

# Estimated Water Use in Puerto Rico, 1988-89

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## CONVERSION FACTORS, ABBREVIATED ELECTRICAL UNITS, AND ACRONYMS

	<b>Multiply</b>	<b>By</b>	<b>To obtain</b>
	acre	0.4047	hectare
	acre-foot	1,233	cubic meter
	cubic foot per second	0.02832	cubic meter per second
	foot	0.3048	meter
	gallon per day	3.785	liter per day
	gallon per minute	0.06308	liter per second
	million gallons per day	43.81	liter per second
	square mile	2.590	square kilometer

### Abbreviated electrical units used in this report:

GWh    gigawatthour  
 kWh    kilowatthour

### Acronyms used in this report:

MSHA    U.S. Mine Safety and Health Administration  
 PRASA    Puerto Rico Aqueduct and Sewer Authority  
 PRDNER    Puerto Rico Department of Natural and Environmental Resources  
 PRDOH    Puerto Rico Department of Health  
 PREPA    Puerto Rico Electric Power Authority  
 PREQB    Puerto Rico Environmental Quality Board  
 SWUDS    State Water-Use Data System  
 USGS    U.S. Geological Survey

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## Abstract

Water use during calendar years 1988 and 1989 was estimated for the 78 municipios of the Commonwealth of Puerto Rico. Eight offstream water-use categories considered during the study are public supply, domestic, commercial, industrial, mining, thermoelectric, livestock, and irrigation. Other water-use categories considered are hydroelectric, reservoir evaporation, and saline water used at thermoelectric powerplants as instream uses, and sewage treatment as a water-use related category.

Freshwater withdrawals for offstream use from surface water and ground water in Puerto Rico were 630 and 573 million gallons per day (Mgal/d) in 1988 and 1989, respectively. The largest amount of freshwater withdrawn (instream use) was for hydroelectric power generation—427 Mgal/d in 1988 and 533 Mgal/d during 1989. The largest amount of saline water withdrawn (instream use) was for thermoelectric power generation—1,603 Mgal/d in 1988 and 1,458 Mgal/d during 1989. Total discharge from public sewage-treatment facilities increased slightly from 98 Mgal/d in 1988 to 123 Mgal/d in 1989.

The mining activities, which in Puerto Rico are the production of sand and gravel, withdrew 2.6 Mgal/d of freshwater in 1988 and 1989. Livestock activities required 8.33 Mgal/d from surface-water and ground-water sources to meet the water requirements of 8.56 million animals reported in Puerto Rico in 1988 and 1989. About 27 percent of all freshwater withdrawals in 1988 and 1989 was for irrigation purposes.

## INTRODUCTION

The National Water-Use Information Program of the U.S. Geological Survey (USGS) is a Federal-State Cooperative Program designed to collect, store, and disseminate water-use information locally and nationwide. The program was implemented in Puerto Rico in 1980 to provide data for the management of the Commonwealth's water resources. Accurate information regarding the amount of water used, and where and how it is used is essential for planners and managers to adequately assess many of the critical water problems facing Puerto Rico.

The major objectives of the National Water-Use Program in Puerto Rico are to:

1. Maintain accountability of the water use;
2. Create a computerized data base for data entry and retrieval of water-use information at the local, regional, and national levels;
3. Collect water-use data of uniform quality;
4. Define new methodologies for obtaining high quality water-use data;
5. Present information and reports that will help in projecting the future water needs of Puerto Rico;
6. Identify water-use problems so that appropriate managements solutions can be determined; and
7. Improve the collection, analysis, and dissemination of water-use information.

In order to meet the general objectives of the Water-Use Program and to maintain an adequate data base, the USGS maintains cooperative agreements with the Puerto Rico Aqueduct and Sewer Authority (PRASA), the Puerto Rico Department of Natural and Environmental Resources (PRDNER), and the Puerto Rico Environmental Quality Board (PREQB) to compile water-use data.

## Purpose and Scope

This report presents estimates of the amount of water withdrawn, returned, and used from surface-water and ground-water sources for offstream and instream uses in Puerto Rico during 1988 and 1989. The eight categories of offstream water use include public supply, domestic, commercial, industrial, mining, thermoelectric power generation, livestock, and irrigation; three categories of instream use include hydroelectric power generation, reservoir evaporation, and saline water use at thermoelectric powerplants. Data for sewage-treatment water releases, a miscellaneous category related to water use, is provided.

Data were obtained from the PRASA, the PRDNER, the Puerto Rico Department of Health (PRDOH), the Tourism Company of Puerto Rico, the Puerto Rico Electric and Power Authority (PREPA), the U.S. Bureau of the Census, and the U.S. Mine Safety and Health Administration (MSHA).

Discussion about the sources and methods used to compile the data parallels the presentation and discussion of water-use data by category. Data tables are compiled by municipio, which constitute the basic political subdivision in Puerto Rico. All data are stored in a computerized storage-retrieval system, the State Water-Use Data System (SWUDS), which is administered by the USGS.

A number of terms are used throughout the body of this report that may be unfamiliar to the reader. Selected terms are highlighted in boldface type at their first usage in the text. Concise definitions of these selected terms are supplied in a glossary at the back of this report.

## Acknowledgments

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## SOURCES AND METHODS USED TO COMPILE WATER-USE DATA

Water-use estimates for a number of categories were compiled for each of the 78 **municipios** in Puerto Rico (fig. 1). During the study, eight **offstream** water-use categories were considered; these include public supply, **domestic, commercial, industrial, mining, thermoelectric power generation, livestock, and irrigation**. Also, three instream water-use categories—hydroelectric power generation, **reservoir evaporation**, and **saline water** withdrawals at thermoelectric powerplants—were considered. **Sewage treatment** was considered as a miscellaneous water-use related category. The sources and methods used to compile water-use data are different for each category and are described in the following sections.

### Public Supply and Sewage Treatment

Public supply includes freshwater withdrawals and deliveries to domestic, commercial, and industrial water-use customers, and **public uses** such as water for firefighting, street washing, municipal parks, and swimming pools. Data were obtained from monthly and annual reports prepared by the PRASA (Puerto Rico Aqueduct and Sewer Authority, 1988a, 1988b, 1989a, 1988b, and 1990).

Public-supply deliveries to commercial facilities include the water distributed by the PRASA to government installations. These data were supplied by the PRASA (Puerto Rico Aqueduct and Sewer Authority, 1989a and 1990). The domestic-use category includes **public-supply facilities**, which are not operated by the PRASA and are known as NON-PRASA systems. These systems serve more than 25 people or have a minimum of 15 hookups. These data were supplied by the PRDOH (Puerto Rico Department of Health, 1988 and 1989).

The **surface-water** public-supply population was calculated by dividing surface-water withdrawals by total withdrawals, and then multiplying the quotient by the total public-supply population (PRASA + NON-PRASA population). The **ground-water** public-supply population was estimated by subtracting the population served by surface-water systems from the total public-supply population. Water used per day per person (**per capita water use**) was estimated by dividing the population using potable water by the annual domestic



water use. This total was divided by the number of days in a year. These calculations yield a water-use estimate of 45 gallons per day per person (gal/d/p) in Puerto Rico.

The sewage-treatment category contains information on the amount of water returned to the hydrologic system by sewage-treatment facilities and the number of public facilities that treat **wastewater**. Return flows from domestic, commercial, and industrial users served by public-supply systems were obtained from annual reports prepared by the PRASA (Puerto Rico Aqueduct and Sewer Authority, 1988b and 1989b). These annual reports indicate the number of public sewage-treatment facilities and the volume of **sewage** treated by municipio.

### Self-Supplied Domestic and Commercial

**Withdrawals** of self-supplied domestic water were estimated by multiplying the population not served by a public-supply system in each municipio by the per capita water-use estimate of daily water consumption. The self-supplied domestic population was determined by subtracting the public-supplied population, served by the PRASA and NON-PRASA systems, from the total population. Total population by municipio for 1988 and 1989 was estimated using the Census of Population and Housing for 1980 and 1990 (U.S. Department of Commerce, 1982 and 1991).

Annual withdrawals of self-supplied commercial water were estimated only for hostelrys throughout Puerto Rico. These withdrawals were calculated by multiplying the number of rooms in hotels and motels on the island by 125 gal/d per room (Metcalf and Eddy, 1972), assuming an occupancy of one person per room per day throughout the entire year. The number of hotels and motels was obtained from the Tourism Company of Puerto Rico (Tourism Company of Puerto Rico, 1991).

### Self-Supplied Industrial and Mining

Annual withdrawals of self-supplied industrial surface water and ground water were estimated from the PRDNER files. These files contain the self-supplied users and the amount of water used by each industry.

The 1988 and 1989 fresh surface-water and ground-water withdrawals used for mining purposes were obtained from the Permits and Franchises Division of the PRDNER and from an inventory of sites conducted by the MSHA. The water withdrawals were determined only for sand and gravel quarries, which are the primary mining activities in Puerto Rico.

### Thermoelectric and Hydroelectric

**Freshwater** use from public supply for the Puerto Nuevo and Palo Seco thermoelectric powerplants; from self-supplied ground-water withdrawals at the Aguirre and Costa Sur powerplants, and the instream saline water use (seawater withdrawals) was obtained from reports prepared by the PREPA. Most of the saline water withdrawn by thermoelectric powerplants is used for cooling purposes.

The total annual amounts of **instream water use** by hydroelectric powerplants throughout Puerto Rico during 1988 and 1989 were obtained from monthly power generation reports by the PREPA. The amount of **hydroelectric power water use** was obtained from the amount of power generated by each powerplant on a monthly basis. The following equation was used to obtain monthly instream water use.

$$\text{Water Use} = P * F / N, \quad (1)$$

where

*P* is the gross power generation, in kWh;

*F* is a specific factor for each reservoir, given the relation between monthly energy production versus instream water requirement, in acre-ft per kWh; and

*N* is the number of days in a month.

### Livestock

**Livestock** in Puerto Rico totaled 8,557,316 animals, according to the 1987 Census of Agriculture (U.S. Department of Commerce, 1989b). The fresh surface-water and ground-water withdrawals used for livestock watering purposes are presented in two subcategories: (1) the water associated with the production of red meat, poultry, eggs, and milk, called "stock" water use; and (2) the "animal specialties" water

use, which includes the water associated with the production of fur-bearing animals, horses, rabbits, and aquaculture (fish farms).

Total freshwater withdrawals for livestock were estimated by multiplying the number of animals in each municipio by the estimated daily amount of water required per animal. Total water use for livestock was estimated by multiplying the daily average watering requirements per animal (Kirk and others, 1982) (table 1) by the total number of animals reported in the agricultural census. **Consumptive use** for the livestock category was estimated to be 100 percent.

### Irrigation

The amount of water withdrawn from ground-water wells or the water diverted from irrigation canals for **irrigation** purposes was estimated by multiplying a factor of 1,933 gallons per day per acre (F. Gómez-Gómez, U.S. Geological Survey, oral commun., 1991) by the number of acres of land irrigated. The 1987 Census of Agriculture (U.S. Department of Commerce, 1989b) provided the number of acres irrigated. The water withdrawn from the irrigation canals for public supply was subtracted from the water withdrawn from reservoirs used in irrigation networks because irrigation canals are also used as source of public supply.

### Reservoir Evaporation

The evaporation from a reservoir is considered to be a consumptive use associated with the storage of water. Reservoir evaporation was calculated for the anthropogenic impoundments, which have a normal

capacity equal to or greater than 5,000 acre-feet. The annual water loss to evaporation for 14 reservoirs throughout Puerto Rico was calculated using the following equation:

$$RE = RA * PE * K, \quad (2)$$

where

*RE* is the reservoir evaporation, in thousands of acre-feet per year;

*RA* is the reservoir area, in thousands of acres;

*PE* is the class A annual pan evaporation, in feet; and

*K* is a constant, equal to 0.7.

The surface area for each reservoir was obtained from the PREPA and the PRDNER. Reservoir levels were assumed to be at the spillway elevation. Class A pan evaporation was taken from the National Oceanic and Atmospheric Administration data (U.S. Department of Commerce, 1988 and 1989a)

## WATER USE BY CATEGORY

Freshwater withdrawals from surface-water and ground-water sources for 1988 totaled 630 Mgal/d. Surface-water withdrawals totaled 461 Mgal/d and ground-water withdrawals totaled 169 Mgal/d. Freshwater withdrawals from surface-water and ground-water sources during 1989 totaled 573 Mgal/d. Surface-water withdrawals totaled 444 Mgal/d and ground-water withdrawals totaled 129 Mgal/d (fig. 2).

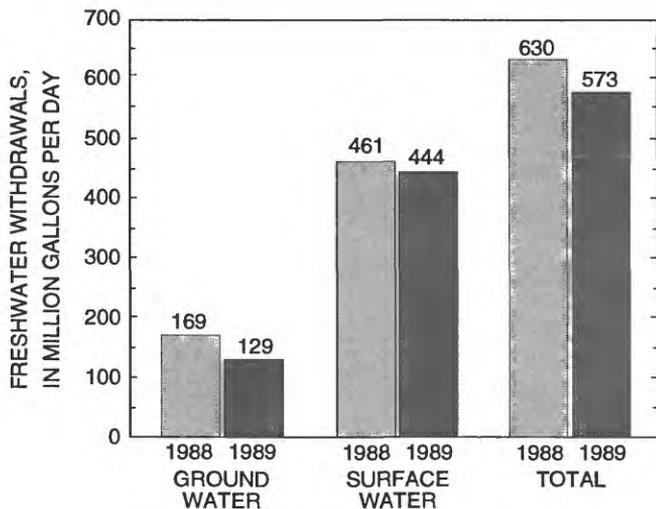
### Public Supply and Sewage Treatment

Freshwater withdrawals by public-supply facilities from surface-water and ground-water sources totaled 420 Mgal/d during 1988 and 398 Mgal/d during 1989. The largest public-supply withdrawal was about 75 Mgal/d from the Sergio Cuevas facility at Trujillo Alto (tables 2 and 3). This facility provides water to the municipios of Trujillo Alto, Caguas, Carolina, San Juan, Guaynabo, and Cataño. Culebra is the only municipio that obtains its public supply from a seawater desalination plant.

