AN ABSTRACT OF THE DISSERTATION OF

Edith Chijioke Anadu for the degree of Doctor of Philosophy in Public Health presented on March 18, 1997. Title: Factors Affecting Risk Perception About Drinking Water and Response to Public Notification.

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Anna K. Harding

Contamination of drinking water occurs despite strict regulations, yet few studies have been conducted to assess the public's perception of risk about drinking water. The purpose of this study was to assess risk perception associated with drinking water supplied by small water systems and to determine alternative measures that people take in response to public notification (PN). The study also explored whether health belief model (HBM) variables and general risk perception about drinking water, were significant predictors of response to PN. Participants were selected from four small Oregon cities (one with a long-term filtration problem and the other with a short-term contamination problem) and two cities without such problems using a stratified random sampling technique. A total of 391 telephone interviews were completed for an average response rate of 69 percent.

Results indicated higher risk perception about drinking water among residents of the city with a long-term drinking water problem (Falls City) when compared to the city with a short-term problem (Jefferson) (p=.008). A higher proportion of residents in Jefferson than in Falls City responded to the PN by boiling water (p=.011), and by taking any action (p=.023) in response to PN. There was a significant difference between the

cities with respect to regular bottled water consumption patterns (p=.0002), with Falls City showing the highest mean ranking for bottled water consumption, of all the cities.

Logistic regression analysis supported the HBM variables perceived seriousness (OR=2.05, p=.001), and household size (OR =2.2; p= .027) as predictors of response to PN by taking any action. Perceived seriousness (OR= 0.5; p=.004) and income (OR= 2.3; p=.000) emerged as preditors of response to PN by drinking bottled water. General risk perception was a significant negative predictor of response to PN by boiling water (OR= 0.57; p=.019).

Mail from the city water utility, county health department and newspapers were the top three sources respondents used to obtain information about drinking water. In all the cities, three quarters of the respondents indicated willingness to pay for the improvement of drinking water, particularly to correct problems related to chemical and microbiological contamination.

FACTORS AFFECTING RISK PERCEPTION ABOUT DRINKING WATER AND RESPONSE TO PUBLIC NOTIFICATION

by

Edith Chijioke Anadu

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Dean of Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

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Edith Chijioke Anadu, Author

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FACTORS AFFECTING RISK PERCEPTION ABOUT DRINKING WATER AND RESPONSE TO PUBLIC NOTIFICATION

CHAPTER ONE

INTRODUCTION

The American public is increasingly concerned over the safety of public drinking water due to increased awareness about environmental pollution and reports of waterborne disease outbreaks (Dandoy, 1990; Glicker, 1992; Olson, 1989; McSwane, Olecno, & Eils, 1994). Public concerns about the quality of drinking water were initially directed at microbial pathogens (Tompson, 1992), but have been extended to chemical contaminants from industry and agriculture, as the impact of such chemicals on human health was recognized (EPA, 1990; Glicker, 1992; Olson, 1989; Steinhart, 1986). Considerable research has been conducted both on microbial quality (Hansen & Ongerth, 1991; Levine & Craun, 1990; Rose, 1985) and chemical contaminants of drinking water (Allen, Henderson & Haas, 1989; EPA,1990; Olson, 1993; Toft, 1993).

The United States Environmental Protection Agency (U.S. EPA) describes drinking water contamination by microbiological organisms as having short-term or acute effects, while most health effects related to chemical contaminants in drinking water are long-term or chronic (EPA, 1990). Some of the adverse health effects of contaminated drinking water include short-term gastrointestinal disorders associated with microbiological contaminants. Chronic effects such as nervous system disorders, cardiovascular and hypertensive effects, and cancer are associated with the consumption of some chemical contaminants in drinking water (Jakubowski, 1988; Wong, Whorton, Gordon, & Morgan, 1988; EPA, 1990).

Another aspect that has been studied is the public's perception of the quality of drinking water (Curry, 1983; Glicker, 1992; Hurd,1993; Manwaring, Zdep & Sayre, 1986) and reasons that some consumers choose to drink bottled water rather than tap water (Bakoulis, 1987; Walmsley & Wickens, 1990). People's perception about the quality of drinking water has been described as subjective because people depend on "intuitive risk judgments" to assess risks (Glicker, 1992 ; Slovic, 1987). In a study of consumer attitudes about the quality of public water, Curry (1983) found that the aesthetic values of drinking water such as taste, odor, hardness and color were given as reasons for people's dissatisfaction with public water supplies. This caused some consumers to either switch to bottled water or purchase home water filters. Current research is unclear as to whether people who consume bottled water are aware that the public water supply is carefully monitored and regulated for safety.

Sound decisions about choices might be influenced by the available information on the type of risk involved, the likelihood of the risk occurring, how the risk is perceived, and safety measures (Lave, 1987). Averill and his colleagues outlined several factors that affect an individual's personal estimation of risk. These factors include control, voluntarism, immediate versus long term consequences, and severity of the potential health problem, among other factors (Averill, Henry, Rubenstein, Sattler & Tirey, 1993). Research has shown that perception of risk influences people's adoption of a prescribed preventive action (Cleary, 1987; Sandman, 1986). It is not known, however, if perception of risk associated with public drinking water and/or barriers to taking the recommended preventive measure affect people's response to public notification directives, their willingness to switch to bottled water, or their likelihood of taking other action such as installing home water treatment devices.

Public drinking water generally comes from two main sources (either surface or groundwater). With either source, the water is often chemically treated to render it safe for drinking. In spite of chemical treatment and filtration, drinking water may contain certain undesirable contaminants such as chlorination by-products, agricultural chemicals/pesticides, or chemicals from domestic and industrial activities (Keating, 1992). Public water supplies are regulated by the U.S.EPA and most State Health or Environmental Departments under the Safe Drinking Water Act (SDWA) of 1974 (as amended in 1986). The SDWA was created to ensure uniform nationwide safety for the public's drinking water. For example, it requires that community water systems which use surface water must filter as well as disinfect the water to remove or reduce potential contaminants to safe levels prior to use by the public (EPA, 1990). Water utilities are also required to routinely test their water for the presence of contaminants. Bottled water, on the other hand, is regulated by the Food and Drug Administration (FDA), if it is transported across state lines.

In spite of the regulation of both bottled water and tap water by these federal agencies, drinking water is not absolutely risk-free. In the case of tap water, Olson (1993) noted that there is widespread violation of the Safe Drinking Water Act (SDWA) by many public water systems, especially with regard to coliform bacteria, turbidity, lead, radioactive contamination and trihalomethanes.

Bottled water consumption in the U.S. increased approximately four-fold, from 1979 to 1989 (Harman, 1991). Approximately 12% of American adults drink bottled water regularly. Almost half of these consumers are under 35 years of age, and there is no gender difference in bottled water consumption patterns (Shwartz, 1987). A more recent report shows that bottled water consumption in the United States in 1995 doubled what is was in 1985 (Hamlin, 1996). The increased consumption of bottled water is attributed to consumers choosing drinks that are more healthy than alcoholic beverages and or soda, and to aesthetic values such as color, odor, and taste (Curry, 1983; Hutton, 1985; Walmsley & Wickens, 1990)). There is also a general concern about the quality of the nation's water supply (Bakoulis, 1987) and awareness of adverse health effects of some drinking water contaminants.

Other possible explanations for the current rising trend in bottled water consumption and the concern of the public about drinking water quality include the close coverage of drinking water contamination and waterborne disease outbreak by the media, and the promotion of bottled drinking water. Mass media has been reported to have some influence on public's perception of risks (Short, 1984). Hurd (1993) reported that 69% of Milwaukee County, Wisconsin residents stated that television news was their first source of information about a cryptosporidium outbreak. Dandoy (1990), stated that in the past 30 years, television has "provided dramatic visual access to information on threats to health and the actions taken by public officials to contain those threats" (p. 1299). One of the ways through which public health officials handle threats to people's health from drinking water is through regulations and the enforcement of such regulations.

Violation of the SDWA has been widely reported to be common among medium and small water systems, chiefly due to inadequate funding, lack of specific treatment facilities, and lack of trained technical and managerial staff. Many small water systems still operate with outdated water treatment facilities, which the Natural Resources Defense Council (NRDC) described as an important factor that contributes to problems in drinking water in the U.S. (Harker, 1985; Manwaring, 1985; OHD, 1995; Olson, 1993). For example, an EPA 1991-1992 report showed that over 250,000 violations of the SDWA affecting more than 100 million people were committed by different water systems in the U.S. (NRDC, 1993). The Drinking Water Section of the Oregon Health Division (1994) reported that the number of individuals served water not meeting the 1974 SDWA standard declined from 140,000 to 200, from 1978 to 1994. However, the task of regulation of the 1986 SDWA in Oregon was described as enormous due to financial limitations of the public water systems and the increasing public interest and concern about the safety of drinking water (OHD, Drinking Water Section, 1994).

Closely linked to the issue of violation of the SDWA is the requirement for public water systems to notify the public of violations of Maximum Contaminant Level (MCL) or when some other provision of the SDWA is violated. The notices explain the health threat of the violation in a simple non-technical language and suggest precautionary measures to be taken as long as the violation exists. The value of public notification (PN) programs lies in their effectiveness in promoting behavioral changes among public water consumers (Wardlaw & Bruvold, 1988). The EPA is currently seeking ways to make public notification more effective in educating and informing consumers about local water supply issues. In an EPA's drinking water initiative meeting held in Washington, D.C. in July 1995, one of the expected outcomes was to generate ideas about how to make PN about local water supplies more effective.

Although there are studies on how consumers respond to PN about violation of drinking water standards (Bruvold & Gatson, 1980; Bruvold, Wardlow & Gatson, 1985; Stegman & Schneider, 1982), few studies have been done to determine the relationship between people's perception of risk about public water and their response to PN. Additionally, previous research has not investigated the relationships between perception of risks and the use of alternative sources of water, and whether people respond differently to a PN in an emergency situation compared with an on-going water problem.

In addition to scanty information regarding people's responses to public notification, the use of a theoretical framework such as the Health Belief Model (HBM), to address the degree to which the perception of risk in drinking tap water affects consumers' drinking water behaviors, has largely been ignored by researchers. The HBM uses variables such as perceived susceptibility to a health problem, seriousness of the health problem, perceived benefit and perceived barriers of taking a health action, and cues to action to explain health-related behaviors. The HBM has been widely applied to other important health concerns, such as why people sought diagnostic x-rays, Hochbaum

(1956). It was used by Kegles (1963) to determine the relationship of belief and attitudinal variables to preventive dental care. Becker et al. (1974) used this model to explain sick-role behavior in low income popuations, while Champion (1991) used it to study breast cancer detection behaviors. Except for a feasibility study by Franz (1976) to examine the behavioral responses of residents in Duluth to drinking water contamination by asbestos, there are few data regarding the use of this theoretical framework for studies on drinking water issues.

This study therefore, examined people's risk appraisal of public drinking water, and their response to public notification regarding drinking water contamination. It compared bottled water consumption patterns of residents in communities with drinking water contamination problem and communities without such problems. The study provides the Oregon Health Division with information regarding PN and people's responses to them.

Purpose of the Study

The primary purpose of the study was to assess perception of risk associated with drinking water supplied by public water systems, and to evaluate responses to public notification regarding drinking water contamination. The study compared the risk perception responses of residents of two Oregon communities who have received PN of water safety violations to responses of residents of two communities who have not received such notification. The communities participating in this study were: (1)

Jefferson, which had microbiological contamination problems due to the February 1996 flood; (2) Falls City (a city with an on-going filtration problem); (3) Oakland and Creswell (which do not have filtration problems and served as comparison communities). The 0study also identified precautionary measures people take (such as boiling water or drinking bottled water) in response to a public notice about drinking water problems.

Research Questions

The following research questions were examined:

1. Does the perception of risk about public drinking water differ between residents of a community who had a drinking water contamination problem due to flooding (short -term problem) and residents of a community with an on-going (long-term problem) drinking water filtration problem?
2. Does perception of risk about drinking water differ between residents of communities who have a drinking water contamination problem (short and long term) and residents in similar sized communities without such problems?
3. Are there significant differences in response to PN instructions (taking action versus taking no action) between residents of a community who had water contamination problems due to flooding (short term) and residents of communities with an on-going (long term) water filtration problem?

4. Are there significant differences in the use of bottled water between residents of communities with drinking water contamination problems and residents of communities without such problems?

5. Are there significant differences in the use of bottled water between residents of a community with a short term drinking water contamination problem (due to flooding) and residents of a community with a long term water filtration problem?

6. Are there significant differences in the use of home water filters between residents of a community with a short term water contamination problem (due to flooding) and residents of a community with a long term water filtration problem?

7. Which of the following variables (perceived susceptibility, perceived seriousness, perceived barriers, perceived benefits of taking the recommended action, gender, age, income, educational status, period of residency, number of people in the household, home ownership, and risk perception about city water), are significant predictors of following the PN instructions?

Research Hypotheses

1. There will be no significant differences in perception of risk about public drinking water between residents of a community who had a drinking water contamination problem due to flooding (short term) and residents of a community with an on-going (long term) drinking water filtration problem.

2. There will be no significant differences in perception of risk about public drinking water between residents of communities who have a drinking water contamination problem and residents in similar sized communities without water contamination problem.

3. There will be no significant differences in response to PN instructions (taking any action versus taking no action) between residents of communities who had a water contamination problem due to flooding problem (short term) and residents of communities with an on-going (long term) filtration problem.

4. There will be no significant differences in the use of bottled water between residents of communities with water contamination problems and residents of communities without such problems.

5. There will be no significant differences in the use of bottled water between residents of a community with a water contamination problem due to the flooding incident (short term) and residents of a community with an on-going filtration (long term) problem.

6. There will be no significant differences in the use of home water filters between residents of a community who have a long term filtration problem and residents of a community with a water contamination problem due to flooding.

7. The following variables (perceived seriousness of potential health problem, and perceived susceptibility to a health problem, perceived benefits and perceived barriers of following the PN instruction, gender, age, income, educational status,

number of people in a household, home ownership, period of residency, and risk perception about city water) will be significant predictors of following the PN instructions.

Significance of the study

Data from this study will provide the Oregon Health Department and water utilities in Oregon with baseline information on people's perception of drinking water risks in four communities in Oregon. The study will contribute to an understanding about how the public acquires information about drinking water problems both in emergency situations and for on-going problems. The study will increase the understanding of barriers to individuals' response to notices concerning drinking water and may be used to improve the quality of public education about consumer protective behaviors regarding drinking water issues. Additionally, the study will make a valuable contribution to the field of environmental health by applying the health belief model to research about drinking water practices.

Delimitations

The public water systems were not randomly selected from all small sized water systems, but were chosen based on whether they had a water contamination problem, and had notified the public about the problem.

Limitations

Although, subjects were randomly selected, the four sample cities were (not randomly) selected based on the size of the water system and whether or not residents were notified about a drinking water problem. Thus, the findings of this study are applicable only to residents of the four cities selected for this study and may not be generalized beyond these communities. Second, individual respondents may or may not have accurately recalled whether or not they received public notification. An additional limitation is that the responses to drinking water practices are self-reported and may thus be a source of error. Finally, people with unlisted numbers and those who do not have a telephone in their home were not included in the survey.

Definition of Terms

Agricultural chemicals : These are chemicals used for agricultural purposes, such as pesticides, herbicides and fertilizers.

Bottled water : Water that is sealed in bottles and offered for sale for people to drink (EPA,1990).

City drinking water : Piped-borne water treated and distributed by a city public water system.

Drinking water risk perception : An individual's subjective perception of the magnitude of risk associated with drinking water.

Industrial chemicals : These are chemicals used in industries for various purposes such as benzene, trichloroethylene, polychlorinated biphenols, dioxin, ethylene dibromide, etc.

Maximum Contaminant Level : This is the maximum concentration of microbiological or chemical contaminants that is allowable in drinking water (EPA, 1992).

Perceived barrier : Factors that are likely to deter or discourage an individual from taking a preventive action.

Perceived benefit : The potential benefits expected by an individual as a result of taking a preventive action necessary to protect health.

Perceived susceptibility: The perception of personal vulnerability to health problems of drinking water.

Perceived seriousness : The degree of importance an individual places on the severity of a potential health problem of drinking water.

Public notification : A requirement of the Safe Drinking Water Act that public water systems inform consumers about violation of operating, monitoring or reporting requirements or when a Maximum Contaminant Level for a microbiological or chemical contaminant is exceeded (EPA, 1992).

Public water system : A water system that provides piped water for human consumption for more than three service connections; or supplies water to a public or commercial establishment which operates a total of at least 60 days and which is used by 10 or more individuals per day or a facility licensed by the Health Division (OHD, 1991).

Small-sized water systems : These are community water systems that serve between 501-3,300 people piped water.

Large-sized water systems : These are community water systems that serve 10,001-100,000 people piped water.

Medium-sized water systems : These are community water systems that serve 3,301-10,000 people piped water.

Safe Drinking Water Act : Federal act that directs EPA to establish standards and requirements necessary to protect the public from all known harmful contaminants in drinking water, and asks the states to accept primary enforcement responsibility for enforcing the federal requirements (EPA, 1992).

CHAPTER TWO

REVIEW OF LITERATURE

The review of the literature is divided into several sections. The first section includes federal and state regulation of drinking water. This is followed by a review of literature concerning public water systems (tap water), and contaminants that have been violated in the communities under study. This third section is on bottled water, including pertinent regulations and consumption patterns. The fourth section discusses drinking water quality and risk perception regarding drinking water. The fifth section provides an overview of the Health Belief Model, which provided the theoretical framework for the study. The final section includes a discussion about public notification and the process.

Federal and State Regulation of Drinking Water

Federal Regulation

The federal Safe Drinking Water Act (SDWA) passed by Congress in 1974 gave the EPA responsibility for water quality standards of public water systems. The purpose of the SDWA was to set up a uniform set of regulations and water quality standards for public water systems throughout the country. Each state was required to enforce the standards through its existing drinking water programs with EPA funding assistance and oversight. If a state assumes this responsibility, it enters a "Primacy" agreement with the EPA. The EPA promulgated two sets of drinking water regulations. Primary standards were issued to protect the public from contaminants in drinking water that produce adverse health effects. Secondary standards were issued for contaminants in drinking water that have adverse aesthetic effects associated with taste, color and odor (FDA, 1993). The EPA also set established legal maximum levels for both primary and secondary contaminants.

The 1974 Safe Drinking Water Act was reauthorized in 1986 and required more monitoring and tests for more potential pollutants in public water systems. It required the EPA to set Maximum Contaminant Level Goals (MCLGs), Maximum Contaminant Levels (MCLs), and monitoring requirements for 83 specific contaminants, and for any contaminant in drinking water that may have an adverse effect on the health of persons and which is known or anticipated to occur in public water systems" (Oregon Health Division, 1991). The MCLGs are non-enforceable health-based goals set at a level at which no known or anticipated adverse effect on human health occurs and allows for an adequate margin of safety, regardless of cost. MCLs are enforceable standards which must be set as close to the MCLGs as feasible, with the use of the best available technology and other means that are available, taking cost and feasibility into consideration. When the feasibility to establish an MCL for a particular contaminant is unlikely, the EPA establishes a treatment technique requirement for the removal or reduction of that contaminant from drinking water to protect the public health from the adverse effect of that contaminant (FDA, 1993).

The 1986 amendments also added more responsibilities for state drinking water programs such as identification and classification of water systems that are required to provide filtration, and implementation of a lead and copper corrosion control program. In addition, states are required to assess the vulnerability of water systems to contamination and to expand laboratory capabilities to deal with the significant increase in regulated contaminants (GAO/RCED, 1992-184).

The SDWA was reauthorized in 1996. This new law requires the EPA to provide a list of technology and treatment techniques that will help small water systems comply with drinking water regulations. Small water systems serving fewer than 3,300 people could use alternative technology when the recommended technology is too expensive. They also are reimbursed for training costs. The law requires the EPA to establish regulations for contaminants in two stages. In the first stage, Maximum Contaminant Level Goal (MCLG) is established for contaminants that are potentially harmful to human health. The second stage requires setting the actual Maximum Contaminant Level (MCL) based on the MCLG. Under the new law, public water systems are required to inform the public if there is a violation of an MCL, or if it fails to use the proper treatment or testing technique.

Public water systems are also required to inform the public if they are operating under a special exception or variance, to a regulation. Large water systems are required to provide annual reports to consumers on water contaminants and health effects of those contaminants. However, systems serving fewer than 10,000 people, including small water systems could publish the report in a local paper instead of mailing it to consumers. But the report should be made available to consumers on request. Very small water systems (serving less than 500 people) are only required to notify the public once a year that the report is available on request. In order to help EPA monitor drinking water systems effectively, all water systems are required to keep record of test results for regulated substances. Also, EPA is required to develop a database of contaminants which will be used to determine the substances that need to be regulated. States are allowed to run their own drinking water program if they adopt regulations as strict as federal standards (Allan, 1996).

State Regulation

State regulation of public drinking water has been handled by the Oregon Health Division since 1986. The State did not assume "primacy" for the 1974 federal SDWA. Thus, the EPA was responsible for the implementation of the SWDA in Oregon from 1978 until 1985 when the Oregon Legislative Assembly authorized the Health Division to apply to EPA for primacy for the federal program. The Oregon Drinking Water Quality Act (Oregon Revised Statues (ORS) 448) was passed in 1981, and was implemented concurrently with the federal drinking water program until 1986, when the state of Oregon assumed full responsibility for regulation of water supplies (Oregon Health Division, 1994).

The 1986 SDWA Amendments required water systems that use surface water to filter as well as disinfect the water for public use. Fifty-five communities serving 125,000

Oregon residents and using surface water sources are reported to have either installed filtration units, connected to other filtered community systems, or switched to wells between 1978 and 1991 (Oregon Health Division, 1992). Currently, 105 out of 157 community water systems in Oregon are filtered, leaving 52 that are unfiltered. Water systems desiring to continue to operate unfiltered systems were required to show by December, 1991 that they met certain criteria to remain unfiltered.

