

# Contributions to the Hydrology of the United States 1956-59

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GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1460



UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

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# Chemical Character of Public Water Supplies of the Larger Cities of Alaska, Hawaii, and Puerto Rico, 1954

*By* E. W. LOHR

CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

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GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1460-A



**UNITED STATES DEPARTMENT OF THE INTERIOR**

**FRED A. SEATON, *Secretary***

**GEOLOGICAL SURVEY**

**Thomas B. Nolan, *Director***

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CONTRIBUTIONS TO THE HYDROLOGY OF THE UNITED STATES

CHEMICAL CHARACTER OF PUBLIC WATER SUPPLIES

OF THE LARGER CITIES OF

ALASKA, HAWAII, AND PUERTO RICO, 1954

By E. W. Lohr

ABSTRACT

Surface water and ground water used for the public supplies for the larger places in Alaska are mainly calcium bicarbonate in type. The concentration of dissolved solids ranges from about 16 to 450 ppm, and the hardness, from about 6 to 300 ppm. Most of the supplies receive no treatment other than chlorination. Supply systems of 13 places serve about 53,000 people, about two-fifths of the total population of the territory.

Surface water used for six public supplies in Hawaii range in dissolved solids from 33 to 78 ppm and in hardness from 10 to 35 ppm. Ground water used for six supplies range in dissolved solids from 78 to 411 ppm and in hardness from 37 to 117 ppm. The ground water generally is sodium bicarbonate or sodium chloride in type. Most of the supplies receive no treatment or only chlorination. Supply systems of 12 areas serve about 328,000 persons or 66 percent of the total population.

The water supplies of larger cities of Puerto Rico are bicarbonate in type and have moderate concentrations of dissolved solids and moderate hardness. They compare favorably in chemical quality with the supplies of the larger cities of the United States east of the Mississippi River. The average concentration of dissolved solids in 10 treated surface-water supplies ranges from 66 to 208 ppm, and the average hardness ranges from 20 to 152 ppm. The average concentration of dissolved solids and hardness in the three ground-water supplies are 352 and 300 ppm, respectively. Most of the supplies receive treatment in addition to chlorination. Supply systems in 25 places serve about 87 percent of the urban population of the island.

INTRODUCTION

The U. S. Geological Survey recently published (1954) two companion reports, Water-Supply Papers 1299 and 1300, entitled "The industrial utility of public water supplies in the United States, 1952." It was originally planned to include in this report data

relative to the public water supplies of the larger cities of the principal territories and possessions of the United States. To this end data were collected for the larger water supplies for Alaska, Hawaii, and Puerto Rico, concurrently with the collection of data for the larger cities of the United States. However, the compiled data for the United States were of such magnitude that they were divided and published in two parts. It was then considered advisable to publish data for the territories and possessions separately.

It is the purpose of this report to make available those data that were collected in Alaska, Hawaii, and Puerto Rico, during 1950-54. The data consist of the population (1950) of the selected cities or places, the population served, ownership, source and treatment of supplies, capacity of treatment plants, storage facilities for both raw and finished water, and chemical analyses of the water. Some of the compiled data may not be applicable to the systems and supplies at the present time, 1955.

### ACKNOWLEDGMENTS

G. W. Whetstone, district chemist, Palmer, Alaska, collected the data for the supplies in Alaska; C. S. Howard, then regional chemist, Salt Lake City, Utah, collected or made arrangements for the collection of most of the data for the supplies in Hawaii; and Sergio Cuevas, former executive director, Puerto Rico Aqueduct and Sewer Authority, furnished the data for the supplies in Puerto Rico. Grateful acknowledgment is made to them and others for assistance.

### ALASKA

Alaska, the largest territory of the United States in land area, covers 571,065 square miles, or more than twice the size of Texas. The population in 1950 was 128,643, of which about 27 percent was urban, that is, places having more than 2,500 inhabitants. Some of the urban places in Alaska do not have public water supplies in the accepted sense, having no common source of supply or distribution system.

The development and furnishing of public water supplies in Alaska are attendant with many difficulties because of climatic and physical conditions. Furnishing supplies in areas of very low temperatures and transmission of them in perennially frozen ground or permafrost are the main problems. The heaving or instability of the soil or tundra owing to alternate freezing and thawing may dislocate or bend water pipes. Provisions have to be made for warming the lines or circulating the water continu-

ously to prevent the lines from freezing. Many ingenious arrangements and devices are in use to provide public water supplies. Thus, the costs of constructing and maintaining a public water-supply system are much greater in areas of low temperatures than in areas of more temperate climate where the availability of the supply is not a problem.

Data are shown in the following pages for the supplies of 13 places that represent a population of about 53,000 or about two-fifths of the total population of the territory. Location of the places is shown on plate 1.

### QUALITY OF PUBLIC SUPPLIES

Both the surface and the ground water used for the larger public supplies are mainly bicarbonate in type. Calcium is the major cation, or basic constituent, and bicarbonate is the major anion or acidic constituent. Surface supplies are relatively low in dissolved solids and low in hardness, comparable in chemical composition to many of the surface supplies of the New England States and Washington and Oregon. The ground-water supplies contain moderate concentrations of dissolved solids and are moderately hard to hard. Only approximate values could be reported from the data available.

Table 1 shows the approximate average concentration of dissolved solids and average hardness of the supplies. The approximate average concentration of dissolved solids in the 8 untreated surface supplies and 6 untreated ground-water supplies is 50 and 200 ppm, and that of hardness is 34 and 152 ppm. Averages are shown for raw water only, as most of the supplies receive no treatment or only chlorination.

### TREATMENT OF THE SUPPLIES

Many of the public water supplies in Alaska receive no treatment. Those supplies taken from natural lakes and impounding reservoirs undergo natural purification in storage such as clarification and improvement in color and general sanitary quality. Supplies taken from wells, particularly from deep sources, generally are of better sanitary quality than untreated surface supplies provided the wells are of a type and construction in which surface contamination is eliminated or minimized.

Of the 14 supplies for the places included in the report, 7 received no treatment; 5, chlorination only; and 2, softening in addition to chlorination.

The treatment or purification of water supplies in cold climates presents a few problems that are not characteristic of

treatment or purification in more temperate climates. The problems usually are the physical characteristics of the water, bacterial activity, and the chemical activity of agents used in the treatment processes.

Table 1--Dissolved solids and hardness in large public supplies in Alaska

Place	Population served	Dissolved solids, raw water (parts per million)		Hardness as CaCO <sub>3</sub> (parts per million)		
				Surface supplies	Ground supplies	
		Surface supplies	Ground supplies	Raw water	Raw water	Finished water
Anchorage	14,600	75	--	60	--	--
Eastchester <sup>a</sup>	3,096	--	150	--	125	--
Fairbanks	5,771	--	200	--	160	81
Juneau.....	5,500	100	105	71	83	83
Ketchikan...	5,400	16	--	12	--	--
Kodiak .....	2,000	41	--	16	--	--
Mountain View <sup>a</sup>	2,880	--	155	--	128	--
Nome.....	1,876	--	450	--	300	70
Petersburg	1,619	16	--	6	--	--
Seward .....	2,000	90	--	70	--	--
Sitka .....	4,500	35	--	21	--	--
Spenard <sup>a</sup> ...	2,108	--	145	--	115	--
Wrangell ...	1,263	30	--	20	--	--
Total or average	52,613	b 50	b 200	b 34	b 152	

<sup>a</sup> Private well supplies.

<sup>b</sup> Approximate values only as some of the reported figures are not averages.



### ANCHORAGE (Population, 11,254)

Ownership: Municipal; also supplies Officers Trailer Court and a population outside the city limits. Total population supplied, about 14,600.

Source: Ship Creek (through intake about 8 miles above city, 65 percent of supply; and through pumping plant, railroad yards, 35 percent).

Treatment: Chlorination.

Raw-water storage: --

Finished-water storage: 200,000 gallons.

### ANALYSIS

(Analysis, in parts per million, by U. S. Geological Survey)

	Ship Creek <sup>a</sup> (raw water)		Ship Creek <sup>a</sup> (raw water)
Silica (SiO <sub>2</sub> ) .....	8.1	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.02	Total .....	53
Manganese (Mn) .....	--	Noncarbonate .....	14
Calcium (Ca) .....	16		
Magnesium (Mg) .....	3.3	Color .....	6
Sodium (Na) .....	3.2	pH .....	7.3
Potassium (K) .....		Specific conductance	
Carb.ate (CO <sub>3</sub> ) .....	0	(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	48	25°C) .....	115
Sulfate (SO <sub>4</sub> ) .....	18	Turbidity .....	--
Chloride (Cl) .....	1.5	Temperature (°F) .....	--
Fluoride (F) .....	--	Date of collection .....	July 21-26, 1951
Nitrate (NO <sub>3</sub> ) .....	.4		
Dissolved solids .....	75		

### Monthly determinations 1951

	Alkalinity as CaCO <sub>3</sub> (ppm)			pH			Hardness as CaCO <sub>3</sub> (ppm)			Turbidity		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water .....	57	68	36	--	7.9	7.2	60	68	39	--	--	--
Finished water .....	--	--	--	--	--	--	--	--	--	--	--	--

<sup>a</sup> Near Anchorage.

### EASTCHESTER (Population, 3,096)

Ownership: Private individuals.

Source: Private domestic wells.

Eastchester is an urban area near Anchorage. See Mountain View and Spenard for analyses of well supplies in the vicinity of Anchorage.

**FAIRBANKS**  
(Population, 5,771)

Ownership: Municipal; private.

Source: Municipal: 2 wells (1 and 2) each about 220 feet deep, just west of the center of town along the Chena River, reported to yield, 1,900 and 1,200 gpm. Emergency supply: dug well 53.5 feet deep owned by the Northern Commercial Co. and reported to yield 1,340 gpm. Private wells.

Treatment: Municipal supply: Softening and coagulation with lime and ferric sulfate, aeration, sedimentation, rapid sand filtration, and chlorination.

Rated capacity of treatment plant: 1,000,000 gpd (designed). One unit only of plant installed, 600,000 gpd (maximum).

Raw-water storage: --

Finished-water storage: --

At present there are 300 service outlets. Private wells are used for supplies by those not served by the municipal system.

The water is pumped from the municipal wells at a temperature of about 38°F, passed through the power plant condensers where the temperature ranges from 55° to 70°. Treatment follows.

The treated water is circulated continuously in the distribution lines to prevent freezing the lines which are for the most part laid in permafrost.

Thermistors have been installed and relevant temperature data are obtained at many points.

