WATER QUALITY OF PUBLIC HOUSING PROJECTS IN THE VIRGIN ISLANDS

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June 1989

Technical Report No. 32

Water Resources Research Center

Caribbean Research Institute

UNIVERSITY OF THE VIRGIN ISLANDS

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TECHNICAL REPORT NO. 32

WATER RESOURCES RESEARCH CENTER

CARIBBEAN RESEARCH INSTITUTE

UNIVERSITY OF THE VIRGIN ISLANDS

ST. THOMAS, U.S.V.I. 00802

PROJECT NO. 02

AGREEMENT NO. 14-08-001-G1455

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 1984 (P.L. 98-242)

ABSTRACT

The predominant source of water for residents of the United States Virgin Islands is cistern-stored water. In this study of cisterns serving residents of public housing, it was found that only about one-half of the samples collected over time from ten study sites were in compliance with the mandates of the Safe Drinking Water Act of 1974 as amended in 1986. Contamination was correlated with absence of free residual chlorine in cisterns. Chlorination practices were irregularly applied by public housing staff during the study period. The presence of pathogenic Pseudomonas aeruginosa is not well-correlated to the standard total coliform indicator suggesting that standard mandates of the Safe Water Drinking Act do not adequately protect human health when applied to cistern-stored water.

ACKNOWLEDGEMENTS

We would like to thank all of the employees of the Virgin Islands Housing Authority but especially Mr. Samuel Gumbs, Water Management Supervisor; Mr. Allison Trotman, Water Treatment Specialist; and Ms. Roxanne Downing, Laboratory Technician; as well as the many residents of the various Public Housing Projects who made this study possible. Special thanks to the office staff of the Caribbean Research Institute, and to the several students employed by the Water Resources Research Center who made media, did some tests, and helped in keeping the study on track.

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INTRODUCTION

Only about one-third of the residents in the U.S. Virgin Islands are served by a potable water distribution system. Almost 80% of Virgin Island residents rely to some extent on rainfall harvesting techniques with cistern storage (22,40,41). All buildings, including housing projects administered by the Virgin Islands Public Housing Authority, are required under the Virgin Islands Code to have cisterns. Most Public Housing projects are not served by the potable water distribution system. Cisterns in those projects are filled with water from a variety of sources including rain water, water transported in trucks from desalination plants, and water transported in trucks from wells. Typically, water that is transported to public housing is rationed by Public Housing officials with service restricted to early morning and night-time hours. In cisterns supplied by potable water and supplemented by rain water, rationing is less frequent.

Public Housing cisterns are covered by the mandates of the Safe Drinking Water Act of 1974 as amended in 1986 because they serve more than 25 residents on a year round basis and/or have more than 15 service connections. Consequently, they must contain $\leq$ 1 total coliform per 100mL of sample (2,4,5). Studies of the quality of cistern-stored water show that such water frequently fails to conform to the established standards (22,29,39,41). Since

cisterns are systems which are open to the environment it is not surprising that they are subject to contamination.

In a previous study of cisterns in private residences in the U.S. Virgin Islands (41), we documented the following observations:

1. Most cisterns would not comply with the mandates of the Safe Drinking Water Act.
2. Major sources of contamination include tree leaves, dust, and animal droppings.
3. Tree leaves are major reservoirs for organisms leading to high heterotrophic plate counts, total coliform, fecal coliform fecal streptococci, and Pseudomonas aeruginosa (Ps. aeruginosa).
4. Chlorination is highly effective at reducing microbial contaminants for 3 to 5 days, but must then be replenished.
5. Cistern sediments provided chlorine-resistant reservoirs for recontamination of cisterns.

