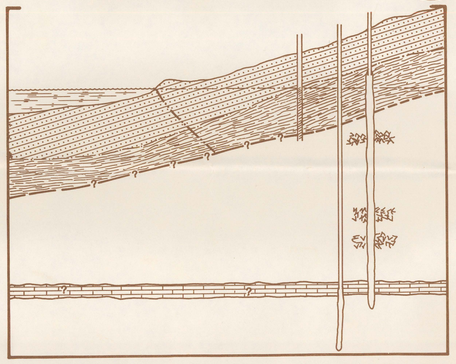
(200)
R290
no. 84-807

Prepared in cooperation with the
WATER RESOURCES RESEARCH INSTITUTE OF THE COLLEGE OF THE VIRGIN ISLANDS

RECONNAISSANCE OF GROUND-WATER QUALITY IN THE U.S. VIRGIN ISLANDS, JULY 1984

UNITED STATES GEOLOGICAL SURVEY
WATER RESOURCES DIVISION
OPEN-FILE DATA REPORT 84-807



Prepared in cooperation with the
WATER RESOURCES RESEARCH INSTITUTE
OF THE COLLEGE OF THE VIRGIN ISLANDS
1984

RECONNAISSANCE OF GROUND-WATER QUALITY IN THE U.S. VIRGIN ISLANDS, JULY 1984

By
René García and Michael Canoy

INTRODUCTION

The demand for ground water in the U. S. Virgin Islands, specially for domestic use has increased markedly in recent years. In 1982, ground water withdrawals for public and domestic use in the U.S. Virgin Islands were about 1.1 million gallons per day (Torres and Dacosta, 1984). Recent investigations show that additional withdrawals might be possible (F. Gómez-Gómez, USGS personal commun., 1984).

In spite of increasing demands for ground water, data on its quality is very scarce. The lack of data constitutes a major gap in the knowledge of the U.S. Virgin Islands' hydrologic environment. There are no active water-quality monitoring networks and the most recent reconnaissance was conducted nearly two decades ago (Cosner, 1972; Jordan, 1975; Jordan and Cosner, 1973; Robison, 1972).

U.S. GEOLOGICAL SURVEY
RESTON, VA.
FEB 22 1985

In 1984, the U.S. Geological Survey, Water Resources Division, conducted a reconnaissance of the ground-water quality at selected wells throughout the U.S. Virgin Islands (fig. 1). The investigation was conducted in cooperation with the Water Resources Research Institute of the College of the Virgin Islands. Wells representing the principal aquifers (fig. 2 and tables 1 to 5), were sampled for physical, chemical and bacteriological characteristics. Selected wells were also sampled to determine potential contamination with priority pollutants as designated by the U.S. Environmental Protection Agency (EPA). This report summarizes the data collected during the investigation (July 1984). The data will provide a base line for future investigations and an assessment of water use versus quality.

We wish to thank the U.S. National Parks Service, Public Works Department in St. Croix and St. John, and the Director of Conservation and Cultural Affairs in St. Thomas for their assistance.

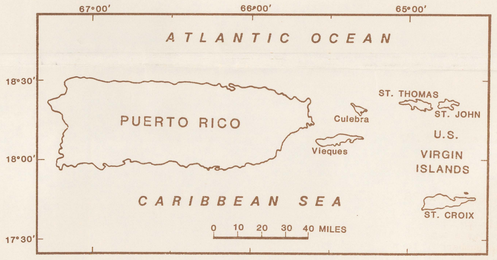


Figure 1.--Geographic location of the U.S. Virgin Islands.

METHODS AND PROCEDURES

Nineteen wells in the U.S. Virgin Islands (fig. 2 and tables 1 to 5), were sampled as follows: eight wells in St. Croix (map numbers 1 to 8), seven wells in St. Thomas (map numbers 9 to 15), and four wells in St. John (map numbers 16 to 19). The wells were selected to represent the most important pumping centers. The samples were collected as close as possible to the well casing. Methods described by Classen (1982), were used for the collection of the samples.

