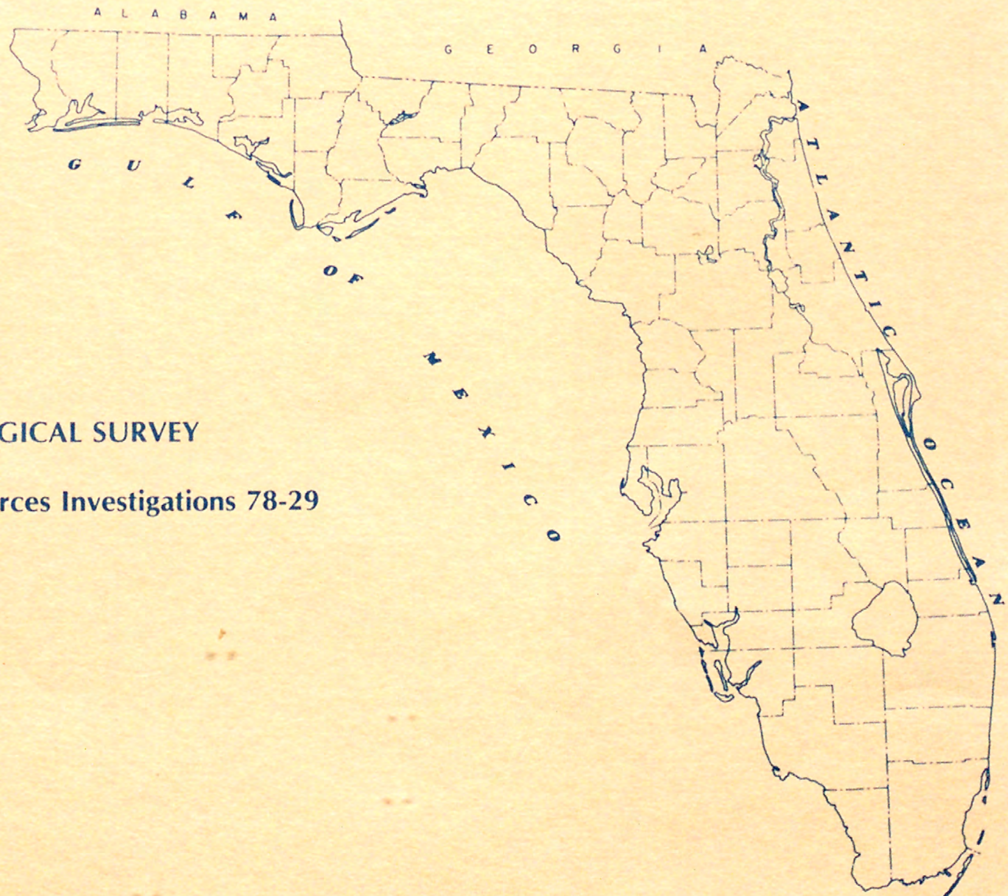
WRI 78-29

WATER-SUPPLY POTENTIAL OF THE LOWER HILLSBOROUGH RIVER, FLORIDA, 1976



U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 78-29

Prepared in cooperation with the
CITY OF TAMPA and the
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT

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By Carole L. Goetz, Ronald C. Reichenbaugh, and Junior K. Ogle

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UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

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Open-File Report

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CONVERSION FACTORS

For readers who may prefer to use metric units rather than U.S. customary units for the terms used in this report, the following conversion table is provided:

U.S. customary	Multiply by	Metric
inch (in)	2.540×10	millimeter (mm)
foot (ft)	3.048×10^{-1}	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
cubic foot per second (ft^3/s)	2.832×10^{-2}	cubic meter per second (m^3/s)
acre-foot (acre-ft)	1.233×10^{-3}	cubic hectometer (hm^3)
million gallons (Mgal)	3.785×10^{3}	cubic meter (m^3)
million gallons per day (Mgal/d)	3.785	megaliter per day (ML/d)

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ABSTRACT

The Tampa Reservoir Dam, constructed in 1945 on the lower Hillsborough River 10 miles above the mouth, provides 12.5 miles of natural channel storage for city water supply. Flow of the lower Hillsborough River and storage in Tampa Reservoir become deficient during annual dry periods. Excluding dead storage, Tampa Reservoir capacity is 2,000 million gallons at a maximum stage of 22.5 feet above mean sea level. For 20-year, annual-minimum-flow conditions, Hillsborough River flow is exceeded when the draft rate reaches 38 million gallons per day. In any year, at full capacity, Tampa Reservoir and Hillsborough River have a 5-percent chance of failing to supply at least 66 million gallons of water per day; and a 2-percent chance of failing to supply at least 59 million gallons per day.

Runoff and effluent from agricultural, industrial, and urban areas enter the stream system above Tampa Reservoir. A wide range of chemical constituents, including nutrients, metals, herbicides, and pesticides analyzed in samples taken at the reservoir, are all below the maximum acceptable limits set by the U.S. Environmental Protection Agency for raw waters used for public supply. Water color exceeds the recommended level based on aesthetic considerations. The color is successfully removed through the treatment process at the Tampa water treatment plant.

INTRODUCTION

The Hillsborough River has been the principal water supply source for the city of Tampa since about 1926 when the Hillsborough County population was less than 100,000. In 1945, the Hillsborough River was impounded by construction of Tampa Reservoir Dam. In 1964, the City of Tampa Water Department began intermittent pumping from nearby Sulphur Springs into the Hillsborough River above the dam to augment supplies when needed. In 1975, the City of Tampa Water Department served a population of 350,000 at an average rate of 52.7 Mgal/d (Leach, 1977).

In 1976, Hillsborough County population exceeded 600,000 (University of Florida, Division of Population Studies, 1975), and is expected to reach 870,000 by 1999 (Hillsborough County Planning Commission, 1973). This population projection represents a 77-percent increase over the 1970 population census of 490,265 (U.S. Bureau of the Census, 1970). Accompanying this tremendous growth, the Hillsborough River basin has undergone land development.

In 1976, land use in the Hillsborough River basin was predominantly rural. The central and northern parts of the basin were largely agricultural. The southern part was largely urban and industrial. Rural and agricultural areas located northeast of Tampa have become urbanized and industrialized during recent years; northward and eastward urbanization and industrialization trends probably will continue. Principal Hillsborough River basin municipalities include Tampa, Temple Terrace, Plant City, Lakeland, and Zephyrhills.

Population and development trends are placing increasing demands on water resources of the Hillsborough River basin. These trends, coupled with a 16-year (1960-75) drought (Parker, 1973; National Oceanic and Atmospheric Administration, 1973-75) resulted in a serious water shortage in Tampa in May of 1975. During May 1975, Tampa Reservoir declined at a rate of about 0.1 ft/d until it reached a historic low stage of 16.8 ft above mean sea level (msl) at the dam on May 27 (plate 1).

Basin land development has introduced varied effluents and runoff from agricultural, industrial and urban areas which enter the stream system of the Hillsborough River. In the agricultural parts of the Hillsborough River basin, surface runoff from numerous dairies and truck farms drain to the Hillsborough River by way of tributaries. Industrial effluents from food processing, manufacturing, and phosphate plants are released to the Hillsborough River stream system. Small enterprises, such as laundromats, discharge wastes to basin waters. Municipal and private waste treatment facilities release domestic effluents to streams in the basin.

