ESTIMATED WATER USE IN ST. THOMAS, U.S. VIRGIN ISLANDS, JULY 1983 - JUNE 1984

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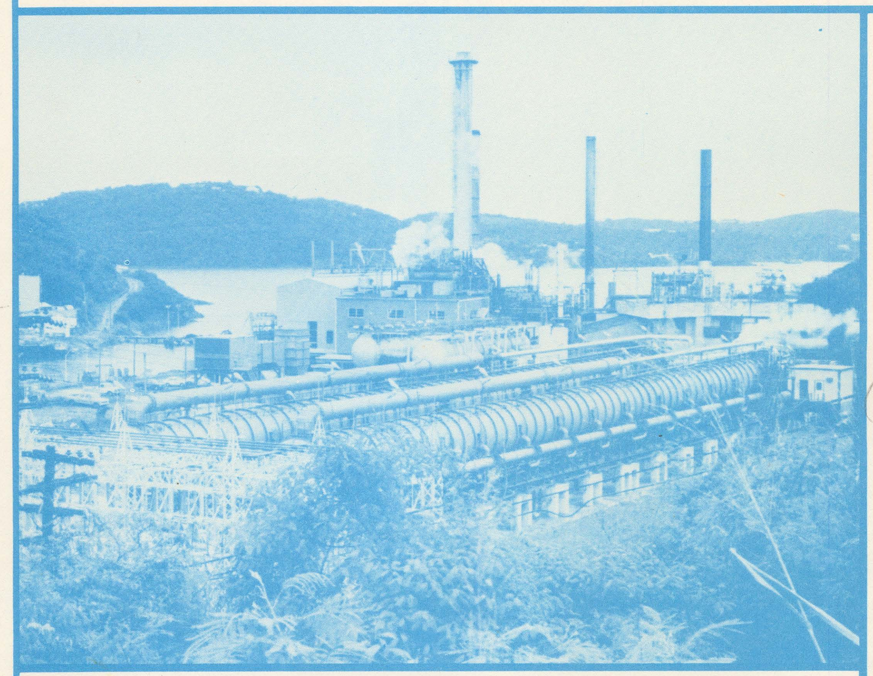

DEPARTMENT OF THE INTERIOR

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WATER RESOURCES DIVISION

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CARIBBEAN RESEARCH INSTITUTE
COLLEGE OF THE VIRGIN ISLANDS
ST. THOMAS, U.S. VIRGIN ISLANDS

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INTRODUCTION

Water use data (withdrawal and return amounts) has always been the most difficult element to define in the hydrologic cycle. The need to determine the amount of water used to meet public, commercial and domestic needs among other uses is essential where the available supply is inadequate. In St. Thomas, U.S. Virgin Islands, where streamflow occurs mostly during periods of intense rainstorms and ground-water resources are limited (Jordan and Cosner, 1973), water-use information is critical.

In 1983, the U.S. Geological Survey, Water Resources Division, in cooperation with the Water Resources Research Institute of the College of the Virgin Islands, began a generalized inventory of water use in St. Thomas.

St. Thomas is located about 20 miles east of Puerto Rico (fig. 1). The island's population increased from 16,000 in 1960 to more than 47,500 in 1984, paralleled with an increase in water production to meet the public water-supply demand (fig. 2).

The water demands have increased also in response to tourism development. Although the production of water increased with the installation of a large-scale seawater desalination plant by the Government of the U.S. Virgin Islands, the demand has not been satisfied.

Only about 40 percent of the water produced is accounted for, mostly due to losses from leakage in the distribution system installed in 1949 (Priede-Sedgwick, Inc., 1979). Other losses are due to unauthorized connections, faulty meters, and uncontrolled public faucets (fig. 3).

WATER SOURCES AND USES

The principal sources and uses of water in St. Thomas are shown in fig. 4. Seawater, rainfall collected from residential roof-top catchments, and ground water are the main water sources in the island. Thermoelectric-power generation, public-water supply, and domestic and commercial self-supply are the principal uses.

