Contaminants in Private Well Water in Selected Counties in Eastern Maryland

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Abstract

The results represent part of a broader project designed to collect and analyze well water samples used for drinking purposes from volunteering underserved farms, families and communities (UFFC) in the Delmarva (Maryland, Delaware, and Virginia) Region. This presentation focuses on activities in four counties in Maryland. Somerset, Dorchester, Wicomico and Worchester counties were selected to investigate potential drinking water quality problems and potential hazards to UFFC in these counties. Survey questions were prepared to complement water sampling and analysis efforts. The overall objectives of this project were to (1) collect well water samples and analyze them for various parameters, (biological and chemical) by physiographic regions throughout the Mid-Atlantic, (2) prepare educational and training materials on drinking water quality for extension and NRCS field agents to assist UFFC in the Mid-Atlantic Region, and (3) to help UFFC locate government programs that would provide monetary assistance to alleviate or solve identified drinking water quality problems. Our main objective was to quantify the levels of selected anions, cations, and trace elements in well water of rural families. Other assessments were to quantify the content of total dissolved solids, electrical conductivity; total and fecal coliforms, hardness index, and determine the pH. The targeted group for this research was farms and families who rely on wells as their primary source of drinking water. Questionnaires were also developed and data ascertained on pertinent information associated with drinking water sources, knowledge of well installation and well placement among other parameters. This information was placed in a database where geospatial information technologies, GIS and GPS, were applied to provide spatial relationships associated with well location, and water quality content parameters. In addition, results are presented on data ascertained from questionnaires. Safe drinking water clinics were held to discus results and proper well construction, location and management for those who provided samples as well as for the local community.

Introduction

The potential for contamination of UFFC drinking water is extremely high since it is obtained largely from wells that may not have wellhead protection, or may be shallow. These water sources are exposed to runoff and other types of pollution from surrounding sources, and the use of poultry and other types of manures as a source of inexpensive fertilizer for their crops or home gardens. The proximity of such facilities and activities to drinking water sources could potentially contribute to fecal coliforms and *E. coli* contamination of well water and nearby streams. These water sources and unfavorable conditions may negatively affect water characteristics by producing objectionable taste, smell, color, and staining characteristics.

Unfortunately, UFFC may not realize that certain household chemicals and fertilizers stored in sheds or barns could represent a threat to their drinking water resources. These facts indicate that water quality education to UFFC is warranted to rectify or avoid potential health problems. Therefore, the 1890 and 1862 Land-Grant Universities continue to fulfill their mission of focusing resources on the underserved communities by extending expertise to assessing drinking water quality, and providing educational opportunities to improve these unfavorable conditions.

Materials and Methods

Water Sampling

Water samples were collected from 216 wells located in four counties in Maryland (Figure 1). All samples were packed in ice during transportation, and delivered immediately to the laboratory for biological and chemical analysis. Biological samples were analyzed upon arrival to the laboratory and chemical samples were stored at 4° C until analyses. Brown plastic bottles (500 ml) were rinsed with weak acid solution and deionized water, and used for sampling water to be tested for chemical analysis, while samples for biological analyses were collected aseptically in 100 ml sterile plastic bottles with seal caps .

Chemical parameters

Zinc, sodium, potassium, calcium, magnesium were measured using methods from Standard Methods for the Examination of Water and Wastewater (APHA, 1998). Manganese, fluoride, copper, iron, turbidity, chloride and sulfate were determined using methods for HACH DR/4000 (1997-2003). Electrical conductivity, and total dissolved solids was obtained using an INOLAB conductivity meter, while nitrate and phosphate were determined using a LACHAT QuiKChem 8000 Flow Injection Apparatus. Sample pH was determined by using an Accumet Basic meter.

Biological parameters

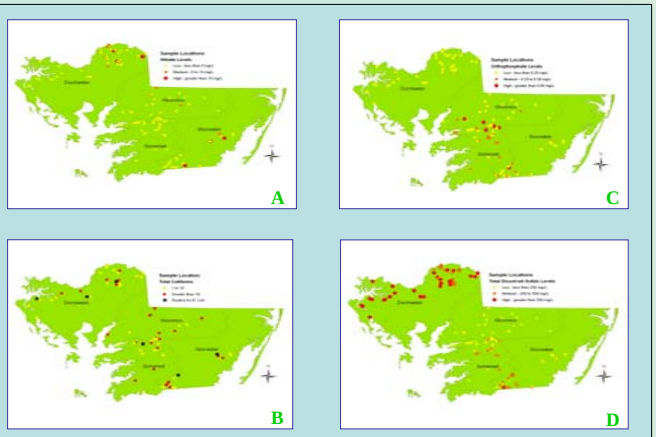
Detection and enumeration of total coliforms and *E. coli* were determined in water samples (USEPA, 2002). The aseptically collected water samples were filtered through a sterile 47- mm cellulose ester filter with a pore size of 0.45 µm (Fisher Scientific, Boston, MA). Filters were placed aseptically on MI agar plates (Difco Laboratories, Detroit, MI) and incubated at 35˚C for 24 h. All fluorescent colonies and any blue, non-fluorescent colonies under long-wave ultraviolet light and blue colonies under normal/ambient light were considered total coliforms and *E. coli*, respectively

Questionnaire Survey Results

An array of questions were asked of persons who donated well water samples using a standard questionnaire. The results of some of the data generated can be seen in Figure - 2.

