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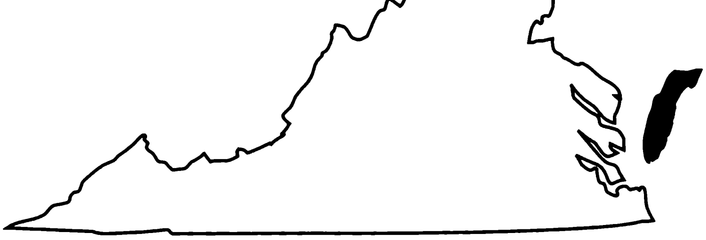

2000

Household Water Quality Series 46
Department of Biological Systems Engineering
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061-0303

Virginia Cooperative Extension

Virginia Tech
1872
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Publication 442-936
November 2000

VIRGINIA STATE UNIVERSITY

EVALUATION OF HOUSEHOLD WATER QUALITY IN ACCOMACK AND NORTHAMPTON COUNTIES, VIRGINIA

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Evaluation of Household Water Quality in Accomack and Northampton Counties, Virginia

ABSTRACT

During Fall 1999 in Accomack and Northampton Counties, Virginia, programs of household water quality education, which included water sampling, testing, and diagnosis, were conducted. Participation in the water quality programs was made available to any resident of these two counties who utilized a private, individual water supply. During the course of the projects, 353 households submitted water samples which were analyzed for iron, manganese, hardness, sulfate, chloride, fluoride, total dissolved solids, pH, saturation index, copper, sodium, nitrate, and total coliform and E. coli bacteria. These analyses identified the major household water quality problems in these two counties as iron/manganese, total dissolved solids, and bacteria. Additionally, a number of samples were determined to have concentrations of sodium high enough to possibly lead to health complications for at-risk segments of the population.

Following completion of the programs, a survey was mailed to the 353 participants. One hundred and ninety-seven participants returned survey forms on which they identified their reason(s) for participating in such a program; the primary reason was concern about safety of their water supply. Returned survey forms also provided insight into measures participants had already taken, or planned to take, to improve the quality of their water supply. Nearly two-thirds of the households who reported having at least one water quality problem had taken, or planned to take, at least one measure to improve the quality of their water supply. Ten percent or more of all participants had taken, or planned to take, one or more of the following actions: purchase or rent water treatment equipment, use bottled water drinking/cooking, and contact a state agency for further assistance.

ACKNOWLEDGMENTS

Many thanks are due the residents of Accomack and Northampton Counties who participated in the educational program. Without their enthusiasm and cooperation, the program could not have succeeded. Special thanks are extended to local media, agency personnel, volunteers, and others who provided support in terms of publicity, encouragement, and interest, thus contributing to the success of the household water quality educational program. Jim McGowan, of the Accomack-Northampton Planning District Commission, was particularly instrumental regarding the initiation of the project. Personnel of the Virginia Department of Health, who spoke at the public meetings, are appreciated for their contributions. The Accomack and Northampton County Cooperative Extension secretaries, Carla Woods and Jenny Whitehead, respectively, were instrumental in handling mailings, addressing phone requests for information, and recordkeeping.

The Boards of Supervisors of both counties are acknowledged for their financial support of the program. The Southeast Rural Community Assistance Project, Inc. of Roanoke, Virginia also provided funding to offset the cost of testing that was assessed to all participants. CSREES/USDA Water Quality Program Support 3-d funds were also made available for this program.

The Water Quality Laboratory of the Department of Biological Systems Engineering at Virginia Tech was responsible for the majority of the water quality analyses, as well as coordination among the various labs and for much of the data management. Julie Jordan, Laboratory Supervisor, and her staff are especially acknowledged for their efforts. Assisting with the general water chemistry analysis was the Soils Testing Laboratory of the Department of Crop and Soil Environmental Sciences at Virginia Tech.

Additional support from Virginia Tech should also be noted. Judy Poff, of the Virginia Water Resources Research Center, was instrumental in providing educational publications for participants at the public meetings. Joe Gray, of the Virginia Cooperative Extension Distribution Center, is appreciated for his assistance in preparing and mailing the evaluation survey packets to participants. Appreciation is due Diane Mahaffey for her efforts in preparing project forms and in typing this manuscript, and to Lori Yates for her assistance in data management. In addition, Bev Brinlee and Tim FisherPoff are acknowledged for their editorial and design contributions.

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INTRODUCTION

The water supply and wastewater disposal requirements of the vast majority of rural homes and farms throughout Virginia are met by individual water supply and wastewater disposal systems. In Accomack and Northampton Counties, for example, the majority of housing units (70%) are served by individual water systems (Koebel et al., 1993). Virtually all of these homes depend on groundwater sources.

Throughout these two counties, most wells were drilled only for farm or domestic water supply. George and Gray (1988) have estimated that 95% of the drilled wells are inadequately constructed, while essentially all dug/bored wells are inadequate. Seven percent of households were also estimated to have failing or inadequate waste disposal systems.

Accomack and Northampton Counties have a combined land area of 662 square miles. Both counties comprise the Eastern Shore of Virginia, a peninsula bordered by Maryland to the north, the Chesapeake Bay to the west, and the Atlantic Ocean to the east. Although within the Coastal Plain physiographic province, there are no major river basins on the Eastern Shore, which is drained by many small streams westward and eastward from the central ridge into tidal estuaries of the Chesapeake Bay and Atlantic Ocean, respectively.

The population of the two-county area decreased by more than 2% during the period 1980-90. Despite this population decline, the total number of housing units increased by 15%, and some new homesites are rural-based without public water and sewage services. As rural home sites encroach on agricultural land, the water supply becomes suspect to residents. Of equal importance is the potential failure of septic systems, since a number of home sites are on land less than ideal for a properly functioning septic system.

In addressing similar concerns, Ross et al. (1991) initiated a pilot program of household water quality education in Warren County, Virginia, which included water sampling, testing, and diagnosis. Based on requests and support from local interests, subsequent programs have been conducted in 62 additional counties. During the course of these projects, nearly 9,500 households submitted water samples through local Virginia Cooperative Extension Offices to be analyzed for the following: iron, manganese, hardness, sulfate, chloride, fluoride, total dissolved solids, pH, saturation index, copper, sodium, nitrate, and total coliform and fecal coliform/E. coli bacteria.

Major household water quality problems identified, as a result of these previous analyses, were determined to be iron/manganese, hardness, fluoride, and total dissolved solids, and because of their potential health significance, corrosivity, bacteria, and to a lesser extent, sodium and nitrate, although the occurrence and extent of these problems varied across counties. In most county programs, a limited number of additional samples from "high-risk" households were tested for over two dozen pesticides and other chemical compounds. Most of these compounds have been detected in measurable quantities in one or more samples, with several values exceeding a corresponding U.S. Environmental Protection Agency Health Advisory Level (HAL) or Maximum Contaminant Level (MCL). It was the need to assess the current state of rural household water supplies in Accomack and Northampton Counties, in addressing the above water quality issues, that led to the implementation of the Household Water Quality Education Program in both counties.

OBJECTIVES

The primary goal of this project was to conduct educational programs on household water quality to include water testing/diagnosis in Accomack and Northampton Counties. The general program objectives were to: (1) improve the quality of life of rural homeowners by increasing awareness and understanding of water quality problems, protection strategies, and treatment alternatives; and (2) create a groundwater quality data inventory to assist local governments in land use and groundwater management planning.

METHODS

Household water quality educational programs were offered through the local Virginia Cooperative Extension Offices in Accomack and Northampton Counties during Fall 1999. Any household resident of these counties who utilized a private, individual water supply was eligible to participate. The programs were patterned after the model developed under the pilot educational program completed in 1989 in Warren County (Ross et al., 1991). Local news media and agency newsletters publicized the program in each county, and program fact sheets were prepared (see Appendix).

The programs were launched through local meetings held in Accomack County (Melfa) and Northampton County (Eastville) in mid-October. Attendees of these initial meetings were presented with information on local hydrogeologic characteristics in relation to groundwater pollution, likely sources of, and activities contributing to, groundwater contamination, the nature of household water quality problems (both nuisance and health-related), and specifics of the water testing program to follow. At these meetings, individuals were invited to sign up to participate in the testing program at a basic cost of $20 per household water sample submitted.

Provisions were made to analyze up to 250 household water samples in Accomack County and 150 in Northampton County. Water sampling kits, for use by the participants themselves, were made available at the meetings and at the county Cooperative Extension offices after the meetings for late registrants. Two types of water sampling kits were distributed: (1) general water chemistry analysis for iron, manganese, hardness, sulfate, chloride, fluoride, total dissolved solids, pH, saturation index (Langlier), copper, sodium, and nitrate; and (2) bacteriological analysis (total coliform and E. coli).

The sampling kits included a 250 ml plastic bottle for general water chemistry samples and a sample identification form (see Appendix). The form included sampling instructions and a questionnaire on which participants were asked to describe the characteristics of their water supply. Also included in the kits was a 125 ml sterilized plastic bottle for bacteriological samples. Instructions called for sampling from a drinking water tap and for flushing water systems prior to sampling to minimize contaminants contributed by the plumbing system. Persons who already had a water treatment device, such as a water softener, were requested to provide information about the type of equipment so that effective evaluation of their water quality and proper interpretation of results could be obtained, as further explained below.

Water samples were collected on November 1 and 15 in both counties. At the close of each collection day, all samples were packed in ice and immediately delivered to Virginia Tech in Blacksburg for analysis.

The general water chemistry and bacteriological analysis was coordinated by the Department of Biological Systems Engineering Water Quality Laboratory at Virginia Tech. The Soils Testing Laboratory of the Department of Crop and Soil Environmental Sciences at Virginia Tech was subcontracted to analyze samples for several of the constituents. Water quality analyses were performed using standard analytical procedures (USEPA, 1979).

After the analysis had been completed for each county, participants were reminded by mail to attend subsequent meetings in either Eastville or Melfa to obtain and discuss the test results and management practices to reduce or prevent water contamination. Complete test results were ultimately mailed to those participants who could not attend any of the meetings. A sample report form and accompanying report interpretation are shown in the Appendix.

At the conclusion of the programs, an evaluation survey was mailed to participants (see Appendix). The objectives of the survey were to determine (1) the reasons for participation in the educational programs and for having household water tested, and (2) the actions to correct water quality problems the participants had taken, or planned to take, as a result of participation in the programs. Limited socio-economic information was also requested to obtain a profile of the total audience reached by the programs.

In addressing overall project objective 2, local government and public officials were kept apprised of water quality test results, during the course of the programs and at their completion. While the project was designed to involve voluntary participation, and quality control in sampling was not assured, the information gathered was nevertheless deemed useful for water quality assessment and planning at county and regional levels.