Seawater is used indirectly as the source of condenser-cooling water by the Virgin Islands Water and Power Authority (WAPA). The waste heat from the Island thermoelectric facility (fig. 5a) is used by the seawater-desalination plant (fig. 5b). Desalinated water from storage tanks (fig. 5c) is distributed to the urban areas in Charlotte Amalie (fig. 5d), by the Virgin Islands Public Works Department (VIPWD). Areas outside the public-water supply distribution system, such as the Donoe housing project at New, (fig. 5e) can be classified as self-supplied users. These obtain their water supply from rainfall catchments, wells, or from commercial water haulers (fig. 5f).

The main urban area of Charlotte Amalie is also served by a seawater system. This system supplies water for fire fighting and flushing of toilets and open drains. Areas outside the seawater system depend on "gray water" (wastewater from other household uses) as their source of water for flushing toilets or irrigation. Where aquifers yield significant water to wells (10 gal/min or more) these are also tapped as a source of water, even if saline, as feed for reverse osmosis units or for flushing.

Bottled water produced locally or imported is an important drinking water source. Bottled water costs approximately \$1.25 per gallon. In 1979 importation of bottled water was estimated at 1,600 gal/d (Peebles, 1979). There are no reliable figures for current imports.

Public-Water Supply

Production of desalinated water during the study period averaged 2.4 million gallons per day (Mgal/d). Only about 0.9 Mgal/d (38 percent) was accounted (revenues from sales) by the VIPWD. About 1.5 Mgal/d was unaccounted for as previously indicated. A recent investigation showed that leakage in the distribution system represents 30 to 40 percent of the total losses (CH2M Hill Southeast, 1983).

The production of desalinated water for public supply increased to a peak of about 2.4 Mgal/d in 1975, declining thereafter to less than 0.6 Mgal/d in 1980. Since 1981, WAPA has installed three new desalination units with a total rated capacity of 3.1 Mgal/d. At present only two units are being operated. Full production capacity will be required when the East End Transmission System becomes operational (fig. 6). This distribution system was constructed in 1977 but has not been utilized.

Water pumped to the seawater distribution-system averages 1.0 Mgal/d. Only about 0.35 Mgal/d of this amount is accounted for at the public sewage treatment plant serving Charlotte Amalie. The remainder may be lost through leaks in the seawater-distribution system. However, various storm drains in Charlotte Amalie are continuously flushed to the ocean by taps from the seawater-distribution system. Discharge from two of these taps were measured and had an average flow of 0.08 Mgal/d each. Five of these taps would account for ½ of the unaccounted flow..

The cost of potable water to WAPA from the desalination units is about \$9.00 per thousand gallons (\$9.00/kgal). This does not include amortization costs of the desalination units (Ajayi and Gómez, 1983). The actual costs charged by VIPWD to consumers connected to the distribution system is \$14/kgal (VIPWD personal communication, 1984).

Thermoelectric-Power Generation

Thermoelectric-Power Generation is the largest single water use category in St. Thomas. Total use was about 67 Mgal/d. This was essentially seawater, except about one percent freshwater obtained directly from the desalination plant for boiler feed.

Domestic Self-Supplied - Rainfall

About two-thirds of the population in St. Thomas is not served by the potable public water supply distribution system, and thus classified as domestic self-supplied. Rainwater collected from rooftop catchment systems and stored in cisterns, and withdrawals from ground water are the sources for domestic self-supply. Estimated water use for this category was about 0.75 Mgal/d. Of this amount, 0.60 Mgal/d (80 percent) was supplied from rainfall. This indicates that rooftop catchments are a major source of water for most private homes especially in the more humid areas of the island (fig. 7).

Virgin Islands law requires all dwellings, apartments and hotels to have a minimum cistern storage of 10 gallons for each square foot of roof area for one story buildings, and 15 gallons for each square foot of roof area for two or more story buildings. All other buildings are required to have cisterns with a minimum useable capacity of 4½ gallons per square foot of roof area except churches and warehouses, which are not required to conform to this standard (Jordan and Cosner, 1973). A comparison of yields between rooftop-rainfall catchments at a high rainfall (Dorothea) and at a low rainfall area (Red Hook), was made using data from July 1983 to June 1984. The comparison was made for a family of four using 25 gallons per capita per day (25 gpcd) with a roof area of 1,000 ft^2 and an initially full cistern (10,000 gal). The family would have required the services of a water hauler only once if they lived in the Dorothea area, and twice if they lived in the Red Hook area. Rainfall could have supplied about 50 percent of the total water needs in the Dorothea area, but only 31 percent at Red Hook.

