PUBLIC PERCEPTION OF, ATTITUDES TOWARD, AND GENERAL KNOWLEDGE OF THE TULSA WATER SUPPLY AND ITS QUALITY

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in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
December, 2006

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ACKNOWLEDGEMENTS

It is with utmost sincerity that I take this special moment to thank those that have endured throughout this struggle. Mother, I thank you for planting the seed in me, loving me, and encouraging me to press forward when no one else believed in me. Father, I suppose that now you finally realize that family always comes first. Michael, my husband, I know from day one you have supported me in this God-ordained endeavor. Thank you for your love and patience with me during this journey. To Morgan and Michelle, I hope that my accomplishments teach both of you that prayer, patience, and persistence are the three necessary ingredients to success. Randolph and Willa Furch, thank you for allowing me to stay at your home during my long trips to and from school. The memories of sitting by the fireplace were lasting.

Dr. Moseley, thank you for helping me begin this journey. I especially thank you, Dr. Caneday, for supporting me in this endeavor from the beginning to the end. Dr. Kimball and Dr. Bryant, thank both of you for stepping in during the later half of this long and tedious journey. Dr. Perry, thank you for being a resolved yet powerful voice that offered words of encouragement when they were needed. I thank Dr. Ted Mills for planting the seed in me during that graduation night in December of 1995. Finally, I thank Arthur and Gayle Webb, for it was a prayer that you voiced that set the stage for this mission.

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CHAPTER I

INTRODUCTION

Potable water is perhaps the most valuable asset that anyone can own. It is believed that this blue gold, extremely vital to every cell of the human anatomy, will be in short supply for the entire world by the year 2020 (Ball, 1999). To each of us it sustains life. Geologically speaking, the Earth is essentially covered with water as a total volume of 325 million cubic miles of the liquid rests upon 70 percent of the surface of the earth (Wright & Nebel, 2002).

After centuries of studying this liquid gold, scientists are able to plot the life cycle of water throughout its many phases. The movement of water between the oceans, air, and land make up the water cycle. Somewhere between the four stages of the hydrologic cycle precipitation, evaporation, condensation, and gravitational flow - a single water molecule spends approximately 400 years in the ocean, 400 years on the land surface of the earth, and roughly 10 days as vapor in the atmosphere (Allaby, 1996).

The total amount of water on the earth is roughly 1.4 billion cubic kilometers (Pielou, 1998). The amount of freshwater in the world is 36 million cubic kilometers (Pielou, 1998). Of the entire content of the water in the world, 97 percent is classified as ocean seawater and can be found only in the oceans (Allaby, 1996). Unfortunately, in its rawest form, seawater is not suitable for human consumption. Therefore, to find suitable

sources of drinking water, we are forced to make rivers, lakes, and underground aquifers our primary sources (Allaby, 1996). The second largest accumulation of the earth's water (2%) can be found in ice caps and glaciers (Botkin & Keller, 2000).

For years scientists have concluded that water, both salt and fresh, flows through a closed pathway known as the water cycle. However, by the 1980s, researchers pronounced a new theory in regard to the hydrogen-oxygen bond. The theory, according to E.C. Pielou (1998), concludes that the water supply of the earth is not closed and continues to grow at a slow place. Scientists propose that "snowballs" or *small comets* comprised of almost pure snow are entering the earth from outside the solar system. Once these 20 to 40 tons of snow enter earth's gravitational field they are pulled to the surface and melt and vaporize during their descent. Researchers estimate that if this phenomenon has been occurring since earth's beginning, then an estimated three trillion tons of water have been added to the earth.

Despite water's seemingly limitless ability to travel, this renewable resource must still be managed, purified, and eventually transported to those in need. With a thorough understanding of the chemical make-up and flow of the colorless liquid, one can only assume that humans would make every attempt possible to protect and preserve their most valuable asset, liquid water. As a renewable resource, water appears to be unevenly distributed throughout the earth. Unfortunately, despite its vast ability to travel, in many locations, it remains a task to find suitable drinking water.

Yet another factor that makes it difficult for mankind to find freshwater is water pollution. Over the years this problem has grown due to an increasing population and an increase in the usage of natural resources and materials (Wright & Nebel, 2002). In the

United States, through the ages, engineers and scientists have learned how to better manage the flow of water. Although great progress has been made in this field, there are still consequences to the mismanagement of storm water run-off—flooding, stream-bank erosion, and increased pollution (Wright & Nebel, 2002). Of greatest concern is increased water pollution. Richard Wright and Bernard Nebel (2002) note that water stewardship is an attitude of both active care and concern for water that guides our ethical decisions. In a further explanation of water stewardship, Nebel mentions the World Water Forum and its conclusion that there is not necessarily a lack of availability of fresh water for the world, but rather there is an inability to manage the water that is available. In the U.S., the top polluter of waterways is agriculture (Spellman, 1998).

Statement of the Problem

There have been many studies on the scientific and analytical effects of on-going water pollution and quality issues between the state of Oklahoma and the state of Arkansas. However, exact research about public perception, attitudes and general knowledge of Oklahoma's second largest city's water supply, Tulsa, is rather limited and underdeveloped. One important area of inquiry, then, is to identify the perception and attitude of the city's citizens toward the water quality problem. Such an inquiry would allow those who openly expect safe drinking water to understand attitudes and misperceptions that need to be addressed in order to make the drinking water more viable and safe for the customer.

Purpose of the Study

The purpose of this investigation is to identify the public's perception, attitudes, and general knowledge of the water quality for the city of Tulsa, Oklahoma. Public perception will be examined in terms of knowledge of the risks of contamination to drinking water. The attitudes of people will be studied as they relate to taste, odor, and interest in water quality, and the attitudes regarding the taste and odor of the drinking water. The goal, in terms of subject selection, will be to get members of the general public who have varied interest in water quality as well as a balance of the members of the public regarding their gender, age, race, and economic status.

Significance of the Study

This study is significant for a number of reasons. Although research does exist that examines public knowledge and perception of drinking water quality in other states, there is very little research that has been done about public knowledge and perception in regard to water quality in Tulsa, Oklahoma. Due to the on-going water quality litigation between the state of Oklahoma and the state of Arkansas regarding the effects of poultry waste, the perception and attitude in regard to water quality of those directly affected by the allegation of water pollution is an area that should be explored and researched as it will bring forth greater understanding to the current body of professional literature on water quality research. In addition, this study can be an important asset in reminding those involved that education is also a valuable tool when discussing the scientific principles behind water quality.

Research Questions

The following research questions were the basis of this study:

1. What is the public's perception, in Tulsa, Oklahoma, of drinking water quality concerning taste and odor across race, gender, income, and age lines?

2. What is the public's general knowledge of drinking water quality in Tulsa, Oklahoma in terms of participation and general knowledge of rules and regulations across race, gender, income, and age lines?

3. What is the public's attitude regarding water quality?

The first and second research questions are further defined and tested as hypotheses. These hypotheses are expressed in the null form, allowing the researcher to make a decision on each aspect of the hypotheses, thereby permitting a decision on the research question.

- H_o related to Research Question 1: There are no significant differences in perceptions of drinking water quality in Tulsa among residents as related to taste and odor across groups by race, gender, income and age.
- H_o related to Research Question 2: There are no significant differences in general knowledge of the drinking water quality in Tulsa among residents as related to taste and odor across groups by race, gender, income and age.

Definition of Terms

The following terms have been defined to add clarity to this study:

Attitudes - Describe how people feel about something (Dillman, 1978).

U.S. EPA - United States Environmental Protection Agency. Formed in 1969 to protect the environment against pressures from other governmental agencies and from industry, on behalf of the public.

General Knowledge - Relating to or including members of a category that possess information, facts, ideas, or truths (Encarta MSN Dictionary, n.d.).

Groundwater - Private property that belongs to the overlying surface owner but is subject to regulation by the OWRB—Oklahoma Water Resources Board (Oklahoma Water Law and Administration, n.d.)

Non-Point Source - The discharge of pollution from an unknown source such as agricultural run-off, storm-water drainage, and atmospheric deposition (Wright & Nebel, 2002).