FINDINGS AND RESULTS

During the course of the projects, 353 individual household water samples were returned for general water chemistry and bacteriological analysis from all areas of the two counties. Two surveys were distributed to all water testing participants: One, the questionnaire with the water sampling kit, to be completed and returned by all participants with the sample submitted for analysis; and the other, an evaluation of the completed programs (see Appendix). For the latter, of the 353 forms mailed, 197 were returned (a 56% response rate). Both surveys provided insight into the characteristics of the households and their water supplies.

Profile of Participant Households

The average length of the respondents' residence in Accomack or Northampton Counties was 14 years. The length of residence reported ranged from 1 to 79 years. Thirty-two percent of those responding had lived in their present county for 5 years or less. The size of the respondents' households ranged from one to six members; average household size was 2.18. It can, therefore, be estimated that more than 750 residents of the two counties were directly impacted by the water analysis/diagnosis aspect of the programs.

More than one-half (56%) of the respondents were college graduates and 93% had at least a complete high school education (see Figure 1); facts that are not surprising, since it is likely that such individuals would have a greater awareness and understanding of water quality issues and be more likely to participate in such a program.

Participation in the program was on the high end of income distribution. Figure 2, which shows the family income (before taxes) of the respondents, indicates that a likely majority of the respondents exceeded the median family income ($23,845 averaged for the two counties and according to the 1990 Census) (Koebel et al., 1993). Twenty percent of respondents declined to indicate family income.

Profile of Household Water Supplies

The initial survey answers, provided by all 353 participants in the water testing programs, helped to characterize their water supplies (see Appendix). One set of questions dealt with the proximity of the household water supply to potential sources of groundwater contamination. One such question sought to define housing density, which may have an impact primarily from the standpoint of contamination from septic systems and related water quality problems. Participants were asked to classify their household environs as one of the following four categories, ranging from low to high density: (1) on a farm, (2) on a remote, rural lot, (3) in a rural community, and (4) in a housing subdivision. As shown in Figure 3, rural community was the most common at 52%, while subdivision (11%) was the least common.

Participants were also asked to identify potential contamination sources within 100 feet of their water supply. The major sources identified were septic system drainfields, streams, and home heating oil storage tanks, noted by 28%, 22% and 21% of all households, respectively. Indications of proximity (within one-half mile) to larger activities which could potentially contribute to groundwater pollution were also sought. Agricultural activities were the most commonly identified; 65% of the participants indicated that their water supply was located within one-half mile of field crop production and 8% within one-half mile of a major farm animal operation.

Information was also obtained regarding characteristics of the participants' water supply systems. Regarding the type of water source supplying the household, all of the participants reported that they rely on a well. Participants were asked to provide an estimate of the well depth, if known. Of those participants indicating well depths, 88% reported depths of more than 50 feet, while 12% reported less than or equal to 50 feet. The maximum well depth reported was 300 feet; the average well depth was 149 feet. Ten percent of the wells were constructed in or prior to 1970. The earliest reported well construction date was 1900.

Household water systems were further identified with respect to the type of material used in the piping network for water distribution throughout the dwellings. The most widely used material was copper (47%), while plastic was reported by 38% of the participants. Ten percent of participants reported, "Don't know."

To properly evaluate the quality of water supplies in relation to the point of sampling, participants were asked if their household water systems had water treatment devices currently installed, and if so, the type of device. The results of the inquiry are presented in Figure 4. Twenty-four percent of the participants reported at least one treatment device installed, with the most common type of treatment device in use being a water softener (66%) followed by sediment filter (30%).

Figure 1. Educational Level Achieved by Participants

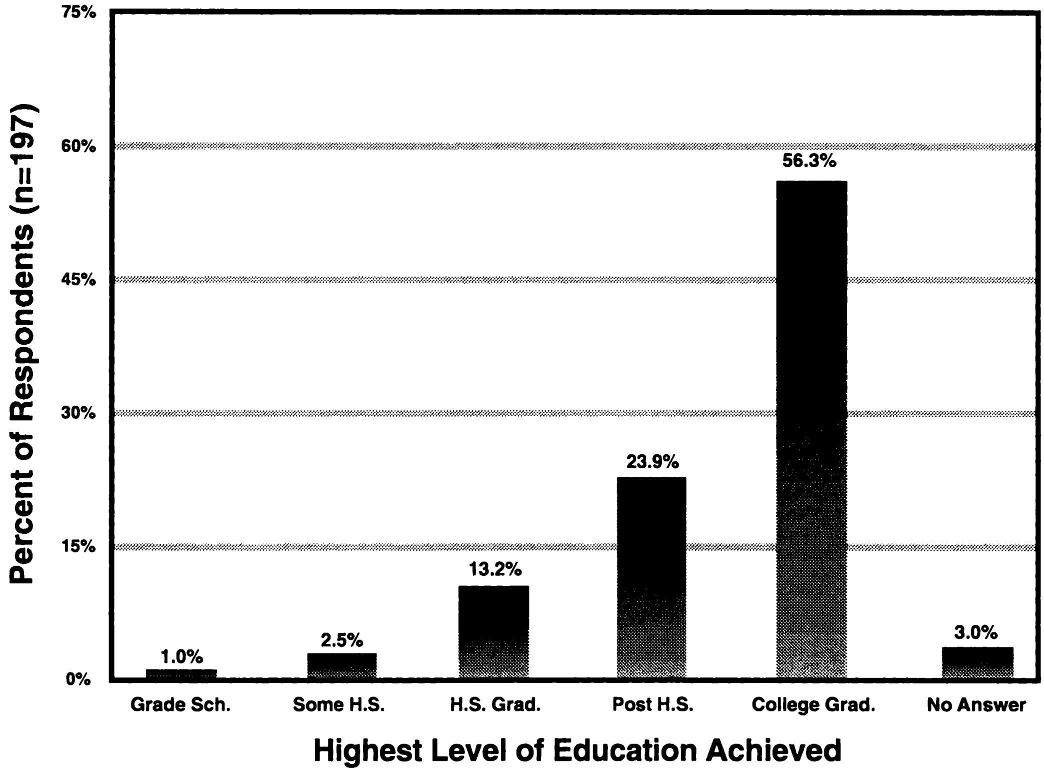


Figure 2. Family Income of Participants

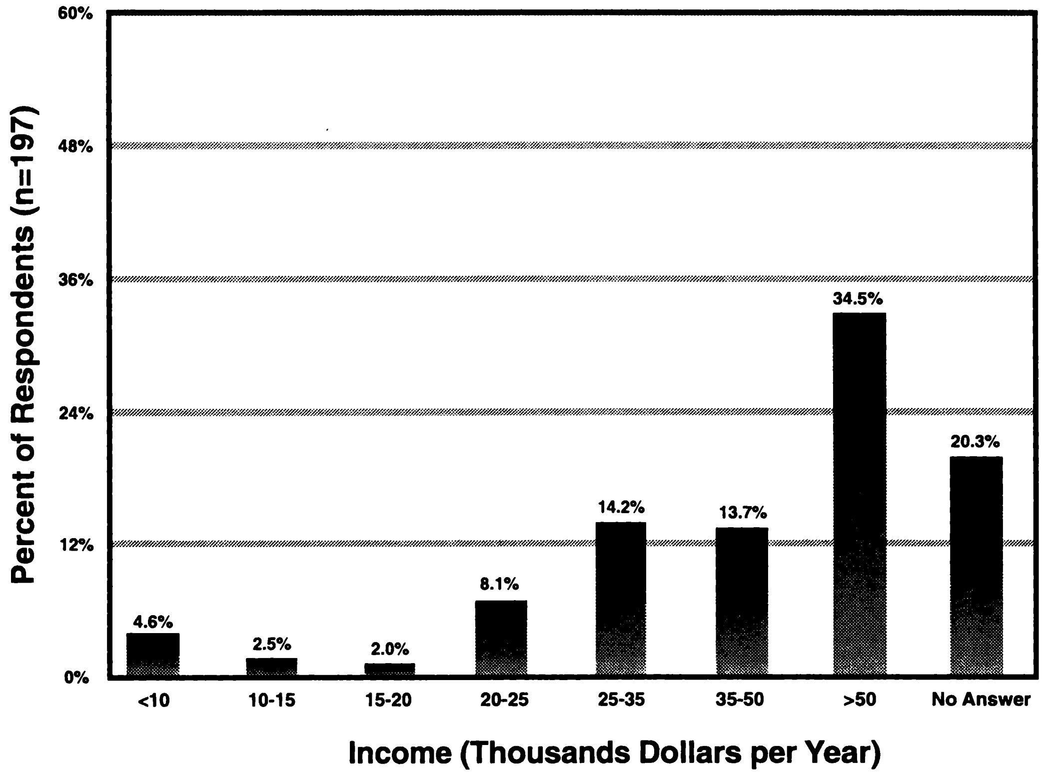
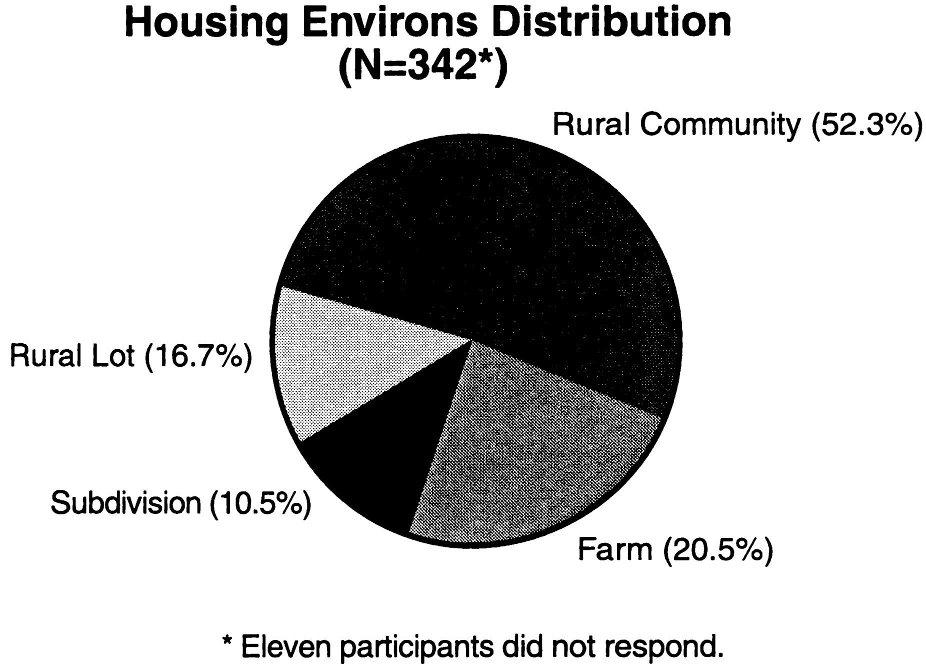


Figure 3. Housing Environs of Participants



Participants' Perceptions of Household Water Quality

Participants were also asked about problems they were experiencing in their household water systems (see Appendix). They were asked initially whether or not they experienced one or more of the following conditions: (1) corrosion of pipes or plumbing fixtures; (2) unpleasant taste; (3) objectionable odor; (4) unnatural color or appearance; (5) floating, suspended, or settled particles in the water; and (6) staining of plumbing fixtures, cooking appliances/utensils or laundry. With the exception of (1) above, with which 16% of the participants identified, participants were given several more specific descriptions from which to choose if answering positively.