The cost of water produced by household roof-top cistern systems is estimated at \$17 to \$19/kgal (CH2M Hill Southeast, 1983). The major cost is associated with construction of a cistern.

Domestic Self-Supplied - Ground Water

Ground water withdrawn for domestic self-supplied use was about 0.15 Mgal/d. Ground-water withdrawals by the Virgin Islands Housing Authority (VIHA) was estimated at 0.10 Mgal/d. An additional 0.05 Mgal/d was used by other domestic self-supplied users.

Ground water for domestic use is available in nearly all parts of the island. There are only a few areas where yields to wells are large enough to warrant the development of public supplies. In their study, Jordan and Cosner divided the island into five ground-water areas according to their potential yield and water quality (fig. 8). The potential yield and water quality of these areas are limited by excessive depth to water, seawater intrusion, waste-water contamination, and contamination from seawater mains.

Commercial Self-Supplied

Condominiums and hotels used about 2.0 Mgal/d of saline water. This is used principally for cooling, flushing toilets, and swimming pools. Small desalination plants produce about 0.1 Mgal/d freshwater.

About 0.2 Mgal/d of the commercial water-use is ground water. This is used mostly for flushing toilets. In some areas, where the ground water is of good quality, the waste water is used for irrigation of lawns (Mahogany Run). However, most of the commercial facilities are located near the coast and pump saline-ground water.

Water haulers supplied an estimated 0.07 Mgal/d of desalinated water from the VIPWD standpipes to commercial users. The average price of water delivered by water haulers is \$55/kgal (Ajayi and Gómez-Gómez, 1983). An estimated amount of 0.05 Mgal/d was obtained from rooftop rainfall catchments.

Public Waste-Water Treatment

There are seven public waste-water treatment facilities in St. Thomas (fig. 9). The airport plant, serving Charlotte Amalie, discharges about 0.5 Mgal/d to the ocean. Instantaneous flow rates measured in June 1984 ranged from 0.16 to 1.4 Mgal/d (fig. 10). Specific conductance measurements indicated that about 70 percent of the effluent was seawater.

The other six waste-water treatment plants serve mostly public-housing projects. These discharge about 0.20 Mgal/d to streams and the ocean.

ACKNOWLEDGMENTS

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Virgin Islands Water and Power Authority: Ms. Maureen E. Blyden, Mr. Steven LaPlace
Virgin Islands Housing Authority: Mr. Anthony E. Boschulte

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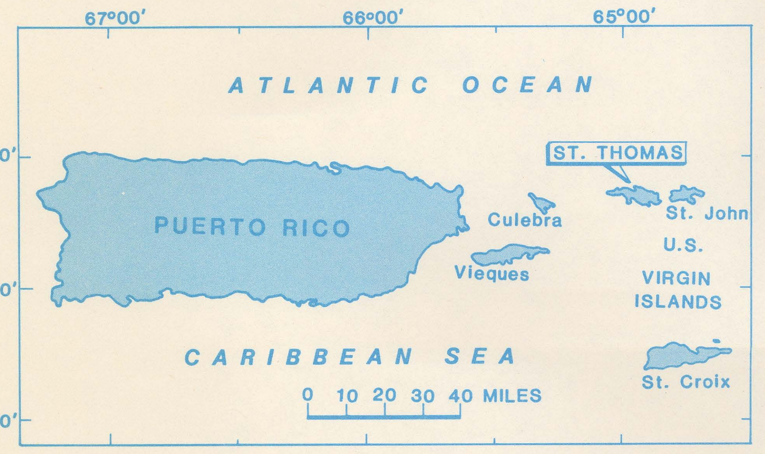


FIGURE 1. Location of the U.S. Virgin Islands.

