

Accuracy of Data for Selected Categories Compiled in the Puerto Rico Water-Use Information Program



U.S. Department of the Interior—U.S. Geological Survey

Introduction

The National Water-Use Information Program (NWIP) of the U.S. Geological Survey (USGS) is a Federal-State Cooperative Program designed to compile, store, and disseminate water-use information locally and nationally. A reliable water-use data base is needed in Puerto Rico to provide historic water-use information to enable scientists to estimate the hydrologic effect of future water demands. The Puerto Rico Water-Use Information Program (PRWIP) was implemented in 1980 to meet this need. Several studies have been conducted by USGS and local cooperative agencies in order to obtain reliable data for selected water-use categories. This report presents information about the accuracy of water-use data reported by categories such as public supply, sewage treatment, and hydroelectric water-use categories. The reported information was compared to site-inspections, production read-outs, USGS unpublished data, and continuous surface-water monitoring data for station 50027750.

Public-Supply Wells

Public-supply wells are tapping aquifers which yield water to public or private water suppliers. This water is then delivered to multiple users for domestic, commercial, industrial, and thermoelectric power uses. The Puerto Rico Aqueduct and Sewer Authority (PRASA) is the primary user of the ground-water resources within the North Coast Limestone aquifer system. Nine municipios located along the north coast of Puerto Rico (Arecibo, Barceloneta, Camuy, Dorado, Florida, Hatillo, Manatí, Vega Alta, and Vega Baja) withdraw a significant amount of their potable water-supply needs from the North Coast Limestone aquifer system (fig. 1). The municipios are shown in figure 1 and coincide with the most productive part of the North Coast Limestone aquifer system. From 1986 to 1990, ground-water withdrawal estimates made by the USGS indicated that withdrawals from this aquifer system for public supply in these municipios were approximately 40

million gallons per day (Mgal/d; Molina-Rivera and Dopazo, 1995; and Dopazo and Molina-Rivera, 1995).

During 1991 and 1992, the USGS conducted an audit of all active public-supply wells within the study area. The main objective of the study was to accurately determine the amount of water withdrawn by the PRASA from aquifers in the central and western portions of the North Coast aquifer system (fig. 1). Data obtained during the audit included cumulative and instantaneous well discharge, electric meter identification and kilowatt-hour readings, motor horsepower rating, and well head discharge pressure (S. Guzmán-Ríos, USGS, written commun., 1996). The instantaneous well discharges obtained by the USGS were compared with the mean annual well discharges reported by the PRASA for 82 active wells to determine the feasibility of using instantaneous well discharge rate from public water-supply wells to obtain mean annual withdrawal estimates. This mean daily value, expressed as gallons per minute



Figure 1. Location of the study area in the north coast of Puerto Rico.

Table 1. Distribution in percent difference obtained from instantaneous well discharge measured by the U.S. Geological Survey and mean annual well discharge reported by the Puerto Rico Aqueduct and Sewer Authority for wells located along the North Coast Limestone aquifer system, Puerto Rico, 1991-92

[Percent difference calculated as USGS value - PRASA value / PRASA value * 100; ≤, less or equal than; ≥, great or equal than; ---, no maximum or minimum]

Municipio	Instantaneous well discharge range (gallons per minutes)	Number of wells in group	Percent difference		Average percent differences
			Maximum	Minimum	
Arecibo	≤100	7	186	-47	50
	101-150	7	20	-61	17
	151-200	1	---	---	17
	201-250	2	181	13	97
	≥251	9	17	-11	5
Barceloneta	≤100	0	0	0	0
	101-150	1	---	---	12
	151-200	1	---	---	28
	201-250	0	0	0	0
	≥251	1	---	---	8
Camuy	≤100	1	---	---	3
	101-150	2	25	10	17
	151-200	0	0	0	0
	201-250	0	0	0	0
	≥251	0	0	0	0
Dorado	≤100	2	561	125	343
	101-150	1	---	---	115
	151-200	0	0	0	0
	201-250	0	0	0	0
	≥251	8	33	1	17
Florida	≤100	4	53	13	35
	101-150	0	0	0	0
	151-200	3	18	-36	21
	201-250	1	---	---	2
	≥251	1	---	---	84
Hatillo	≤100	2	5	3	4
	101-150	1	---	---	14
	151-200	0	0	0	0
	201-250	0	0	0	0
	≥251	0	0	0	0
Manati	≤100	4	291	26	139
	101-150	2	12	-14	13
	151-200	1	---	---	19
	201-250	0	0	0	0
	≥251	8	43	-38	12
Vega Alta	≤100	0	0	0	0
	101-150	1	---	---	22
	151-200	0	0	0	0
	201-250	0	0	0	0
	≥251	1	---	---	13
Vega Baja	≤100	1	---	---	5
	101-150	1	---	---	0
	151-200	0	0	0	0
	201-250	1	---	---	2
	≥251	7	13	-6	4

(gal/min), was compared with the instantaneous well discharge obtained in the USGS audit to calculate the expected percent error of the discharge estimate by municipio and well size (table 1).