Twenty percent of the participants responded that their water had an unpleasant taste. For these participants, the identification of tastes is presented in Figure 5. "Sulfur" taste was the most common problem (44%), followed by "metallic", identified by 32% of those who reported taste problems. Seventeen percent of those with taste problems indicated "other" including such a description as flat.

An objectionable odor was reported by 26% of the participants. Of these, the description of odors selected is shown in Figure 6. The most prevalent odor described, by far, was "rotten egg," or sulfur, identified by 72% of those reporting odor problems. Thirteen percent reported "other" odors, such as fishy.

Twelve percent of the participants affirmed their water had an unnatural color or appearance. "Yellow" was identified by 44% of those who reported appearance problems (Figure 7), followed by "milky" and "muddy" at 20% and 17%, respectively. Ten percent offered their own descriptions by selecting "other" to include brownish.

A related question sought to identify the presence of solid particles in participants' water supplies. Sixteen percent described such a condition; more than one-half of these (54%) reported that they noticed "white flakes" in their water (Figure 8). Seven percent indicated "other," including such a description as sand.

Staining problems on plumbing fixtures, cooking appliances/utensils, and/or laundry were reported by 56% of the participants. As presented in Figure 9, the major problem, by far, was that of "rusty" identified by 89% of those with staining problems.

Household Water Quality Analysis

Ultimately, two sample groups resulted: the "tap water" and "raw water" samples. The "tap water" group consisted of the 353 individual household water supplies analyzed to represent the actual water quality at the drinking water tap (including treated water). The "raw water" group consisted of samples from untreated systems only - a total of 261 samples.

The raw water sample results presented below may not be entirely indicative of the status of raw groundwater quality in Accomack and Northampton Counties. This may be particularly true for many of the nuisance contaminants for which treatment systems have been installed, since many of the already treated supplies likely represented the worst cases for specific contaminants correctable by treatment devices. Therefore, the inclusion of actual raw water (before treatment) analyses, if they had been available from those households with treatment devices installed, would likely have tended to worsen the overall assessment of raw water quality in the two counties.

General Water Chemistry Analysis

The tests included in the general water chemistry analysis are listed in Table 1, along with the detection limits, where appropriate, for each test as determined by laboratory equipment and testing procedure constraints. Also presented are the averages and ranges for each sample group defined for both counties combined. Table 2 provides, for both sample groups and each county, as well as both counties combined, the percentage of constituent values exceeding a given water quality standard or guideline. The results and importance of each test for both of the sample groups are individually discussed below.

Iron. Iron in water does not usually present a health risk. It can, however, be very objectionable if present in amounts greater than 0.3 mg/L. Excessive iron can leave brown-orange stains on plumbing fixtures and laundry. It may give water and/or beverages a bitter metallic taste and may also discolor beverages.

Overall, 26% of samples in the tap water and 29% of samples in the raw water sample groups had iron concentrations exceeding the U.S. Environmental Protection Agency (EPA) Secondary Maximum Contaminant Level (SMCL) of 0.3 mg/L. It should be noted that the occurrence of excessive iron was slightly greater for Accomack County as compared to Northampton County (Table 2). The presence of iron was not surprising in view of the generally accepted notion that excessive iron is prevalent in rural water supplies throughout much of Virginia. Only 3% of the participants reported the installation of an iron removal filter, however, water softeners, which can remove small amounts of iron, as well as manganese, had been installed in 16% of the households. Despite the treatment equipment in place, the results of the sample questionnaire (see Appendix) revealed that 89% of the 196 who reported staining problems, or 49% of all participants, classified the color of those stains as "rusty" (red/orange/brown). Stains of this color on plumbing fixtures, cooking appliances/utensils, and/or laundry are usually attributed to excessive iron concentrations.

It should be noted that the SMCL for iron is likely based more on taste considerations than long-term staining tendencies, particularly on plumbing fixtures. It has been suggested that concentrations below 0.1 mg/L are preferred, when stain prevention is of concern. When a value of 0.1 mg/L was used as the threshold concentration, an additional 28% of samples in the tap water and 32% of samples in the raw water sample groups of both counties combined exceeded this limit.

Manganese. Manganese does not present a health risk. However, if present in amounts greater than 0.05 mg/L, it may give water a bitter taste and produce black stains on laundry, cooking utensils, and plumbing fixtures.

The results of these analyses indicated that the extent of manganese problems in the two counties was slightly less than that of iron, with 16% and 17%, respectively, of the tap water and raw water samples exceeding the SMCL. It should be noted that a higher percentage of these samples were from Nothampton County (Table 2). While manganese stains are generally dark and only 4% of all participants indicated "black" stains, the "particles in water" description of "black specks," reported by 3% of all participants, may also provide evidence of excessive manganese concentrations.

Hardness. Hardness is a measure of calcium and magnesium in water. Hard water does not present a health risk. However, it keeps soap from lathering, decreases the cleaning action of soaps and detergents, and leaves soap "scum" on plumbing fixtures, and scale deposits in water pipes and hot water heaters. Softening treatment is highly recommended for very hard water (above 180 mg/L). Water with a hardness of about 60 mg/L or less does not need softening.

Hardness is an additional "natural" parameter usually linked to karst terrain and limestone formations that are not prevalent in this region of Virginia. The exception to this rule is in far eastern Virginia where ancient maine deposits have provided a source of calcium. As mentioned above, 16% of all participants had installed a water softener (Figure 4), however, only 4% of samples in both sample groups exceeded the maximum recommended hardness level of 180 mg/L.

Hardness tolerance, like that of many nuisance contaminants, is somewhat relative to individual preferences. For example, water with total hardness between 60 mg/L and 180 mg/L may warrant the installation of a commercial water softener in the view of some household water users while others are satisfied with untreated water. Seventy-two percent of the tap water samples and 84% of the raw water samples of both counties combined were in the range of 60 mg/L to 180 mg/L total hardness, indicating that more than three-fourths of all samples could be classified as "moderately hard" or harder.

Sulfate. High sulfate concentrations may result in adverse taste or may cause a laxative effect. The SMCL for sulfate is 250 mg/L. Sulfates are generally naturally present in groundwater and may be associated with other sulfur-related problems, such as hydrogen sulfide gas. This gas may be caused by the action of sulfate-reducing bacteria, as well as by other types of bacteria (possibly disease-causing bacteria) on decaying organic matter. While it is difficult to test for the presence of this gas in water, it can be easily detected by its characteristic "rotten egg" odor, which may be more noticeable in hot water. Water containing this gas may also corrode iron and other metals in the water system and may stain plumbing fixtures and cooking utensils.

Sulfate concentrations were relatively low for both the raw water and tap water sample groups. Only one of the tap water samples (from Northampton County) exceeded 250 mg/L. The complaints of a "rotten egg/sulfur" odor by nearly three-fourths of those reporting odor problems indicate that hydrogen sulfide gas may be a somewhat widespread problem in household water systems in the two counties; a conclusion that can not be confirmed by the presence of sulfate.