**ANALYSES**

(Analyses, in parts per million, by U. S. Geological Survey)

	Wells 1 and 2		Well on 2d Ave. (raw water)
	Raw water	Finished water	
Silica (SiO <sub>2</sub> ) .....	23	23	33
Iron (Fe) .....	2.9	.08	.86
Manganese (Mn) .....	.31	.00	--
Calcium (Ca) .....	44	18	54
Magnesium (Mg) .....	11	8.7	13
Sodium (Na) .....	5.6	5.3	7.6
Potassium (K) .....	3.3	3.0	
Carbonate (CO <sub>3</sub> ) .....	0	7	0
Bicarbonate (HCO <sub>3</sub> ) .....	176	57	209
Sulfate (SO <sub>4</sub> ) .....	19	25	21
Chloride (Cl) .....	1.5	7.8	7.5
Fluoride (F) .....	.3	.3	.1
Nitrate (NO <sub>3</sub> ) .....	.2	.2	.2
Dissolved solids .....	<sup>a</sup> 197	<sup>a</sup> 126	<sup>a</sup> 240
Hardness as CaCO <sub>3</sub> :			
Total .....	155	81	188
Noncarbonate .....	11	22	16
Color .....	110	0	Amber
pH .....	7.1	8.6	7.0
Specific conductance (micromhos at 25°C) .....	308	189	375
Turbidity .....	--	--	--
Temperature (°F) .....	38	--	38
Date of collection .....	July 27, 1954	July 27, 1954	Oct. 17, 1949

<sup>a</sup> Sum of determined constituents.

## FAIRBANKS, Analyses--Continued

	Wells 1 and 2		Well on 2d Ave. (raw water)
	Raw water	Finished water	
Depth (feet) .....	220		90
Diameter (inches) .....	24		48
Date drilled .....	--		--
Percent of supply .....	--		--

**JUNEAU**  
(Population, 5, 956)

Ownership: Juneau Water Co. supplies major part of the population. Total population supplied about 5, 500.

Source: Gold Creek; spring and small mountain stream.

Treatment: Chlorination on high-pressure system. None on low-pressure system.

Raw-water storage: 100,000 gallons (low-pressure system).

Finished-water storage: 1,000,000 gallons (high pressure system).

The city uses salt water for fire protection.

**ANALYSES**

(Analyses, in parts per million, by U. S. Geological Survey)

	Gold Creek <sup>a</sup>	Spring <sup>a</sup>	Spring and mountain stream <sup>a</sup>
Silica (SiO <sub>2</sub> ) .....	2.9	4.5	4.4
Iron (Fe) .....	.03	.04	.03
Manganese (Mn) .....	.0	.0	.0
Calcium (Ca) .....	31	29	23
Magnesium (Mg).....	4.4	2.6	2.1
Sodium (Na).....	1.3	1.9	1.7
Potassium (K) .....	1.0	1.7	1.4
Carbonate (CO <sub>3</sub> ) .....	0	0	0
Bicarbonate (HCO <sub>3</sub> ).....	67	88	69
Sulfate (SO <sub>4</sub> ).....	40	12	9.9
Chloride (Cl) .....	1.0	1.8	1.8
Fluoride (F) .....	.0	.1	.1
Nitrate (NO <sub>3</sub> ) .....	1.5	3.3	3.1
Dissolved solids .....	119	105	82
Hardness as CaCO <sub>3</sub> :			
Total .....	95	83	66
Noncarbonate .....	41	11	10
Color .....	3	3	5
pH.....	7.2	7.1	7.1
Specific conductance (micromhos at 25°C) .....	192	174	135
Turbidity .....	--	--	--
Temperature (°F) .....	39	39	44
Date of collection .....	Mar. 11, 1952	Feb. 18, 1952	Feb. 18, 1952

<sup>a</sup> Finished water.

## JUNEAU, Analyses--Continued

## Determinations by the Alaska Department of Health

	Alkalinity as CaCO <sub>3</sub> (ppm)			pH			Hardness as CaCO <sub>3</sub> (ppm)			Turbidity		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water.....	--	--	--	--	--	--	--	--	--	--	--	--
Finished water...	55	--	--	8.0	--	--	71	--	--	40	--	--

KETCHIKAN  
(Population, 5,305)

Ownership: Ketchikan Public Utilities; also supplies about 200 people outside the town limits. Total population supplied, about 5,400.

Source: Ketchikan Lake, 75 percent of supply; Carlanna Lake, 25 percent.

Emergency supply: Hoadley Creek.

Treatment: None.

Raw-water storage: 3,900,000,000 gallons. Major use is for the production of power.

## ANALYSES

(Analyses, in parts per million, by U. S. Geological Survey)

	Ketchi- kan Lake	Carlan- na Lake		Ketchi- kan Lake	Carlan- na Lake
Silica (SiO <sub>2</sub> ) .....	1.8	1.8	Hardness as CaCO <sub>3</sub> :		
Iron (Fe) .....	.05	.06	Total .....	4	4
Manganese (Mn) .....	.0	.0	Noncarbonate.....	0	2
Calcium (Ca) .....	1.0	.8	Color .....	25	20
Magnesium (Mg).....	.3	.4	pH .....	6.0	5.5
Sodium (Na) .....	1.1	.9	Specific conductance		
Potassium (K) .....	.5	.3	(micromhos at		
Carbonate (CO <sub>3</sub> ) .....	0	0	25°C) .....	12.9	16.6
Bicarbonate (HCO <sub>3</sub> ) .....	4	2	Turbidity .....	--	--
Sulfate (SO <sub>4</sub> ) .....	1.4	1.0	Temperature (°F)...	32	--
Chloride (Cl) .....	1.8	3.0	Date of collection...	Feb. 11, 1952	Feb. 11, 1952
Fluoride (F) .....	.1	.2			
Nitrate (NO <sub>3</sub> ) .....	.5	.3			
Dissolved solids.....	14	17			

## Determinations by the Alaskan Department of Health

	Alkalinity as CaCO <sub>3</sub> (ppm)			pH			Hardness as CaCO <sub>3</sub> (ppm)			Temperature		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water <sup>a</sup> .....	7	--	--	5.2	--	--	12	--	--	45	--	--
Raw water <sup>b</sup> .....	2	--	--	5.5	--	--	12	--	--	45	--	--

<sup>a</sup> Ketchikan Lake.

<sup>b</sup> Carlanna Lake.

**KODIAK**  
(Population, 1,710)

Ownership: Municipal. Total population supplied, about, 2,000.

Source: Two surface water reservoirs near the town.

Treatment: Chlorination.

Raw-water storage: Two reservoirs of about 5,000,000 and 40,000,000 gallons capacity.

**ANALYSIS**

(Analysis, in parts per million, by U. S. Geological Survey)

	Finished water		Finished water
Silica (SiO <sub>2</sub> ) .....	7.2	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.07	Total .....	16
Manganese (Mn) .....	--	Noncarbonate .....	3
Calcium (Ca) .....	4.3	Color .....	--
Magnesium (Mg) .....	1.4	pH .....	6.9
Sodium (Na) .....	6.7	Specific conductance	
Potassium (K) .....		(micromhos at	
Carbonate (CO <sub>3</sub> ) .....	0	25°C) .....	62.0
Bicarbonate (HCO <sub>3</sub> ) .....	16	Turbidity .....	--
Sulfate (SO <sub>4</sub> ) .....	3.3	Temperature (°F) .....	--
Chloride (Cl) .....	10	Date of collection .....	Aug. 8, 1949
Fluoride (F) .....	.1		
Nitrate (NO <sub>3</sub> ) .....	.1		
Dissolved solids .....	a 41		

<sup>a</sup> Sum of determined constituents.

**MOUNTAIN VIEW**  
(Population, 2,880)

Ownership: Private individuals.

Source: Private domestic wells.

Mountain View is a town near Anchorage. The analyses selected are intended to show the general quality of the well water in the Mountain View area.

**ANALYSES**

(Analyses, in parts per million, by U. S. Geological Survey)

	Well <sup>a</sup>	Well <sup>b</sup>		Well <sup>a</sup>	Well <sup>b</sup>
Silica (SiO <sub>2</sub> ) .....	18	16	Hardness as CaCO <sub>3</sub> :		
Iron (Fe) .....	.05	.04	Total .....	128	128
Manganese (Mn) .....	--	--	Noncarbonate .....	24	0
Calcium (Ca) .....	35	33	Color .....	--	--
Magnesium (Mg) .....	10	11	pH .....	--	--
Sodium (Na) .....	5.7	4.8	Specific conductance		
Potassium (K) .....	1.1	1.4	(micromhos at		
Carbonate (CO <sub>3</sub> ) .....	--	--	25°C) .....	--	--
Bicarbonate (HCO <sub>3</sub> ) .....	127	156	Turbidity .....	--	--
Sulfate (SO <sub>4</sub> ) .....	17	2.0	Temperature (°F) .....	--	--
Chloride (Cl) .....	11	2.0	Date of collection ...	Nov. 28, 1952	Dec. 3, 1952
Fluoride (F) .....	--	--			
Nitrate (NO <sub>3</sub> ) .....	1.9	.2			
Dissolved solids .....	<sup>c</sup> 163	<sup>c</sup> 147			

<sup>a</sup> Gateway Service Station, Palmer Highway, Mountain View.

<sup>b</sup> Sunset Trailer Court, Roosevelt Ave., Mountain View.

<sup>c</sup> Sum of determined constituents.

## MOUNTAIN VIEW, Analyses--Continued

	Well <sup>a</sup>	Well <sup>b</sup>
Depth (feet) .....	32	112
Diameter (inches).....	30	6
Date dug.....	1946	1952
Percent of supply .....	--	--

<sup>a</sup> Gateway Service Station, Palmer Highway, Mountain View.<sup>b</sup> Sunset Trailer Court, Roosevelt Ave., Mountain View.

NOME  
(Population, 1, 876)

Ownership: Pioneer Water Co.; Bronson Water Co.; and the United States Smelting, Refining and Mining Co. (Moonlight Water Co., furnishes water to the city during summer months).

Source: Pioneer Water Co., 1 well 68 feet deep and reported to yield 150 gpm; Bronson Water Co., 1 dug well 25 feet deep and reported to yield 200 gpm; Moonlight Water Co., Bourbon Creek well 20 feet deep and reported to yield 100 gpm.

Treatment: Softening and chlorination.

Rated capacity of treatment plant: --

Raw-water storage: --

Finished-water storage: --

The Moonlight Water Co. supply is pumped into town from about 3 miles north.

