHYSICAL AND CHEMICAL DATA BY STATION

CLEAR LAKE WATER QUALITY INVESTIGATION

STATION 28

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (jcu)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]									Remarks
											Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	
	1965																			
28	5/20	0940	surf.	62	250				9.2	102										
			10	62	250															
			20	62	250															
			35	62	250				8.8	98										
	5/28		surf.				35													
	6/9	1300	surf.				15													

CLEAR LAKE WATER QUALITY INVESTIGATION

STATION 30

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1964																			
30	6/5		surf.								0.9	0.0	3.5	20		0.20	0 .00			Algae bloom
	6/9		surf.	67	320	2.5		8.1	7.8	91	1.3	1.8	3.4	16	1.1	0.14	0 .00		0.08	
	6/26		surf.	78	290	5.5		8.7	17.4	230	0.3	0.0	3.8	12	0.2	0.12	0.01			Cool, clear, windy
	7/3		surf.	73	300	2.0		8.6	10.1	126		0.4	3.8	15	0.4	0.23	0.13			Heavy concentrations of algae
	7/16		surf. 15	77 77	305	2.8		8.1 8.0			0.9	0.0	3.7	18	0.2	0.12	0.00	1.25		
	7/22	1135	surf. 15	76 75	315	2.4	75	8.0 8.0	8.7 7.0	112 90	1.2	0.9	2.6	17	0.6	0.29	0 .00	0.05		
	7/28	1140	surf. 16	80 78	290	3.2	15	8.7 8.3	11.5 5.3	150 70	0.4	0.0	4.1	15	0.9	0.15				
	8/7	1230	surf. 16	78 78	280 280	1.5	40	8.8 8.8	12.5 11.8	165 156	0.3	1.8		15	0.5	0.08				
	8/13	1200	surf. 16	76 76	295 290	4.7	5	7.9 8.0	7.8 7.1	101 92	0.1	1.8		15	0.8	0.05				
	8/21	1230	surf. 16	77 77	295 295	1.6	10	9.3 9.1	11.0 7.7	144 101	0.0	1.3	3.6	12	0.3	0				
	9/3	1215	surf. 16	75 73	295 295	1.2			9.4 6.4	120 80	0.3	0.4	3.7	12	1.0	0.51				
	9/15	1315	surf. 16	73 72	290 295	1.2	80	8.8 8.7	14.5 11.5	181 143	0.2	2.4	3.1	20	1.3	0.25				Algae
	9/30	1330	surf. 16	69 69	310 315	1.2	70	8.3 8.3	11.2 10.2	134 122	0.5	0.3	1.9	15	1.0	0				Clumps of algae
	10/8	1105	surf. 16	70 69	310 310	1.5	50	8.0 7.8	9.0 8.0	110 96	0.3	0.8	5.5	15	1.0	0.20				Algae
	10/20	1000	surf. 10	65 65	310 310	1.8	40	7.8 8.2	10.0 9.6	115 110	0.1	0.8	6.2	10	1.6	0.21				Clumps of algae
	11/5	1428	surf. 13	63 60	310 315	1.8	80	7.2 7.2	6.4 4.6	72 50	0.3	0.7	2.4	14	1.7	0.26				Algae
	11/24	1145	surf. 5 13	52 52 51	335 335 335	3.0	10	7.3 7.3	7.9 7.9	70 68	0.7 0.9	1.7 1.4	2.4 2.5							

a Analyses made using Hach reagents and colorimeter.

b Analyses made using the Brucine method with a spectrophotometer after 9-15-64.

TABLE 4 (cont.)

PHYSICAL AND CHEMICAL DATA BY STATION
CLEAR LAKE WATER QUALITY INVESTIGATION
STATION 30

Station	Date	Time	Depth (ft)	Temperature (°F)	Specific conductance (micromhos at 25°C)	Secchi (ft)	Turbidity (j.c.u.)	pH	Dissolved Oxygen (ppm)	Oxygen Saturation (%)	Mineral constituents in parts per million[a]: Ammonium (NH_4)	Nitrate[b] (NO_3)	Ortho Phosphate (PO_4)	Sulfate (SO_4)	Boron (B)	Total Iron (Fe)	Soluble Iron (Fe)	Manganese (Mn)	Copper (Cu)	Remarks
	1964																			
30	12/8	1440	surf.	51	340	3.0	5	7.3	8.1	80	0.7	1.2	2.0		1.5					
			5	50	340															
			12	50	340			7.3	7.9	76	1.0	0.8	1.9		1.8					
	1965																			
	1/20	1240	surf.	49	310	2.0	45	7.7	10.7	101	0.3	0.6	4.2		1.7					
			5	49	310															
			19	48	310			7.8	8.9	84	0.4	0.7	1.7		3.8					
	2/17	1410	surf.	50	290	1.2	50	7.2	9.2	88	0.4	0.5	2.2							
			2	49	290															
			5	49	290															
			15	49	290															
			19	48	290			7.5	9.1	85	0.5	1.0	3.9							
	3/9	1440	surf.	54	280	1.7	25	7.9	9.4	95		2.3	5.7							
			5	53	280															
			18	50	280			7.6	7.7	74		3.3	0.6							
	4/20	1200	surf.	60	235	3.4	20		9.6	105										
			5	59	235															
			10	59	240															
			20	57	240				8.8	92										
	4/27	1545	surf.	72	265	1.7	15		16.0	198										Algae
			2	66	265															
			5	61	265															
			10	58	260															
			20	57	260				10.0	105										
	5/11	1345	surf.	70	220	2.8	15	9.2	14.6	178										Heavy algae,
			20					8.2	8.6	105										
	5/20	1015	surf.	66	250	2.2	35		11.0	127										
			10	66	255															
			20	65	255				8.1	93										Heavy algae