**Table 1.** Daily livestock water requirements

[gal/d, gallon per day]

Livestock	Water required (gal/d)
Dairy cows.....	35
Cattle, horses, mules.....	12
Hogs.....	4
Sheep, goats.....	2
Rabbits.....	1
Chickens.....	.06

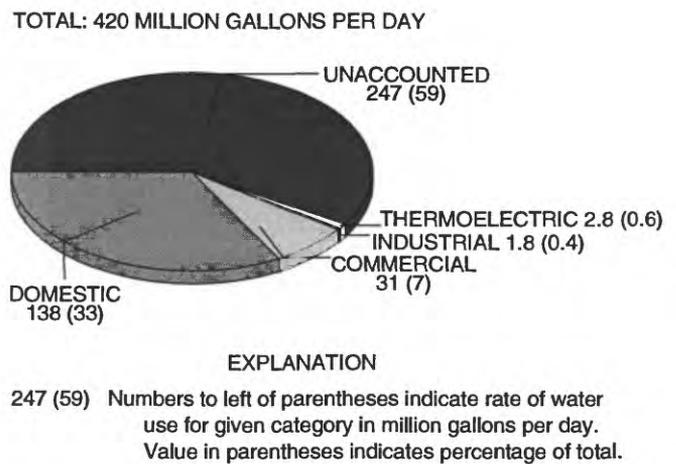


**Figure 2.** Freshwater withdrawals in Puerto Rico during 1988 and 1989.

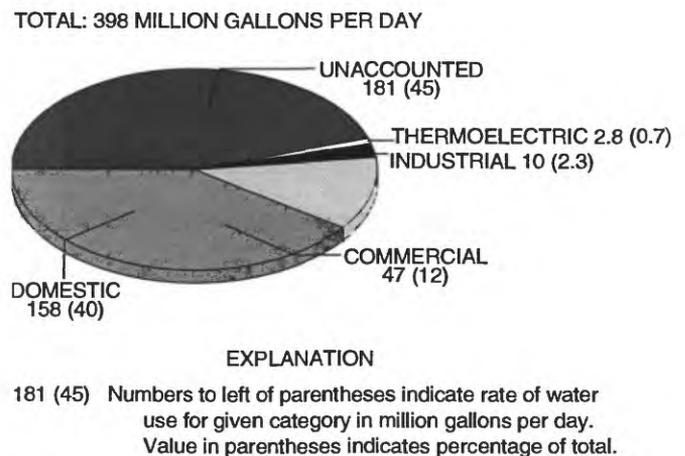
The distribution of potable water by the PRASA during 1988 was as follows: 138 Mgal/d (33 percent) for domestic use; 31 Mgal/d (7 percent) for commercial use; 1.8 Mgal/d (0.4 percent) for industrial use; 2.8 Mgal/d (0.6 percent) for thermoelectric use; and 247 Mgal/d (59 percent) for unaccounted use. Unaccounted use includes the public uses, losses due to system distribution leaks, illegal connections, and accounting errors (fig. 3). During 1989, the PRASA delivered the following amounts: 158 Mgal/d (40 percent) for domestic use; 47 Mgal/d (12 percent) for commercial use; 10 Mgal/d (2.3 percent) for industrial use; 2.8 Mgal/d (0.7 percent) for thermoelectric use; and 181 Mgal/d (45 percent) for unaccounted use (fig. 4).

Deliveries from public-supply systems by type of use for each municipio during 1988 and 1989 are listed in tables 4 and 5. Large positive values resulting from the difference between withdrawals and deliveries within a municipio and listed under "unaccounted use" in tables 4 and 5 may represent large exports of public-water supply to adjacent areas in addition to the reasons previously defined under unaccounted use. Negative values indicate importation of public-water supply from adjacent areas to such an extent that public-supply deliveries to a municipio exceed its public-supply withdrawals.

During 1988 and 1989, Guayama was the only municipio that discharged raw sewage to the ocean. Culebra did not have any sewage-treatment system in 1988 or in 1989 and only seven regional wastewater-treatment plants (RWWTP) were operating in Puerto



**Figure 3.** Public-supply deliveries to domestic, commercial, industrial, thermoelectric, and unaccounted uses in Puerto Rico during 1988.



**Figure 4.** Public-supply deliveries to domestic, commercial, industrial, thermoelectric, and unaccounted uses in Puerto Rico during 1989.

Rico during those years. Those plants were: Puerto Nuevo RWWTP in San Juan serving the municipios of San Juan and some sectors of Cataño and Guaynabo; Bayamón RWWTP in Cataño serving Bayamón and some sectors of Guaynabo and Cataño; Carolina RWWTP in Loíza serving Carolina, Canóvanas and Trujillo Alto; Arecibo RWWTP in Arecibo provided services to Domingo Ruíz Ward and the eastern part of Arecibo; Aguada RWWTP in Aguada provided service to Aguada, Aguadilla, and Moca; Mayagüez RWWTP in Mayagüez serving Mayagüez, Cabo Rojo, and Hormigueros; and Ponce RWWTP in Ponce serving only Ponce area.

**Table 2.** Total freshwater withdrawals by public-supply facilities and population served by municipio, by source for 1988

[Location of municipios are shown in figure 1. Mgal/d, million gallons per day]

Municipio	Withdrawals (Mgal/d)			Population served (thousands)		
	Surface water	Ground water	Total	Surface water	Ground water	Total
Adjuntas.....	1.35	0.70	2.05	8.02	4.32	12.34
Aguada.....	.05	.01	.06	28.87	.00	28.87
Aguadilla .....	14.13	.00	14.13	48.55	.00	48.55
Aguas Buenas .....	.94	.12	1.06	19.70	2.07	21.77
Aibonito.....	2.03	.74	2.77	14.45	5.12	19.57
Añasco .....	.42	.00	.42	21.81	.00	21.81
Arecibo .....	2.85	13.76	16.61	14.51	70.53	85.04
Arroyo.....	.00	1.04	1.04	.00	16.87	16.87
Barceloneta.....	.00	2.88	2.88	.00	16.98	16.98
Barranquitas.....	1.38	.24	1.62	18.47	1.31	19.78
Bayamón.....	.63	.00	.63	205.18	.00	205.18
Cabo Rojo.....	.00	3.35	3.35	.00	32.85	32.85
Caguas .....	6.95	.15	7.10	118.82	1.07	119.89
Camuy.....	.96	.71	1.67	14.15	10.47	24.62
Canóvanas.....	5.69	.01	5.70	23.55	.00	23.55
Carolina .....	.00	.01	.01	.00	174.31	174.31
Cataño.....	.00	.00	.00	23.19	.00	23.19
Cayey .....	4.49	1.09	5.58	33.28	7.87	41.15
Ceiba.....	.00	.00	.00	14.19	.00	14.19
Ciales .....	1.61	.36	1.97	11.45	2.43	13.88
Cidra .....	2.84	.97	3.81	19.10	6.86	25.96
Coamo.....	1.61	1.28	2.89	16.27	12.97	29.24
Comerio .....	2.27	.49	2.76	10.91	2.11	13.02
Corozal .....	3.08	.08	3.16	28.93	.00	28.93
Culebra .....	.05	.01	.06	.95	.19	1.14
Dorado .....	.00	5.17	5.17	.00	27.68	27.68
Fajardo .....	6.50	.01	6.51	32.09	.00	32.09
Florida.....	.02	1.73	1.75	.00	6.70	6.70
Guánica.....	.00	3.49	3.49	.00	17.45	17.45
Guayama.....	4.41	.63	5.04	32.32	4.63	36.95
Guayanilla.....	.23	1.71	1.94	2.21	17.21	19.42
Guaynabo.....	26.94	.00	26.94	77.78	.00	77.78
Gurabo .....	.02	.49	.51	.00	23.54	23.54
Hatillo .....	2.68	.77	3.45	19.53	5.61	25.14
Hormigueros.....	.00	.80	.80	.00	15.42	15.42
Humacao.....	2.36	.09	2.45	46.95	1.79	48.74
Isabela.....	2.93	.00	2.93	36.38	.00	36.38
Jayuya .....	1.31	.18	1.49	13.89	.00	13.89
Juana Díaz .....	1.67	4.05	5.72	9.08	22.02	31.10
Juncos .....	2.73	1.11	3.84	19.46	7.91	27.37

**Table 2.** Total freshwater withdrawals by public-supply facilities and population served by municipio, by source for 1988—  
Continued

Municipio	Withdrawals (Mgal/d)			Population served (thousands)		
	Surface water	Ground water	Total	Surface water	Ground water	Total
Lajas .....	1.36	0.00	1.36	19.36	0.00	19.36
Lares .....	2.13	.01	2.14	25.60	.00	25.60
Las Marías .....	.69	.01	.70	6.51	.00	6.51
Las Piedras.....	.21	.13	.34	10.91	6.75	17.66
Loíza .....	.00	.00	.00	29.42	.00	29.42
Luquillo .....	2.01	.00	2.01	15.25	.00	15.25
Manatí.....	0.00	7.24	7.24	0.00	39.93	39.93
Maricao.....	.97	.01	.98	3.50	.00	3.50
Maunabo.....	.09	1.02	1.11	.67	9.60	10.27
Mayagüez .....	15.02	.57	15.59	3.32	87.39	90.71
Moca .....	.62	.09	.71	22.03	2.84	24.87
Morovis.....	2.06	.00	2.06	18.89	.00	18.89
Naguabo.....	12.13	.16	12.29	19.87	.00	19.87
Naranjito.....	.83	.11	.94	24.59	.00	24.59
Orocovis .....	2.33	.21	2.54	19.63	.00	19.63
Patillas .....	.15	1.19	1.34	2.26	15.06	17.32
Peñuelas.....	2.19	.09	2.28	19.51	.00	19.51
Ponce .....	18.07	7.80	25.87	129.03	55.45	184.48
Quebradillas.....	2.35	.31	2.66	16.77	2.21	18.98
Rincón.....	.00	1.22	1.22	.00	10.87	10.87
Río Grande.....	18.22	.04	18.26	37.31	.00	37.31
Sabana Grande.....	1.73	.25	1.98	18.57	2.68	21.25
Salinas.....	.11	2.47	2.58	.00	23.59	23.59
San Germán .....	1.44	.75	2.19	20.29	9.44	29.73
San Juan.....	.00	.00	.00	.00	426.93	426.93
San Lorenzo.....	2.70	.02	2.72	24.46	.00	24.46
San Sebastián.....	2.55	.00	2.55	30.04	.00	30.04
Santa Isabel.....	.00	2.68	2.68	.00	15.98	15.98
Toa Alta .....	51.67	.00	51.67	32.57	.00	32.57
Toa Baja.....	.00	2.33	2.33	.00	94.50	94.50
Trujillo Alto.....	75.23	.00	75.23	55.29	.00	55.29
Utuado .....	2.69	.13	2.82	28.63	.00	28.63
Vega Alta .....	.17	5.19	5.36	24.11	.79	24.90
Vega Baja.....	1.26	5.38	6.64	8.36	35.69	44.05
Vieques .....	.00	.00	.00	8.18	.00	8.18
Villalba .....	1.75	.16	1.91	18.35	.74	19.09
Yabucoa .....	.64	1.86	2.50	5.68	23.84	29.52
Yauco .....	1.98	.15	2.13	35.29	1.26	36.55
Total.....	330.48	89.81	420.29	1,718.29	1,383.83	3,102.12

**Table 3. Total freshwater withdrawals by public-supply facilities and population served by municipio, by source for 1989**

[Location of municipios are shown in figure 1. Mgal/d, million gallons per day]

Municipio	Withdrawals (Mgal/d)			Population served (thousands)		
	Surface water	Ground water	Total	Surface water	Ground water	Total
Adjuntas.....	1.33	0.20	1.53	13.14	1.29	14.43
Aguada.....	.00	.05	.05	35.67	.00	35.67
Aguadilla .....	12.82	.00	12.82	57.21	.00	57.21
Aguas Buenas .....	.71	.16	.87	25.35	.00	25.35
Aibonito.....	1.77	.60	2.37	19.30	6.33	25.63
Añasco .....	.34	.06	.40	25.29	.00	25.29
Arecibo .....	3.19	12.98	16.17	18.82	76.46	95.28
Arroyo.....	.00	1.05	1.05	.00	19.75	19.75
Barceloneta .....	.00	2.87	2.87	.00	20.36	20.36
Barranquitas.....	1.33	.25	1.58	22.53	1.70	24.23
Bayamón.....	.57	.00	.57	204.31	.00	204.31
Cabo Rojo.....	.00	3.00	3.00	.00	41.10	41.10
Caguas .....	5.74	.36	6.10	135.24	.48	135.72
Camuy.....	.90	.79	1.69	15.83	13.89	29.72
Canóvanas.....	5.20	.00	5.20	29.37	.00	29.37
Carolina .....	.00	.12	.12	.00	172.78	172.78
Cataño.....	.00	.00	.00	.00	.00	.00
Cayey.....	4.03	.87	4.90	40.05	8.25	48.30
Ceiba.....	.00	.00	.00	12.35	.00	12.35
Ciales .....	1.52	.28	1.80	13.50	2.42	15.92
Cidra .....	2.62	.88	3.50	25.85	8.19	34.04
Coamo.....	1.53	1.27	2.80	17.37	14.17	31.54
Comerío .....	1.50	.19	1.69	14.26	1.44	15.70
Corozal .....	3.03	.02	3.05	30.19	.00	30.19
Culebra .....	.08	.01	.09	1.55	.20	1.75
Dorado .....	.00	2.26	2.26	.00	32.25	32.25
Fajardo.....	5.58	.00	5.58	38.08	.00	38.08
Florida.....	.00	1.73	1.73	.00	9.77	9.77
Guánica.....	.00	3.48	3.48	.00	21.42	21.42
Guayama.....	3.59	.62	4.21	34.73	5.92	40.65
Guayanilla.....	.22	1.59	1.81	2.60	18.66	21.26
Guaynabo.....	24.01	.00	24.01	78.20	.00	78.20
Gurabo .....	.00	.75	.75	.00	24.79	24.79
Hatillo.....	2.80	.76	3.56	24.56	6.67	31.23
Hormigueros .....	.00	.79	.79	.00	16.49	16.49
Humacao.....	2.36	.06	2.42	57.10	1.45	58.55
Isabela.....	2.79	.00	2.79	42.02	.00	42.02
Jayuya.....	1.33	.00	1.33	15.73	.00	15.73
Juana Díaz .....	1.63	3.85	5.48	10.67	25.20	35.87
Juncos .....	3.31	.62	3.93	28.51	5.34	33.85