In recognition of the significance of the SDWA in regulating water standards, the Oregon Health Division reported that the number of people in Oregon that were served substandard water decreased from 264,000 in 1978 to 75, 000 in 1992. This apparent improvement in the quality of tap water in Oregon was attributed to the vigorous attempt by community and regulatory agencies to comply with the 1974 federal SDWA and the 1986 SDWA Amendments. Compliance with the 1986 SDWA standard however, remains a problem for smaller water systems because they lack financial resources, proper equipment and technical/managerial experience (Kramer, Herwaldt, Craun, Claderon & Junarek, 1996; OHD, 1994).

Public Water Systems in Oregon

By definition, a public water system provides piped water for human consumption to more than three service connections; or supplies water to a public or commercial establishment which operates a total of at least 60 days per year and which is used by 10 or more individuals per day or is a facility licensed by the Health Division (Oregon Health

Division, 1991). The source water for the state of Oregon public water systems is supplied by surface and groundwater sources. Eighty percent of the Oregon population drink public water from surface water sources, whereas 20% of the population drink water from ground-water sources (Oregon Health Division, 1992).

The 3,549 public water systems presently in Oregon are classified into community water systems, nontransient noncommunity water systems, transient noncommunity water systems and state regulated water systems. The descriptions of the different types of the Oregon public water systems are as follows:

1. Community water system: A public water system which provides piped water to 15 or more year-round service connections or 25 or more year-round residents. Typical community water systems are cities, water districts, water associations, mobile home parks and rural subdivisions.
2. Nontransient noncommunity water system: A public water system which does not serve a residential population, but which regularly serves at least 25 of the same people during at least six months per year. Factories and schools are typical nontransient noncommunity water systems.
3. Transient noncommunity water system: A public water system that serves a transient population of at least 25 people per day for at least 60 days per year. Examples of transient noncommunity water systems are campgrounds, restaurants, motels, highway rest areas and stores.
4. State regulated water system: A public water system which provides piped water to more than three but fewer than 15 service connections or at least 10 but less

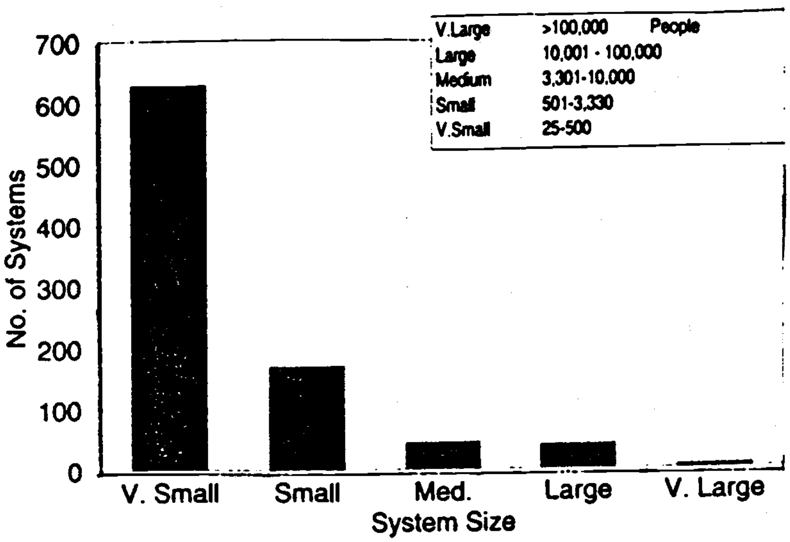
than 25 year-round residents. Small mobile home parks, subdivisions and rural residential systems are examples of state regulated water systems.

The focus of this paper is on small community water systems. Community water systems are grouped into very large, large, medium, small, and very small water systems depending on the size of population served by the system.

Small Water Systems

Small water systems are systems that serve less than 3,300 people. Because majority of these systems are privately owned, they have more limited access to government funding than are publicly owned water systems (Teernstra, 1993). Eighty-seven percent of community water systems in the country are small systems (Shanaghan, 1994). The state of Oregon has many more small and very small community water systems than it does medium, large and very large water systems (See Figure 1). Due to financial constraints, most small water systems operate with a deteriorated physical infrastructure, and limited technical and managerial staff. Consequently, compliance to drinking water standards has been a problem for such systems (Kramer, Herwaldt, Craun, Claderon & Junarek, 1996; Shanaghan, 1994). Small water systems have been reported to frequently violate federal drinking water regulations, particularly microbiological standards (Goodrich, Adams, Lykins & Clark, 1992; Newman, 1993). Figure 2 shows that most systems in Oregon that have problems meeting drinking water standards are small and very small water systems.

Fig. 1 Community Water Systems by Size.

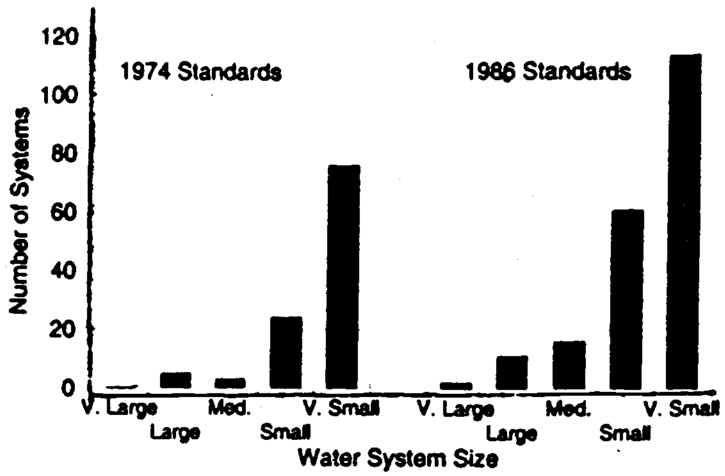


Source: Oregon Health Divison, 1995

To provide reasonably- priced safe drinking water to the public, small water sytems are allowed to use the next best but less expensive technology than that which large systems are required to use to comply to the same law. This provision of 1986 SDWA as Amended in 1996 is termed a "variance".

Restructuring has been recommended to improve the viability of small water systems,. The EPA defines restructuring as "the adoption of management and/or ownership changes that help a drinking water system address new responsibilities and increased costs (EPA, 1992, p.2). The different ways suggested by the EPA is for restructuring is for small systems ot jointly purchaseand share chemicals/technologies and services, wholesale purchase of water, merging with larger systems, or changing into a non-profit cooperative or public service in order to be qualify for federal or state grants and loans (EPA. 1992; Shanaghan, 1994). However, factors such as loss of control, lack of cooperation from viable systems to accommodate "problem-small" systems, transfer of ownership, have been identified by small water systems as impediments in adopting restructuring activities.

Fig. 2. Problem Water System by Size



Source: Oregon Health Divison, 1995

Contaminants in Drinking Water

Chemical Contaminants

Drinking water contamination by organic and inorganic chemicals occur in the United States periodically in spite of treatment, and regulation by the EPA. Chemical contaminants present in finished water come from different sources such as the source water, the treatment process and/or the water distribution system. Chlorination disinfection by-products such as Trihalomethanes (THMs) and lead have been reported as the two chemical contaminants that have received much publicity in recent times (McSwane, Oleckno, & Eils, 1994).

Trihalomethane Compounds

THM compounds are produced by the reaction of chlorine (purposely added to disinfect water against contamination by microorganisms) with the decay products of vegetation (EPA, 1994; Munson, Yeykal & Smith, 1994; Neal, 1985). Chronic exposure to excessive amounts of trihalomethanes have been linked to bladder cancer, liver and kidney damage, heart and neurological effects and effects on fetuses (Clark, 1992; EPA, 1994; Munson, Yeykal & Smith, 1994). However, the use of ozone, and chloramine disinfection as alternatives to chlorination and the use of granular activated carbon, have been reported to reduce the level of these compounds in drinking water. ((Lykins, 1994;

NRDC, 1993). Another remedial action against water contamination by THMs is through watershed protection. This option offers reduction in the amount of nutrient and organic matter in surface water, thus reducing the production of THMs (Palmstrom, Carlson & Cooke, 1992).

Lead in Drinking Water

Drinking water is a major source of exposure to lead in the United States (Ember, 1988; Raloff, 1988). Research has shown that lead can accumulate in the body to cause damage to the brain, kidney, nerves, red blood cells (EPA, 1993; Kramer, Herwaldt, Craun, Calderon, & Kunarek, 1996). The source of lead in drinking water has been reported to come from lead-based solder, lead pipes used to convey water from treatment plants to service lines that lead into people's homes (EPA, 1993). When corrosive water is distributed to consumers through lead pipes, lead levels in the water at the tap can exceed the EPA interim primary drinking water standard for lead of 0.05mg/L. Corrosive water thus encourage the leaching of lead into tap water (Patterson & O'Brien, 1979; Subramanian & Connor, 1991).

Control of Lead in Tap Water

A remedy recommended to consumers for the control of lead in drinking water is to flush the pipes before drawing water for drinking, if a particular faucet has not been used at least for six hours (EPA, 1993). On the part of water utilities, passivation (reducing the water's ability to corrode lead components) could be applied to source water when there is the problem of excess lead in water (Birden, Calbrese & Stoddard, 1985; Lee, Becker & Collins, 1989).

The government has also contributed to the control of lead through the ban of lead-based solder and lead pipes in plumbing systems. Under the Safe Drinking Water Act of 1974, the maximum limit for lead in drinking water was 50 ppb. In 1985, the EPA set a goal of 20 ppb as the maximum allowable lead contamination of drinking water (Ember, 1988). As a result of the established adverse health effects of lead, the 1986 amendments of the SDWA banned the use of solder and flux containing more than 0.2% lead and pipe fittings with more than 8% lead in all the installation and repair of all residential and non-residential plumbing. Further, under the rules adopted by the EPA, all small water systems serving less than 3,300 people began tap water monitoring for lead by July 1993 (EPA, 1991). Municipal systems that still do not comply with the recommended lead action levels after the installation of anti-corrosion systems must replace lead service pipes over a 15-year period (EPA, 1991). In addition, the violation of MCL for lead in drinking water requires public notification. For example, all public water systems that exceed the MCL of .015mg/L for lead are required to deliver the EPA-developed public education program to consumers within 60 days. The public education program must be continued until the problem is corrected (EPA, 1991).

Chemical Contaminants of Water in Oregon

Nitrates and heavy metals such as lead, mercury, arsenic, cadmium and chromium are some contaminants that are likely to pollute water supplies in Oregon (Lenhart and Sward, 1993). These may get into ground or surface water through various routes. For example, water may become polluted from chemical spill on the ground or leaking underground storage tanks. Other sources of pollution include yard and garden products, household chemicals or automobile products, including waste oil from oil changes in cars. From January 1993 to June, 1994, 353 water systems in Oregon reported 717 detections of organic and inorganic chemicals (OHD, 1994).

Microbiological Contaminants of Drinking Water

Waterborne diseases outbreak (WBDO) associated with pathogens remain a public health problem in spite of improved methods water purification and the regulation of drinking water (McSwane, Oleckno, & Eils, 1994). For example, 73.3% of the 30 waterborne diseases outbreak (WBDO) reported in the U.S. between 1993 - 1994, were associated with pathogens. Thus, microbial contamination of tap water is one of the factors of concern for tap water consumers in the United States.

The leading pathogens associated with those waterborne diseases outbreaks are *Giardia lamblia* and *Cryptosporidium parvum* (Kramer, Herwaldt, Craun, Calderon, & Kunarek, 1996). Additionally, coliform bacteria has been reported as a contaminant which many water systems are most likely to violate. The number of violations of Maximum Contaminant Level (MCL) for coliform bacteria, nationwide in 1992, was 3,156 (Kramer, et al. 1996).

Most of the WBDOs in the U.S. have been linked to non-community or small water systems which do not have sophisticated water treatment facilities (Herwaldt, Craun, Stokes & Juranek1991). Also, the likelihood of occurrence of WBDOs is greater when water sources are not well protected, not disinfected, not filtered and/or poorly disinfected or filtered. Research has shown that some drinking water systems, especially small systems do not filter their water due to lack of filtration facilities, defective equipment, or poor maintenance of filtration units (Herwaldt, et al.1991; Kramer, et al.1996).

The EPA regulates microbial content of drinking water through the Total Coliform Rule and the Surface Water Treatment Rule. Total coliform is used to assess the overall water quality and the water treatment process, while Escherichia Coli is an indicator of water contamination by fecal matter (Berger, 1992). The Surface Water Treatment Rule requires surface water systems and groundwater under the direct influence of surface water to disinfect and filter their water. This rule became effective on December 31, 1990. Under the rule, public water systems that use surface water are required to inactivate 99.9% Giardia cysts and 99.99% of viruses (EPA, 1991). An exception to the rule is, if the water meets "source water quality criteria for turbidity, and total or fecal coliform, and a watershed control program to decrease the possibility of contamination by human enteric viruses and giardia cysts" (EPA, 1991; Moore et al., 1993).

Giardiasis

A waterborne disease, giardiasis is caused by a protozoan parasite called *Giardia lamblia*. According to Junarek (1986) waterborne transmission of the parasite giardia occurs mainly in mountainous region of the U.S. where communities drink chlorinated but unfiltered water from streams. Levine, Stephenson and Craun (1990) observed that most of the waterborne disease outbreaks caused by Giardia lamblia have been associated with drinking chlorinated but unfiltered surface water. Waterborne giardiasis occur when people consume water that has been contaminated with viable giardia cysts, introduced into a water course (through defecation) by an infected human or animal (Jarroll, Binghan & Meyer, 1981; Junarek, 1986; Monzingo, Wilson & Kunkle, 1987).

Further, Giardia cysts have been reported to be resistant to normal chlorination used for municipal water treatment (Junarek, 1986; Levine, Stephenson & Craun, 1990) because factors such as pH of water above 7.5, low water temperature, turbidity, low contact time and low concentration of chlorine reduce the effectiveness of chlorine (Junarek, 1986). However, Wickramanayake, Rubin & Sproul (1994) reported that ozone could be used instead of chlorine, since ozone is less affected by temperature changes.

Although adequate filtration of water in addition to disinfection help to reduce the incidence of giardiasis, the cost of sand filters and their installation is prohibitive and so are not affordable by small sized water systems. Further, pore sizes of sands filters are not small enough to remove giardia cysts, therefore, water needs to undergo sedimentation, followed by flocculation or coagulation before filtration and chlorination (Junarek, 1986).

Cryptosporidiosis

Cryptosporidiosis is a waterborne disease caused by a protozoan parasite called *Cryptosporidium parvum*. According to Rose (1985), very little was known about the occurrence of *Cryptosporidium* in the environment until 1985. Cryptosporidiosis has been reported to be life threatening to children and immunosuppressed persons such as AIDS patients (Smith, 1992), and people who have had cancer chemotherapy or organ transplant (Hansen & Ongerth, 1991), but it is self-limiting in immunocompetent individuals (Berger, Regli, & Almodovar, 1992; Smith, 1992). *Cryptosporidium* infect some domestic and wild animals as well as humans (Hansen & Ongerth, 1991; Rose, 1988; Smith, 1992). In a study of waterborne disease outbreaks between 1986 and 1988, Levine and Craun (1990) found that the contamination of chlorinated filtered public water supply by *Cryptosporidium* caused the largest outbreak that affected about 13,000 persons in that three-year period. In April, 1993 an outbreak of Cryptosporidiosis in Milwaukee, Wisconsin affected an estimated 40, 000 people and $37 million was reported to be lost in wages and productivity (Smith & Urbanito, 1994).

Cryptosporidium has been found to be resistant to disinfectants used in treating drinking water, such as chlorine (Robertson, Campbell & Smith, 1992). Additionally, sand filters have been reported to be ineffective in removing *Cryptosporidium* oocysts completely from unfiltered water (Rose, 1988). In fact, *Cryptosporidium* has been reported to be more resistant to chlorine than giardia (Herwaldt, Gunther, Stokes & Junarek, 1991). Berger and his colleagues (1992), described chlorine disinfection efficiency for *Cryptosporidium* oocyst as impractical, and only marginal with ozone. According to the EPA (1994), the resistance of *Cryptosporidium* to disinfection would undoubtedly increase the number of systems incapable of meeting the 99.9% reduction of oocysts compared to *Giardia lamblia* cysts (EPA, 1994).

Microbiological Contaminants of Drinking Water in Oregon

The Oregon State University Extension Service (1994) observed that giardiasis is a major cause of waterborne illness in Oregon. The number of reported cases of giardiasis in Oregon was 1008 in 1993, and 920 cases in 1994. However, there has not been any increase in the number of reported cases in the last few years.

The reporting of cases of Cryptosporidiosis is not mandatory in Oregon, but few cases began to be reported during summer and early fall of 1988. The reporting of cluster of cases resulted in identifying a serious outbreak of Cryptosporidiosis in Jackson County Oregon during which 15,000 people were reported sick (OHD, 1992). Clusters of cases were also reported in Southeastern Oregon in 1992 (OHD, 1993). According to the Herwaldt et al. 1993), the outbreak of Cryptosporidiosis in Oregon in February, 1992 was linked to a disinfected spring water source that supplied a community of 800 people (a small sized water system). The other outbreak in Oregon in May of the same year was associated with inadequate filtration of a river water source.

Although two outbreaks of Cryptosporidiosis were reported in Oregon in 1992, reported cases of this disease compared to giardiasis is low. For instance, in 1993 only 22 cases of Cryptosporidiosis were reported while 1008 cases of giardiasis were reported during that period. In 1994, only 19 cases of Cryptosporidiosis were reported while 920 cases of giardiasis were reported.

Coliform bacteria is another microbial contaminant that has been reported in Oregon. The presence of Coliform in drinking water is an indication of contamination with human and/or animal feces (Kramer, et al.1996). Federal and state regulations require pubic water systems to periodically test drinking water for the presence of this bacteria (EPA, 1992). The Drinking Water Program of the Oregon Health Division, reported that 16.7% of the 600 confirmed detections of coliform bacteria in drinking water between January, 1993 and June,1994 were confirmed as fecal coliform. Boil water advisories were reported to have been given to the public in the affected cities. In February 1996, following a flooding incident in Oregon, total coliform and E. coli were detected in the city of Jefferson's public water system, resulting in a boil water advisory to the public.

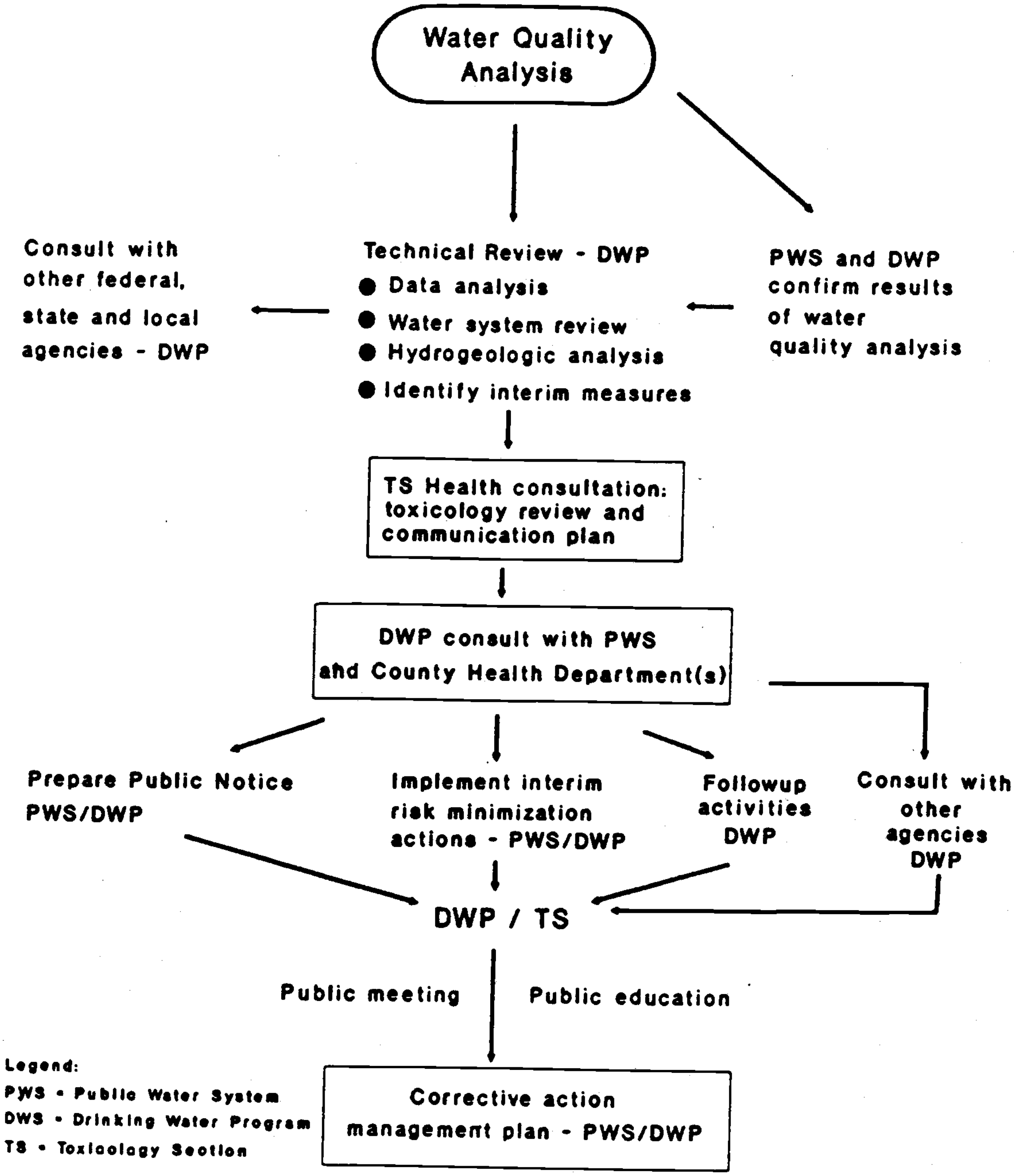
Public Notification

Public notification about tap water is a form of information required to be given to consumers when a water system violates certain drinking water standard established by the 1974 SDWA. It is required when a water system fails to comply with the treatment technique requirement or maximum contaminant level established for some organic and inorganic contaminants, turbidity, biological and radio-logical contaminants. Notification of consumers is also required if a water system has been granted an exemption or variance, when a system fails to perform required monitoring or testing procedures or when an established schedule for compliance with SDWA cannot be met.