Odor - A smell whether pleasant or unpleasant (Merriam-Webster, 1998).

Perception - Capacity for understanding; Observation (Merriam-Webster, 1998).

Point Source - The discharge of pollution from known sources such as factories, sewage systems, power plants, and oil wells (Wright & Nebel, 2002).

Stream Water - Public water subject to appropriation (Oklahoma Water Law and Administration, n.d.).

Taste - To test the flavor of something by taking a little into the mouth (Merriam-Webster, 1998).

Water Quality Act (1987) - Addresses regional pollution with a watershed approach; requires states to address and deal with non-point source pollution (Wright, 2002).

Water Pollution - The human-caused addition of any material in amounts that cause undesired alterations to the water (Wright, 2002).

Watershed - The total land area that drains directly or indirectly into a particular stream or river (Wright, 2002).

Scope of the Study

This study involves surveying members of the general community located in the city of Tulsa, Oklahoma. Since this is a commonly explored area of research, a survey was designed to meet the specific needs of this particular study by adapting a tool from a public opinion poll conducted within the state of Illinois. The goal was to survey people who have limited and/or no special knowledge regarding the drinking water quality of the city of Tulsa, but who are customers of the Tulsa water utility. The history of the city of Tulsa details a place that once flourished during the days of the Black Wall Street and the oil boom. In what many consider to be an ideal place to raise a family, the leaders of the city struggle to bring Tulsa back to the prominence that it once boasted about in the past. This study took place during 2006. Members of the general public were sought from residents that live in the city of Tulsa.

Limitations

There are several limitations in this study regarding the water quality issue that affects the northern half of the city of Tulsa. The first was the number of participants. An attempt was made to get a broad representation of the general public by surveying approximately 300 people within the Tulsa community. A second limitation was the focus on the water quality issue that affects those participants that receive water from the

Mohawk treatment water plant, which services north and west Tulsa, as opposed to the A.B. Jewell water plant.

Additionally, no randomization techniques were used. The final limitation is the fact that only the viewpoints of the community members that reside in the 74105 zip code area of the city of Tulsa were explored. Ideally, the input of city water quality samplers and tasters, and others involved in the overall upkeep of Tulsa's water would be beneficial in obtaining a more well-rounded understanding of the functions, but, this particular limitation is necessary to make the study more manageable.

The fact that the researcher is a citizen of the city of Tulsa who both resides and works within the northern half of the city is a limitation as it presents a challenge to keep bias out of the research and paper. Finally, a delimitation exists related to the boundaries that are the framework for this study. The delimitation is the notion that the final survey may not be able to get all of the possible perceptions that people may have regarding the water quality and taste problem that affects the northern half of the city of Tulsa.

Assumptions

Several assumptions were made in the scope of this study. The first assumption was that the subjects responded honestly to the questionnaire. Secondly, it is assumed that the subjects understood the content of the survey items and questions being asked of them. A third assumption was that the subjects have a fairly accurate understanding of what qualifies as water quality in regard to taste and odor, and, their perceptions are based on that understanding.

CHAPTER II

REVIEW OF LITERATURE

Introduction

To fully understand the scope of this dissertation it is imperative that one is familiar with water and the perception that the general public possesses in regard to clean and safe water. Such an understanding will help establish the reason people have certain perceptions and attitudes toward water quality, which, in turn, has an impact on people's perceptions and attitudes toward the taste and odor of their drinking water. Additionally, it is important to understand the city of Tulsa, Oklahoma, in terms of history as this factual information addresses some of the long-standing issues that have long haunted and segregated the city of Tulsa. A thorough understanding of these facts will be beneficial in exposing the reasons people have certain perceptions and attitudes in regard to the water quality issue.

Water Quality

Water quality refers to the attributes that make water colorless and odorless and free of any toxins or organic materials (Spellman, 1998). In addition, water quality is a major focus of this study, particularly as perceived by residents of the city of Tulsa.

Over the years the global demand for water has grown. With the general predictability of the weather it can be statistically noted that overall, the amount of

precipitation remains almost constant on a yearly basis. Population surges throughout the world have made water a natural resource that, unless it is reused, a necessity that may often be difficult to attain. Specifically, in the United States, personal water usage has increased dramatically with the addition of in-home laundries, automatic lawn sprinklers, and extra bathrooms (Spellman, 1998). Additionally, technological advances have led to the increased use of water in the industrial field. Personal and industrial demands are two factors that have altered the supply and demand for potable water. And, as the population of the world increases so too does the global demand for water (Spellman, 1998).

Approximately 90% of drinking water consumed in the U.S. is supplied from groundwater (Spellman, 1998). A large portion of the drinking water in America is provided through a multitude of community water supply systems while a smaller percentage is supplied by private water wells. Prior to distribution to the public, water collected from water supply systems is cycled through a series of treatment conditions to ensure that the water that finally leaves the tap is clean. Polluted or untreated water can contain contaminants that present both internal and external health risks to humans (Spellman, 1998).

Technological advances in medicine and science have afforded the American public the opportunity to expect safe drinking and recreational waters. Yet, America's waterways are continually engulfed with excessive aquatic growth, oil slicks, sludge worms, and an increase in carp. Scientists now wonder whether water quality in the United States, a leader among many nations, has improved since the introduction of water quality ideals in the early 1900s (Spellman, 1998).

Regulation of Water Quality

The policing of water and its many impurities have been on the increase since the early 1900s. The first federal law implemented that actually addressed water pollution in the United States of America was the Rivers and Harbors Appropriations Act (Appendix D), also known as the Refuse Act, which was passed in 1899 (Adams et. al, 1997). The problems of the past were not as elaborate as the problems of today, and the basis of the Refuse Act was to protect the navigation of America's waters and not the overall quality. As time passed overseers of the Refuse Act began to base their pursuit for clean water on the only known water law in effect, the Refuse Act of 1899. As the quality of water in the nation's waterways slowly began to decline, the initial goal of regulating water quality evolved into ensuring that the health of the general public was not affected (Spellman, 1998). The early goals of water scientists were to remove suspended material, treat biodegradable organics, and eliminate pathogenic organisms (Spellman, 1998). Eventually, to offset the aforementioned problem, wastewater treatment plants were constructed to control the discharge of wastewater into the environment.

As the nation continued to flourish so too did the growth of aquatic plants in polluted waters. By the 1970s leaders began to recognize the need to improve technologies in the treatment of drinking water and wastewater. The year 1972 led to national guidelines that would become the basis for the Water Pollution Control Act and Amendments, also known as the Clean Water Act (CWA) (Spellman, 1998). Found in the Code of Federal Regulations (CFR), Title 40, Parts 121 through 122, the CWA was a result of Congress' answer to President Nixon's veto in 1972 of their proposed Federal Water Pollution Control Act (Adams et. al, 1997). The act required that the United States

Environmental Protection Agency (U.S.EPA) set general standards for wastewater discharges (Spellman, 1998). The basic premises of the act provided for limitations on the pollution that industries were discharging into the nation's waters, water quality standards, and a program that required entities to obtain permission to discharge waste into water (Spellman, 1998). Specifically, this act was important because it called for the formation of a National Pollution Discharge Elimination System (NPDES). Under the NPDES guidelines, each company that wanted to discharge waste into American waters was required to obtain a permit that documented the secondary treatment of the wastewater and whether or not the company utilized the best method available to treat the effluent.

Branching from the basic 1969 National Environmental Policy Act (NEPA), Congress' first response to protect the American environment, the Safe Drinking Water Act (SDWA) was passed in 1974. The SDWA granted the U.S.EPA the power to regulate the contaminants that were discovered in public drinking water systems that serviced twenty-five or more customers (Spellman, 1998). Extrapolating from this mandate, the U.S.EPA established that there was a maximum level of contaminants that could be contained in the drinking water that is delivered to the general public. If, by chance, testing proved that this maximum level of contaminants was violated the public utility system provider was obligated to make necessary adjustments to remedy the problem.