TABLE 5

MINERAL ANALYSES OF LAKE STATIONS

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org. Nitrogen (N)	Ortho phosphate (PO_4)	Total + org. phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents		Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Remarks
					Mineral constituents in parts per million / equivalents per million																						
4	5/22/64		298	8.5	25 1.25	17 1.37	11 0.48	2.4 0.06	5 0.17	157 2.57	5.9 0.12	7.4 0.21		1.2 0.02					0.03	0.8	Aluminum Arsenic Lead Manganese Zinc Total Iron	0.13 0.00 0.02 0.00 0.01 0.22	184	15	131	0	
6			298	8.2	24 1.20	16 1.34	10 0.44	2.4 0.06	0 0.00	162 2.62	5.8 0.12	6.9 0.19		1.3 0.02					0.01	0.8	Aluminum Arsenic Lead Manganese Zinc Total Iron	0.92 0.00 0.01 0.03 0.05 1.2	183	14	127	0	
7			299	8.5	25 1.25	16 1.29	10 0.44	2.4 0.06	5 0.17	156 2.56	5.4 0.11	7.4 0.21		1.1 0.02					0.04	0.9	Aluminum Arsenic Lead Manganese Zinc Total Iron	0.12 0.00 0.02 0.00 0.03 0.24	186	14	127	0	
8			296	8.4	25 1.25	16 1.29	10 0.44	2.4 0.06	4 0.13	156 2.56	5.1 0.11	6.9 0.19		1.3 0.02					0.03	0.9	Aluminum Arsenic Lead Manganese Zinc Total Iron	0.12 0.00 0.01 0.00 0.02 0.20	188	14	127	0	
10			330	7.2	25 1.25	19 1.53	12 0.52	2.6 0.07	0 0.00	183 3.00	5.9 0.12	6.9 0.19		0.6 0.01					0.03	1.1	Aluminum Arsenic Lead Manganese Zinc Total Iron	0.11 0.00 0.03 0.00 0.02 0.46	194	15	139	0	
17			299	8.3	25 1.25	16 1.29	10 0.44	2.4 0.06	0 0.00	166 2.72	5.3 0.11	7.4 0.21		1.2 0.02					0.04	0.9	Aluminum Arsenic Lead Manganese Zinc Total Iron	0.09 0.00 0.01 0.00 0.02 0.17	182	14	127	0	
22			301	8.4	24 1.20	17 1.42	10 0.44	2.5 0.06	3 0.10	160 2.62	6.1 0.13	7.8 0.22		1.3 0.02					0.01	1.0	Aluminum Arsenic Lead Manganese Zinc Total Iron	0.18 0.00 0.01 0.00 0.02 0.25	185	14	131	0	
24			304	8.4	25 1.25	16 1.33	11 0.48	2.4 0.06	3 0.10	162 2.66	5.9 0.12	7.4 0.21		1.3 0.02					0.00	0.9	Aluminum Arsenic Lead Manganese Zinc Total Iron	0.13 0.00 0.01 0.00 0.03 0.15	181	15	127	0	

TABLE 5 (cont)

MINERAL ANALYSES OF LAKE STATIONS

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Mineral constituents in parts per million / equivalents per million: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org. Nitrogen (N)	Ortho phosphate (PO_4)	Total + org. phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$: Total ppm	Hardness as $CaCO_3$: N C ppm	Remarks
28	5/22/64		310	8.2	25 1.25	17 1.37	11 0.48	2.4 0.06	0 0.00	174 2.85	5.6 0.12	7.8 0.22		0.4 0.01					0.02	1.0	Aluminum 0.03 Arsenic 0.00 Lead 0.00 Manganese 0.00 Zinc 0.02 Total Iron 0.14	175	15	131	0	
30			323	8.0	25 1.25	18 1.47	12 0.52	2.5 0.06	0 0.00	179 2.93	5.3 0.11	7.8 0.22		0.4 0.01					0.02	1.0	Aluminum 0.02 Arsenic 0.01 Lead 0.04 Manganese 0.00 Zinc 0.04 Total Iron 0.16	184	16	136	0	
4	3/11/65		217								7.1			4.4		0.27	0.42	0.55		0.6	Ammonia plus Organic Nitrogen 0.5					
6			215								6.9			2.2		0.30	0.44	0.47		0.6	Ammonia plus Organic Nitrogen 0.4					
12			234								7.6			3.5		0.30	0.41	0.30		0.7	Ammonia plus Organic Nitrogen 0.5					
13			215								6.9			3.1		0.29	0.41	0.53		0.6	Ammonia plus Organic Nitrogen 0.6					
15			220								6.7			2.2		0.28	0.44	0.50		0.6	Ammonia plus Organic Nitrogen 0.5					
22			246								8.1			3.1		0.29	0.39	0.31		0.8	Ammonia plus Organic Nitrogen 0.6					
24			256								8.1			2.6		0.28	0.33	0.29		0.8	Ammonia plus Organic Nitrogen 0.5					
28			275								8.1			3.1		0.23	0.25	0.24		0.9	Ammonia plus Organic Nitrogen 0.5					
30			281								8.9			2.2		0.15	0.26	0.19		1.0	Ammonia plus Organic Nitrogen 0.6					

TABLE 5 (cont)

MINERAL ANALYSES OF LAKE STATIONS

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Mineral constituents in parts per million / equivalents per million: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org Nitrogen (N)	Orthophosphate (PO_4)	Total + org. phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$: Total ppm	Hardness as $CaCO_3$: N C ppm	Remarks
4	4/20/65												0.01	4.0	0.6		0.46				Aluminum 53.0 Beryllium 1.3* Bismuth 0.67* Cadmium 3.3* Chromium 3.3* Colbalt 3.3* Copper 11.0 Gallium 13.0* Germanium 0.67* Iron 100.0 Lead 3.3 Manganese 6.7 Molybdenum 0.67** Nickel 2.7 Titanium 1.3 Vanadium 2.1 Zinc 13.0*					
6													0.04	4.0	0.5		0.42				Aluminum 53.0 Beryllium 1.3* Bismuth 0.67* Cadmium 3.3* Chromium 3.3* Colbalt 3.3* Copper 10.0 Gallium 13.0* Germanium 0.67* Iron 107.0 Lead 3.3 Manganese 3.3* Molybdenum 0.67** Nickel 2.7 Titanium 1.3 Vanadium 2.0 Zinc 13.0*					
12													0.09	4.0	0.5		0.43				Aluminum 49.0 Beryllium 1.3* Bismuth 0.67* Cadmium 3.3* Chromium 3.3* Cobalt 3.3* Copper 9.3 Gallium 13.0* Germanium 0.67* Iron 93.0 Lead 3.3* Manganese 3.3* Molybdenum 0.67** Nickel 2.6 Titanium 1.3 Vanadium 2.0 Zinc 13.0*					

*less than the amount indicated.
**equal to, but slightly less than the amount indicated.

TABLE 5 (cont.)

MINERAL ANALYSES OF LAKE STATIONS

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Mineral constituents in parts per million / equivalents per million: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org. Nitrogen (N)	Orthophosphate (PO_4)	Total + org. phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$: Total ppm	Hardness as $CaCO_3$: N.C. ppm	Remarks
13	4/20/65												0.04	4.4	0.4		0.44				Aluminum 59.0 Beryllium 1.3* Bismuth 0.67* Cadmium 3.3* Chromium 3.3* Cobalt 3.3* Copper 13.0 Gallium 13.0* Germanium 0.67* Iron 93.0 Lead 3.3* Manganese 3.3* Molybdenum 0.67** Nickel 2.6 Titanium 1.3 Vandium 2.0 Zinc 13.0*					
15													0.04	5.8	0.5		0.37				Alumiun 39.0 Beryllium 1.3* Bismuth 0.67* Cadmium 3.3* Chromium 3.3* Cobalt 3.3* Copper 9.3 Gallium 13.0* Germanium 0.67* Iron 73.0 Lead 3.3* Manganese 3.3* Molybdenum 0.67** Nickel 2.1 Titanium 1.3* Vanadium 2.3 Zinc 13.0*					
22													0.03	5.8	0.4		0.35				Aluminum 37.0 Beryllium 1.3* Bismuth 0.67* Cadmium 3.3* Chromium 3.3* Cobalt 2.7 Copper 11.0 Gallium 13.0* Germanium 0.67* Iron 57.0 Lead 3.3* Manganese 3.3* Molybdenum 0.67** Nickel 1.9 Titanium 1.3* Vanadium 2.3 Zinc 13.0*					

*less than the amount indicated.
**equal to, but slightly less than the amount indicated.