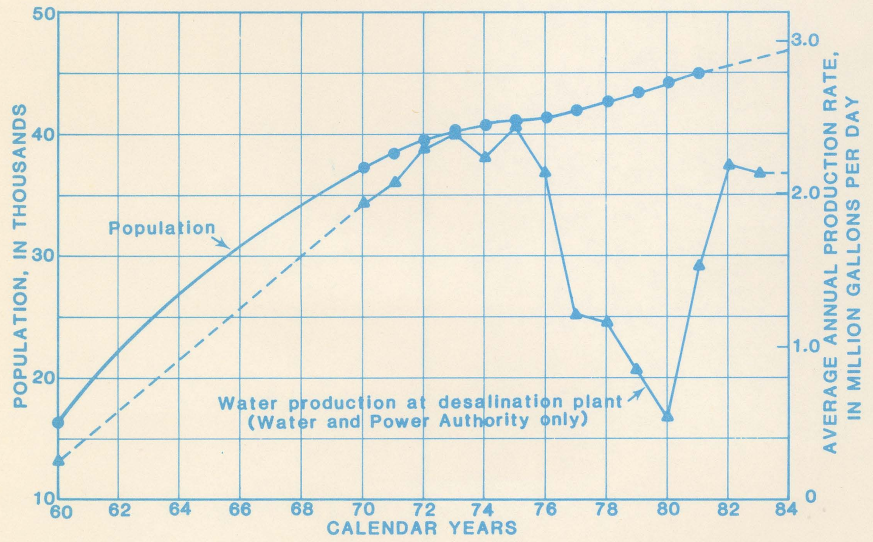


FIGURE 2. Water production and population trends in St. Thomas. (Source: Virgin Islands Office of Policy, Planning, and Research.)

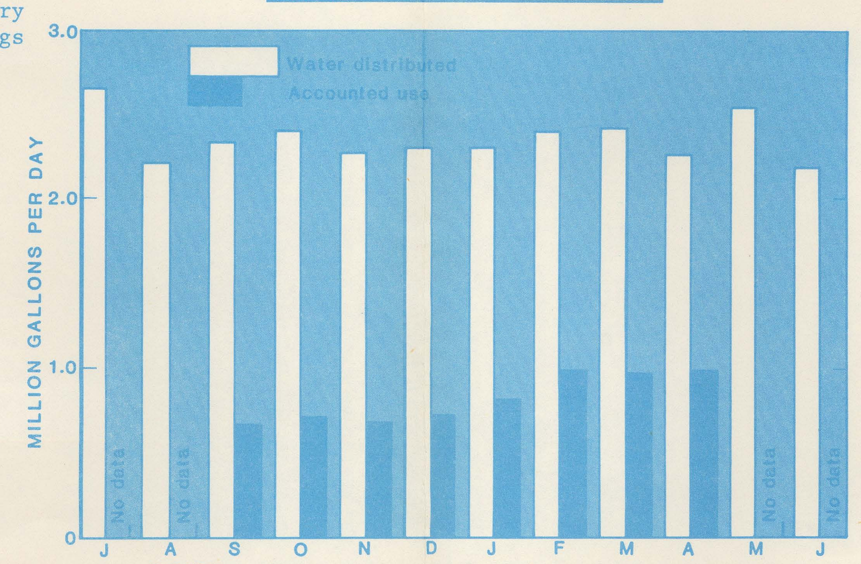


FIGURE 3. Comparison of the quantity of water distributed and accounted use by Virgin Islands Public Works Department.

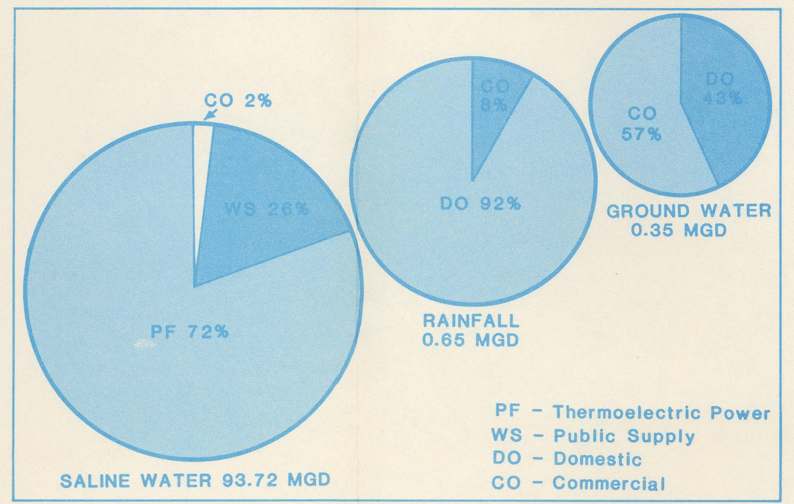


FIGURE 4. Estimated water use by source and major use category in St. Thomas during July 1983 to June 1984.