Results and Discussion

Nitrate levels varied among samples. Nitrate concentration levels ranged from 0 to 38 mg/l. The EPA Maximum Concentration Level (MCL) for nitrate in drinking water is 10 mg/l. Only 4 % of the total samples collected exceeded the MCL. The majority of samples that exceeded EPA maximum drinking water standards for nitrate-nitrogen were located in Dorchester and Worcester counties, while the lower values were found in Wicomico and Somerset counties (Figure - 1). In contrast, the highest concentration levels for phosphorus (P) was found in Somerset and Wicomico counties. A large portion of Maryland's poultry industry activity is located in these two counties. EPA water quality criteria states that surface waters that are maintained at 0.01 to 0.03 mg/l of total P tend to be uncontaminated by algae blooms. The highest measured value for P was 0.78 mg/l which exceeds the level required to cause eutrophication in surface water bodies. Twenty-five percent of all samples tested for Total Dissolved Solids (TDS) were above EPA's MCL, and 28% tested above the turbidity maximum. Twenty-five percent of samples tested for manganese exceeded the MCL, while only 8 % tested high for iron. The chemical and biological parameters that exceeded MCL standards set by EPA are shown in Figure 3.



Figures - 1: Levels of nitrate-N (A), total coliforms (B), orthophosphate (C) and total dissolved solids (D) in water samples collected from four MD counties.

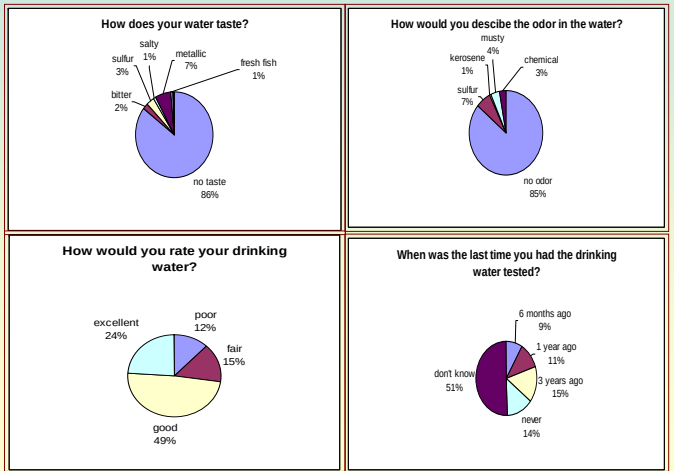


Figure -2. Questionnaire responses from participants who submitted well water samples

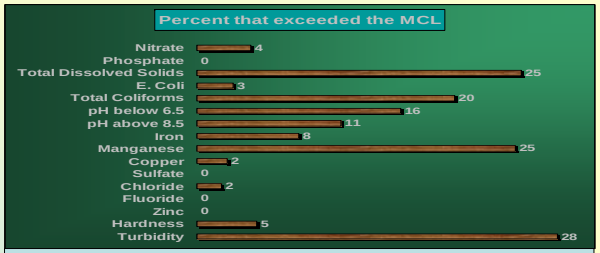


Figure - 3. Percentage of water samples that exceeded USEPA MCL for the biological and chemical parameters.

Conclusions

Water samples were collected in rural areas where low income, minority individuals dwelled, which was the main targeted group for this study. Thus only a small portion of the state was covered, and in selected communities within the four counties. Interpretation of water quality parameters is confined to the area where samples were collected. However, geographical patterns were developed relative to the parameters tested (Fig. 1). Higher levels of nitrate (Fig. 1A) were present in upper Dorchester County near the city of Cambridge and lower Worcester County near the town of Snow Hill. The highest levels of phosphate (Fig. 1C) are clustered in lower Wicomico County and upper Somerset County which are areas of concentrated poultry production. Higher levels for total dissolved solids (Fig. 1D) clustered in upper Dorchester County near the Choptank River and in lower Worcester County near the Pocomoke River. Total coliforms and *E. coli* (Fig. 1B) counts did not develop a pattern. It is worth mentioning that concern was noted relative to the biological data that resulted in 20% of the samples exceeding the EPA standard for total coliforms. All of the UFFC that had high values are being revisited to evaluate the results and possible contributing conditions. Values for chlorine, fluoride, sulfate, copper, zinc, sodium, and calcium were found to be below those of MCL values set by EPA, and thus deemed unharmful.

Acknowledgements

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References

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