## ANALYSES

(Analyses, in parts per million, by U. S. Geological Survey)

	Well <sup>a</sup>		Well <sup>b</sup>	Bourbon Creek Well <sup>c</sup>
	Raw water	Finished water		
Silica (SiO <sub>2</sub> ) .....	9.5	12	7.1	5.1
Iron (Fe).....	.02	.03	.0	.01
Manganese (Mn) .....	.00	--	.0	.00
Calcium (Ca) .....	102	8.8	91	40
Magnesium (Mg) .....	9.7	1.4	23	3.1
Sodium (Na).....	37	173	50	2.3
Potassium (K) .....	1.6		1.7	.6
Carbonate (CO <sub>3</sub> ) .....	0	137	0	0
Bicarbonate (HCO <sub>3</sub> ).....	317	0	272	129
Sulfate (SO <sub>4</sub> ) .....	25	103	51	9.0
Chloride (Cl).....	69	48	119	3.5
Fluoride (F) .....	.0	.1	.0	.0
Nitrate (NO <sub>3</sub> ) .....	.4	.5	2.0	.4
Dissolved solids .....	431	514	479	129
Hardness as CaCO <sub>3</sub> :				
Total .....	294	28	322	113
Noncarbonate .....	34	0	98	7

<sup>a</sup> Pioneer Water Co.<sup>b</sup> Bronson Water Co.<sup>c</sup> Moonlight Water Co. (United States Smelting, Refining and Mining Co.).<sup>d</sup> Finished water.

## NOME, Analyses--Continued

	Well <sup>a</sup>		Well <sup>b</sup>	Bourbon Creek Well <sup>cd</sup>
	Raw water	Finished water		
Color.....	0	20	0	0
pH.....	7.4	10.8	7.4	6.8
Specific conductance (micromhos at 25°C) .....	730	1,100	883	235
Turbidity .....	--	--	--	--
Temperature (°F) .....	--	--	--	--
Date of collection .....	June 22, 1954	June 16, 1952	June 22, 1954	June 25, 1954
Depth (feet) .....	68	--	25	20
Diameter (inches) .....	--	--	60 by 60	36
Date drilled .....	1943	--	1948	1941
Percent of supply .....	--	--	--	--

<sup>a</sup> Pioneer Water Co.<sup>b</sup> Bronson Water Co.<sup>c</sup> Moonlight Water Co. (United States Smelting, Refining and Mining Co.)<sup>d</sup> Finished water.PETERSBURG  
(Population, 1,619)

Ownership: Municipal.

Source: Creek (unnamed) south of town.

Treatment: Chlorination (hypochlorites).

Raw-water storage: --

Finished-water storage: --

There are 474 service outlets (domestic and commercial).

## ANALYSIS

(Analysis, in parts per million, by U. S. Geological Survey)

	Creek (finished water)		Creek (finished water)
Silica (SiO <sub>2</sub> ) .....	2.9	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	--	Total .....	6
Manganese (Mn) .....	--	Noncarbonate .....	0
Calcium (Ca) .....	1.6		
Magnesium (Mg) .....	.4	Color .....	--
Sodium (Na) .....	3.0	pH .....	--
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....	0	(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	9	25°C).....	16.0
Sulfate (SO <sub>4</sub> ) .....	1	Turbidity .....	--
Chloride (Cl) .....	2	Temperature (°F).....	--
Fluoride (F) .....	--	Date of collection .....	Oct. 18, 1948
Nitrate (NO <sub>3</sub> ) .....	.9		
Dissolved solids .....	<sup>a</sup> 16		

<sup>a</sup> Sum of determined constituents.

## CONTRIBUTIONS TO HYDROLOGY

SEWARD  
(Population, 2, 114)

Ownership: Municipal (the town purchased the system from the Seward Water Co. January 1, 1952). Total population supplied, about 2,000.

Source: Small streams impounded (250 feet elevation above town). Gravity system.

Treatment: None.

Raw-water storage: --

## ANALYSIS

(Analysis, in parts per million, by U. S. Geological Survey)

	Streams (tap sample)		Streams (tap sample)
Silica (SiO <sub>2</sub> ) .....	5.3	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.02	Total .....	67
Manganese (Mn) .....	--	Noncarbonate .....	20
Calcium (Ca) .....	25		
Magnesium (Mg) .....	1.1	Color .....	5
Sodium (Na) .....	1	pH .....	7.4
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....		(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....		25°C) .....	142
Sulfate (SO <sub>4</sub> ) .....	57	Turbidity .....	--
Chloride (Cl) .....	16	Temperature (°F) .....	--
Fluoride (F) .....	1.8	Date of collection .....	Nov. 12,
Nitrate (NO <sub>3</sub> ) .....	.2		1951
Dissolved solids .....	1.5		
	88		

SITKA  
(Population, 1,985)

Ownership: Sitka Public Utilities. Population supplied outside of town limits about 2,400. Total population supplied, about 4,500.

Source: Cascade Creek, 75 percent of supply; Indian River, 25 percent of supply.

Emergency supply: Indian River (pumping station).

Treatment: Chlorination.

Raw-water storage: Some small storage above dam on Cascade Creek.

Finished-water storage: 100,000 gallons.

## ANALYSIS

(Analysis, in parts per million, by U. S. Geological Survey)

	Finished water		Finished water
Silica (SiO <sub>2</sub> ) .....	5.0	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.02	Total .....	19
Manganese (Mn) .....	.0	Noncarbonate .....	3
Calcium (Ca) .....	5.8		
Magnesium (Mg) .....	1.0	Color .....	5
Sodium (Na) .....	2.3	pH .....	6.9
Potassium (K) .....	.4	Specific conductance	
Carbonate (CO <sub>3</sub> ) .....	0	(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	19	25°C) .....	51.3
Sulfate (SO <sub>4</sub> ) .....	4.3	Turbidity .....	--
Chloride (Cl) .....	4.5	Temperature (°F) .....	32
Fluoride (F) .....	.1	Date of collection .....	Mar. 7,
Nitrate (NO <sub>3</sub> ) .....	.3		1952
Dissolved solids .....	35		



## SITKA, Analysis--Continued

Determinations by the Alaska Department of Health

	Alkalinity as CaCO <sub>3</sub> (ppm)			pH			Hardness as CaCO <sub>3</sub> (ppm)			Temperature		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water.....	8.5	--	--	6.8	--	--	21	--	--	--	40	--
Finished water....												

SPENARD  
(Population, 2, 108)

Ownership: Private individuals.

Source: Private domestic wells.

Spenard is a village in the vicinity of Anchorage. The analyses selected are intended to show the general character of the well supplies in the Spenard area.

## ANALYSES

(Analyses, in parts per million, by U. S. Geological Survey)

	Well a	Well b	Well c	Well d	Well e
Silica (SiO <sub>2</sub> ) .....	16	21	18	12	41
Iron (Fe) .....	.16	.26	.09	.11	--
Manganese (Mn) .....	--	--	--	--	--
Calcium (Ca) .....	19	24	26	30	30
Magnesium (Mg) .....	8.0	4.9	11	27	10
Sodium (Na) .....	3.3	1.7	8.1	14	6.2
Potassium (K) .....	1.4		1.9	2.4	1.7
Carbonate (CO <sub>3</sub> ) .....	--	--	--	--	--
Bicarbonate (HCO <sub>3</sub> ) .....	108	97	148	132	164
Sulfate (SO <sub>4</sub> ) .....	8	1.6	9.0	18	1.0
Chloride (Cl) .....	2	1.5	2.0	6	2.0
Fluoride (F) .....	--	.1	--	--	--
Nitrate (NO <sub>3</sub> ) .....	.5	.4	.2	.12	.4
Dissolved solids .....	f 111	f 103	f 149	f 187	f 173
Hardness as CaCO <sub>3</sub> :					
Total .....	81	80	110	186	116
Noncarbonate .....	0	1	0	78	0
Color .....	--	--	--	--	--
pH .....	--	--	--	--	--
Specific conductance (micromhos at 25°C) .....	--	--	--	--	--
Turbidity .....	--	--	--	--	--
Temperature (°F) .....	--	--	--	--	--
Date of collection .....	Dec. 10, 1952	July 12, 1950	Nov. 19, 1952	Nov. 19, 1952	Nov. 20, 1952

a Owner: M. W. Clark, Rogers Park, Galewood and Eastway Avenues.

b Spenard Road at Romig Park, Romig Park subdivision.

c Spenard Washeteria, Spenard Road.

d Spenard Cocktail Lounge, Spenard and Lena Roads.

e Woodland Park School, Woodland Park.

f Sum of determined constituents.

## CONTRIBUTIONS TO HYDROLOGY

## SPENARD, Analyses--Continued

	Well a	Well b	Well c	Well d	Well e
Depth (feet) .....	164	79	209	69	277
Diameter (inches).....	6	6	6	6	8
Date drilled .....	1951	1950	1952	1950	1952
Percent of supply .....	--	--	--	--	--

<sup>a</sup> Owner: M. W. Clark, Rogers Park. Galewood and Eastway Avenues.

<sup>b</sup> Spenard Road at Romig Park, Romig Park subdivision.

<sup>c</sup> Spenard Washeteria, Spenard Road.

<sup>d</sup> Spenard Cocktail Lounge, Spenard and Lena Roads.

<sup>e</sup> Woodland Park School, Woodland Park.

**WRANGELL**  
(Population, 1,263)

**Ownership: Municipal.**

Source: Creek and impounding reservoirs.

Treatment: None

Raw-water storage: 4,000,000 gallons.

## ANALYSIS

(Analysis, in parts per million, by U. S. Geological Survey)

	Raw water		Raw water
Silica (SiO <sub>2</sub> ) .....	0.4	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	2.0	Total .....	15
Manganese (Mn) .....	.0	Noncarbonate .....	5
Calcium (Ca) .....	3.5		
Magnesium (Mg) .....	.7	Color .....	5
Sodium (Na) .....	1.5	pH .....	6.1
Potassium (K) .....	.3	Specific conductance	
Carbonate (CO <sub>3</sub> ) .....	0	(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	12	25°C) .....	25.9
Sulfate (SO <sub>4</sub> ) .....	.6	Turbidity .....	--
Chloride (Cl) .....	1.0	Temperature (°F) .....	38
Fluoride (F) .....	.2	Date of collection .....	Feb. 3,
Nitrate (NO <sub>3</sub> ) .....	.9		1952
Dissolved solids .....	28		

### Determinations by the Alaska Department of Health

[illegible]

## HAWAII

The Territory of Hawaii comprises 8 main islands and several smaller ones in the northern Pacific Ocean just below the Tropic of Cancer, about 4,800 miles from San Francisco, Calif. The total land area is 6,407 square miles and the population, in 1950, was 499,794. The island of Hawaii, from which the territory takes its name, is the largest of the group, making up about two-thirds of the land area but having less than one-seventh of the population. All the islands are volcanic in origin, arising from a base of about 15,000 feet below sea level and reaching a maximum height of about 14,000 feet above sea level.