SOURCE, DISTRIBUTION, AND USERS OF DESALINATED WATER IN ST. THOMAS

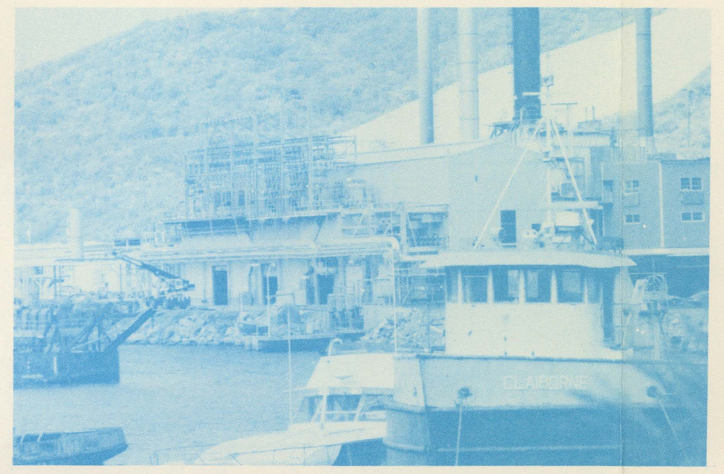


FIGURE 5a. Seawater intake at the Thermoelectric Power Plant at Krum Bay (Sub Base).

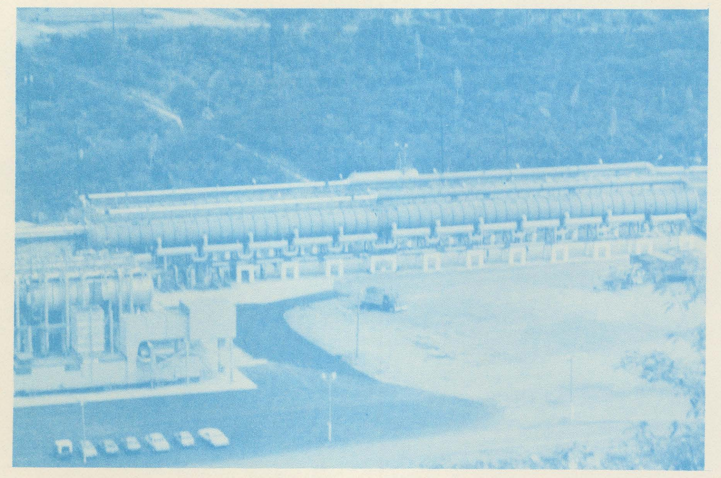


FIGURE 5b. Seawater flash vaporization desalination plant at Krum Bay (Sub Base).

FIGURE 5c. Desalinated water storage tanks at Sara Hill near Sub Base.

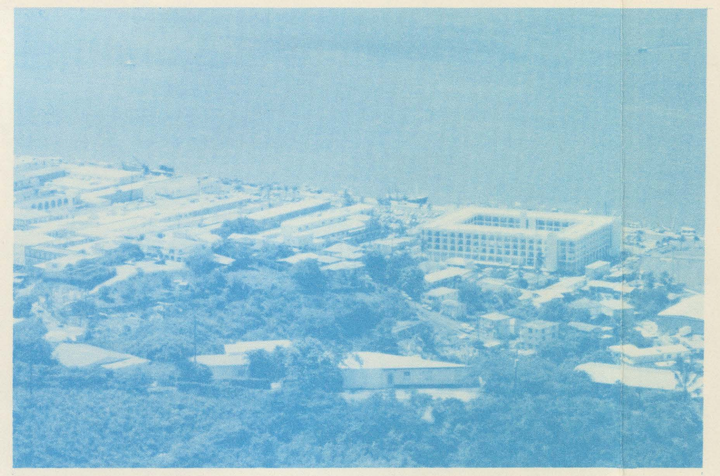


FIGURE 5d. Domestic and commercial users at Charlotte Amalie area.