The city of Tampa, the Southwest Florida Water Management District, and the U.S. Geological Survey entered into a cooperative, investigative program in 1975 to determine the ability of the lower Hillsborough River

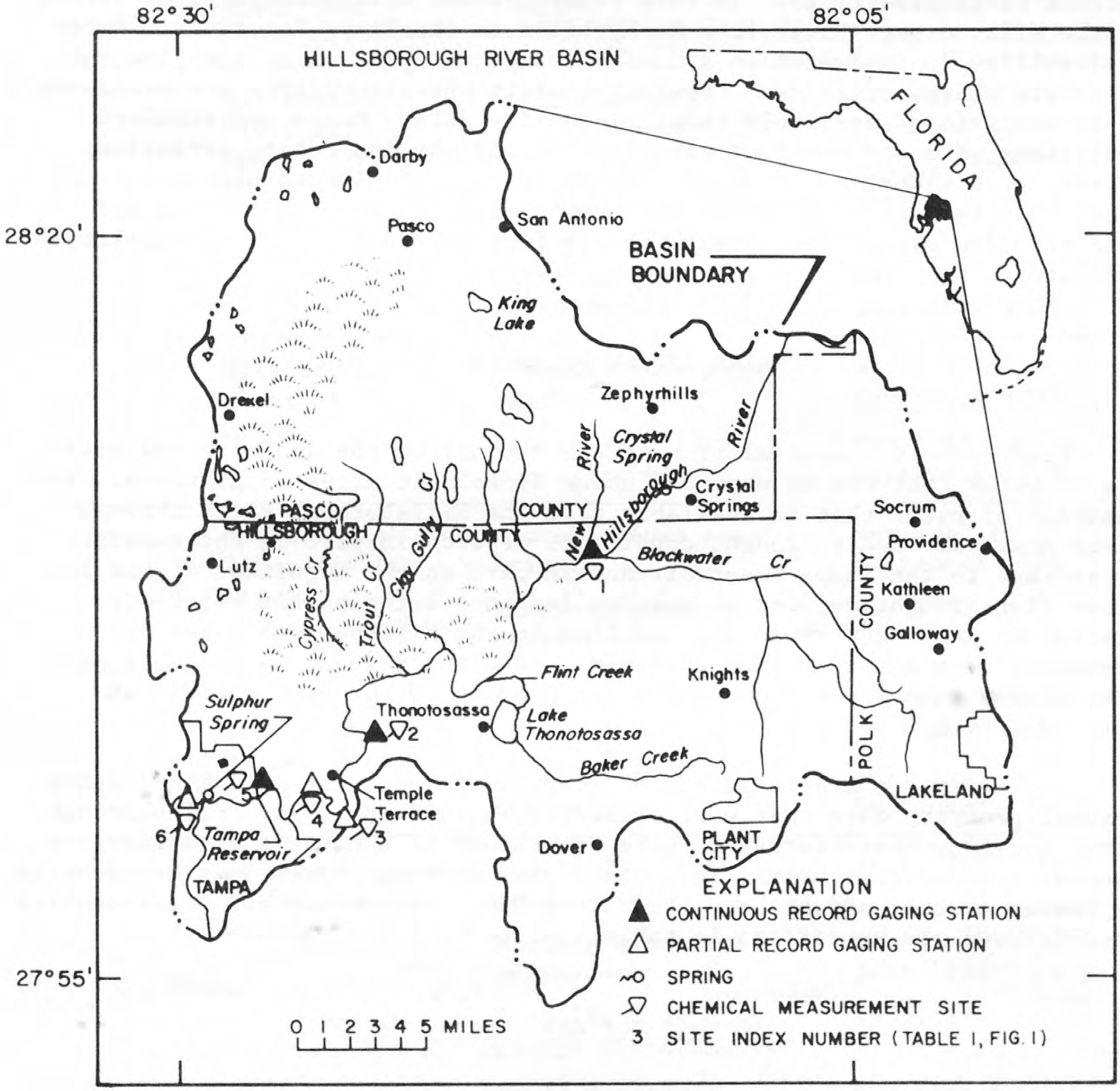

Figure 1. --Location of the Hillsborough River basin with water-quality sampling sites and stream-flow stations

to continue to supply water of good quality. The program was designed to evaluate the water-supply potential of the Hillsborough River under existing and future conditions.

The purpose of this report is to provide results of a water-supply assessment study of the lower Hillsborough River and Tampa Reservoir, for current basin conditions. In this report, lower Hillsborough River refers to the Hillsborough River from Zephyrhills to the Tampa Reservoir. Water availability is evaluated in a draft-storage analysis using low-flow and reservoir characteristics. Chemical-quality characteristics are evaluated in an analysis of available chemical-quality data. Means and standard deviations of major chemical constituents and physical characteristics, metals, herbicides, pesticides, and PCB (polychlorinated biphenyls) are provided. Variations of selected chemical-quality characteristics are also provided along with comparisons of federal regulatory water-quality standards.

WATER-SUPPLY POTENTIAL

Water-supply potential of a stream depends on the quantity and quality of water that can be provided under hydrologic stress conditions. The quantity of water that is available from the Hillsborough River through Tampa Reservoir under drought conditions depends in part on the quantity in storage in the Tampa Reservoir and in part on the magnitude of the low flows (for drought periods of various lengths) entering the reservoir. Storage in Tampa Reservoir and low flow in the Hillsborough River are evaluated in a draft-storage analysis. This analysis shows probable maximum yields that the stream system can provide for drought periods of various lengths.

The storage characteristics of Tampa Reservoir were determined using channel-geometry data that were collected in 1970 and 1975. Hillsborough River low-flow characteristics were determined on the basis of streamflow records from several points including: Hillsborough River near Zephyrhills, at Fowler Avenue, and at Tampa Reservoir Dam. Streamflow and water-quality records used are summarized in table 1.

Reservoir Characteristics

From its source in Pasco County, the Hillsborough River flows 54 mi southwestward to Hillsborough Bay (fig. 1). Land elevations in the basin range from sea level near the mouth of Hillsborough River to 140 ft, east of Plant City (Menke and others, 1961).