Both the quality and quantity of water supplied to tenants of public housing is a frequent matter of public concern in the Virgin Islands. While concern peaked following an outbreak of typhoid at a Public Housing project on St. Croix in 1985 in which 66 cases were diagnosed (40), the issue is frequently raised in less dramatic ways. In this study, we attempt to assess the quality of water supplied to Public Housing. Specifically we wish to:

1. Assess the degree to which Public Housing cisterns are in compliance with Safe Drinking Water standards.

2. Assess health risks to Public Housing tenants from other pathogenic contaminants such as Ps. aeruginosa and Salmonella spp.

3. Develop further information upon which to base changes in water quality standards for cistern-stored water.

MATERIALS AND METHODS

Site Selection: A total of 10 cisterns from 5 Public Housing projects located on the island of St. Thomas were sampled between September 1987 and June 1988. The cisterns chosen served large numbers of residents. Two of the projects were served by potable water distribution system while the others were not. Two of the projects appeared to be well maintained while the other three did not appear to be so. One housing unit or office was picked as the sampling point for each study cistern.

Sample Collection Procedures: Sample sites were divided into two groups of five. An attempt was made to collect from each group on alternating Mondays. In practice, while we attempted to adhere to this schedule, we sometimes ended up collecting samples from the other group due to water shortages.

Samples were collected in sterile 1 liter clear borosilicate glass wide mouth bottles with ground glass stoppers containing 0.8 mL of 10% sodium thiosulfate (2,4).

Samples were collected from faucets after the water was allowed to flow for two minutes (2,4). They were transported to the laboratory in light protected containers. Samples were not chilled on collection because analysis generally commenced within 2.5 hours of sampling. While die off does occur even after only short intervals (31,32,) the

die off would be insignificant for the times involved (45).

Physical-Chemical analysis: Measurements of pH, conductivity, turbidity, and free and total residual chlorine were conducted by standard methods (2).

Microbiological analysis. Total coliform, fecal coliform, fecal streptococcus, Pseudomonas aeruginosa, and heterotrophic plate count analyses were performed on each sample; Salmonella typhi and spp analysis were done in addition on each sample during the first half of the study. All analyses with the exception of the heterotrophic plate count were done via the membrane filter (MF) technique. The heterotrophic plate count was done using the spread plate technique (2).

Total coliform, fecal coliform, and fecal streptococcus were isolated on m-Endo Agar (Difco Laboratories, Detroit, MI) (2,4), m-FC Agar (Difco) (2,3,4), and KF Streptococcus Agar (Difco) (2,3,4), respectively, The heterotrophic plate count (2) was performed using Standard Plate Count Agar (Difco). All media were prepared in accordance with the manufacturer's instructions. Analysis for Ps. aeruginosa and Salmonella typhi and Salmonella spp were performed by non-standard methods described below.

Sample volumes of 100, 50, 25, and 10 mL were filtered. Total coliform, fecal streptococcus, and Ps. aeruginosa samples were filtered through 0.45m filters (GN-6, 66068;

Gelman Sciences Inc., Ann Arbor, MI.) (2,3,4,). Fecal coliform samples were filtered through 0.7m filters (Millipore Corporation, Bedford, Mass.) (2). 0.1 and 1 mL volumes of 3 dilutions ranging from 1 to 10^{-6} were run in duplicate for the heterotrophic plate counts.

Total coliforms, fecal streptococcus, and the heterotrophic plate counts were incubated at 35 $\pm$ 0.5^{o}C (2,4). Fecal coliform plates were incubated at 44.5 $\pm$ 0.2^{o}C (2,4). Total coliforms and fecal coliforms were incubated for 24 hours; fecal streptococcus, and heterotrophic plate counts were incubated for 48 hours (2,4).

Pseudomonas aeruginosa analysis: Ps. aeruginosa was isolated on a new medium, m-CX agar, developed in this laboratory (41). The P. aeruginosa plates were preincubated at 30 $\pm$ 0.5 ^{o}C for 3-4 hours and then incubated at 41.5 $\pm$ 0.5^{o}C (2,6,11,14,28) for the remaining 44 hours.