The territory is divided for census purposes into four counties, Hawaii, Honolulu, Kanai, and Maui (includes Kalawao County). Kalawao County in the Island of Molokai consists only of Kalaupapa Leper Settlement. Honolulu, on the Island of Oahu, is the chief city and includes one-half the total population of the territory.

Water-supply data are shown for 12 areas including cities, towns, villages, and districts representing about 328,000 persons or about 66 percent of the total population. Location of the places is shown in plate 1.

## QUALITY OF WATER

The surface waters used for six public supplies are characterized by low concentrations of dissolved solids and low hardness. The concentration of dissolved solids averages 54 ppm and the hardness averages 22 ppm. The ground water used for six public supplies has considerably higher concentrations of dissolved solids and greater hardness than the surface waters. The average concentrations of dissolved solids is 188 ppm and the average hardness is 66 ppm. Data relative to the dissolved solids and hardness of the supplies are shown in table 2.

The surface waters are not characterized by any one particular chemical type or class. Either sodium or calcium may be the predominant cation, and bicarbonate, sulfate, or chloride the principal anion. The ground water, however, generally can be described as principally of the sodium bicarbonate or sodium chloride type. This is especially true of the supplies of Honolulu.

The relatively high silica content of the water is associated with the lava rocks which are the principal aquifers.

The greater part of the chloride content of the shallow ground waters is likely due to the fact that the islands are oceanic and are affected by salt spray. The rain water falling on the islands

contains greater concentrations of chloride than the rain water on continental areas relatively short distances interior from the coastline. Chloride that occurs in the deeper ground water is probably associated with admixing of the fresh water and salt water near the interface between the fresh-water lens (basal ground water) and the underlying salt water.

### TREATMENT OF THE SUPPLIES

Most of the supplies, both surface and ground, receive no treatment or only chlorination either continuous or during emergencies. One surface supply is filtered through slow sand filters.

Table 2. --Dissolved solids and hardness in large public supplies of Hawaii

Place	Population served	Dissolved solids (parts per million)		Hardness as CaCO <sub>3</sub> (parts per million)	
		Surface supplies	Ground supplies	Surface supplies	Ground supplies
Hawaii County: Hilo	27,198	54		22	
Honolulu County:					
Honolulu	248,034	--	177	--	56
Wahiawa	8,369	--	154	--	40
Waipahu	7,169	--	411	--	117
Kauai County: Lihue District	6,000		141		69
Maui County:					
Kahului <sup>a</sup>	6,306				
Kaunakakai	973	56		10	
Lahaina	4,025	67		32	
Lanai City	2,900		170		79
Paia <sup>b</sup>	3,195	33		18	
Puunene	6,620	33		18	
Wailuku	7,424	78	78	35	37
Total or average	328,213	54	188	22	66

<sup>a</sup> Supplied by Wailuku.

<sup>b</sup> See Puunene for analysis.

**HILO, HAWAII COUNTY, HAWAII ISLAND**  
(Population, 27, 198)

Ownership: Municipal.

Source: Streams 80 percent of supply (95 percent, 1950); springs 20 percent; (5 percent, 1950). Emergency supply, 2 shallow wells.

Treatment: Chlorination.

Raw-water storage: 4, 190, 000 gallons.

Finished-water storage: None.

**ANALYSES**

(Analyses, in parts per million, by Department of Health, Honolulu, Hawaii)

	Stream supply <sup>a</sup>	Kaumana Springs		Stream supply <sup>a</sup>	Kaumana Springs
Silica (SiO <sub>2</sub> ) .....	7.2	19	<b>Hardness as CaCO<sub>3</sub>:</b>		
Iron (Fe) .....	.3	.1	<b>Total</b> .....	22	33
Manganese (Mn) .....	.0	.0	<b>Noncarbonate</b> .....	12	13
Calcium (Ca) .....	6.0	8.0			
Magnesium (Mg).....	1.8	3.0	<b>Color</b> .....	5	0
Sodium (Na) .....	8.4	6.8	<b>pH</b> .....	6.7	6.0
Potassium (K) .....			<b>Specific conductance</b> (micromhos at 25°C) .....	--	--
Carbonate (CO <sub>3</sub> ) .....	0	0	<b>Turbidity</b> .....	0	0
Bicarbonate (HCO <sub>3</sub> ) .....	12	24	<b>Temperature (°F)</b> ...	72	--
Sulfate (SO <sub>4</sub> ) .....	19	18	<b>Date of collection</b> ...	Mar. 19, 1951	Mar. 19, 1951
Chloride (Cl) .....	4.0	3.0			
Fluoride (F) .....	.1	.1			
Nitrate (NO <sub>3</sub> ) .....	.0	.3			
Dissolved solids.....	<sup>b</sup> 54	<sup>b</sup> 71			

<sup>a</sup> Reservoir No. 1.

<sup>b</sup> Sum of determined constituents.

**HONOLULU, HONOLULU COUNTY, OAHU ISLAND**  
(Population 248,034)

**Ownership:** Board of Water Supply, City and County of Honolulu.

**Source:** Three artesian well pumping stations, 39 percent of supply; 3 underground pumping stations, 54 percent; 7 spring and mountain tunnel systems, 7 percent. Emergency supply, 2 connections with the U.S. Navy water system. The 3 artesian well groups include 25 wells ranging in depth from 240 to 636 feet.

**Treatment:** Six of the 7 mountain sources are regularly chlorinated. The artesian well and underground pumping stations are equipped with chlorinators, which are not regularly used.

**Raw-water storage:** None except natural underground storage.

**Finished-water storage:** 22,060,000 gallons.

**ANALYSES**

(Analyses, in parts per million,  
by Board of Water Supply, City and County of Honolulu)

	Kaimuki pump low service	Beretania pump low service	Kalihi pump low service
Silica (SiO <sub>2</sub> ) .....	34	36	32
Iron (Fe) .....	<.02	<.02	<.02
Manganese (Mn) .....	<.03	<.02	<.02
Calcium (Ca) .....	6.8	6.2	10
Magnesium (Mg) .....	8.7	6.8	11
Sodium (Na) .....	49	37	37
Potassium (K) .....			
Carbonate (CO <sub>3</sub> ) .....	--	--	--
Bicarbonate (HCO <sub>3</sub> ) .....	81	76	70
Sulfate (SO <sub>4</sub> ) .....	10	5.8	8.7
Chloride (Cl) .....	56	38	59
Fluoride (F) .....	<.1	<.1	<.1
Nitrate (NO <sub>3</sub> ) .....	1.4	1.2	1.0
Dissolved solids .....	215	165	205
Hardness as CaCO <sub>3</sub> .			
Total .....	53	43	71
Noncarbonate .....	0	0	13
Color .....	1.3	0	0
pH .....	8.1	8.2	8.1
Specific conductance (micromhos at 25°C) .....	352	260	340
Turbidity .....	0	0	.5
Temperature (°F) .....	--	--	--
Date of collection .....	Oct. 17, 1950	Oct. 17, 1950	Oct. 17, 1950
Depth (feet) .....	240 - 308	533 - 636	360 - 490
Diameter (inches) .....	12	10 and 12	12
Date drilled .....	1898 - 1928	1895 - 1926	1900 - 1926
Percent of supply .....	10	18	11

## HONOLULU, HONOLULU COUNTY, OAHU ISLAND--Continued

## ANALYSES

(Analyses, in parts per million,  
by Board of Water Supply, City and County of Honolulu)

	Kalihi shaft 6	Halawa shaft 12	Waialae shaft 7
Silica (SiO <sub>2</sub> ) .....	38	41	38
Iron (Fe) .....	< .02	< .02	< .02
Manganese (Mn) .....	< .02	< .02	< .02
Calcium (Ca) .....	8.7	8.3	27
Magnesium (Mg) .....	9.1	7.4	26
Sodium (Na) .....	36	25	57
Potassium (K) .....			
Carbonate (CO <sub>3</sub> ) .....	--	--	--
Bicarbonate (HCO <sub>3</sub> ) .....	67	66	89
Sulfate (SO <sub>4</sub> ) .....	7.9	4.8	20
Chloride (Cl) .....	52	32	144
Fluoride (F) .....	< .1	< .1	< .1
Nitrate (NO <sub>3</sub> ) .....	.9	1.4	1.9
Dissolved solids .....	190	155	<sup>a</sup> 358
Hardness as CaCO <sub>3</sub> :			
Total .....	59	51	174
Noncarbonate .....	4	0	101
Color .....	0	0	0
pH .....	8.0	7.9	7.8
Specific conductance (micromhos at 25°C) .....	305	226	672
Turbidity .....	.5	1.0	1.6
Temperature (°F) .....	--	--	--
Date of collection .....	Oct. 17, 1950	Oct. 17, 1950	Oct. 16, 1950
Depth (feet) .....	--	--	--
Diameter (inches) .....	--	--	--
Date drilled .....	--	--	--
Percent of supply .....	26	27	1

<sup>a</sup> Sum of determined constituents.

## HONOLULU, HONOLULU COUNTY, OAHU ISLAND--Continued

## ANALYSES

(Analyses, in parts per million,  
by Board of Water Supply, City and County of Honolulu)

	Upper Nuuanu aerator	Lower Nuuanu aerator	Booth Spring	Makiki Spring
Silica (SiO <sub>2</sub> ) .....	7.8	12	20	18
Iron (Fe).....	.04	.01	.10	.01
Manganese (Mn).....	.01	< .01	< .02	< .01
Calcium (Ca) .....	2.3	5.1	20	20
Magnesium (Mg) .....	3.2	6.0	7.9	8.5
Sodium (Na).....	12	14	23	26
Potassium (K) .....				
Carbonate (CO <sub>3</sub> ) .....	--	--	--	--
Bicarbonate (HCO <sub>3</sub> ).....	23	40	120	126
Sulfate (SO <sub>4</sub> ) .....	2.7	8.8	4.3	4.4
Chloride (Cl).....	16	18	20	22
Fluoride (F) .....	< .1	< .1	< .1	< .1
Nitrate (NO <sub>3</sub> ) .....	.5	.2	.9	1.4
Dissolved solids .....	54	<sup>a</sup> 84	155	165
Hardness as CaCO <sub>3</sub> :				
Total .....	19	37	82	84
Noncarbonate .....	0	5	0	0
Color.....	.7	1.3	3.4	1.7
pH .....	7.1	6.9	7.8	7.9
Specific conductance (micromhos at 25° C) .....	92	143	266	284
Turbidity .....	0	0	1.5	0
Temperature (° F) .....	--	--	--	--
Date of collection .....	June 7, 1949	June 28, 1949	June 29, 1949	June 29, 1949
Depth (feet) .....	--	--	--	--
Diameter (inches) .....	--	--	--	--
Date drilled .....	--	--	--	--
Percent of supply .....	1	3	.5	.8

<sup>a</sup> Sum of determined constituents.WAHIAWA, HONOLULU COUNTY, OAHU ISLAND  
(Population, 8,369)

Ownership: Wahiawa Water Co.