The Tampa Reservoir Dam (plate 1) is located on Hillsborough River 10 mi above the mouth, and impounds drainage from an area of about 650 mi^2. Due to the gentle, land-surface gradient, Tampa Reservoir is un-

Table 1. -- Streamflow and water-quality records used in this report

Site index number 1/	Name of station	Type of data available	Period of record
1	Hillsborough River near Zephyrhills	Daily or monthly discharge	October 1939 to September 1976
2	Hillsborough River at Fowler Avenue	Daily discharge	October 1933 to December 1939
		Gage heights and miscellaneous discharge measurements	January 1961 to September 1976
		Chemical-quality constituents	May 1966 to September 1976
3	Hillsborough River at Harney	Miscellaneous gage height	April 1968 to September 1976
		Chemical-quality constituents	May 1966 to September 1976
4	Hillsborough River at 56th Street	Miscellaneous gage height	May 1967 to September 1976
		Chemical-quality constituents	May 1966 to September 1976
5	Hillsborough River at Tampa Reservoir Dam	Daily discharge	October 1938 to September 1976
		Chemical-quality constituents	July 1923 to September 1976
6	Sulphur Springs at Sulphur Springs	Yearly discharge measurement	1917, 1929, 1930
		Monthly discharge measurement	February 1931-June 1934
		Miscellaneous discharge measurements	1935, 1945, 1946
		Daily discharge	May 1956 to September 1976
		Chemical-quality constituents	October 1923 to September 1976

1/ See figure 1.

usually long, extending 12.5 mi upstream to Fletcher Avenue. The reservoir is a meandering, v-shaped channel that averages about 15 ft in depth. In the lower part of the reservoir, many sand bars create one main deep channel and a second or third shallow channel. At low stages, Tampa Reservoir is about 1,000 ft wide near the dam and narrows upstream to about 100 ft near Temple Terrace.

The aerial photo of the Hillsborough River (plate 1) was taken during very low flow, 1 day before the historic low stage (16.8 ft) of May 27, 1975. The aerial photomap shows numerous sand bars in the reservoir extending a mile or two upstream from the 56th Street Bridge.

Channel geometry for selected reservoir cross sections is shown graphically on the aerial photomap (plate 1). The river bed, in profile from Tampa Reservoir Dam to Fletcher Avenue, shown in figure 2, indicates several sinkholes; the deepest, 4.4 mi upstream from the dam, is 12 ft below mean sea level. The bed profile also shows numerous ledges that would restrict downstream flow of water to the Tampa water treatment plant under low reservoir stages. Major ledges occur at 1.6, 2.0, 3.1, 6.7, and 9.1 mi upstream from the dam. These ledges would create upstream pools having the following elevations: 3.6, 4.6, 7.7, 12.8, and 15.5 ft above msl. Entrapped pool water that is unavailable for use at the water plant without pumping, is referred to as dead storage and amounts to about 7.0 percent of the total storage at a stage of 22.5 ft above msl.

The elevation of the banks of the Hillsborough River along the 12.5-mi reservoir reach varies between 19.9 and 32.2 ft above msl. Three hundred feet above the Tampa Reservoir Dam the elevation of the left bank (looking downstream) is 23.0 ft above msl and the elevation of the right bank is 25.0 ft above msl. At approximately 0.4 mi above the dam the left bank is 19.9 ft above msl. Small swampy areas border the Hillsborough River along one bank and sometimes on both banks in the reach from 3.9 mi (at 56th Street, plate 1) above the dam to 12.5 mi above the dam (Fletcher Avenue). Some of the highest bank elevations occur between river mile 7.3 and 8.3 above the dam, where the right bank ranges from 28 to 32 ft above msl. However, the left bank is bordered by small swamps and its elevation is several feet lower, 19.9 to 27 ft above msl.

The volume of water held in Tampa Reservoir for various stages at the dam is shown as a graph in figure 3. This curve is based on an analysis of the 1970 and 1975 Tampa Reservoir channel-geometry data. The curve shows a volume of 2,150 Mgal for a maximum reservoir stage of 22.5 ft above msl. Subtracting 150 Mgal for dead storage, gives maximum usable reservoir storage of 2,000 Mgal. Maximum usable reservoir storage is approximately 1.5 percent of the average annual runoff of 145,000 Mgal/yr for the 37 years of record at Tampa Reservoir. Usable reservoir storage amounts to 1,330 Mgal for an average reservoir stage of 20 ft above msl. Usable storage for the minimum observed stage of 16.8 ft above msl, which occurred May 27, 1957, is about 700 Mgal.

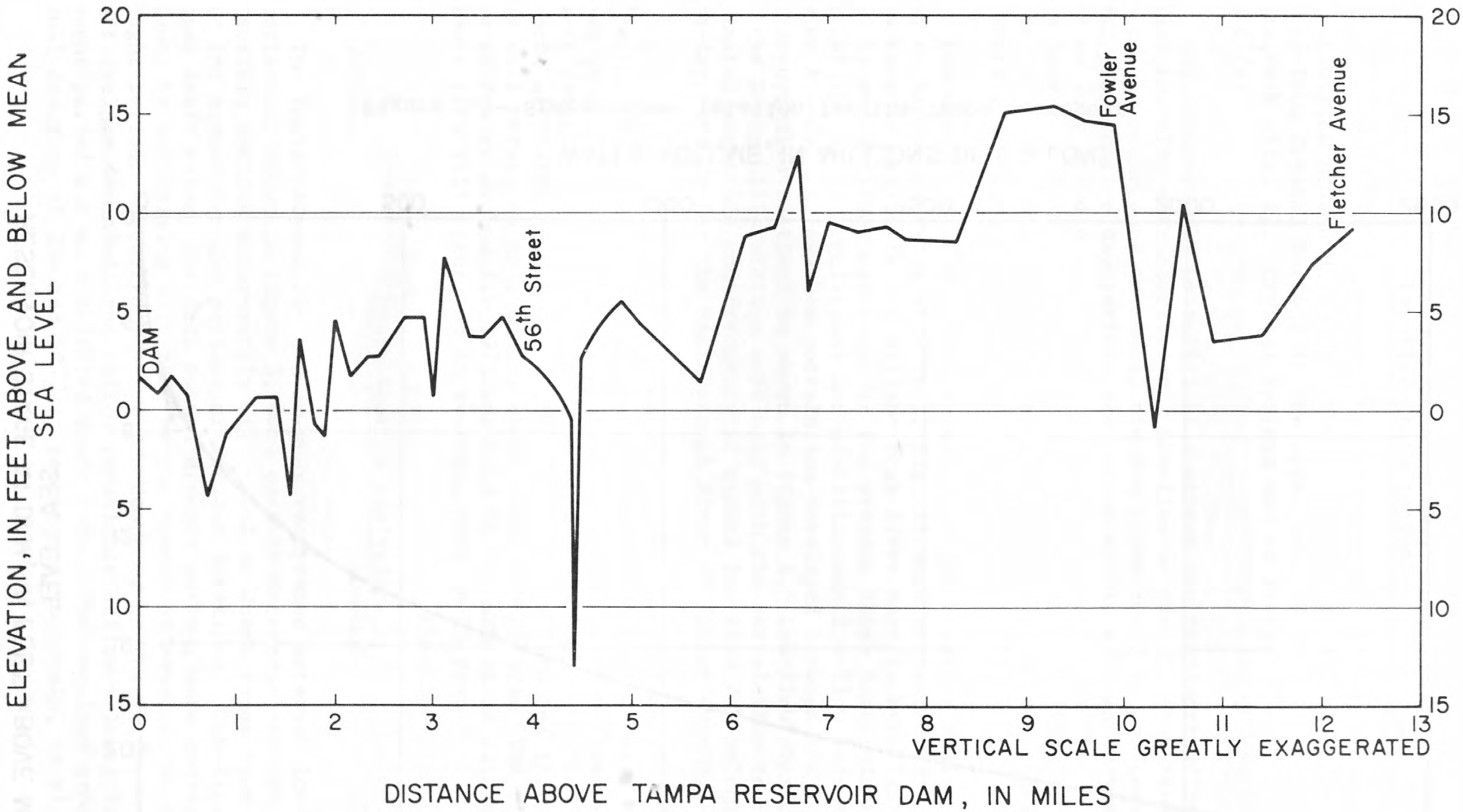

Figure 2. --Hillsborough River bed profile from Tampa Reservoir Dam to Fletcher Avenue