**Table 3.** Total freshwater withdrawals by public-supply facilities and population served by municipio, by source for 1988—  
Continued

Municipio	Withdrawals (Mgal/d)			Population served (thousands)		
	Surface water	Ground water	Total	Surface water	Ground water	Total
Lajas .....	1.79	0.00	1.79	24.63	0.00	24.63
Lares .....	1.44	.03	1.47	29.12	.00	29.12
Las Marías .....	.70	.01	.71	7.93	.00	7.93
Las Piedras.....	1.20	.12	1.32	16.83	1.68	18.51
Loíza.....	.00	.00	.00	.00	.00	.00
Luquillo .....	2.31	.00	2.31	16.15	.00	16.15
Manatí.....	0.00	6.99	6.99	0.00	42.60	42.60
Maricao.....	1.10	.01	1.11	3.53	.00	3.53
Maunabo.....	.09	.92	1.01	.78	10.29	11.07
Mayagüez .....	14.70	.47	15.17	69.68	29.77	99.45
Moca.....	.32	.07	.39	21.94	4.95	26.89
Morovis.....	2.77	.00	2.77	22.57	.00	22.57
Naguabo.....	12.67	.09	12.76	22.29	.00	22.29
Naranjito.....	1.55	.10	1.65	28.57	.58	29.15
Orocovis .....	2.18	.06	2.24	24.29	.00	24.29
Patillas .....	.31	1.11	1.42	2.38	17.60	19.98
Peñuelas.....	2.22	.06	2.28	22.57	.00	22.57
Ponce .....	15.24	7.60	22.84	125.07	62.08	187.15
Quebradillas.....	2.27	.33	2.60	20.44	2.97	23.41
Rincón.....	.00	.59	.59	.00	14.07	14.07
Río Grande.....	18.21	.01	18.22	45.64	.00	45.64
Sabana Grande.....	1.99	.14	2.13	25.16	1.77	26.93
Salinas.....	.00	2.61	2.61	.00	29.15	29.15
San Germán .....	1.43	.60	2.03	2.37	9.95	32.32
San Juan.....	.00	.26	.26	.00	429.30	429.30
San Lorenzo.....	2.51	.06	2.57	6.89	.00	26.89
San Sebastián.....	2.11	.01	2.12	8.68	.00	38.68
Santa Isabel.....	.00	.62	.62	.00	17.54	17.54
Toa Alta .....	53.12	.00	53.12	41.62	.00	41.62
Toa Baja.....	.00	2.52	2.52	.00	97.45	97.45
Trujillo Alto.....	74.97	.00	74.97	55.79	.00	55.79
Utado .....	2.43	.03	2.46	31.24	.00	31.24
Vega Alta .....	.15	1.78	1.93	2.30	27.28	29.58
Vega Baja.....	1.58	5.07	6.65	13.60	43.64	57.24
Vieques .....	.00	.00	.00	8.50	.00	8.50
Villalba .....	1.69	.18	1.87	20.01	.83	20.84
Yabucoa .....	.49	1.86	2.35	6.36	23.00	29.36
Yauco .....	2.09	.02	2.11	43.22	.00	43.22
Total.....	321.46	76.85	398.31	1,929.53	1,423.27	3,352.80

**Table 4. Public-supply deliveries by type of use and municipio for 1988**

[Location of municipios are shown in figure 1. Unaccounted use: Positive values are the difference between withdrawals and deliveries in a municipio. Negative values indicate importation of public-water supply from adjacent municipios to such an extent that public-supply deliveries to a municipio exceed its public-supply withdrawals. Mgal/d, million gallons per day]

Municipio	Water deliveries by type of use (Mgal/d)					
	Domestic	Commercial	Industrial	Thermoelectric power	Unaccounted use	Total deliveries
Adjuntas.....	0.52	0.13	0.00	0.00	1.40	2.05
Aguada.....	1.09	.19	.03	.00	-.25	.06
Aguadilla.....	2.15	.74	.02	.00	11.22	14.13
Aguas Buenas.....	.95	.13	.00	.00	-.02	1.06
Aibonito.....	.94	.23	.00	.00	1.60	2.77
Añasco.....	.87	.12	.04	.00	-.61	.42
Arecibo.....	3.36	.96	.04	.00	12.25	16.61
Arroyo.....	.74	.17	.01	.00	.12	1.04
Barceloneta.....	.76	.27	.01	.00	1.84	2.88
Barranquitas.....	.95	.15	.00	.00	.52	1.62
Bayamón.....	9.00	1.80	.13	.00	-10.30	.63
Cabo Rojo.....	1.57	.39	.02	.00	1.37	3.35
Caguas.....	5.23	1.02	.02	.00	.83	7.10
Camuy.....	1.16	.31	.02	.00	.18	1.67
Canóvanas.....	1.11	.28	.04	.00	4.27	5.70
Carolina.....	7.80	1.37	.03	.00	-9.19	.01
Cataño.....	1.34	.33	.14	.00	-1.81	.00
Cayey.....	1.58	.33	.03	.00	3.64	5.58
Ceiba.....	.49	.05	.00	.00	-.54	.00
Ciales.....	.53	.14	.01	.00	1.29	1.97
Cidra.....	1.33	.18	.02	.00	2.28	3.81
Coamo.....	1.03	.20	.01	.00	1.65	2.89
Comerío.....	.54	.10	.01	.00	2.11	2.76
Corozal.....	1.00	.18	.01	.00	1.97	3.16
Culebra.....	.03	.01	.00	.00	.02	.06
Dorado.....	1.26	.31	.02	.00	3.58	5.17
Fajardo.....	1.54	.36	.00	.00	4.61	6.51
Florida.....	.34	.05	.00	.00	1.36	1.75
Guánica.....	.77	.18	.01	.00	2.53	3.49
Guayama.....	1.48	.41	.01	.00	3.14	5.04
Guayanilla.....	.81	.18	.00	.00	.95	1.94
Guaynabo.....	4.23	1.52	.01	1.21	19.97	26.94
Gurabo.....	.89	.13	.00	.00	-.51	.51
Hatillo.....	1.23	.38	.06	.00	1.78	3.45
Hormigueros.....	.70	.09	.01	.00	.00	.80
Humacao.....	2.33	.55	.03	.00	-.46	2.45
Isabela.....	1.55	.37	.01	.00	1.00	2.93
Jayuya.....	.54	.14	.00	.00	.81	1.49
Juana Díaz.....	1.30	.24	.03	.00	4.15	5.72
Juncos.....	1.21	.20	.02	.00	2.41	3.84

**Table 4.** Public-supply deliveries by type of use and municipio for 1988—*Continued*

Municipio	Water deliveries by type of use (Mgal/d)					Total deliveries
	Domestic	Commercial	Industrial	Thermoelectric power	Unaccounted use	
Lajas .....	0.98	0.20	0.01	0.00	0.17	1.36
Lares .....	.97	.16	.00	.00	1.01	2.14
Las Marías .....	.27	.08	.00	.00	.35	.70
Las Piedras.....	.70	.11	.00	.00	-.47	.34
Lóíza.....	1.32	.22	.01	.00	-1.55	.00
Luquillo .....	.78	.18	.01	.00	1.04	2.01
Manatí.....	1.57	.42	0.05	0.00	5.20	7.24
Maricao.....	.12	.04	.02	.00	.80	.98
Maunabo.....	.42	.10	.00	.00	.59	1.11
Mayagüez .....	4.18	.86	.23	.00	10.32	15.59
Moca.....	.91	.15	.01	.00	-.36	.71
Morovis.....	.72	.12	.01	.00	1.21	2.06
Naguabo.....	.88	.18	.02	.00	11.21	12.29
Naranjito.....	.93	.14	.00	.00	.13	.94
Orocovis .....	.83	.13	.00	.00	1.58	2.54
Patillas .....	.78	.12	.00	.00	.44	1.34
Peñuelas.....	.78	.15	.01	.00	1.34	2.28
Ponce .....	7.75	1.49	.10	.00	16.53	25.87
Quebradillas.....	.84	.22	.00	.00	1.60	2.66
Rincón.....	.49	.10	.01	.00	.62	1.22
Río Grande.....	1.81	.26	.00	.00	16.19	18.26
Sabana Grande.....	.97	.17	.01	.00	.83	1.98
Salinas.....	1.09	.26	.01	.00	1.22	2.58
San Germán .....	1.23	.26	.01	.00	.69	2.19
San Juan.....	23.02	7.02	.17	.00	-30.21	.00
San Lorenzo.....	.87	.11	.01	.00	1.73	2.72
San Sebastián.....	1.17	.35	.02	.00	1.01	2.55
Santa Isabel.....	.62	.14	.02	.00	1.90	2.68
Toa Alta .....	1.54	.20	.03	.00	49.90	51.67
Toa Baja.....	4.54	.53	.07	1.58	-4.39	2.33
Trujillo Alto.....	1.07	.32	.00	.00	73.84	75.23
Utua.....	1.06	.27	.00	.00	1.49	2.82
Vega Alta .....	1.06	.25	.01	.00	4.04	5.36
Vega Baja.....	2.06	.36	.04	.00	4.18	6.64
Vieques .....	.40	.11	.00	.00	-.51	.00
Villalba .....	.69	.13	.01	.00	1.08	1.91
Yabucoa .....	1.33	.22	.06	.00	.89	2.50
Yauco.....	.53	.29	.00	.00	1.31	2.13
Total.....	137.53	31.31	1.81	2.79	246.85	420.29

**Table 5. Public-supply deliveries by type of use and municipio for 1989**

[Location of municipios are shown in figure 1. Unaccounted use: Positive values are the difference between withdrawals and deliveries in a municipio. Negative values indicate importation of public-water supply from adjacent municipios to such an extent that public-supply deliveries to a municipio exceed its public-supply withdrawals. Mgal/d, million gallons per day]

Municipio	Water deliveries by type of use (Mgal/d)					
	Domestic	Commercial	Industrial	Thermoelectric power	Unaccounted use	Total deliveries
Adjuntas.....	0.54	0.12	0.00	0.00	0.87	1.53
Aguada.....	1.25	.19	.05	.00	-1.44	.05
Aguadilla .....	2.35	1.24	.26	.00	8.97	12.82
Aguas Buenas.....	.93	.12	.03	.00	-.21	.87
Aibonito.....	1.05	.22	.32	.00	.78	2.37
Añasco .....	1.01	.13	.06	.00	-.80	.40
Arecibo .....	4.30	1.40	.16	.00	10.31	16.17
Arroyo.....	.87	.19	.04	.00	-.05	1.05
Barceloneta.....	.93	.37	.01	.00	1.56	2.87
Barranquitas.....	.93	.17	.01	.00	.47	1.58
Bayamón.....	11.59	2.09	.34	.00	-13.45	.57
Cabo Rojo.....	1.75	.45	.02	.00	.78	3.00
Caguas .....	6.04	1.50	.26	.00	-1.70	6.10
Camuy.....	1.15	.34	.02	.00	.18	1.69
Canóvanas.....	1.17	.25	.03	.00	3.75	5.20
Carolina .....	10.19	3.17	.67	.00	-13.91	.12
Cataño.....	1.48	1.56	1.06	.00	-4.10	.00
Cayey.....	1.91	.33	.13	.00	2.53	4.90
Ceiba.....	.53	.07	.01	.00	-.61	.00
Ciales .....	.61	.12	.05	.00	1.02	1.80
Cidra .....	1.42	.21	.07	.00	1.80	3.50
Coamo.....	1.20	.27	.36	.00	.97	2.80
Comerío .....	.59	.10	.02	.00	.98	1.69
Corozal .....	1.09	.19	.01	.00	1.76	3.05
Culebra .....	.04	.01	.00	.00	.04	.09
Dorado .....	1.55	.37	.03	.00	.31	2.26
Fajardo.....	1.66	.57	.08	.00	3.27	5.58
Florida.....	.38	.06	.00	.00	1.29	1.73
Guánica.....	.93	.20	.02	.00	2.33	3.48
Guayama.....	1.70	.66	.05	.00	1.80	4.21
Guayanilla.....	.96	.18	.00	.00	.67	1.81
Guaynabo.....	4.67	2.76	.25	1.21	15.12	24.01
Gurabo .....	1.04	.16	.03	.00	-.48	.75
Hatillo .....	1.39	.44	.06	.00	1.67	3.56
Hormigueros .....	.79	.09	.02	.00	-.11	.79
Humacao.....	2.51	1.28	.37	.00	-1.74	2.42
Isabela.....	1.77	.42	.04	.00	.56	2.79
Jayuya.....	.55	.14	.08	.00	.56	1.33
Juana Díaz .....	1.41	.26	.04	.00	3.77	5.48
Juncos .....	1.35	.22	.05	.00	2.31	3.93