FIGURE 5e. Domestic self-supplied users at Donoe housing project.

FIGURE 5f. Commercial water hauler at Virgin Islands Public Works Department's potable water standpipe at Sub Base.

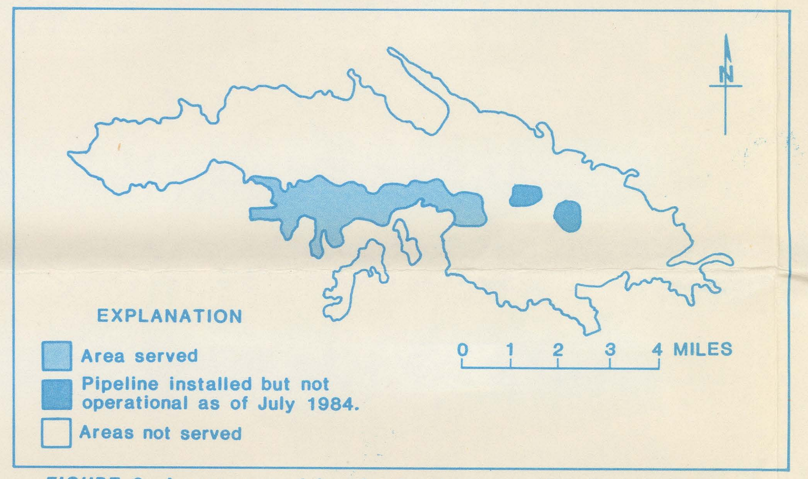


FIGURE 6. Areas served by the fresh-water distribution system.

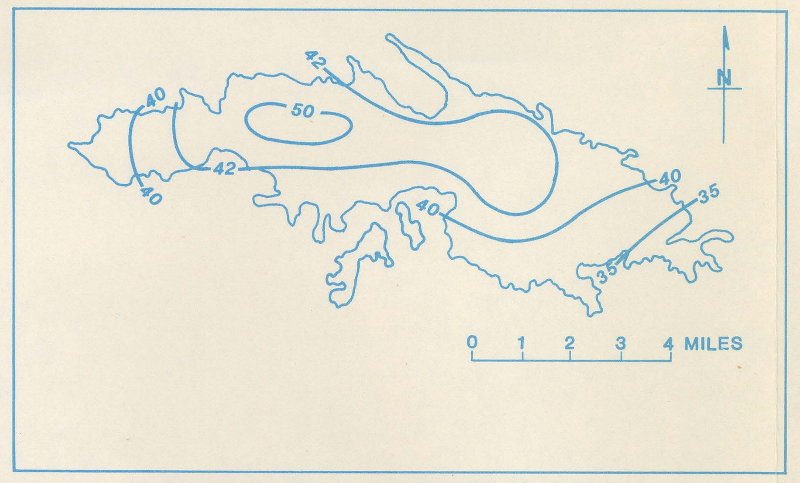
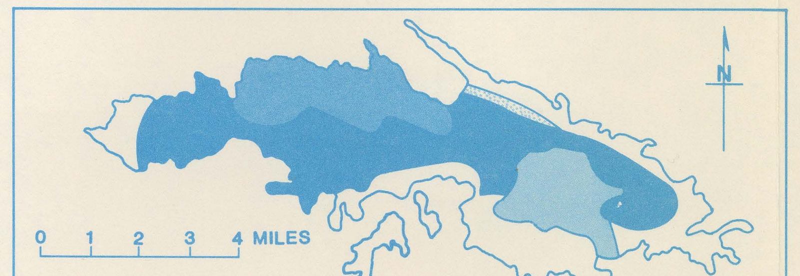


FIGURE 7. Average-annual rainfall, in inches. (Prepared by R.J. Calvesbert, (NWS) NOAA.)