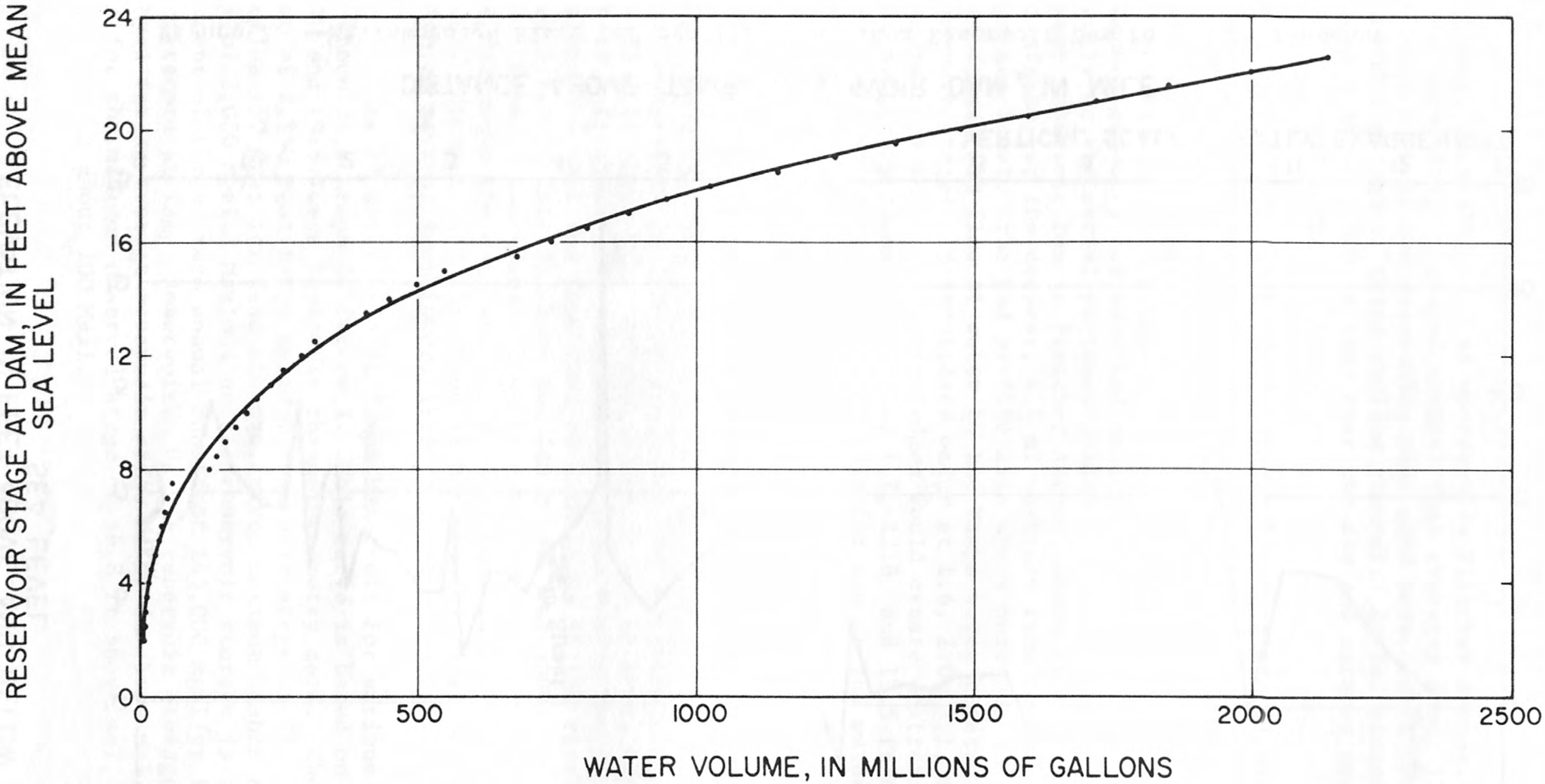

Figure 3. --Stage-volume relation for the Tampa Reservoir

Low-Flow Characteristics

Low flow of the Hillsborough River is sustained primarily by discharge from Crystal Springs in the upper basin above Hillsborough River State Park (fig. 1). Crystal Springs has an average discharge of about 60 ft^3/s.

The water-supply potential of a stream can be described in terms of annual low-flow characteristics. Low-flow or drought characteristics refer to the occurrence of annual minimum flows for 7 to 365 consecutive days. Consecutive day periods are chosen within a climatic year that begins on July 1 and ends June 30. Low-flow characteristics can be obtained from long-term streamflow records by a statistical analysis of observed annual minimum flows or can be estimated for short-term streamflow records, by correlation with that of a nearby long-term station.

Low-flow characteristics for Hillsborough River at Fowler Avenue (inflow to Tampa Reservoir at site 2, fig. 1) were estimated using streamflow records available for Hillsborough River near Zephyrhills (site 1, fig. 1) and Hillsborough River at the present Tampa Reservoir Dam (site 5, fig. 1) (prior to regulation) and miscellaneous low-flow measurements for Fowler Avenue. A low-flow correlation developed between the Fowler Avenue and Zephyrhills stations is shown in figure 4. Low-flow characteristics for the Zephyrhills station were used with the correlation to develop the estimated magnitude and frequency of annual low flow for selected consecutive-day periods for the Hillsborough River at Fowler Avenue (fig. 5).

Annual 7-day low flows shown in figure 5 range from 45 ft^3/s to 133 ft^3/s for recurrence intervals ranging from 1.25 to 100 years; 60-day low flows range from 51 ft^3/s to 184 ft^3/s; and 365-day low flows range from 164 ft^3/s to 900 ft^3/s. During 1975, the 7-day low flow calculated from records at Fowler Avenue was 49.5 ft^3/s. It is estimated that a lower flow will occur, on an average, about once in 90 years. The 60-day low flow at Fowler Avenue for 1975 was 67.3 ft^3/s, and it is estimated that a lower flow will occur, on an average, once in 25 years.