Temperature, specific conductance, pH and total alkalinity of the samples were measured at each site immediately upon collection of the samples. The depth of the water level below land surface was also determined. Samples for chemical analysis of trace elements, common ions and nutrients were collected, filtered, and preserved in accordance with procedures described by Skougstad and others (1979), and Goerlitz and Brown (1972). Samples for the determination of priority pollutants were collected at five wells (map numbers 4, 7, 13, 15, and 19), and preserved in accordance with methods established by Brown and others (1970). The samples were shipped to the U.S. Geological Survey National Water-Quality Laboratory in Doraville, Georgia, for chemical analyses. Determinations of fecal coliform and fecal streptococci bacteria were completed from raw water samples using the membrane filter method (Greeson and others, 1977). Processing and incubation of the samples were begun in the field shortly after collection.

RESULTS

Results of the field and laboratory determinations are shown in tables 1 to 5. The principal findings of the reconnaissance were as follows:

1. Specific conductance values normally ranged from 1,400 to 3,000 micromhos per centimeter (umhos/cm). Well numbers 6 and 9 had values which surpassed 4,500 umhos/cm.

2. Fecal coliform and fecal streptococci bacteria were detected in samples from 18 of the 19 wells sampled. Colony counts of fecal streptococci bacteria were as high as 5,800 colonies/100 milliliters (mL) of raw water sampled.

3. Nitrate concentrations exceeded 1.0 milligrams per liter (mg/L) at ten of the wells sampled.

4. Chloride concentrations generally ranged from 180 to 600 mg/L. At 13 wells (map numbers 1, 4, 5 thru 8, 10, 12, 13, 15, 17, and 18), chloride concentrations exceeded drinking water standards of 250 mg/L (EPA Drinking Water Regulations).

5. Sulfate concentrations for most wells were less than the drinking water standard of 250 mg/L. All the wells sampled had total dissolved solids exceeding the EPA secondary drinking water standard of 500 mg/L.

6. Concentrations of organic compounds and most trace elements at selected sites were less than detection limits.

Additional information about the wells sampled and the data in this report is available from the U.S. Geological Survey, Water Resources Division, Caribbean District office in San Juan, Puerto Rico (Tel. (809) 753-4414).

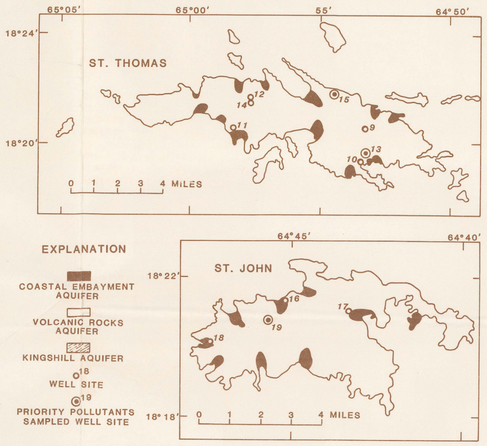


Figure 2.--Principal aquifers and selected wells sampled in the U.S. Virgin Islands.

Table 1.--Physical, chemical, and bacteriological characteristics from selected wells in the U.S. Virgin Islands, July 1984.

WELL NUMBER ON MAP	LOCATION (LAT/LONG)	WELL NAME	OPERATED BY	DWL (FT)	T (DEG C)	SC (UMHOS /CM)	pH (UNITS)	ALK	FC	FS	NO2	NO2-NO3	PO4	TOC
1	174245644758	Golden Grove no. 1	DPW	36.75	29.0	1725	7.4	574	K 8	1	0.255	0.750	0.040	1.0
2	174308644841	Adventure no. 16	DPW	40.74	33.0	1750	7.6	531	< 1	< 1	.190	.710	.014	3.4
3	174258645222	Prosperity no. 1	DPW	34.83	28.5	1325	7.0	316	< 1	K 4	.025	1.1	.001	1.2
4	174329644547	Barren Spot no. 5	DPW	70.96	27.5	3175	7.6	597	< 1	K 2	.016	1.0	.015	.8
5	174225644719	Fairplains no. 6	DPW	58.07	27.5	5750	7.0	489	< 1	< 1	.016	.687	.071	.9
6	174527644601	Concordia no. 1	DPW	25.27	27.5	2975	7.0	458	< 1	40	.015	.710	.013	.9
7	174659644716	Rust-up-twist	PO	32.13	27.0	2550	7.4	500	K 4	5800	.030	.850	.052	.8
8	174526643713	Zell's Well	PO	78.93	32.5	4675	7.2	446	38	2300	.016	.940	.014	.9
9	182033645312	V.I.H.A. no. 2	VIHA	73.86	29.0	1150	7.0	602	1	65	.008	ND	.009	1.7
10	181913645307	Bavoni no. 2	PO	24.37	28.5	2350	7.2	554	< 1	370	.011	8.0	.009	2.4
11	182036645813	C.V.I. no. 2	CVI	46.83	29.0	1250	7.4	485	1	94	.007	5.8	.011	1.1
12	182141645746	Agriculture Station	USDA	65.15	25.5	1900	7.1	448	1	23	.009	1.1	.054	1.0
13	181945645257	Polycarib no. 3	PO	118.27	28.0	2425	7.2	580	1	K 488	.016	2.3	.003	3.8
14	182130645745	Bryan's Well no. 2	PO	ND	25.5	1250	6.9	251	K 36	4	.006	2.8	.065	.7
15	182142645427	Mohagony Run no.9	PO	81.70	28.0	2230	6.8	580	< 1	4700	< .001	< .010	<.001	2.0
16	182112644519	N.P.S. no. 9	USNPS	ND	27.0	1925	6.8	518	< 1	10	.005	.597	.009	1.2
17	182058644322	Carolina Well	DPW	5.82	27.5	2000	6.8	287	6	109	.008	1.2	.012	1.2
18	182010644728	N.P.S. no. 2	USNPS	27.75	29.0	2500	7.0	560	30	3900	.011	4.9	.012	2.0
19	182043644546	Sussanaberg no. 5	DPW	62.89	25.5	1450	7.0	538	5	8	< .001	1.6	.007	1.7