Figure 4. Household Water Treatment Devices Installed

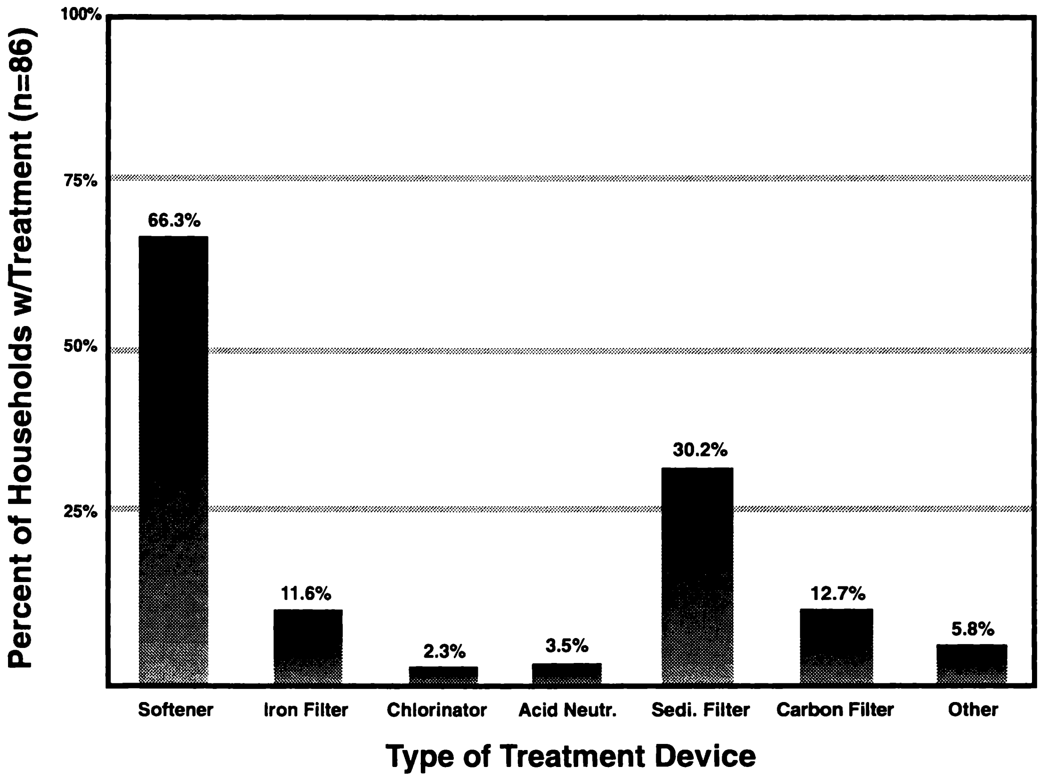


Figure 5. Unpleasant Tastes Reported by Participants

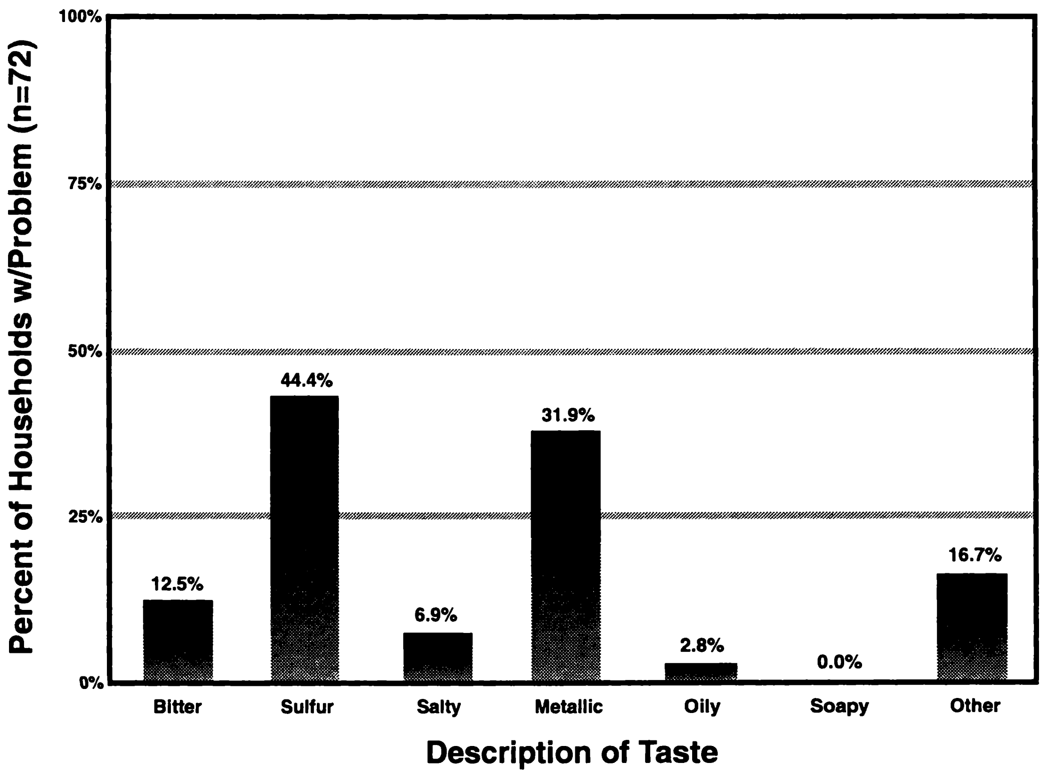


Figure 6. Objectionable Odors Reported by Participants

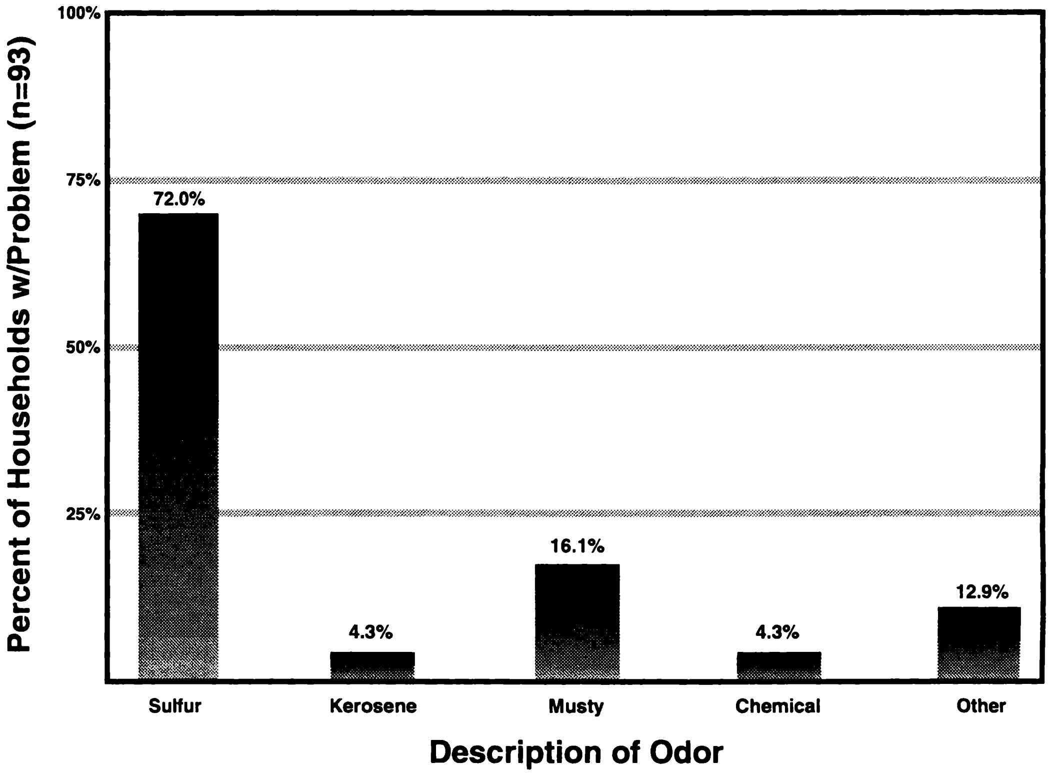


Figure 7. Unnatural Appearance Reported by Participants

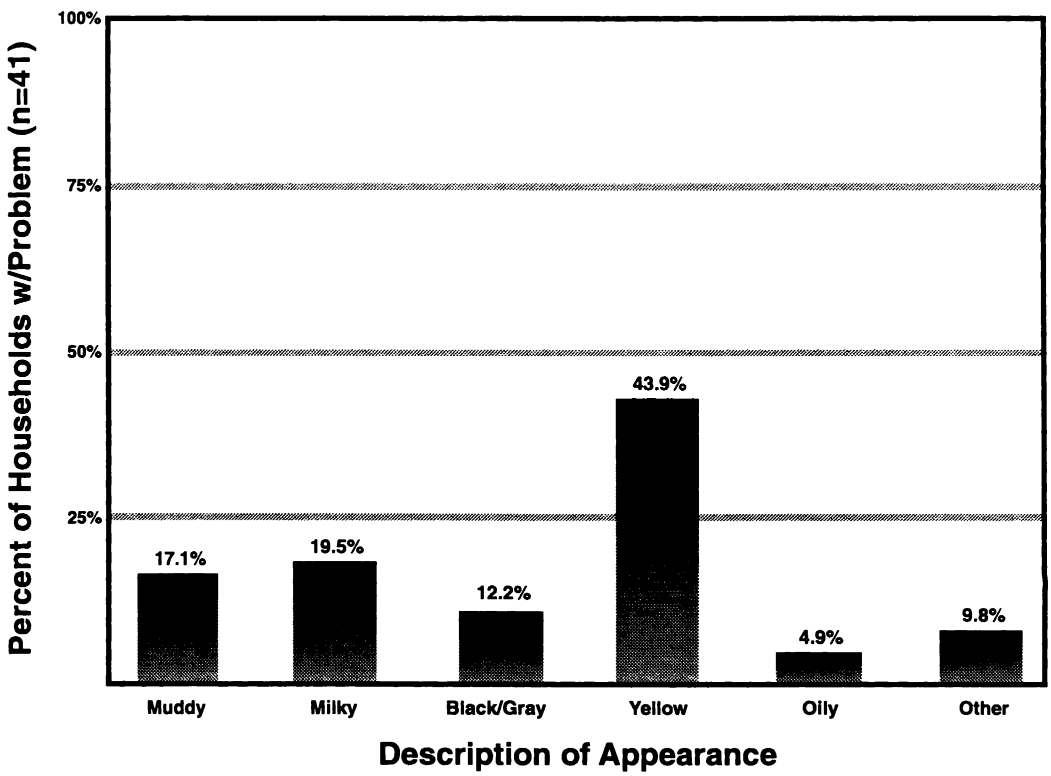


Figure 8. Particles in Water Reported by Participants

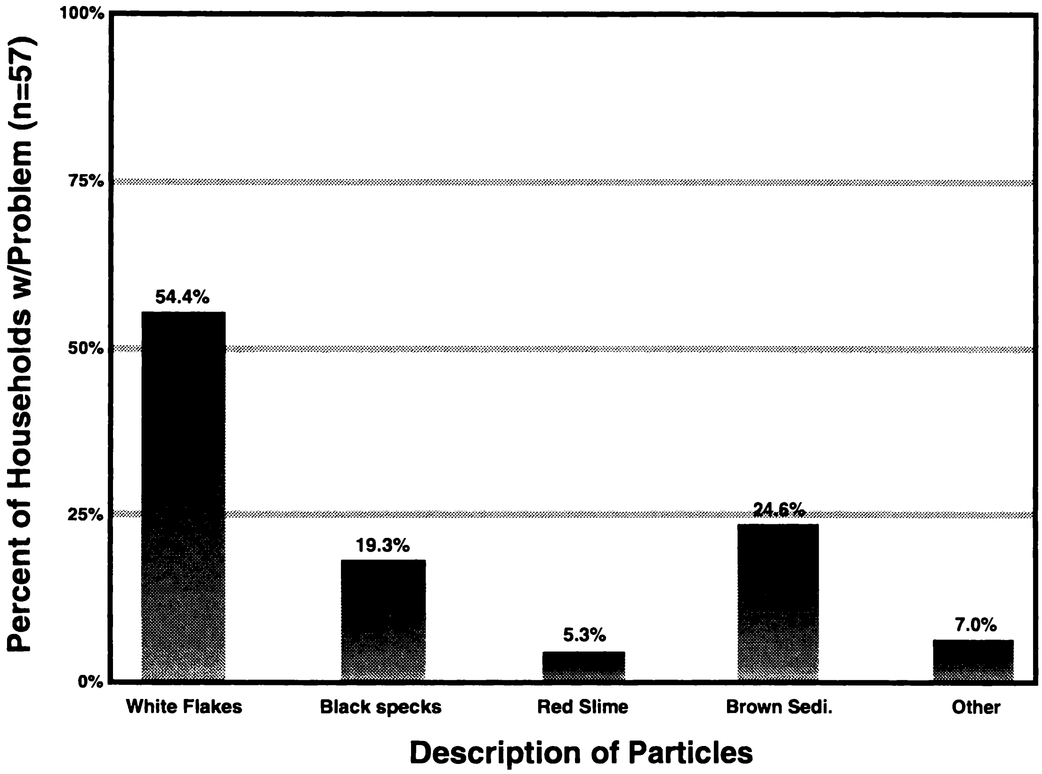
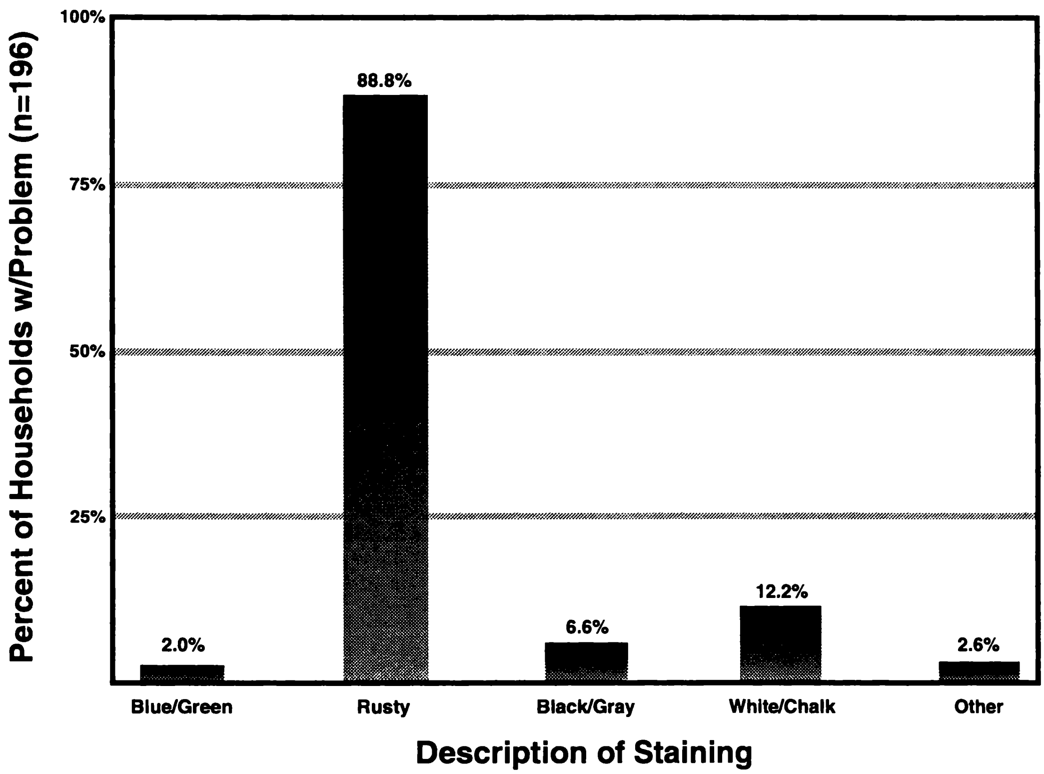