Draft-Storage Analysis

The Fowler Avenue 20- and 50-year recurrence interval low-flow characteristics, shown in figure 5, were used to determine storage necessary to sustain various water-supply withdrawal or draft rates from the reservoir for annual drought periods of various durations. Low-flow and selected draft rates, for each annual drought period, were converted to volumes by multiplying each rate by the number of consecutive days in each drought period. Required storage was computed as the difference between draft (volume demanded) and inflow (available inflow volume) for each drought period and each selected draft rate. The required storage, for annual droughts of 20- and 50-year recurrence intervals, is plotted for

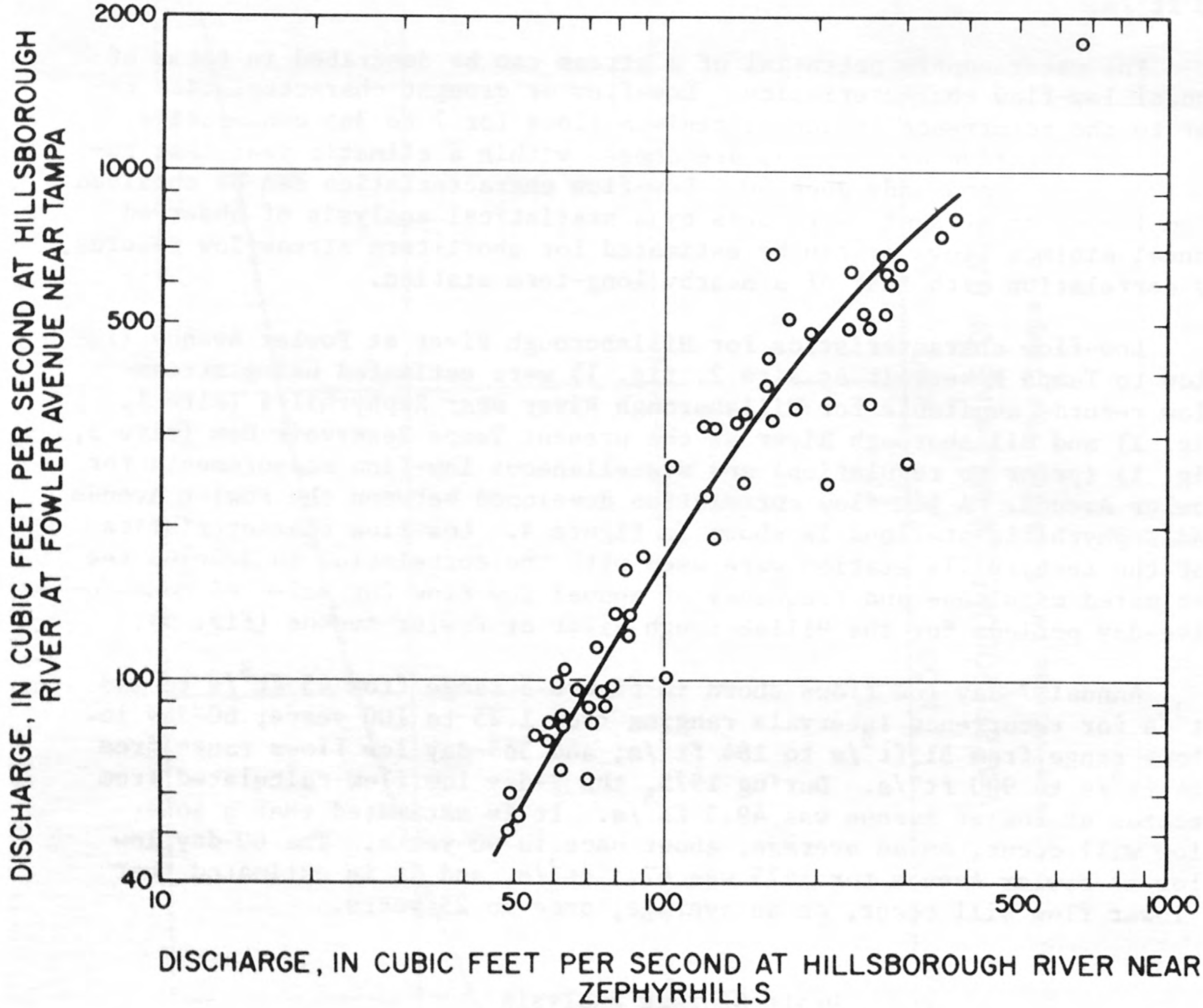

Figure 4. --Low-flow correlation between Hillsborough River at Fowler Avenue near Tampa and Hillsborough River near Zephyrhills

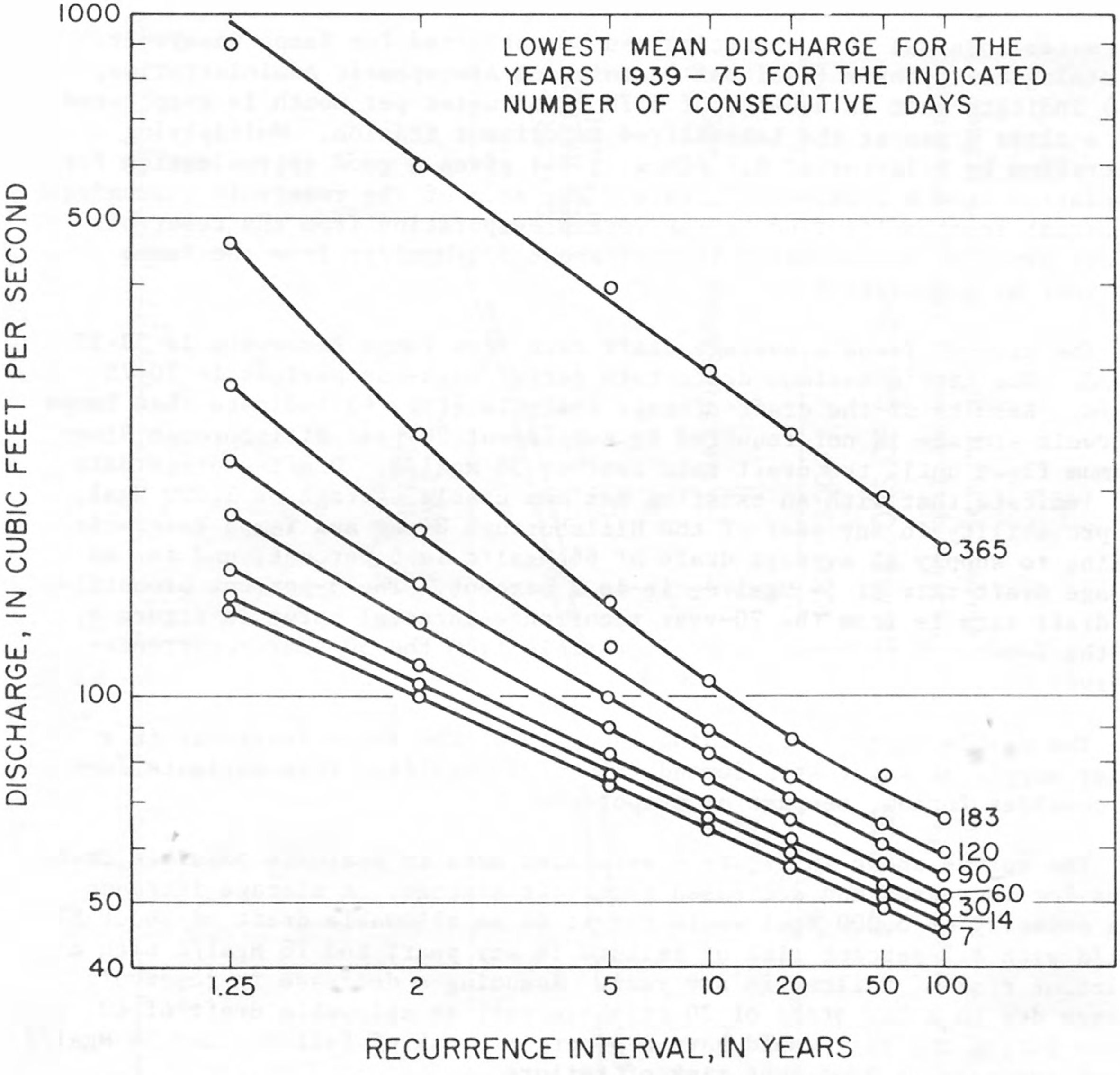

Figure 5. --Magnitude and frequency of annual low-flow of the Hillsborough River at Fowler Avenue near Tampa