Salmonella spp. analysis: 200 and 100 mL samples were filtered through 0.45 mm filters (Gelman Sciences) which were placed filter face up on pads saturated with m-Tetrathionate Broth base (Difco) with added iodine solution and 1:50,000 Brilliant Green dye - both are used to inhibit non-pathogenic organisms (2). The broth also contained l-cystine (3 mg /L) to improve the sensitivity (2).

After 3 hours on this pre-enrichment media, the filter was transferred to a pad saturated with m-Brilliant Green Broth (Difco) for 21 hours. Both incubations were at 35^{o}C.

Salmonella typhi analysis: 200 and 100 mL samples were filtered through the 0.45 mm filter, the filter was placed on a pad saturated with m-Bismuth Sulfite Broth (Difco) and incubated for 48 hours.

Verification of isolates. Up to five typical and, if present, five atypical colonies were picked from each medium for each sample, and subjected to verification (4). Colonies were counted with the aid of a variable magnification dissecting scope with a minimum magnification of 10x (Parco EMZ745 10L with annular fluorescent illumination; Parco Scientific Co., Bienna, OH) (2,4). The heterotrophic plate counts were counted with the aid of a Quebec Colony Counter (2,4).

Typical green sheen, and atypical red colonies were picked from the m-Endo Agar plates and verified in Lauryl Tryptose Broth (Difco) and Brilliant Green Bile 2% (Difco) (2,4,).

Typical blue and atypical gray or blue-gray colonies from the m-FC Agar plates were verified in Lauryl Tryptose Broth and EC Medium (Difco) (2,3,4,36).

Typical red-pink to red colonies from the KF Streptococcus Agar plates were verified for growth in Brain Heart Infusion Broth (Difco) 35 and 44.5 $\pm$ 0.2^{o} C; for growth in Brain Heart Infusion Broth with 40% Bile, and by the Catalase test (2,4).

Typical fluorescent yellow to yellow green or blue green, mucoid colonies, and atypical small, clear, flat, non-mucoid colonies were picked from the m-CX Agar plates and verified on Skim Milk Agar (Brown and Foster) (2,6,11,13,14,28), Pseudomonas Isolation Agar (Difco)(12), King's B medium (same as Difco's Pseudomonas F Agar)(12), Acetemide Broth, and Gluconate Broth on a routine basis.

RESULTS

Samples were collected on a rotating basis from ten cisterns in five public housing projects over a period of nine months from September 1987 through June 1988. A summary of the bacteriological determinations appears in Table I.

The number of samples collected from each site varied from five to ten. Water was supplied to some of the study sites intermittently. If no water was available from a site on a scheduled sampling day, samples were picked up the following week where possible. Some sites (e.g. 6 and 8) were frequently without water.

Bacterial contents of each study site varied considerably between samplings. Table I reports the number of samples collected at each location, the averages over time of the total coliform, fecal coliform, fecal streptococcus, Ps. aeruginosa, and Standard Plate count analysis for each sample site. The ranges of values found are also reported. If drinking water contains more that one total coliform per 100 mL, it violates the mandates of the Safe Drinking Water Act. Averages over time of the total coliform count are presented in Table I.

Table I does not report results of tests that were made for Salmonella typhi or spp. Since Salmonella was not detected in any of the first 64 samples taken, a decision was made to discontinue testing for this organism in the remaining samples.

TABLE I

Summary of Bacterial Determinations
from Ten Public Housing Cisterns

Average Values and (Ranges)