E X P L A N A T I O N

DWL - Depth to water level below land surface, in feet
T - Temperature, in degrees Celsius
SC - Specific conductance, in micromhos per centimeter at 25°C
ALK - Total alkalinity as calcium carbonate, in milligrams per liter
FC - Fecal coliform bacteria, in colonies per 100 milliliters
FS - Fecal streptococci bacteria, in colonies per 100 milliliters
DPW - Virgin Islands Department of Public Works
VIHA - Virgin Islands Housing Authority
USDA - United States Department of Agriculture

NO2 - Nitrite as nitrogen, total
NO2 + NO3 - Nitrite plus nitrate as nitrogen, total
PO4 - Phosphorus, orthophosphate
TOC - Organic carbon, total
TDS - Total dissolved solids
-- - No data
PO - Privately operated
CVI - College of the Virgin Islands
USNPS - United States National Park Service

(Milligrams per liter)

Table 2.--Concentrations of dissolved common ions and trace elements from selected wells in the U.S. Virgin Islands, July 1984.

WELL NUMBER ON MAP	COMMON IONS, DISSOLVED (MILLIGRAMS PER LITER)									TRACE METALS, TOTAL (MICROGRAMS PER LITER)							
	Ca	Mg	Na	K	SO4	Cl	F	SiO2	TDS	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
1	67	48	280	0.9	99	270	0.6	47	1150	2	100	1	2	2	1.7	3	< 1
2	37	36	250	.5	55	190	.6	38	919	2	< 100	1	2	2	0.6	2	< 1
3	100	29	92	.7	33	170	.5	37	610	2	100	1	6	2	0.5	1	< 1
4	21	10	590	8.0	170	460	.9	28	1640	--	--	--	--	--	--	--	--
5	220	10	750	2.7	270	1500	.5	40	3190	2	200	1	2	1	0.6	4	1
6	120	65	420	6.4	190	600	.6	36	1670	--	--	--	--	--	--	--	--
7	35	42	440	1.3	55	490	.8	38	1390	1	< 100	1	< 1	1	0.4	1	< 1
8	120	81	670	7.2	220	1100	.8	33	2460	1	< 100	< 1	< 1	< 1	1.4	8	< 1
9	71	46	230	1.1	61	160	.8	45	977	1	< 100	1	5	3	< 0.1	2	< 1
10	66	83	340	2.3	99	440	.5	46	1410	1	< 100	1	5	1	0.2	3	< 1
11	39	32	230	.9	44	180	.8	48	861	1	< 100	1	1	1	0.3	3	< 1
12	37	24	330	.8	72	330	.3	34	1090	1	< 100	1	3	< 1	0.5	2	< 1
13	40	43	370	1.9	90	410	.7	27	1320	--	--	--	--	--	--	--	--
14	16	13	220	.8	32	230	.3	35	696	1	< 100	1	4	1	0.3	1	< 1
15	180	62	280	6.9	200	390	1.1	33	1460	--	--	--	--	--	--	--	--
16	77	64	230	3.3	42	370	.5	36	1120	1	< 100	1	4	1	0.4	1	< 1
17	41	46	290	3.2	120	430	.3	36	1140	1	< 100	1	5	< 1	0.5	1	< 1
18	100	75	360	2.2	67	490	.5	38	1460	1	< 100	2	6	1	0.6	< 1	< 1
19	66	54	180	3.2	30	180	.6	40	869	--	--	--	--	--	--	--	--