Figure 9. Staining Problems Reported by Participants



Chloride. Chloride in drinking water is not a health risk. With the possible exception of coastal areas, natural levels of chloride are generally low, and high levels in drinking water may indicate contamination from a septic system, road salts, fertilizers, industry, or animal wastes. High levels of chloride may speed corrosion rates of metal pipes and cause pitting and darkening of stainless steel. The EPA has set an SMCL for chloride of 250 mg/L. Three percent of the tap water and raw water samples exceeded the SMCL for chloride.

Fluoride. Fluoride is of concern primarily from the standpoint of its effect on teeth and gums. Small concentrations of fluoride are considered to be beneficial in preventing tooth decay, whereas moderate amounts can cause brownish discoloration of teeth, and high fluoride concentrations can lead to tooth and bone damage. For these reasons, the EPA has set both a SMCL of 2 mg/L and a Maximum Contaminant Level (MCL) of 4 mg/L. None of the samples in the tap water and raw water sample groups exceeded either standard.

Total Dissolved Solids (TDS). High concentrations of dissolved solids may cause adverse taste effects and may also deteriorate household plumbing and appliances. The EPA SMCL is 500 mg/L total dissolved solids. Average TDS concentrations were 275 mg/L and 291 mg/L for the raw water and tap water sample groups, respectively. Eight percent of samples in each sample group exceeded the standard. The maximum TDS concentrations among the raw water and tap water samples were 1840 mg/L and 2930 mg/L, respectively.

pH. The pH indicates whether water is acidic or alkaline. Acidic water can cause corrosion in pipes and may cause toxic metals from the plumbing system to be dissolved in drinking water. The life of plumbing systems may be shortened due to corrosion, requiring expensive repair and replacement of water pipes and plumbing fixtures. Treatment is generally recommended for water with a pH below 6.5. Alkaline water with a pH above 8.5 is seldom found naturally and may indicate contamination by alkaline industrial wastes. The EPA has set a suggested range of between 6.5 and 8.5 on the pH scale for drinking water.

The average pH reading was 7.6 for both the tap water and raw water samples. None of the samples in either sample group exceeded a pH of 8.5, with a maximum pH value of 8.5. Three percent of both the tap water and raw water samples had a pH value of less than 6.5, with a majority of these from Northampton County. While the remaining samples had a pH above 6.5, slightly acidic water with a pH between 6.5 and 7.0 can lead to less immediate staining and corrosion problems. An additional 4% and 5% of samples in the tap water and raw water sample groups, respectively, fell into this category.

Saturation Index. The saturation index (Langlier) is used, in addition to pH, to evaluate the extent of potential corrosion of metal pipes, plumbing fixtures, etc. It is a calculated value based on the calcium concentration, total dissolved solids concentration, measured pH, and alkalinity. A saturation index greater than zero indicates that protective calcium carbonate deposits may readily form on pipe walls. A saturation index less than zero indicates that the water does not have scale-forming properties and pipes may be subject to corrosion. Saturation index values between -1 and +1 are considered acceptable for household water supplies.

No saturation index values were determined to be above +1 in either sample group. Values of less than -1, however, were determined for 26% of the tap water samples and 14% of the raw water samples with a majority of these from Northampton County. Average saturation index values were -0.99 for the former and -0.79 for the latter sample group with minimum values of -4.88 for the tap water samples and -4.16 for the raw water samples. There is an apparent partial explanation for this discrepancy. It is well documented that water softeners, which impacted 16% of the tap water samples, tend to enhance corrosion potential by removing scale-forming calcium from the water. For this reason, as well as the additional sodium imparted to the water (see below), it is sometimes recommended that water softeners be installed for hot water only or, in the case of extremely hard water, that at least drinking water lines bypass the softening equipment.

Copper. The EPA health standard for copper in public drinking water supplies is 1.3 mg/L, the maximum level recommended to protect people from acute gastrointestinal illness. Even lower levels of dissolved copper may give water a bitter or metallic taste and produce blue-green stains on plumbing fixtures. Consequently, EPA has established an SMCL for copper of 1.0 mg/L in household water.

None of the tap or raw water samples exceeded the recommended health level of 1.3 mg/L or the SMCL of 1.0 mg/L. The maximum copper concentration measured was 0.47 mg/L. Since natural levels of copper in groundwater are low, and the primary contributor of copper in drinking water is corrosion of copper water pipes and fittings, low copper levels were expected, even in the case of tap water samples, assuming that water lines were flushed properly prior to sampling.

Sodium. Sodium may be a health hazard to people suffering from high blood pressure or cardiovascular or kidney diseases. For those on low-sodium diets, 20 mg/L is suggested as a maximum level for sodium in drinking water, although a physician should be consulted in individual cases. Average sodium concentrations were 53 mg/L and 42 mg/L for the tap water and raw water sample groups, respectively, while the maximum concentration was 961 mg/L in the former case and 334 mg/L in the latter case. For the tap water and raw water samples, respectively, 53% and 43% exceeded 20 mg/L with a majority of these samples from Accomack County (Table 2). Although in coastal areas much of the excessive sodium found in well water supplies can be deemed "natural", part of these discrepancies were likely primarily due to the impact of installed water softeners on the tap water sample group (16% of all participants reported the use of a water softener).

It should be reemphasized, however, that the suggested threshold of 20 mg/L for sodium is relatively low and applicable only to individuals suffering from health problems, such as heart disease or high blood pressure. To evaluate the presence of high sodium levels in the context of an otherwise healthy individual, a threshold value of 100 mg/L sodium has been suggested. Eleven percent of the raw water and 14% of the tap water samples exceeded this 100 mg/L threshold. Again, the likely influence of water softeners on sodium concentrations can be seen, even under higher threshold value.

Nitrate. High levels of nitrate may cause methemoglobinemia or "blue-baby" disease in infants. Though the EPA has set a MCL for nitrate (as N) of 10 mg/L, it suggests that water with greater than 1 mg/L not be used for feeding infants. Levels of 3 mg/L or higher may indicate excessive contamination of the water supply by commercial fertilizers and/or organic wastes from septic systems or farm animal operations, which may be subject to seasonal and climatic influences.

The maximum concentration of nitrate obtained was 27.3 mg/L for the tap water and 11.4 mg/L for the raw water sample groups. Only four of the tap water samples (all from Northampton County) and one of the raw water samples exceeded the MCL of 10 mg/L. Thus, serious nitrate contamination does not appear to be a widespread problem in either county. When a 1 mg/L threshold value was selected, however, a higher occurrence of nitrate was determined. In this case, 8% of the tap water and 6% of the raw water samples exceeded the level of potential concern to infant health. Furthermore, 6% of the tap water and 5% of the raw water samples had nitrate concentrations exceeding 3 mg/L, indicating that health-impacting

Table 1. Average and range of concentration of contaminants comprising general water chemistry analysis for Accomack and Northampton Counties.

Test	Detection Limit	Measured Concentrations					
		Raw Water (n=261)			Tap Water (n=353)		
		Avg.[1]	Min.	Max.	Avg.	Min.	Max.
Iron (mg/L)	0.005	0.359	DL[2]	7.920	0.331	DL	7.920
Manganese (mg/L)	0.001	0.035	DL	1.803	0.030	DL	1.803
Hardness (mg/L)	0.3	110.9	DL	1050.7	95.0	DL	1050.7
Sulfate (mg/L)	0.3	8.7	DL	134.5	10.8	DL	293.0
Chloride (mg/L)	40.0	19.0	DL	743.0	65.0	DL	1250.0
Fluoride (mg/L)	0.5	0.56	DL	1.97	0.57	DL	1.97
TDS (mg/L)	1.0	275.0	62.0	1840.0	291.0	29.0	2930.0
pH	-	7.57	5.93	8.20	7.61	5.93	8.50
Saturation Index	-	-0.79	-4.16	0.07	-0.99	-4.88	0.48
Copper (mg/L)	0.002	0.012	DL	0.469	0.014	DL	0.469
Sodium (mg/L)	0.01	41.87	4.14	334.10	53.33	4.14	961.00
Nitrate (mg/L)	0.005	0.430	DL	11.433	0.597	DL	27.307

[1] *Averages calculated on the basis of below detection limit (DL) values set equal to the DL.*

[2] *Sample concentration non-detectable, i.e., below the detection limit for the given contaminant.*

Table 2. Percent of concentrations exceeding established standards for contaminants comprising general water chemistry and bacteriological analysis for Accomack and Northampton Counties.