The results of the areal public water-supply ground-water withdrawal survey indicate that in the absence of monthly meter readings, instantaneous well discharge rates can be used to:

(1) estimate the mean annual ground-water withdrawal rate from the upper aquifer system (which includes essentially all wells tapping the unconfined aquifer north of latitude 18° 25') within an accuracy of about 10 percent; and,

(2) estimate the mean annual ground-water withdrawal rate at the municipio level within an accuracy of 20 percent, giving proper consideration to wells taken out of production for major maintenance work or other reasons. Otherwise, the municipio aggregated mean annual withdrawal estimate could have an accuracy of less than 65 percent.

Public Sewage-Treatment Plants Discharge

Public sewage-treatment plants (STP's) receive and treat sewage from various water users. The USGS conducted a study in cooperation with the PRASA during 1986 to 1987 to determine the mean daily outflow rate at 12 public STP's located throughout Puerto Rico over a 15- to 20-day period. These STP's were located in Barranquitas, Coamo, Corozal, Guayanilla, Luquillo, Naguabo, San Lorenzo, Toa Alta, Utuado, Vieques, Villalba, and Yauco (fig. 2). The daily mean effluent discharges measured by the USGS at each of these STP's were compared with the mean annual discharge reported by the PRASA.

At each of the STP's a rating curve of the effluent discharge was generated by measuring the flow using a 90-degree V-notch thin-plate weir and a stage recorder. Each weir was carefully inspected by USGS hydrologists to ensure proper installation and the theoretical



Figure 2. Location of selected public sewage-treatment plants in Puerto Rico.

stage-discharge rating was used for discharge computations. Discharge data collected from the weirs were determined to be accurate. The stage was determined with a recording instrument and verified with a manual readout staff gage. The stage recorders used were digital recorders with a precision of 0.01 foot. The PRASA values for mean annual effluent discharge were obtained from two reports that contain inflow and outflow data for all public STP's located in Puerto Rico (PRASA, 1987, 1988).

The total effluent discharge estimated by the USGS for the 12 STP's was 4.97 Mgal/d; the mean effluent discharge reported by the PRASA was 5.45 Mgal/d. The average percent difference between the total effluent discharge values reported by the USGS and the mean annual effluent discharge values reported by the PRASA range from 40 to -54 with an average absolute difference of 20 percent (table 2).

Table 2. Total effluent discharges estimated by the U.S. Geological Survey and mean annual discharges reported by the Puerto Rico Aqueduct and Sewer Authority for 12 public sewage-treatment plants located throughout Puerto Rico, 1986-87, and percent difference between these values

[Percent difference calculated as PRASA value - USGS value / USGS value * 100; Mgal/d, million gallons per day]

Sewage-treatment plant location	Mean effluent discharge (Mgal/d)		Average percent difference
	USGS	PRASA	
Barranquitas	0.20	0.28	40
Coamo	0.53	0.63	19
Corozal	0.49	0.56	14
Guayanilla	0.36	0.38	6
Luquillo	0.58	0.70	21
Naguabo	0.22	0.10	-54
San Lorenzo	0.58	0.67	15
Toa Alta	0.33	0.33	0
Utuado	0.48	0.48	0
Vieques	0.18	0.15	-17
Villalba	0.23	0.16	-30
Yauco	0.79	1.01	28

Hydroelectric Water Use

Hydroelectric water use is defined as the amount of water used at power plants where the turbine generators are driven by falling water. In most cases, the facility intake is located in the stream channel. Therefore, hydroelectric water use is considered as an instream surface-water use. During 1990, there were 11 active hydroelectric power plants in Puerto Rico. These were located in the municipios of Arecibo (Dos Bocas), Naguabo (Río Blanco), Orocovis (Toro Negro II), Patillas (Patillas), Peñuelas (Garzas I and II), Utuado (Caonillas I and II), Villalba (Toro Negro I), and Yauco (Yauco I and II) (fig. 3). During 1990, 362 Mgal/d of water were used to generate 108 gigawatt-hours of electricity.