E X P L A N A T I O N

Ca - Calcium
Mg - Magnesium
Na - Sodium
K - Potassium
SO4 - Sulfate
Cl - Chloride
F - Fluoride
SiO2 - Silica
TDS - Total dissolved solids
As - Arsenic
Ba - Barium
Cd - Cadmium
Cr - Chromium
Pb - Lead
Hg - Mercury
Se - Selenium
Ag - Silver
-- - No data

Table 3.--Concentrations of priority pollutants at selected wells in the U.S. Virgin Islands, July 1984.

WELL NUMBER ON MAP	Al	Sb	As	Be	Cd	Cr	Cu	Fe	Pb	Li	Mn	Hg	Mo	Ni	Se	Ag	Zn	CYANIDE
4	70	< 1	2	< 10	< 1	< 10	< 1	< 10	1	10	< 10	0.1	2	< 1	4	< 1	10	< 0.01
7	< 10	< 1	< 1	< 10	< 1	< 10	< 1	10	2	50	< 10	.3	< 1	2	6	< 1	10	< .01
14	10	< 1	--	< .5	1.2	--	11	7.7	< 10	< 4	180	--	< 10	--	--	2	13	< .01
16	10	1	--	< .5	1.5	--	< 10	230	< 10	< 4	17	--	< 10	--	--	1	190	< .01
19	20	< 1	< 1	< 10	< 1	< 10	1	< 10	1	< 4	< 10	< .1	< 1	1	1	< 1	21	< .01

E X P L A N A T I O N

Concentrations in micrograms per liter

Al - Aluminum
Sb - Antimony
As - Arsenic
Be - Beryllium
Cd - Cadmium
Cr - Chromium
Cu - Copper
Fe - Iron
Pb - Lead
Li - Lithium
Mn - Manganese
Hg - Mercury
Mo - Molybdenum
Ni - Nickel
Se - Selenium
Ag - Silver
Zn - Zinc
-- - No data

Concentrations in milligrams per liter

Cyanide

Table 4.-- Purgeable organic, base-neutral, and acid extractable compounds for which analyses were performed in samples from five wells in the U.S. Virgin Islands, July 1984.

Minimum detection limit 3.0 micrograms per liter

Benzene
Bromoform
Carbon tetrachloride
Chlorobenzene
Chloroethane

2-Chloroethyl vinyl ether
Chloroform
Dibromochloromethane
Dichlorobromomethane
Dichlorodifluoromethane

1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethylene
1,2-trans-Dichloroethylene
1,2-Dichloropropane

1,3-Dichloropropene
Ethylbenzene
Methylbromide
Methylene chloride
1,1,2,2-Tetrachloroethane

Tetrachloroethylene
Toluene
1,1,1-trichloroethane
1,1,2-Trichloroethane
Trichloroethylene

Trichlorofluoromethane
Vinyl chloride

Minimum detection limit 1.0 micrograms per liter

Acenapthene
Acenapthylene
Anthracene
Benzo (a) anthracene
Benzo (b) fluoranthene

Benzo (k) fluroanthene
Benzo (g,h,i) perylene
Benzo (a) pyrene
4-Bromophenyl phenyl ether
Butyl benzyl phthalate

bis (2-Chloroethoxy) methane
bis (2-Chlorethyl) ether
bis (2-Chloroisopropyl) ether
2-Chloronaphthalene
4-Chlorophenyl phenyl ether

Chrysene
Dibenzo (a,h) anthracene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene

Diethyl phthalate
Dimethyl phthalate
Di-n-butyl phthalate
2,4-Dinitrotoluene
2,6-Dinitrotoluene

Di-n-octylphthalate
bis (2-Ethylhexyl)phthalate
Fluoranthene
Fluorene
Hexachlorobenzene

Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno (1,2,3) pyrene
Isophorone

Naphthalene
Nitrobenzene
n-Nitrosodi-n-propylamine
n-Nitrosodimethylamine
n-Nitrosodiphenylamine

Phenanthrene
Pyrene
1,2,4-Trichlorobenzene
4-Chloro-3-methylphenol
2-Chlophenol

2,4-Dichlorophenol
2,4-Dimethylphenol
4,6-Dinitro-2-methylphenol
2,4-Dinitrophenol
2-Nitrophenol

4-Nitrophenol
Pentachlorophenol
Phenol
2,4,6-Trichlorophenol
2,3,7,8-Tetrachlorophenol

4-Bromophenyl phenol
3,3-Dichlorobenzid

All concentrations were below minimum detection level.