EXPLANATION

Area	Potential yield in gallons per day	Possible restraints
	3000-30,000	Waste-water contamination and seawater intrusion
	1000-10,000	Seawater encroachment
	250-1000	Excessive depth to water or seawater intrusion
	Under 50,000	Seawater intrusion
	Under 1000	Contamination from seawater mains or seawater encroachment

FIGURE 8. Ground-water areas, potential yield to wells, and restraints which could limit withdrawals. (Adapted from Jordan and Cosner, 1973.)

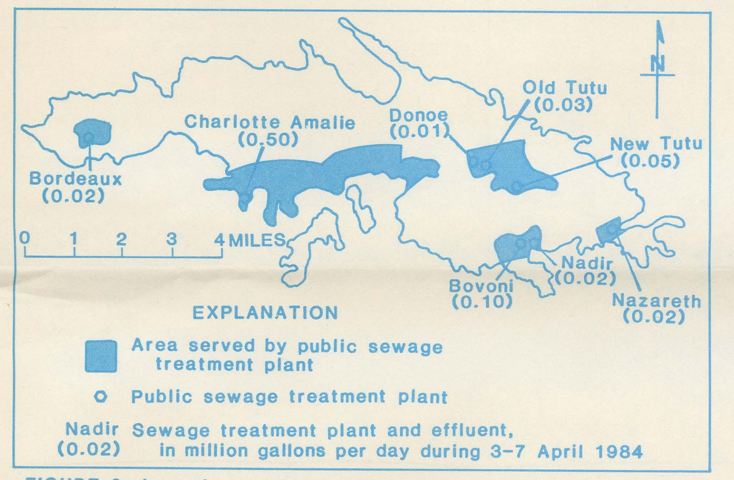


FIGURE 9. Location, outflow volume, and areas served by the public sewage treatment plants in St. Thomas.

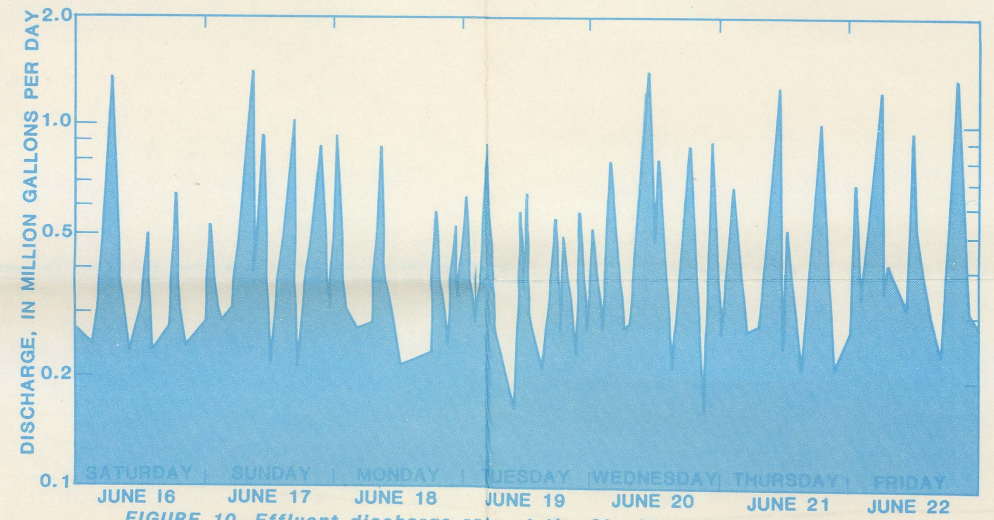


FIGURE 10. Effluent discharge rate at the Charlotte Amalie waste-water treatment facility during June 16-22, 1984.