Source: Two wells (330-3, 330-6) 880 and 990 feet deep; reported to yield 575 and 1,500 gpm.

Treatment: Usually none (standby chlorinator at wells). Routine chlorination where water from open reservoirs is used.

Raw-water storage: None.

Finished-water storage: Two reservoirs 4,000,000 and 5,000,000 gallons; tanks 130,000 gallons.



## WAHIAWA, HONOLULU COUNTY, OAHU ISLAND --Continued

## ANALYSES

(Analyses, in parts per million, by Department of Health, Honolulu, Hawaii)

	Well 330-3	Well 330-6		Well 330-3	Well 330-6
Silica (SiO <sub>2</sub> ) .....	79	41	Hardness as CaCO <sub>3</sub> :		
Iron (Fe) .....	.05	.1	Total .....	58	31
Manganese (Mn) .....	--	--	Noncarbonate.....	3	0
Calcium (Ca) .....	11	5.9	Color .....	0	0
Magnesium (Mg).....	7.4	3.3	pH .....	--	--
Sodium (Na) .....	15	29	Specific conductance		
Potassium (K) .....			(micromhos at		
Carbonate (CO <sub>3</sub> ) .....	0	0	25°C) .....	--	--
Bicarbonate (HCO <sub>3</sub> ) .....	67	72	Turbidity .....	0	0
Sulfate (SO <sub>4</sub> ) .....	8.7	4.0	Temperature (°F)...	--	--
Chloride (Cl) .....	22	21	Date of collection...	Jan. 19, 1949	Dec. 2, 1949
Fluoride (F) .....	.1	.1			
Nitrate (NO <sub>3</sub> ) .....	.9	.1			
Dissolved solids.....	<sup>a</sup> 179	<sup>b</sup> 141			
Depth (feet) .....				880	990
Diameter (inches).....				16	18
Date drilled .....				1941	1947
Percent of supply .....					

<sup>a</sup> Sum of determined constituents. Includes 1.9 ppm of Al<sub>2</sub>O<sub>3</sub>.<sup>b</sup> Sum of determined constituents. Includes 0.7 ppm of Al<sub>2</sub>O<sub>3</sub>.WAIPAHAU, HONOLULU COUNTY, OAHU ISLAND  
(Population, 7,169)

Ownership: Suburban Water System, City and County of Honolulu.

Source: Well (241) 205 feet deep.

Treatment: None.

Storage: 300,000 gallons.

## ANALYSIS

(Analysis, in parts per million, by Department of Health, Honolulu, Hawaii)

	Well 241		Well 241
Silica (SiO <sub>2</sub> ) .....	62	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.14	Total .....	117
Manganese (Mn) .....	--	Noncarbonate .....	44
Calcium (Ca) .....	20	Color .....	0
Magnesium (Mg) .....	16	pH .....	7.4
Sodium (Na) .....	81	Specific conductance	
Potassium (K) .....		(micromhos at	
Carbonate (CO <sub>3</sub> ) .....	0	25°C) .....	--
Bicarbonate (HCO <sub>3</sub> ) .....	87	Turbidity .....	0
Sulfate (SO <sub>4</sub> ) .....	40	Temperature (°F).....	--
Chloride (Cl) .....	132	Date of collection .....	Dec. 2, 1947
Fluoride (F) .....	.1		
Nitrate (NO <sub>3</sub> ) .....	5.3		
Dissolved solids .....	<sup>a</sup> 411		

<sup>a</sup> Includes 1.6 ppm of Al<sub>2</sub>O<sub>3</sub>.

## WAIPAHAU, HONOLULU COUNTY, OAHU ISLAND, Analysis--Continued

	Well 241
Depth (feet) .....	205
Diameter (inches) .....	12
Date drilled .....	1926
Percent of supply .....	100

**LIHUE DISTRICT, KAUAI COUNTY, KAUAI ISLAND**  
(Population, 6,760)

Ownership: The Lihue Plantation Co. Ltd., supplies Ahukini, Hanamaulu, part of Kapaia and part of Lihue. Total population supplied about 3,000. County of Kauai, Bureau of Water Works, supplies part of Kapaia and Lihue, and Nawiliwili. Total population supplied about 3,000. Total combined population supplied about 6,000.

Source: The Lihue Plantation Co. supply: Infiltration tunnel about 6,000 feet west of Lihue. Emergency supply: ditch (used only during periods of electric power failure).

County of Kauai supply: Infiltration tunnel about 4 miles west of Lihue.

Emergency supply: Lihue Plantation Co. supply. Yield from the tunnels is reported to be 2,080 and 500 gpm.

Treatment: None.

Storage: Lihue Plantation Co., tank 269,000 gallons.

**ANALYSES**

(Analyses, in parts per million, by Department of Health, Honolulu, Hawaii)

	Tap sample <sup>a</sup>	Tap sample <sup>b</sup>		Tap sample <sup>a</sup>	Tap sample <sup>b</sup>
Silica (SiO <sub>2</sub> ) .....	30	43	<b>Hardness as CaCO<sub>3</sub>:</b>		
Iron (Fe) .....	.04	.1	Total .....	59	79
Manganese (Mn) .....	0	0	Noncarbonate .....	2	1
Calcium (Ca) .....	7.6	11			
Magnesium (Mg) .....	9.3	12	Color .....	0	0
Sodium (Na) .....	19	14	pH .....	7.5	--
Potassium (K) .....			Specific conductance		
Carbonate (CO <sub>3</sub> ) .....	0	0	(micromhos at		
Bicarbonate (HCO <sub>3</sub> ) .....	67	93	25° C) .....	--	--
Sulfate (SO <sub>4</sub> ) .....	4.7	6.8	Turbidity .....	0	0
Chloride (Cl) .....	24	18	Temperature (° F) ...	--	--
Fluoride (F) .....	.4	.1	Date of collection ...	Apr. 8,	Feb. 7,
Nitrate (NO <sub>3</sub> ) .....	1.8	.6		1947	1950
Dissolved solids .....	<sup>c</sup> 130	<sup>c</sup> 152			

<sup>a</sup> At Ahukini, Lihue Plantation Co. system.

<sup>b</sup> At Nawiliwili, County of Kauai system.

<sup>c</sup> Sum of determined constituents.

**KAHULUI, MAUI COUNTY, MAUI ISLAND**  
(Population, 6,306)

Ownership: Maui County (see Wailuku).

**KAUNAKAKAI, MAUI COUNTY, MOLOKAI ISLAND**  
(Population, 973)

Ownership: Maui County.

Source: Makaelee Stream 74 percent of supply; Conant-Kawela well, 39 feet deep and reported to yield 477 gpm, 26 percent.

Treatment: None.

Storage: 80,000 gallons.

**ANALYSIS**

(Analysis, in parts per million, by Department of Health, Honolulu, Hawaii)

	Stream and well		Stream and well
Silica (SiO <sub>2</sub> ) .....	6.8	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	--	Total .....	10
Manganese (Mn) .....	0	Noncarbonate .....	0
Calcium (Ca) .....	2.4		
Magnesium (Mg) .....	1.0	Color .....	30
Sodium (Na) .....	15	pH .....	7.3
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....		(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	21	25°C) .....	--
Sulfate (SO <sub>4</sub> ) .....	3.1	Turbidity .....	10
Chloride (Cl) .....	17	Temperature (°F) .....	
Fluoride (F) .....	.3	Date of collection .....	Apr. 15,
Nitrate (NO <sub>3</sub> ) .....	.6		1947
Dissolved solids .....	<sup>a</sup> 56		

<sup>a</sup> Sum of determined constituents.

**LAHAINA, MAUI COUNTY, MAUI ISLAND**  
(Population, 4,025)

Ownership: Maui County.

Source: Kanaha Stream.

Treatment: None.

Storage: 718,000 gallons.

**ANALYSIS**

(Analysis in parts per million, by Department of Health, Honolulu, Hawaii)

	Kanaha Stream		Kanaha Stream
Silica (SiO <sub>2</sub> ) .....	20	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.1	Total .....	32
Manganese (Mn) .....	.0	Noncarbonate .....	2
Calcium (Ca) .....	8.0		
Magnesium (Mg) .....	3.0	Color .....	0
Sodium (Na) .....	4.9	pH .....	7.8
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....		(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	0	25°C) .....	--
Sulfate (SO <sub>4</sub> ) .....	37	Turbidity .....	0
Chloride (Cl) .....	4.3	Temperature (°F) .....	--
Fluoride (F) .....	8.0	Date of collection .....	Mar. 13,
Nitrate (NO <sub>3</sub> ) .....	.1		1951
Dissolved solids .....	--		
	<sup>a</sup> 67		

<sup>a</sup> Sum of determined constituents.

**LANAI CITY, MAUI COUNTY, LANAI ISLAND**  
(Population, 2,746)

Ownership: Hawaiian Pineapple Co. Ltd.; also supplies Harbor and about 50 people in other places. Total population supplied, about 2,900.

Source: Five deep irrigation wells (1 to 5), 63 percent of supply; tunnels, 21 percent; slope shaft and well, 16 percent.

Treatment: None.

Storage: 3,250,000 gallons.

The water from well 1 of the irrigation wells is not potable and this well is not connected to the potable supply system. For the year 1950 most of the domestic and industrial supply was furnished by the tunnels, well 2, and slope shaft and well.

**ANALYSIS**

(Analysis in parts per million, by Department of Health, Honolulu, Hawaii)

	Composite sample <sup>a</sup>		Composite sample <sup>a</sup>
Silica (SiO <sub>2</sub> ) .....	51	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.05	Total .....	79
Manganese (Mn) .....	0	Noncarbonate .....	17
Calcium (Ca) .....	12		
Magnesium (Mg) .....	11	Color .....	0
Sodium (Na) .....	16	pH .....	--
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....	0	(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	71	25°C) .....	--
Sulfate (SO <sub>4</sub> ) .....	15	Turbidity .....	0
Chloride (Cl) .....	29	Temperature (°F) .....	--
Fluoride (F) .....	.1	Date of collection .....	May 8, 1949
Nitrate (NO <sub>3</sub> ) .....	.4		
Dissolved solids .....	<sup>b</sup> 170		

<sup>a</sup> Underground, Maunalei Gulch and well 2, Kapohaku Gulch.

<sup>b</sup> Sum of determined constituents.

**PAIA, MAUI COUNTY, MAUI ISLAND**  
(Population, 3,195)

Ownership: Hawaiian Commercial Sugar Co., Ltd. (see Puunene).

Source: Wailoa Ditch.