TABLE 5 (cont.)

MINERAL ANALYSES OF LAKE STATIONS

CLEAR LAKE WATER QUALITY INVESTIGATION

Mineral constituents in parts per million / equivalents per million

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org Nitrogen (N)	Ortho phosphate (PO_4)	Total + org. phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents		Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Remarks
24	4/20/65												0.04	3.5	0.5		0.38				Aluminum	33.0					
																					Beryllium	1.3*					
																					Bismuth	0.67*					
																					Cadmium	3.3*					
																					Chromium	3.3*					
																					Cobalt	3.3*					
																					Copper	14.0					
																					Gallium	13.0*					
																					Germanium	0.67*					
																					Iron	67.0					
																					Lead	3.3*					
																					Manganese	5.9					
																					Molybdenum	0.67**					
																					Nickel	2.2					
																					Titanium	1.3*					
																					Vanadium	2.2					
																					Zinc	13.0*					
28													0.08	4.0	0.7		0.33				Aluminum	33.0					
																					Beryllium	1.3*					
																					Bismuth	0.67*					
																					Cadmium	3.3*					
																					Chromium	3.3*					
																					Cobalt	3.3*					
																					Copper	13.0					
																					Gallium	13.0					
																					Germanium	0.67*					
																					Iron	73.0					
																					Lead	3.3*					
																					Manganese	3.3*					
																					Molybdenum	0.67**					
																					Nickel	1.7					
																					Titanium	1.3*					
																					Vanadium	2.5					
																					Zinc	13.0*					
30													0.00	2.6	0.5		0.32				Aluminum	26.0					
																					Beryllium	1.3*					
																					Bismuth	0.67*					
																					Cadmium	3.3*					
																					Chromium	3.3*					
																					Cobalt	3.3*					
																					Copper	10.0					
																					Gallium	13.0*					
																					Germanium	0.67*					
																					Iron	49.0					
																					Lead	3.3					
																					Manganese	3.3*					
																					Molybdenum	0.67**					
																					Nickel	1.5					
																					Titanium	1.3					
																					Vanadium	2.5					
																					Zinc	13.0*					

*less than the amount indicated.
**equal to, but slightly less than the amount indicated.

TABLE 5 (cont)

MINERAL ANALYSES OF LAKE STATIONS

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Mineral constituents in parts per million / equivalents per million: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org. Nitrogen (N)	Ortho phosphate (PO_4)	Total + org. phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$: Total ppm	N C ppm	Remarks
4	4/27/65	74	185										0.23	3.1	0.6	0.07	0.38									
6		68	190										0.21	2.6	0.2	0.09	0.35									
12		70	225										0.32	3.1	0.2	0.18	0.36									
13		68	215										0.15	3.5	0.2	0.09	0.36									
15		72	185										0.25	3.5	0.6	0.04	0.36									
22		70	245										0.18	3.5	0.3	0.09	0.35									
24		70	230										0.12	4.0	0.4	0.07	0.40									Some Algae
28		72	250										0.25	1.8	0.9	0.18	0.48									Algae Bloo
30		72	265										0.28	2.2	1.4	0.09	0.25									Algae
4	5/4/65		224	8.2	20 1.00	12 1.00	9.0 0.39	2.4 0.06	0 0.00	125 2.05	6.2 0.13	5.0 0.14	0.38	1.3 0.04	0.4	0.24	0.38	0.31	0.00	0.5		138	16	100	0	
6			225	8.4	20 1.00	12 1.00	9.0 0.39	2.2 0.06	4 0.13	120 1.97	11 0.23	4.7 0.13	0.04	2.2 0.04	0.3	0.24	0.30	0.45	0.00	0.5		141	16	100	0	
12			235	8.4	21 1.05	12 1.03	9.7 0.42	2.2 0.06	0 0.00	132 2.16	6.6 0.14	5.1 0.14	0.05	1.8 0.04	0.4	0.24	0.37	0.18	0.00	0.6		146	16	104	0	
13			230	8.5	20 1.00	13 1.04	9.0 0.39	2.2 0.06	2 0.07	125 2.05	6.2 0.13	4.8 0.14	0.01	1.8 0.04	0.4	0.21	0.36	0.33	0.00	0.5		141	16	102	0	
15			227	8.5	20 1.00	12 1.02	9.0 0.39	2.3 0.06	4 0.13	120 1.97	14 0.29	4.8 0.14	0.00	1.3 0.04	0.3	0.23	0.34	0.18	0.00	0.6		140	16	101	0	
24			240	8.4	20 1.00	14 1.14	9.7 0.42	2.3 0.06	2 0.07	131 2.15	7.6 0.16	5.8 0.16	0.00	1.3 0.04	0.4	0.23	0.35	0.19	0.00	0.6		151	16	107	0	
28			252	8.4	22 1.10	14 1.14	9.9 0.43	2.2 0.06	3 0.10	138 2.26	6.7 0.14	5.8 0.16	0.00	1.8 0.03	0.5	0.18	0.27	0.05	0.00	0.7		174	16	112	0	
4	5/11/65												0.22	1.3	0.7	0.20	0.35	0.44	0.01							
6													0.01	3.5	0.7	0.21	0.35	0.31	0.00							
12													0.04	4.4	0.5	0.21	0.30	0.54	0.01							
13													0.00	3.1	0.7	0.20	0.36	0.71	0.01							
15													0.00	2.2	0.7	0.20	0.34	0.40	0.04							
22													0.23	4.0	0.5	0.25	0.37	0.51	0.01							
24													0.05	2.7	0.8	0.21	0.36	0.09	0.01							
28													0.08	1.3	1.2	0.16	0.37	0.10	0.01							

TABLE 5 (cont)

MINERAL ANALYSES OF LAKE STATIONS

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Mineral constituents in parts per million / equivalents per million: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org. Nitrogen (N)	Orthophosphate (PO_4)	Total + org phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents	Total dissolved solids in ppm	Per cent sodium	Hardness as $CaCO_3$: Total ppm	N C ppm	Remarks
30	5/11/65												0.13	1.3	0.9	0.09	0.25	0.14	0.01							
4	5/20/65												0.11	2.7	1.8	0.18	0.28			0.6	Aluminum 113 Beryllium 1.3* Bismuth 0.67* Cadmium 3.3* Chromium 3.3* Cobalt 3.3** Copper 3.3* Gallium 13* Germanium 0.67* Iron 123 Lead 6.7 Manganese 3.3* Molybdenum 0.67* Nickel 3.7 Titanium 2.7 Vanadium 2.2 Zinc 13*					
6													0.06	1.8	0.3	0.18	0.31			0.6	Aluminum 100 Beryllium 1.3* Bismuth 0.67* Cadmium 3.3* Chromium 3.3* Cobalt 3.3* Copper 3.3* Gallium 13* Germanium 0.67* Iron 130 Lead 3.3* Manganese 3.3* Molybdenum 0.67* Nickel 2.0 Titanium 3.3 Vanadium 2.3 Zinc 13*					
12													0.00	2.2	0.4	0.17	0.28			0.6	Aluminum 66 Beryllium 1.3* Bismuth 0.67* Cadmium 3.3* Chromium 3.3* Cobalt 3.3* Copper 3.3* Gallium 13* Germanium 0.67* Iron 107 Lead 3.3* Manganese 3.3* Molybdenum 0.67* Nickel 1.5 Titanium 2.7 Vanadium 2.5 Zinc 13*					

*less than the amount indicated.
**equal to, but slightly less than the amount indicated.