Test	Standard	Percent of Values Exceeding Standard					
		Raw Water			Tap Water		
		Total n=261	Acc. n=175	Nor. n=86	Total n=353	Acc. n=233	Nor. n=120
Iron (mg/L)	0.3	28.7	30.3	25.6	25.5	27.5	21.7
Manganese (mg/L)	0.05	17.2	15.4	20.9	15.9	14.2	19.2
Hardness (mg/L)	180.0	3.8	4.0	3.5	3.7	3.4	4.2
Sulfate (mg/L)	250.0	0	0	0	0.3	0	0.8
Chloride (mg/L)	250.0	3.1	3.5	2.4	3.1	3.0	3.3
Fluoride (mg/L)	2/4	0/0	0/0	0/0	0/0	0/0	0/0
TDS (mg/L)	500.0	8.4	9.1	7.0	8.2	8.6	7.5
pH - Low	6.5	3.4	1.1	8.1	3.1	0.9	7.5
pH - High	8.5	0	0	0	0	0	0
Saturation Index - Low	-1.0	14.2	8.6	25.6	25.5	19.7	36.7
Saturation Index - High	+1.0	0	0	0	0	0	0
Copper (mg/L)	1.0/1.3	0/0	0/0	0/0	0/0	0/0	0/0
Sodium (mg/L)	20.0	43.3	48.5	32.5	53.3	58.0	44.1
Nitrate (mg/L)	10.0	0.4	0	1.2	1.1	0	3.3
Total Coliform	ABSENT	21.8	21.7	22.1	22.4	23.2	20.8
E. coli	ABSENT	2.7	2.9	2.3	2.3	2.1	2.5

levels would likely be approached in a number of cases in both counties. In both of the non-standard threshold cases, incidences of excessive nitrate were substantially higher for Northampton County than for Accomack County.

Bacteriological Analysis

A common hazard of private household water supplies is contamination by potentially harmful bacteria and other microorganisms. Microbiological contamination of drinking water can cause short-term gastrointestinal disorders, such as cramps and diarrhea, that may be mild to very severe. Of the non-gastrointestinal disorders, one particularly important disease transmissible through drinking water is Viral Hepatitis A. Other diseases include salmonella infections, dysentery, typhoid fever, and cholera.

Coliform bacterial detection is simply an indication of the possible presence of pathogenic, or disease-causing organisms. Detection of coliform bacteria is confirmed by a total coliform analysis result above zero. Coliforms are always present in the digestive systems of all warm-blooded animals and can be found in their wastes. Coliforms are also present in the soil and in plant material. While a water sample with total coliform bacteria present may have been inadvertently contaminated during sampling, other possibilities include surface water contamination due to poor well construction, contamination of the household plumbing system, or water table contamination. To determine whether or not the bacteria were from human and/or animal waste, positive total coliform tests were followed up by an analysis for E. coli bacteria. Therefore, most probable number quantitative bacteria counts were obtained for both total coliform and E. coli bacteria.

Of the 353 household water samples from the two counties analyzed for total coliform bacteria, 79 (22%) tested positive (present). Subsequent E. coli analysis for these total coliform positive samples resulted in 8, or 10%, positive results, or 2% of all household water samples undergoing bacteriological analysis. The percentages of positive total coliform and E. coli results for the raw water sample group were 22 and 3, respectively. Quantitative bacteria counts ranged from zero up to the detection limit of 2400 colonies/100ml for total coliform and 39 colonies/100ml for E. coli bacteria.

The susceptibility of household water supplies to bacteriological contamination has often been associated with the type of water source. For example, it is generally accepted that the likelihood of bacteriological contamination of springs is greater than that of well water supplies, which usually offer better protection from surface, or near surface, contaminants. Similarly, deep drilled wells are better protected than shallow dug and bored wells. This contention is clearly borne out by the results of this program, which indicated that the incidence of total coliform and E. coli contamination of dug/bored wells was 25% and 8%, respectively, while for drilled wells, positive total coliform and E. coli results were obtained for 20% and 1% of the samples.

The age of a water source/system is an additional factor which may have an influence on contamination susceptibility. With respect to wells in particular, deterioration of the well structure over time, cumulative damage caused by equipment traffic, etc., and prolonged exposure of the wellhead area to potentially harmful pollutants may all contribute to the eventual contamination of the well. A major age-related impact could relate to the development of, and conformance with, well construction standards through the years. Major legislation in Virginia to address such issues has been enacted in recent years, most notably in the early 1970's and early 1990's. Therefore, for the purpose of examining the occurrence of bacteriological contamination with well age, the sample results were evaluated for the following three

Table 3. Measures taken or planned by respondents, since water quality analysis, to improve water supply (Accomack and Northampton Counties)

Measure	Percent of All Respondents (n=197)	Percent of Respondents who Reported the Following Problems			
		Health Only (n=69)	Nuisance Only (n=25)	Health & Nuisance (n=29)	None (n=74)
Contact an Agency, such as the Health Department	9.6	13.0	8.0	27.6	0
Seek Additional Water Testing from Another Lab	5.6	8.7	4.0	13.8	0
Determine Source of Undesirable Condition	6.1	8.7	4.0	10.3	2.7
Pump Out Septic System	2.5	2.9	4.0	3.4	1.4
Improve Physical Condition of Water Source	0.5	1.4	0	0	0
Shock-Chlorinate Water System	5.1	13.0	0	3.4	0
Obtain New Water Source	1.5	0	4.0	0	2.7
Use Bottled Water for Drinking/Cooking	11.7	13.0	20.0	31.0	0
Temporary Disinfection, such as Boiling Water	0.5	0	0	3.4	0
Purchase or Rent Water Treatment Equipment	13.7	11.6	28.0	27.6	5.4
Improve Existing Water Treatment Equipment	7.1	11.6	4.0	13.8	1.4
Take Other Measures to Eliminate/Reduce Contaminant(s)	3.6	7.2	0	0	2.7
Have Not Done Anything	54.3	37.7	40.0	24.1	86.5

construction date categories: (1) pre-1970, (2)1970-1989, and (3) 1990 to date. With respect to total coliform bacteria, for each of the above categories, the percentages of well water samples determined to be positive were as follows: (1) 15, (2) 24, and (3) 27. For E. coli bacteria, the corresponding percentages were: (1) 4, (2) 3, and (3) 1. For E. coli bacteria specifically, an overall improvement was noted with time, likely influenced not only by the newness of the wells, but also recent legislation.

Fecal bacteria present in household water supplies may have originated from animal waste generation or human waste from septic systems. Although, positive results should be viewed with concern, they are not a cause for panic. Individuals have probably been drinking this water for some time with no ill effects and could possibly continue to do so. Nevertheless, such problems should be further investigated and remedied, if possible. Program participants whose water tested positive were given information regarding emergency disinfection, well improvements, septic system maintenance and other steps to correct the source of contamination. After taking initial corrective measures, they were advised to have the water retested for total coliform, followed by E. coli tests, if warranted.

Post-Program Survey

Following the completion of the educational program, a survey form (see Appendix) was mailed to the 353 households whose water supply had been tested. The objectives of the survey were to determine: 1) reasons for program participation and for having water tested, and 2) what the respondents had done to correct water quality problems as a result of participation in the educational program. One hundred and nintey-seven (56%) had returned the survey forms by the deadline.

Household Water Testing History

Participants were asked to indicate their previous experience with water testing and, specifically, if and when they had last had a laboratory analysis of their present household water supply. Twenty-six percent of the respondents indicated that they had previously obtained water test results. Of those reporting a prior testing date, 60% had done so within the past five years and 19% within the past two years.

Reasons for Program Participation

People participated in the water quality program for one or more reasons. Seventy-four percent of the respondents were prompted to participate by concern about the safety of their water supply. Thirty-seven percent of the respondents were prompted by nuisance problems, such as staining, objectionable taste and odor, etc. Ten percent wanted to follow up on previous tests of their household water. Nineteen percent cited other reasons, such as general curiosity and low-cost opportunity.

Follow-up Activities Taken or Planned

Participants were asked to indicate the measures they planned to take, or had already taken, to improve the quality of their water supply, since receiving the results of their water quality analysis. Table 3 presents the results of this inquiry, with the greatest number of households (10% or more) indicating that they had already taken, or planned to take, one or more of the following actions: purchase or rent water treatment equipment, use bottled water for drinking/cooking, and contact a state agency for further assistance.

Participants were asked if the water analysis showed that their water was unsatisfactory for one or more of the following: bacteria, nitrate, sodium, iron, manganese, hardness, and pH. Responses were grouped in four categories: 1) households with potential health problems (positive bacteria test results and/or unsatisfactory levels of nitrate or sodium in their water samples), 2) households with unsatisfactory levels of nuisance contaminants (one or more of the following: iron, manganese, hardness, and pH), 3) households with potential health problems and unsatisfactory levels of nuisance contaminants, and 4) households with neither potential health problems nor unsatisfactory levels of nuisance contaminants.

The measures planned or already taken to improve household water as follow-up to the water quality analysis were generally in agreement with the water quality problems identified by the testing. Of the households with potential health problems only, and those with health problems in combination with unsatisfactory levels of nuisance contaminants, 66% had taken, or planned to take, at least one measure to improve their water supply. The measure taken by the greatest number of households in these two categories was use bottled water drinking/cooking.

Respondents were actually slightly less likely to address health-related problems than nuisance problems. Of the households with unsatisfactory levels of one or more nuisance contaminants only and those with nuisance problems in combination with potential health problems, 68% had taken, or planned to take, at least one measure to improve their water supply. Not unexpectedly, the group of households that reported the fewest folllow-up measures (14%) were the households with neither potential health problems nor unsatisfactory levels of nuisance contaminants.

CONCLUSIONS

The Household Water Quality Educational Programs conducted in Accomack and Northampton Counties were considered to be successful. The opportunity to participate in the programs was well-received by Eastern Shore residents. Individuals participated in the programs primarily because of concern about the safety of their water supply. Despite being voluntary programs, a geographically distributed sample representing diverse household and water supply characteristics was obtained. While the project was designed for voluntary participation and quality control in sampling was not assured, the type of information gathered and summarized was, nevertheless, deemed useful for water quality assessment at county and regional levels.

Water quality analysis, for many nuisance constituents, generally supported the participants' descriptions of their water supplies regarding such problems as staining, taste and odor, and appearance. The severity of these symptoms is confirmed by the high incidence of water treatment devices installed – 24% of all households participating had one or more water treatment devices installed.

Considering the results for both the raw and tap water sample groups, and the influence of the water treatment devices in use, the major remaining household water quality problems in Accomack and Northampton Counties, existing from a nuisance standpoint, were iron/manganese and total dissolved solids. The major health-related concern was bacteria. Furthermore, elevated sodium concentrations may present a health risk to some adults in a number of cases. Twenty-two percent of the samples tested positive for total coliform and 2% were positive for E. coli bacteria. In these positive cases, participants were advised of ways to improve water supply conditions and were encouraged to pursue retesting for coliform bacteria.