Storage: 10,000 gallons.

For chemical analyses of water, see Puunene.

**PUUNENE, MAUI COUNTY, MAUI ISLAND**  
(Population, 6,620)

Ownership: Hawaiian Commercial Sugar Co., Ltd.

Source: Wailoa Ditch.

Treatment: Slow sand filtration.

Rated capacity of treatment plant: 2,000,000 gpd.

Raw-water storage: None.

Finished-water storage: 1,300,000 gallons.

Puunene town and part of Wailuku district added to Kahului village since 1940 to form Kahului city.

## PUUNENE, MAUI COUNTY, MAUI ISLAND--Continued

## ANALYSIS

(Analysis in parts per million, by Department of Health, Honolulu, Hawaii)

	Wailoa Ditch <sup>a</sup>		Wailoa Ditch <sup>a</sup>
Silica (SiO <sub>2</sub> ) .....	5.6	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.50	Total .....	18
Manganese (Mn) .....	---	Noncarbonate .....	9
Calcium (Ca) .....	1.6		
Magnesium (Mg) .....	3.5	Color .....	0
Sodium (Na) .....	2.4	pH .....	--
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....		(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	0	25°C) .....	--
Sulfate (SO <sub>4</sub> ) .....	11	Turbidity .....	0
Chloride (Cl) .....	5.8	Temperature (° F) .....	--
Fluoride (F) .....	8.0	Date of collection .....	Jan. 3,
Nitrate (NO <sub>3</sub> ) .....	.1		1949
Dissolved solids .....	.4		
	<sup>b</sup> 33		

<sup>a</sup> Finished water.<sup>b</sup> Sum of determined constituents.

## WAILUKU, MAUI COUNTY, MAUI ISLAND

(Population, 7, 424)

Ownership: Maui County; also supplies Kahului. Total population supplied, 13,730.

Source: Iao Tunnel, 64 percent of supply; Kinihapai Stream, 36 percent.

Treatment: Chlorination.

Raw-water storage: 2,000,000 gallons.

Finished-water storage: 1,000,000 gallons.

## ANALYSES

(Analyses, in parts per million, by Department of Health, Honolulu, Hawaii)

	Iao Tunnel	Kiniha- pai Stream		Iao Tunnel	Kiniha- pai Stream
Silica (SiO <sub>2</sub> ) .....	12	11	Hardness as CaCO <sub>3</sub> :		
Iron (Fe) .....	.1	.1	Total .....	37	35
Manganese (Mn) .....	0	0	Noncarbonate.....	6	0
Calcium (Ca) .....	9.0	9.0			
Magnesium (Mg).....	3.6	3.1	Color .....	0	0
Sodium (Na) .....	11	12	pH .....	8.0	7.8
Potassium (K) .....			Specific conductance		
Carbonate (CO <sub>3</sub> ) .....			(micromhos at		
Bicarbonate (HCO <sub>3</sub> ) .....	0	0	25°C) .....	--	--
Sulfate (SO <sub>4</sub> ) .....	38	48	Turbidity .....	0	0
Chloride (Cl) .....	12	11	Temperature (° F)...	--	--
Fluoride (F) .....	.1	.1	Date of collection...	Apr. 9,	Apr. 9,
Nitrate (NO <sub>3</sub> ) .....	0	0		1951	1951
Dissolved solids.....	<sup>a</sup> 78	<sup>a</sup> 78			

<sup>a</sup> Sum of determined constituents

## PUERTO RICO

Puerto Rico ranks third in land area and first in population among the territories and possessions of the United States. The land area is 3,423 square miles, and the population in 1950 was 2,210,703, of which about 40 percent was urban.

Before 1945 the water systems and the sanitary sewer systems were the property of the municipal governments. In 1945 a government instrumentality, the Puerto Rico Aqueduct and Sewer Service, now Authority, was created and took over control of these facilities. The construction and operation of these facilities have been greatly broadened and improved under the Authority.

Data are shown in this report for 12 public supplies, which also furnish 13 other places. The population thus served by these 25 public supplies is about 35 percent of the total population and about 87 percent of the urban population of the island. Location of the suburban areas is shown in plate 1.

## QUALITY OF WATER

The chemical quality of the larger supplies of Puerto Rico, as indicated by the compiled data, compares favorably with the larger public supplies of the United States east of the Mississippi River. In general, the water is of the bicarbonate type and has moderate concentrations of dissolved solids and moderate hardness. The concentrations of dissolved solids and the hardness are much higher, for the supplies described in the report, in the ground waters than in the surface waters.

Table 3 shows the concentration of dissolved solids in the finished water and the average hardness of the raw and finished water. The average concentration of dissolved solids in the finished surface-water supplies is about 140 ppm and in the ground-water supplies about 350 ppm. The average hardness of the raw and the finished surface-water supplies is about 93 and 95 ppm. The average hardness of the ground-water supplies is about 300 ppm.

## TREATMENT OF SUPPLIES

Treatment which includes coagulation, rapid sand filtration, and chlorination was given to 9 of the 14 large supplies in Puerto Rico. The treatment for two surface-water supplies consisted of plain sedimentation and chlorination. The three well supplies were chlorinated only.

## PUERTO RICO--Continued

Table 3--Dissolved solids and hardness in large public supplies in Puerto Rico

Place	Population served	Dissolved solids finished water (parts per million)		Hardness as CaCO <sub>3</sub> (parts per million)		
				Surface supplies		Ground supplies
		Surface supplies	Ground supplies	Raw water	Finished water	Finished water
Aguadilla	25,900	<sup>a</sup> 162		133	124	
Arecibo	29,500	<sup>a</sup> 153		130	129	
Caguas	39,500	101		60	56	
Cayey	18,900	<sup>a</sup> 208	394	<sup>a</sup> 130	<sup>a</sup> 130	<sup>a</sup> 244
Coamo	11,900	<sup>a</sup> 150		<sup>a</sup> 100	<sup>a</sup> 100	
Fajardo	18,900	<sup>a</sup> 66		<sup>a</sup> 20	<sup>a</sup> 20	
Guayama	19,408	115		35	52	
Humacao	15,750	109		68	64	
Manatí	10,350		288			231
Mayagüez	61,200	173		142	152	
Ponce	100,000	151	<sup>a</sup> 375	119	118	<sup>a</sup> 425
San Juan	429,100	150		82	104	
Total or Average	780,408	<sup>a</sup> 140	<sup>a</sup> 352	<sup>a</sup> 93	<sup>a</sup> 95	<sup>a</sup> 300

<sup>a</sup> Approximate value only, as some of the reported figures are not average.

**AGUADILLA**  
(Population, 18,276)

Ownership: Puerto Rico Aqueduct and Sewer Authority; also supplies about 2,500 people outside the city limits and the cities of Aguada and Moca. Total population supplied, about 25,900.

Source: Lago de Guajataca (Isabela irrigation district), impounding reservoir for power, irrigation, and water supply.

Treatment: Prechlorination, coagulation with alum, sedimentation, rapid sand filtration, and postchlorination.

Rated capacity of treatment plant: 2,000,000 gpd.

Raw-water storage: Lago de Guajataca, 7,000,000,000 gallons; at treatment plant, 350,000 gallons.

Finished-water storage: 1,380,000 gallons.

The water flows by gravity from the irrigation canal to the treatment plant.

**ANALYSIS**

(Analysis, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Finished water <sup>a</sup>		Finished water
Silica (SiO <sub>2</sub> ) .....	6.0	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.2	Total .....	108
Manganese (Mn) .....	--	Noncarbonate .....	22
Calcium (Ca) .....	39		
Magnesium (Mg) .....	2.5	Color .....	5
Sodium (Na) .....	16	pH .....	7.1
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....	--	(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	105	25°C) .....	--
Sulfate (SO <sub>4</sub> ) .....	24	Turbidity .....	1
Chloride (Cl) .....	22	Temperature (°F) .....	<sup>c</sup> 84
Fluoride (F) .....	0	Date of collection .....	Sept. 11-Oct.
Nitrate (NO <sub>3</sub> ) .....	.7		10, 1951
Dissolved solids .....	b 162		

Regular determinations at treatment plant

Year or period 1950-51	Alkalinity as CaCO <sub>3</sub> (ppm)			pH			Hardness as CaCO <sub>3</sub> (ppm)			Turbidity		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water.....	102	124	82	8.2	8.4	8.0	133	--	--	20	125	10
Finished water...	91	112	72	7.2	7.4	7.0	124	--	--	<1	<1	<1

<sup>a</sup> Monthly composite sample.

<sup>b</sup> Sum of determined constituents.

<sup>c</sup> Sept. 11-Oct. 10, 1951.



**ARECIBO**  
(Population, 28,659)

Ownership: Puerto Rico Aqueduct and Sewer Authority; also supplies about 800 people outside the city limits. Total population supplied about 29,500.

Source: Río Tanama.

Treatment: Prechlorination, coagulation with alum, sedimentation, rapid sand filtration, and postchlorination.

Rated capacity of treatment plant: 1,500,000 gpd.

Raw-water storage: At treatment plant, 260,000 gallons.

Finished-water storage: 850,000 gallons.

The water flows by gravity from the river to the treatment plant.

**ANALYSIS**

(Analysis, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Finished water		Finished water
Silica (SiO <sub>2</sub> ) .....	7.2	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.3	Total .....	111
Manganese (Mn) .....	--	Noncarbonate .....	15
Calcium (Ca) .....	42		
Magnesium (Mg) .....	1.6	Color .....	5
Sodium (Na) .....	11	pH .....	7.2
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....		(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	118	25°C).....	--
Sulfate (SO <sub>4</sub> ) .....	18	Turbidity .....	1
Chloride (Cl) .....	12	Temperature (°F).....	77
Fluoride (F) .....	.1	Date of collection .....	Sept. 12-Oct.
Nitrate (NO <sub>3</sub> ) .....	3.1		11, 1951
Dissolved solids .....	<sup>a</sup> 153		

Regular determinations at treatment plant

Year or period 1950-51	Alkalinity as CaCO <sub>3</sub> (ppm)			pH			Hardness as CaCO <sub>3</sub> (ppm)			Turbidity		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water.....	125	138	98	8.1	8.4	7.8	130	--	--	50	300	1
Finished water...	110	126	72	7.4	7.6	7.0	129	--	--	<1	<1	<1

<sup>a</sup> Sum of determined constituents.

**CAGUAS**  
(Population, 33,759)

Ownership: Puerto Rico Aqueduct and Sewer Authority; also supplies about 1,300 people outside the city limits and the city of Gurabo. Total population supplied, about 39,500.

Source: Río Quebradillas.

Treatment: Prechlorination, coagulation with alum, sedimentation, rapid sand filtration, and postchlorination.