When a drinking water contamination occurs in a public water system in Oregon, the Drinking Water Program (DWP) and the public water system concerned perform water quality analyses to confirm the problem. A technical review of the system is conducted by the DWP in consultation with other related federal, state and local agencies. The Toxicology Section of the Oregon Health Department (OHD) evaluates the toxicity of the suspected contaminant based on established standards and prepares public notification plans in conjunction the DWP, the affected public water system, and County Health Department. Interim and long-term corrective actions are undertaken by the drinking water program, while public notice is given to advise the public on what measures to take in order to protect their health. Figure 3, shows the drinking water contamination response process by the Oregon DWP.

Thus, the purpose of public notification (PN) is to inform people of an impending health threat in order to enable them make informed decisions regarding risk reduction behaviors. It also provides information on steps being taken by the utility concerned to correct the violation and whether consumers need to use alternatives such as bottled water (Morgan, Fischhoff, Bostrom, Lave, & Atman, 1992, Covello, 1993), and to fulfill an individual's right to know (Shulte, et al. 1993). Public notices regarding drinking water issues are commonly placed in the legal notice section of local newspapers. Other avenues used include radio or television broadcasts, or notices posted by the water utility.

Fig. 3. Drinking Water Contamination Response Process



Source: Oregon Health Division, 1995

In April 1989, under EPA's subsequent regulations of drinking water, water system violations were categorized into Tier 1 and Tier 2 violations based on the severity of the violation. Tier 1 violations in community water systems are an MCL violation, a variance or exemption schedule, or a treatment violation. Tier 1 violations which can cause immediate illness are designated "acute violations" and such violations require public notification through television and radio within 72 hours. This step is followed by a newspaper notice within 14 days and a mail or hand delivered notice within 45 days. If a violation continues, a quarterly notice by mail or hand delivery must be repeated. Community water systems which commit Tier 1 "nonacute" violations are required to follow the same procedures as in acute violations, except that the first attempt to notify the public is done through local newspaper. When a community water systems violates either a monitoring or reporting requirement or a testing procedure, or when a variance or exemption is issued a water system, Tier 2 notification is required.

Public notification for Tier 2 violations is required to be given by a community water system within 3 months of the violation in a local newspaper. The newspaper notice is followed by a quarterly mail or hand delivered notice until the violation is corrected. (Abbot, 1988; EPA, 1987; Hoffbuhr, 1988). Studies on public notification have focused on notification of workers more than notification about public drinking water issues (Bayer, 1986; Leviton, Chen, Marsh, & Talbot, 1993; Rudolph, 1993; Schulte & Ringen, 1984). Public notification could be regarded as a one-way communication effort from an agency (water utility) to the public, unlike risk communication (RC), which Covello

(1990) defined as the exchange of information among stakeholders about the nature, magnitude or control of a risk. According to Covello (1993), the interpretation of risk information is complicated by factors such as inaccurate perception of risk, lack of interest in technical jargon, strong belief in one's ability to avoid harm and belief and opinions that are resistant to change. Therefore, a consideration of individual's characteristics and biases are important for an understanding of people's response to risk messages (McCallum, Hammond & Covello, 1991). Additionally, the impact of a message on the recipient is influenced by the credibility of the source of the message. (McCallum, Hammond, & Covell, 1991). It has also been suggested that notification materials be adapted to reflect the diversity of those to be notified as well as take into account the literacy level of the target group (Averill, Henry, Rubestein, Sattler, & Tirey, 1993; Covello, 1993).

Although government and industry officials are grouped among the highly knowledgeable sources of information on environmental health issues, people's trust in government and industry have been reported to have declined over the past twenty years (Covello, 1993). In situations where a state or federal agency has been generally suspected or unpopular, risk information provided by state or federal officials may be less believable than information obtained from other sources (Fessenden-Raden, Fitchen & Heath, 1987).

Some studies have examined consumers' awareness of PN in California (Bruvold & Gatson, 1980; Stegman & Schneider, 1982: Bruvold, Warlaw, & Gatson, 1985), and the cost effectiveness of PN from the water system's point of views (Stegman & Schneider, 1982). Bruvold and his colleague (1980) studied consumers' knowledge of receipt of public notification, their understanding of the water quality problem that required notification and consumers' rating of the value of the notice. They reported that while 47 percent of the respondents recalled receiving the notice, 44 percent reported that they did not receive the notice, while 9 percent of the respondents were not sure whether they received it or not. In 1982, Stegman and Schneider, conducted a study to determine people's awareness of public notification and the impact of the notification on consumers' willingness to accomodate additional expenditures by their water systems. Bruvold et al. (1985), evaluated public notification requirements in California. The purpose of that study was to assess public awareness of public notification, the impact of the media used on consumers' awareness of the drinking water contamination problem. They also determined the level of knowledge of the contaminant following the receipt of the notice and the knowledge of the long term solution to the problem. Results of the study showed an awareness rate of 68% and there was no relationship between consumer's awareness and media used. Respondents who were aware of the notification were more likely to have some knowledge about the contaminant of concern. But consumer's awareness was influenced by whether the respondents paid their water bills by themselves or not, since PN were sent with bills. Bruvold and his colleagues remarked that consumers who received PN should be able to specify contaminant of concern and its adverse effects. Wardlaw (1988) observed that understanding the notification message does not guarantee that people will take preventive action because the recommended preventive measure may not be acceptable by consumers.

With the exception of a consumer attitude survey on water quality issues by Hurd (1993), which addressed people's responses to drinking water contamination by

Cryptosporidium, very few studies have specifically studied individual consumers' response to PN. Wardlaw (1986), studied household actions taken in response to notification and found that 80 percent of (N=900) respondents took no action. However, she noted that most notifications do not recommend any preventive measures. Also, the issue of whether a consumer's perceived susceptibility to and perceived seriousness of health problem posed by specific contaminants affects his/her response to public notification has received little attention from researchers.

Bottled Water

The U.S Food & Drug Administration (FDA) defines bottled water as water that is sealed in bottles or other containers and is intended for human consumption (Ballentine and Herndon, 1983). Bottled water is obtained from different sources such as springs, drilled wells, artesian wells and public water supply systems. In many cases, it may be free of contamination. It may, however, become contaminated either at the source, at the processing plant, during transportation/distribution, or during storage at home (EPA, 1990). Bottled water is often recommended when contaminants in tap water exceed the health based drinking water standards or when corrosion of plumbing materials causes lead and/or copper to leach into the drinking water.

Bottled water sales have been reported to be better in some regions than in others in the United States due to geographical differences in water quality, especially with regards to aesthetic values. For instance, while the Northeast region with approximately

20.6% of the U.S. population accounts for 21% of the bottled water consumption, the Pacific region with about 15% of the nation's population accounts for 41% of the bottled water consumption (Hutton, 1985; Schwart 1987).

In general, while per capita use of bottled water is on the increase in all regions, people in the Pacific region of the United States were reported to have consumed more bottled water per person per year than people in other parts of the country. Hutton (1985) reported that 5.5% of consumers in the United States use bottled water, while 16.7% of consumers drank bottled water in California. In 1991, the per capita consumption of bottled water exceeded the per capita consumption of juice, tea or powdered drinks compared to the year 1981 when per capita consumption of bottled water did not exceed any of these drinks (FDA, 1993). The rise in the consumption of bottled water may be due to some factors such as increased awareness about environmental pollution and subsequent source water pollution, perceived low aesthetic quality of some tap water, and health consciousness (Hutton, 1985; Lambert, 1993).

According to the Government Accounting Office (GAO, 1991) report, almost half of the people surveyed in recent published surveys reported drinking bottled water because it tasted better than tap water. Nearly, 25% gave safety/health reasons for drinking bottled water, while another 25% were convinced that bottled water is free of contaminants. This view is supported by other researchers (Curry, 1983; Bakoulis 1987; Milius, 1988; Lambert, 1993) who cited poor taste of tap water, as well as purity and health factors as reasons consumers choose to drink bottled water instead of tap water.

Processing and Labeling of Bottled Water

According to the International Bottled Water Association (IBWA), 25 -30% of the bottled water companies in the U.S draw water from public water supply instead of their own well and springs. Other bottled water companies (approximately 75%) draw their source water from natural springs or wells which are believed to be more protected than surface water, because the soil on top of groundwater is expected to filter out any impurities that may infiltrate groundwater. Lenhart and Sward (1993), explained that the geology of an area, soil-type, precipitation, condition of wells and plumbing, and the characteristics and occurrence of particular contaminants are all factors that determine the likelihood that a contaminant reaches a given water supply.

In general, source water for bottled water receives a variety of treatments during processing before being bottled. For example, chlorinated tap water is processed/treated to remove chlorine tastes (the primary complaint about tap water) and some chlorine by-products before bottling. Spring water may be subjected to filtration and ozonation (disinfection process) to become "natural spring water" before being bottled (Allen & Darby,1994). The various treatments given to source water before bottling notwithstanding, concerns have been expressed about the microbiological quality of bottled water. For instance, there are concerns about the increase in the number of bacteria present in bottled water which are stored in sealed containers at room temperature. However, the bottled water quality standards established in 1973 are expected to protect consumers against pathogenic microorganisms and toxic contaminants if bottled water is processed with the use of multiple barriers and monitored as stipulated by the FDA bottled water standards. In a 1990 report of the Subcommittee on Oversights and Investigations (1990), some of the solutions offered to alley the fears of consumers about microbiological deterioration of bottled water are refrigeration, indicating bottling date and expiration date on labels of bottled water.

Labels on drinking water containers provide information about source-water, processing method, purity, health/nutritional attributes to targeted consumers. Hence some bottled water are labeled spring water, distilled water, carbonated, sodium-free, nursery bottled water among other labeling terms. Many reports have shown that some bottled water companies do not label their products accurately (Milius, 1988; Cech, 1990; Lambert, 1993). Additionally, federal regulations do not require water bottling companies to disclose the source of water on bottled water labels (Cech,1990). It is not surprising therefore, that the FDA found the claim on Perrier's mineral water label ("calorie free" and "naturally sparkling") to be false, based on the fact that water does not contain calories naturally and the fact that the gas and the water were taken out of the ground separately. When carbon dioxide that was not obtained from a specific spring is added to water from that particular spring, the product is allowed to be labeled "sparkling" instead of "natural sparkling" Allen, et al. (1989).

As a result of inconsistencies in regulations and labeling of bottled water products, the International Bottled Water Association (IBWA) petitioned FDA to establish stricter guidelines for bottled water in 1988 (Lambert,1993). There are suggestions that bottled water labels should indicate the source of water, concentration of each mineral in the water and the level of any substance which routinely exceeds the maximum contaminant levels in order to give consumers the chance to make informed decisions. Having a uniform nationwide definition will guard against misleading labeling by some water bottlers and "ensure that bottled water products are informatively and consistently labeled throughout the country (FDA, 1993).

Regulation of Bottled Water

Bottled water standards were developed by FDA in 1973 to regulate bottled water nationwide. The FDA under Federal Food Drug and Cosmetic Administration (FFDCA) sets the legally enforceable maximum contaminants levels for bottled water sold in interstate commerce (Consumer reports, 1991; GAO/RCED, 1991). The FDA requires bottled water products to be clean and safe for human consumption, to be processed and distributed under hygienic conditions and to be produced in compliance with FDA Good Manufacturing Practices (EPA, 1990; Lambert, 1993). The Current Good Manufacturing Practice regulations require sampling and analysis of source water and of every bottled water product at least once every year. It also makes provision for the sampling and analysis of water taken after processing but before bottling, as often as necessary to maintain uniformity and ensure that the method of processing is effective (FDA, 1993).

The FDA looks into the possibility of the particular contaminant being present in the source water or whether it is added in the course of production or distribution of bottled water and the possibility of such a contaminant being removed in the course of processing bottled water. When it is obvious that the presence of a contaminant is linked to material, processing method or distribution system such as lead in pipes, and if it can be avoided by bottlers, the FDA could propose a lower allowable level than the MCL for that particular contaminant (FDA, 1993). Under the 1996 SDWA Amendment, the FDA is required to issue regulations for contaminants in bottled water based on EPA regulations for contaminants in tap water. Also, in the case of tap water, the FDA requires water bottlers to notify the public whenever the microbiological, physical, chemical or radiological quality of bottled water is below the required standard.

Although bottled water that is shipped interstate receives federal oversight by the FDA, each state is responsible for ensuring the safety of bottled water sold in intrastate commerce. However, states are not required to have the same standard as the FDA regulations (GAO,1991). Different states have their own inspection and licensing programs. Thus, there are variations in water testing requirements and regulations from one state to another in the U.S. resulting in some states having stricter labeling laws than others (Milius, 1988). The state of North Carolina for example, defines "spring water" as water taken from a natural orifice in the earth's surface through which water freely flows without the use of mechanical means, while California defines "spring water" as water that issues by natural forces out of the earth at a particular place. The California definition implies that spring water may be derived from natural orifice or from a bore hole adjacent to the natural orifice. Thus, water collected from a bore hole adjacent to the spring could be called spring water in California but not in North Carolina (FDA, 1993).

The National Sanitation Foundation conducts yearly plant inspections of domestic IBWA members for product certification, but this inspection is not mandatory. It has therefore been suggested that a third party certification process be instituted to make certain that bottled water products comply with the FDA regulations and that testing should be standardized and uniformly monitored (report of the Subcommittee on Oversight and investigations, 1990). In the state of Oregon bottled water regulation is done by the Food Safety Division of the Department of Agriculture.

Drinking Water Quality and Risk Perception

Drinking Water Quality

It is not unusual for people to describe drinking water quality in terms of safety, and/or in terms of aesthetic value, depending on personal convictions and experiences. Chemicals which occur naturally in water, or chemicals produced during water treatement, and algae, particularly blue-green algae, are some of the factors that contribute to poor aesthetic quality of drinking water (Kotak, Prepas, & Hrudey, 1994;Young, Horth, Crane, Ogden, & Arnott, 1996). Studies on drinking water quality have focused on either the importance of aesthetic values or concern about chemical contaminants as primary influences in whether people drink public water, use water from other sources or install home water treatment devices (Auslander, & Langlois, 1993; Curry, 1983; Hurd, 1993).

A study conducted in 1983 in Chicago to determine the relationship between perception of quality of drinking water and decision to use bottled water or other home devices (n=300). Result of the study showed that consumers' primary reasons for giving low rating to the quality of drinking water were health reasons and aesthetic problems. Dissatisfaction with the quality of local drinking water was the main reason these participants drank bottled water or purchased home filter units (Curry, 1983).

A more recent study on perception of drinking water quality involved a focus group discussion on what water quality meant to the public (Hurd,1993). The focus group discussion served as a preliminary study to a national Consumer Attitude Survey on drinking water issues. Results of that study showed that 40% of the respondents associated drinking water quality with "health and safety", while 29% reported that they think more of aesthetics (appearance and taste) (Hurd, 1993). In the main study, issues such as reasons for drinking bottled water and the use of home treatment devices, and relationship between media coverage of water quality issues and consumers' perception of the quality of local drinking water were studied, (n=1603). The results indicated that 35% of the respondents who reported drinking bottled water were concerned about the health and safety, while another 35% reported drinking bottled water as a substitute for soft drinking, coffee or other beverages. People who were aware of media coverage about a possible drinking water problem rated their water quality lower than other respondents.

The second part of the main study by Hurd (1993) assessed the impact of a Milwaukee Cryptosporidium outbreak on the residents' attitudes toward water quality following a "boil water" advisory, (n=400). The study also evaluated changes in their drinking water habits as a result of the outbreak. Results indicated that over half (68%) of the respondents reported boiling their drinking water, and 58% used bottled water, compared to 27% who reported that they drank any bottled water before the incident. Although the use of home water treatment devices were not common (6%) among the respondents, 40% of the devices that were in use were reported to have been purchased due to the outbreak.

In another drinking water study conducted in Toronto, Canada, people were questioned over the telephone about their perception of drinking water quality and the use of alternatives to public water (n=200) (Auslander, & Langlois, 1993). The study was based on a Toronto Community Health Survey which showed increased concern about drinking water and an increased use of alternatives to tap water. The results indicated that respondents who rated tap quality as poor, and were concerned about chemicals in drinking water used alternatives to tap water more than those who rated it as good or very good. Less than twenty percent (19.5%) of the study participants reported using bottled water regularly, 11% used home treatment devices, while 12% boiled their drinking water on a regular basis. It was also found that taste, presence of chemical pollutants, presence of sediments and chlorine were reported as reasons for dissatisfaction with tap water (Auslander, & Langlois, 1993). The researchers in that study noted also that there were no demographic differences between respondents who reported using alternatives and tap water users.

Risk Perception About Drinking Water

Risk perception has been described as a vague term with multiple dimensions (Coleman, 1993; Glicker, 1992). One definition that seems to be widely used in the literature is "intuitive risk judgments" (Slovic, 1987). From the multidimensional view point, risk perception is thought to be "influenced by complicated social, cultural, and psychological factors, as well as by objective information (Glicker, 1992, p. 46). This description is supported by (Coleman, 1993) who described it as attitudes, beliefs, cognitions and feelings about risk. Risk perception literature also shows that people see familiar hazards to be less risky, than unfamiliar risks (Sandman, 1986).

Hurd (1993) suggested that drinking water risk perception is closely related to subjective perception of drinking water quality. This is because of the subjective judgment and assumption that water quality is based on such factors as taste, color, odor. In the present study, risk perception about drinking water is regarded as a person's subjective judgment (based on both aesthetic and non-aesthetic qualities of water) about drinking water drawn from a public water system. This is based in part on the definition of risk perception by Slovic (1987). It is also based on past studies which demonstrate that people are concerned about the safety of drinking water, based on their subjective feelings about physical properties of water, chemical and microbiological water contaminants, as well as media coverage of drinking water problems (Auslander, & Langlois, 1993; Curry, 1983; EPA, 1990; Hurd, 1993; Glicker, 1992; Olson, 1989).

Few studies have been focused entirely on risk perception about drinking water. Most studies have assessed risk perception related to other environmental and health risks such as radon, nuclear waste, and chemical pollution. Coleman (1993) included drinking water risk as one of eight health risks in her study investigating the inflence of mass media and interpersonal communication on societal and personal risk judgments. The other seven risk variables in that study included heart diseases, AIDS, smoking, household radon, chemicals on food, household chemicals and low-level radioactive waste. This study used a mail questionnaire to interview a random sample of New York residents (n=671). Findings of the study suggested that participants rated their own personal susceptibility to the eight risks, lower than that of society in general. On a scale of 1 (low likelihood of coming to harm) to 6 (high likelihood), the mean score for personal risk judgment and societal risk judgment about drinking water was 3.59, and 4.67 respectively.

In a similar study on risk perception, personal risk perspectives were contrasted with population risk perspectives, and intervention strategies for changing risk behavior were addressed (Jefferey, 1989). The findings of this study support were similar to Coleman's study suggesting that individuals tend to underestimate their own health risk.

A British study described health risk perception was described as physical risk, or the feeling that a product may contain foreign or toxic substances capable of causing harm to individuals when ingested (Mitchel & Boustani, 1992). This study involved 180 respondents from the South Eastern part of the United Kingdom which has the highest per capita consumption of breakfast cereals. The researchers hypothesized that physical risk will be the most important risk perceived in the purchase of breakfast cereals, among other perceived risks (taste, financial, social, psychological and convenience risks). Results of the study however, indicated that risk in terms of taste was perceived as the most important risk while physical risk was ranked second.

In a nationwide study of gender, race and perception of environmental health risk, 1512 randomly selected participants were interviwed by telephone to determine health risks related to factors such as lifestyle risks, environmental conditions and selected technologies such as nuclear power (Flynn, Slovic & Mertz, 1994). It was reported that perception of risk for all 25 environmental hazards studied was higher for white women than white men. This difference was attributed partly to biological/social differences and to limited familiarity with science and technology, especially with nuclear and chemical hazards on the part of women. Also, white males with higher educational status and high household income were less likely to describe a particular hazard as posing a serious threat.

This finding is similar to the result of the Milwaukee study by Hurd (1993), in which 37% of the respondents in the low income group (annual household income of less than $15,000) indicated that they were more worried about their health and safety than were individuals (12%) with household incomes above $50,000. When asked about their perception of the seriousness of the outbreak of *Cryptosporidium*, Hurd (1993), found that 57% of Milwaukee County residents described it as a very serious threat to public health and safety with more women (66%) than men (46%) reporting it to be a very serious threat.

Reseach has shown that risk perception could be regarded as an important component of the health belief model, since action taken by an individual regarding a potential health risk is influenced by that individual's perception of risk. Further, precise or inaccurate risk perception could positively or negatively influence the action taken by an individual about a potential hazard (Glik et al. 1991).