To date, both the CWA and the SDWA have proven to be effective in ensuring that U.S. waterways are properly policed. However, one has to wonder if, as a nation, we are being effective in our effort to protect a human necessity. Additionally, the SDWA has set a standard limit on the amount of contaminants that can be allowed in public

drinking water despite the fact that scientists have noted that the allowed contaminants can have an adverse affect on the health of humans. Finally, despite the fact that a majority of the public drinking water systems ensure compliance by determining that their product remains at or below the maximum level of contaminants, the odor and color of the product that they continue to offer varies greatly. And, unfortunately, odor and color issues are not usually addressed until the public complains (Spellman, 1998).

Water Treatment

In general, water that exits the tap has undergone some type of treatment. The purpose of treating the water is to remove impurities that are hazardous to the health of the general public. Normally, the responsibility of treating the water lies with the local public water company. The particular treatment method that the utility company utilizes relies heavily upon the source of the drinking water. Surface water normally requires filtration and disinfection while groundwater normally requires the removal of hard minerals such as calcium and magnesium (Spellman, 1998).

Typical steps in the water treatment process call first for the screening of the raw water to remove large debris such as rocks, leaves, and tree limbs. This is commonly done by guiding the raw water through wire screens. Following the screening process the water is mixed with chemicals that force solids to bind together to create larger more visible solids. This process is continued to allow the particles to coagulate and become bigger to allow for their removal. Next, the coagulated water is held in a tank where flocculation, slow mixing of the chemicals with the water, takes place for approximately thirty minutes (Spellman, 1998). The result is the formation of larger particles of floc

material.

Sedimentation occurs next as the water rests in a clarifier for approximately one to ten hours. During this phase the water sits long enough to allow the larger, suspended solids to settle at the bottom of the tank. The water from the tank is then filtrated to remove any suspended material that was not eliminated during any of the prior treatment steps.

Finally, the water is disinfected to destroy or inactivate disease-causing organisms (Spellman, 1998). In areas where water is "hard" yet another step is introduced in the treatment process to remove the excess calcium and magnesium.

The water that the city of Tulsa supplies to all of its citizens is processed through a similar format. Both the A.B. Jewell and the Mohawk Water Treatment Plants follow the same procedure. The whole process begins with the screening of raw water as it flows into the plant through chambers where wire screens accumulate the large rubble that, if allowed to pass through, would damage the equipment. Following the screening phase of the water treatment process carbon powder is added to the water to control both the taste and odor of the water. Additionally, potassium permanganate and chlorine are added to control organics (City of Tulsa Water Treatment Process, n.d.). Next, the water enters into one of four clarifier basins. In the clarifier basin, flash mixers quickly and uniformly combine chemicals with the water to form heavy clumps of materials. These chemical coagulants act like large magnets by pulling smaller contaminants toward the larger clumps. The technical term for the large clumps of waste is "floc" (City of Tulsa Water Treatment Process, n.d.). During the next phase, flocculation, the large heavy clumps of floc begin to sink to the bottom. The lighter particles of impurities are left floating in the

water where they are eventually removed by sedimentation and filtration. Both the A.B. Jewell and the Mohawk Water Treatment Plants have four clarifier basins that have the ability to treat 30 million gallons of water per day (City of Tulsa Water Treatment Process, n.d.).

Next the water enters into the sedimentation basin. The purpose of the four-zone sedimentation basin is to slow the flow of the water to allow gravity to pull any remaining suspended particles to the bottom. In the inlet zone of the sedimentation basin the flocculated water is distributed evenly throughout the entire basin. From there it travels to the settling zone, the largest portion of the basin, where the moving water rests undisturbed to allow remaining suspended particles the opportunity to settle. Once the settled particles reach the bottom of the basin, also known as the sludge zone, they are scraped away, pumped out, and the remaining water is compressed out by belt presses. Finally, the water is slowly ushered out through the outlet zone.

Next the water enters into the final phase of solid removal as it travels through a bed of material (sand or coal) where particles that did not settle out in the basins are finally removed. Both the A.B. Jewell and the Mohawk Water Treatment Plants have twelve filters that are six feet deep and contain approximately forty-five to sixty inches of granular activated carbon over twelve inches of sand (City of Tulsa Water Treatment Process, n.d.).

To end the entire process the filtered water flows into a clear well, a ten million gallon underground tank, where chlorine is added to kill germs that cause diseases. The now disinfected water is pumped by six pumps to the system to be distributed.

In an effort to prepare for the future, both water treatment plants have been equipped with hydraulics and piping that would allow for the easy addition of more equipment should the need arise (City of Tulsa Water Treatment Process, n.d.).

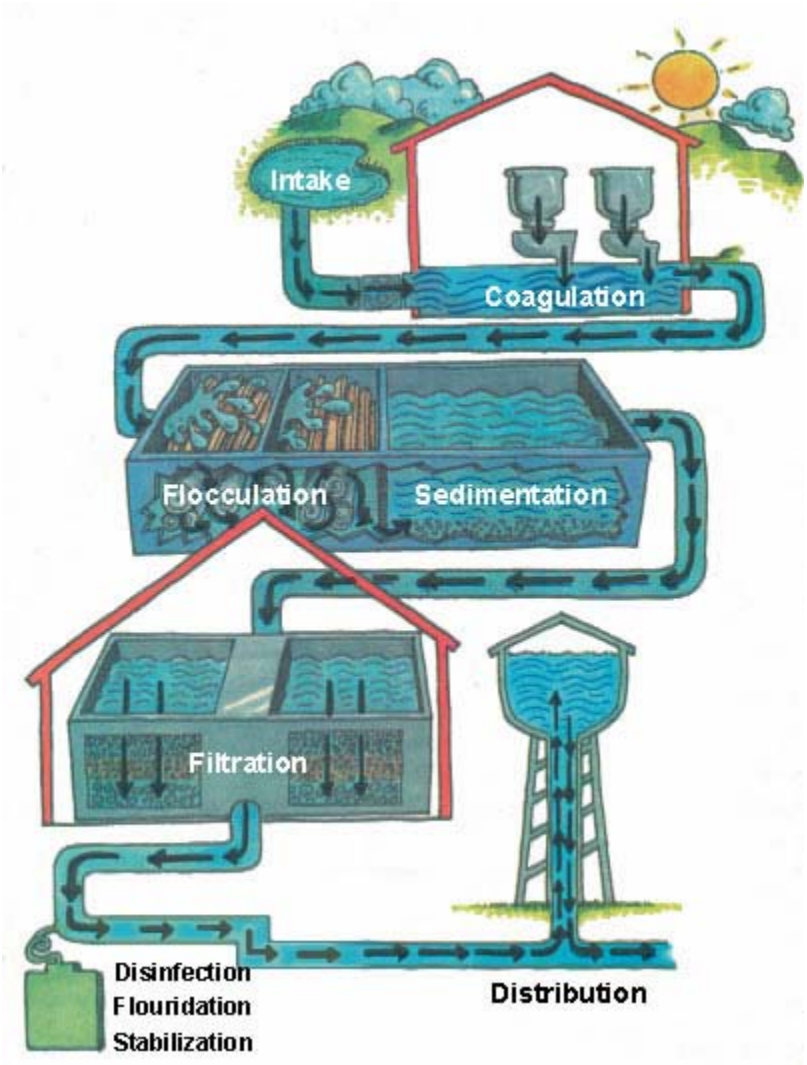

Figure 1: Water Treatment Process

Water Quantity

Over the past few years the importance of water has increased. Why is it that this precious renewable, natural resource, which is continually replenished through the hydrologic cycle, is on the verge of becoming rare? Approximately thirty trillion gallons of freshwater are recycled from the sea to the land on a daily basis yet only a third of that quantity is readily available for us to consume (Ball, 1999). Between 1950 and 1990 statisticians have discovered that world water use tripled, and that in 1996 humans were consuming over half of the available water (Ball, 1999). If these rates continue to persist, and it is likely that they will considering the fact that the population continues to increase, it is predicted that the availability of freshwater will eventually decrease (Ball, 1999).