TABLE 5 (cont.)

MINERAL ANALYSES OF LAKE STATIONS

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Mineral constituents in parts per million / equivalents per million: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org. Nitrogen (N)	Ortho phosphate (PO_4)	Total + org. phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents		Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$: Total ppm	N.C. ppm	Remarks
13	5/20/65												0.05	1.8	0.3	0.19	0.34			0.6	Aluminum	93					
																					Beryllium	1.3*					
																					Bismuth	0.67*					
																					Cadmium	3.3*					
																					Chromium	3.3*					
																					Cobalt	3.3*					
																					Copper	3.3*					
																					Gallium	13*					
																					Germanium	0.67					
																					Iron	133					
																					Lead	3.3*					
																					Manganese	3.3*					
																					Molybdenum	0.67*					
																					Nickel	2.3					
																					Titanium	3.7					
																					Vanadium	2.5					
																					Zinc	13*					
15													0.05	1.3	0.5	0.14	0.30			0.6	Aluminum	72					
																					Beryllium	1.3*					
																					Bismuth	0.67*					
																					Cadmium	3.3*					
																					Chromium	3.3*					
																					Cobalt	3.3*					
																					Copper	6.7					
																					Gallium	13*					
																					Germanium	0.67*					
																					Iron	57					
																					Lead	3.3*					
																					Manganese	3.3**					
																					Molybdenum	0.67**					
																					Nickel	2.0					
																					Titanium	3.6					
																					Vanadium	2.0					
																					Zinc	13*					
22													0.06	1.8	1.2	0.21	0.54			0.6	Aluminum	75					
																					Beryllium	1.3*					
																					Bismuth	0.67*					
																					Cadmium	3.3*					
																					Chromium	3.3*					
																					Cobalt	3.3*					
																					Copper	11					
																					Gallium	13*					
																					Germanium	0.67*					
																					Iron	87					
																					Lead	3.3*					
																					Manganese	3.3*					
																					Molybdenum	0.67**					
																					Nickel	2.6					
																					Titanium	3.1					
																					Vanadium	2.3					
																					Zinc	13*					

*less than the amount indicated.
**equal to, but slightly less than the amount indicated.

TABLE 5 (cont.)

MINERAL ANALYSES OF LAKE STATIONS

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Mineral constituents in parts per million / equivalents per million																		Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$		Remarks
					Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org Nitrogen (N)	Ortho phosphate (PO_4)	Total + org. phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents				Total ppm	N.C. ppm	
24													0.10	1.8	0.4	0.18	0.26			0.6	Aluminum	73					
																					Beryllium	1.3*					
																					Bismuth	0.67*					
																					Cadmium	3.3*					
																					Chromium	3.3*					
																					Cobalt	3.3*					
																					Copper	12					
																					Gallium	13*					
																					Germanium	0.67*					
																					Iron	100					
																					Lead	3.3*					
																					Manganese	3.3*					
																					Molybdenum	0.67**					
																					Nickel	2.1					
																					Titanium	4.3					
																					Vanadium	2.5					
																					Zinc	13*					
28													0.01	1.8	0.4	0.17	0.30			0.7	Aluminum	67					
																					Beryllium	1.3*					
																					Bismuth	0.67*					
																					Cadmium	3.3*					
																					Chromium	3.3*					
																					Cobalt	3.3*					
																					Copper	16					
																					Gallium	13*					
																					Germanium	0.67*					
																					Iron	90					
																					Lead	3.3*					
																					Manganese	3.3*					
																					Molybdenum	0.67**					
																					Nickel	1.4					
																					Titanium	2.3					
																					Vanadium	2.8					
																					Zinc	13*					
																0.15	0.24										Filtered
30													0.05	0.4	1.5	0.02	0.34			0.8	Aluminum	93					
																					Beryllium	1.3*					
																					Bismuth	0.67*					
																					Cadmium	3.3*					
																					Chromium	3.3*					
																					Cobalt	3.3*					
																					Copper	17					
																					Gallium	13*					
																					Germanium	0.67*					
																					Iron	140					
																					Lead	3.3*					
																					Manganese	3.3**					
																					Molybdenum	0.67**					
																					Nickel	4.8					
																					Titanium	8.0					
																					Vanadium	3.0					
																					Zinc	13*					
																0.04	0.30										Filtered

*less than the amount indicated.
**equal to, but slightly less than the amount indicated.

TABLE 5 (cont.)

MINERAL ANALYSES OF LAKE STATIONS

CLE¥AR LAKE WATER QUALITY INVESTIGATION

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Mineral constituents in parts per million / equivalents per million																	Total dissolved solids in ppm	Per cent sodium	Hardness as $CaCO_3$		Remarks
					Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org. Nitrogen (N)	Ortho phosphate (PO_4)	Total + org. phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents			Total ppm	N.C. ppm	
4	6/8/65												0.05	0.4	0.6	0.07	0.20									
6													0.25	1.3	0.7	0.08	0.25									
12													0.00	0.9	0.6	0.10	0.19									
13													0.05	0.9	0.7	0.04	0.24									
15													0.01	0.9	0.7	0.06	0.24									
22													0.15	0.4	1.0	0.10	0.27									
24													0.22	1.8	0.5	0.11	0.21									
28													0.21	0.9	1.2	0.12	0.24									