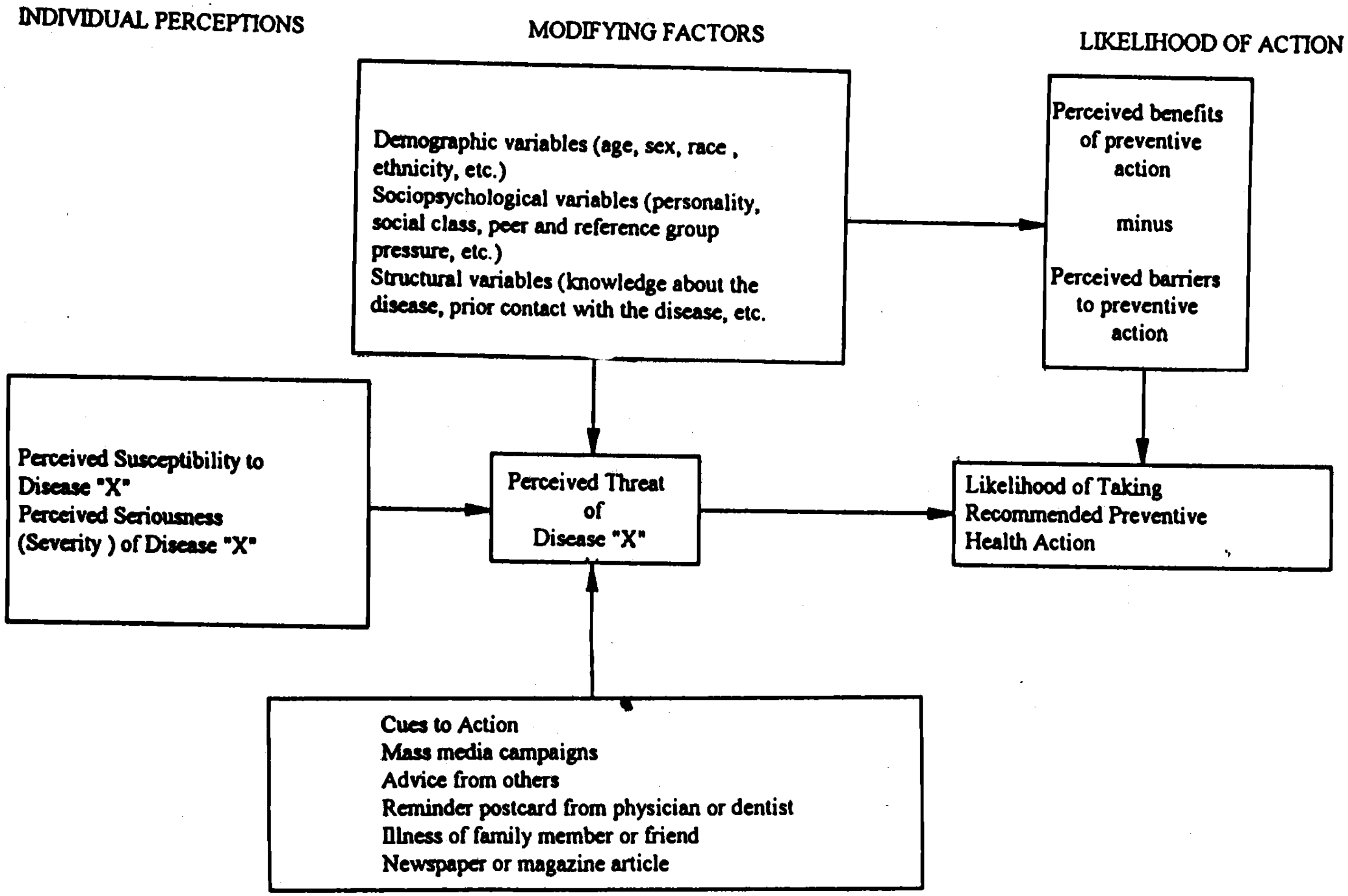
Theoretical Framework

The Health Belief Model

The health belief model (HBM)(Hochbaum, 1958; Rosenstock, 1966) was developed on the premise that a person's decision to undertake a preventive health action is determined by the interaction of perceived susceptibility to and perceived seriousness of a health problem and the perception of benefits relative to the cost of the action. It has been described as an example of value-expectancy theory which proposes that individuals have a desire either to avoid being ill or to get well if they are ill; and that people expect that taking personal action would prevent illness or reduce the threat (Janz and Becker, 1974; Rosenstock, 1991; Rosenstock, Strecher and Becker, 1994). The HBM was originally developed in the 1950s for use in determining why people failed to participate in programs designed to prevent or detect disease (Rosenstock, et al. 1994). Since then it has been applied to different types of studies to explain or to predict people's health behavior and the use of preventive health services. Such studies include screening tests for tuberculosis in which Hochbaum (1958) reported that 82% of people who believed that they were susceptible to tuberculosis and believed in the benefits of X-rays had X-rays, while fewer number of people (62%) who believed they were susceptible but did not believe in the benefits of X-rays obtained an X-ray. Other studies that tested the HBM include, Poliomyelitis immunization (Rosenstock, Derryberry, and Carriger, 1959), preventive dental visits (Kegeles, 1963), cervical cancer detection tests (Kegeles, Kirscht, Haefner, and Rosenstock, 1965), prediction of dietary compliance (Becker, Maiman, Kirscht, et al 1977), and HIV risk behavior change (Rosenstock, et al. 1994).

The components of the HBM that are assumed to predict people's behavior include: 1) Individual perceptions, which are, perceived susceptibility to a health threat, perceived severity of the consequences of the health problem including medical, financial and social consequences; 2) Modifying factors, which include demographic, sociopsychological and structural variables; and, 3) Likelihood of taking a recommended health action based on perceived benefits of the action being more than the perceived barriers of taking the action. Anoher component of the model include the presence or absence of cues to action such as symptoms or mass media communications and sociodemographic characteristics (Becker et al., 1974; Petosa & Jackson, 1991) (See Figure 4). Rosenstock et al. (1994), pointed out that the HBM views the perception of threat as a combination of perceived susceptibility and perceived severity. A person's belief about the severity of the health problem caused by a certain contaminant and/or being vulnerable to a particular health problem would influence the willingness of an individual to take preventive action. Thus, it is expected that people might respond

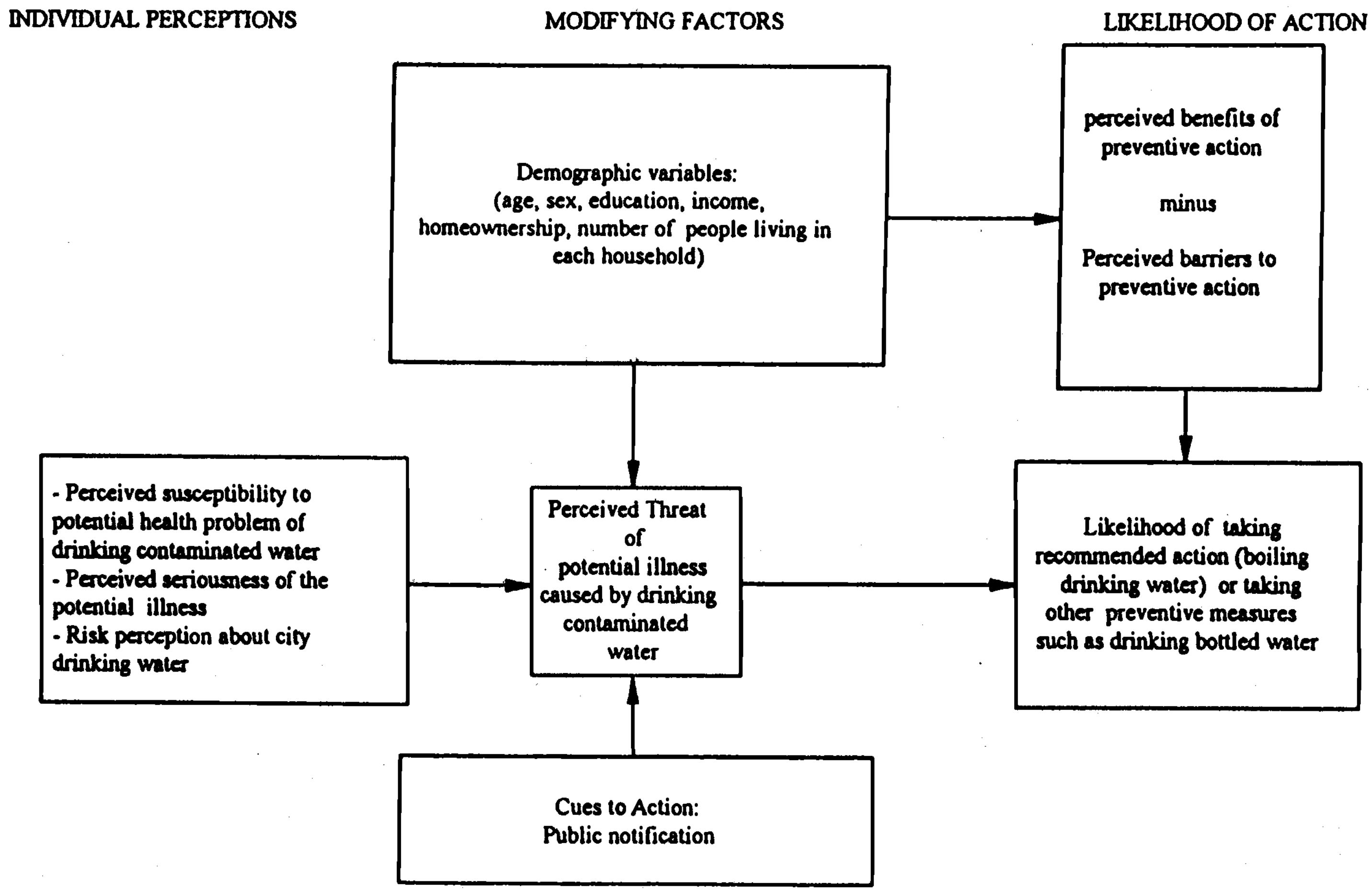
Fig. 4. The Health Belief Model



Source: Becker, Drachman & Kirscht, 1974 positively to a public notification recommendation if they believe that the consequences of the health problem under consideration are severe enough to make them sick or interfere with their daily schedule. For example, a water contaminant such as *giardia* which causes people to have diarrhea, might "force" people to take a preventive action more than contamination by lead, which have some chronic effects with little or no overt symptoms.

The response to public notification directives would thus depend upon an individual's subjective perception of getting sick from drinking contaminated water and/or on the person's perception of the seriousness and susceptibility to the health threat from drinking water contamination (See Figure 5). The health belief model posits that people who believe themselves to be susceptible to a certain health problem are more likely to take measures to avoid that health problem than people who do not consider themselves vulnerable. Thus, a threat must be seen as having personal consequences for it to cause a behavioral change in an individual (Franz, 1976). In addition, the decision to adopt the PN recommendations might depend on whether the perceived benefits of choosing any of the options outweighs the perceived barriers. Consumers are often faced with not knowing whether or not adopting a particular preventive activity such as installing a home filter will have a positive impact on their health status (Cleary, 1989). Using the HBM as an example, possible benefits of using filtered water are reduced chance of illness, better peace of mind, and approval from family and friends (Franz, 1976). Possible barriers include costs, time and the inconvenience of switching from a drinking tap water to which an individual was already accustomed.

Fig. 5. An Adapted Health Belief Model



Adapted from Becker, Drachman & Kirscht, 1974

The HBM stipulates that a stimulus such as educational messages in this case, public notification or people's perception of risk is needed to initiate the appropriate health behavior by creating an awareness about the condition (Maiman, Becker, Kirscht, Haefner, & Drachman, 1977). In a study of Duluth citizens' responses to asbestos in drinking water Franz (1976), reported that considerable publicity regarding turbidity of water prompted many respondents to start using filtered water. It is thererfore, important to understand whether actions taken by people to improve the quality of their drinking water is a function of the impact of public notification.

In applying the cue to action dimension of the HBM to HIV risk behavior change, Rosenstock and his colleagues (1994) hypothesized that cues to action will have a strong association with AIDS preventive behavior if an individual's perception of threat of AIDS is high and perceived benefits is greater than the perceived barriers. Cleary (1989) remarked that the HBM could be used to describe the factors which influence behavior if people are provided with accurate information and they cautiously consider alternative behaviors available to them. Given that public notifications about violation of a drinking water standards are meant to provide people with directives on preventive action to be taken against a potential health threat, one would expect that persons residing in cities with long-standing violations who receive public notification (PN), would follow the directives given in such notices.

Many studies which used the HBM have shown that people fail to adopt prescribed preventive action because the effort required to avoid the ill-health condition is greater than the potential benefit (Rosenstock, Stretcher & Becker, 1988). In a review of preventive health behavior studies that employed HBM between 1974-1984, it was found that three components of HBM, perceived susceptibility, perceived benefits and perceived barriers were associated with the outcomes (Janz and Becker, 1984). Data regarding the role of perceived severity in predicting health behavior however, remain inconclusive (Langlie, 1977: Janz & Becker, 1984). Additionally, the severity component of the HBM might be difficult for respondents to conceptualize when they do not exhibit symptoms of the health problem under consideration, or for health threats that are described as having long term effects or for medical conditions which they have not personally experienced (Janz & Becker, 1984). It was concluded that perceived susceptibility was more important in preventive health behaviors but perceived barriers was the most powerful overall predictor of health-related behavior out of the four HBM components (perceived susceptibility, perceived seriousness, perceived barriers and perceived benefits). This is consistent with the report of a study by Fishera and Frank (1994) which found an association between perceived barriers to mammography and nurses' compliance with mammography screening for breast cancer. Franz (1976) in his feasibility study of public behavior and attitude in response to reported hazardous drinking water stated that the likelihood of using filtered water is dependent on an individual's perception of the potential benefits relative to the barriers involved.

The utility of the demographic dimension of the health belief model in predicting preventive behavior has been only rarely addressed in HBM studies (Weissfeld, Kirscht & Brock, 1990). Weissfeld et al. (1990) found in their study of health beliefs in a population that females, non-whites, less educated and lower income people showed more concern about health and higher susceptibility to the consequences of a health problem. In a study of public perception of freshwater issues, O'Connor, Bord and Fisher (1994) found that more women were concerned about water quality problems than men. Based on results of several studies conducted using the HBM as the framework, Langlie (1977) observed that incorporating some modifying variables such as "perceived internal control" to improve the predictive power of the model was important and had been successfully done. This variable (perceived internal control) assumes that individuals who feel that they have some control over what happens to them are more likely to see preventive health action as efficacious.

Self-Efficacy

Bandura (1977) developed the concept of self-efficacy, which is described as one's conviction about being capable of coping with a specific task. The suggestion that the concept of self-efficacy could be a valuable part of the HBM received wide approval. For example, Rosenstock, Strecher and Becker (1988) remarked that it would improve the explanatory power of the HBM especially when used for long term preventive behavior change studies. Strecher et al. (1986) observed that change in behavior is dependent on both outcome and efficacy expectations. An outcome expectation was defined as a person's belief that a particular behavior will result into a given outcome. Efficacy expectation, on the other hand, was described as a person's belief about one's capability of performing the specific behavior necessary to produce an outcome (Bandura, 1982).

Hence, health behaviors that are believed to be easy to perform are more likely to depend on an outcome expectation rather than efficacy expectation. Thus, for a preventive action to be undertaken on a long term basis, an individual should be convinced that he/she can successfully implement the recommended action required to produce the expected outcome. Bandura (1982) explained that if an individual has some doubts about whether he/she can perform a particular task that will result into a certain outcome, such a belief might influence that individual's level of performance. Basically, the stronger a person's convictions in his/her own effectiveness, the higher the likelihood that the individual will adopt a preventive action.

Janz and Becker (1984) suggested that self-efficacy could be regarded as a part of perceived barrier component of the HBM. Rosenstock et al.(1988), however, pointed out that incorporating self-efficacy into that component of the HBM may limit the explanatory power of the perceived barrier component. They went further to recommend that self-efficacy dimension be incorporated into HBM when people are expected to modify complex lifestyle practices such as smoking, alcoholic and substance abuse, physical activity and dietary habits. Therefore, complying with public notification such as "boil water" order, flushing of tap for one minute, or making a switch to bottled water until a drinking water contamination problem is corrected might not be regarded by many people as complex and, the utility of self-efficacy in this study might be limited .

Similar to the suggestion of incorporating self-efficacy to the HBM, Gochman (1972) suggested that a motivational component be included in the HBM to improve the predictability of the model. This recommendation is due to the importance of motivation in influencing health behavior. Champion (1984) defined health motivation as "a generalized state of intent that results in behaviors to maintain or improve health. Studies that have included health motivation as a dimension of the HBM have found that individuals who showed higher health motivation were more likely to comply with prescribed preventive health behavior (Champion, 1991; Fischera & Frank, 1994). However, incorporating the health motivation component into the present study would broaden the scope of the present study too much, since the health belief model has several variables which seem appropriate for evaluating the likelihood of taking action in response to PN.

Health Locus of Control

Health Locus of Control (HLC) is another health behavioral model that might be applied to the study of drinking water behavior. Researchers have studied people's beliefs regarding the areas ("forces within self" and "forces external to oneself") from which a person's health is controlled (Rotter, 1966; Wallston, Wallston, Kaplan & Maides, 1976). Strecher et al. (1986) stated that, "health locus of control refers to a generalized expectation about whether one's health is controlled by one's own behavior or forces external to onself" (p.77). Although no empirical data could be found to support the use of health locus of control in studying drinking water behaviors, the concept of "forces external to oneself" appears to be important in predicting drinking water behavior of individuals. However, the HBM has the "cues to action"component which could serve the purpose of that HLC concept since both concepts (forces external to onself and cues to action) relate to stimulating people to take action.

CHAPTER THREE

RESEARCH DESIGN AND METHODS

This chapter describes the sample selection procedures, preparation of the survey instrument, pilot study, data collection and data analysis.

Selection of Towns

The study surveyed residents in four communities in Oregon who are served by small community water systems. Two towns were selected as affected communities and two towns were selected to represent comparison communities. The affected communities were Falls City and Jefferson; the control communities were Oakland and Creswell. Falls City was selected among other cities with small water systems because it has an on-going filtration problem and residents of Falls City have been notified of this problem several times since 1993. Oakland was selected as the comparison city for Falls City because it has a small water system but does not have a filtration problem. Jefferson was selected due to a filtration problem caused by the recent February 1996 flooding that occurred throughout Oregon. The Jefferson city water utility issued PN to residents regarding the problem. Creswell was selected as a comparison city for Jefferson because it has similar number of household connections, did not have filtration problems. Thus no public notices regarding drinking water violations have been issued in Creswell.

Selection of Subjects

Residents within these four communities were selected using the stratified random sampling technique. First, the four communities (strata) were grouped according to whether they had filtration problem or not, and whether the problem was short term or long term. A sampling frame was designed for each of the four communities. The sampling frame was derived from a list of public water users in each of the selected cities as well as household phone listing of the cities. These two lists were cross-matched to exclude non-city tap water (well-water) users and to get a comprehensive phone number listing of city water users. A random number of potential respondents were then computer generated from the sampling frame of each of the cities. The target population for the study was adult males and females residing in the selected cities, who use the city tap water. The unit of analysis was either male or female over 18 years of age residing in the randomly selected households.

Sample Size

Sample size was determined to be a representative sample of the target population based on a population estimate (p=.50), the standard error of the estimate, tolerable range of error of 5%, and a confidence level of 95%. Using the standard error formula of: Square Root [P* (1.00-P)/ n], an approximate sample size of 384 (n) was obtained by multiplying this formula by the confidence level and dividing by the margin of error (5%) (Aday, 1989). The overall sample size of 308 was then obtained by dividing 384 by (1+

n/1541), where 1541 is the total sampling frame for all the cities (Levy & Lemeshow, 1991). Adjustment was made for a 70% response rate based on the pilot study, by dividing 308 by 0.70, bringing the expected overall sample size to 440. This sample size (n=440) was then proportionally allocated to each of the cities using the formula: $n_a = n/N * N_a$ where n_a is the expected sample size drawn for each strata (city); a = 1,2,3,4. Strata 1=Falls City, Strata 2=Jefferson, Strata 3= Oakland and Strata 4=Creswell; n being the expected general sample size. N represents the total sampling frame number from all cities, and N_a represents the sampling frame for a specific city (as recommended by a consultant statistician from the Department of Statistics, O.S.U). (See Appendix A).

Preparation of the Survey Instrument

No instrument specifically designed for the purpose of the present study was available, therefore an instrument was developed to specifically collect data regarding the following variables: risk perception, awareness about PN, sources of information about drinking water problems, and action taken in response to PN. Other questions included: perceived benefits and barriers of taking the recommended preventive action, perceived susceptibility to and perceived severity of health problem caused by drinking contaminated water, bottled water consumption patterns, use of home filtered water and demographic variables. Recommendations by Dillman (1978), and Frey & Oishi (1995) for formatting questions for telephone surveys were useful in developing the instrument. The Survey Research Center at Oregon State University assisted the researcher in organizing the questionnaire to enhance readability of the questions and to make them more appropriate to be administered by phone. The instrument was then reviewed by the following persons for content validity : 1) a specialist in health advisories, 2) two environmental health professionals who work with public drinking water systems, 3) one extension specialist and, 4) five public health professionals. Three lay persons reviewed it for clarity of the questions and ease of understanding by respondents. It was then revised before being pilot tested. A brief description of sections of the questionnaire are as follows:

Risk perception questions. This set of questions (Q1a-1i) focused on factors which people are likely to relate to water contamination, such as, cloudiness, microorganisms, chlorine taste and/or odor, and chemical contamination. Question 1 also asked whether respondents were afraid of getting sick from their city water and their overall feeling about the likelihood of getting sick from drinking their city water. Questions were formatted using 5-point Likert scale, with 1 assigned to "strongly disagree and 5 assigned to "strongly agree".

Information sources. This part of the questionnaire (Q2a-2k) asked questions about sources from which respondents obtained information about problems with their city water. These questions and those in the following awareness section used dichotomous (yes or no) wording.

Awareness. This section of the questionnaire (Q3a-3c) queried people's awareness of any official notice regarding a drinking water problem since January, 1996. It asked respondents to specify the problem and action taken in response to the problem.

Perceived barriers/benefits and Perceived susceptibility/seriousness. The items for perceived benefits and barriers and perceived susceptibility and seriousness were derived from literature on different HBM studies on health behaviors by Becker, Drachman, & Kirscht (1984), Champion (1984), Maiman et al. (1977), Weissfeld, Kirscht & Brock (1990). These items were modified to address peoples' concerns about drinking water contamination issues. The questions in this section of the instrument were formatted using a Likert five-point scale.

Drinking water practices. This set of questions (Q6), sought to find out peoples' long term drinking water practices including, how often bottled water, home filtered water and how often drinking water was boiled 6 months prior to data collection. A 5-point Likert scale was used with these questions with 1 assigned to "never" and 5 to "all the time".

Likely reasons for drinking bottled water. Question 7 covered some of the reasons that might have caused people to decide to drink bottled water (Q7), while Question 8 (Q8) addressed reasons that people might consider important enough to cause them to start drinking bottled water. This 5-point Likert scale assigned 1 to "not at all important" and 5 to "very important"

Willingness to pay. This set of ("yes, no") questions asked respondents about their willingness to pay a little more for the city to correct any problem related to aesthetics, presence of industrial and /or agricultural chemicals, presences of microorganisms and lead.

Demographic information. This part of the questionnaire dealt with information relating to gender, age, number, and type of people in the household, home ownership. Other demographic information covered in this section included gross household income levels and period of residency in the cities (See Appendix B).