**Table 5.** Public-supply deliveries by type of use and municipio for 1989—*Continued*

Municipio	Water deliveries by type of use (Mgal/d)					
	Domestic	Commercial	Industrial	Thermoelectric power	Unaccounted use	Total deliveries
Lajas .....	1.05	0.20	0.01	0.00	0.53	1.79
Lares .....	1.08	.17	.00	.00	.22	1.47
Las Marías .....	.06	.00	.00	.00	.65	.71
Las Piedras.....	.76	.13	.10	.00	.33	1.32
Lóíza.....	1.43	.21	.00	.00	-1.64	.00
Luquillo .....	.81	.20	.05	.00	1.25	2.31
Manatí.....	1.85	.50	.12	.00	4.52	6.99
Maricao.....	.14	.04	.02	.00	.91	1.11
Maunabo.....	.44	.11	.00	.00	.46	1.01
Mayagüez .....	4.44	1.61	1.55	.00	7.57	15.17
Moca.....	.97	.14	.01	.00	-.73	.39
Morovis.....	.82	.12	.00	.00	1.83	2.77
Naguabo.....	.95	.16	.02	.00	11.63	12.76
Naranjito.....	1.06	.14	.00	.00	.45	1.65
Orocovis .....	.76	.12	.01	.00	1.35	2.24
Patillas .....	.85	.13	.01	.00	.43	1.42
Peñuelas.....	.87	.14	.01	.00	1.26	2.28
Ponce .....	8.72	2.66	.63	.00	10.83	22.84
Quebradillas.....	.93	.23	.02	.00	1.42	2.60
Rincón.....	.58	.11	.01	.00	-.11	.59
Río Grande.....	2.03	.25	.03	.00	15.91	18.22
Sabana Grande.....	1.17	.19	.04	.00	.73	2.13
Salinas.....	1.21	.24	.01	.00	1.15	2.61
San Germán .....	1.40	.31	.22	.00	.10	2.03
San Juan.....	26.07	12.46	.67	.00	-38.94	.26
San Lorenzo.....	.97	.10	.04	.00	1.46	2.57
San Sebastián.....	1.69	.36	.06	.00	.01	2.12
Santa Isabel.....	.69	.14	.05	.00	-.26	.62
Toa Alta .....	1.80	.20	.06	.00	51.06	53.12
Toa Baja.....	4.88	.60	.13	1.58	-4.67	2.52
Trujillo Alto.....	1.19	.27	.00	.00	73.51	74.97
Utgado .....	1.18	.26	.00	.00	1.02	2.46
Vega Alta .....	1.24	.41	.58	.00	-.30	1.93
Vega Baja.....	2.24	.38	.05	.00	3.98	6.65
Vieques .....	.41	.10	.00	.00	-.51	.00
Villalba .....	.75	.14	.02	.00	.96	1.87
Yabucoa .....	1.09	.24	.02	.00	1.00	2.35
Yauco .....	1.78	.39	.02	.00	-.08	2.11
Total .....	157.94	46.78	9.68	2.79	181.12	398.31

Total discharge from public sewage-treatment facilities increased from 98 Mgal/d in 1988 to 123 Mgal/d in 1989. However, the number of public sewage-treatment facilities decreased from 98 in 1988 to 87 in 1989. This change corresponds to the shut-down of the facilities at the municipios of Trujillo Alto and completion of trunk lines to the regional sewage-treatment facilities at Loíza and Mayagüez. A summary of the amount of water released by public sewage-treatment facilities and the number of operating facilities by municipio during 1988 and 1989 are presented in table 6.

### **Self-Supplied Domestic and Commercial**

An average of 26 percent of the total offstream freshwater withdrawals in Puerto Rico was used for domestic purposes during 1988 and 1989. Public-supply systems delivered 137 Mgal/d for domestic use during 1988 and 158 Mgal/d in 1989 to an estimated population of 3.2 million people. The average per capita domestic water use from public supply was estimated to be 45 gallons during both years. The population served by self-supplied systems was estimated to be about 364,000 in 1988 and 202,000 in 1989, which represents withdrawals of 17 Mgal/d in 1988 and 6 Mgal/d in 1989, applying the same per capita use obtained for public supplied users (tables 7 and 8). Most of the water withdrawn by self-supplied commercial systems provided water to hotels, motels, and guest houses and was estimated to be less than 1 Mgal/d during 1988 and 1989. The total number of rooms endorsed by the Puerto Rico Tourism Company was 2,608 in 1988 and 2,682 in 1989 (table 9).

### **Self-Supplied Industrial and Mining**

Withdrawals of self-supplied ground water by industrial users were estimated to be about 7 Mgal/d during 1988 and 1989. Most of the industrial self-supplied ground-water withdrawals were from aquifers along the north coast of Puerto Rico. The

municipio of Manatí had the largest withdrawal of water with 2.2 Mgal/d during 1988 and 1989 (table 10).

The primary mining activity in Puerto Rico is the production of sand and gravel. This mining activity required an estimated 2.6 Mgal/d of water for each year. Most of the production was concentrated in the northeastern part of Puerto Rico, with the largest fresh ground-water withdrawal occurring in Toa Baja. Mining water-use activities during 1988 and 1989 are summarized by municipio in table 11.

### **Thermoelectric and Hydroelectric**

Puerto Rico has four thermoelectric powerplants: Costa Sur in Guayanilla, Aguirre in Salinas, Puerto Nuevo in Guaynabo, and Palo Seco in Toa Baja (fig. 5). These four powerplants generated 12,600 gigawatthours (GWh) of electricity in 1988 and had an instream water use of 1,600 Mgal/d of saline surface water (seawater) for cooling, and used 1,450 Mgal/d of saline water in 1989 in the production of 11,820 GWh of electricity. In 1988 and 1989, the PRASA delivered 2.8 Mgal/d of freshwater to the Puerto Nuevo and Palo Seco powerplants. Withdrawals of self-supplied ground water at the Aguirre and Costa Sur powerplants were 2.8 Mgal/d in 1988 and 2.3 Mgal/d in 1989 (tables 12 and 13).

During 1988 and 1989, Puerto Rico had 11 active hydroelectric powerplants Dos Bocas in Arecibo, Río Blanco in Naguabo, Toro Negro II in Orocovis, Patillas in Patillas, Garzas I and II in Peñuelas, Caonillas I and II in Utuado, Toro Negro I in Villalba, and Yauco I and II in Yauco (fig. 6). These powerplants generated 136 GWh of electricity in 1988 with an average instream water use of 427 Mgal/d. Total hydroelectric power generated in 1989 was 177 GWh with an average instream water use of 533 Mgal/d (table 14).

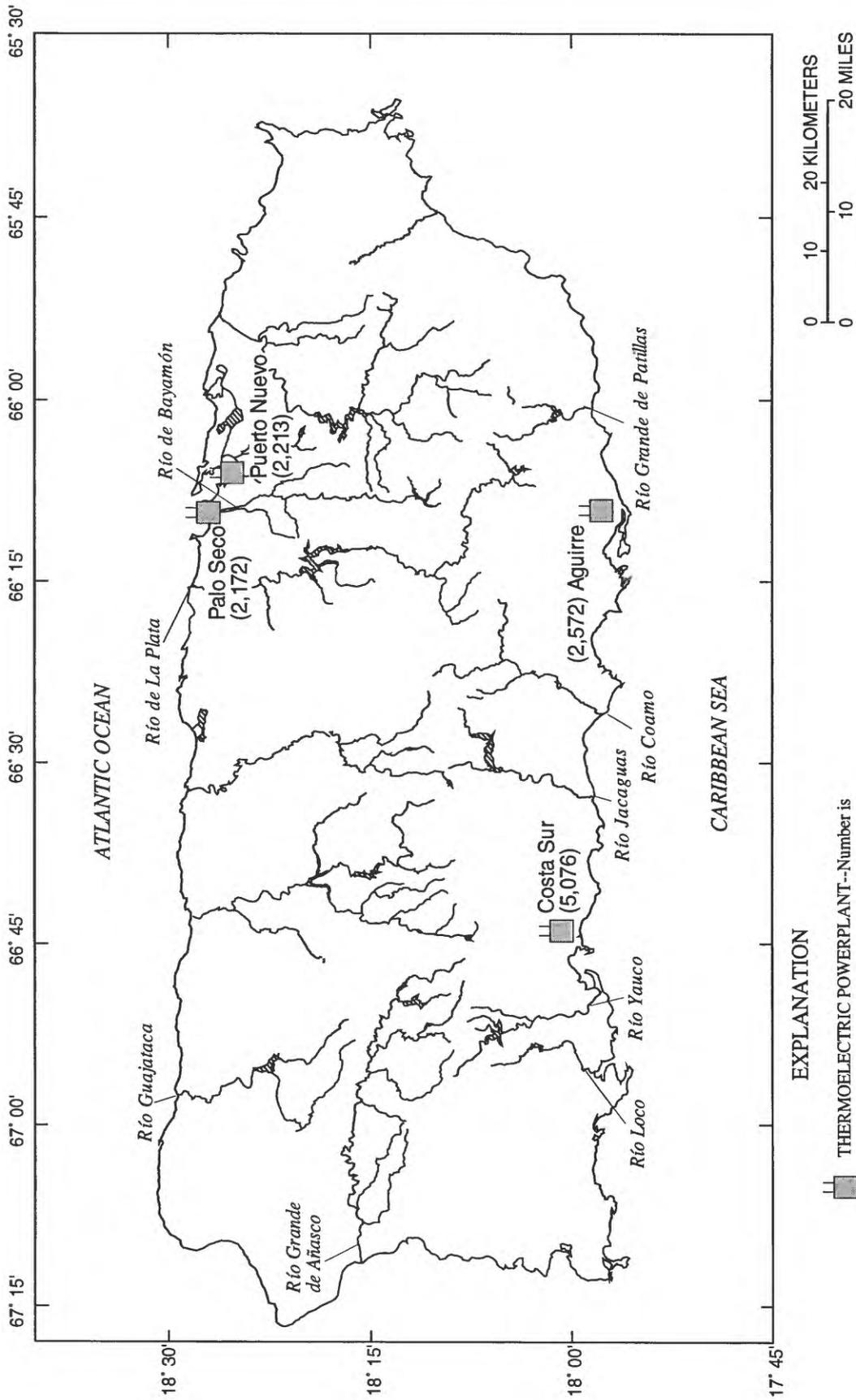
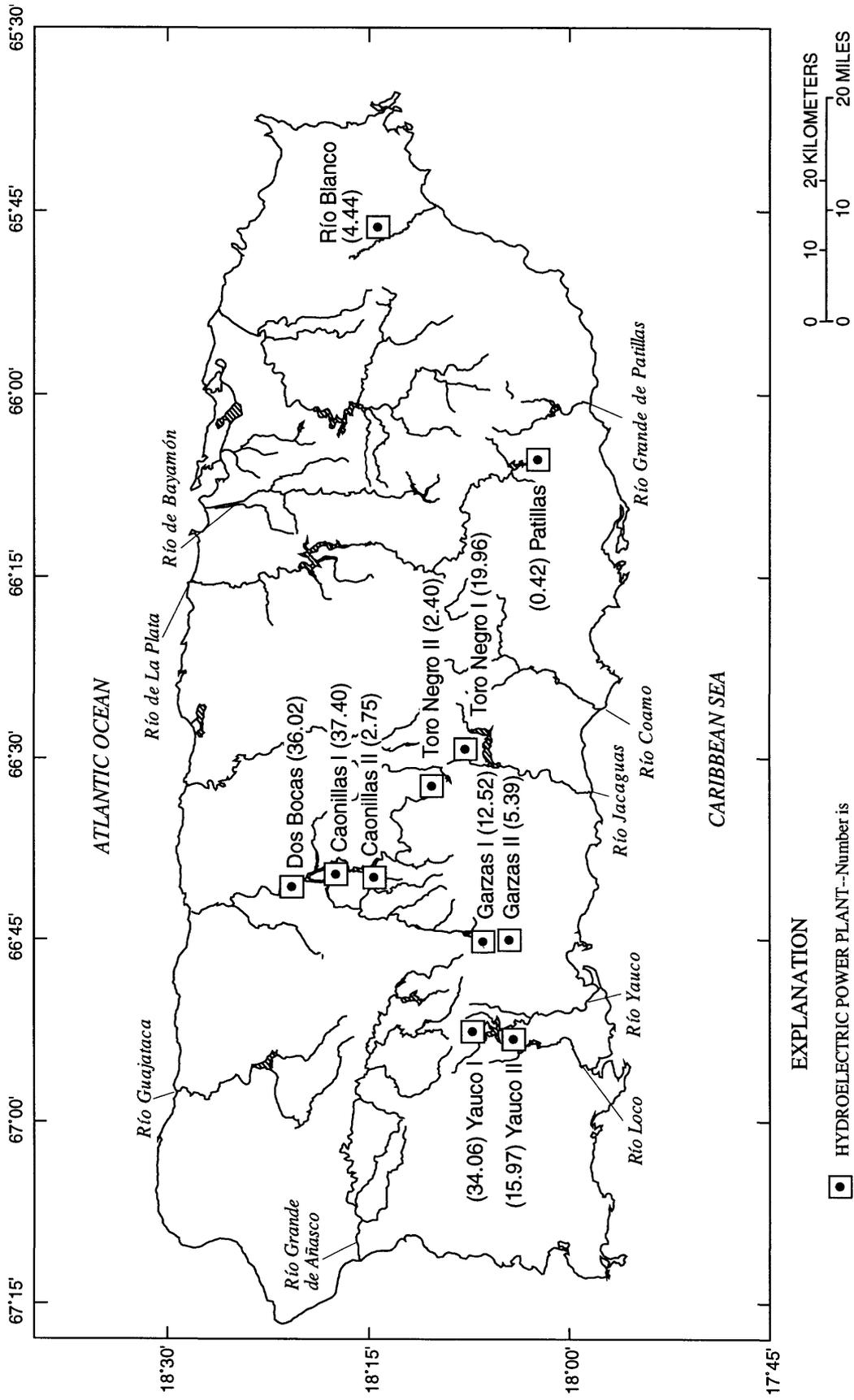


Figure 5. Location of active thermoelectric powerplants in Puerto Rico during 1988 and 1989.