Safe and clean drinking and recreational water is now a highly valued resource to the entire world. In the March 2005 issue of the *Journal of American Water Works Association* editors noted that both the Secretary-General of the United Nations and the Administrator of the United States Environmental Protection Agency have anticipated that in the future there is the possibility that international wars may occur over the declaration of water rights. The rationale behind their prediction lies in the fact that humans have continued to populate areas where water is in short supply.

Californians have improved upon irrigation methods first introduced by the Romans in A.D. 312 as they have managed to spend billions of dollars diverting water to an area where it does not normally flow (DeVilliers, 2000). With an annual diversion of four million acre-feet of water to their state which rests near a salt-water ocean, California has managed to make a state, scientifically classified as desert, flourish (DeVilliers, 2000).

The average citizen of the United States of America consumes more than one hundred times the amount of water consumed by a citizen of Uganda (Ball, 1999). Citizens of Western Europe use an average of approximately 25 to 70 gallons of water per person per day; further, in Europe, almost 80 percent of the water diverted for domestic and industrial uses ends up as waste (Ball, 1999). In Asia a mere 62 percent of its total domestic and industrial water used is actually consumed (Ball, 1999).

As the world population continues to rise the overall demand for freshwater will increase. United Nations Educational, Scientific, and Cultural Organization (UNESCO) predicts that by the year 2020 there will be a serious shortage of available freshwater throughout the world (Ball, 1999).

Water Law

With the predicted looming worldwide shortage of available freshwater it is important to focus on the governance of this recyclable resource. In an effort to define international water law the United Nations organization constructed the Food and Agriculture Organization (FAO) and in 1978 they compiled a list of international waterways of interest (DeVilliers, 2000). According to DeVilliers (2000), history has produced three groups that have attempted to define water rights in an effort to ward off water wars. The first is the Institut de Droit International, the International Law Association (ILA), and the International Law Commission (ILC). The Institut, founded in 1873, is a non-official organization that has played major roles in diplomatic negotiations. Also founded in 1873, the ILA is a professional body comprised of many different countries. The 34 elected-members of the ILC are the most prominent as it was

created by the United Nations (UN) to work first hand on projects recommended by the UN. The ILC notes that even though everyone should have the equal opportunity to utilize available waters, no one has the right to harm water that is valuable to other states (DeVilliers, 2000).

In the United States, laws regarding water rights vary between each state. The state of Wyoming rules that whoever first establishes that he/she possesses the right to utilize water to irrigate is the holder to one cubic foot of water per second for every 70 acres of land (DeVilliers, 2000). Additionally, Wyoming leaders ruled that if a person does not use his/her water for five years then they relinquish their right to claim possession of the water (DeVilliers, 2000).

Initially, the oldest right to the use of groundwater in the mid-western state of Oklahoma granted 12 acre-feet of water per year to interested parties (Oklahoma Water Atlas, 1990). Following the passing of the Reclamation Act in 1902, studies were completed to determine how adequately supplied watersheds could be utilized. The results of the 1905 study generated the first water law in Oklahoma which stated the appropriate steps to take to acquire water rights and listed regulations to use of water (Oklahoma Water Atlas, 1990). A repeal of the Oklahoma Groundwater Act of 1949 concluded that groundwater must be put to beneficial use within five years of acceptance of an official application, or, like Wyoming, the right to the water will be relinquished (Oklahoma Water Laws and Administration, n.d.). Additionally, in the state of Oklahoma, the average amount of use of groundwater granted to applicants is two acre-feet per year per acre of land owned (Oklahoma Water Law and Administration, n.d.).

Water Pollution

As the world's population continues to grow and develop mankind has found that pollution of all sorts continues to increase as well. In today's complicated society it is still hard to imagine that an issue of the past continues to be a problematic issue of the present, and, possibly the future. As the population of the world increases so too does the need to utilize to the fullest all of the natural resources that continually cycle throughout the earth. As in the early days of its transition from Tallasi to Tulsa, polluted water has been and continues to be a major issue for city leaders. According to Nebel and Wright, pollution, in terms of water, "is "contamination with undesirable amounts of material or heat. The material may be a natural substance or a synthetic substance" (Wright, 2002). Most water pollution is produced by humans, and, because of this fact, it is possible to discern from whence the pollution originated. Scientifically speaking, water pollution evolves from either a point source or a non-point source. Point source contamination sites refer to the discharge of materials from power plants, oil wells, sewage systems, and factories. Non-point source contamination refers to runoff from croplands and storm-water drainage from lawns and streets (Wright, 2002). In an attempt to control water pollution scientists recommend first, that the primary source of the pollution is identified and the pollution is then reduced and/or eliminated, and prior to discharging the water into the system it is recommended that it is thoroughly treated to reduce and possibly remove all pollutants (Wright, 2002).

One such troubled watershed is the Mississippi River. This large watershed encompasses forty percent of the land area of the United States. As the Mississippi River flows naturally to, through, and around pastures and green fields, it collects water that it

eventually carries to the Gulf of Mexico. As America has increased its production of agricultural growth this particular watershed has experienced an alteration due to the increased application of fertilizer on the agricultural fields. Simultaneously, wetlands that bordered rivers were drained of their water and thus were no longer capable of holding agricultural runoff. The final result was an excess amount of nitrogen that eventually made its way to the Gulf of Mexico and created a dead zone—an area where oxygen no longer exist in the bottom sediments, a phenomenon that normally occurs naturally over an extended period of time. What happened? Eutrophication happened (Wright, 2005).

Eutrophication

A eutrophic lake is an old lake that has a relatively high level of chemical nutrients (Botkin & Keller, 2000). A eutrophic lake is commonly recognized by its surface that has a covering of green algae. The process of eutrophication occurs when an oligotrophic lake becomes overloaded with nutrients. To thoroughly understand the process of eutrophication, often referred to as "well-nourished", one must begin by looking at the natural life of phytoplankton and benthic (aquatic) plants (Wright, 2002).

Benthic plants, those plants that grow roots in the bottom of a body of water, can exist solely under water as submerged aquatic vegetation (SAV) or partially under water as emergent vegetation (Wright, 2002). These underwater grasses provide a source of food and shelter for fish, waterfowl, and other animals within the ecosystem. Through the summer months SAV play an essential role as they absorb excess nutrients from water, mainly nitrogen and phosphorus, and make them unavailable for use by the algae (Chesapeake Bay, 1979).

Phytoplankton are microscopic plants that live in water (NASA, n.d.). Similar to land plants, phytoplankton contain chlorophyll and need sunlight, water and nutrients to grow (NASA, n.d.). These microscopic plants live suspended in the water but are commonly found near the surface of the water where sunlight is readily available. In ideal conditions, phytoplankton live for approximately one to two days. Studies indicate that these two types of aquatic plants are over-nourished when excess amounts of nutrients are introduced into the watershed.

Eutrophication is the natural aging process of a lake (Allaby, 1996). With the recent introduction of pollutants into watersheds scientists have discovered that the once natural process of eutrophication has been altered. Cultural eutrophication occurs when humans do something to speed up the natural aging process of lakes (Botkin, 2000). Looking at the natural balance of phytoplankton and SAV it is easy to note how an excess of nutrients can cause an imbalance. In most cases, the major nutrients responsible for the eutrophication of watersheds are nitrogen and phosphorus. Both nutrients can be found in human and animal waste products, fertilizers, certain plant material, and detergents and are introduced into the ecosystem by either point or non-point sources (Lemons, 1996).

Nitrogen is important to the life cycle of plants as they readily accept the nutrient in the form of nitrate (NO_3) (Allaby, 1996). In much the same manner as when phosphorus is applied to suburban lawns as fertilizer, it increases the growth of grass, and, in the case of eutrophication, the growth of bacteria and algae in the water (Botkin, 2000).

First, the excess amount of nutrients promotes the increased growth of phytoplankton (Wright, 2002). In the case of cultural eutrophication, as the water

becomes cloudier, or turbid, the photosynthetic process begins to decrease at certain depths within the water. The algae photosynthesize during the day and use large amounts of dissolved oxygen (DO) during the night (Lemons, 1996). Eventually, as the algae die, their remains sink to the bottom and are decomposed by aerobic bacteria. In turn, because of the increase in food supply, the bacteria secure the oxygen they need from that dissolved in the water. Over time, the water becomes depleted of dissolved oxygen (DO) (Allaby, 1996). Consequently, as all available DO is depleted, fish, shellfish and other higher level organisms eventually die due to suffocation (Wright, 2002).