After data collection, the question on how long people have lived in a community was coded to reflect short-term (1-5 years) residency, intermediate term (6-25 years) residency, long-term (26-50 years) residency and very long term residency (50 years and above). The variable age was also recoded into three age groups to reflect young adulthood (18-39 years), middle-age (40-59 years) and old age (60 years and above).

Pilot Study

The survey instrument was approved by the Oregon State University Institutional Review Board for the protection of human subjects. It was then piloted with 40 adult residents, 20 from Sodaville and 20 from Philomath, to check for clarity of the questions. Those two cities were chosen because Sodaville (with a small water system) had a problem with their city drinking water and its residents were notified of the problem. Philomath (with a small water system) did not have a drinking water problem and so, it was used as the comparison city.

The questionnaire was then revised to include a "Don't Know' column to the Likert Scale questions to accommodate respondents who might not have answers to some of the questions. Questions about types of water treatment devices that people have in their homes, use of bottled water for preparing fruit juices, hot and cold beverages and how much an individual spends per month to purchase bottled were eliminated from the questionnaire to limit the interview time to a maximum of 15 minutes (Dillman, 1978).

Data Collection and Interview Protocol

Data was collected using telephone interview procedures. Randomly chosen household phone numbers were called between 7:00pm and 9:00pm on Mondays through Thursdays, and Saturdays between 10:00am and 9:00pm when people were likely to be found at home. The adult over 18 years of age with the most recent birthday was interviewed in each household. This protocol ensured a random sample of adults within households in the four cities. A total of 63 adults in Falls City, 67 in Oakland, 130 in Jefferson, and 131 adult residents of Creswell completed the interview. Each interview took between 12-15 minutes.

The interviewers started each interview process by stating their names and the purpose of the study (from Oregon State University). Respondents were assured that no response was right or wrong and that the survey was confidential. If an interviewer got an answering machine, a message was left stating that a researcher from Oregon State University will be calling back at a definite date and time for an interview. After 5 calls to a particular household, the phone numbers was regarded as "unreached". If a potential respondent was contacted at a "bad" time, a more convenient time was arranged for the interview. The outcome of all calls made was recorded in a chart as follows: 1) completed, 2) incomplete, 3) refusal, 4) no answer, 5) answering machine, 6) well water, 7) disconnected. A breakdown of the data collection process is shown in Appendix C. Table 3 shows survey response rate by city. The overall response rate was 69%.

Table 1
Survey Response Rate by City

City	Pop.	Un-reached	Reached	Refusal	Inc.	Complete	Response Rate
Fall City	818	78	84	19	2	63	75%
Oakland	844	85	85	18	-	67	78%
Jefferson	1805	152	203	71	2	130	64%
Creswell	2431	141	192	59	2	131	68%

Data Analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS for Windows, 6.0). The independent variables (IVs) in the study included: Demographic data (participant's age, gender, home ownership, educational level, income and period of residency); perceived susceptibility to health problem of contaminated drinking water, perceived seriousness of the problem, perceived barriers and perceived benefits of taking the recommended action, and cues to action. The dependent variables (DV) or the outcome measure included: following the directive of a public notice or taking other actions, ranging from choosing to drink bottled water, or use of home water filter, or not taking any action.

Factor analysis was conducted using a principal component factor technique to determine whether sets of statements designed to measure a specific construct are conceptually related to one another to adequately measure it (Aday, 1989). A rotated varimax test was run to "maximize the relationships between the variables and some of the factors" (Kinnear & Gray, 1994, 216) and factor loading coefficient of .45 was used as the criterion for inclusion of an item on a factor. It is expected that a scale which is designed to measure one construct will retain only one factor at the conclusion of the factor analysis. In the present study, one factor was retained for each of the HBM constructs (perceived susceptibility, perceived seriousness, perceived barriers and perceived benefits). The risk perception items yielded two factors (chemical risk and aesthetic risk perception). For the purpose of the study, the two risk perception factors were jointly named general risk perception (GRP). Internal consistency reliability analyses for the scaled items were computed and the results are presented in Table 2. Items that showed low correlations with their respective scales were excluded, and internal consistency coefficients were rerun until maximum reliability for each item was achieved. For example, the Cronbach's alpha increased to .76 from .55 with the exclusion of items Q4c and 4h from the reliability analysis for perceived barriers.

Table 2
Internal Consistency Reliability Results of Survey Scales

Scale	Cronbach's Alpha
Perceived Susceptibility	.82
Perceived Seriousness	.76
Perceived Benefits	.65
Perceived Barriers	.66
Risk Perception	.66

Descriptive statistics such as frequency distributions, measures of central tendency (mean and median) and measures of dispersion (standard deviation), were conducted. A risk perception score was computed by adding up each respondent's scores on each of the items on Question 1 to obtain a total score of the strength of each person's general risk perception (GRP). The mean score was then used for a t-test and for analysis of variance (ANOVA) procedures. The t-test for two independent samples which measures differences between two group means (Pagano & Gauvreau, 1993) was used to test hypothesis #1. One-Way Analysis of Variance, (the extension of two-sample t-test) which is used to compare three or more group means was used to test hypothesis #2. Hypothesis #3 was tested using Chi- square test of independence which is used to determine whether observed differences in proportions between study groups is statistically significant (Portney & Watkins, 1993).

A statistical significant difference indicates that the two categorical variables are not independent of each other. The Kruskall-Wallis One-Way ANOVA was used to test hypothesis #4 because more than two independent groups were being compared; the distributions were not normal, and the data were ordinal. The Mann-Whitney U test of difference between two independent (Portney & Watkins, 1993) groups was used to test hypotheses #5 and #6 because measurement was done on an ordinal scale and the distributions were not normal. The test measures the difference between the sums of ranks of two independent groups. The null hypothesis is true, if the ranks of scores in the two groups are equally distributed. A significant level of alpha = .05 was used for all hypothesis testing.

Pearson's Product Moment Correlation analysis was performed to check for multicollinearity among independent variables (IV), and the relationship between the dependent variable and the IV before regression analysis. This was necessary because when two or more of the independent variables are highly correlated they provide redundant information about the variability in the dependent variable (Pagano and Gauvreau, 1993). When coefficients are .75 and above, multi-collinearity is considered a problem (Afifi and Clark, 1990). Total scores for perceived susceptibility items, perceived seriousness items, perceived benefit and perceived barrier items were computed for each respondent before the variables were entered into the logistic regression model.

Standard logistic regression, which examines the predictive relationship between a dichotomous dependent variable (taking action or not taking action regarding public notification) and continuous or categorical independent variables was used to test hypothesis #7(Grimm & Yarnold, 1994). This regression model is a version of the multiple regression equation, in which the risk of developing an outcome is a function of independent variables (Hennekens & Buring, 1987). In the present study, the strength of the relationships are expressed in the form of odds ratio, the ratio of the probability that the respondents followed the public notification recommendations compared to the probability that they did not follow the PN instructions. The coefficients that are the results at the conclusion of logistic regression shows the extent of the increase or decrease in the log odds produced by one unit of change in the value of the independent variable (Hennekens & Buring, 1987). The default deviation coding scheme which allows logistic regression coefficients to compare each category to the average effect of all categories was used in coding the data for the regression run. All theoretically relevant independent variables were entered in the model at the same time. The independent variables which showed any relationship with the dependent variable were selected and another logistic regression was re-run to get a final reduced model. Cases were excluded from the logistic regression analysis if they were from residents living in the cities without drinking water problems. Missing information from other variables such as income, age and HBM variables also resulted in the exclusion of additional respondents (subjects from Falls City and Jefferson) from the logistic regression analysis.

CHAPTER FOUR

RESULTS

The results of the data analyses are presented in this chapter. First, demographic characteristics (gender, age, educational and income level, number of people in a household, home ownership and period of residency) of the study sample are presented. This is followed by a comparative description of respondents' sources of information about city water, and sources of information regarded as most reliable. Willingness of consumers to pay for the improvement of the quality of city water and reasons given by respondents for drinking bottled water are presented in the next section. The next section presents the result of correlations between dependent and independent variables and respondent's awareness about public notification. Results of the analysis of the health belief model variables and general risk perception are presented in the fifth section. The last section of this chapter presents the results of the descriptive analysis along with hypothesis testing of the research questions.

Characteristics of Study Sample

Out of a total of 391 adults who were interviewed, 159 were males and 232 were females. The mean age of the subjects was 49.38 years and the average number of people living in a household was three. Overall, 84% of the subjects were homeowners while 16% were renters. The average length of residency was 18.33 years. Table 3 displays the gender, age and number of years of residency of subjects in Falls City and the comparison city Oakland. The same information is presented in Table 4 for Jefferson and the comparison city, Creswell. The number of females from Falls City and Oakland was 37 (58.7%) and 43 (64.2%) respectively. Twenty-six (41.3%) subjects from Falls City were males and 24 (35.8%) from Oakland were males. The ages of subjects in both cities ranged from 18-89 years. Twenty-three subjects (36.5%) in Falls City and 11(16.4%)

Table 3
Selected Demographic Characteristics of Sample in Falls City and Oakland
(Long-Term Drinking Water Problem/No Problem)

	Falls City Responses N=63		Oakland Responses N=67	
	n	%	n	%
Gender				
Female	37	58.7	43	64.2
Male	26	41.3	24	35.8
Total	63	100	67	100
Age				
18-39 years	23	36.5	11	16.4
40-59 years	20	31.7	33	49.3
60 + years	18	28.6	20	29.8
No Response	2	3.2	3	4.5
Total	63	100	67	100
Years of Residency				
1- 5 years	13	20.6	10	14.9
6-25 years	35	55.6	37	55.2
26-50 years	8	12.7	18	26.9
51 years+	7	11.1	2	3.0
Total	62	100	66	100

subjects in Oakland were between 18-39 years of age. Twenty subjects (31.7%) in Falls City and 33 (49.3%) in Oakland reported being in the 40-59 years age group. Eighteen subjects (28.6%) in Falls City, and 20 (29.8%) in Oakland were 60 years and above. Two subjects (3.2%) in Falls City and three subjects (4.5%) in Oakland did not respond to the question about age.

Table 4
Selected Demographic Characteristics of Sample in Jefferson and Creswell (Short-Term Drinking Water problem /No Problem)

	Jefferson Responses N=130		Creswell Responses N=131	
	n	(%)	n	(%)
Gender				
Female	75	57.7	78	59.5
Male	55	42.3	53	40.5
Total	130	100	130	100
Age				
18-39 years	37	28.5	38	29.0
40-59 years	64	49.2	49	37.4
60 years+	24	18.5	38	29.0
No Response	5	3.8	6	4.6
Total	130	100	131	100
Years of Residence				
1-5years	48	36.9	30	22.9
6- 25 years	61	46.9	64	48.9
26-50 years	18	13.8	26	19.8
51years+	3	2.4	11	8.4
Total	128	100	128	100

The number of years of residency for subjects in Falls City and Oakland appear to be similar. Table 3 shows that 13 subjects (20.6%) reported having lived in Falls City for less than six years while 10 (14.9%) of subjects in Oakland have lived in that city for the same length of time. Approximately one third of the respondents in each of the two cities have resided either in Falls City and Oakland between six and 25 years. A small proportion of subjects have lived in both cities for a period of 26 to 50 years as shown in Table 3, while a smaller proportion of the subjects reported living in the two cities for over a period of fifty years, 7 (11.1%) in Falls City and 2 (3.0%) in Oakland.

The gender, age group and years of residence of subjects in Jefferson and Creswell are presented in Table 4. The number of female and male subjects in Jefferson was 75 (57.7%) and 55 (42.3%) respectively. In Creswell, 78 (59.7%) were females and 53 (40.5%) were males. Thirty-seven subjects (28.5%) in Jefferson and 38 (29%) in Creswell were in the 18-39 years age group; 64 (49.2%) subjects in Jefferson, and 49 (37.4%) subjects in Creswell were in the 40-59 years age group. The number of subjects 60 years and above was 24 (18.5%) in Jefferson and 38 (29.0%) in Creswell. Five subjects (3.8%) in Jefferson and 6 (4.6%) in Creswell did not respond to the question. The period of residency for subjects in Jefferson and Creswell are as follows: 48 (36.9%) of subjects in Jefferson and 30 (22.9%) in Creswell reported having lived in Jefferson and Creswell respectively for less than six years. Over half of the respondents in the two cities: 61 (46.9%) and 64 (48.9) have resided in their respective cities for six to 25 years. Eighteen subjects (13.8%) and 26 (19.8%) have lived in both cities between 26 -50 years. Only 3 (2.4%) and 11(8.4%) have lived in both cities for more than 50 years.

As shown on Table 5, only one subject in Falls City (1.6%) and one in Oakland (1.5%) had less than an 8th grade education. Seven respondents in both cities attended high school but did not graduate. Twenty-two subjects (35.5%) in Falls City and 21

(31.3%) in Oakland had a high school degree; 9 (14.5%) of respondents in Falls City and 6 (9.0%) of those in Oakland had community college education; 6 (9.7%) subjects in Falls City and 4 (6.0%) in Creswell had technical/trade school degree, while another 6 subjects (9.7%) in Falls City and 10 (14.9%) in Oakland attended college but did not graduate. Seven subjects (11.3%) in Falls City and 11 (16.4%) in Oakland had a college degree.

Table 5
Income and Educational Attainment of Residents of Falls City and Oakland
(Long-Term Drinking Water problem/No Problem)

	Falls City Responses N=63		Oakland Responses N=67	
Educational Status	n	%	n	%
Less than 8th grade	1	1.6	1	1.5
High School (No degree)	7	11.3	7	10.4
High School degree or GED	22	35.5	21	31.3
Community College	9	14.5	6	9.0
Technical/Trade School degree	6	9.7	4	6.0
Attended college (No degree)	6	9.7	10	14.9
College degree	7	11.3	11	16.4
Masters Degree and above	3	4.8	3	4.5
Refused to answer	1	1.6	4	6.0
Total	63	100	67	100
Income Range				
Less than $15,000	17	27.4	6	9.0
$15,001-$25,000	13	21.0	16	24.2
$25,001-$35,000	7	11.3	17	25.8
$35,001-$45,000	10	16.1	6	9.1
$45,001-$60,000	7	11.3	8	12.1
> $60,000	3	4.8	4	6.1
Refused to answer	6	8.1	9	13.6
Total	63	100	67	100

Three subjects each in both cities had graduate degrees. One of the subjects in Falls City and 4 (6.0%) in Oakland did not answer the question about their educational status.

Six levels of income were represented in the study. A higher proportion of subjects 17 (27.4%) in Falls City than 6 (9%) in Oakland had household annual income levels of less than $15,000; 13 subjects (21%) in Falls City and 16 (24.2%) in Oakland lived in households with an income range of between $15,001 and $25,000. Seven subjects (11.3%) in Falls City and 17 (25.8%) in Oakland reported that their household annual income fell into the income range of $25,001- $35,000. Ten subjects (16.1%) in Falls City and 6 (9.1%) in Oakland reported household income range of $35,001 - $45,000. Similar proportion of subjects 7 (11.3%) in Falls City and 8 (12.1%) had annual household income levels of $45,001 - $60,000; 3 subjects (4.8%) in Falls City and 4 (6.1%) in Oakland reported household income levels of more than $60,000. Six subjects (8.1%) in Falls City and 9 (13.6%) in Oakland did not answer the question about household income levels.

Presented in Table 6 are the eight levels of education represented in Jefferson and Creswell. Less than 2% of subjects in both Jefferson and Creswell had lower than 8 years of education. Respondents who attended high school without degree in the two cities were 6 (4.6%) in Jefferson and 22 (16.8%) in Creswell. Those who graduated from high school accounted for 42 (32.3%) in Jefferson and 35 (26.7%) in Creswell. There were 14 (10.8%) in Jefferson and 13 (9.9%) in Creswell who had a community college education. Seven subjects (5.4%) in Jefferson and 4 (3.1%) in Creswell had technical/trade school degree. Sixteen (12.3%) subjects in Jefferson and 7 (5.3%) in Creswell attended college;

20 (15.4%) subjects in Jefferson and 35 (26.7%) in Creswell had college degrees while only 5 (3.8%) and 9 (6.9%) of subjects in Jefferson and Creswell respectively had masters degree and above. Nineteen (14.6%) of the subjects in Jefferson and 4 (3.1%) in Creswell did not answer the question about educational level. Six levels of income were represented in the study. Seven subjects (5.4%) in Jefferson and 15 (11.5%) subjects in Creswell had a household annual income levels of less than $15,000; 9 subjects (6.9%) in Jefferson and 20 (15.3%) in Creswell had household annual income range of between $15,001 and $25,000. Twenty subjects (15.4%) in Jefferson and 29 (22.1%) in Creswell reported that their household annual income fell into the income range of $25,001-$35,000. Eighteen subjects (13.8%) in Jefferson and 14 (10.7%) in Creswell reported a household income range of $35,001 -$45,000.

Another twenty subjects (15.4%) in Jefferson and 17 (13.0%) had annual household income levels of $45,001 - $60,000. Fourteen subjects (10.8%) in Jefferson and 9 (6.9%) in Creswell reported household income levels of more than $60,000. Forty-two (32.2%) subjects in Jefferson and 27 (20.6%) in Creswell did not answer the question about household income levels. Refusal rates in Jefferson and Creswell far exceeded refusal rates in Falls City and Oakland.

Table 6
Income and Educational Attainment of Residents in Jefferson and Creswell
(Short-term Water problem/No Problem)

	Jefferson Responses N=130		Creswell Responses N=131	
	n	%	n	%
Educational Status				
Less than 8th grade	1	.8	2	1.5
High School (No degree)	6	4.6	22	16.8
High School degree or GED	42	32.3	35	26.7
Community College	14	10.8	13	9.9
Technical/Trade School degree	7	5.4	4	3.1
Attended college (No degree)	16	12.3	7	5.3
College degree	20	15.4	35	26.7
Masters Degree and above	5	3.8	9	6.9
Refused to answer	19	14.6	4	3.1
Total	130	100	131	100
Income Range				
Less than $15,000	7	5.4	15	11.5
$15,001-$25,000	9	6.9	20	15.3
$25,001-$35,000	20	15.4	29	22.1
$35,001-$45,000	18	13.8	14	10.7
$45,001-$60,000	20	15.4	17	13.0
> $60,000	14	10.8	9	6.9
Refused to answer	42	32.3	27	20.6
Total	130	100	131	100

Source of Information About Drinking Water

Table 7 shows frequencies and percentages of subjects who responded "Yes" to the question about the source from which information about city water reaches them. Overall, most respondents (74%) indicated that they found information about city water in the newspaper. Mail (58.6%) and poster from city water (56.8%) and family/friends (56%) were the next popular source of information indicated by respondents.

Table 7
Sources of Information about Drinking Water by City

	Overall N=391 n (%)	Falls City N=63 n %	Oakland N=67 n (%)	Jefferson N=130 n (%)	Creswell N=131 n (%)
Information Sources					
Television	143(36.6)	14 (22.2)	26 (38.8)	61 (46.9)	42 (32.1)
Radio	136(34.8)	10 (15.9)	26 (38.8)	62 (47.7)	38 (29.0)
Newspaper	291(74.0)	52 (82.5)	56 (83.6)	103(79.2)	80 (61.1)
Family/Friends	219(56.0)	46 (73.0)	35 (52.2)	77 (59.2)	61 (46.6)
County Health Dept.	201(51.4)	25 (39.9)	46 (68.7)	68 (52.3)	62 (47.3)
Poster (Water utility)	222(56.8)	48 (76.2)	39 (58.2)	85 (65.4)	50 (38.2)
Mail (Water Utility)	229(58.6)	54 (85.7)	47 (70.1)	74 (56.9)	54 (41.2)
Phone (Water Utility)	166(43.0)	32 (50.8)	35 (52.2)	58 (44.6)	41 (31.5)
Doctor	93 (23.7)	14 (22.2)	17 (25.4)	30 (23.1)	32 (24.4)

The third set of information sources reported were county health department (51.4%), and phone calls from the city water utility (43.0%). While 36.6% of the subjects got their information from television, 34.8% indicated they received information regarding their city drinking water from radio. The medical doctor, as a source of information was the least indicated (23.7%) of all the sources.

The two most widely reported source of information about drinking water in Falls City and Oakland were newspapers and mail from water utility. For residents in Jefferson, newspaper and poster from water utility were the popular sources of information, while newspapers and county health department were reported as sources of information by the residents of Creswell.

Table 8 shows the overall frequencies and percentages of the responses from all the cities (combined) and responses from specific cities. In all the four cities, mail from city water utility 88 (22.5%) emerged as the most reliable source of information about city drinking water. The County health department 67 (17.1%) was the second-reported reliable source of information, while the newspaper 65 (16.6%) ranked third out of the ten sources listed. Falls City respondents (61.0%) regarded mail from their city water utility as the most reliable source of information, while the same number of respondents 15 (23.1%) in Oakland ranked mail from city water utility and newspaper (23.1%) equally. In Jefferson, the newspaper was regarded as the most reliable source of information about drinking water by 24 (18.5%) of the subjects, but the county health department was the most reliable source by the respondents in Creswell 36 (27.5%).

Table 8
Sources Regarded as the Most Reliable
Source of Information about City Drinking Water

	All Cities N=391	**Falls City N=59**	**Oakland N=65**	**Jefferson N=130**	**Creswell N=129**
	n (%)	**n (%)**	**n (%)**	**n (%)**	**n (%)**
Information Sources					
Television	14(2.22)	26(38.8)	61(46.9)	42(32.1)	5 (3.90)
Radio	15(3.80)	(-)	1 (1.50)	6 (4.60)	8 (6.20)
Newspaper	65(16.6)	7(11.9)	15(23.1)	24(18.5)	9(14.70)
Family/Friends	33(8.40)	6(10.2)	4(6.20)	13(10.0)	10(7.80)
County health Dept	67(17.1)	1(1.70)	10(15.4)	20(15.4)	36(27.9)
Poster(Water Utility)	19(4.90)	(-)	(-)	9 (6.90)	10(7.70)
Mail (Water Utility)	88(22.5)	36(61.0)	15(23.1)	19(14.6)	18 (14.0)
Phone (Water Utility)	10(2.60)	3 (5.10)	3 (4.60)	(-)	4 (3.10)
Doctor	25(6.40)	5 (8.50)	9 (13.8)	(-)	11(8.50)
Don't Know	43(11.0)	1 (1.70)	4 (6.2)	22 (6.9)	8 (6.20)
Total	391	100	100	100	100

The number of subjects missing data varied by city and was small.