various draft rates in figure 6. The storage required, as shown in figure 6 does not allow for reservoir losses due to evaporation and siltation, or seepage to or from the reservoir. Data shown in figure 6 also do not allow for inflow due to pumping from Sulphur Springs. As much as 13 to 16 Mgal/d is diverted from Sulphur Springs to Tampa Reservoir during the dry season when flow from the Hillsborough River is low.

Water loss due to evaporation can be estimated for Tampa Reservoir. Climatological records (National Oceanic and Atmospheric Administration, 1975) indicate that an average of 5.76 in of water per month is evaporated from a class A pan at the Lake Alfred Experiment Station. Multiplying evaporation by a factor of 0.7 (Chow, 1964) gives a good approximation for evaporation from a reservoir surface. The area of the reservoir (assuming a constant area) multiplied by the yearly evaporation from the reservoir surface gives an annual water loss of about 570 Mgal/yr from the Tampa Reservoir by evaporation.

The city of Tampa's average draft rate from Tampa Reservoir is 52-55 Mgal/d. The city's maximum draft rate during high-use periods is 70-75 Mgal/d. Results of the draft-storage analysis (fig. 6) indicate that Tampa Reservoir storage is not required to supplement 20-year Hillsborough River minimum flows until the draft rate reaches 38 Mgal/d. Draft-storage data also indicate that with an existing maximum usable storage of 2,000 Mgal, the probability in any year of the Hillsborough River and Tampa Reservoir failing to supply an average draft of 66 Mgal/d is 5 percent; and for an average draft rate of 59 Mgal/d, it is 2 percent. The 5-percent probability draft rate is from the 20-year recurrence-interval curve in figure 6, and the 2-percent probability draft rate is from the 50-year recurrence-interval curve.

The usable storage or holding capacity of the Tampa Reservoir is a 36-day supply of water at a demand rate of 55 Mgal/d. This estimate does not consider inflow, seepage or evaporation.

The curves shown in figure 6 were also used to evaluate possible draft rates for increased and decreased reservoir storage. A storage increase to a capacity of 5,000 Mgal would result in an allowable draft of about 83 Mgal/d with a 5-percent risk of failure in any year; and 76 Mgal/d with a 2-percent risk of failure in any year. Assuming a decrease in reservoir storage due to a low stage of 20 ft above msl, an allowable draft of 60 Mgal/d during any year would have a 5-percent risk of failure; and 54 Mgal/d during any year, a 2-percent risk of failure.

Quality of Water

The mean concentration and standard deviation of selected chemical constituents and physical characteristics of water in the Tampa Reservoir are listed in tables 2, 3, 4, and 5. Data presented in these tables include sampling of water during high- and low-flow seasons. Major chemical

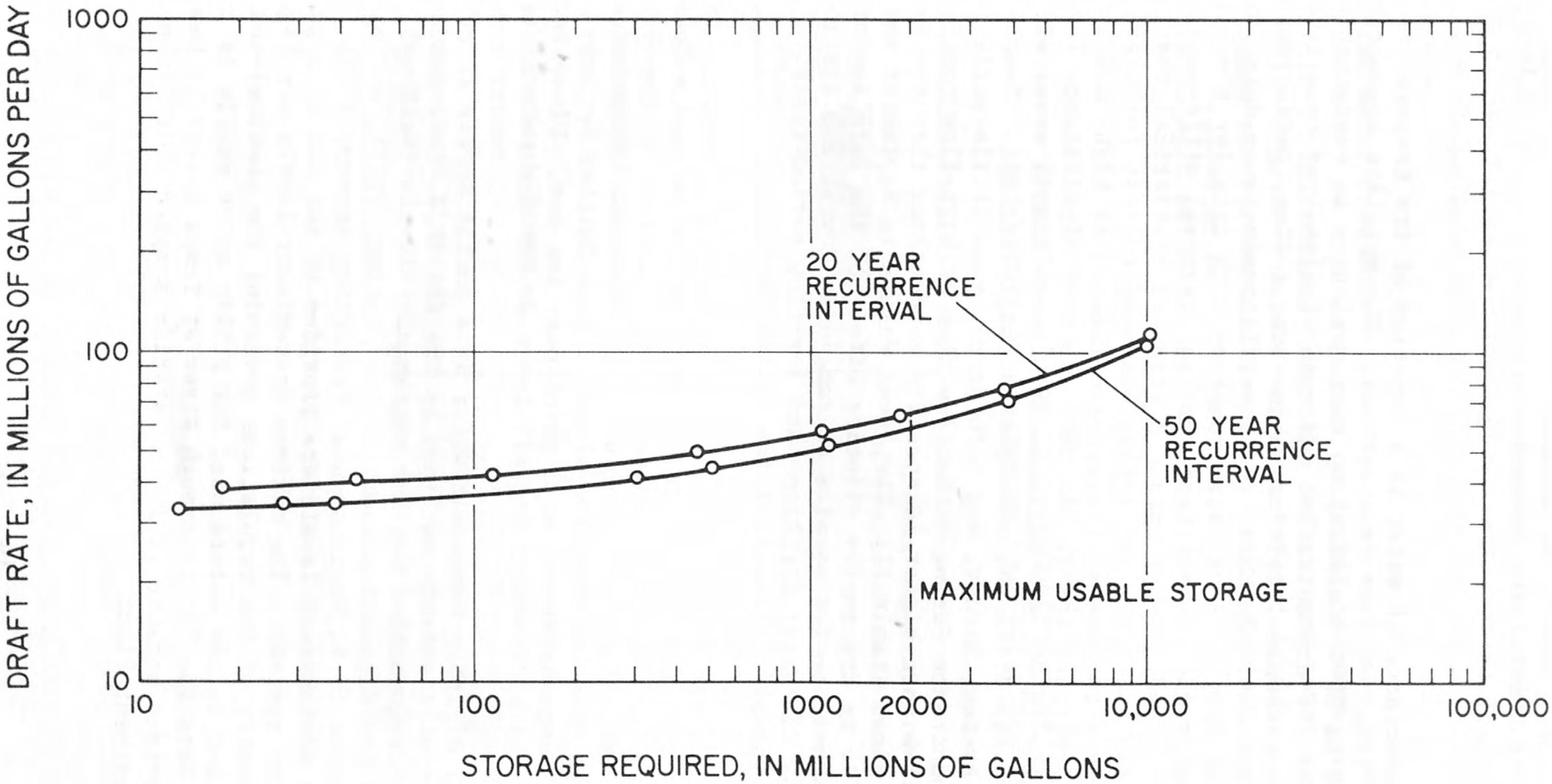

Figure 6. --Tampa Reservoir draft-storage relationship showing storage required to sustain various draft rates during an annual drought of the given critical period in days

constituents and physical properties, metals, herbicides, pesticides, and PCB (polychlorinated biphenyls) are discussed with regard to their implications on the suitability of untreated reservoir water for use as a potable water supply.