TABLE 6

SPECIAL LAKE AND STREAM MINERAL ANALYSES
CLEAR LAKE WATER QUALITY INVESTIGATION

Mineral constituents in parts per million / equivalents per million

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org. Nitrogen (N)	Ortho phosphate (PO_4)	Total + org phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Remarks
14N/7W/ 31	2/20/64		306	8.2	26 / 1.30	16 / 1.32	10 / 0.44	2.0 / 0.05	0 / 0.00	166 / 2.72	4.1 / 0.08	7.4 / 0.21		1.9 / 0.03						0.9		189	14	131	0	Intake for Clearlake Oake Water District
14N/8W/ 32D	5/22/64		296	8.3	24 / 1.20	17 / 1.34	9.8 / 0.45	2.4 / 0.06	0 / 0.00	162 / 2.66	5.4 / 0.11	6.9 / 0.19		1.5 / 0.02					0.01	0.8	Aluminum 0.27 Arsenic 0.00 Lead 0.01 Manganese 0.00 Zinc 0.00 Total Iron 0.67	219	14	127	0	Gas seep in the Narrows
14N/8W/ 32D	6/16/64		332	6.7	27 / 1.35	18 / 1.47	13 / 0.56	2.6 / 0.07	0 / 0.00	180 / 2.95	7.9 / 0.16	7.6 / 0.21		0.0 / 0.00		0.10			0.05	1.3	Aluminum 0.64 Arsenic 0.00 Lead 0.01 Manganese 0.01 Zinc 0.10 Total Iron 0.58 Total Phosphate 0.13 ABS 0.0	208	16	141	0	Gas seep in the Narrows
13N/8W/ 5J	6/16/64		312	7.9	25 / 1.25	16 / 1.35	12 / 0.52	2.8 / 0.07	0 / 0.00	170 / 2.79	8.9 / 0.18	6.9 / 0.19		0.4 / 0.01		0.04			0.03	1.0	Aluminum 0.14 Arsenic 0.00 Lead 0.00 Manganese 0.00 Zinc 0.00 Total Iron 0.14 Total Phosphate 0.50 ABS 0.0	196	16	130	0	100 feet off shore - Horseshoe Cove
13N/8W/ 6B	6/16/64		1620	7.0	93 / 4.64	117 / 9.60	103 / 4.48	14 / 0.36	0 / 0.00	1040 / 17.04	0.0 / 0.00	66 / 1.86		0.0 / 0.00		0.345			0.01	15	Aluminum 0.03 Arsenic 0.03 Lead 0.00 Manganese 0.03 Zinc 0.03 Total Iron 20.0 Total Phosphate 0.01 ABS 0.0	1020	23	713	0	Big Soda Sprir in Soda Bay
14N/9W/ 32D	6/16/64		309	7.8	24 / 1.20	18 / 1.44	12 / 0.52	2.4 / 0.06	0 / 0.00	169 / 2.77	8.7 / 0.18	6.4 / 0.18		0.4 / 0.01		0.10			0.03	1.0	Aluminum 0.27 Arsenic 0.01 Lead 0.01 Manganese 0.00 Zinc 0.03 Total Iron 0.16 Total Phosphate 0.15 ABS 0.0	191	16	132	0	Spring in Clear Lake at Rancheria

TABLE 6 (cont.)

SPECIAL LAKE AND STREAM MINERAL ANALYSES

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Mineral constituents in parts per million / equivalents per million: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org. Nitrogen (N)	Ortho phosphate (PO_4)	Total + org. phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents	Total dissolved solids in ppm	Per cent sodium	Hardness as $CaCO_3$: Total ppm	N.C. ppm	Remarks
13N/7W/30H	6/16/64		326	7.6	25 / 1.25	17 / 1.43	13 / 0.56	2.9 / 0.07	0 / 0.00	178 / 2.92	7.9 / 0.16	6.9 / 0.19		0.3 / 0.00		0.11			0.04	1.1	Aluminum 0.18 Arsenic 0.00 Lead 0.00 Manganese 0.00 Zinc 0.02 Total Iron 0.27 Total Phosphate 0.59 ABS 0.0	205	17	134	0	100 feet off-shore from Jago Bay
13N/7W/29R	6/16/64		327	7.6	26 / 1.30	17 / 1.42	12 / 0.52	2.9 / 0.07	0 / 0.00	181 / 2.97	7.4 / 0.15	6.5 / 0.18		0.5 / 0.01		0.07			0.04	1.2	Aluminum 0.18 Arsenic 0.00 Lead 0.00 Manganese 0.03 Zinc 0.01 Total Iron 0.34 Total Phosphate 0.53 ABS 0.0	209	16	136	0	Outlet of Channel at Brown's Landing
15N/9W 30N	12/20/64		84	8.1	4.8 / 0.24	5.8 / 0.48	2.7 / 0.12	0.9 / 0.02	0 / 0.00	48 / 0.79	0 / 0.00	2.0 / 0.06		0.6 / 0.01				0.08		0.0		43	14	36	0	Runoff from lava rocks
15N/9W 29L	12/20/64		74	8.1	7.8 / 0.39	2.8 / 0.23	2.2 / 0.10	2.9 / 0.07	0 / 0.00	39 / 0.64	0.8 / 0.02	1.2 / 0.03		1.9 / 0.03				2.28		0.1		84	13	31	0	Rodman Slough at Bridge to Nice during height of storm
13N/8W 4M	3/26/65		4240	9.9	5.3 / 0.26	29 / 2.36	850 / 36.98	205 / 5.24	840 / 27.97	885 / 14.51	3.6 / 0.07	224 / 6.32		0 / 0.00			0.31	0.02		94		3060	82	131	0	Little Borax Lake
Adobe Creek	10/12/64	56											2.7	5.3	0.6		0.28									Soda Bay Road Bridge
	3/26/65	53	305	8.6	19 / 0.95	22 / 1.77	7.8 / 0.34	1.1 / 0.03	4.0 / 0.13	141 / 2.31	15 / 0.31	5.0 / 0.14		6.7 / 0.11	0.2		0.06	0.01		0.2		147	11	136	13	Soda Bay Road Bridge
Cole Creek	3/26/65		219	8.5	10 / 0.50	13 / 1.10	12 / 0.52	4.3 / 0.11	4.2 / 0.14	100 / 1.64	1.8 / 0.04	14 / 0.39		0.1 / 0.00		0.24		0.06		0.3		151	23	80	0	Soda Bay Road Bridge
Kelsey Creek	4/14/50		200	8.5	14 / 0.7	21 / 1.71	6.2 / 0.27		0 /	134 / 2.2	9.6 / 0.2	3.5 / 0.1		0.4 / 0.1						0.04		122	10	121	11	Soda Bay Road Bridge
	10/12/64	55											0	2.7	0.5		0.47									Soda Bay Road Bridge
	3/26/65	51	237	9.0	15 / 0.75	20 / 1.67	5.1 / 0.22	1.4 / 0.04	12 / 0.40	126 / 2.07	2.8 / 0.06	3.9 / 0.11		0.0 / 0.00			0.14	0.02		0.0		128	8	121	0	Soda Bay Road Bridge
Manning Creek	10/12/64	55											2.0	0.0	0.0		0.2									Kelseyville Highway Bridge
	3/26/65	52	350	9.0	15 / 0.75	26 / 2.17	14 / 0.61	1.2 / 0.03	11 / 0.36	128 / 2.10	38 / 0.79	9.8 / 0.28		0.1 / [illegible]			0.26	0.01		0.3		166		146	23	Kelseyville Highway Bridge

TABLE 6 (cont.)