**Figure 6.** Location of active hydroelectric powerplants in Puerto Rico during 1988 and 1989.

**Table 6. Sewage-treatment water releases and number of facilities by municipio, for 1988 and 1989**

[Location of municipios are shown in figure 1. Mgal/d, million gallons per day]

Municipio	1988		1989		Municipio	1988		1989	
	Total public releases (Mgal/d)	Number of facilities	Total public release (Mgal/d)	Number of facilities		Total public releases (Mgal/d)	Number of facilities	Total public release (Mgal/d)	Number of facilities
Adjuntas .....	0.23	1	0.25	1	Lajas.....	0.23	3	0.23	3
Aguada .....	.28	1	.35	1	Lares.....	.25	1	.27	1
Aguadilla.....	1.26	0	1.74	0	Las Marías.....	.06	1	.00	1
Aguas Buenas. .	.19	1	.19	1	Las Piedras.....	.32	2	.33	2
Aibonito .....	.32	2	.41	1	Loíza .....	.76	2	.82	2
Añasco.....	.31	1	.43	1	Luquillo.....	.52	1	.53	1
Arecibo.....	1.87	1	2.52	1	Manati .....	.99	0	1.19	0
Arroyo .....	.44	1	.48	1	Maricao .....	.04	1	.06	1
Barceloneta.....	.34	1	.54	1	Maunabo .....	.17	1	.19	1
Barranquitas ....	.18	1	.21	1	Mayagüez.....	3.24	2	4.08	1
Bayamón .....	9.22	4	11.72	0	Moca .....	.21	0	.22	0
Cabo Rojo .....	.67	1	.68	1	Morovis.....	.16	2	.15	2
Caguas.....	4.30	2	5.50	2	Naguabo.....	.28	3	.31	3
Camuy .....	.25	1	.29	1	Naranjito .....	.09	1	.09	1
Canóvanas .....	.34	2	.34	1	Orocovis.....	.09	2	.09	2
Carolina.....	8.48	1	12.07	1	Patillas.....	.23	1	.25	1
Cataño .....	1.24	1	1.92	1	Peñuelas .....	.22	1	.24	1
Cayey .....	1.12	3	1.24	2	Ponce.....	7.14	1	8.47	1
Ceiba .....	.27	1	.31	1	Quebradillas ....	.15	0	.16	0
Ciales.....	.17	1	.22	1	Rincón.....	.10	1	.12	0
Cidra.....	.28	2	.33	1	Río Grande.....	.86	5	.90	5
Coamo .....	.51	1	.63	1	Sabana Grande.	.39	1	.49	1
Comerío.....	.19	1	.22	1	Salinas.....	.45	2	.52	2
Corozal .....	.35	1	.39	1	San Germán.....	.69	1	1.02	1
Culebra.....	.00	0	.00	0	San Juan .....	26.50	1	34.61	1
Dorado.....	.63	1	.83	1	San Lorenzo ....	.39	1	.48	1
Fajardo .....	1.40	1	1.58	1	San Sebastián ..	.41	1	.50	1
Florida .....	.16	1	.19	1	Santa Isabel .....	.32	1	.41	1
Guánica .....	.29	2	.36	2	Toa Alta.....	.70	2	.82	2
Guayama .....	1.13	0	1.34	1	Toa Baja .....	3.35	1	3.50	1
Guayanilla .....	.35	1	.35	1	Trujillo Alto ....	.40	2	.52	1
Guaynabo .....	4.19	0	5.69	0	Utua.....	.43	1	.45	1
Gurabo.....	.38	1	.44	1	Vega Alta.....	.49	1	.73	1
Hatillo.....	.22	1	.26	0	Vega Baja.....	.92	1	1.02	1
Hormigueros....	.33	0	.35	0	Vieques.....	.11	1	.10	1
Humacao .....	.30	3	1.83	3	Villalba.....	.23	1	.27	1
Isabela .....	.45	1	.48	1	Yabucoa.....	.36	1	.38	1
Jayuya.....	.21	1	.25	1	Yauco .....	.74	1	.89	1
Juana Díaz.....	.45	1	.47	1	Total .....	97.73	98	123.34	87
Juncos.....	.44	1	.53	1					

**Table 7. Domestic self-supplied withdrawals and deliveries from public-supply systems, by municipio, for 1988**

[Location of municipios are shown in figure 1. Mgal/d, million gallons per day; gal/d, gallon per day; --, not applicable]

Municipio	Self supplied			Public supplied		Total withdrawals and deliveries (Mgal/d)	Per capita use (gal/d)	
	Population (thousands)	Withdrawals (Mgal/d)			Population served (thousands)			Deliveries from public supply (Mga/d)
		Surface water	Ground water	Total				
Adjuntas.....	6.98	0.08	0.30	0.38	12.34	0.52	0.90	42.14
Aguada.....	6.17	.05	.21	.26	28.87	1.09	1.35	37.76
Aguadilla.....	9.84	.49	.00	.49	48.55	2.15	2.64	44.28
Aguas Buenas.....	3.06	.03	.11	.14	21.77	.95	1.09	43.64
Aibonito.....	4.84	.24	.00	.24	19.57	.94	1.18	48.03
Añasco.....	5.03	.00	.21	.21	21.81	.87	1.08	39.89
Arecibo.....	7.02	.00	.33	.33	85.04	3.36	3.69	39.51
Arroyo.....	1.66	.00	.08	.08	16.87	.74	.82	43.86
Barceloneta.....	3.57	.00	.17	.17	16.98	.76	.93	44.76
Barranquitas.....	5.03	.15	.10	.25	19.78	.95	1.20	48.03
Bayamón.....	10.27	.49	.00	.49	205.18	9.00	9.49	43.86
Cabo Rojo.....	4.78	.00	.23	.23	32.85	1.57	1.80	47.79
Caguas.....	10.46	.12	.37	.49	119.89	5.23	5.72	43.62
Camuy.....	3.70	.00	.17	.17	24.62	1.16	1.33	47.12
Canóvanas.....	12.28	.53	.10	.63	23.55	1.11	1.74	47.13
Carolina.....	1.13	.00	.05	.05	174.31	7.80	7.85	44.75
Cataño.....	9.73	.47	.00	.47	23.19	1.34	1.81	57.78
Cayey.....	4.31	.13	.06	.19	41.15	1.58	1.77	38.40
Ceiba.....	2.52	.09	.00	.09	14.19	.49	.58	34.53
Ciales.....	3.83	.15	.00	.15	13.88	.53	.68	38.18
Cidra.....	8.19	.00	.42	.42	25.96	1.33	1.75	51.23
Coamo.....	3.99	.06	.09	.15	29.24	1.03	1.18	35.23
Comerío.....	6.83	.30	.00	.30	13.02	.54	.84	41.47
Corozal.....	3.19	.12	.00	.12	28.93	1.00	1.12	34.57
Culebra.....	.35	.01	.00	.01	1.14	.03	.04	26.32
Dorado.....	2.03	.00	.10	.10	27.68	1.26	1.36	45.52
Fajardo.....	3.83	.20	.00	.20	32.09	1.54	1.74	47.99
Florida.....	1.70	.00	.09	.09	6.70	.34	.43	50.75
Guánica.....	2.30	.00	.11	.11	17.45	.77	.88	44.13
Guayama.....	4.36	.00	.21	.21	36.95	1.48	1.69	40.05
Guayanilla.....	2.06	.03	.06	.09	19.42	.81	.90	41.71
Guaynabo.....	12.68	.85	.00	.85	77.78	4.23	5.08	54.38
Gurabo.....	4.16	.01	.16	.17	23.54	.89	1.06	37.81
Hatillo.....	6.81	.38	.11	.49	25.14	1.23	1.72	48.93
Hormigueros.....	.00	.00	.00	.00	15.42	.70	.70	45.40
Humacao.....	4.65	.22	.01	.23	48.74	2.33	2.56	47.80
Isabela.....	2.43	.11	.00	.11	36.38	1.55	1.66	42.61
Jayuya.....	1.48	.06	.00	.06	13.89	.54	.60	38.88
Juana Díaz.....	13.76	.00	.06	.06	31.10	1.30	1.36	41.80

**Table 7.** Domestic self-supplied withdrawals and deliveries from public-supply systems, by municipio, for 1988—*Continued*

Municipio	Self supplied				Public supplied		Total withdrawals and deliveries (Mgal/d)	Per capita use (gal/d)
	Population (thousands)	Withdrawals (Mgal/d)			Population served (thousands)	Deliveries from public supply (Mga/d)		
		Surface water	Ground water	Total				
Juncos .....	2.20	0.09	0.03	0.12	27.37	1.21	1.33	44.21
Lajas .....	3.50	.18	.00	.18	19.36	.98	1.16	50.62
Lares .....	2.96	.04	.08	.12	25.60	.97	1.09	37.89
Las Marías .....	2.68	.11	.00	.11	6.51	.27	.38	41.47
Las Piedras .....	9.14	.24	.14	.38	17.66	.70	1.08	39.64
Loíza .....	.00	.00	.00	.00	29.42	1.32	1.32	44.87
Luquillo .....	2.21	.12	.00	.12	15.25	.78	.90	51.15
Manatí .....	.00	.00	.00	.00	39.93	1.57	1.57	39.32
Maricao .....	2.81	.10	.00	.10	3.50	.12	.22	34.29
Maunabo .....	1.97	.05	.03	.08	10.27	.42	.50	40.90
Mayagüez .....	8.83	.43	.02	.45	90.71	4.18	4.63	46.08
Moca .....	7.31	.30	.00	.30	24.87	.91	1.21	36.59
Morovis .....	5.57	.23	.00	.23	18.89	.72	.95	38.12
Naguabo .....	2.35	.11	.00	.11	19.87	.88	.99	44.29
Naranjito .....	2.47	.06	.05	.11	24.59	.93	1.04	37.82
Orocovis .....	1.16	.05	.02	.07	19.63	.83	.90	42.28
Patillas .....	1.94	.10	.00	.10	17.32	.78	.88	45.03
Peñuelas .....	2.33	.08	.02	.10	19.51	.78	.88	39.98
Ponce .....	3.53	.08	.08	.16	84.48	7.75	7.91	42.01
Quebradillas .....	2.11	.09	.01	.10	18.98	.84	.94	44.26
Rincón .....	1.26	.00	.06	.06	10.87	.49	.55	45.08
Río Grande .....	6.07	.23	.08	.31	37.31	1.81	2.12	48.51
Sabana Grande .....	1.07	.06	.01	.07	21.25	.97	1.04	45.65
Salinas .....	4.37	.00	.33	.33	23.59	1.09	1.42	46.21
San Germán .....	4.82	.21	.00	.21	29.73	1.23	1.44	41.37
San Juan .....	.24	.00	.49	.49	26.93	23.02	23.51	53.92
San Lorenzo .....	.16	.10	.39	.49	24.46	.87	1.36	35.57
San Sebastián .....	8.14	.09	.34	.43	30.04	1.17	1.60	38.95
Santa Isabel .....	3.45	.00	.14	.14	15.98	.62	.76	38.80
Toa Alta .....	9.09	.45	.00	.45	32.57	1.54	1.99	47.28
Toa Baja .....	.00	.00	.00	.00	94.50	4.54	4.54	48.04
Trujillo Alto .....	.00	.00	.00	.00	55.29	1.07	1.07	19.35
Utua .....	6.25	.24	.00	.24	28.63	1.06	1.30	37.02
Vega Alta .....	8.49	.01	.38	.39	24.90	1.06	1.45	42.57
Vega Baja .....	.17	.11	.47	.58	44.05	2.06	2.64	46.77
Vieques .....	.23	.01	.00	.01	8.18	.40	.41	48.90
Villalba .....	3.90	.12	.02	.14	19.09	.69	.83	36.14
Yabucoa .....	5.95	.12	.16	.28	29.52	1.33	1.61	45.05
Yauco .....	4.65	.18	.02	.20	36.55	.53	.73	14.50
Total .....	364.39	9.76	7.28	17.04	3,102.12	137.53	154.57	--

**Table 8.** Domestic self-supplied withdrawals and deliveries from public-supply systems, by municipio, for 1989

[Location of municipios shown in figure 1. Mgal/d, million gallons per day; gal/d, gallon per day; --, not applicable]

Municipio	Self supplied				Public supplied		Total withdrawals and deliveries (Mgal/d)	Per capita use (gal/d)
	Population (thousands)	Withdrawals (Mgal/d)			Population served (thousands)	Deliveries from public supply (Mga/d)		
		Surface water	Ground water	Total				
Adjuntas .....	4.95	0.03	0.16	0.19	14.43	0.54	0.73	37.42
Aguada .....	.00	.00	.00	.00	35.67	1.25	1.25	35.04
Aguadilla .....	1.65	.06	.00	.06	57.21	2.35	2.41	41.08
Aguas Buenas.....	.00	.00	.00	.00	25.35	.93	.93	36.69
Aibonito .....	.00	.00	.00	.00	25.63	1.05	1.05	40.97
Añasco.....	.00	.00	.00	.00	25.29	1.01	1.01	39.94
Arecibo.....	.00	.00	.00	.00	95.28	4.30	4.30	45.13
Arroyo .....	.00	.00	.00	.00	19.75	.87	.87	44.05
Barceloneta.....	.39	.00	.02	.02	20.36	.93	.95	45.68
Barranquitas .....	.98	.00	.04	.04	24.23	.93	.97	38.38
Bayamón .....	3.55	.98	.00	.98	204.31	11.59	12.57	56.73
Cabo Rojo .....	.00	.00	.00	.00	41.10	1.75	1.75	42.58
Caguas .....	.00	.00	.00	.00	135.72	6.04	6.04	44.50
Camuy .....	.00	.00	.00	.00	29.72	1.15	1.15	38.69
Canóvanas .....	6.95	.23	.11	.34	29.37	1.17	1.51	39.84
Carolina.....	3.84	.00	.20	.20	172.78	10.19	10.39	58.98
Cataño .....	33.75	.02	.00	.02	.00	1.48	1.50	.00
Cayey .....	.00	.00	.00	.00	48.30	1.91	1.91	39.54
Ceiba .....	4.57	.17	.00	.17	12.35	.53	.70	42.91
Ciales.....	1.98	.03	.04	.07	15.92	.61	.68	38.32
Cidra.....	.84	.00	.03	.03	34.04	1.42	1.45	41.72
Coamo .....	2.00	.01	.06	.07	31.54	1.20	1.27	38.05
Comerio.....	4.36	.02	.13	.15	15.70	.59	.74	37.58
Corozal .....	2.42	.06	.02	.08	30.19	1.09	1.17	36.10
Culebra .....	.00	.00	.00	.00	1.75	.04	.04	22.86
Dorado.....	.00	.00	.00	.00	32.25	1.55	1.55	48.06
Fajardo .....	.00	.00	.00	.00	38.08	1.66	1.66	43.59
Florida .....	.00	.00	.00	.00	9.77	.38	.38	38.89
Guánica .....	.00	.00	.00	.00	21.42	.93	.93	43.42
Guayama .....	.80	.02	.02	.04	40.65	1.70	1.74	41.82
Guayanilla.....	.27	.01	.02	.03	21.26	.96	.99	45.16
Guaynabo .....	13.47	.68	.00	.68	78.20	4.67	5.35	59.72
Gurabo.....	3.43	.01	.12	.13	24.79	1.04	1.17	41.95
Hatillo.....	1.10	.04	.01	.05	31.23	1.39	1.44	44.51
Hormigueros.....	.00	.00	.00	.00	16.49	.79	.79	47.91
Humacao .....	.00	.00	.00	.00	58.55	2.51	2.51	42.87
Isabela .....	.00	.00	.00	.00	42.02	1.77	1.77	42.12
Jayuya.....	.00	.00	.00	.00	15.73	.55	.55	34.97
Juana Díaz .....	9.16	.00	.36	.36	35.87	1.41	1.77	39.31