The specific conductance of water is a function of its temperature and type and concentration of ions in solutions. The specific conductance readings are adjusted to 25°C (Celsius) so that variation in conductance are a function only of the concentration and type of dissolved constituents (chiefly bicarbonate, carbonate, calcium, magnesium, sodium, potassium, sulfate and silica) present. In this way, specific conductance data for the low-flow months of April and May were compared with data for the high-flow months of September and October to detect any seasonal differences in concentrations of dissolved constituents. A standard statistical test, student's t-test (Alder and Roessler, 1964), was used to test for significant differences between the means of samples collected at high- and low-flow periods at the 5-percent level. At the 5-percent significance level, by chance alone, 1 time in 20, the differences between sample means will be declared significantly different when they actually are not. Samples collected at Fowler Avenue, Harney, and 56th Street show little variation in mean specific conductance during either low-flow or high-flow conditions. The April-May low flows were higher in specific conductance than the September-October high flows (table 2). The lower values in September and October are assumed to be due to the diluting effect of the late summer rains. Specific conductance for samples at remaining downstream station was not significantly different for high- and low-flow period tests, but was more highly variable throughout the entire year.

Samples collected near Tampa Reservoir Dam were slightly higher in specific conductance than those collected at the upstream stations (tables 2 and 3). Both sodium and chloride concentrations (table 3) at the dam are about twice as high as at any of the upstream stations. This increase is believed to result from the addition of water from Sulphur Springs that is pumped into Tampa Reservoir at a point near the dam. Dissolved calcium, alkalinity and bicarbonate are all lower at the dam than upstream.

The suitability of Tampa Reservoir water as a public supply is goverened by two groups of standards outlined by the EPA (U.S. Environmental Protection Agency): recommended maximum contaminant levels (National Academy of Sciences and National Academy of Engineering, 1973), and maximum contaminant levels (U.S. Environmental Protection Agency, 1975). The recommended maximum contaminant levels are provided by the EPA as a guideline for public water systems. The maximum contaminant levels are legal requirements. A summary of the regulations governing the chemical-quality constituents important in raw waters used for public water supply is provided as table 6. Data for "Hillsborough River at Tampa Reservoir Dam" station is also provided because it is the station sampled which is nearest the Tampa Water Treatment Plant.

Table 6 shows that water color sometimes exceeds the recommended level based on aesthetic considerations. The Tampa Water Treatment Plant removes color from the reservoir water, and renders aesthetically pleasing, clear drinking water for Tampa residents. Remaining water constituent levels at Tampa Reservoir Dam fall well below the maximum levels shown in the table.

The water from Sulphur Springs, which is used to augment supplies at the reservoir, is high in sodium, chloride, sulfate, magnesium, calcium, alkalinity, bicarbonate, inorganic carbon, and total dissolved solids (table 3). The mean values for chloride and sulfate from Sulphur Springs fall below the recommended levels (National Academy of Sciences and National Academy of Engineering, 1973). However, the mean chloride value is only 30 mg/L below the recommended limit of 250 mg/L.

Table 2. -- Comparison of specific conductance for typical low-flow and high-flow seasons at four Hillsborough River stations

Station	Mean and standard deviation of specific conductance measurements (umho/cm at 25°C)	
	Low-flow	High-flow
Hillsborough River at Fowler Avenue	309 ± 35	283 ± 67
Hillsborough River at Harney	316 ± 58	230 ± 56
Hillsborough River at 56th Street	301 ± 51	254 ± 67
Hillsborough River at Tampa Reservoir Dam	374 ± 278	291 ± 217

Table 3. -- Mean and standard deviation of major chemical constituents and physical characteristics at selected stations along the Hillsborough River (1923-76)

[Concentrations in milligrams per liter except as noted.]

Station name	Stage, in feet above mean sea level	Turbidity, in Jackson turbidity units	Color, in platinum-cobalt units	Specific conductance, in micromhos at 25° Celcius	Biochemical oxygen demand	pH	Carbon dioxide	Alkalinity as calcium carbonate	Bicarbonate
Hillsborough River at Fowler Avenue	21.69±3.75	4±3	41±42	304±63	1.1±.9	7.5±.8	8.6±3.9	120±24	140±30
Hillsborough River at Harney	21.35±1.14		10±5	299±87		8.0±.6		140±18	160±35
Hillsborough River at 56th Street	21.33±1.12		23±15	306±89		7.9±.2		130±12	160±14
Hillsborough River at Tampa Reservoir Dam	21.28±1.22	4±0	75±55	325±194	2.3±1.9	7.5±.5	4.5±2.0	84±36	100±43
Sulphur Springs at Sulphur Springs	7.14±.29	2.7±3.8	11±18	1010±360	.8±.7	7.5±.3	5.4±1.6	120±22	150±27

Table 3. -- Mean and standard deviation of major chemical constituents and physical characteristics at selected stations along the Hillsborough River (1923-76) - continued

[Concentrations in milligrams per liter except as noted.]

Station name	Carbonate	Total nitrogen	Total nitrate as nitrogen	Total phosphorus	Dissolved ortho-phosphorus as phosphorus	Total organic carbon	Total inorganic carbon	Total carbon	Hardness as calcium carbonate
Hillsborough River at Fowler Avenue	0±0	1.0±.51	.29±.67	.53±.22	.39±.21	11±6.9	28±8.5	37±4.7	130±22
Hillsborough River at Harney	8±11				.36±.06				150±15
Hillsborough River at 56th Street	0±0				.22±.06				140±8.8
Hillsborough River at Tampa Reservoir Dam	2±4	.90±0	.04±.09	.42±0	.13±.09	14±8	22±8.5	36±7.1	110±52
Sulphur Springs at Sulphur Springs	0±0		.46±.09	.11±0	.14±.12	3.8±3.5	35±1.9	39±2.5	250±35

Table 3. -- Mean and standard deviation of major chemical constituents and physical characteristics at selected stations along the Hillsborough River (1923-76) - continued

[Concentrations in milligrams per liter except as noted.]

Station name	Non-carbonate hardness as calcium carbonate	Dissolved calcium	Dissolved magnesium	Dissolved sodium	Dissolved potassium	Dissolved chloride	Dissolved sulfate	Dissolved fluoride	Dissolved silica	Suspended solids	Dissolved solids (Residue at 180° Celcius)
Hillsborough River at Fowler Avenue	15±7.6	46±7.8	4.5±.6	8.0±1.6	1.4±.8	12±2.7	16±5.6	.3±.1	6.5±2.6	4±3	184±20
Hillsborough River at Harney	8.0±3.0	52±5.5	5.0±4.0	8.1±1.3	1.5±.4	12±2.5	14±2.5	.3±.1	5.7±4.1		192±15
Hillsborough River at 56th Street	12±1.5	48±3.0	4.8±.4	8.2±.5	.9±.2	9.0±6.2	14±1.9	.3±0	3.9±1.4		182±2
Hillsborough River at Tampa Reservoir Dam	23±22	35±18	4.0±3.0	17±23	1.4±1.4	20±32	16±14	.3±.1	7.4±5.7		189±145
Sulphur Springs at Sulphur Springs	140±22	78±12	15±1.7	120±18	3.8±.7	220±34	83±8.8	.3±.5	12±14		728±157

Table 4. -- Mean and standard deviation of concentrations of metals at two stations along the Hillsborough River (1967-75)

[Concentrations in micrograms per liter.]