If water remains low in nutrients, the populations of phytoplankton are minimal and the water body will be clear, allowing light to penetrate and support the growth of SAV. However, if nutrient levels are increased, then phytoplankton grow abundantly and shade out sunlight that is essential to the growth of SAV. Thus, as the stage is set, phytoplankton rapidly increase. In the case of eutrophication, having clear water is essential because SAV requires water that is transparent enough to allow adequate light to pass through to allow photosynthesis to take place.

Overall, eutrophication begins with nutrient enrichment, progresses to the life and eventual death of phytoplankton, the growth of bacteria, and, finally, the reduction of dissolved oxygen and the eventual death of higher organisms (Wright, 2002).

Oklahoma: The Research Setting

The State of Oklahoma (Appendix B) covers approximately 69,898 square miles, which includes 1,231 square miles of inland water. Measuring from north to south the total distance ranges from approximately 166 to 222 miles (minus the Panhandle).

Occupied by both mountainous regions and level plains the state of Oklahoma contains a variation of soils from rich, black grassland to sterile blow sand. There are about 500 cited creeks and rivers in the state of Oklahoma with the majority of the rivers flowing across the state from the northwest toward the southeast. Major rivers include the Mississippi River, the Arkansas River, and the Red River. Both the Arkansas and the Red Rivers act as auxiliary streams for the Mississippi River. Branching from the Arkansas River are the Cimarron, Canadian, Verdigris, Grand, Illinois, and Poteau rivers. Branching from the Red River are the North Fork, Washita, Blue Boggy, and Kiamichi rivers (Encarta MSN Encyclopedia, n.d.).

Oklahoma possesses more artificial lakes than any other state in the nation (Oklahoma! Online, n.d.). A vast majority of the larger lakes within the state are located in the areas of Oklahoma where precipitation is the greatest (Encarta MSN Encyclopedia, n.d.). Controlled primarily by the United States Army Corps of Engineers (U.S. COE) but with the assistance of the U.S. Bureau of Reclamation, and the Grand River Dam Authority, the major reservoirs of the state were created for flood control, the generation of power, water supply, and recreation. Of the major reservoir systems several of them are vital travel ways for barges that travel along the Mississippi River system to the Tulsa port of Catoosa (Encarta MSN Encyclopedia, n.d.).

Dust Bowl to Conservation

Prior to the year of 1889 most of Oklahoma's land was widely uncultivated. However, with the opening of Unassigned Lands and western reservations many fertile areas were overgrazed. Eventually, the native vegetation that held the soil in place and

assisted with the natural flow of water was consumed. This human alteration led to the destruction of farmland by natural phenomena such as gully and wind erosion. Resulting during the dry years were violent dust storms that ultimately blew the remaining rich topsoil away. Consequently, the Oklahoma Dust Bowl tragedy of the 1930s was born (Encarta MSN Encyclopedia, n.d.). The Dust Bowl was a four-year tragedy in which faithful Oklahomans endured failed crops, low grain prices, and the onset of mechanical farming techniques (The Oklahoma Drought Management Team, 2004). During that dreadful time period Oklahoma's contribution to the national community as a whole dwindled as crops failed to produce, grain prices remained relatively low (resulting in little or no profit for farmers), and the introduction of mechanized farming practices led to the exodus of more than 59,000 Oklahomans (The Oklahoma Drought Management Team, 2004).

Since those arid days both farmers and ranchers have worked with government and not for profit agencies to conserve fertile soil in Oklahoma. Together they have utilized farming techniques such as contour plowing and terracing to prevent major erosion from occurring again. Additionally, they have also built dams and made retention ponds and reservoirs to dictate the flow of water. In areas where the climate is dry and arid appropriate grasses were planted to prevent soil from simply blowing away during Oklahoma windstorms (Encarta MSN Encyclopedia, n.d.). Aside from soil conservation the conservation of water also resulted from the 1930's Dust Bowl.

Years later, Governor Henry Bellmon formed the Oklahoma Drought Action Coordinating Council in June of 1988. The purpose of the council was to improve state drought mitigation efforts by utilizing more timely and effective monitoring, assessment,

and response techniques. As a result of the council's collaboration with other states a ten-step plan was formulated to palliate state drought episodes (The Oklahoma Drought Management Team, 2004).

Reminded of those dreaded arid days, state emergency officials and water resource planners recommended that Governor Frank Keating develop a plan to ward off yet another dry situation when the 1995 Oklahoma drought began. Beginning roughly around October of 1995 and lasting through the first half of 1996, Oklahoma experienced its most severe drought on record (The Oklahoma Drought Management Team, 2004). Between February and April of 1996 a large area of the state received less than ten percent of its normal monthly average precipitation (The Oklahoma Drought Management Team, 2004). Between October 1995 and May 1996, Oklahoma received only 48% of its average rainfall, an event that was recorded in state history books as the driest period on record for this century (The Oklahoma Drought Management Team, 2004). By August of 1996, Governor Keating signed Executive Order 96-24 and brought into existence the Oklahoma Drought Management Team—a group responsible for the development of a long-term plan to deal with current and future drought problems within the state of Oklahoma (The Oklahoma Drought Management Team, 2004).

The Beginning of the City of Tulsa

The year 1830 marks the birth of the city of Tulsa, Oklahoma. In the beginning the area surrounding Tulsa was widely known as Indian Territory. The namesake was fitting, as it was the portion of Oklahoma that was established to accommodate the relocation of several Indian Tribes such as the Creeks, Seminoles, Quapaws, Cherokees,

Shawnees, and the Seneca. A majority of these Indian Tribes moved into the Oklahoma area following the endorsement of the Indian Removal Act of 1830, a law which forced them to surrender their lands east of the Mississippi to the Federal Government in exchange for land in Indian Territory (Tulsa Preservation Commission, n.d.).

Tallasi to Tulsa

By 1834 a group of Creek Indians ended a two-year journey from Alabama at a location on the Arkansas River that they ultimately referred to as "Tallasi" (Johnson, 1998). Eventually the Creeks, also known as the Muskogee, began to exhibit their own separate ideals and built flourishing towns of their own that consisted of both public and private buildings (McReynolds, 1954). Within the community each Creek home had a garden plot, cattle, ponies, and the town itself maintained a common depository for visitors to the town and others that were in need of help (McReynolds, 1954). Finally, by the later half of the 1800s, Tallasi became known as "Tulsey Town" (Johnson, 1998).

Throughout 1892 white settlers continued to move into the area and the land began to become further developed as the addition of railroads increased accessibility to land that had been officially opened to all settlers (Tulsa Preservation Commission, n.d.). Finally, by 1898 the city of Tulsa, Oklahoma, was officially incorporated (City of Tulsa On-line, 2000). Two years following its incorporation the city had reached a total population of 1,390 people (Tulsa Preservation Commission, n.d.). The growth rate of the city began to flourish in 1901 when oil was discovered in Red Fork, located across the Arkansas River in what was then known as the Creek Nation. Eventually, Red Fork became a part of Tulsa County (OIL: Titan of Greater Tulsa, 2005). With the discovery

of oil came investors and their families. The year 1904 brought about the rise of a housing shortage; finally, as the city grew, neighborhoods were constructed away from the oil sites on the north side of the Arkansas River. From this outward growth, North Tulsa was annexed. To accommodate the growth of the city, a bridge was constructed across the river to allow both people and general necessities to quickly cross to the other side (Tulsa Preservation Commission, n.d.). By 1905 the city of Tulsa had seen a population increase to 6,500 citizens. The year 1910 then marked an overall population growth that exceeded 18,000. Yet another population explosion reached Tulsa when oil was once again found in the Osage Nation (Tulsa) and the population explosion topped out at 72,000; finally, by 1930 the total population of Tulsa reached 141,258 (Tulsa Preservation Commission, n.d.).