Willingness to Pay for Improvement of City Water

Respondents in the four sample cities were asked whether or not they would be willing to pay a little more for the city to correct any problem related to some aesthetic quality and some contaminants of drinking water. Table 9 shows that residents of Oakland (comparison city) were more willing to pay for both aesthetics and different contaminants than residents of the problem city, Falls City.

Table 9
Willingness to Pay for Improvement of Water Quality by City

	All Cities N=391 n(%)	Falls City N=62 n(%)	Oakland N=66 n(%)	Jefferson N=130 n(%)	Creswell N=126 n(%)
Aesthetics					
Cloudiness	248(64.9)	41(66.1)	45(69.2)	82(63.1)	80(64.0)
Chlorine taste	234(60.9)	32(51.6)	45(68.2)	67(51.5)	90(71.4)
Chlorine odor	228(59.4)	34(54.8)	40(60.6)	66(50.8)	88(69.8)
Hardness	146(38.0)	17(27.0)	20(30.3)	47(36.2)	62(49.2)
Contaminants					
Industrial chem.	295(76.8)	40(64.5)	51(77.3)	99(76.2)	105(83.3)
Agric. chem.	292(76.0)	37(59.7)	53(80.3)	97(74.6)	105(83.3)
Microorganism	300(78.1)	51(82.3)	48(72.7)	95(73.1)	106(84.1)
Lead	305(79.4)	43(69.4)	52(78.8)	105(80.8)	105(83.3)

Of the four aesthetic qualities (cloudiness, chlorine taste, chlorine odor, and hardness), residents in both cities, were shown to be least willing to pay for treating hardness of water. Only 17(27%), respondents in Falls City and 20 (30.3%) were willing to pay for improving hardness.

Jefferson and Creswell residents were more willing to pay for the improvement of contaminants than for aesthetics. Also, Creswell (comparison city) residents expressed more willingness to pay for both aesthetics and contaminants than the problem city, Jefferson. Forty-seven (36.2%) of respondents in Jefferson were willing to pay for hardness, while 62 (49.2%) were willing to pay for it in Creswell.

Reasons for Drinking Bottled Water

Respondents who reported that they drank bottled water regularly (Often, very often and all the time) were asked to rate reasons for drinking bottled water on a scale of one to five (1= Not all important and 5 = Very important). This was to verify the importance of the factors listed in Table 10 (concern about health, dissatisfaction with the city water treatment, contamination or influence of family/friends) to respondents' decisions to use bottled water. The results showed that Falls City residents considered health reasons, concern about filtration, microorganisms and dislike for taste/odor as very important reasons for choosing to drink bottled water. Oakland residents considered, health reasons, bottled water as an alternative to soft drinks, and dislike for taste/odor of water as the three top reasons for using bottled water. Residents of Jefferson reported health reasons, dislike for taste/odor and family members drinking bottled water as very important reasons for using bottled water. Health reasons and dislike for taste/odor emerged as very important reasons for drinking bottled water among residents of Creswell.

Table 10
Reasons for Drinking Bottled Water by City

	All Cities *N=163 Median	Falls City *N=39 Median	Oakland *N=28 Median	Jefferson *N=50 Median	Creswell *N=46 Median
Health reasons	5.00	5.00	4.00	5.00	5.00
Alternative to soft drink	4.00	2.00	4.00	4.00	4.00
Your family drinks it	4.00	4.00	3.00	4.50	3.00
Water not well filtered	4.00	5.00	2.00	4.00	3.00
Don't like taste/odor	5.00	4.50	4.00	5.00	5.00
Industrial chem	3.00	2.00	2.00	4.00	4.00
Microorganisms	4.00	5.00	3.00	4.00	4.00
Agric. chemicals	3.00	2.50	3.50	3.00	3.50
Friends drink it	2.00	1.00	1.00	3.00	3.00

*N include only respondents who reported drinking bottled water regularly

In general, Falls City and Oakland residents did not indicate that the presence of agricultural and industrial chemicals in public water were important enough to move them to drink bottled water. Jefferson and Creswell residents on the other hand ranked industrial chemical and microorganism as moderately important reasons for using bottled water. Health reasons and dislike for odor/taste were commonly reported by respondents in all four cities as very important reasons to drink bottled water.

Bivariate Correlation Analyses

Table 11 presents the bivariate correlation analysis of the relationships among the independent variables (demographic variables, health belief model variables and general risk perception) and their relationship with the dependent variable (Any Action). The dependent variable was negatively and significantly correlated with awareness of public notification (Aware) ($r=-.205$, $p<.05$), but positively correlated with the number of people in a household (HHS) ($r=.225$, $p<.01$) and perceived seriousness (Pser) ($r=.280$, $p<.01$). All the other variables including, perceived benefits (Pben) and perceived barriers (Pbar) did not show any relationship with "taking any action" in response to PN.

Among the independent variables (IVS), awareness of PN showed a negative relationship with HHS ($r = -.119$, $p<.01$), perceived susceptibility (Psus) ($r =-.222$, $p<.01$), and general risk perception (GRP) ($r =-.181$, $p<.01$). The correlation between PN and age was significant ($r = .119$, $p<.05$). Gender correlated with GRP ($r = .190$, $p<.01$). Age was negatively correlated with all the other IVS except for period residency which showed a significant relationship with it ($r =.369$, $p<.01$). The variable HHS showed a significant correlation with income ($r = .238$, $p<.01$), with perceived susceptibility ($r =.121$, $p<.05$) and negatively correlated with period of residency ($r = -.186$, $p<.01$). Home ownership (Own) was negatively and significantly correlated with income ($r =-.123$, $p<.05$) and period of residency ($r = -.126$, $p<.05$) but correlated with GRP ($r = .119$, $p<.05$). Education was significantly correlated with income ($r = .256$, $p<.01$), while income showed a negative but significant relationship with period of residency ($r = -.170$,

Table 11

Correlations among the Independent Variables (Demographic variables, HBM Scales and General Risk Perception) and Response to Public Notification by Taking Any Action

	Act.	Aware	Gend.	Age	HHS	Own	Educ	Inc.	Resd.	Pbar	Pben	Pser	Psus	GRP
Act	1.000													
Aware	-.205*	1.000												
Gend	.058	-.078	1.000											
Age	-.087	.119*	-.056	1.000										
HHS	.225**	-.138*	.022	-.409**	1.000									
Own	.023	.035	.032	-.158**	-.021	1.000								
Educ	.070	-.042	-.024	-.107	.059	-.078	1.000							
Inc	.150	-.015	-.092	-.221	.238**	-.123*	.256**	1.000						
Resid	-.056	.093	.011	.369**	-.186**	-.126*	-.128*	-.170*	1.000					
Pbar	.137	.029	.027	-.013	.053	-.007	.035	.058	-.042	1.000				
Pben	-.018	.080	-.056	-.051	.068	.074	.021	.162**	-.138**	-.016	1.000			
Pser	.280**	-.001	.037	-.020	.019	-.014	-.011	-.002	-.048	.172**	.026	1.000		
Psus	.141	-.222**	.090	-.177**	.121*	.036	-.024	-.040	-.175**	.018	-.157**	.122*	1.000	
GRP	.164	-.181**	.190**	-.172**	.077	.119*	-.062	-.085	-.162**	.025	-.033	.200**	.509**	1.000

* Significant at the 0.05 level (2-tailed) ** Significant at the 0,01 level (2-tailed)

p<.01) and a positive association with perceived benefit (r =.162, p<.01). Period of residency was negatively and significantly correlated with perceived benefit (r = -.138, p<.01) perceived susceptibility (r= -.175, p<.01) and general risk perception (r= -.162, p<.01). The variable perceived barrier was significantly correlated with perceived seriousness (r=.172, p<.01), while perceived benefit showed negative but significant relationship with perceived susceptibility (r =-.157, p<.01). Perceived seriousness was significantly correlated with perceived susceptibility (r =.122, p<.05) and general risk perception (r =.200, p<.01). The highest significant correlation was between perceived susceptibility and general risk perception (r = .509, p< .01), which indicated that the higher an individual's risk perception, the more vulnerable he/she feels about potential health problem of drinking water.

Table 12 displays the bivariate correlation analysis performed to determine the relationships among the independent variables (demographic variables, health belief model variables and general risk perception) and their relationship with the dependent variable (Drinking boiling water). The relationship among the independent variables (IVS) are the same as in correlation matrix presented in Table 10 but the relationship between the IVS and a different DV (Boiling drinking water in response to PN) is presented in the first column of the table. Boiling drinking water in response to PN was negatively correlated with general risk perception (r = -.209, p<.01), and was not significantly correlated to any of the other thirteen independent variables. Table 13 presents the bivariate correlation analysis performed to determine the relationships among

Table 12
Correlations among the Independent Variables (Demographic variables, HBM Scales and General Risk Perception) and Response to Public Notification by Drinking Boiled Water

	Boil.	Aware	Gend.	Age	HHS	Own	Educ	Inc.	Resd.	Pbar	Pben	Pser	Psus	GRP
Boil	1.000													
Aware	.142	1.000												
Gend.	-.128	-.078	1.000											
Age	-.008	.119*	-.056	1.000										
HHS	-.150	-.138	.022	-.409**	1.000									
Own	.016	.035	.032	-.158**	-.021	1.000								
Educ	.021	-.042	-.024	-.107*	.059	-.078	1.000							
Inc	.040	-.015	-.092	-.221**	.238**	-.123*	..256**	1.000						
Resid	-.042	.093	.011	.369**	-.186**	-.126*	-.128	-.170**	1.000					
Pbar	-.099	.029	.027	-.013	.053	-.007	.035	.058	-.042	1.000				
Pben	-.124	.080	-.056	-.051	.068	.074	.021	.162**	-.138**	-.016	1.000			
Pser	-.061	-.001	.037	-.020	.019	-.014	-.011	-.002	-.048	.172**	.026	1.000		
Psus	.003	-.222	.090	-.177**	.121	.036	-.024	-.040	-.175**	.018	-.157**	.122*	1.000	
GRP	-.209**	-.181**	.190**	-.172**	.077	.119*	-.062	-.085	-.162	.025	-.033	.200**	.509**	1.000

*Significant at the 0.05 level (2-tailed) **Significant at the 0.01 level (2-tailed) the independent variables (demographic variables, health belief model variables and general risk perception) and their relationship with the dependent variable (Drinking bottled water in response to PN). The relationship among the independent variables (IVS) are the same as in correlation matrix presented in Tables 11 and 12, but the relationship between the IVS and a different DV (Drinking bottled water in response to PN) is shown in the first column of Table 13. Only income ($r = .336$, $p<.01$) and perceived seriousness ($r = -.233$, $p<.01$) were significantly correlated with the dependent variable. All the other independent variables did not show any relationship with the dependent variable.

In summary, the dependent variable (DV) (Taking any action in response to PN), correlated significantly with awareness of PN, houshold size and perceived seriousness. The second DV, boiling water showed a significant but negative relationship with general risk perception, while the third DV correlated significantly with income and perceived seriousness.

Table 13
Correlations among the Independent Variables (Demographic variables, HBM Scales and General Risk Perception) and Response to Public Notification by Drinking Bottled Water

	Bott	Aware	Gend.	Age	HHS	Own	Educ	Inc.	Resd.	Pbar	Pben	Pser	Psus	GRP
Bottle	1.000													
Aware	.110	1.000												
Gend	.021	-.078	1.000											
Age	.096	.119*	-.056	1.000										
HHS	-.083	-.138*	.022	-.409**	1.000									
Own	-.038	.035	.032	-.158**	-.021	1.000								
Educ	-.061	-.042	-.024	-.107*	.059	-.078	1.000							
Inc	.336**	-.015	-.092	-.221**	.238**	-.123*	.256**	1.000						
Resid	.159	.093	.011	.369**	-.186	-.126*	-.128*	-.170**	1.000					
Pbar	-.050	.029	.027	-.013	.053	-.007	.035	.058	-.042	1.000				
Pben	-.079	.080	-.056	-.051	.068	.074	.021	.162**	-.138**	-.016	1.000			
Pser	-.233**	-.001	.037	-.020	.019	-.014	-.011	-.002	-.048	.172**	.026	1.000		
Psus	-.092	-.222**	.090	-.177**	.121	.036	-.024	-.040	-.175**	.018	-.157**	.122*	1.000	
GRP	.001	-.181**	.190**	-.172**	.077	.119*	-.062	-.085	-.162**	.025	-.033	.200**	.509**	1.000

* Significant at the 0.05 level (2-tailed) ** Significant at the 0.01 level (2-tailed)

Awareness of Public Notification

Awareness of PN was measured because people are likely to take action to protect themselves against a potential health problem if they are aware of a problem. The result of responses to the question on whether subjects in this study heard or read about any problem regarding their city drinking water is presented on Table 14. The level of awareness about PN in the city with a long-term (LT) (Falls City) drinking water problem was higher (85.7%) than for respondents in the city with short-term (ST) (Jefferson) drinking water problem (70%).

Table 14
Awareness of Public Notice by City
(Long-Term Drinking Water Problem/Short-Term Problem)

	Falls City N=63		Jefferson N=130	
Aware of Notice	n	%	n	%
Yes	54	85.7	91	70
No	9	14.3	39	30
Total	63	100	130	100

Health Belief Model Variables

The next section provides results of the analyses of the health belief model variables and general risk perception. Mean scores and standard deviation of the health belief model (HBM) variables and general risk perception by city are presented in Table 15. The range of mean scores for the variables in Table 15 is from 1-5, with higher means representing stronger opinion. Subjects in Falls City showed a lower mean score (mean=3.49, SD= 1.23) for the two perceived barrier variables than subjects from the other cities Oakland, (mean=3.69, SD=1.40), Jefferson (mean =3.73, SD=1.35) and Creswell (mean=3.73, SD=1.26). All the other cities also had higher mean scores than Falls City for perceived benefits and perceived seriousness, but Falls City showed higher mean score for perceived susceptibility (mean=3.35, SD=1.44) than the other three cities, Oakland (mean=2.24, SD=1.24), Jefferson (mean=2.54, SD=1.20) and Creswell (mean=2.26, SD=1.15). The mean score for general risk perception was higher for the two problem cities, Falls City (mean=3.66, SD=.77), and Jefferson (mean=3.33, SD=.77) than for the two comparison cities Oakland (mean=3.23, SD=.73) and Creswell (mean=3.19, SD=.71).

Table 15
Mean and Standard Deviation of HBM Variables and Risk Perception by City

Variables	Falls City	Oakland	Jefferson	Creswell
Perceived Barriers	(n=63)	(n=67)	(n=129)	(n=129)
Mean	3.49	3.69	3.73	3.73
SD	1.23	1.40	1.35	1.26
Perceived Benefits	(n=57)	(n=61)	(n=123)	(n=119)
Mean	3.48	3.75	3.73	3.76
SD	1.11	0.93	1.02	0.89
P. Seriousness	(n=63)	(n=66)	(n=130)	(n=129)
Mean	4.37	4.39	4.47	4.47
SD	0.91	0.99	0.94	0.86
P. Susceptibility	(n=57)	(n=63)	(n=105)	(n=121)
Mean	3.35	2.24	2.54	2.26
SD	1.44	1.24	1.20	1.15
Risk Perception	(n=56)	(n=61)	(n=101)	(n=124)
Mean	3.66	3.23	3.33	3.19
SD	0.77	0.73	0.77	0.71

Hypotheses Testing

Hypothesis 1

This hypothesis stated that there will be no significant differences in risk perception about public drinking water between residents of a community with an on-going (long-term) water filtration problem and residents of a community with a short-term water contamination problem. A t-test was used to measure the difference between the mean general risk perception of residents of the two cities (See Table 16).

Table 16
Differences Between Falls City and Jefferson on General Risk Perception

City	n	Mean	SD	t-value	Prob. t (2-tailed)
Falls City	56	3.66	0.75	2.67	.008
Jefferson	101	3.33	0.74		

The mean value of general risk perception for respondents in Falls City was 3.66 and 3.33 for the respondents in Jefferson. A significant difference in risk perception was found (t=2.67, p= .008) between residents of Falls City and Jefferson with respect to general risk perception about their city drinking water. Falls City residents had higher GRP than did residents in Jefferson. Because a significant difference in general risk perception was found, the first null hypothesis was rejected.

Hypothesis 2

This hypothesis stated that there will be no significant differences in risk perception about drinking water between residents of communities who have a drinking water contamination problem and residents in similar sized communities without contamination problem. The hypothesis was tested using a One-way Analysis of Variance procedure to determine whether there were differences in mean risk perception among residents of the four cities. Result of the analysis revealed a significant difference between the group means (F=5.877, p= .001) as shown in Table 17.

Table 17
Univariate ANOVA for General Risk Perception by Water-Problem Cities

Source	df	Sum of Sq.	Mean Sq.	F Ratio	F Prob.
Between Groups	3	9.380	3.127	5.877	.001
Within Groups	338	179.827	.532		
Total	341	189.206			

This suggests that residents in Falls City with a long term drinking water problem are more likely to perceive risk about their drinking water than are residents in Jefferson, with a short-term problem and cities without a drinking water problem. Because significant differences in risk perception were found between the communities, the second null hypothesis was rejected.

A Post-hoc Tukey HSD test was conducted to determine exactly which means differ from each other. The result is presented in Table 18. It showed that the mean general risk perception (GRP) for Falls City differed from all the other cities, while the means for all the other three cities did not differ.

Table 18
Post-hoc Tukey HSD Test
for Significant General Risk Perception by City

Cities	Means	P-Value
Creswell	3.19	NS
Oakland	3.23	NS
Jefferson	3.33	NS
Falls City	3.66	.0001

Hypothesis 3

Hypothesis 3 stated that there will be no significant differences in response to PN between residents of the community who had a drinking water contamination problem due to flooding and residents of the community with an on-going filtration problem. This hypothesis was tested using Chi-square analysis. The first set of results describe response to PN by boiling drinking water. The second set reported response to PN by drinking bottled water, while the third set of results present response to PN by taking any action.

Boil Water Response: Results showing responses to public notification (PN) by boiling drinking water is presented in Table 19. About one third, (35.2%) of the residents in Falls City who were aware of the PN, boiled their drinking water, while a higher proportion, 35 (64.8%) did not boil their drinking water. Of the respondents in Jefferson who were aware of the PN, a higher proportion of respondents 52 (57.1%) reported boiling their drinking water while 39 (42.9%) did not boil their water as directed by the city water utility.

Table 19
Response to the Boil water Public Notification by City
(Long-Term Drinking Water Problem/Short-Term Problem)

	Falls City Responses N=63*		Jefferson Responses N=130*	
	n	%	n	%
Boil Water Order				
Yes	19	35.2	52	57.1
No	35	64.8	39	42.9
Total	54	100	91	100
Chi-square = 6.539, df =1, significant at p=.011 (2-tailed)				

* N does not include respondents who were not aware of the public notification

A significant difference was found between the two cities with respect to boiling water in response to PN (Chi-square = 6.539, df=1, p=.011), (See Table 19).

Bottled Water Response: Results showed that 35 (63.6%) of residents in Falls City reported drinking bottled water in response to PN while 20 (36.4%) did not. In Jefferson, 70 (76.9%) drank bottled water and 21 (23.1%) did not drink bottled water (Table 20).

Table 20
Response to Public Notification (Bottled Water) by City
(Long-term Drinking Water /Short-term Problem)

	Falls City Responses N=63		Jefferson Responses N=130	
	n	%	n	%
Drank Bottled Water?				
Yes	35	63.6	70	76.9
No	20	36.4	21	23.1
Total	55	100	91	100
Chi-square =2.997, df=1, Not significant at p=.083				

* N does not include respondents who were not aware of the public notification

Chi-square test was used to test for the differences between Falls City respondents with long term (LT) drinking water problem and respondents in Jefferson with short-term (ST) drinking water problem with respect to drinking bottled water in response to the PN. The result is presented in Table 20. No significant differences were found between the two cities (Chi-square 2.997, df=1, p=.083) with respect to drinking bottled water in response to the notice.

Any Action Response: More than three quarters (76.4%) of the residents of the city with a LT drinking water problem who knew about the PN took some action in response to the PN, while 13 (23.6%) took no action. Of the respondents in Jefferson who were aware of the PN, 83 (90.2%) reported taking some preventive action about the problem, while 9 (9.8%) did not take any action (Table 21).

Table 21
Response to Public Notice (Any Action) by City
(Long-Term Drinking Water Problem/Short-Term Problem)

	Falls City Responses N=63		Jefferson Responses N=130	
	n	%	n	%
Any Action				
Yes	42	76.4	83	90.2
No	13	23.6	9	9.8
Total	55	100	92	100
Chi-square 5.191, df=1, significant at p=.023				

* N does not include respondents who were not aware of the public notification

Chi-square test was conducted to test for the differences in the relationship between the city of residence and response to PN. A significant difference (Chi-square = 5.191, df =1, p=.023) was found between residents of the city with a LT drinking water problem and residents of Jefferson who had a ST drinking water problem with respect to taking some action to prevent any potential health problem of drinking water. The result suggests that residents in the community with a long-term drinking water problem responded differently to PN than residents in the community with a short-term drinking water problem. Because a significant difference was found between the cities in response to PN (by boiling and by taking any action), the third null hypothesis was rejected.

Hypothesis 4

This hypothesis stated that there is no significant difference in bottled water use between residents of communities with a drinking water contamination problem and residents of communities without such a problem. The results indicated that among residents of the four sample cities, Falls City had the highest number (27%) of respondents who drank bottled water "All the time" or "Very often" (19%). This compares to 11.9% of Oakland residents who drank bottled water "All the time", and 9% who reported drinking bottled water "Very often". The number of respondents from Jefferson who reported drinking bottled water "All the time" was 13.1%, compared with 9.3% in Creswell (See Table 22). The two comparison cities (Creswell 58.1%, and Oakland 44.8%) showed higher proportion of respondents who had "Never" used bottled water, than was found in Falls City (30.2%) and Jefferson (37.7%).