Site	No. of Samples per site	Total[a] Coliform	Fecal Coliform	Fecal Strep.	Ps. aeurginosa	Standard[b] Plate Count
1	9	13 (0-50)	1 (0-3)	0 (0-2)	22(0-151)	550 (11-2400)
2	8	48 (0-338)	1 (0-8)	23(0-160)	10 (0-72)	1400 (10-5300)
3	8	1 (0-4)	0 (0-0)	2 (0-14)	15(0-112)	2400 (0-14000)
4	9	2 (0-11)	1 (0-8)	98(0-640)	166(0-799)	1900 (2-12000)
5	8	15 (0-100)	1 (0-9)	0 (0-0)	0 (0-1)	450 (6-2500)
6	6	0 (0-0)	0 (0-1)	0 (0-0)	0 (0-0)	250 (1-650)
7	10	46 (0-220)	8 (0-27)	62(0-412)	19 (0-91)	7700(760-30000)
8	5	30 (0-103)	6 (0-20)	11 (0-40)	201(0-617)	1600 (420-3000)
9	9	614(0-1650)	307(3-568)	21(0-475)	80(1-207)	10000(400-30000)
10	9	5 (0-29)	2 (0-8)	167(0-972)	5 (0-22)	1200 (210-4400)

a. Counts for Total Coliform, Fecal Coliform, Fecal Streptococcus and Pseudomonas aeruginosa are given as counts per 100 mL.

b. Standard Plate Counts are given as counts per mL.

It is interesting to examine the fraction of samples collected from particular cisterns over time that are in compliance. This information is reported in Table II. It should be noted that the number of samples reported in this table is fewer for some sites than reported in Table I because the coliform analysis for some of the samples was not considered to be reliable. Only 56% of the samples collected from public housing cisterns were in compliance with the total coliform standard. While all sites were out of compliance at least once, some sites such as Sites 7,8,and 9 were frequently out of compliance on sampling dates.

Fecal coliform has been proposed as an alternative standard to total coliform for some water supplies (34,35,41). If samples are judged on this proposed standard ($\leq$ 1 fecal coliform per 100 mL), they are judged to be in compliance slightly more frequently than based on the total coliform standard (Table II). Even using this standard, water is often of dubious quality.

Ps. aeruginosa is an opportunistic pathogen that is known to occur in potable water supplies, as well as in cistern water supplies in the Virgin Islands (41). As indicated in Table I, Ps. aeruginosa was found at least once in each cistern studied with one exception. Table III compares the occurrence of total coliforms with that of Ps. aeruginosa. Ps. aeruginosa was found in 52% of the samples tested. Of the samples containing this organism, 69% (27 out

Table II

Percent of Samples In Compliance With
Total Coliform Standards or Proposed Fecal Coliform Standards

Sample Site	Times Sampled	Total Coliform Standard % in Compliance	Fecal Coliform (Proposed) Standard % in Compliance
1	9	67	67
2	8	75	75
3	7	71	100
4	8	62	88
5	8	62	88
6	6	83	83
7	9	22	44
8	5	20	60
9	8	12	-0-
10	8	75	62
Average % Compliance		56%	66%

Table III

Joint Contamination of Cisterns
by
Coliform Bacteria and Ps.aeurginosa

The number and percentages of samples having any Ps.aeurginosa and/or violating the total coliform standard are shown:

	Ps. Positive	Ps. Negative
Coliform Positive	27 (36%)	6 (8%)
Coliform Negative	12 (16%)	32 (40%)
Total No. of samples: 76		

of 39 samples) were found to violate the total coliform standard.

To assess the origin of total coliform contamination, the ratio of fecal coliform to fecal streptococcus was determined for each sample. Fecal coliform to fecal streptococcus ratios for those samples that were contaminated by coliform bacteria are shown in Table IV.

The normal habitat of fecal streptococci is the intestines of humans and animals; thus these organisms are indicators of fecal pollution. In combination with fecal coliform data, data on fecal streptococci may provide more specific information about pollution sources because certain