During the early portion of the twentieth century Tulsey Town began to prosper, and, eventually, Tulsey Town became known as Tulsa, a prosperous and growing city. By the 1920s Tulsa was one of the largest cities in the Southwestern portion of the United States (Johnson, 1998). Tulsa was now the main urban city of the region as it rapidly outpaced surrounding communities such as Sand Springs, Glenpool, Sapulpa, and Muskogee (Tulsa Metropolitan Utility Authority, n.d.).

Tulsa Water--History in the Making

With the rapid and overwhelming population growth city leaders contemplated the next step as they attempted to find viable drinking water for members of the public. They opted to draw water from the Arkansas River, a river whose content consisted of lots of sediments and an extremely high salt content (Tulsa Metropolitan Utility

Authority, n.d.). By 1904 a water pumping plant was constructed to deliver water from the Arkansas River to residents of the city of Tulsa. Far from perfection, the water that exited the tap was dirty, salty, undesirable, and not feasible for cooking or drinking (Tulsa Metropolitan Utility Authority, n.d.). Despite this fact, the city continued to grow, and amidst its wealthy days it became known as the "Magic City" (Johnson, 1998).

In his book Black Wall Street: From Riot to Renaissance in Tulsa's Historic Greenwood District, Hannibal Johnson eloquently described the city's transformation from rags to riches in 1921 as the "caterpillar-to-butterfly metamorphosis" (1998). For approximately ten solid years, between 1900 and 1910, many Tulsans and members of surrounding communities became wealthy, as black gold (oil) was plentiful in nearly every direction around the city. The primary oil fields at the time were located in Glenpool and Cushing, and, alone, they formulated the foundation for what would constitute the cultural and economic base of Tulsa today (2005) (OIL: Titan of Greater Tulsa, 2005).

Again, city leaders faced the challenge of supplying the city's residents with viable drinking water. And, with the abundance of oil, the city began to grow at an alarmingly rapid pace. Finally, it was concluded that safe, salt-free, and non-muddy water should be a regular option for city dwellers, so leaders opted to construct an adequate water pipeline.

It began with an idea suggested by a former city engineer named T.C. Hughes in 1912 whereupon he concluded, after a study of several topographic maps, that the water from Spavinaw Creek would flow by gravity to a point somewhere toward Tulsa or west of Catoosa. The idea was further studied after Col. C.B. Douglass and a few of his friends

began making fishing trips to Spavinaw and the Grand River. Douglass and his friends established a group to educate citizens about the clear water of Spavinaw Creek. One of their methods was to put on display 5-gallon jugs of Spavinaw Creek water by 5-gallon jugs of Arkansas River water (Clinton, 1945). With a location 50 miles east and north of the city of Tulsa the Spavinaw Lake was fed by a crystal clear creek that drained approximately a 400 square mile area of the pure and refreshing Ozark wilderness (Clinton, 1945).

After years of arguing, the then mayor (Thaddeus D. Evans—1920) appointed members to a water board to govern the water plans of the city of Tulsa. In turn, the board hired J. H. Trammel of Fort Worth, Dallas, to create a survey entailing the withdrawal of water from Spavinaw Creek and the creation of pipe lines. As it stands, he concluded that the gravity theory first presented by Hughes was a feasible and working plan. In addition, he also found that it could be improved upon by planting the lines up the Bird Creek valley up to Mohawk—an idea which meant that the water supply could be ten miles closer to Tulsa than Hughes previously envisioned. By 1922 a contract to construct the Spavinaw Creek project was agreed upon. Final plans were completed and by September of 1922; two million dollars worth of bonds were sold to fund the project. October 1922 marked the beginning of the project that would give the city of Tulsa water from the Spavinaw Creek. The Spavinaw dam project was completed on March 21, 1924. Water began to pour through the pipeline on November 12, 1924, and, by late afternoon on November 14 cool water began to flow from the Spavinaw Creek into city taps (Clinton, 1945). Currently, Lake Eucha feeds Lake Spavinaw, as it has been commonly known as a holding cell for soon to be treated water (Lassek, 2001).

Since its original construction the Mohawk plant was consistent and reliable in providing citizens of Tulsa with safe and clean drinking water. In 1992, the Oklahoma Water and Pollution Control Association named Mohawk "Water Plant of the Year". The original Mohawk Water Treatment Plant serviced north and western Tulsa for 70 years until it was finally replaced in 1999. City officials spent a total of 75 million dollars to construct a new plant to the immediate south of the original plant (Tulsa Metropolitan Utility Authority, n.d.).

Statistically speaking, Lake Spavinaw has a total surface area of 1,637 acres; length of 5.5 miles; width of .75 miles; storage capacity of 31,686 acre-feet; mean depth of 29.8 feet. Lake Eucha, constructed in 1952, has a total surface area of 2,880 acres; length of 8.5 miles; storage capacity of 80,000 acre-feet (Tulsa Metropolitan Utility Authority, n.d.). To date, the Eucha and Spavinaw watershed covers 415 total square miles. Of that total distance, seventy percent of the watershed is located in Mayes and Delaware counties (Oklahoma) while the remaining 30 percent is located in Benton County, Arkansas (Lassek, 2001).

Pathway of Water—Flooding Issues

Along with rapid population explosion, Tulsa, due to its central location along the Arkansas River, has also endured its share of flooding. Early records indicate that Tulsa experienced its first major, recorded flood during 1908. The flooding of the Arkansas River caused approximately $250,000 in total damages. Another major flood struck the city on June 13, 1923 and left 4,000 people homeless. Finally, city and national leaders began to search for solutions to high waters that struck throughout the nation. In an effort

to reduce Tulsa's ravaging waters the U.S. Army Corps of Engineers built levees around Tulsa's oil refineries that were located along the Arkansas River. The flooding of newly constructed homes in the late 1950s along the river led citizens to request that something be done to resolve the flooding issue. In an effort to again appease the community, the U.S. Army Corps of Engineers completed construction of the Keystone Dam (1964) fifteen miles upstream from Tulsa.

Approximately two years later, city leaders acquired the Mingo watershed. Tulsa continued to be troubled by floods nearly every two years between the years of 1960 and 1970. Finally, tired of reacting to the situation, victims petitioned to leaders that something be done to alleviate the flooding problem. More floods continued to occur—May, 1970; April and May, 1974; May, 1976. Eventually, by 1978, victims were heard and the city adopted an ordinance that granted the city control over specific alterations to the landscape of the metropolis, an indication that changes were forthcoming. Ultimately, after the 1984 Memorial Day flood in which 14 people were killed, 288 people were injured, and 7,000 buildings were destroyed, city leaders began the process of solving Tulsa's flooding problem. As a result, three hundred homes were relocated along with a 228 capacity mobile home park. A total of $30 million dollars were directed toward the entire project, including $10.5 million for basic flood control and $2.1 million for the development of floodwater drainage plans. Yet another flood impeded the city of Tulsa during 1986, however, flood plain management of the Arkansas River had finally alleviated the problem (Hardt, 1994).

Today, Tulsa is a flourishing city that stretches across approximately 200 square miles of terrain in Oklahoma's Osage Hills. Located on the Arkansas River, the city of

Tulsa is divided by a ridgeline (Appendix E). Along the line, southwestern creeks flow directly into the Arkansas River while the northeastern basin follows a pathway that drains into Bird Creek and finally flows into the Verdigris River just east of Tulsa (Hardt, 1994).

Tulsa Water—The Problem of Today

Within the state of Oklahoma, rights of dominion over water lie within the sovereignty of the Grand River Dam Authority (GRDA) and the Oklahoma Water Resources Board (OWRB). The GRDA oversees Grand Lake O' the Cherokees and Lake Hudson and several other tributaries. The OWRB authority is a nine-member team appointed by the Governor that is responsible for the management of all remaining bodies of water within the state of Oklahoma (Oklahoma Water Law and Administration, n.d.). When applying the ownership of water rule in Oklahoma one of the OWRB's primary requirements is that the permit holder put the assigned water to beneficial use (Oklahoma Water Law and Administration, n.d.). Included in the definition of beneficial use are agriculture, irrigation, water supply, municipal, industrial, navigation, recreation, and the breeding of fish and wildlife (Oklahoma Water Law and Administration, n.d.). In an effort to best manage the state's predominately flourishing resources the OWRB divided the state's water supply into 49 stream systems and 46 groundwater basins (Oklahoma Water Law and Administration, n.d.). To reduce the likelihood of disputes over waters shared with neighboring states, Oklahoma actively participates in four interstate stream compacts which clearly spell out how much water a specific state is allowed to develop or store on an interstate stream (Oklahoma Water Law and Administration, n.d.).