**Table 8.** Domestic self-supplied withdrawals and deliveries from public-supply systems, by municipio, for 1989—*Continued*

Municipio	Self supplied			Public supplied		Total withdrawals and deliveries (Mgal/d)	Per capita use (gal/d)	
	Population (thousands)	Withdrawals (Mgal/d)		Population served (thousands)	Deliveries from public supply (Mgal/d)			
		Surface water	Ground water					Total
Juncos.....	0.00	0.00	0.00	0.00	33.85	1.35	1.35	39.88
Lajas.....	.00	.00	.00	.00	24.63	1.05	1.05	42.63
Lares.....	.00	.00	.00	.00	29.12	1.08	1.08	37.09
Las Marías.....	1.32	.00	.05	.05	7.93	.06	.11	7.57
Las Piedras.....	8.84	.28	.03	.31	18.51	.76	1.07	41.06
Lóíza.....	28.46	.00	.00	.00	.00	1.43	1.43	.00
Luquillo.....	1.63	.00	.00	.00	16.15	.81	.81	50.15
Manatí.....	.00	.00	.00	.00	42.60	1.85	1.85	43.43
Maricao.....	2.73	.10	.00	.10	3.53	.14	.24	39.66
Maunabo.....	1.22	.04	.00	.04	11.07	.44	.48	39.75
Mayagüez.....	.50	.02	.00	.02	99.45	4.44	4.46	44.65
Moca.....	5.66	.21	.00	.21	26.89	.97	1.18	36.07
Morovis.....	2.30	.08	.00	.08	22.57	.82	.90	36.33
Naguabo.....	.13	.01	.00	.01	22.29	.95	.96	42.62
Naranjito.....	.00	.00	.00	.00	29.15	1.06	1.06	36.36
Orocovis.....	.00	.00	.00	.00	24.29	.76	.76	31.29
Patillas.....	.00	.00	.00	.00	19.98	.85	.85	42.54
Penuelas.....	.00	.00	.00	.00	22.57	.87	.87	38.55
Ponce.....	.73	.02	.02	.04	187.15	8.72	8.76	46.59
Quebradillas.....	.00	.00	.00	.00	23.41	.93	.93	39.73
Rincón.....	.00	.00	.00	.00	14.07	.58	.58	41.22
Río Grande.....	.00	.00	.00	.00	45.64	2.03	2.03	44.48
Sabana Grande.....	.00	.00	.00	.00	26.93	1.17	1.17	43.45
Salinas.....	.00	.00	.00	.00	29.15	1.21	1.21	41.51
San Germán.....	2.44	.10	.00	.10	32.32	1.40	1.50	43.32
San Juan.....	8.16	.00	.44	.44	429.30	26.07	26.51	60.73
San Lorenzo.....	8.00	.06	.22	.28	26.89	.97	1.25	36.07
San Sebastián.....	.00	.00	.00	.00	38.68	1.69	1.69	43.69
Santa Isabel.....	1.83	.00	.07	.07	17.54	0.69	.76	39.34
Toa Alta.....	1.26	.05	.00	.05	41.62	1.80	1.85	43.25
Toa Baja.....	.00	.00	.00	.00	97.45	4.88	4.88	50.08
Trujillo Alto.....	.00	.00	.00	.00	55.79	1.19	1.19	21.33
Utua.....	3.69	.10	.03	.13	31.24	1.18	1.31	37.77
Vega Alta.....	4.39	.01	.15	.16	29.58	1.24	1.40	41.92
Vega Baja.....	.00	.00	.00	.00	57.24	2.24	2.24	39.13
Vieques.....	.01	.00	.00	.00	8.50	.41	.41	48.24
Villalba.....	2.44	.01	.09	.10	20.84	.75	.85	35.99
Yabucoa.....	6.62	.02	.21	.23	29.36	1.09	1.32	37.13
Yauco.....	.00	.00	.00	.00	43.22	1.78	1.78	41.18
Total.....	202.82	3.47	2.65	6.12	3,352.80	157.94	164.06	--

**Table 9.** Commercial self-supplied withdrawals for hostelry and number of rooms, by municipio, for 1988 and 1989

[Location of municipios are shown in figure 1. Mgal/d, million gallons per day; gal/d, gallon per day; --, no data]

Municipio	1988		1989	
	Hostelry self-supplied withdrawals	Number of rooms	Hostelry self-supplied withdrawals	Number of rooms
Aguadilla	--	--	0.01	58
Arecibo	0.01	80	.01	80
Bayamón	.01	80	.01	80
Cabo Rojo	.02	143	.02	165
Caguas	.03	240	.03	240
Coamo	.01	48	.01	48
Dorado	.10	816	.10	816
Guánica	.01	72	--	--
Humacao	.03	278	.03	278
Lajas	.01	76	.01	76
Mayagüez	.03	232	.03	228
Ponce	.02	200	.01	200
Quebradillas	.01	73	.01	93
Rincón	.01	53	.01	53
Río Grande	.01	100	.01	100
San Germán	--	--	.01	50
Vieques	.01	117	.01	117
Total	.32	2,608	.32	2,682

**Table 10.** Self-supplied ground-water withdrawal estimates for industrial facilities, by municipio, for 1988 and 1989

[Location of municipios are shown in figure 1. Municipios at which total withdrawals are equal to or greater than 1.0 Mgal/d. All values in million gallons per day. --, no data]

Municipio	Self-supplied ground-water withdrawals	
	1988	1989
Arecibo	1.15	--
Barceloneta	1.79	2.20
Guayama	1.05	1.20
Manatí	2.17	2.25
Total	6.16	5.65

**Table 11.** Mining withdrawals by municipio, for 1988 and 1989

[Location of municipios are shown in figure 1. All withdrawals in million gallons per day]

Municipio	Freshwater withdrawals each year		
	Surface	Ground	Total
Aguada .....	0.00	0.01	0.01
Caguas .....	.01	.01	.02
Carolina .....	.06	.00	.06
Dorado .....	.00	.29	.29
Guaynabo .....	.12	.00	.12
Naranjito .....	.01	.00	.01
San Germán .....	.17	.00	.17
San Lorenzo .....	.14	.00	.14
Toa Alta .....	.19	.00	.19
Toa Baja .....	.00	1.00	1.00
Vega Alta .....	.00	.04	.04
Vega Baja .....	.00	.51	.51
Total .....	.70	1.86	2.56

## Livestock

During 1988 and 1989, livestock enterprises in Puerto Rico reported 8,557,316 animals (U.S. Department of Commerce, 1989b). The stock subcategory, which includes dairy cows, cattle, poultry, hogs and pigs, sheep and goats, totaled 8,525,121 animals. About 8.2 Mgal/d were withdrawn from surface-water and ground-water sources during 1988 and 1989 for the stock subcategory. There were 32,195 horses and rabbits reported for the animal specialties subcategory in Puerto Rico in 1988 and 1989 (U.S. Department of Commerce, 1989b). Withdrawals for the animal specialties subcategory were 0.12 Mgal/d from surface-water and ground-water sources during this period (tables 15 and 16).

**Table 12.** Self-supplied withdrawals, deliveries from public supply, and power generated by thermoelectric powerplants, by municipio, for 1988

[Location of municipios are shown in figure 1. Mgal/d, million gallons per day; GWh, gigawatthour]

Municipio	Self-supplied withdrawals (Mgal/d)			Deliveries from public supply (Mgal/d)	Total withdrawals and deliveries (Mgal/d)	Power generated (GWh)
	Saline surface water	Fresh ground water	Total			
Guayanilla.....	576.00	1.11	577.11	0.00	1.11	3,667.50
Guaynabo.....	573.00	.00	573.00	1.21	1.21	2,532.04
Salinas.....	.00	1.67	1.67	.00	1.67	3,906.44
Toa Baja.....	454.00	.00	454.00	1.58	1.58	2,502.89
Total .....	1,603.00	2.78	1,605.78	2.79	5.57	12,608.87

**Table 13.** Self-supplied withdrawals, deliveries from public supply, and power generated by thermoelectric powerplants, by municipio, for 1989

[Location of municipios are shown in figure 1. Mgal/d, million gallons per day; GWh, gigawatthour]

Municipio	Self-supplied withdrawals (Mgal/d)			Deliveries from public supply (Mgal/d)	Total withdrawals and deliveries (Mgal/d)	Power generated (GWh)
	Saline surface water	Fresh ground water	Total			
Guayanilla.....	549.00	1.27	550.27	0.00	1.27	5,288.02
Guaynabo .....	537.00	.00	537.00	1.21	1.21	2,254.94
Salinas.....	.00	1.05	1.05	.00	1.05	2,632.66
Toa Baja .....	372.00	.00	372.00	1.58	1.58	1,647.26
Total.....	1,458.00	2.32	1,460.32	2.79	5.11	11,822.88

**Table 14.** Water use and power generated by hydroelectric powerplants, by municipio, for 1988 and 1989

[Location of municipios are shown in figure 1. Mgal/d, million gallons per day; GWh, gigawatthour]

Municipio	1988		1989	
	Water use (Mgal/d)	Power generated (GWh)	Water use (Mgal/d)	Power generated (GWh)
Arecibo .....	258.44	28.08	299.47	32.53
Naguabo ....	21.42	7.92	23.38	8.60
Orocovis ....	.92	1.91	1.03	2.13
Peñuelas.....	6.60	11.56	6.55	11.49
Utuado .....	40.22	23.84	42.80	25.28
Villalba .....	11.79	17.77	12.64	18.76
Yauco.....	87.68	45.02	147.16	78.59
Total.....	427.07	136.10	533.03	177.38

## Irrigation

In Puerto Rico, about 27 percent of all offstream freshwater withdrawals in 1988 and 1989 were for irrigation purposes. The public irrigation network operated by the PREPA consists of four major irrigation systems (fig. 7). These systems operate as follow;

1. Guayama Irrigation District (south coast), withdraws water from the Río Guamaní and Lago Patillas and delivers it to agricultural lands in Patillas, Arroyo, Guayama, and Salinas;
2. Juana Díaz Irrigation District (south coast), withdraws water from Lago Guayabal and delivers it to agricultural lands in Juana Díaz and Santa Isabel;
3. Valle de Lajas Irrigation District (southwest), withdraws water from Lago Loco and delivers it to Cabo Rojo, Lajas, Guánica, and some sections of Yauco and Sabana Grande;

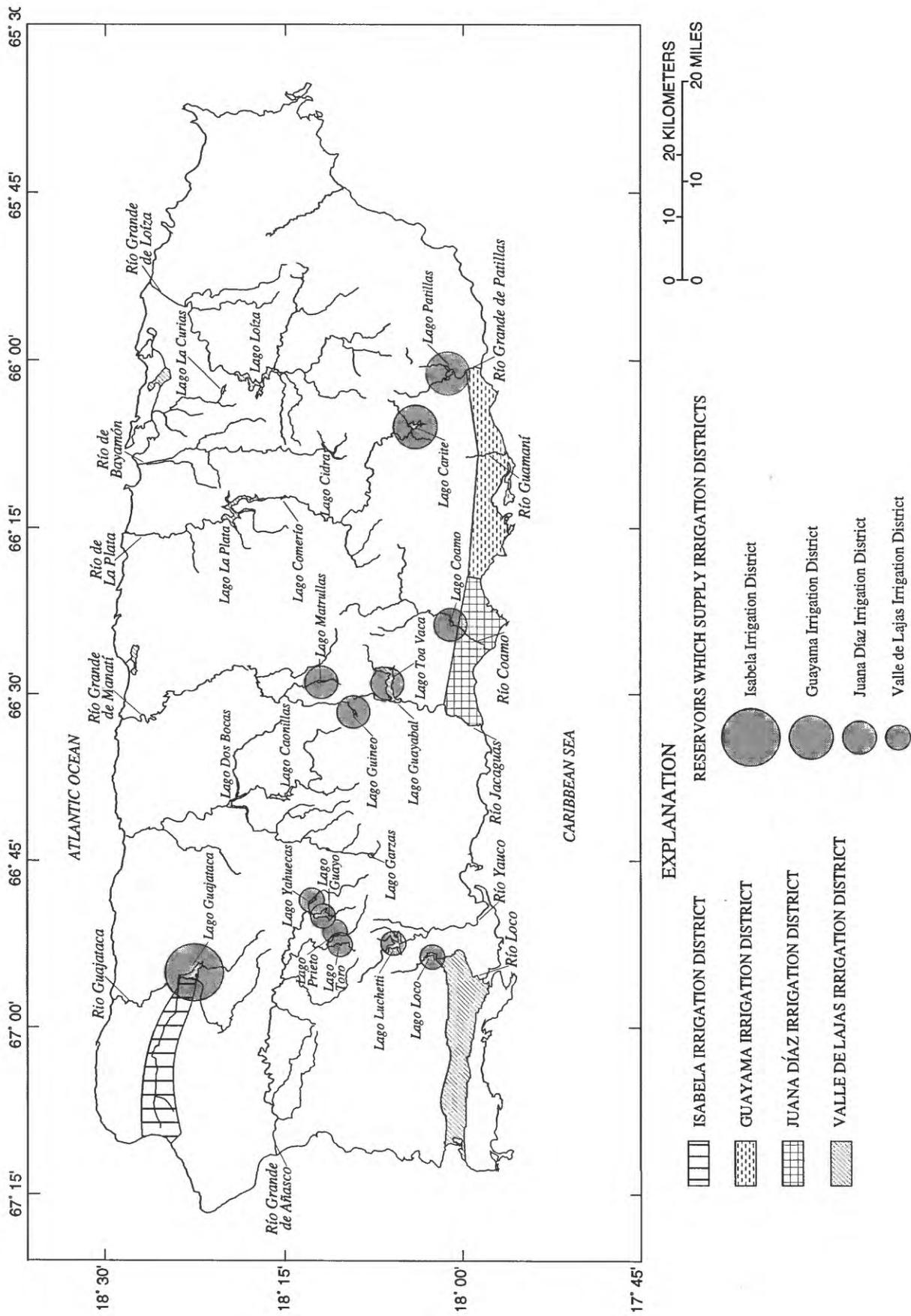


Figure 7. Location of irrigation districts and principal reservoirs in Puerto Rico.