Table 22
Bottled Water Consumption Patterns of Residents of the Four Cities

	All Cities N=391	Falls City N=63	Oakland N=67	Jefferson N=130	Creswell N=129
	n(%)	n(%)	n(%)	n(%)	n(%)
Bottled Water Use					
Never	173(44.5)	19(30.2)	30(44.8)	49(37.7)	75(58.1)
Occasional	65(16.7)	8(12.7)	11(16.4)	32(24.5)	14(10.9)
Often	63(16.2)	7(11.1)	12(17.9)	24(18.5)	20(15.5)
Very often	34(8.7)	12(19.0)	6(9.0)	8(6.2)	8(6.2)
All the time	54(13.9)	17(27.0)	8(11.9)	17(13.10	12(9.3)
Total	391(100)	63(100)	67(100)	130(100)	129(100)

A Kruskall-Wallis ANOVA was used to test the fourth hypothesis. The result of the analysis showed that Falls City had the highest mean ranking for bottled water consumption (See Table 23). This means that a higher proportion of Falls City residents drink bottled water than the rate found in the other three cities. Bottled water consumption was least common in Creswell. Therefore, the two problem communities had higher rates of bottled water consumption than the comparison cities. Because a significant difference was found in bottled water consumption pattern among residents in the four sample cities (Chi -square =20.119, df=3, p<.0002). The fourth null hypothesis was rejected. This suggests that respondents from Falls City were more likely to use bottled water than respondents from the other ciites.

Table 23
Kruskall Wallis ANOVA for Bottled Water Consumption by Cities

Cities	N	Mean Rankings
Falls City	(n =63)	240.88
Oakland	(n =67)	192.94
Jefferson	(n=130)	200.35
Creswell	(n=129)	168.27
Total N	389	

Chi -Square =20.119, df=3, Significant at p=.0002 (2-tailed)

Hypothesis 5

Hypothesis 5 stated that there is no significant difference in the use of bottled water between residents of the city with a LT drinking water problem (Falls City) and residents of Jefferson with a ST drinking water problem. Table 23 shows that while 27% of respondents from Falls City reported drinking bottled water "All the time", 13% of respondents from Jefferson drank bottled water "All the time" (Table 24). Conversely, more respondents from Jefferson reported that they "Never" drink bottled water (37.7%) than residents of Falls City (30.2%).

Table 24
Bottled Water Consumption Pattern of Residents in Falls City and Jefferson

	Falls City N=63		Jefferson N=131	
	n	(%)	n	(%)
Bottled Water Use				
Never	19	30.2	49	37.7
Occasionally	8	12.7	32	24.5
Often	7	11.1	24	18.5
Very often	12	19.0	8	6.2
All the time	17	27.0	17	13.1
Total	63	100	130	100

The result of hypothesis testing using a Mann-Whitney U procedure showed a significant difference between residents of the two cities in terms of use of bottled water (U=3180, p<.0094). The null hypothesis was rejected because differences exist between residents of the two cites. The higher mean ranking of 111.52 for Falls City suggests that residents of Falls City which has a long-term problem were more likely than residents of Jefferson (89.96) which had a short-term problem to use bottled water (See Table 25).

Table 25
Difference in Bottled Water Consumption by Water-Problem Cities

Cities	N	Mean Rankings
Falls City	(n=63)	111.52
Jefferson	(n=130)	89.96
Total N	193	
Mann-Whitney U=3180, Significant at p=.0094 (2-tailed)		

Hypothesis 6

Hypothesis 6 stated that there will be no significant difference in the use of home water filters between residents of the community who have a long term filtration problem and residents of community who had a short term water contamination problem due to flooding. This hypothesis was tested using Mann-Whitney U procedures. Results showed that the proportion of subjects who reported using home water filters "All the time" since the beginning of the year was 12.7% and 12.5% for Falls City and Jefferson respectively. However, a higher proportion of subjects from Falls City (7.9%) reported using filtered water "Very often" compared to 2.3% of subjects in Jefferson (See Table 26). A higher proportion of respondents in Jefferson (78.9%) reported that they 'Never' used filtered water than respondents living in Falls City (61.9%).

Table 26
Use of Home Water Filters in Falls City and Jefferson (Problem Cities)

	Falls City N=63		Jefferson N=128	
	n	%	n	%
Use of Filtered Water				
Never	39	61.9	101	78.9
Occasionally	7	11.1	5	3.9
Often	4	6.4	3	2.3
Very often	5	7.9	3	2.3
All the time	8	12.7	16	12.5
Total	63	100	128	100

Result of the hypothesis testing presented in Table 27 shows a significant difference between residents of Falls City and Jefferson with respect to the use of filtered water (Mann-Whitney U=3427.5, p<.0303). The residents of the city with a long term drinking water problem were shown to be more likely to use home water filters than residents of Jefferson with a short-term drinking water problem. Because there were differences in the use of home water filters between residents of the two cities, the sixth null hypothesis was rejected.

Table 27
Differences in Home Filtered Water Use by Water-Problem Cities

Cities	N	Mean Rankings
Falls City	(n=63)	105.60
Jefferson	(n=128)	91.28
Total N	191	
Mann-Whitney U=3427.5 Significant at p=.0303 (2-tailed)		

Hypothesis 7

This hypothesis tested whether any of the independent variables, perceived seriousness (Pser) and perceived susceptibility (Psus) to a health problem, perceived benefits (Pben) and perceived barriers (Pbar) of following the public notification (PN) instruction, awareness of PN, gender, age, income, educational level, household size, home ownership, period of residency and general risk perception (GRP) about city water) are significant predictors of following PN instructions.

Table 28
Logistic Regression Model For Demographic Variables, HBM Variables, and Risk Perception as Predictors of Taking Any Action Based on the Receipt of PN (Full Model)

Variable	β	S.E.	P-value	R	OR
Age	-.0246	.6251	.9687	.0000	.9757
Aware	-1.5253	.8327	.0670	-.1240	.2176
Education	.1811	.4104	.6590	.0000	1.1985
Gender	-.2674	.4067	.5108	.0000	.7654
GPR	-.0586	.0677	.3870	.0000	.9431
Household Size	.9878	.5493	.0721	.1183	1.3724
Income	-.9060	.7530	.2289	.0000	.4041
Home Ownership	-.4257	1.3068	.7446	.0000	.6533
Pbar	-.0592	.1371	.6658	.0000	.9425
Pben	.0624	.0938	.5062	.0000	1.0644
Pser	.3922	.1448	.0068	.2458	1.6756
Psus	-.0199	.1019	.8449	.0000	.9803
Residency	.0057	.5013	.9909	.0000	1.0057
Constant	5.4685	3.6492	.0904		
Model Chi-Square =21.069,		df=13,	Sig = .0716		

Dependent Variable: Taking Any Action (1=Taking Any Action). n=130

Three separate standard logistic regressions were conducted to test this hypothesis. Table 28 presents the full model result of the first logistic regression analysis which was run to determine which of the independent variables (IVS) were significant predictors of the probability of responding to PN by taking any action. Overall, 90.18% of respondents were correctly classified by the full model. An Odds Ratio (OR) was used to express the strength of the relationship between an independent variable and the probability that the respondents followed the recommendations. An Odds Ratio greater than one shows an increasing probability of positive response.

Of all the IVS in the reduced model (See Table 29), number of people in the household (HHS) showed a statistical significant (OR= 2.2, p =.0267) relationship with taking any type of action in response to public notification. Perceived seriousness (Pser) also showed a statistical significance of (p=.0009) with an Odds Ratio of (OR= 2.05). This means that the probability of taking any form of action in response to the PN increased 2.05 times as perceived seriousness increased, and as number of people in a household increased the probability of taking any action in response to PN increased 2.2 times. Overall, 83.67% of the respondents were correctly classified by the reduced model.

Table 29
Logistic Regression Model For Demographic Variables, HBM Variables, and Risk Perception as Predictors of Taking Any Action Based on the Receipt of PN (Reduced Model)

Variables	β	S.E	P-value	R	OR
Household Size	.8048	.3631	.0267	.1500	2.2362
Pser	.7204	.2171	.0009	.2637	2.0552
Constant	-1.8428	.9617	.0543		
Model Chi-Square =16.003,		df =2	Sig =.0003		

Dependent Variable: Taking Any Action (1=Taking Any Action). n=130

The second logistic regression model determined the best predictors for boiling water in response to public notification. The full model presented in Table 30 showed that two variables (income and general risk perception) were predictors of the participants' response to PN. Sixty-five percent of the respondents were correctly classified by the full model.

Table 30
Logistic Regression Model For Demographic Variables, HBM Variables, and Risk Perception as Predictors of Boiling Drinking Water Based on the Receipt of PN (Full Model)

Variable	β	S.E.	P-value	R	OR
Age	-.1243	.2141	.5616	.0000	.8831
Aware	-3.2965	11.1288	.7671	.0000	.0370
Education	-.0448	.1197	.7084	.0000	.9562
Gender	.1069	.2287	.6401	.0000	1.1129
GRP	-.8267	.3858	.0321	-.1328	.4375
Household Size	-.1656	.1487	.2655	.0000	.8474
Income	.3247	.1456	.0258	.1422	1.3836
Home Ownership	-.0017	.3298	.9959	.0000	.9983
Pbar	-.0655	.1640	.6896	.0000	.9366
Pben	-.3126	.2359	.1851	.0000	.7316
Pser	.0319	.2349	.8918	.0000	1.0325
Psus	.2755	.2078	.1850	.0000	1.3172
Residency	.0131	.0166	.4283	.0000	1.0132
Constant	6.1020	11.3321	1.5902		

Model Chi-Square = 17.609, df =13, Sig =.1729
Dependent Variable: Boiling Drinking Water (1= Boiling Drinking Water). n=130

Of the two variables (income and general risk perception) that showed statistical significance with the full model, a re-run of logistic regression retained only general risk perception in the reduced model. The negative coefficient means that general risk perception was a negative predictor for boiling water in response to public notification (OR=.57, p=.0194) (See Table 31). Overall, 62.62% of the respondents were correctly classified by the reduced model.

Table 31
Logistic Regression Model For Demographic Variables, HBM Variables, and Risk Perception as Predictors of Boiling Drinking Water Based on the Receipt of PN (Reduced Model)

Variable	β	S.E.	P-value	R	OR
GRP	-.5570	.2382	.0194	-.1387	.5729
Constant	1.9466	.8526	.0224		
Model Chi-Square =	5.775	df = 1,	Sig = .0163		

Dependent Variable: Boiling Drinking Water (1= Boiling Drinking Water). n=130

The third logistic regression model determined the best predictors for drinking bottled water in response to public notification. Table 32 shows the full model for this regression run. Two variables (income, perceived seriousness) were significant predictors of drinking bottled water among those who received PN. The full model classified 77.78% of the respondents correctly.

Table 32
Logistic Regression Model For Demographic Variables, HBM Variables, and Risk Perception as Predictors of Drinking Bottled Water Based on the Receipt of PN (Full Model)

Variable	β	S.E.	P-value	R	OR
Age	.0447	.4316	.9175	.0000	1.0457
Aware	-3.1548	11.1304	.7768	.0000	.0426
Education	.1551	.3167	.6243	.0000	1.1678
Gender	.0569	.2757	.8365	.0000	1.0585
GRP	.4490	.4355	.3025	.0000	1.5668
Household Size	.1803	.1659	.2770	.0000	1.1976
Income	.3705	.1781	.0375	.1358	.6904
Home Ownership	.5501	.4620	.2338	.0000	1.7334
Pbar	.0162	.1870	.9307	.0000	1.0164
Pben	-.1427	.2647	.5899	.0000	.8670
Pser	-.6359	.2572	.0134	-.1806	.5295
Psus	-.3439	.2460	.1622	.0000	.7090
Residency	.0294	.0206	.1542	.0156	1.0299
Constant	4.546	11.3419	.6885		
Model Chi-Square = 24.617,		df=13	Sig=.0259		

Dependent Variable: Drinking Bottled Water (1= Drinking Bottled Water). n=130

The two IVs that showed statistical significance were used to run another regression to produce the reduced model shown in Table 33. Income and perceived seriousness were retained in the reduced model. The result showed that as income increased, the probability of responding to PN by drinking bottled water increased 2.3 times and the p-value was (p=.0003). Perceived seriousness was statistically significant (OR=.49, p=.0042) but was a negative predictor of a subject's response to PN by drinking bottled water. Overall, 74.26% of the respondents were correctly classified by the reduced model.

Table 33
Logistic Regression Model For Demographic Variables, HBM Variables, and Risk Perception as Predictors of Drinking Bottled Water Based on the Receipt of PN (Reduced Model)

Variable	β	S.E.	P-value	R	OR
Income	.8443	.2332	.0003	.2825	2.3262
Pser	.7077	.2472	.0042	-.2110	.4928
Constant	2.3465	1.0987	.0327		
Model Chi-Square =21.206,		df = 2,	Sig = .0000		

Dependent Variable: Drinking Bottled Water (1= Drinking Bottled Water). n=130

In summary, the regression models determined whether any of the independent variables (perceived seriousness and perceived susceptibility to a health problem, perceived benefits and perceived barriers, gender, age, income, educational level, household size, home ownership, period of residency and risk perception about city water) are significant predictors of either boiling water, drinking bottled water or taking any other action in response to PN. Results of logistic regression showed that perceived seriousness and household size were found to be significant predictors of taking any action in response to PN. General risk perception was a significant negative predictor of boiling water, while income and perceived seriousness were significant predictors of drinking bottled water in response to PN.

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

Discussion

The purpose of the study was to assess risk perception associated with drinking water supplied by public water systems and to determine alternative measures that people take in response to public notification (PN). The study also explored whether health belief model (HBM) variables and general risk perception about drinking water were significant predictors of response to PN. The channels regarded as reliable sources of information about drinking water and the respondents willingness to pay for correction of water problems were also evaluated.

This chapter provides a discussion of the results, conclusions and recommendations based on the findings of the study presented in Chapter Four. The chapter is organized in eight sections. The first five sections address specific research questions. The next section presents information sources about drinking water, and discusses respondents' willingness to pay for problems related to public drinking water. The last two sections present the conclusions and recommendations.

Risk Perception About Public Drinking Water

Significant differences in risk perception about public drinking water were found between residents of the community with a short-term (ST) drinking water problem (Jefferson) and residents of the community with a long-term drinking water problem (Falls City). The higher level of risk perception which occurred in Falls City may be due to the fact that the contamination problem has been on-going for several years, and residents have been receiving quarterly notices about the problem. Jefferson residents, on the other hand were notified far fewer times and only during the February, 1996 flooding. Because the problem has been on-going, it may be that the increased awareness and familiarity of the drinking water filtration problem through quarterly PN messages has an effect on risk perception. This explanation is supported by an observation that a person's sense of risk increases as more information about a hazard are read (Sandman, 1986).

Past studies show that women are more concerned about risks than men (Flynn, Slovic & Mertz, 1994). In the present study, the two problem cities (Falls City and Jefferson) had similar percentage of female study participants. Therefore, the higher levels of risk perception among Falls City residents than Jefferson residents is likely to be due to other factors such as the chronicity of the drinking water problem in that city.

The current study, did not support earlier research suggesting that people see familiar hazards (long-term water filtration problem in Falls City) to be less risky, than unfamiliar risks (Sandman, 1986). This is because Falls City residents were found to have a higher level of risk perception than Jefferson residents even though they were more familiar/aware of the drinking water problem in their city than the residents of Jefferson. On the other hand, results of this study support previous studies which have shown that people accept risks related to natural disaster than artificial risks (Hance, Chess & Sandman, 1990). Jefferson residents may have accepted the drinking water problem due to flooding as a natural disaster, thus leading them to exhibit a lower level of risk perception than Falls City residents.

Differences in risk perception regarding drinking water were also found between the two problem cities (Falls City and Jefferson) and the two comparison cities (Oakland and Creswell). Post-hoc analysis showed similar mean general risk perception (GRP) scores for Oakland, Creswell and Jefferson residents, and elevated GRP scores in Falls City. It appears that the long-term awareness/continuity of the drinking water problem in Falls City may have contributed to the higher level of risk perception expressed by the respondents in that city. Further, it is surprising that Jefferson residents showed similar level of risk perception about their city water as respondents in Creswell and Oakland, because Jefferson experienced contamination problems during the flooding of February, 1996, and the comparison cities did not experience any problem. One possible explanation for this finding is that the flooding incident was viewed by Jefferson residents as a transient and therefore, less serious problem.

Response to Public Notification (PN) Recommendation

The study found differences in response to PN (boiling water, drinking bottled water or taking any action) between residents of the city with a long-term (LT) drinking water problem (Falls City) and the city with a short-term (ST) drinking water problem (Jefferson). Approximately one third, (35.2%) of the residents in Falls City who were aware of the PN, boiled their drinking water as directed by the city water utility, while a higher proportion, (64.8%) did not boil their drinking water. Of the respondents in Jefferson who were aware of the PN, a higher proportion of respondents (57.1%) reported boiling their drinking water while (42.9%) did not boil their water as directed by the city water utility. Literature suggests that the level of compliance to boil-water order could be affected by the cost of time and energy (Laughland, Musser & Shortle, 1993).

One explanation for the difference in the response between the two cities may be that the content of the notices given in the two cities was not at all similar. For example, the two notices given in Jefferson in February 1996 following the flood, advised residents to boil their drinking water for a minimum of five minutes due to the presence of microbiological contaminants. On the other hand, residents of Falls City have been receiving quarterly notices stating that "the city water is currently untreated and unfiltered but is disinfected with a continuous supply of chlorine that keeps a residual in the water supply all the time." The notices in Falls City, however, did not recommend any specific remedial action to consumers. Other studies have shown that it is not unusual for public drinking water notices to not specify any remedial action to consumers (Wardlaw, 1986).

Therefore, the higher proportion of respondents in Jefferson (where boil-water order was given) who responded to the PN by boiling their water, could be explained by the fact that the notice was very specific with instructions to boil water.

A lower proportion of respondents in the present study (57.1% in Jefferson, and 35% in Falls City) responded to the PN by boiling their water, when compared to the Milwaukee study which reported that 68% of the respondents boiled their water in response to PN about a drinking water contamination problem (Hurd, 1993). One possible explanation to the somewhat low response (by boiling water) among Jefferson respondents compared to the Milwaukee study might be that the city of Jefferson provided them the option of obtaining drinking water from the Fire Department. Further, studies have shown that people fail to adopt prescribed preventive actions because of the feeling that the effort required of people to avoid the ill-health condition could be more than the potential benefit (Rosenstock, Stretcher & Becker, 1988). Thus, the fact that there was no waterborne disease outbreak associated with the water contamination incident in Jefferson, may have caused people to underestimate the benefit of boiling drinking water and a lower response to PN when compared to the Milwaukee study.

Approximately three quarters (76.9%) of Jefferson's residents drank bottled water in response to PN compared to 63.6% of Falls City residents. This difference could be attributed to the fact that a higher proportion of Falls City residents than Jefferson's had annual household income of less than $15,000. Thus, Jefferson residents with higher income levels had higher proportion of respondents who drank bottled water in response to PN than Falls City residents.

The results also showed that more respondents in both cities chose to drink bottled water in response to PN than boiling their drinking water. This finding might be due to the fact that respondents considered using bottled water to be more convenient than boiling their drinking water; or that they had been using bottled water for sometime as an alternative to drinking public water. Furthermore, bottled water use rose from the usual rate (before PN) of 27% in Falls City to 63.6% as a result of the PN, and from the usual 13% to 76.9% in Jefferson. Bottled water use in response to PN in both cities was higher than the 58% reported by Milwaukee County residents in response to a boil-water order during the Cryptosporidium outbreak (Hurd, 1993).

The third method of evaluating response to PN was to determine whether or not any action was taken by study participants. People's responses to risk messages may range from doing nothing, to using adaptive coping mechanism, to panic (Vining, 1987). The results of this study showed that residents in the community with a long-term drinking water problem responded differently to PN than residents in the community with a short-term drinking water problem. A higher proportion of respondents in Jefferson (90.2%) than in Falls City (76.4%) took some action in response to PN. This result suggests that the public is likely to take action when notified about a problem with their drinking water.

The high proportion of respondents in Jefferson (90.2%) who reported doing something about the notification is comparable to the 84% of respondents reported in the 1993 Milwaukee cryptosporidium outbreak study (Hurd, 1993). The proportion of respondents in this study who reported taking any action is very high compared to a study on consumers' response to a PN (Wardlaw, 1986) in California in which only 20% of the respondents reported taking any action. The low response in that study was attributed to the fact that the notice did not recommend any specific action to consumers.

In summary, most of the respondents who received PN about a drinking water problem responded to the notice regardless of the city of residence. Giving a specific instruction about what prevention action to take may have contributed to the higher response to PN (by boiling) found in Jefferson than in Falls City. The majority of residents in both cities drank bottled water, and the period of time respondents had experienced a drinking water problem (long-term or short-term) did not seem to affect this choice. Also, there was a dramatic increase in bottled water use in response to PN among residents in the two problem cities compared to their usual bottled water consumption patterns before PN was given. The chronicity of the problem, appeared to affect participant's decision to take or not to take any action. Residents who experienced a short-term problem were more likely to take any action than were residents who experienced a chronic problem.

Bottled Water Consumption Patterns

Bottled water consumption patterns of residents of Oregon, and particularly residents in the four sample cities of this study, have not been widely studied. In the present study, bottled water use of all the respondents was evaluated by asking a question about their water consumption pattern before the flooding incident of February, 1996. The results showed that 14% of the study participants drink bottled water all the time. This is comparable to the 12% reported by American adults (Shwartz, 1987). In a more recent study which reported bottled water usage in the western region of the U.S., 16% (n=234) of the respondents reported using bottled water as their only source of drinking water (Hurd, 1993).

Residents of the two problem cities were found to drink bottled water more regularly ("all the time") than the comparison cities (Oakland and Creswell). Falls City also had the highest number of respondents who drank bottled water "All the time" or "Very often" (See Table 22). The fact that bottled water use in Falls City was higher than in all the other cities seems to reflect the long-term water problem in that city. Also, regular bottled water use in Falls City (27%) was higher compared to the 16% regular use reported in 1993 for the Western region of U.S. (Hurd, 1993).