fecal streptococci are host specific; however, the fecal streptococcus subspecies S. faecalis subsp. liquefaciens is not restricted to the intestines of humans and animals. It has been found associated with vegetation, insects, and certain types of soils. This may be detrimental, especially for indicating low density fecal contamination, because when the count is below 100 fecal streptococci / 100 mL this organism generally predominates, and ratios should not be used. In general, however, ratios in excess of 4.1 are taken to indicate a predominantly human origin of the coliform bacteria. Ratios less than 0.7 are taken to indicate pollution from non-human sources. Ratios between 0.7 and 4.1 usually indicate wastes of mixed human and animal sources (2). Normally fecal coliform / fecal streptococcus ratios are applied to water quality studies of lakes, streams, and estuaries; our purpose for doing these ratios is one of a qualitative and not quantitative nature. The use of these ratios is not intended to pinpoint an exact source or point of contamination, but rather to aid in determining whether any observable contamination is essentially due to environmental contamination, or whether there might be septic tank infusion. There is no fixed pattern observable among study sites or within any one study site. In most samples it would appear that the source of the contamination is from the environment; at study site 9 however there are

Table IV

Fecal Coliform/Fecal Strepteococcus Ratios
For Determining coliform Origins

Sample Site	Sample Date	Total Coliform	Fecal Coliform	Fecal Strep.	FC/FS Ratio
1	10/26/87	58	2	0	Large
1	12/07/87	0	0	2	0
1	03/14/88	34	5	427	0.01
1	04/04/88	0	0	2	0
2	11/09/87	338	8	160	0.05
2	03/14/88	37	3	394	0.01
4	11/09/87	11	8	43	0.19
4	04/04/88	7	1	47	0.02
5	10/19/87	7	9	0	Large
5	04/04/88	24	0	7	0
6	04/11/88	0	4	0	Large
7	09/21/87	21	4	18	0.22
7	10/26/87	42	14	412	0.03
7	11/30/87	220	27	0	Large
7	12/14/87	10	4	4	1
7	01/11/88	27	4	0	Large
7	03/07/88	26	0	20	0
7	04/11/88	20	0	12	0
8	10/12/87	5	2	2	1
8	10/26/87	103	20	40	0.50
8	04/11/88	3	0	3	0
9	09/28/87	0	3	0	Large
9	10/05/87	876	257	461	0.56
9	10/26/87	940	554	196	2.83
9	11/23/87	1650	568	152	3.74
9	12/07/87	152	6	2	3.00
9	01/11/88	65	451	475	0.95
9	02/29/88	349	108	284	0.38
9	03/28/88	350	369	580	0.64
10	10/26/87	29	8	972	0.01
10	12/07/87	1	0	14	0
10	01/11/88	0	0	15	0
10	02/29/88	0	3	30	0.10
10	03/28/88	180	47	71	0.66

Only samples containing more than one FC or more than one FS are reported.

frequently high numbers of both fecal coliform and fecal streptococci, this suggests that there might be a septic infusion into the cistern; however this data is moderated by other data from the same site which suggests that the contamination may be of environmental origin.

All samples were tested for free residual chlorine. Chlorination practices at each of the study sites varied considerably. Free residual chlorine values in excess of 0.2 mg/L (the minimum advisable concentration) were never detected in two of the ten sites (Sites 7 & 10). In two others (Sites 8 & 9), it was detected only once. There were no sites where chlorine was detected in more than half the samples taken. The free residual chlorine levels and bacterial levels from a typical sample site (Site 2) are reported in Table V. Half of the samples from this cistern contained free residual chlorine; none of these were contaminated. In 76 samples taken from the ten study sites, only two samples that contained free residual chlorine in excess of 0.2 mg/L had coliform levels in excess of standards; only one sample with that much free residual chlorine contained Ps. aeruginosa.

Table V

Dependence of Bacterial Populations*
On Free Residual Chlorine

Free Chlorine	Total Coliform	Fecal Coliform	Fecal Strep	Ps. aeurginosa	Standard Plate Coun
0.00	338	8	160	72	5300
0.00	37	3	394	41	ND
0.00	0	0	0	0	0
0.00	0	0	0	0	10
0.10	0	0	0	0	0
0.20	0	0	0	0	10
0.20	0	0	0	0	150
0.25	0	0	0	0	15
0.30	0	0	0	0	0

*This data represents samples taken from a single cistern (Cistern over the period from September, 1987 through March, 1988. Samples from other cisterns show similar patterns.