**Table 15.** Total freshwater withdrawals and number of animals served for the stock subcategory, by municipio, for 1988 and 1989

[Location of municipios are shown in figure 1. Total freshwater withdrawals less than 10,000 gallons per day are shown as 0.00 and are not included in totals. Mgal/d, million gallons per day]

Municipio	Freshwater withdrawals (Mga/d)			Stock population					Total
	Surface water	Ground water	Total	Dairy cows	Cattle	Poultry	Hogs and pigs	Sheep and goats	
Adjuntas .....	0.02	0.00	0.02	114	496	60,798	855	63	62,326
Aguada .....	.00	.02	.02	78	750	5,523	778	195	7,324
Aguadilla .....	.00	.04	.04	454	1,613	9,385	700	98	12,250
Aguas Buenas.....	.03	.00	.03	118	1,402	23,923	1,313	276	27,032
Aibonito .....	.00	.11	.11	206	3,165	906,399	1,990	662	912,422
Añasco.....	.00	.01	.01	33	630	4,321	610	84	5,678
Arecibo.....	.00	.61	.61	13,563	8,638	127,970	6,462	671	157,304
Arroyo .....	.00	.01	.01	18	520	33,782	192	250	34,762
Barceloneta.....	.00	.05	.05	1,160	707	509	447	279	3,102
Barranquitas .....	1.00	.00	1.00	199	1,746	982,059	1,973	594	986,571
Bayamón .....	.29	.00	.29	45	597	7,098	4,751	300	12,791
Cabo Rojo .....	.00	.12	.12	629	7,412	20,494	813	995	30,343
Caguas.....	.01	.17	.18	3,150	2,874	281,438	2,674	182	290,318
Camuy .....	.00	.31	.31	7,001	4,564	14,811	2,655	309	29,340
Canóvanas .....	.00	.08	.08	515	3,059	24,558	4,133	1,177	33,442
Carolina.....	.11	.00	.11	1,725	2,721	63,353	1,943	230	69,972
Cataño .....	.00	.00	.00	0	0	0	0	0	0
Cayey .....	.00	.11	.11	904	2,777	499,526	3,667	661	507,535
Ceiba .....	.03	.00	.03	224	1,363	25,070	953	60	27,670
Ciales.....	.00	.03	.03	386	1,182	10,424	428	210	12,630
Cidra.....	.11	.00	.11	1,134	2,771	302,814	3,538	992	311,249
Coamo .....	.00	.23	.23	483	9,242	1,505,883	2,375	2,984	1,520,967
Comerio.....	.07	.00	.07	125	1,391	546,882	4,635	417	553,450
Corozal .....	.08	.00	.08	741	2,206	196,218	3,922	416	203,503
Culebra.....	.01	.00	.01	0	896	500	10	937	2,343
Dorado.....	.00	.09	.09	1,977	1,602	8,977	400	20	12,976
Fajardo .....	.06	.00	.06	670	2,782	10,716	352	276	14,796
Florida .....	.00	.02	.02	341	307	1,100	47	39	1,834
Guánica .....	.00	.03	.03	29	1,935	931	1,038	1,001	4,934
Guayama .....	.00	.04	.04	115	2,014	115,141	838	1,091	119,199
Guayanilla .....	.00	.03	.03	36	2,146	2,528	867	192	5,769
Guaynabo .....	.02	.00	.02	38	595	49,599	2,045	74	52,351
Gurabo.....	.00	.11	.11	2,218	1,994	20,012	1,328	181	25,733
Hatillo.....	.00	.93	.93	23,775	7,358	21,687	1,077	454	54,351
Hormigueros.....	.00	.02	.02	305	547	900	236	90	2,078
Humacao .....	.00	.07	.07	811	3,052	2,297	1,136	233	7,529
Isabela .....	.00	.12	.12	2,164	2,543	6,583	2,538	328	14,156
Jayuya.....	.02	.00	.02	55	730	13,726	1,919	165	16,595
Juana Díaz.....	.00	.08	.08	535	2,883	42,613	4,692	666	51,389

**Table 15.** Total freshwater withdrawals and number of animals served for the stock subcategory, by municipio, for 1988 and 1989—Continued

Municipio	Freshwater withdrawals (Mga/d)			Stock population					
	Surface water	Ground water	Total	Dairy cows	Cattle	Poultry	Hogs and pigs	Sheep and goats	Total
Juncos.....	0.00	0.15	0.15	2,972	3,331	2,428	1,318	250	10,299
Lajas.....	.00	.15	.15	614	10,010	52,311	1,589	1,516	66,040
Lares.....	.02	.00	.02	163	711	44,903	508	147	46,432
Las Marías.....	.01	.00	.01	135	225	9,125	699	115	10,299
Las Piedras.....	.22	.00	.22	4,086	5,477	60,269	1,517	138	71,487
Loíza.....	.04	.00	.04	172	1,528	7,132	2,628	349	11,809
Luquillo.....	.04	.00	.04	556	1,099	60,638	1,505	34	63,832
Manatí.....	.01	.16	.17	2,861	2,873	12,410	6,273	459	24,876
Maricao.....	.01	.00	.01	50	288	2,321	153	95	2,907
Maunabo.....	.02	.00	.02	83	1,255	1,790	407	203	3,738
Mayagüez.....	.00	.04	.04	330	1,318	15,406	1,476	317	18,847
Moca.....	.04	.00	.04	302	1,935	3,956	1,226	155	7,574
Morovis.....	.16	.00	.16	2,947	3,874	5,983	2,636	508	15,948
Naguabo.....	.27	.00	.27	4,948	4,460	1,752	11,085	236	22,481
Naranjito.....	.06	.00	.06	223	1,286	365,706	2,814	635	370,664
Orocovis.....	.05	.00	.05	757	1,435	9,784	759	245	12,980
Patillas.....	.00	.05	.05	84	3,487	51,015	1,424	473	56,483
Peñuelas.....	.00	.03	.03	7	1,934	23,117	614	242	25,914
Ponce.....	.00	.05	.05	43	2,577	11,774	4,023	1,143	19,560
Quebradillas.....	.00	.10	.10	1,997	1,978	5,838	1,645	189	11,647
Rincón.....	.00	.02	.02	15	1,275	4,526	215	65	6,096
Río Grande.....	.06	.00	.06	109	3,048	143,323	1,715	553	148,748
Sabana Grande.....	.00	.02	.02	26	1,406	1,014	596	174	3,216
Salinas.....	.00	.09	.09	145	2,689	760,024	1,262	1,664	765,784
San Germán.....	.00	.05	.05	92	3,153	60,812	2,131	391	66,579
San Juan.....	.01	.00	.01	40	102	97,969	981	57	99,149
San Lorenzo.....	.13	.00	.13	1,592	5,581	12,366	2,115	381	22,035
San Sebastián.....	.19	.00	.19	3,966	3,927	7,276	1,673	235	17,077
Santa Isabel.....	.00	.01	.01	6	676	325	150	52	1,209
Toa Alta.....	.11	.00	.11	2,172	1,581	41,400	1,812	143	47,108
Toa Baja.....	.00	.04	.04	556	1,536	220	254	18	2,584
Trujillo Alto.....	.03	.00	.03	270	1,036	27,302	2,190	254	31,052
Utua.....	.07	.00	.07	751	2,463	86,042	2,708	688	92,652
Vega Alta.....	.00	.05	.05	717	1,539	2,164	1,459	160	6,039
Vega Baja.....	.00	.08	.08	1,441	1,244	63,315	1,211	340	67,551
Vieques.....	.00	.10	.10	350	6,917	111	96	130	7,604
Villalba.....	.04	.00	.04	98	1,951	41,128	1,496	367	45,040
Yabucoa.....	.00	.08	.08	939	2,923	4,915	3,432	162	12,371
Yauco.....	.00	.05	.05	120	3,097	6,505	906	768	11,396
Total.....	3.45	4.76	8.21	102,809	190,435	8,058,943	141,031	31,903	8,525,121

**Table 16.** Total freshwater withdrawals and number of animals served for the animal specialties subcategory, by municipio, for 1988 and 1989

[Location of municipios are shown in figure 1. Mgal/d, million gallons per day]

Municipal	Freshwater withdrawals (Mgal/d)			Animal specialties population (excluding fish farms)			Municipal	Freshwater withdrawals (Mgal/d)			Animal specialties population (excluding fish farms)		
	Surface water	Ground water	Total	Horses	Rabbits	Total		Surface water	Ground water	Total	Horses	Rabbits	Total
Adjuntas.....	0.00	0.00	0.00	115	93	208	Lajas .....	0.00	0.10	0.01	271	162	433
Aguada.....	.00	.00	.00	45	113	158	Lares .....	.00	.00	.00	87	210	297
Aguadilla .....	.00	.00	.00	4	0	4	Las Marías .....	.00	.00	.00	34	210	244
Aguas Buenas ..	.00	.00	.00	90	105	195	Las Piedras.....	.01	.00	.01	200	396	596
Aibonito.....	.00	.00	.00	274	775	1,049	Loíza .....	.00	.00	.00	82	0	82
Añasco.....	.00	.00	.00	23	110	133	Luquillo .....	.01	.00	.01	277	0	277
Arecibo .....	.00	.00	.00	176	290	466	Manatí.....	.00	.00	.00	60	928	988
Arroyo.....	.00	.00	.00	31	0	31	Maricao.....	.00	.00	.00	3	161	164
Barceloneta.....	.00	.00	.00	18	210	228	Maunabo .....	.00	.00	.00	44	105	149
Barranquitas.....	.00	.00	.00	97	97	194	Mayagüez .....	.00	.00	.00	75	1,542	1,617
Bayamón.....	.00	.00	.00	78	58	136	Moca.....	.00	.00	.00	58	0	58
Cabo Rojo.....	.00	.01	.01	248	275	523	Morovis.....	.01	.00	.01	288	240	528
Caguas .....	.00	.01	.01	157	284	441	Naguabo.....	.00	.00	.00	103	210	313
Camuy.....	.00	.00	.00	102	1,791	1,893	Naranjito .....	.00	.00	.00	43	1,187	1,230
Canóvanas.....	.00	.00	.00	222	1,239	1,461	Orocovis .....	.00	.00	.00	78	305	383
Carolina .....	.00	.00	.00	104	210	314	Patillas .....	.00	.00	.00	201	237	438
Cataño.....	.00	.00	.00	0	0	0	Peñuelas.....	.00	.00	.00	69	105	174
Cayey.....	.00	.00	.00	131	192	323	Ponce .....	.00	.00	.00	203	244	447
Ceiba.....	.00	.00	.00	109	0	109	Quebradillas.....	.00	.00	.00	34	210	244
Ciales .....	.00	.00	.00	45	0	45	Rincón.....	.00	.00	.00	39	110	149
Cidra .....	.00	.00	.00	92	1,313	1,405	Río Grande.....	.00	.00	.00	177	186	363
Coamo.....	.00	.02	.02	1,025	220	1,245	Sabana Grande.	.00	.00	.00	51	320	371
Comerio .....	.00	.00	.00	161	1,037	1,198	Salinas.....	.00	.01	.01	236	105	341
Corozal .....	.00	.00	.00	86	284	370	San Germán ....	.00	.00	.00	109	218	327
Culebra .....	.00	.00	.00	68	105	173	San Juan.....	.00	.00	.00	37	121	158
Dorado.....	.00	.00	.00	61	105	166	San Lorenzo.....	.01	.00	.01	183	240	423
Fajardo.....	.00	.00	.00	88	105	193	San Sebastián...	.00	.00	.00	68	444	512
Florida.....	.00	.00	.00	8	0	8	Santa Isabel.....	.00	.00	.00	45	0	45
Guánica.....	.00	.00	.00	62	0	62	Toa Alta .....	.00	.00	.00	133	70	203
Guayama.....	.00	.00	.00	247	194	441	Toa Baja.....	.00	.01	.01	259	105	364
Guayanilla.....	.00	.00	.00	131	0	131	Trujillo Alto.....	.00	.00	.00	74	439	513
Guaynabo.....	.00	.00	.00	37	105	142	Utuaado .....	.00	.00	.00	132	271	403
Gurabo .....	.00	.00	.00	154	206	360	Vega Alta .....	.00	.00	.00	46	210	256
Hatillo.....	.00	.00	.00	206	818	1,024	Vega Baja.....	.00	.00	.00	75	675	750
Hormigueros ....	.00	.00	.00	19	311	330	Vieques .....	.00	.00	.00	143	105	248
Humacao.....	.00	.00	.00	170	531	701	Villalba .....	.00	.00	.00	97	0	97
Isabela.....	.00	.01	.01	218	220	438	Yabucoa .....	.00	.00	.00	102	203	305
Jayuya.....	.00	.00	.00	155	572	727	Yauco .....	.00	.00	.00	93	312	405
Juana Díaz .....	.00	.00	.00	164	0	164	Total.....	0.04	0.08	0.12	9,606	22,589	32,195
Juncos .....	.00	.00	.00	76	35	111							

4. Isabela Irrigation District (northwest), withdraws water from Lago Guajataca and delivers it to the municipios of Aguadilla, Isabela, and Moca.

Irrigation withdrawals averaged about 170 and 150 Mgal/d during 1988 and 1989, respectively, to irrigate 48,070 acres in 1988 and 35,540 acres in 1989. Surface-water sources accounted for 67 percent (116 Mgal/d) of the total withdrawals in 1988; ground-water sources accounted for 32 percent (56 Mgal/d). During 1989, water withdrawals from surface-water sources accounted 77 percent (115 Mgal/d) and ground-water withdrawals 23 percent (34 Mgal/d) (tables 17 and 18).