To estimate the accuracy of the hydroelectric water use, the amount of water used by the hydroelectric power plant at Dos Bocas in Arecibo to generate electricity was compared with the amount of water recorded during 1990 at the USGS gaging station at Río Grande de Arecibo above Arecibo (50027750). This surface-water station is located 10.4 miles downstream of the Lago Dos Bocas dam (fig. 3). The following equation is used to obtain monthly instream water use at hydroelectric facilities, using data from the Puerto Rico Electric and Power Authority (PREPA):

$$\text{Water Use} = P (F / N)$$

where

P is the gross power generation, in kilowatt-hours for a given month;

F is a specific factor for each reservoir, given the instream water requirement, in acre feet per kilowatt-hour; and,

N is the number of days in a month.

The mean monthly discharge reported by the USGS during 1990 at the gaging station at Río Grande de Arecibo above Arecibo (50027750) and the hydroelectric water-use estimate obtained from the PREPA are listed in table 3. The monthly average percent difference between the amount of water computed by the USGS (Curtis and others, 1991) and the amount of water

reported by the PREPA (1990) ranged from 47 to -5 with an average absolute difference of 19 percent. Except for February (table 3), USGS measurements were always less than those reported by PREPA. The differences between the USGS and the PREPA measurements may be attributed to streamflow losses to the aquifer between the dam and the gaging station.

References

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Table 3. Values and percent difference between mean monthly discharges at gaging station Río Grande de Arecibo above Arecibo 50027750 during 1990 and Puerto Rico Electric and Power Authority mean monthly reported values.

[Percent difference calculated as PREPA value - USGS value /USGS value * 100; Mgal/d, million gallons per day]

Month	Mean water discharge (Mgal/d)		Average percent differences
	USGS	PREPA	
January	125	132	6
February	78	74	-5
March	147	192	31
April	190	251	32
May	156	188	20
June	126	132	5
July	104	106	2
August	100	102	2
September	268	340	27
October	630	721	14
November	319	447	40
December	189	278	47

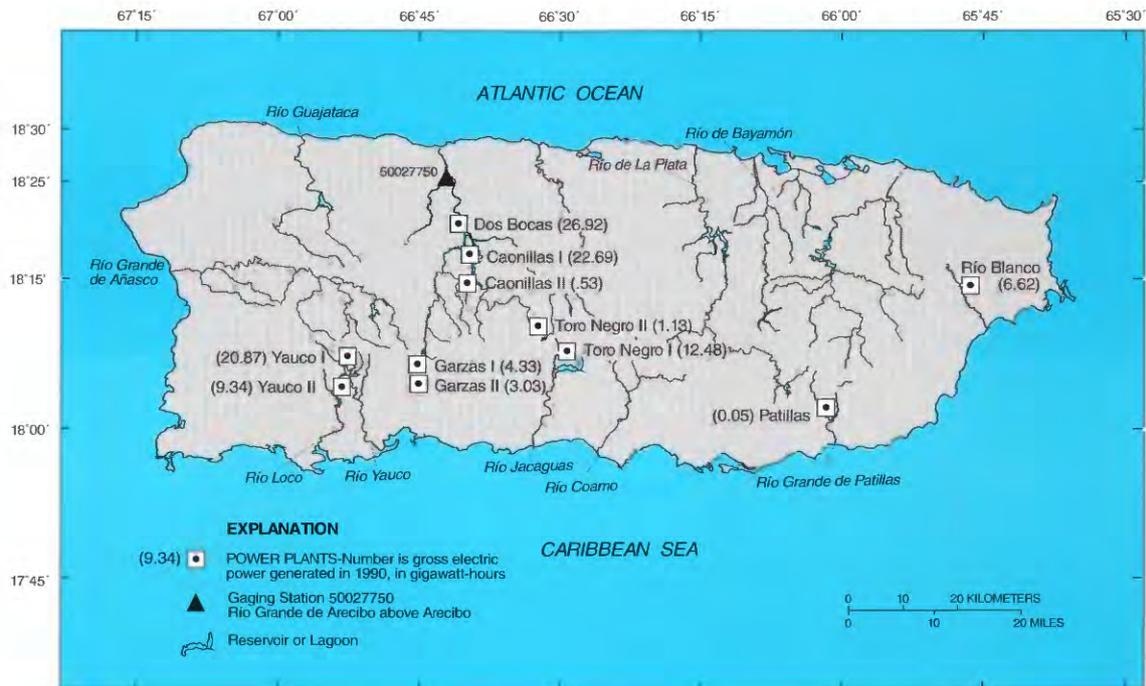


Figure 3. Location of gaging station 50027750 and active hydroelectric power plants in Puerto Rico during 1990.

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