Sixty-five percent of the households that reported having at least one water quality problem had taken, or planned to take, at least one measure to improve the quality of their water supply. Ten percent or more of all respondents had taken, or planned to take, one or more of the following actions: purchase or rent water treatment equipment, use bottled water for drinking/cooking, and contact a state agency for further assistance.

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APPENDIX*

(1) Program Fact Sheet

(2) Sample Identification and Questionnaire Form

(3) Sample Water Quality Analysis Report

(4) Report Interpretation

(5) Post-Program Survey

* *The following examples (2) – (5) represent forms, reports, etc. used in the Accomack County Program only. Paperwork for Northampton County was similar, except for the information that was county-specific.*

(1) Program Fact Sheets

Virginia Cooperative Extension

Virginia Tech

EASTERN SHORE WELL-WATER TESTING PROGRAM

Purpose

Conduct an educational and well water-testing program that will describe to participants the quality of their drinking water and create a groundwater quality data inventory to assist in groundwater management on the Eastern Shore. You will learn about potential health concerns and how to improve water quality.

Whose water will be tested?

400 household water samples from private wells on the Eastern Shore of Virginia will be tested. 150 samples in Northampton County and 250 samples in Accomack County will be analyzed. Samples kits will be given on a first come first serve basis.

Water will be tested for:

A water analysis of iron, manganese, hardness, sulfate, chloride, fluoride, TDS, pH, saturation index, copper, sodium, nitrate, total coliform, and E. coli will be prepared for each person. *All results will be kept confidential. Information gathered will have no names and will not be of sufficient detail to determine a particular water supply.* Participants will be given individual sample results and have the results explained.

Cost: $10.00

The value of this service is over $ 100.00 per sample, but due to grants and sponsors, the cost to homeowners has been reduced. Make checks payable to: **VCE-Northampton** or **VCE-Accomack.**

Sponsors for the program

Virginia Tech, the Southeast Rural Community Assistance Project, Inc., Virginia Cooperative Extension, Accomack and Northampton County Boards of Supervisors, the Eastern Shore Groundwater Committee, and the Eastern Shore Health District.

Important Dates

Pre-registration and Information Meeting

Monday, October 18, 1999, 7PM	Northampton High School Cafeteria
Tuesday, October 19, 1999, 7PM	Nandua High School Auditorium

Water Sample Collection and Submission

(Sample must be collected immediately before bringing to the Extension Office)

Monday, November 1, 1999	7AM-12:30PM	Accomack Extension Office
Monday, November 1, 1999	7AM-12:30PM	Northampton Extension Office
Monday, November 15, 1999	7AM-12:30PM	Accomack Extension Office
Monday, November 15, 1999	7AM-12:30PM	Northampton Extension Office

Follow-Up Meeting

Monday, December 13, 1999	3PM and 7PM	Accomack County	TBA
Tuesday, December 14, 1999	3PM and 7PM	Northampton County	TBA

If you are a person with a disability and desire any assistive devices, services, or other accommodations to participate in this activity, please contact either local Virginia Cooperative Extension Office at (757) 787-1361 or (757) 414-0731 during the business hours of 8AM to 4:30PM to discuss accommodations.

(2) Sample Identification and Questionnaire Form

ACCOMACK COUNTY HOUSEHOLD WATER QUALITY PROGRAM

Accomack County Cooperative Extension
P.O. Box 60
Accomac, VA 23301-0060
(757) 787-1361

SAMPLE IDENTIFICATION (Please **print** clearly and provide complete information on both sides of form.)

Sample No.:________________ Date collected:____________________

FOR OFFICE USE ONLY
Map Grid No.____________________
Lab Sample No.____________________

Sample submitted by:

Name:____

Mailing address:____

____

Telephone:____

Household water supply source **drawn for sample** (check **one**):

___*well* ___*spring* _ *cistern* ___*other (Specify:* ______________________________*)*

If ***well*** is checked above: (*a*) is it a ____ *dug or bored well,* ____ *drilled well,* ____ *don't know;*

(*b*) what is its approximate depth, if known? __________*feet*

(*c*) what year was well constructed, if known? ________

Do other households share the same water supply? ___ *yes* ___ *no* **If** *yes*, approximately how many? ________

Water treatment devices currently installed and affecting **cold water only** drawn at faucet for sample (check **all** that apply):

_____*none* _____*acid water neutralizer*

_____*water softener (conditioner)* _____*sediment filter (screen or sand type)*

_____*iron removal filter* _____*activated carbon (charcoal) filter*

_____*automatic chlorinator* _____*other (specify:* ____*)*

SAMPLING INSTRUCTIONS: You must take your water samples only on the collection day you have been assigned. For the general water analysis sample, use the larger plastic bottle as described below. A separate, smaller bottle is provided for bacteriological samples which should be taken last. If you have any questions about sampling procedures, call the Extension Office a 787-1361.

1. Do not remove caps from sample bottles until you are ready to take each sample. Do not touch inside of cap or mouth of either bottle.

2. Turn on the cold water faucet in the kitchen or bathroom (select a stationary, non-swivel faucet, if possible) and allow the water to run until it becomes as cold as it will get; then let it run for one more minute.

3. Slowly and carefully fill the larger bottle to avoid splashing or overflowing. Pour out this rinse water and then refill bottle completely. Tighten cap on bottle securely.

4. Let the water run for an additional two or three minutes. Reduce flow to prevent splashing and carefully fill the smaller bottle only once to the shoulder (just below the threaded top). DO NOT RINSE BOTTLE. Replace cap tightly.

5. Do not write anything on the bottle labels. If samples are not to be delivered immediately, store in refrigerator or on ice until ready to deliver later that day.

6. Fill out this Sample Identification Form and Questionnaire (on reverse side) completely and bring it, along with both water sample bottles, to the designated collection site on your assigned collection day.

Sample Identification and Questionnaire Form (cont.)

QUESTIONNAIRE (Please answer the following questions as completely as possible, considering how you view the **present** condition of the water sampled, including improvements due to any treatment devices identified on other side of form.)

1. Describe the location of your home. (Check **one**)
   _____*on a farm* _____*on a remote, rural lot* _____*in a rural community* _____*in a housing subdivision*

2. What pipe material is primarily used throughout your house for water distribution? (Check **one**)
   ___*copper* __*lead* __*galvanized steel* __*plastic (PVC, PE, etc.)* __*other (specify:* ______________________*)* __ *don't know*

3. Do you have problems with corrosion or pitting of pipes or plumbing fixtures? _____*yes* _____*no*

4. Does your water have an unpleasant taste? _____*yes* _____*no*

5. If *yes*, how would you describe the taste? (Check **all** that apply)
   ___*bitter* ___*sulfur* ___*salty* ___*metallic* ___*oily* ___*soapy* ___*other (specify:*______________________________*)*

6. Does your water have an objectionable odor? _____*yes* _____*no*

7. If *yes*, how would you describe the odor? (Check **all** that apply)
   ___*"rotten egg" or sulfur* ___*kerosene* ___*musty* ___*chemical* ___*other (specify:*______________________________*)*

8. Does your water have an unnatural color or appearance? _____*yes* _____*no*

9. If *yes*, how would you describe the color or appearance? (Check **all** that apply)
   ___*muddy* ___*milky* ___*black/gray tint* ___*yellow tint* ___ *oily film* ___ *other (specify:*__________________________*)*

10. Do you have problems with staining of plumbing fixtures, cooking appliances/utensils, or laundry? ___*yes* ___*no*

11. If *yes*, how would you describe the color of stains? (Check **all** that apply)
    ___*blue-green* ___*rusty (red/orange/brown)* ___*black or gray* ___*white or chalk* ___*other (specify:*__________________*)*

12. In a standing glass of water, do you notice floating, suspended, or settled particles? _____*yes* _____*no*

13. If *yes*, how would you describe this material? (Check **all** that apply)
    ___*white flakes* ___*black specks* ___*reddish-orange slime* ___*brown sediment* ___*other (specify:*____________________*)*

14. If your water supply is located **100 feet or less** from any of the following, please indicate. (Check **all** that apply)
    _____*septic system drain field* _____*home heating oil storage tank (above or below ground)*
    _____*pit privy or outhouse* _____*pond or freshwater stream*
    _____*cemetery* _____*tidal shoreline or marsh*

15. If your water supply is located **½ mile or closer** to any of the following, please indicate. (Check **all** that apply)
    _____*landfill* _____*marina*
    _____*illegal dump* _____*field crops/nursery*
    _____*active quarry* _____*farm animal operation*
    _____*abandoned quarry, industry, etc.* _____*manufacturing/processing operation (specify:*____________________*)*
    _____*commercial underground storage tank or supply lines (gasoline service station, heating oil supplier, etc.)*

This material is based upon work supported by the U.S. Department of Agriculture, Extension Service.

(3) Sample Water Quality Analysis Report

Accomack County
Household Water Quality Program

Accomack County Cooperative Extension
P.O. Box 60
Accomac, VA 23301
(757) 787-1361

Sample No: A

P.O. Box
Accomac, VA 23301
(757) 789-

Source: Dug/Bored Well

Treatment: None

Water Quality Results
Date of Sample: 11/15/99

Test	Household Water Sample	Maximum Recommended Level or Range
Iron (mg/l)	0.3412**	0.3
Manganese (mg/l)	0.0149	0.05
Hardness (mg/l)	98.4	180
Sulfate (mg/l)	17.392	250
Chloride (mg/l)	< 40	250
Fluoride (mg/l)	< 0.5	2
Total Dissolved Solids (mg/l)	146	500
pH	7.7	6.5 to 8.5
Saturation Index	-0.68	-1 to 1
Copper (mg/l)	< 0.002	1.0
Sodium (mg/l)	8.93	20
Nitrate-N (mg/l)	< 0.005	10
Total Coliform Bacteria (col/100ml)	122**	0
E. Coli Bacteria (col/100ml)	0	0

** Measured Value exceeds recommendation for household water.

Analysis coordinated by Water Quality Laboratory, Dept. of Biological Systems Engineering, Virginia Tech, Blacksburg, VA. The information provided is for the exclusive use of the homeowner and should not be used as official documentation of water quality. This material is based upon work supported by the U.S. Department of Agriculture, Extension Service.

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Virginia Cooperative Extension programs and employent are open to all, regardless of race, color, religion, sex, age, veteran status, national origin, or political affiliation. An equal opportunity/affirmative action employer.

(4) Report Interpretation

Accomack County Household Water Quality Program

INTERPRETING YOUR HOUSEHOLD WATER QUALITY ANALYSIS REPORT

IRON
Iron in water does not usually present a health risk. It can, however, be very objectional if present in amounts greater than 0.3 mg/l. Excessive iron can leave red-orange-brown stains on plumbing fixtures and laundry. It may give water and/or beverages a bitter, metallic taste and discolor beverages.