SPECIAL LAKE AND STREAM MINERAL ANALYSES

CLEAR LAKE WATER QUALITY INVESTIGATION

Station	Date sampled	Temp in °F	Specific conductance (micromhos at 25°C)	pH	Mineral constituents in parts per million / equivalents per million: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Ammonium (NH_4)	Nitrate (NO_3)	Org. Nitrogen (N)	Orthophosphate (PO_4)	Total + org. phosphate (PO_4)	Dissolved Iron (Fe)	Copper (Cu)	Boron (B)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$: Total ppm	Hardness as $CaCO_3$: N.C. ppm	Remarks
Middle Creek	10/12/64	53											1.8	0.0	0.3		0.28									Highway 20 Bridge
	3/25/65	65	190	8.1	18 0.90	9.0 0.74	6.8 0.30	1.0 0.03	0 0.00	95 1.56	13 0.27	4.1 0.12		0.5 0.01			0.08	0.02		0.1		92	15	82	4	Highway 20 Bridge
Scott Creek	10/12/64	52											1.5	0.0	0.6		0.45									½ mile west of Saratoga Springs Road
	3/25/65	55	200	8.2	16 0.80	12 0.96	7.6 0.33	1.2 0.03	0 0.00	106 1.74	10 0.21	4.6 0.13		0.1 0.00			0.10	0.01		0.1		96	16	88	1	½ mile west of Saratoga Springs Road
Siegler Creek	2/20/64		522	8.4	24 1.20	36 2.94	27 1.17	4.9 0.12	6 0.20	239 3.92	10 0.21	37 1.04		1.3 0.02						2.0		321	22	207	1	at Lower Lake Road
	5/1/64		643	8.1	30 1.50	45 3.69	33 1.44	6.0 0.15	0 0.00	316 5.18	13 0.27	46 1.30		2.2 0.04						2.8	Alluminum 3.3* Beryllium 1.3* Bismuth 0.67* Cadmium 3.3* Chromium 3.3* Cobalt 3.3** Copper 5.3 Gallium 13* Germanium 0.67* Iron 11 Lead 3.3* Manganese 3.3* Molybdenum 0.67* Nickel 1.2 Titanium 1.3* Vanadium 4.0 Zinc 13*	387	21	260	1	at Lower Lake Road
Schindler Creek	10/12/64	52											0.9	1.8	0.8		0.97									Bridge in Clearlake Oaks

APPENDIX A

WATER QUALITY CRITERIA

WATER QUALITY CRITERIA

Criteria presented in the following sections can be utilized in evaluating mineral quality of water relative to existing or anticipated beneficial uses. It should be noted that these criteria are merely guides to the appraisal of water quality. Except for those constituents, which are considered toxic to human beings, these criteria should be considered as suggested limiting values. A water which exceeds one or more of these limiting values need not be eliminated from consideration as a source of supply, but other sources of better quality water should be investigated.

Domestic and Municipal Water Supply

The following tabulation gives the limiting concentrations of mineral constituents for drinking water, as prescribed by the United States Public Health Service.

UNITED STATES PUBLIC HEALTH SERVICE
DRINKING WATER STANDARDS
1962

Constituent	Mandatory Limit in ppm
Arsenic (As)	0.05
Barium (Ba)	1.0
Cadmium (Cd)	0.01
Hexavalent chromium (Cr^{+6})	0.05
Cyanide (CN)	0.2
Lead (Pb)	0.05
Selenium (Se)	0.01
Silver (Ag)	0.05

Constituent	Nonmandatory, but recommended limit
Alkyl benzene sulphonate (detergent)	0.5
Arsenic (As)	0.01
Carbon chloroform extract (exotic organic chemicals)	0.2
Chloride (Cl)	250
Copper (Cu)	1.0

UNITED STATES PUBLIC HEALTH SERVICE
DRINKING WATER STANDARDS
1962 (Continued)

Constituent	Nonmandatory, but recommended limit
Cyanide (CN)	0.01
Fluoride (F)	1.7
Iron (Fe)	0.3
Manganese (Mn)	0.05
Nitrate (NO_3)	45
Phenols	0.001
Sulfate (SO_4)	250
Total dissolved solids	500
Zinc (Zn)	5

In addition, the United States Public Health Service recently announced limits on concentrations of radioactivity in drinking waters. These limits are as follows:

Radionuclide	Recommended maximum limit micromicrocuries per liter
$Radium^{226}$	3
$Strontium^{90}$	10
Gross beta activity	1,000*

*In the known absence of $strontium^{90}$ and alpha emitters

Interim standards for certain mineral constituents have recently been adopted by the California State Board of Public Health. Based on these standards temporary permits may be issued for drinking water supplies failing to meet the United States Public Health Service Drinking Water Standards, provided the mineral constituents in the following table are not exceeded.

UPPER LIMITS OF TOTAL SOLIDS AND SELECTED MINERALS IN DRINKING WATER AS DELIVERED TO THE CONSUMER

	Permit	Temporary Permit
Total solids	500 (1000)**	1500 ppm
Sulfates (SO_4)	250 (500)**	600 ppm
Chlorides (Cl)	250 (500)**	600 ppm
Magnesium (Mg)	125 (125)	150 ppm

**Numbers in parentheses are maximum permissible, to be used only where no other more suitable waters are available in sufficient quantity for use in the system

The California State Board of Public Health has defined the maximum safe amounts of fluoride ion in drinking water in relation to mean annual temperature.

Mean annual temperature	Mean monthly fluoride ion concentration
50°F	1.5 ppm
60°F	1.0 ppm
70°F - above	0.7 ppm

Even though hardness of water is not included in the above standards, it is of importance in domestic and industrial uses. Excessive hardness in water used for domestic purposes causes increased consumption of soap and formation of scale in pipe and fixtures. The following tabulation for degrees of hardness has been suggested by the United States Geological Survey:

Range of Hardness, expressed as $CaCO_3$, in ppm	Relative classification
0 - 60	Soft
61 - 120	Moderately hard
121 - 200	Hard
Greater than 200	Usually requires softening

Industrial Water Supply

Water quality criteria for industrial waters are as varied and diversified as industry itself. Food processing, beverage production, pulp and paper manufacturing, and textile industries have exacting requirements. However, cooling or metallurgical operations permit the use of poor quality waters. In general, where a water supply meets drinking water standards, it is satisfactory for industrial use, either directly or following a limited amount of polishing treatment by the industry.

Irrigation Water

Criteria for mineral quality of irrigation water have been developed by the Regional Salinity Laboratories of the United States Department of