In early 2003, leaders of the city of Tulsa (Oklahoma) launched a major campaign to lead the city into the year 2025. With a slogan titled Vision 2025: Foresight 4 Greater Tulsa, the underlying goal of the proposal was to again bring the city of Tulsa to the forefront with a promised reward of riches and perhaps, yet another reason to boast about the city. Finally, on September 9, 2003, Tulsa County voters unanimously approved a one-penny sales tax that would increase over the next thirteen years; a significant political victory for all of Tulsa's leaders because the core of Tulsa's success had always been based on private enterprise. With the passage of Vision 2025, Tulsa County voters agreed to the collection of $885 million tax dollars that would be set aside to fund a total of thirty-two projects to promote the growth and development of economic and community infrastructure for future generations. In short, voters agreed to a four-part measure that ensures the disbursement of $350 million to Economic Development (Boeing Company), $22.3 million to Capital Improvements (American Airlines), $350.3 million to Economic Development (Education, Health Care and Events facilities), and $157.4 million to Capital Improvements (Community Enrichment) (About Vision 2025, 2003). City leaders hope that the passage of the Vision 2025 will return Tulsa to the glorious days that were once common during the height of the oil boom and the climax of what historians have often referred to as "The Black Wall Street of America" (Johnson, 1998).

The whole story actually began on November 16, 1907 when President Theodore Roosevelt officially proclaimed Oklahoma the forty-sixth state of the United States of America (McReynolds, 1954). From that day forward it appeared that the city of Tulsa,

located along the northern bank of the Arkansas River, was destined to play a major role in the development of a free society (Johnson, 1998).

During its early days of glory, Tulsa began to outshine surrounding communities such as Owasso, Bartlesville, Sand Springs, and Sapulpa. As with any pattern of outward growth, the overall population of the city began to expand as well which eventually led to an increase in the expectation for clean drinking water. With its close proximity to the Arkansas River, it was only fitting that city leaders and developers look toward this prime water source to tackle the ongoing demand.

In the case of the water quality issue that the city of Tulsa is currently facing, the problem appears to be in the form of cultural eutrophication. One of Tulsa's primary water supplying lakes is being overwhelmed with an abundant growth of algae that is being fed by an excessive amount of phosphorus. In a report offered by the Tulsa Metropolitan Utility Authority it was concluded that the major source of phosphorus in Spavinaw Creek is runoff from chicken-growing operations in northeastern Oklahoma and northwestern Arkansas (Appendix F). In fact, several studies of the state's water have associated the high content of phosphorus in Lake Eucha/Spavinaw with nutrient-rich chicken waste that, for many years now, has been applied to pastures as fertilizer. Following the natural pathway of water, the waste eventually flows into streams and lakes via ground water and the run-off of water. Scientist have noted that twenty-four percent of the phosphorus comes from a city wastewater plant located in Decatur, Arkansas, that processes large amounts of waste from a nearby chicken processing plant. The remaining seventy six percent, the study noted, occurs naturally (Lassek, 2001).

Currently, the city of Tulsa has two primary water sources (Lake Oologah and Lake Spavinaw); and, an additional secondary source, Lake Hudson (Lassek, 2001). As a continuously growing city, Tulsa collects fees from approximately seventeen other entities for the sale of treated water. Water retrieved from Lake Oologah is treated at the A.B. Jewell Water Treatment Plant, and, like Lake Spavinaw, it supplies approximately 250,000 customers with treated water. The water that is supplied by Lake Spavinaw and its filtering lake, Lake Eucha, is treated at the Mohawk treatment plant and supplies drinking and recreational water.

After a thorough investigation, researchers have concluded that the abundance of *anabaena circinales*, a blue-green algae that excretes geosmin, is caused by an excessive amount of phosphorus. Geosmin is a chemical that causes water to have a specific taste and a foul odor; humans can detect geosmin at very low levels (Lassek, 2001). Further, it is also recognized that chlorine treatment of water including geosmin has the potential to yield trihalomethane, an acknowledge carcinogen.

By November of 2000, the taste and odor problem was so severe that city leaders opted to draw water from Lake Hudson, a secondary supplier, as opposed to Lake Eucha/Spavinaw. It was a decision that cost $3,200.00 per day to maintain for a total of ten weeks. By the seventh month of the 2000-2001 fiscal year the city had already spent $500,000.00 to treat the insufficient water from Lake Spavinaw and Lake Eucha (Lassek, 2001).

Finally, after ongoing discussions between fourteen poultry companies and the state of Arkansas, Oklahoma Attorney General Drew Edmonson decided to file a long-threatened lawsuit. Edmondson sought an injunction to prevent poultry farmers from

applying excess chicken litter to the land as fertilizer. Following failed negotiations that began in November 2001 Edmondson complained to Tulsa's U.S. District Court of the Northern District of Oklahoma that fourteen poultry companies were in violation of the federal Solid Waste Disposal Act (Lassek, 2001).

Research Regarding Water Quality

Arising from the ongoing polluting of one of humankind's most valuable resources, research and literature about how the general public feels about water quality has been on the increase. In a recent *State of the Industry Report*, the *Journal of American Water Works Association* compiled information gathered from the mailing of more than 10,500 surveys to *American Water Works Association* members around the world. In their summarization of the tabulated data, Jon Runge and John Mann listed regulatory factors, business factors, source water supply, security, and water storage/infrastructure as the top five issues of concern. Final results showed that the first issue, regulatory factors, was of extra concern to members in the four state region of Texas, Oklahoma, Arkansas, and Louisiana. The second issue, business factors, involved such concerns as public and private funding and allocations for repairs and upgrades. Although it rated third among the five issues, source water supply was deemed critical because statistics show that an inflated human population can drain an existing water supply. Fourth on the list of critical issues is security. This particular problem became a severe threat following the September 11th attack on America. Finally, the last issue listed was water storage/infrastructure. Many members were concerned about the replacement of aging infrastructures. Of relevance were consumer issues, which ranked seventh among all

topics covered. Runge and Mann wrote that water professionals were concerned because their consumers, the general public, (1) either do not understand the real value of water or (2) lack confidence in the safety and overall quality of the water supply.

John Peckenham and his research team designed a pilot-study on the premises that the 1996 amendment to the Safe Drinking Water Act "parallels" the notion that overall water quality is linked to the quality of the watershed. In the *Journal of American Water Works Association*, Peckenham concluded that the management of the watershed is the first line of defense against drinking water contamination, an idea that has been presented in the past. The conclusion of the three-phase pilot-study conducted in the state of Maine brought about the development of a free guide to assist water suppliers in their effort to manage water quality issues.

In 2004 the Kentucky Environmental Education Council (KEEC), in conjunction with the University of Kentucky Survey Research Center, conducted a follow-up survey to answer basic questions about issues that deal with air, land, and water quality. Final results of the survey reported on the knowledge, attitudes, and overall behaviors of Kentucky citizens regarding the environment. Additional information cited the differences in some of those questions by socioeconomic group. As far as knowledge is concerned, 17% of Kentuckians surveyed ranked water pollution as their number one concern. Air pollution ranked second with 9%, while litter ranked third with 5%. In-depth questioning revealed that although water pollution is a primary concern, most members of the Kentucky community that were surveyed cannot correctly identify runoff from fields and lawns as the main source of water pollution in the state; rather, they attribute factory waste as the primary source of water pollution. Further investigation into their

attitudes and opinions revealed that 50% of survey participants reported that the quality of water, in general, was excellent or good. And, when asked about water quality in their area, 56% agreed that it was excellent or good. Closing statements argue for interdisciplinary environmental education because, of those surveyed. While most understood the scientific facts behind environmental issues, few were able to connect their day-to-day actions and behaviors to common environmental ailments.