It is important to note that Jefferson did not have any drinking water problem before the flooding incident. Therefore, the higher rate of bottled water consumption reported by residents in Jefferson compared to residents of Creswell and Oakland (non-problem cities) would not likely be explained by the problem associated with flood. One explanation may be that there were other aesthetic problems with Jefferson's water. Past studies have shown that aesthetic values such as color, odor, and taste are some of the reasons people use alternatives to public drinking water (Auslander & Langlois, 1992; Curry, 1983; Walmsley & Wicken, 1992).

Further, the difference in bottled water consumption patterns between residents of the problem cities and the comparison cities could be due to the difference in the levels of risk perception about drinking water. It is possible that the higher level of risk perception about drinking water for residents of Falls City and Jefferson, when compared to Creswell and Oakland residents, was the driving force behind the higher rate of bottled water consumption reported in Falls City and Jefferson.

The present research found that fewer residents in Jefferson (short-term problem city) drank bottled water than those in Falls City (long-term problem city). Respondents in Jefferson reported taste/odor and health reasons as the two top reasons for drinking bottled water. Inadequate filtration of city water, health reasons and concern about microorganisms were reported by residents in Falls City as the top reasons for drinking bottled water (See Table 10). This finding is supported by the results of previous studies which found safety/health reasons, taste of tap water and concern about some contaminants as some of the reasons people drink bottled water (Curry, 1983; GAO, 1991; Lambert, 1993).

Bottled water consumption in Falls City therefore, might be a reflection of the type of drinking water problem (filtration) that exists in that city. When Jefferson residents were questioned about their use of bottled water, they were asked to report on their use before the flooding event. Therefore, the microbiological contamination problem caused by the flooding should not have influenced their answer about bottled water use.

Use of Home Water Filters

The study assessed the differences in the use of home water filters between residents of the community which has a long term filtration problem (Falls City) and the community with a short-term problem (Jefferson). This question was designed to determine whether Falls City residents use home filtered water since they have been receiving quarterly notices reminding them that their city water is unfiltered. Also, it was important to evaluate the use of home water filters because people may prefer the convenience of a home water filter to either boiling their water or purchasing bottled water as precautionary measure against a drinking water contamination problem.

The results showed that residents of Falls City (long-term problem) were more likely to use home water filters than were residents of Jefferson which had a short-term problem. The higher rate of use of home water filters in Falls City could be partly explained by the "chronic" nature of the filtration problem in that city. It is also possible that the wording of the message in the quarterly notice given to Falls City residents for at least four years drove participants to use home water filters. The Falls City notice specifically stated that the city water is "untreated and unfiltered". Thus, Falls City respondents might have reasoned that the use of home water filter was an appropriate way to remediate the filtration problem.

However, it is noteworthy that filters are difficult to maintain and are very selective for the types of problems they can correct. For example, filters have the tendency to harbor bacteria and other microorganisms if the filter cartridge is not changed as often as recommended (NRDC, 1993).

Predictors of Response to PN

The research investigated which of the independent variables (perceived barriers, perceived benefits, perceived seriousness, perceived susceptibility, awareness of PN, age, gender, education, income, household size, home ownership and risk perception) are significant predictors of following PN instructions. Three separate analyses were conducted to determine which variables predicted response to PN (boiling water, drinking bottled water, or taking any action). The results showed perceived seriousness, household size, income, and general risk perception as predictors of response to PN.

The results showing general risk perception as one of the predictors of response to PN is supported by the reports in the literature, that a person's level of risk perception influences the action taken by that individual to deal with the potential health risk (Sandman, 1987; Glik, et al.1991). Risk perception however, emerged as a negative predictor of response to PN by boiling water, which means that as the level of risk about drinking water increases, the less likely the resident is to boil water in response to PN. It is unclear whether this response to boiling water meant that individuals took other preventive action such as drinking bottled water or used home filters.

With regards to PN response by drinking bottled water, income and perceived seriousness of a potential health threat of drinking water emerged as predictors of response to PN. This finding shows that the higher the income, the higher the probability of drinking bottled water in response to PN. This explanation is supported by a recent nationwide study on bottled water use, which showed that the use of bottled water was highest among individuals with high annual household income (over $50,000) (Hurd, 1993). However, it should be noted that the evaluation of bottled water use in that study was not based on people's response to PN.

Perceived seriousness however, was shown to be a negative predictor of the likelihood of drinking bottled water in response to PN. This finding suggests that even if residents perceive problems in their drinking water to be serious, it does not necessarily mean that people respond by drinking bottled water. It may be that other factors (such as cost, the inconvenience of going out to purchase it) might affect a person's decision to not use bottled water.

Household size and perceived seriousness were positive predictors of taking any action in response to PN. This suggests that the higher the number of people in a household, the greater the chance that the something will be done in response to PN. This finding is supported by previous studies which found that individuals tend to underestimate their own risk (Jeffery, 1989), thus the likelihood of taking any action based on one individual's personal perceived threat would be lower than when all family members are perceived to be at risk. It may be that people are more willing to take a chance than having more family members take the chance of getting sick from drinking contaminated water.

Also, the result indicated that people with high level of perceived seriousness, are more likely to do something about PN. This finding is supported by HBM studies which have widely reported perceived seriousness to be associated with taking a recommended action in order to prevent a potential illness (Janz & Becker, 1984; Rosenstock, Strecher, & Becker, 1994).

Sources of Information about City Drinking Water

Respondents were questioned about the sources from which information about city water reaches them. The overall results showed that most respondents (74%) indicated that they obtained information about their city water in the newspaper. Mail (58.6%) and poster from city water (56.8%) were the next popular sources of information indicated by respondents (See Table 7).

In all four cities, mail from city water utility (22.5%) emerged as the most reliable source of information about city drinking water. The County health department (17.1%) was the second-reported reliable source of information, while the newspaper (16.6%) ranked third out of the nine sources evaluated in this study.

Contrary to past studies which show that people regard risk information provided by the government or industry to be less believable than from other sources (Covello, 1993; Fessenden-Raden, Fitchen & Health, 1987), the present study found mail from city water utility to be one of the popular and reliable sources of information about drinking water.

Willingness to Pay for Improvement of City Water

Respondents in the four sample cities were asked whether or not they would be willing to pay more for the city to correct any problem related to some aesthetic quality and some contaminants of drinking water. The results showed that regardless of city of residency, higher proportion of respondents were willing to pay for contaminants than for improvement of aesthetics problems. In all the cities, higher proportion of respondents were more willing to pay for taste, odor, and cloudiness, than for hardness of water.

A higher percentage of respondents in the present study (See Table 9) indicated willingness to pay for the improvement of water quality compared to 20% reported in a California study (Stegman & Schneider, 1982). The result of the present study is comparable to the result of a 1993 national survey on willingness of consumers to pay for drinking water quality. In that study, about 50% of the respondents were reported to be "very willing" to pay for water quality to be brought up to federal standards (Hurd, 1993).

Conclusions

The research showed that a higher proportion of residents of Falls City (with long-term filtration problem) were aware of the PN than residents of Jefferson. This difference in the level of awareness reflects the chronicity of the drinking water problem in Falls City.

Second, the study demonstrated that the chronicity of a drinking water problem affects residents' level of risk perception about drinking water, with residents of Falls City showing higher level of risk perception about their city water than did Jefferson residents.

Residents of the two problem cities also showed higher levels of risk perception than the residents in the two comparison cities (Oakland and Creswell). Thus, risk perception about drinking water appears to be impacted by the level of awareness of a drinking water problem, presence (in problem cities) or absence (in the comparison cities) of a drinking water contamination problem as well as the chronicity of a problem.

Third, a higher percentage of Jefferson residents than Falls City residents responded to the PN by taking any action, and by drinking bottled water. However, there was no statistically significant difference between the cities with respect to drinking bottled water in response to PN. There were differences between respondents in the city with a short-term problem (Jefferson) and the city with a chronic problem (Falls City) with regards to response to PN by boiling water. A higher proportion of residents in Jefferson than in Falls City responded to the PN by choosing this alternative. This difference could be attributed to the content of the notice sent out to residents of the two cities. The notices given in Falls City specified the problem and possible adverse health effect, but they failed to recommend a specific remedial action. The Jefferson notice, on the other hand, specified the problem and provided a remedial action, but it did not give any information regarding adverse health effects of the contaminant.

Fourth, there was a significant difference between the cities with respect to their regular bottled water consumption patterns, with Falls City showing the highest mean ranking of all the cities for bottled water consumption. Health reasons, taste/odor of water and concern about microorganisms emerged as the three top reasons for drinking bottled water. Falls City residents rated filtration problems as one of the topmost reasons for drinking bottled water, which is a reflection of the problem in that city.

Fifth, the HBM variable perceived seriousness, and some demographic factors, as well as risk perception about drinking water were helpful for interpreting respondents' response to PN about drinking water. Income, number of people in a household, level of risk perception and perceived seriousness were predictors of response to PN. Risk perception was a predictor of boiling water as a response to PN, while income and perceived seriousness were predictors of response by drinking bottled water. Perceived seriousness, and number of people in a household predicted response by taking any action. The perceived barriers and perceived benefits dimension of the HBM appeared not to have influenced respondents' likelihood of taking action in response to PN. It is noteworthy that levels of risk perception, and perceived seriousness which emerged as predictors of response to PN, were higher among Falls City residents than residents of Jefferson and the two comparison cities. Thus, the chronic nature of a drinking water problem has an impact on people's response to PN.

Sixth, mail from city water utility, county health department and newspapers were the three top information channels which people reported to be reliable sources through which they get information about drinking water.

Finally, three quarters of the respondents were willing to pay for the improvement of the quality of their city water especially to correct any problem related to chemical and microbiological contamination, than for aesthetics.

Recommendations

One of the objectives of this study was to determine ways of improving public notification programs on drinking water. Based on the findings of this study, it is recommended that notices be sent out concurrently through the information channels (mail from city water, county health department, and newspapers) reported by participants to be reliable. Changing the format of notices especially with long-term drinking water problems which require several quarterly notices is important for the effectiveness of a PN program. Also, specifying what preventive action consumers should take, and the adverse health effects of the particular contaminant in question should be included in the notices. For example, in the present study, residents of Falls City were notified about the unfiltered city water. Many respondents used home filters in response to the notices, which may or may not have been satisfactory. Therefore, it is recommended that notices in Falls City should specify that only National Sanitation Foundation filters be used and for certain purposes. Furthermore, many respondents drank bottled water in response to the PN even though the notices did not specify it. Thus, water utilities should consider giving consumers choices between boiling of drinking water and using bottled water as interim measures until a contamination problem is corrected.

Since perceived seriousness of a potential health problem of drinking water contaminant was important in predicting response to PN, future studies should be designed to determine whether messages which underscore the severity of a potential health problem will have a positive influence on people's response to PN. This could be done simply by stating the adverse effects of the contaminant in the notice. The present study focused on factors that affect people's response to PN, and compared levels of risk perception among participants in different cities, in order to assess the impact of the chronicity of a drinking water problem on risk perception. Further study is needed on other factors that affect risk perception about drinking water, such as demographic variables (gender, education, income, age), and being environmentally conscious, among other factors.

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APPENDICES

Appendix A: Drinking Water Survey Instrument

Hello:

My name is ___________ ___________. I am conducting a survey on people's concerns about their city drinking water. Information collected in the study will be used for a Ph.D thesis at Oregon State University. I need to ask some questions of the adult in your house with the most recent birthday. Is that you?

"YES": I will only need 12-15 minutes of your time. This survey is confidential and participation is voluntary. "Your responses to the questions will help researchers make decisions about how to promote drinking water education. "May I proceed with the questions?".

☞ "YES": GOTO QUESTIONS

"NO": Is that person available? YES: Can you call them to the phone?

NO: When is a good time to call? _____________

"Again NO": "Your responses will not be used to set water rates; nor will your name or responses be released for general use. What you think is valuable to us. Are you sure you don't want to answer?" If "NO" say "thank you for your time." and hang up.

QUESTIONS: Thank you for your time today. No response to these questions is right or wrong. Some of the questions are YES/NO, but others will require specific answers. Here we go.......

Q1. RISK PERCEPTION

I will read you a list of statements describing risks about drinking water. Using a scale of 1 to 5, please tell me how strongly you agree or disagree with each of the statements. "1" means you strongly disagree; "5" means you strongly agree. Ready?

Statement	Strongly disagree				Strongly agree	Don't know
a. It is safe to drink your city water if it is cloudy.	1	2	3	4	5	DK
b. You are afraid of getting sick from drinking your city water.	1	2	3	4	5	DK
c. Filtering your city water at home makes you feel safer drinking it.	1	2	3	4	5	DK
e. If your city water is clear, it can still be unsafe to human health.	1	2	3	4	5	DK
f. If your city water contained chemicals from an agricultural source it would be unsafe to drink	1	2	3	4	5	DK
g. In general, it is likely that you would get sick from drinking your city water.	1	2	3	4	5	DK
h. City water with chlorine odor or taste is unsafe to drink.	1	2	3	4	5	DK
I. If your city water contained chemicals from an industrial source it would be unsafe to drink.	1	2	3	4	5	DK

Q2. INFORMATION SOURCES

2. From which of the following sources do you obtain information about problems with your city drinking water? Please answer YES or NO.

	Information Source	Yes	No
2a.	TV	1	2
2b.	Radio	1	2
2c.	Newspaper or newsletter	1	2
2d.	Family or friends	1	2
2e.	County Health Department	1	2
2f.	Poster from the city water utility division	1	2
2g.	Mail from the city water utility division	1	2
2h.	Phone call from the city water utility	1	2
2i.	Your doctor	1	2

2j . . . . .Other (Specify)

2k. Of the sources I read to you, which one do you find to be the most reliable source of information about your city's drinking water?
(Specify)____________________________________

Q3. AWARENESS

3a. Have you read or heard about any official notice regarding a problem in your city drinking water since January this year ?

YES (1) . . . . ☞ GOTO 3B
NO (2) . . . . ☞ GOTO 4
DON'T KNOW (3) ☞ GOTO 4

3b. Can you tell me what the problem was about? Specify__________________________

3c. Please answer YES or NO to each of the options I will read to you. In response to the notice, what action did you take? Did you...........

Actions Taken	Yes	No
Start filtering tap water for drinking?	1	2
Start boiling tap water for drinking?	1	2
Start boiling but sometimes drank bottled water?	1	2
Start boiling in addition to filtering?	1	2
Start drinking bottled water?	1	2
Take any action?	1	2

Others . . . .(Specify)____________

Q4. PERCEIVED BARRIERS AND BENEFITS

During the February 96 flooding, residents of some cities were asked to boil their CITY drinking water. I will now read you statements that may have affected people's decision to boil their drinking water. Using a scale of 1 to 5, please tell me how strongly you agree or disagree with each of the statements. Again, "1" means you strongly disagree; "5" you strongly agree.

Statement	Strongly disagree				Strongly agree	Don't know
a. Boiling your city water will make you feel safer drinking it.	1	2	3	4	5	DK
b. Boiling your city water will get rid of microorganisms that may be in the water.	1	2	3	4	5	DK
c. Friends would laugh at you for boiling your city water.	1	2	3	4	5	DK
d. Boiling your drinking water is time consuming.	1	2	3	4	5	DK
e. Boiling your city water will get rid of industrial and/or agricultural chemicals that may be in the water.	1	2	3	4	5	DK
f. Changing to boiling your home drinking water will be difficult.	1	2	3	4	5	DK
g. Boiling your city water will protect you from waterborne diseases.	1	2	3	4	5	DK
h. Your family would support you in boiling your drinking water.	1	2	3	4	5	DK
I. Boiling your drinking water reduces your anxiety over it's safety.	1	2	3	4	5	DK

Q5. PERCEIVED SUSCEPTIBILITY
AND PERCEIVED SERIOUSNESS

Now, I will read you a list of statements that describe how concerned you might be about health problems from drinking water. Again, using a scale of 1 to 5, please tell me how strongly you agree or disagree with each of the statements. "1" means you strongly disagree; "5" you strongly agree.

Statement	Strongly disagree				Strongly agree	Don't know
a. You would consider any sickness from drinking your city water to be a serious matter.	1	2	3	4	5	DK
b. Cloudy drinking water poses a health threat to you.	1	2	3	4	5	DK
c. You would consider city water harmful to your health, if it contained microorganisms.	1	2	3	4	5	DK
d. You worry about getting sick fromdrinking your city water.	1	2	3	4	5	DK
e. Your city drinking water does contain contaminants that threaten your health.	1	2	3	4	5	DK
f. You feel vulnerable to illness from your drinking water.	1	2	3	4	5	DK
g. If you had a waterborne disease, it would disrupt your daily activities.	1	2	3	4	5	DK
h. You do not feel that health problems caused by drinking your city water could be serious.	1	2	3	4	5	DK

Q6. DRINKING WATER PRACTICES

I will read you a list of statements which describe peoples' long term drinking water practices. Using a scale of 1 to 5, please tell me how often you used bottled water, home filtered water or how often you boiled your drinking water in the past 6 months. "1" means- Never and "5" means-All the time.

Statement	Never				All the time	Don't Know
a. How often did you drink bottled water purchased from a store since January this year? GO TO Q7	1	2	3	4	5	DK
b. How often did you drink home-filtered water since January this year?. GO TO Q8	1	2	3	4	5	DK
c. How often have you boiled your drinking water since January this year? GO TO Q8	1	2	3	4	5	DK
d. How often did you substitute bottled water for your city water since January this year? GO TO Q7	1	2	3	4	5	DK

If answer to Question #6a is All the time, -- (5) or (4) or (3), Go To Q7; Otherwise GoToQ8. For Questions 6b & 6c Go To Q8 regardless of the responses.
If answer to Question 6d is All the time, -- (5) or (4) or (3), Go to Q7; Otherwise Go to Q8.

Q7. LIKELY REASONS FOR DRINKING BOTTLED WATER

I have a list of reasons people give for drinking bottled water. Using a scale of 1-5, please tell me how important or unimportant these reasons were in your decision to drink bottled water. "1" means Not at all important, and "5" means Very important.

Statement	Not at all Important				Very Important	Don't know
a. Health reasons.	1	2	3	4	5	DK
b. An alternative to soft drinks.	1	2	3	4	5	DK
c. Your family drinks it.	1	2	3	4	5	DK
d. Your city water treatment plant does not filter the city water adequately.	1	2	3	4	5	DK
e. You do not like taste, or odor of the city water.	1	2	3	4	5	DK
f. You are worried about industrial chemicals that may be present in your city water.	1	2	3	4	5	DK
g. You are worried about micro-organisms in your city water.	1	2	3	4	5	DK
h. You are worried about agricultural chemicals that may be in the city water.	1	2	3	4	5	DK
I. Your friends drink it.	1	2	3	4	5	DK

Q8. LIKELY REASONS TO START DRINKING BOTTLED WATER

I have a list of reasons people give for drinking bottled water. Using a scale of 1-5, Please tell me how important or unimportant each of the reasons would be in your decision to start drinking bottled water. "1" Means Not at all important and "5" means Very important.

Statement	Not at all Important				Very Important	Don't know
a. Health reasons.	1	2	3	4	5	DK
b. An alternative to soft drinks.	1	2	3	4	5	DK
c. Your family drinks it.	1	2	3	4	5	DK
d. Your city water treatment plant does not filter the city water adequately.	1	2	3	4	5	DK
e. You do not like taste, or odor of the city water.	1	2	3	4	5	DK
f. You are worried about industrial chemicals that may be present in your city water.	1	2	3	4	5	DK
g. You are worried about micro-organisms in your city water.	1	2	3	4	5	DK
h. You are worried about agricultural chemicals that may be in the city water.	1	2	3	4	5	DK
I. Your friends drink it.	1	2	3	4	5	DK

Q9. WATER QUALITY AND WILLINGNESS TO PAY MORE.

I will read you a list of factors that might affect the quality of your city water. As I read each one, please tell me if you would be willing or not willing, to pay a little more for the city to correct any problem related to each one of them.

Problem	YES	NO
9a. Cloudiness	1	2
9b. Chlorine taste	1	2
9c. Chlorine odor	1	2
9d. Hardness	1	2
9e. Presence of Industrial chemicals	1	2
9f Presence of agricultural chemicals	1	2
9g. Presence of microorganisms	1	2
9h. Presence of Lead	1	2

Q10. DEMOGRAPHIC INFORMATION

a. Gender (By observation)

Male	1
Female	2

b. What year were you born ----------------------

DK/NR ----------------------

c. How many people live in your household? ----------------------

d. Do any of these individuals live in your household currently? Please answer "YES or NO" as I read each option.

Statement	YES	No
Child less than 2 years old.	1	2
Pregnant woman.	1	2
Nursing mother.	1	2
Person with depressed immune system	1	2

e. Do you rent or own a home? (Circle One).

Own	1
Rent	2
Other	3

f. I will read you a list of educational levels, please stop me when I get to the highest educational level you have completed.

Educational Levels	Responses
Less than 8th grade	1
Attended High school but did not graduate	2
High school graduate or GED	3
Community college degree	4
Technical/ Trade school degree	5
Attended College (no degree)	6
College degree	7
Masters degree and above	8
Don't know/No response	9

g. I will read you a list of annual gross household income levels before deductions for income taxes, for the year 1995, please stop me when I get to the income level that applies to your household.

Income Levels	Responses
Less. than $15,000	1
$15,001 - $25,000	2
$25,001 - $35,000	3
$35,001- $45,000	4
$45,001- $60,000	5
More than $60,000.	6
Don't know/No response	7

h. How long have you lived in this community? Years___________

THANK YOU VERY MUCH FOR YOUR TIME.

Appendix B:
Sampling Frame

Community	Sampling Frame (N.)
Falls City	232
Oakland	242
Jefferson	509
Creswell	558

Appendix C:

Proportional Allocation of Sample Size by City

Community	Sample (random)	n_a
Falls City	162	65
Oakland	170	67
Jefferson	355	143
Creswell	390	165

Appendix D:
Data Collection (Phone Calls) Summary

City	Pop-ulation	Sampling Frame	Sample (random)	N/A, Ans. Mach.	Well-water	Disconn-ection
Falls City	818	232	162	49	8	21
Oakland	844	242	170	77	2	6
Jefferson	1805	509	355	96	4	52
Creswell	2431	558	390	90	29	22