Rated capacity of treatment plant: 2,000,000 gpd.

Raw-water storage: 350,000 gallons.

Finished-water storage: 3,200,000 gallons.

The water flows by gravity from the river to the treatment plant.

## CAGUAS--Continued

## ANALYSIS

(Analysis, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Finished water		Finished water
Silica (SiO <sub>2</sub> ) .....	5.8	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.1	Total .....	57
Manganese (Mn) .....	--	Noncarbonate .....	14
Calcium (Ca) .....	12		
Magnesium (Mg) .....	6.6	Color .....	<5
Sodium (Na) .....	14	pH .....	7.0
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....	--	(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	52	25°C).....	--
Sulfate (SO <sub>4</sub> ) .....	20	Turbidity .....	1
Chloride (Cl) .....	17	Temperature (°F) .....	79
Fluoride (F) .....	.2	Date of collection .....	Sept. 12-Oct.
Nitrate (NO <sub>3</sub> ) .....	--		11, 1951
Dissolved solids .....	a 101		

## Regular determinations at treatment plant

Year or period 1950-51	Alkalinity as CaCO <sub>3</sub> (ppm)			pH			Hardness as CaCO <sub>3</sub> (ppm)			Turbidity		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water.....	60	70	34	8.1	8.3	7.6	60	--	--	80	400	7
Finished water...	39	56	22	7.0	7.9	6.7	56	--	--	<1	<1	<1

<sup>a</sup> Sum of determined constituents.

## CAYEY

(Population, 18,429)

Ownership: Puerto Rico Aqueduct and Sewer Authority; also supplies about 500 people outside the city limits. Total population supplied, about 18,900.

Source: Santo Domingo Creek, 65 percent of supply; 2 wells (Muñoz Rivera and Polverín) 200 and 167 feet deep, 35 percent. The yield of the wells is reported to be 90 and 125 gpm, respectively.

Treatment: Chlorination.

Finished-water storage: 410,000 gallons.

The water from the creek flows by gravity to two covered concrete distribution reservoirs and is chlorinated as it enters the reservoirs. The water from one well is pumped to the distribution reservoirs; the water from the other well is pumped directly to high-service area, the water being chlorinated at the pump house.

## CAYEY--Continued

## ANALYSES

(Analyses, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Santo Domingo Creek	Polverín well		Santo Domingo Creek	Polverín well
Silica (SiO <sub>2</sub> ) .....	17	28	Hardness as CaCO <sub>3</sub> :		
Iron (Fe) .....		.1	Total .....	130	244
Manganese (Mn) .....	--	--	Noncarbonate.....	0	0
Calcium (Ca) .....	38	68	Color .....	10	5
Magnesium (Mg) .....	8.5	18	pH .....	8.0	7.8
Sodium (Na) .....	26	52	Specific conductance		
Potassium (K) .....			(micromhos at		
Carbonate (CO <sub>3</sub> ) .....	--	--	25°C) .....	--	--
Bicarbonate (HCO <sub>3</sub> ) .....	185	364	Turbidity .....	12	2
Sulfate (SO <sub>4</sub> ) .....	5.9	9.0	Temperature (° F)...	--	--
Chloride (Cl) .....	20	26	Date of collection...	Sept. 14-	Sept. 14-
Fluoride (F) .....	--	.1		Oct. 13,	23, 1951
Nitrate (NO <sub>3</sub> ) .....	--	13		1951	
Dissolved solids.....	<sup>a</sup> 208	<sup>a</sup> 394			
Depth (feet) .....					167
Diameter (inches).....					20-16-12
Date drilled .....					1945
Percent of supply .....					--

<sup>a</sup> Sum of determined constituents.

**COAMO**  
(Population, 11, 592)

Ownership: Puerto Rico Aqueduct and Sewer Authority; also supplies about 350 people outside the city limits. Total population supplied, about 11,900.

Source: Río Coamo.

Treatment: Chlorination, plain sedimentation.

Finished-water storage: 750,000 gallons.

The water from the river flows by gravity to five covered concrete distribution reservoirs, and is chlorinated as it enters. A filtration plant is under construction.

## COAMO--Continued

## ANALYSIS

(Analysis, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Coamo River		Coamo River
Silica (SiO <sub>2</sub> ) .....	23	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	--	Total .....	101
Manganese (Mn) .....	--	Noncarbonate .....	16
Calcium (Ca) .....	29		
Magnesium (Mg) .....	6.9	Color .....	25
Sodium (Na) .....	9.0	pH .....	7.3
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....	--	(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	104	25°C).....	--
Sulfate (SO <sub>4</sub> ) .....	5.8	Turbidity .....	15
Chloride (Cl) .....	20	Temperature (°F).....	--
Fluoride (F) .....	0	Date of collection .....	Sept. 15-Oct.
Nitrate (NO <sub>3</sub> ) .....	1.1		16, 1951
Dissolved solids .....	<sup>a</sup> 150		

<sup>a</sup> Sum of determined constituents.

FAJARDO  
(Population, 15,336)

Ownership: Puerto Rico Aqueduct and Sewer Authority; also supplies about 1,900 people outside the city limits and the city of Ceiba. Total population supplied, about 18,900.

Source: Río Fajardo.

Treatment: Prechlorination, coagulation with alum, sedimentation, and post-chlorination.

Rated capacity of treatment plant: 1,200,000 gpd.

Raw-water storage: At plant, 440,000 gallons.

Finished-water storage: 1,340,000 gallons.

The water from the river flows by gravity to the treatment plant. Top water from the sedimentation basins flows to a 2-compartment concrete distribution reservoir.

## ANALYSIS

(Analysis, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Finished water		Finished water
Silica (SiO <sub>2</sub> ) .....	11	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.1	Total .....	20
Manganese (Mn) .....		Noncarbonate .....	8
Calcium (Ca) .....	7.0		
Magnesium (Mg) .....	.6	Color .....	< 5
Sodium (Na) .....	12	pH .....	6.8
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....	--	(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	15	25°C).....	--
Sulfate (SO <sub>4</sub> ) .....	13	Turbidity .....	3
Chloride (Cl) .....	14	Temperature (°F).....	--
Fluoride (F) .....	.2	Date of collection .....	Sept. 10-Oct.
Nitrate (NO <sub>3</sub> ) .....	.6		9, 1951
Dissolved solids .....	<sup>a</sup> 66		

<sup>a</sup> Sum of determined constituents.

**GUAYAMA**  
(Population, 19,408)

Ownership: Puerto Rico Aqueduct and Sewer Authority.

Source: Lago Carite (Puerto Rico Water Resources Authority). Impounding reservoir for power, irrigation, and water supply; annual inflow 10,000,000,000 gallons.

Treatment: Prechlorination, coagulation with alum, sedimentation, rapid sand filtration, postchlorination, and stabilization with hydrate of lime.

Rated capacity of treatment plant: 1,500,000 gpd.

Raw-water storage: 370,000 gallons.

Finished-water storage: Three concrete reservoirs, 1,080,000 gallons.

The water is pumped from the irrigation canal to the treatment plant.

**ANALYSIS**

(Analysis, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Finished water		Finished water
Silica (SiO <sub>2</sub> ) .....	8.4	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.1	Total .....	44
Manganese (Mn) .....	--	Noncarbonate .....	3
Calcium (Ca) .....	12	Color .....	5
Magnesium (Mg) .....	3.3	pH .....	9.0
Sodium (Na) .....	17	Specific conductance	
Potassium (K) .....		(micromhos at	
Carbonate (CO <sub>3</sub> ) .....	--	25°C) .....	--
Bicarbonate (HCO <sub>3</sub> ) .....	49	Turbidity .....	1
Sulfate (SO <sub>4</sub> ) .....	16	Temperature (°F) .....	79
Chloride (Cl) .....	15	Date of collection .....	Oct. 30-Nov.
Fluoride (F) .....	--		7, 1951
Nitrate (NO <sub>3</sub> ) .....	.2		
Dissolved solids .....	115		

Regular determinations at treatment plant

Year or period 1950-51	Alkalinity as CaCO <sub>3</sub> ppm			pH			Hardness as CaCO <sub>3</sub> ppm			Turbidity		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water.....	36	40	32	7.3	7.6	7.1	35	--	--	25	80	20
Finished water...	50	55	45	9.2	9.5	9.0	52	--	--	<1	<1	<1

**HUMACAO**  
(Population, 10,851)

Ownership: Puerto Rico Aqueduct and Sewer Authority; also supplies about 1,750 people outside the city limits and the city of Las Piedras. Total population supplied, about 15,750.

Source: Río Humacao.

Treatment: Prechlorination, coagulation with alum, sedimentation, rapid sand filtration, and postchlorination.

Rated capacity of treatment plant: 1,000,000 gpd.

Raw-water storage: 310,000 gallons.

Finished-water storage: 760,000 gallons.

## HUMACAO--Continued

The water from the river flows by gravity to the treatment plant. The treated water is stored in a concrete distribution reservoir.

## ANALYSIS

(Analysis, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Finished water		Finished water
Silica (SiO <sub>2</sub> ) .....	13	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.1	Total .....	28
Manganese (Mn) .....	--	Noncarbonate .....	18
Calcium (Ca) .....	9.5		
Magnesium (Mg) .....	1.0	Color .....	5
Sodium (Na) .....	29	pH .....	7.1
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....		(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....		25°C) .....	--
Sulfate (SO <sub>4</sub> ) .....	33	Turbidity .....	1
Chloride (Cl) .....	16	Temperature (°F) .....	81
Fluoride (F) .....	.2	Date of collection .....	Sept. 11-Oct.
Nitrate (NO <sub>3</sub> ) .....	1.2		11, 1951
Dissolved solids .....	109		

## Regular determinations at treatment plant

Year or period 1950-51	Alkalinity as CaCO <sub>3</sub> ppm			pH			Hardness as CaCO <sub>3</sub> ppm			Turbidity		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water.....	46	72	20	7.8	8.2	7.5	68	--	--	130	1,100	10
Finished water...	25	42	6	7.0	6.6	6.4	64	--	--	<1	<1	<1

**MANATÍ**  
(Population, 10,092)

Ownership: Puerto Rico Aqueduct and Sewer Authority; also supplies about 250 people outside the city limits. Total population supplied, about 10,350.

Source: One well 210 feet deep; reported to yield 425 gpm. Auxiliary supply, 1 well 212 feet deep; reported to yield 400 gpm.

Treatment: Chlorination.

Finished-water storage: 580,000 gallons.

The chlorinated water is pumped to a 2-compartment concrete distribution reservoir.