Station name	Total arsenic	Total cadmium	Total chromium	Total cobalt	Total copper	Total iron	Dissolved iron	Total lead	Total manganese	Total nickel	Total zinc	Total aluminum	Total mercury
Hillsborough River at Fowler Avenue	4±5	0.3±0.5	0±0	0±0	0±0	200±160	90±100	10±10	10±4	4.8±6.1	10±0	60±20	0.1±0.1
Hillsborough River at Tampa Reservoir Dam	0±0	0±0	10±0		210±0	260±260	50±30	10±0	20±0		20±0		.1±0

Table 5. -- Quantity of herbicides, pesticides and PCB in whole water samples collected at the Hillsborough River at Tampa Reservoir Dam, June 16, 1975

[Concentrations are in micrograms per liter.]

Station name	Total aldrin	Total lindane	Total chlordane	Total DDD	Total DDE	Total DDT	Total dieldrin	Total endrin	Total ethion	Total toxaphene	Total heptachlor
Hillsborough River at Tampa Reservoir Dam	0.00	0.00	.1	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00

Station name	Total heptachlor epoxide	Total PCB	Total malathion	Total parathion	Total diazinon	Total methyl parathion	Total 2, 4-D	Total 2, 4, 5-T	Total silvex	Total trithion	Total methyl trithion
Hillsborough River at Tampa Reservoir Dam	0.00	0	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00

Table 6. -- Summary of regulations governing the chemical-quality constituents important in raw waters used for public water supply

Constituent	EPA recommended maximum contaminant levels	EPA maximum contaminant levels	Standard based on	Constituent level at Hillsborough River at Tampa Reservoir Dam
Color	75 platinum-cobalt units		Aesthetic considerations	75 $\pm$ 55 platinum-cobalt units
Nitrate-nitrogen		10 mg/L as N	Adverse physiological effects	.04 $\pm$ .09 mg/L
Hardness	No recommendation		User preference	110 $\pm$ 52 mg/L
Chloride	250 mg/L		Taste preference	20 $\pm$ 32 mg/L
Sulfate	250 mg/L		Adverse taste and laxative effects	16 $\pm$ 14 mg/L
Fluoride		1.4 mg/L	Adverse physiological effects	0.3 $\pm$ 0.1 mg/L
Arsenic		50 ug/L	Adverse physiological effects	0 $\pm$ 0 ug/L
Cadmium		10 ug/L	Adverse physiological effects	0 $\pm$ 0 ug/L
Chromium		50 ug/L	Adverse physiological effects	10 $\pm$ 0 ug/L
Copper	1000 ug/L		Taste preference	210 $\pm$ 0 ug/L

Table 6. -- Summary of regulations governing the chemical-quality constituents important in raw waters used for public water supply - continued

Constituent	EPA recommended maximum contaminant levels	EPA maximum contaminant levels	Standard based on	Constituent level at Hillsborough River at Tampa Reservoir Dam
Dissolved iron	300 ug/L		User preference	50 ± 30 ug/L
Lead		50 ug/L	Toxicity to humans	10 ± 0 ug/L
Manganese	50 ug/L		User preference	20 ± 0 ug/L
Zinc	5000 ug/L		Taste preference	20 ± 0 ug/L
Aldrin	1 ug/L		Adverse physiological effects	0.00 ug/L
Lindane		4 ug/L	Adverse physiological effects	0.00 ug/L
Chlordane	3 ug/L		Adverse physiological effects	0.1 ug/L
DDT	50 ug/L		Adverse physiological effects	0.00 ug/L
Dieldrin	1 ug/L		Adverse physiological effects	0.00 ug/L
Endrin		0.2 ug/L	Adverse physiological effects	0.00 ug/L

Table 6. -- Summary of regulations governing the chemical-quality constituents important in raw waters used for public water supply - continued

Constituent	EPA recommended maximum contaminant levels	EPA maximum contaminant levels	Standard based on	Constituent level at Hillsborough River at Tampa Reservoir Dam
Toxaphene		5 ug/L	Adverse physiological effects	0 ug/L
Heptachlor	0.1 ug/L		Adverse physiological effects	0.00 ug/L
Heptachlor epoxide	0.1 ug/L		Adverse physiological effects	0.00 ug/L
Malathion	100 ug/L		Adverse physiological effects	0.00 ug/L
Parathion	100 ug/L		Adverse physiological effects	0.00 ug/L
Diazinon	100 ug/L		Adverse physiological effects	0.00 ug/L
Methyl parathion	100 ug/L		Adverse physiological effects	0.00 ug/L
2, 4-D		100 ug/L	Adverse physiological effects	0.10 ug/L
2, 4, 5-T	2 ug/L		Adverse physiological effects	0.00 ug/L
Silvex		10 ug/L	Adverse physiological effects	0.00 ug/L

SUMMARY

Increases in population; and agricultural, industrial, and urban development within the Hillsborough River basin have increased the quantity of water needed for public supply. The quantity of water available at Tampa Reservoir has become acutely deficient during particularly dry periods of the year. Runoff and effluent from agricultural, industrial and urban areas enter the stream system in upper and lower reaches of the Hillsborough River affecting the quality of water available at the Tampa Water Treatment Plant but to what degree is not known.

Tampa Reservoir extends 12.5 mi upstream from Tampa Dam and, at low stages, is about 1,000 feet at its widest point near the dam, narrowing to about 100 ft near Temple Terrace. The reservoir has a meandering v-shaped channel that averages about 15 ft in depth.

Results of a draft-storage analysis indicate that a 38-Mgal/d draft rate will not exceed 20-year Hillsborough River minimum flow. In any year, assuming a full reservoir on July 1, Tampa Reservoir and Hillsborough River have a 5-percent chance of failing to supply at least 66 Mgal/d and a 2-percent chance of failing to supply at least 59 Mgal/d.

The available Tampa Reservoir storage is 2,000 Mgal at a maximum stage of 22.5 ft above msl. This storage is approximately 1.5 percent of the average flow.

Water-quality samples taken at the Tampa Reservoir Dam show sodium and chloride values to be approximately twice as high as at any of the upstream stations. However, the concentration of these ions as well as other inorganic and organic chemicals that were tested are all below the maximum acceptable limits set by the EPA for raw waters used for public supply (1975, p. 59570-59571; National Academy of Sciences and National Academy of Engineering, 1973, p. 50-93). Color exceeds the recommended level. The color is removed through the treatment process at the Tampa Water Treatment Plant.

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