Table 5. Organochlorine insecticides, polychlorinated byphenils, and polychlorinated naphthalenes for which analyses were performed in samples from five wells in the U.S. Virgin Islands, July 1984.

Minimum detection level 0.01 micrograms per liter

ALDRIN
DDD
DDE
DDT
DIELDRIN

ENDRIN
ENDOSULFAN
HEPTACHLOR
HEPTACHLOR EPOXIDE
LINDANE

METHOXYCHLOR
MIREX

Minimum detection level 0.1 micrograms per liter

CHLORDANE
GROSS POLYCHLORINATED BIPHYNELS (AS PCB)
GROSS POLYCHLORINATED NAPHTHALENES (AS PCN)
AROCHLOR 1016
AROCHLOR 1221

AROCHLOR 1232
AROCHLOR 1242
AROCHLOR 1248
AROCHLOR 1254
AROCHLOR 1260

PERTHANE

Minimum detection level 1.0 micrograms per liter

TOXAPHENE

All concentrations were below minimum detection level.

REFERENCES

Brown, E., and others, 1970, Methods for the collection and analysis of water samples for dissolved minerals and gases: U.S. Geological Survey Techniques of Water Resources Investigations, Book 5, Chapter A1, 160 p.

Classen, H.C., 1982, Guidelines and techniques for obtaining water samples that accurately represent the water chemistry of an aquifer: U.S. Geological Survey Open-File Report 82-1024, 49 p.

Cosner, O.J., 1972, Water in St. John, U.S. Virgin Islands: U.S. Geological Survey Open-File Report, (unnumbered).

Goerlitz, D.F., and Brown, E., 1972, Methods for analysis organic substances in water: U.S. Geological Survey, Techniques of Water Resources Investigations, Book 5, Chapter A3, 40 p.

Greeson, P.E., and others, 1977, Methods for collection and aquatic biological and microbiological samples: U.S. Geological Survey, Techniques of Water Resources Investigations, Book 5, Chapter A4, 332 p.

Jordan, D.G., 1975, A survey of the water resources of St. Croix, U.S. Virgin Islands: U.S. Geological Survey Open-File Report, (unnumbered), 51 p.

Jordan, D.G., and Cosner, O.J., 1973, A survey of the water resources of St. Thomas, U.S. Virgin Islands: U.S. Geological Survey Open-File Report, (unnumbered), 55 p.

Robison, T.M., and others, 1972, Water records of the U.S. Virgin Islands, 1962-69: U.S. Geological Survey Open-File Data Report, 163 p.

Skougstad, M.W., and others, 1979, Methods for determinations of inorganic substances in water and fluvial sediments: U.S. Geological Survey, Techniques of Water Resources Investigations, Book 5, Chapter A1, 626 p.

The National Drinking Council, 1977, Drinking water and Health: National Academy of Sciences, Washington, D.C., 1977, 939 p.

Torres, H., and Dacosta, R., 1984, Estimated water use in St. Thomas, U.S. Virgin Islands, July 1983 to June 1984, U.S. Geological Survey Open-File Data Report 84-721, 1 pl.

U.S. Environmental Protection Agency, Drinking Water Regulations: 40 C.F.R., Part 141.

TECHNICAL REPORT NO. 20
CARIBBEAN RESEARCH INSTITUTE
COLLEGE OF THE VIRGIN ISLANDS
ST. THOMAS U.S.VIRGIN ISLANDS 00802

PROJECT NO. 375003
AGREEMENT NO. 14-08-0001-G-875

THE RESEARCH ON WHICH THIS REPORT IS BASED WAS FINANCED IN PART BY THE UNITED STATES DEPARTMENT OF THE INTERIOR AS AUTHORIZED BY THE WATER RESEARCH AND DEVELOPMENT ACT OF 1978 (P.L. 950467).