## MANATÍ--Continued

## ANALYSIS

(Analysis, in parts per million, by Puerto Rico Aqueduct and Sewer Authority,

	Deep well		Deep well
Silica (SiO <sub>2</sub> ) .....	15	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.3	Total .....	231
Manganese (Mn) .....	--	Noncarbonate .....	12
Calcium (Ca) .....	63		
Magnesium (Mg) .....	18	Color .....	5
Sodium (Na) .....	17	pH .....	7.6
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....		(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	267	25° C).....	--
Sulfate (SO <sub>4</sub> ) .....	12	Turbidity .....	7
Chloride (Cl) .....	20	Temperature(° F) .....	--
Fluoride (F) .....	.2	Date of collection .....	Sept. 14-23,
Nitrate (NO <sub>3</sub> ) .....	8.8		1951
Dissolved solids .....	288		
Depth (feet) .....			210
Diameter (inches) .....			20-16
Date drilled .....			1947
Percent of supply .....			--

## MAYAGÜEZ

(Population, 58,944)

Ownership: Puerto Rico Aqueduct and Sewer Authority; also supplies about 2,300 people outside the city limits. Total population supplied, about 61,200.

Source: Río Yagüez. Auxiliary or emergency supply, pumping station in river bed near treatment plant.

Treatment: Prechlorination, coagulation with alum, sedimentation, rapid sand filtration, postchlorination.

Rated capacity of treatment plant: 3,600,000 gpd.

Raw-water storage: 580,000 gallons.

Finished-water storage: Concrete distribution reservoir, 1,870,000 gallons.

Water from the river flows by gravity to the treatment plant. The auxiliary supply is pumped.

## MAYAGÜEZ--Continued

## ANALYSIS

(Analysis, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Finished water		Finished water
Silica (SiO <sub>2</sub> ) .....	13	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.1	Total .....	96
Manganese (Mn) .....	--	Noncarbonate .....	38
Calcium (Ca) .....	25		
Magnesium (Mg) .....	8.1	Color .....	5
Sodium (Na) .....	13	pH .....	6.8
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....	--	(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	70	25°C).....	--
Sulfate (SO <sub>4</sub> ) .....	39	Turbidity .....	1
Chloride (Cl) .....	14	Temperature (°F).....	--
Fluoride (F) .....	.2	Date of collection .....	Aug. 1-31,
Nitrate (NO <sub>3</sub> ) .....	6.6		1951
Dissolved solids .....	173		

## Regular determinations at treatment plant

Year or period 1950-51	Alkalinity as CaCO <sub>3</sub> (ppm)			pH			Hardness as CaCO <sub>3</sub> (ppm)			Turbidity		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water.....	126	144	60	7.9	8.2	7.6	142	--	--	75	2,000	8
Finished water...	101	124	20	6.9	7.2	6.4	152	--	--	<1	<1	<1

## PONCE

(Population, 96,492)

Ownership: Puerto Rico Aqueduct and Sewer Authority; also supplies about 3,500 people outside the city limits. Total population supplied, about 100,000.

Source: Río Portugués, 52 percent of supply; 5 wells (Canas, Alhambra, Oliver, Ruíz Belvis, Morel Campos) 300, 300, 178, 160, and 300 feet deep and reported to yield 1,100, 900, 650, 500, and 1,400 gpm respectively, 48 percent of supply.

Treatment: River water: Prechlorination, coagulation with alum, sedimentation, rapid sand filtration, and postchlorination. Well water: chlorination.

Rated capacity of treatment plant: 4,000,000 gpd.

Raw-water storage: At plant, 820,000 gallons.

Finished-water storage: 5,200,000 gal. (main concrete distribution reservoir and high-service area reservoir of 30,000 gallons).

The water from the river flows by gravity to the treatment plant.



## PONCE--Continued

## ANALYSIS

(Analysis, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Rio Portugués <sup>a</sup>		Rio Portugués <sup>a</sup>
Silica (SiO <sub>2</sub> ) .....	13	Hardness as CaCO <sub>3</sub> :	
Iron (Fe) .....	.1	Total .....	87
Manganese (Mn) .....	--	Noncarbonate .....	18
Calcium (Ca) .....	26		
Magnesium (Mg) .....	5.4	Color .....	5
Sodium (Na) .....	11	pH .....	7.4
Potassium (K) .....		Specific conductance	
Carbonate (CO <sub>3</sub> ) .....		(micromhos at	
Bicarbonate (HCO <sub>3</sub> ) .....	84	25°C).....	--
Sulfate (SO <sub>4</sub> ) .....	20	Turbidity .....	0.6
Chloride (Cl) .....	15	Temperature (°F).....	79
Fluoride (F) .....	0	Date of collection .....	Aug. 1-31,
Nitrate (NO <sub>3</sub> ) .....	.6		1951
Dissolved solids .....	151		

## Regular determinations at treatment plant

	Alkalinity as CaCO <sub>3</sub> (ppm)			pH			Hardness as CaCO <sub>3</sub> (ppm)			Turbidity		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water.....	100	132	48	8.1	8.3	7.8	119	--	--	75	360	1
Finished water...	90	128	42	7.4	7.7	6.8	118	--	--	<1	<1	<1

<sup>a</sup> Finished water.

## ANALYSES

(Analyses, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Canas well	Ruiz Belvis well	Morel Campos well
Silica (SiO <sub>2</sub> ) .....	23	22	18
Iron (Fe) .....	.1	.1	.1
Manganese (Mn) .....	--	--	--
Calcium (Ca) .....	104	97	152
Magnesium (Mg).....	26	15	35
Sodium (Na).....	75	23	184
Potassium (K) .....			
Carbonate (CO <sub>3</sub> ) .....		--	--
Bicarbonate (HCO <sub>3</sub> ).....	314	242	324
Sulfate (SO <sub>4</sub> ).....	71	72	166
Chloride (Cl) .....	115	57	295
Fluoride (F) .....	0	.1	0
Nitrate (NO <sub>3</sub> ) .....	44	.3	84
Dissolved solids .....	<sup>a</sup> 613	<sup>a</sup> 406	<sup>a</sup> 1,090
Hardness as CaCO <sub>3</sub> :			
Total .....	366	304	523
Noncarbonate .....	109	105	258

<sup>a</sup> Sum of determined constituents.

## PONCE, Analyses--Continued

	Canas well	Ruiz Belvis well	Morel Campos well
Color .....	5	5	5
pH.....	7.0	7.4	7.1
Specific conductance (micromhos at 25°C) .....	--	--	--
Turbidity .....	1.5	1.0	.9
Temperature (°F) .....	81	81	81
Date of collection .....	Aug. 1-31, 1951	Aug. 1-31, 1951	Aug. 1-31, 1951
Depth (feet) .....	300	160	300
Diameter (inches) .....	33-20	16-12	20
Date drilled .....	1937	1946	1946
Percent of supply .....	--	--	--

SAN JUAN  
(Population, 224,767)

Ownership: Puerto Rico Aqueduct and Sewer Authority; also supplies about 26,500 people outside the city limits and Bayamón, Carolina, Cataño, Guaynabo, Loíza, Río Grande, Río Piedras, and Trujillo Alto. Total population supplied, about 429,100.

Source: Cidra Reservoir (Río Bayamón) 71 percent of supply; Río Grande de Loíza, 27 percent; and Río Piedras (stored in Las Curiás Reservoir), 2 percent.

Treatment: Cidra Reservoir water: Screening, prechlorination, coagulation with alum, sedimentation, rapid sand filtration, postchlorination, and addition of hydrated lime. Water from Río Grande de Loíza: Aeration, prechlorination, coagulation with alum, sedimentation, rapid sand filtration, postchlorination, and addition of hydrated lime. Water from Río Piedras: Prechlorination, coagulation with alum, sedimentation, pressure filtration, and postchlorination.

Rated capacity of treatment plants: Guaynabo plant, 26,000,000 gpd; Río Grande de Loíza plant, 30,000,000 gpd; Río Piedras plant, 6,000,000 gpd.

Raw-water storage: 1,900,000,000 gallons.

Finished-water storage: 20,000,000 gallons.

Cidra Reservoir water, collected in the upper third of the Río Bayamón watershed, flows in open channel to Aguas Buenas diversion dam where it enters a 36-inch gravity aqueduct to Guaynabo treatment plant, where it is treated. Water from Río Grande de Loíza is pumped through a 48-inch concrete transmission line to the Río Grande de Loíza plant, where it is treated. Water from Río Piedras flows from the storage reservoir to the treatment plant. This plant is operated only as an auxiliary.

## SAN JUAN--Continued

## ANALYSES

(Analyses, in parts per million, by Puerto Rico Aqueduct and Sewer Authority)

	Finished water <sup>a</sup>	Finished water <sup>b</sup>	Finished water <sup>c</sup>
Silica (SiO <sub>2</sub> ) .....	12	14	22
Iron (Fe) .....	.1	.1	.15
Manganese (Mn) .....	--	--	--
Calcium (Ca) .....	18	21	19
Magnesium (Mg).....	8.4	8.4	7.9
Sodium (Na).....	13	18	13
Potassium (K).....			
Carbonate (CO <sub>3</sub> ) .....	--	--	0
Bicarbonate (HCO <sub>3</sub> ).....	66	85	87
Sulfate (SO <sub>4</sub> ).....	22	17	15
Chloride (Cl) .....	20	27	15
Fluoride (F) .....	--	--	.0
Nitrate (NO <sub>3</sub> ) .....	3.1	0	.7
Dissolved solids .....	d <sub>157</sub>	d <sub>147</sub>	141
Hardness as CaCO <sub>3</sub> :			
Total .....	79	87	80
Noncarbonate .....	26	17	9
Color .....	< 5	0	2
pH.....	7.1	7.2	7.3
Specific conductance (micromhos at 25° C) .....	--	--	222
Turbidity .....	< 1	< 1	--
Temperature (° F).....	--	--	--
Date of collection .....	Sept. 1-30, 1951	Jan. 1-15, 1951	Spring 1953

## Regular determinations at treatment plant

Year or period 1950-51 <sup>e</sup>	Alkalinity as CaCO <sub>3</sub> (ppm)			pH			Hardness as CaCO <sub>3</sub> (ppm)			Turbidity		
	Av	Max	Min	Av	Max	Min	Av	Max	Min	Av	Max	Min
Raw water.....	58	102	16	7.4	8.2	6.6	82	--	--	210	3,000	20
Finished water...	50	86	8	7.5	8.2	6.0	104	--	--	<1	<1	<1

<sup>a</sup> Río Bayamón (Guaynabo plant).<sup>b</sup> Río Grande de Loíza.<sup>c</sup> Collected at San Patricio Hospital, Veterans Administration Center, San Juan, Puerto Rico. Analysis by U. S. Geological Survey.<sup>d</sup> Sum of determined constituents.<sup>e</sup> Loíza treatment plant.