### Reservoir Evaporation

The amount of water that evaporated from 14 reservoirs throughout Puerto Rico was estimated to be about 23,700 acre-ft in 1988 and 1989 from a total reservoir area of 6,390 acres. Lago Toa Vaca and Lago Guayabal in Villalba had the largest amount of evaporation, totaling 5,790 acre-ft in 1988 and 5,950 acre-ft in 1989 from a total reservoir area of 1,160 acres (table 19).

**Table 17.** Freshwater withdrawals and irrigated land by type for irrigation use, by municipio, for 1988

[Location of municipios are shown in figure 1. Mgal/d, million gallons per day]

Municipio <sup>35</sup>	Freshwater withdrawals (Mgal/d)			Irrigated land by type (thousand acres)		
	Surface water	Ground water	Total	Spray	Flood	Total
Aguadilla .....	0.33	0.04	0.37	0.02	0.17	0.19
Arroyo .....	1.78	1.28	3.06	.66	.92	1.58
Cabo Rojo .....	.39	.58	.97	.30	.20	.50
Coamo .....	.12	.73	.85	.38	.06	.44
Fajardo .....	.00	.19	.19	.10	.00	.10
Guánica .....	1.70	1.14	2.84	.59	.88	1.47
Guayama .....	7.30	.48	7.78	1.73	3.57	5.30
Isabela .....	.75	.15	.90	.08	.39	.47
Juana Díaz .....	.00	15.12	15.12	3.09	.77	3.86
Lajas .....	6.65	2.03	8.68	1.05	3.44	4.49
Patillas .....	33.03	.00	33.03	.00	.76	.76
Peñuelas .....	.00	.01	.01	.00	.00	.00
Ponce .....	.00	3.70	3.70	5.88	1.67	7.55
Quebradillas ...	19.98	.00	19.98	.19	.58	.77
Salinas .....	.00	12.23	12.23	4.65	.62	5.27
Santa Isabel ....	.00	18.02	18.02	6.39	2.03	8.42
Villalba .....	21.96	.00	21.96	.00	.05	.05
Yabucoa .....	.00	.06	.06	.03	.00	.03
Yauco .....	22.44	.00	22.44	2.26	4.56	6.82
Total .....	116.43	55.76	172.19	27.40	20.67	48.07

**Table 18.** Freshwater withdrawals and irrigated land by type for irrigation use, by municipio, for 1989

[Location of municipios are shown in figure 1. Mgal/d, million gallons per day]

Municipio	Freshwater withdrawals (Mgal/d)			Irrigated land by type (thousand acres)		
	Surface water	Ground water	Total	Spray	Flood	Total
Aguadilla .....	0.33	0.04	0.37	0.02	0.17	0.19
Arroyo .....	1.86	.91	2.77	.47	.96	1.43
Cabo Rojo .....	.39	.58	.97	.30	.20	.50
Coamo .....	.12	.73	.85	.38	.06	.44
Fajardo .....	.00	.19	.19	.10	.00	.10
Guánica .....	1.70	1.14	2.84	.59	.88	1.47
Guayama .....	9.02	.00	9.02	1.36	.00	1.36
Isabela .....	.75	.15	.90	.08	.39	.47
Juana Díaz .....	1.49	5.97	7.46	3.09	.77	3.86
Lajas .....	6.65	2.03	8.68	1.05	3.44	4.49
Patillas .....	29.10	.00	29.10	.00	.76	.76
Ponce .....	.08	7.15	7.23	3.70	.04	3.74
Quebradillas .....	19.53	.00	19.53	.19	.58	.77
Salinas .....	1.22	5.82	7.04	3.01	.63	3.64
Santa Isabel .....	1.55	8.93	10.48	4.62	.80	5.42
Villalba .....	19.04	.00	19.04	.00	.05	.05
Yabucoa .....	.00	.06	.06	.03	.00	.03
Yauco .....	22.27	.00	22.27	2.26	4.56	6.82
Total .....	115.10	33.70	148.80	21.25	14.29	35.54

**Table 19.** Water evaporation from reservoirs and their surface area, by municipio, for 1988 and 1989

[Location of municipios are shown in figure 1]

Municipio	Reservoir	Reservoir area (thousand acres)	Evaporation (thousand acre-feet)	
			1986	1987
Adjuntas .....	Lago Garzas	0.10	0.34	0.35
Adjuntas .....	Lago Guayo	.28	.90	.92
Arecibo .....	Lago Dos Bocas	.63	1.97	1.98
Cidra .....	Lago Cidra	.27	.92	.90
Comerio .....	Lago Comerío II	.06	.19	.19
Guayama .....	Lago Carite	.33	1.05	1.08
Patillas .....	Lago Patillas	.31	1.22	1.18
Quebradillas .....	Lago Guajataca	1.00	3.70	3.66
Toa Alta .....	Lago La Plata	.56	1.74	1.75
Trujillo Alto .....	Lago Lofza	.71	2.62	2.48
Utua .....	Lago Caonillas	.70	2.17	2.19
Villalba .....	Lago Toa Vaca	.84	4.16	4.27
Villalba .....	Lago Guayabal	.33	1.63	1.67
Yauco .....	Lago Luchetti	.27	1.12	1.11
Total .....		6.39	23.73	23.73

## SUMMARY

Water use was estimated for the 78 municipios of the Commonwealth of Puerto Rico during 1988 and 1989. Eight offstream water-use categories were considered during the study—public supply, domestic, commercial, industrial, mining, thermoelectric, livestock, and irrigation. Other water-use categories considered were hydroelectric, reservoir evaporation, and saline water used at thermoelectric powerplants as instream uses and sewage treatment as a water-use related category.

Freshwater withdrawals from surface-water and ground-water sources in 1988 totaled 630 Mgal/d: surface-water withdrawals totaled 461 Mgal/d and ground-water withdrawals totaled 169 Mgal/d. Freshwater withdrawals during 1989 from surface-water and ground-water sources totaled 573 Mgal/d: surface-water withdrawals totaled 444 Mgal/d and ground-water withdrawals totaled 129 Mgal/d.

The largest amount of potable water delivered by the PRASA during 1988 and 1989 was for unaccounted uses, 59 percent (247 Mgal/d) and 45 percent (181 Mgal/d), respectively. The next largest delivery was for domestic uses, 33 percent (138 Mgal/d) in 1988 and 40 percent (158 Mgal/d) during 1989.

The number of public sewage-treatment facilities decreased from 98 in 1988 to 87 in 1989. Total discharge from public sewage-treatment facilities was 98 Mgal/d in 1988 and 123 Mgal/d in 1989.

The population served by self-supplied systems was estimated to be about 364,000 in 1988 and 202,000 in 1989, which represents withdrawals of 17 Mgal/d in 1988 and 6 Mgal/d in 1989. Commercial self-supplied withdrawals were estimated to be less than 1 Mgal/d during 1988 and 1989.

Industrial self-supplied ground-water withdrawals were estimated at about 7 Mgal/d during 1988 and 1989. Mining water-use activities during 1988 and 1989 required an estimated of 2.6 Mgal/d of water during both years, primarily for the production of sand and gravel. Puerto Rico has four thermoelectric powerplants that generated 12,600 GWh of electricity with an instream water use of 1,600 Mgal/d in 1988 and 11,820 GWh of electricity with an instream water use of 1,450 Mgal/d during 1989. Freshwater deliveries from the PRASA to the Puerto Nuevo and

Palo Seco powerplants during 1988 and 1989 were 2.8 Mgal/d. Withdrawals of self-supplied ground water for Aguirre and Costa Sur powerplants were 2.8 Mgal/d in 1988 and 2.3 Mgal/d in 1989. Hydroelectric powerplants generated 136 GWh of electricity in 1988 with an average instream water use of 427 Mgal/d and 177 GWh during 1989 with an average instream water use of 533 Mgal/d.

Livestock enterprises reported 8,557,316 animals in Puerto Rico during 1988 and 1989. The stock sub-category withdraw from surface-water and ground-water sources 8.2 Mgal/d and the animal specialties sub-category withdrew 0.12 Mgal/d during this period.

Irrigation withdrawals accounted 116 Mgal/d from surface-water sources and 56 Mgal/d from ground-water sources for 1988. During 1989, the water withdrawals from surface-water sources were 115 Mgal/d and from ground-water withdrawals 34 Mgal/d. An estimated 23,700 acre-ft of water was evaporated from a total reservoir surface area of 6,390 acres during 1988 and 1989.

## REFERENCES

- Kirk, J.R., Jarhoe, J., Sanderson, E.W., Sasman, R.T., and Lonquist, C., 1982, Water withdrawals in Illinois, 1980: Illinois State Water Survey Circular 152, 47 p.
- Metcalf and Eddy, 1972, Wastewater engineering treatment-disposal-reuse: McGraw-Hill, New York, 920 p.
- Puerto Rico Aqueduct and Sewer Authority, 1988a, Annual Water Production Report 1987-88, 89 p.
- \_\_\_\_\_, 1988b, Statistical Report for Executive Director, (Monthly Reports).
- \_\_\_\_\_, 1989a, Annual Water Production Report 1988-89, 93 p.
- \_\_\_\_\_, 1989b, Statistical Report for Executive Director, (Monthly Reports).
- \_\_\_\_\_, 1990, Annual Water Production Report 1989-90, 110 p.
- Puerto Rico Department of Health, 1988, NON-PRASA Systems Inventory, 36 p.
- \_\_\_\_\_, 1989, NON-PRASA Systems Inventory, 35 p.
- Tourism Company of Puerto Rico, 1991, Office of Statistics and Economic Studies—Selected Statistics: 95 p.
- U.S. Department of Commerce, 1982, 1980 census of population and housing: Puerto Rico, Bureau of the Census, PHC80-V-53, 11 p.
- \_\_\_\_\_, 1988, Climatological data annual summary, Puerto Rico and the Virgin Islands: National Oceanic and Atmospheric Administration, v. 34, no. 13, 21 p.
- \_\_\_\_\_, 1989a, Climatological data annual summary, Puerto Rico and the Virgin Islands: National Oceanic and Atmospheric Administration, v. 35, no. 13, 21 p.

U.S. Department of Commerce, 1989b, 1987 census of agriculture: Puerto Rico, Bureau of the Census, AC 87-A-52, 217 p.

\_\_\_\_ 1991, 1990 census of population and housing: Puerto Rico, Bureau of Census, CPH-1-53, 199 p.

## GLOSSARY

**Commercial water use:** Water for motels, hotels, restaurants, office buildings, other commercial facilities, and civilian and military institutions. Water is obtained from a public supply or is self supplied.

**Consumptive use:** That part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment.

**Domestic water use:** Water for household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. Water is obtained from a public supply or is self supplied.

**Freshwater:** Water that contains less than 1,000 milligrams per liter (mg/L) of dissolved solids; generally, more than 500 mg/L of dissolved solids is undesirable for drinking and many industrial uses.

**Ground water:** Generally all subsurface water as distinct from surface water; specifically, that part of the subsurface water in the saturated zone, where the water is under pressure greater than atmospheric.

**Hydroelectric power water use:** The use of water in generating electricity at powerplants where the turbine generators are driven by falling water; an instream use.

**Industrial water use:** Water used to manufacture products such as steel, chemical, and paper products. The category includes water used in petroleum refining such as processing, washing, and cooling operations. This category includes self-supplied water and water purchased from a water supplier.

**Instream use:** Water use taking place within the stream channel for such purposes as hydroelectric power generation, navigation, water-quality improvement, fish propagation, and recreation. In Puerto Rico, instream water is primarily used in the generation of hydroelectric power.

**Irrigation water use:** Application of water on lands to assist in the growing of crops and pastures or to maintain vegetative growth in recreational lands, such as parks and golf courses.

**Livestock water use:** Water for stock watering, feed lots, dairy operations, fish farming, and other farm needs. Livestock as used here includes cattle, sheep, goats, hogs, and poultry. Also included are such animal specialties as horses, rabbits, bees, pets, fur-bearing animals in captivity, and fish in captivity.

**Mining water use:** Water use for the extraction of minerals occurring naturally including solids, such as coal and ores; liquids, such as crude petroleum; and gases, such as natural gas. Also includes uses associated with quarrying, well operations (dewatering), milling (crushing, screening, washing floatation, and so forth), and other preparations customarily completed at the mine site or as part of a mining activity. The primary mining activity in Puerto Rico is the production of sand and gravel.

**Municipio:** Is the minimum legal or jurisdictional unit in Puerto Rico as used by the U.S. Bureau of Census. It is more or less equivalent to a county in the United States.

**Offstream use:** Water withdrawn or diverted from a ground- or surface-water source for use in public supply, industry, irrigation, livestock, thermoelectric power generation, and other activities.

**Per capita water use:** The average amount of water used per person during a standard time period, generally per day.

**Public-supply facilities:** Water withdrawn by public and private water suppliers and delivered to groups of users. Public suppliers provide water for various uses, such as domestic, commercial, thermoelectric power, industrial, and public water use.

**Public water use:** Water supplied from a public supply and used for such purposes as firefighting, street washing, and municipal parks and swimming pools.

**Reservoir evaporation:** Water loss by evaporation from impoundments that have a normal capacity equal to or greater than 5,000 acre-feet. Normal capacity defined as the total volume in a reservoir below the average retention level, including dead storage but excluding flood-control and surcharge storage.

**Saline water:** Water that contains more than 1,000 mg/L of dissolved solids.

**Self-supplied:** Water withdrawn from a surface-water or ground-water source by a user rather than being obtained from a public supply.

**Sewage:** Wastewater carried off by sewer and drains.

**Sewage treatment:** The processing of wastewater for the removal or reduction of contained solids or other undesirable constituents.

**Surface water:** An open body of water, such as a stream or a lake.

**Thermoelectric power water use:** The amount of water used in the production of electric power generated with fossil fuel. Fossil fuels include coal, oil, and natural gas. The water used is self-supplied or is delivered by a water supplier through a distribution system.

**Wastewater:** Water that carries wastes from homes, businesses, and industries.

**Withdrawal:** Water removed from the ground or diverted from a surface-water source for use.