MANGANESE
Manganese does not present a health risk. However, if present in amounts greater than 0.05 mg/l it may give water a bitter taste and produce black stains on laundry, cooking utensils, and plumbing fixtures.

HARDNESS
Hardness is a measure of calcium and magnesium in water. Hard water does not present a health risk. However, it keeps soap from lathering, decreases cleaning action of soaps and detergents, leaves soap "scum" on plumbing fixtures, and leaves scale deposits on water pipes and hot water heaters. Softening treatment is highly recommended for very hard water (above 180 mg/l). Water with a hardness of about 50 mg/l or less does not need softening. Water hardness may also be reported in units of grains per gallon, or gpg (1 gpg = 17.1 mg/l hardness). In all but extremely hard water situations, it may be desirable to soften only the hot water.

SULFATE
High sulfate concentrations may result in adverse taste as well as cause a laxative effect. The Secondary Maximum Contaminant Level for sulfate is 250 mg/l. Sulfates are generally naturally present in groundwater and be linked to other sulfur-related problems, such as hydrogen sulfide gas. This gas may be caused by the action of sulfate reducing bacteria as well as other types of bacteria on decaying organic matter. While it is difficult to test for the presence of hydrogen sulfide gas in water, it can be easily detected by its characteristic "rotten egg" odor which may be more noticeable in hot water. Water containing this gas may also corrode iron and other metals in the water system as well as stain plumbing fixtures and cooking utensils.

CHLORIDE
Chloride in drinking water is not a health risk. Natural levels of chlorides are low; high levels in drinking water usually indicate contamination from a septic system, road salts, fertilizers, industry, or animal wastes. High levels of chloride may speed corrosion rates of metal pipes, and causing pitting and darkening of stainless steel. The EPA has set a Secondary Maximum Contaminant Level for chloride of 250 mg/l.

FLUORIDE
Fluoride is of concern primarily from the standpoint of its effect on teeth and gums. Small concentrations of fluoride are considered to be beneficial in preventing tooth decay while moderate amounts can cause brownish discoloration of teeth and high fluoride concentrations can lead to tooth and bone damage. For these reasons, the EPA has set both a Secondary Maximum Contaminant Level and a Maximum Contaminant Level of 2 and 4 mg/l, respectively.

TOTAL DISSOLVED SOLIDS (TDS)
High concentrations of dissolved solids may cause adverse taste effects and may also lead to increased deterioration of household plumbing and appliances. The EPA Secondary Maximum Contaminant Level is 500 mg/l total dissolved solids.

pH
The pH of water indicates whether it is acidic (below 7.0) or alkaline (above 7.0). Acidic water can cause corrosion in pipes, and may cause toxic metals from plumbing systems, such as copper and lead, to be dissolved in drinking water. Dissolved copper may give water a bitter or metallic taste, and produce blue-green stains on plumbing fixtures. The life of plumbing systems may be shortened due to corrosion requiring expensive repair and replacement of water pipes and plumbing fixtures. The use of plastic pipes throughout the water distribution system should lessen these concerns. Water with a pH below 6.5 is considered to be acidic enough to require treatment. Alkaline water with a pH above 8.5 is seldom found naturally, and may indicate contamination by alkaline industrial wastes. The EPA has set a suggested range of between 6.5 and 8.5 on the pH scale for drinking water.

Report Interpretation (cont,)

SATURATION INDEX
The saturation (Langlier) index, in addition to pH, is used to evaluate the extent of potential corrosion of metal pipes, plumbing fixtures, etc. It is a calculated value based on the calcium concentration, total dissolved solids concentration, measured pH, and alkalinity, and is a measure of the scale formation potential of the water. A saturation index greater than zero indicates that protective calcium carbonate deposits may readily form on pipe walls. A saturation index less than zero indicates that the water does not have scale-forming properties and pipes may be subject to corrosion. Saturation index values between -1 and +1 are considered acceptable for household water supplies. NOTE: **Values of less than -1 need not be of concern if the water is not acidic (indicated by a pH of 7.0 or above).** Water softener owners may note a saturation index reading lower than desired. While these treatment devices correct hardness, they may enhance the corrosion potential of the water. Concerns about resulting drinking water quality may be lessened by softening only the hot water or bypassing drinking water lines.

COPPER
The EPA drinking water standard for copper is 1.3 mg/l, based on concerns about acute gastrointestinal illness. Since dissolved copper also leaves blue-green stains on plumbing fixtures, a Secondary Maximum Contaminant Level of 1.0 mg/l is also provided for copper. While copper in household water most often comes from the corrosion of brass and copper plumbing materials, this type of contamination is not likely to be detected under the sampling procedure followed in this program which called for flushing the water lines. Therefore, any excessive amounts of copper from the water source itself may indicate contamination from industrial wastes or dumps/landfills.

SODIUM
Excessive sodium has been linked to problems with high blood pressure, and heart and kidney diseases. Moderate quantities of sodium in drinking water are not considered harmful since an individual normally receives most (over 90%) of his/her sodium intake from food. For those on low-sodium diets, both the American Heart Association and EPA suggest 20 mg/l as a maximum level for sodium in drinking water; a physician should be consulted in individual cases. Water softening by ion-exchange will increase sodium levels in water. To reduce sodium in drinking water requiring such treatment, soften only the hot water or bypass drinking water lines.

NITRATE
High levels of nitrate may cause methemoglobinemia or "blue-baby" disease in infants. Though the EPA has set a Maximum Contaminant Level for nitrate-nitrogen of 10 mg/l, they suggest that water with greater than 1 mg/l be used with caution for feeding infants. Levels of higher than 3 mg/l may indicate excessive contamination of water supply by commercial fertilizers as well as organic wastes from septic systems or farm animal operations.

TOTAL COLIFORM BACTERIA
Microbiological contamination of drinking water can cause short term gastrointestinal disorders, resulting in cramps and diarrhea that may be mild to very severe. Other diseases of concern are Viral Hepatitis A, salmonella infections, dysentery, typhoid fever, and cholera. While coliform bacteria do not cause disease, they serve as indicators of the possible presence of disease bacteria. Coliform bacteria are always present in the digestive systems of humans and animals and could also come from other sources such as soil or decaying vegetation. Analysis for total coliform bacteria is the EPA standard test for microbiological contamination of a water supply, for which none should be present.

E COLI
In the event that there are coliform bacteria present, a test for fecal bacteria, such as E.coli, is necessary to determine whether or not any bacteria are from human and/or animal waste. E. coli bacteria, this species of which is harmless, always originate within the intestinal tract of warmblooded animals and humans and do not survive very long outside of the digestive system. The presence of E. coli bacteria indicates that waste from a septic system or nearby animals is likely contaminating the water supply.

Glossary

EPA - U. S. Environmental Protection Agency

mg/l - Concentration unit of milligrams per liter in water, equivalent to one part per million (ppm).

Maximum Contaminant Level (MCL) - Legally enforceable national standard set by the EPA to protect the public from exposure to water hazards. Standards only apply to public drinking water systems, but, they also serve as a guide for individual water supplies.

Secondary Maximum Contaminant Level (SMCL) - Concentration limits for nuisance contaminants and physical problems. These standards are not enforced by governments. However, they are useful guidelines for individual water supplies.

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December 1999

This material is based upon work supported by the U. S. Department of Agriculture-Extension Service.

(5) Post-Program Survey

Accomack County

HOUSEHOLD WATER QUALITY PROGRAM EVALUATION SURVEY

Please answer each question below as instructed in reference to your **household** water supply only. **Your answers are completely confidential and cannot be identified with any individual participant**.

1. Have you had a laboratory test of your water supply before this Household Water Quality Education Program? Yes _____ No _____

   If Yes, about what year was your last test? _________

2. What prompted you to participate in this program? (Check **all** that apply.)

   _____ Concern about safety of my water supply
   _____ Nuisance problems such as staining, objectionable taste or odor, corrosion, etc.
   _____ Follow-up to previous test of my water supply
   _____ Other (explain) ______________________________

3. Did your household water analysis in this program show that your water was unsatisfactory for **any** of the following tests? (Check **one** response for each test.)

Nitrate	Yes _____	No _____
Sodium	Yes _____	No _____
Iron	Yes _____	No _____
Manganese	Yes _____	No _____
Hardness	Yes _____	No _____
pH	Yes _____	No _____

4. What were the results of the tests for the following? (Check **one** response for each test.)

Total coliform bacteria	Present _____	Absent _____
E. coli bacteria	Present _____	Absent _____

5. Since receiving the results of your water quality analysis, which of the following measures do you plan to take, or have already taken, to improve the quality of your water supply? (Check **all** that apply.)

   _____ Contact a state agency such as the Health Dept., Dept. of Environmental Quality, etc. for assistance or additional information
   _____ Seek additional water testing from a laboratory
   _____ Determine source of undesirable condition
   _____ Pump out septic system
   _____ Improve physical condition of water source (well, spring, or cistern)
   _____ Shock chlorinate water system
   _____ Obtain new water source
   _____ Use bottled water for drinking/cooking
   _____ Temporary disinfection, such as boiling water
   _____ Purchase or rent water treatment equipment
   _____ Improve functioning of existing water treatment equipment
   _____ Take other measures to eliminate or reduce contaminant(s) in your water (explain)

____

____

Haven't done anything because______________________________

____

Post-Program Survey (cont,)

The following questions are designed to provide us with a profile of the total audience we've reached with this program. **Be assured that answers cannot be identified with individual participants.**

6. How many years have you lived at your present location? _____

7. Number of persons in your household. _____

8. What is the highest grade in school you've completed? (Check **one**.)

   _____ Grade school
   _____ Some high school
   _____ High school graduate
   _____ Some education after high school
   _____ College graduate

9. What is your **family** income before taxes? (Check **one**.)

   _____ Less than $10,000
   _____ $10,000 to $14,999
   _____ $15,000 to $19,999
   _____ $20,000 to $24,999
   _____ $25,000 to $34,999
   _____ $35,000 to $49,000
   _____ $50,000 or more

10. Other comments about the Household Water Quality Education Program:

    ____
    ____
    ____

11. Are there other educational programs that you would like to see offered by the Accomack County Extension Office?

    ____
    ____

12. How did you hear about this Household Water Quality Education Program? (Check **all** that apply.)

    _____ Newspaper
    _____ Radio
    _____ Television
    _____ Extension Newsletter
    _____ Flyer from child's school
    _____ Friend or Neighbor
    _____ Other (explain)
    ____

Thank you for your participation. Please return this survey form by **February 21, 2000.** A postage-paid envelope has been provided for your use in returning this form to:

Jim Belote, Accomack County
Virginia Cooperative Extension
Extension Distribution Center
112 Landsdowne Street
Blacksburg, VA 24060-9984

Notes

VT/002/1100/150/211771/442936