DISCUSSION

Water is supplied to the study cisterns in several ways. Two of the housing units studied (Sites 1-5 and 6-7) are connected to potable water lines but seldom receive water from those lines. During the course of this study, the cisterns in these units were supplied both by truck and from rain catchments. Each of these cisterns was empty on at least one occasion during regular water sampling visits. One complex (Site 8) is not connected to potable water and must rely on trucked water. This cistern was frequently without water on sampling visits. The remaining two complexes (Sites 9 and 10) receive the bulk of their water from the potable water distribution system.

Water supplied by cisterns in public housing units in the U.S. Virgin Islands is of extremely variable quality. Even though the quality of water in Public Housing cisterns is not uniformly good, it is generally better than that of water found in many private residential cisterns (41), presumably because of better chlorination practices. It should be noted, though, that there are enhanced risks in public housing units because of irregular water supplies. Water in complexes not served by the potable distribution system was usually rationed. In those complexes, residents fill containers and bath tubs when water is available and store it for variable lengths of time under conditions that

may increase the risk of contamination.

Those handling water supplies in public housing are not doing all they can to enhance and protect water quality. None of the sites studied could be totally secured from casual access, though Public Housing officials do make a constant effort. Chlorination, while attempted in most (but not all) cisterns studied, seems to be carried out on an irregular basis. None of the cisterns studied contained free residual chlorine in more than half of the samples collected. In two sites, no evidence of chlorination at any time was observed.

The erratic nature of chlorination is consistent with batch chlorination procedures that are carried out on an irregular basis. In housing projects with many cisterns, considerable variability in chlorination practice was observed among those cisterns sampled. For example, water from site 6 was chlorinated on half the sampling visits while water from site 7 in the same housing project was never observed to be chlorinated. The data suggest that maintenance workers are not successful in carrying out chlorination in a routine fashion. Since all samples were collected Monday morning before the arrival of maintenance workers, it is possible that chlorination of water delivered over the weekend was not always carried out until after samples were collected. It was not determined if water was more regularly chlorinated during the period from Monday to Friday. It is also likely that the shortage of water

coupled with irregular delivery and almost immediate usage makes it difficult to chlorinate water in any systematic way.

In one housing unit studied which had a continuous injection chlorinator (Site 9), no residual chlorine was detected in any of the samples. The sample collector observed that the chlorinator was turned on, so that it seems clear that it was not being properly maintained by maintenance workers.

Human health risks associated with most of the samples observed to be contaminated were mitigated somewhat by indications that the sources of contamination were of non-human origin (Table IV). There were instances however where high fecal coliform / fecal streptococcus ratios indicate that the source of the contamination might be due to human contributions. These high ratios suggest a possible septic infusion into the water, either before or after delivery; or, via direct human contact. These high ratios generally occurred in sample cisterns supplied by potable water. It is difficult to know whether contamination arises in the original source of the water, during transport through the pipes, or while the water is resident in the cistern.

The fecal coliform test has been proposed as an alternative standard for drinking water (34,35,41). In many European countries, this test is run in parallel with the total coliform test and calls for zero (0) fecal coliform per 100 mL of sample. With cisterns, however, since fecal

coliforms occur naturally in the environment (15,19,21, 22,29,41), a standard ≤ 1 fecal coliform / 100 mL is a reasonable one. This standard in some ways compares favorably with some European standards for treated water. In the United Kingdom, for example, it is permissible to have ≤ 2 *E. coli* per 100 mL in 5% of the samples collected each year (8).

In this study on public housing cisterns, and in the previous one on private residential cisterns (41), most instances of high total coliform levels are associated with non-human sources of contamination. Of the 76 samples collected we found that 44% violated the Safe Drinking Water Standard of ≤ 1 total coliform per 100 mL.