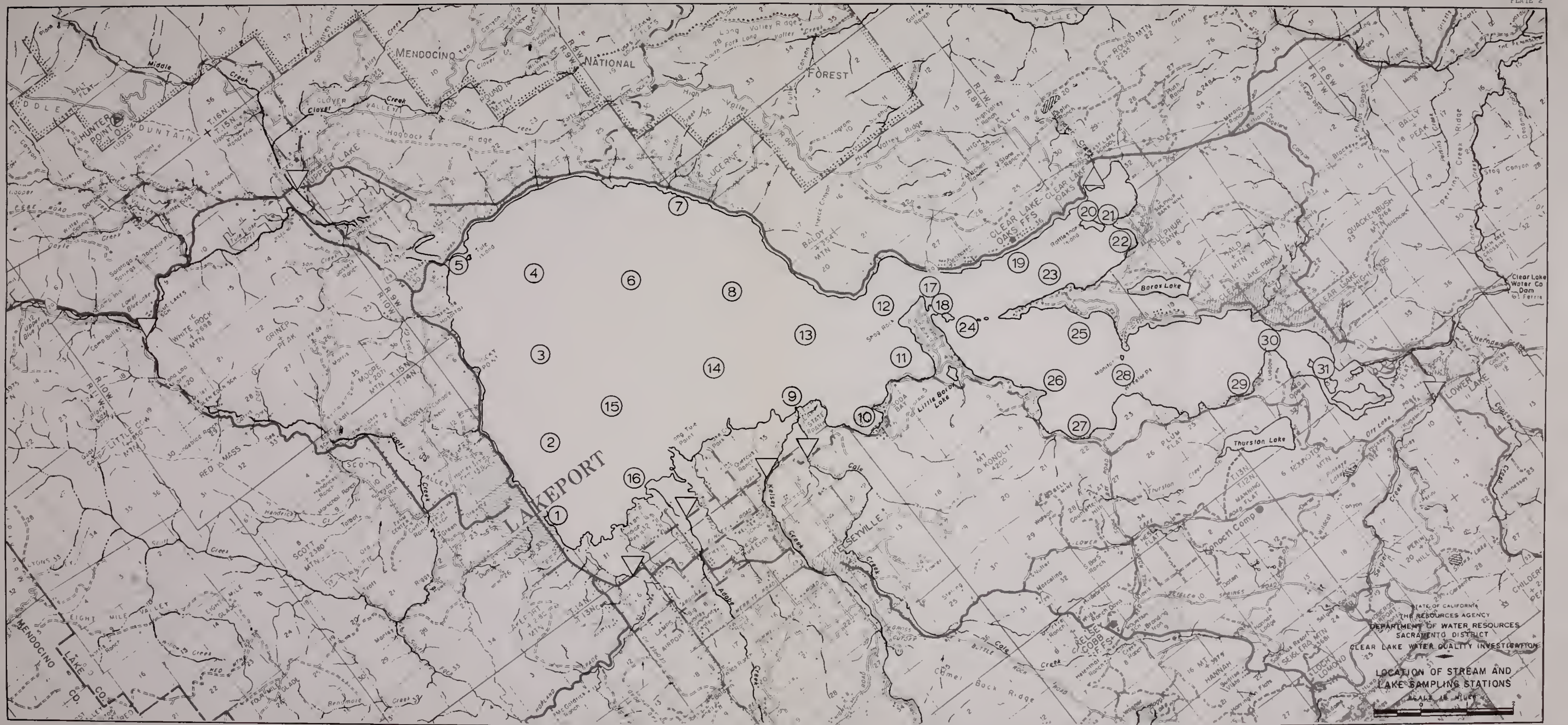
Agriculture in cooperation with the University of California. Because of diverse climatological conditions and the variation in crops and soils in California, only general limits of quality for irrigation waters can be suggested.

QUALITATIVE CLASSIFICATION OF IRRIGATION WATERS

Chemical properties	Class 1 Excellent to good	Class 2 Good to injurious	Class 3 Injurious to Unsatisfactory
Total dissolved solids, in ppm	Less than 700	700 - 2000	More than 2000
Conductance, in micromhos at 25°C	Less than 1000	1000 - 3000	More than 3000
Chlorides in ppm	Less than 175	175 - 350	More than 350
Sodium in percent of base constituents	Less than 60	60 - 75	More than 75
Boron in ppm	Less than 0.5	0.5 - 2.0	More than 2.0

These criteria have limitations in actual practice. In many instances a water may be wholly unsuitable for irrigation under certain conditions of use, and yet be completely satisfactory under other circumstances. Consideration also should be given to soil permeability, drainage, temperature, humidity, rainfall, and other conditions that can alter the response of a crop to a particular quality of water.

LEGEND
ROCK TYPES
Qal ALLUVIUM
Qv VOLCANIC
Kl LOWER CRETACEOUS SEDIMENTS
Kjf CRETACEOUS-JURASSIC KNOXVILLE & FRANCISCAN BEDS
S SERPENTINE
GEOLOGIC SYMBOLS
LITHOLOGIC CONTACT
FAULT
GAS SEEPS
THERMAL SPRINGS
VOLCANIC CONES
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SACRAMENTO DISTRICT
CLEAR LAKE WATER QUALITY INVESTIGATION
CLEAR LAKE DRAINAGE BASIN
WITH AREAL GEOLOGY
SCALE IN MILES
1 0 1 2
LAKEPORT
KELSEYVILLE
LUCERNE
UPPER LAKE
LOWER LAKE
Qal
Qv
Kjf
Kl
S
Camel Back Ridge
Lake County
Mendocino County
Sonoma County


STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SACRAMENTO DISTRICT
CLEAR LAKE WATER QUALITY INVESTIGATION
LOCATION OF STREAM AND
LAKE SAMPLING STATIONS
LAKEPORT
KELSEYVILLE
UPPER LAKE
LUCERNE
CLEAR LAKE OAKS
LOWER LAKE
MENDOCINO NATIONAL FOREST
Borax Lake
Thurston Lake
Little Borax Lake
SODA BAY
MT KONOCTI
SULPHUR BANK
CLEAR LAKE PARK
CLEAR LAKE HIGHLANDS
LAKE CO.
MENDOCINO
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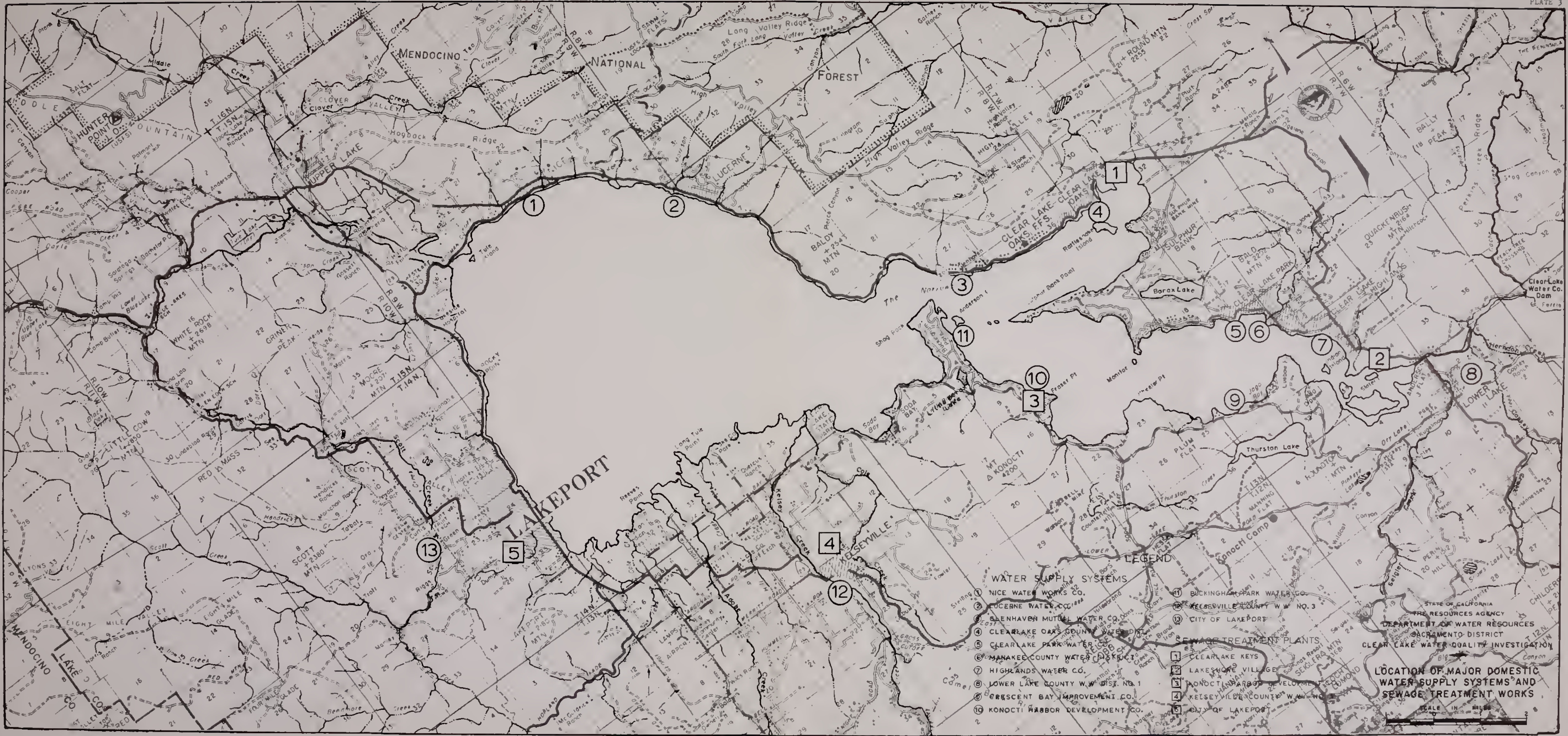
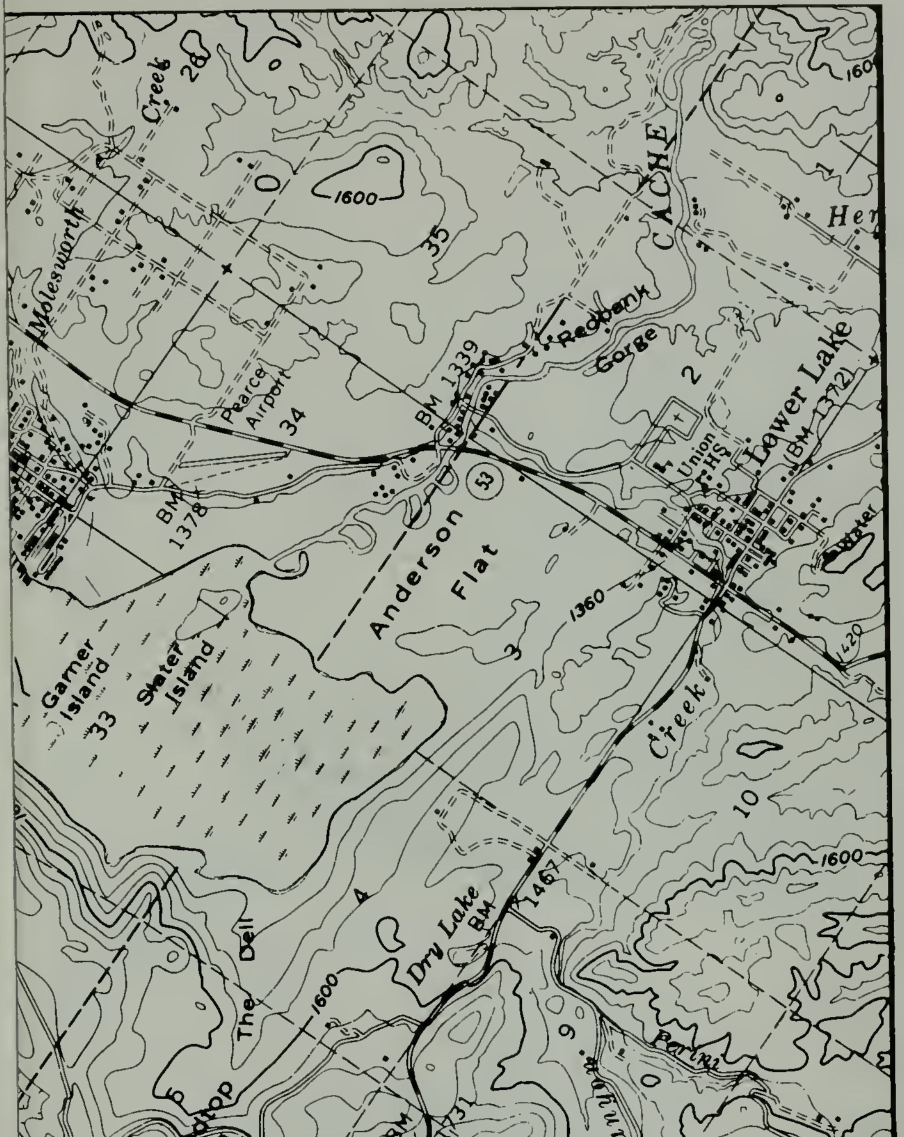

MENDOCINO NATIONAL FOREST
UPPER LAKE
LUCERNE
CLEAR LAKE OAKS
SULPHUR BANK
LAKEPORT
KELSEYVILLE
MT KONOCTI
LOWER LAKE
LEGEND
WATER SUPPLY SYSTEMS
① NICE WATER WORKS CO.
② LUCERNE WATER CO.
③ GLENHAVEN MUTUAL WATER CO.
④ CLEARLAKE OAKS COUNTY WATER DIST.
⑤ CLEARLAKE PARK WATER CO.
⑥ MANAKEE COUNTY WATER DISTRICT
⑦ HIGHLANDS WATER CO.
⑧ LOWER LAKE COUNTY W.W. DIST. NO. 1
⑨ CRESCENT BAY IMPROVEMENT CO.
⑩ KONOCTI HARBOR DEVELOPMENT CO.
⑪ BUCKINGHAM PARK WATER CO.
⑫ KELSEYVILLE COUNTY W.W. NO. 3
⑬ CITY OF LAKEPORT
SEWAGE TREATMENT PLANTS
1 CLEARLAKE KEYS
2 LAKESHORE VILLAGE
3 KONOCTI HARBOR DEVELOPMENT CO.
4 KELSEYVILLE COUNTY W.W. NO.
5 CITY OF LAKEPORT
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SACRAMENTO DISTRICT
CLEAR LAKE WATER QUALITY INVESTIGATION
LOCATION OF MAJOR DOMESTIC WATER SUPPLY SYSTEMS AND SEWAGE TREATMENT WORKS
SCALE IN MILES
0 1 2



water collected in the Oaks and Lower Arm
esents the surface sample and the lower
The samples in Konocti Bay were collected
r of the samples.

Figure 13. Boron concentrations (in ppm) of lake water collected in the Oaks and Lower Arm of Clear Lake. The upper figure represents the surface sample and the lower figure represents the bottom sample. The samples in Konocti Bay were collected on a different date than the remainder of the samples.