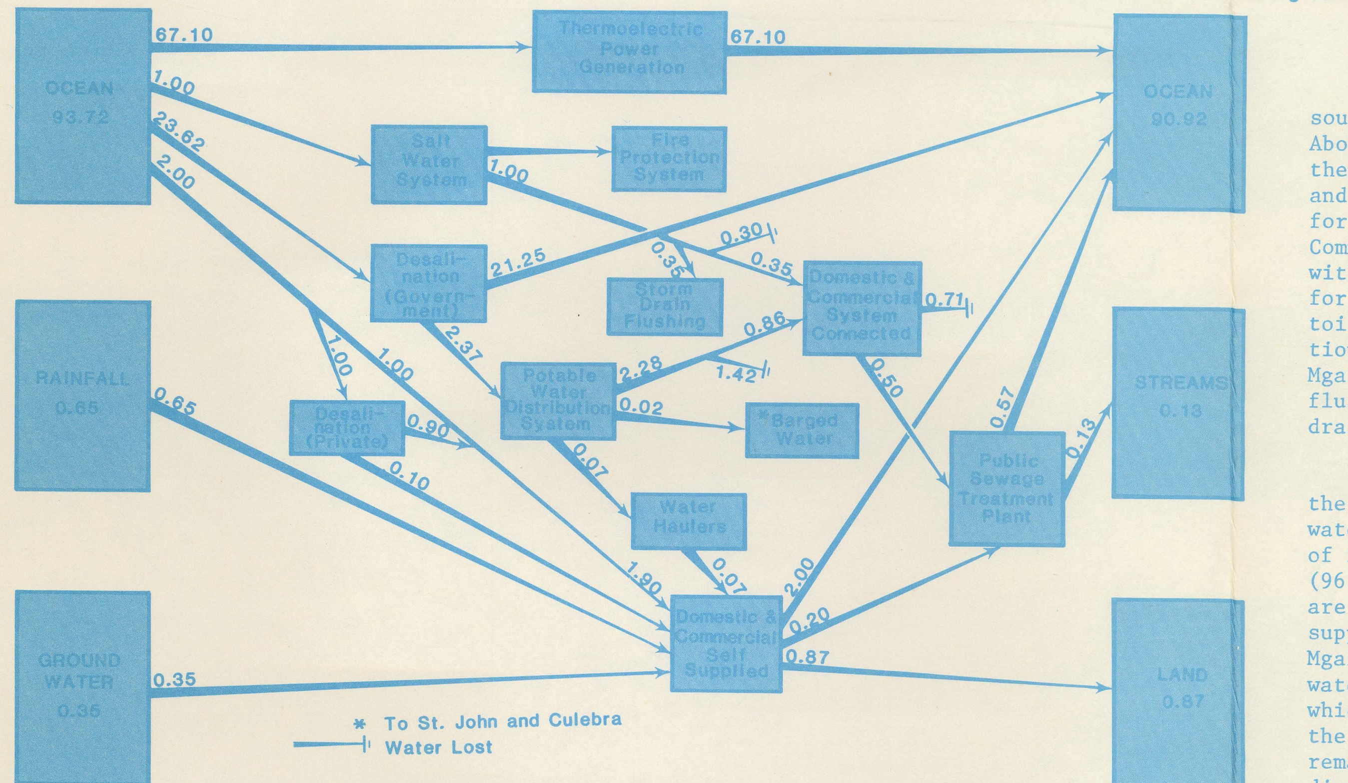


FIGURE 11. Water sources, uses, disposition, and amount for each use category in St. Thomas, in million gallons per day.

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SUMMARY

Seawater is the principal source of water in St. Thomas. About 67.1 Mgal/d are used for thermoelectric power generation and 23.6 Mgal/d are withdrawn for desalination purposes. Commercial self-supplied users withdraw about 2.0 Mgal/d mostly for cooling, and flushing of toilets. The seawater distribution system supplies about 1.0 Mgal/d for fire fighting and for flushing of toilets and storm drains (fig. 11).

Seawater desalination is the principal source of freshwater with an average production of 2.5 Mgal/d. About 2.4 Mgal/d (96 percent of total production) are distributed for public supply. Of this amount 2.3 Mgal/d are pumped to the public-water supply distribution system which serves only one-third of the island's population. The remainder, or 0.10 Mgal/d, is distributed by commercial water haulers to rural areas in St. Thomas or barged (0.02 Mgal/d) to the adjacent islands of St. John and Culebra. Commercial self-supplied users obtained about 0.10 Mgal/d of freshwater from privately operated desalination units.

Rainfall and ground water supply about 1.0 Mgal/d and are the main source of freshwater to two-thirds of the island's population.

Public waste-treatment plants discharge an average of 0.7 Mgal/d. Seventy percent of the effluent is seawater.