In all cases where either the total coliform and/or the proposed fecal coliform standard was violated, we found that one-quarter of the samples that violated the total coliform standard did not have levels of fecal coliform in excess of the proposed standard. 6.5 percent of the fecal coliform violations were total coliform negative. As a result, a fecal coliform standard would result in fewer samples being judged as violating safe water standards. It must be emphasized, however, that this standard would do no better at indicating the presence of *Ps. aeruginosa* than the total coliform standard, since coliforms are indicators of enteric contamination, and *Ps. aeruginosa* is not an enteric pathogen. From this standpoint, the water could prove to be bacteriologically safe from enteric pathogens, yet still

prove to be unsafe for drinking. Approximately one-third of all Pseudomonas occurrences (12 out of 39) did not test positively for total coliform (Table III). Indeed other studies (9,25,29,34) have shown similar results.

SUMMARY

Residents of public housing units in St. Thomas, U.S. Virgin Islands are at least periodically exposed to health risks from drinking their cistern stored water. These risks can be traced back to the maintenance and distribution of cistern water. Inconsistent chlorination coupled with water that is apparently supplied to cisterns from sources that are sometimes contaminated are the direct causes of this risk.

In this study, ten cisterns in five public housing facilities were regularly sampled over a ten month period. Three interacting basic problems with water quality are evident. Water is supplied to public housing cisterns in an irregular fashion. The water contained in the cisterns is frequently out of compliance with the mandates of the Safe Drinking Water Act (4). Maintenance practices, including chlorination and protecting water supplies from tampering, are not thorough.

About half of the water samples (44%) collected over the course of this study violated the accepted standard of $\leq$ 1 total coliform per 100 mL. Certain cisterns appear to pose greater risks than other (Sites 7-9). While *Salmonella spp.* was not detected in any sample where tests for those organisms were done (testing was discontinued half way through the study in the absence of any positive tests), *Ps.*

aeruginosa, an opportunistic pathogen associated with ear infections, diarrheal disease, urinary tract, lung, and wound infections (16,24,46), was found in about half (52%) of the samples. Even though the quality of water in public housing cisterns is not uniformly good, it is generally better than that of water found in many private residential cisterns (41).

It is clear that, where applied, chlorination is effective in lowering health risks (10,17,23,26,30,35). Only two of the 24 samples that contained free residual chlorine levels in excess of 0.2 mg/L (the U.S.E.P.A. standard) were found to violate total coliform standard. Only one of the same samples contained Ps. aeruginosa. On the other hand, those 24 chlorinated samples represented only 30% of the samples collected. 60% of the unchlorinated samples (those in which no chlorine residual could be found) were contaminated.

Application of the total coliform standard of $\leq$ 1 total coliform per 100 ml to judge water quality is not sufficient in the case of cistern water. To the extent that Ps. aeruginosa is a threat to human health (and housing units in this study include units with high populations of the very young and very old), the total coliform standard does not adequately delineate that threat (41,46,47), and as such, it is felt that supplemental Pseudomonas testing should be done on cistern water samples.

RECOMMENDATIONS

Based upon the results of our research the following recommendations are made:

1. Chlorination is essential. Although housing projects are chlorinating their supplies, it is not being done with uniformity. To remedy this problem Housing should chlorinate each cistern urder their control regularly, so that a small amount (0.2 mg/L) of residual chlorine is always present in the water.

2. Inspect and clean all cisterns every other year, preferably each year.

3. Inspect all access points leading into and from the cisterns to check for vandalism and cleanliness.

4. Repair promptly all leaking pipes, faucets, and toilets.

5. Educate residents of Public Housing Projects in the area of water conservation and water quality maintenance.

Long term goals should also be established by Housing. Some of these goals should be:

1. Extending the potable water distribution system to the outlying projects to provide them with water on a 24 hour basis.

2. Proper planning in the future to prevent the problems now being experienced. This plan should include preventive maintenance and regular disinfection procedures.

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