In what appears to be the perfect model to guide this particular study, Craig A. Miller, Ph.D. (2003) surveyed citizens of Illinois to assess their perceptions of water quality in the state. In the August 2003 survey titled *Public Perceptions of Water Quality in Illinois: A Report to the Lumpkin Family Foundation*, Dr. Miller stated the purpose was to investigate public perceptions of water quality; to determine the perception of risks of contaminants to both surface and domestic water supplies; and, compare the attitudes about water of the general public to the attitudes about water that policy makers have about water.

In this two-fold study, participants for the general public section were generated by a sampling company from public telephone directories. Of the names generated, a total of 3,000 individuals were randomly selected to participate. The design of the questionnaire focused, first, on determining citizens' perceptions of water quality in comparison to other issues. Additionally, the questionnaire focused on finding the perceptions of drinking water quality, threats to water quality, perceived threats to water in the state of Illinois, and attitudes toward water issues overall.

Those selected to participate in the study were initially mailed a cover letter that explained the purpose of the study, a survey questionnaire, and a stamped return

envelope. To retain confidentiality, survey participants on the mailing list were assigned a number code that was used to cross-reference questionnaires as they were returned. Following the Dillman (1978) method, Dr. Miller then mailed a postcard reminder to participants that had been mailed an initial survey but failed to respond. Then, ten days following the postcard mailing, a second copy of the survey questionnaire, cover letter, and stamped return envelope was again mailed to those who had not yet responded.

Following their effort to attain a fair representation of the Illinois public, Dr. Miller and his research crew noted an average 42% overall response rate from the three surveyed sections. The team discovered that water quality rated as the issue of highest importance to community members. The team also discovered that Illinois residents were concerned about fertilizers, pesticides, and herbicides contaminating their drinking water. Additionally, they found that Illinois residents perceived runoff from agriculture such as fertilizers, pesticides, and herbicides to be the greatest threat to surface water in their state.

Solving the Problem

Knowing the importance of water and water quality one must ask what can be done to remedy cultural eutrophication? Best Management Practices (BMPs) indicate that the first goal is to prevent, rather than cure, the control of discharges into watersheds (Allaby, 1996). Unfortunately, in the case of cultural eutrophication, the primary prevention policy is not always an option. Thus, the next step in the alleviation of cultural eutrophication becomes twofold as point and non-point sources must be recognized and addressed.

In the process of tackling cultural eutrophication, the initial step is to identify the major point and non-point sources of pollution for the affected water body (Wright, 2002). The key issue that must be recognized when formulating BMP is the fact that, like snowflakes, no two lakes are identical. One natural possibility for treating the body of water is to set up seaweed farms. The addition of seaweed farms, scientists suggest, will allow the nutrients in eutrophic lakes to be utilized for growing commercially used products (Lemons, 1996). Another natural treatment is to add bivalve suspension feeders (oysters and clams) to the eutrophic waters and allow them to eat the algae growths from the top of the lake down to the bottom of the lake (Lemons, 1996).

The ideal situation is to treat the problem naturally. However, natural remedies are often dependent upon the overall eutrophic state of the lake, and, in many cases, are not feasible alternatives for treating cultural eutrophication. Therefore, if eliminating the waste discharge is not an option, then, the next step in curing cultural eutrophication is to find an alternative method of discharging the waste, or, possibly lowering the overall nutrient make-up of the discharge (Allaby, 1996).

Tackling point source pollution sites involves the placement of several restrictions upon the community that surrounds the site. In such cases, many states have opted to implement restrictions by banning the use of phosphate detergents, or, by altering plant effluents and requiring companies to lower their overall amount of waste discharges (Wright, 2002). The Clean Water Act (CWA) is essential as it gives states the authority to implement and enforce their own Total Maximum Daily Load (TMDL) program to evaluate all sources of pollutants that enter into their waters (Wright, 2005). When all

BMPs have failed, specifically, in cases where a lake is extremely eutrophic, physically removing the sediment by dredging has proven to be highly effective (Allaby, 1996).

In the case of the Tulsa watershed, the Oklahoma Water Resources Board has recommended that the excess nutrients caused by the application of chicken waste to pastures as a fertilizer be reduced by approximately seventy percent. Scientists and political officials believe this action will prevent further degradation of the Lake Eucha and Lake Spavinaw watershed (Lassek, 2001).

CHAPTER III

METHODOLOGY

This study is significant for a number of reasons. First, there is very little research that has been done about city of Tulsa residents' knowledge and perception in regard to water taste and odor. Due to the ongoing water quality dispute between the state of Oklahoma and the state of Arkansas, the perception and attitude in regard to water quality of those directly affected by the pollution is a topic that should be explored and researched as it will bring forth specific understandings to the current body of professional literature on water quality research. The methods used in this descriptive study were modeled after a previous study conducted on Illinois residents (Miller, 2003).

In order to identify the general knowledge, perceptions, and attitudes the general public has toward water quality within the city of Tulsa, it was important to discuss the historical, social, and economic issues related to the city as a whole. This format allows for the proper development of a survey tool that converges on pertinent perceptions and attitudes related to quality drinking water. The final survey tool utilized in this study was based upon the method developed by distinguished professor Don Dillman (1978). Additionally, the final survey tool was also based upon a previous tool recently utilized by Craig Miller to survey public perceptions of water quality within the state of Illinois (Miller, 2003).

Although the on-going water quality argument is not new to the research field, the perception and knowledge of members of the city of Tulsa that are directly affected is a field that has remained essentially untouched. Due to this fact, coupled with constraints on time and funding, this particular research has limited ability to generalize about perceptions, general knowledge and attitudes of water quality. However, it is a good beginning point for scientists and attorneys alike as the right to clean drinking water has led the state of Oklahoma to the courtroom with the state of Arkansas. This chapter presents the subjects, instrumentation, procedures, and design and analysis of this descriptive study.

Procedures

This research is a descriptive study of the public's general knowledge, attitudes, and perception of water quality in the downtown area of the city of Tulsa, Oklahoma. Once the data were collected, all of the information was tallied to determine the answers that participants chose and how frequently they were chosen. Finally, the frequency results were compared and cross-tabulated to determine whether or not a difference existed in attitude, knowledge, and/or perception according to respondents' age, race, income level, and gender. The results are displayed in cumulative data tables. Significant differences among the independent variables are represented in bar graphs. The computer program used to analyze the data is the Statistical Package for the Social Sciences (SPSS) (Gay, 2000). The alpha level is set at $p<.05$. Attitudes of the general public were measured using a Likert scale (Miller, 2003).

Approximately one month prior to the study , during May 2006, a written request was made to the city of Tulsa utilities department for a public list of all of the residents of the city of Tulsa that reside in the 74105 zip code area. Roughly one week later a hard copy and an email copy of the generated list were returned to the researcher following the payment of $75.00. The generated list contained a total of 10,808 names of residents and businesses that were located in the 74105 zip code area. The 2000 U.S. Census Bureau noted that the 74105 zip code contained an overall population of 28,456 people (13, 598 males and 14,857 females) with a racial background that consisted of 23, 077 Caucasians, 2, 174 African-Americans, 1, 214 American Indians, 291 Asians, 14 Native Hawaiian/ Pacific Islanders, and 658 individuals that were classified as some other race. Since a total of 300 participants were sought, the total number of names on the list, 10,808, was divided by 300. The result of the mathematical equation was equal to 36. Thus, beginning from the first name recorded on the list every thirty-sixth person was randomly selected to participate in the survey. If during the selection process a business was selected then another thirty-sixth person count was made until a Tulsa resident was chosen. This process was followed until the end of the list was reached. Due to the inclusion of businesses on the list reaching the end of the list did not result in a total of 300 survey participants. Therefore, beginning from the last name on the list every thirty-sixth person was chosen until a total of 300 known Tulsa residents had been selected to participate in the study.

Following the selection process, initial mailings on June 12, 2006 of 300 surveys were mailed from the Oklahoma State University-Tulsa campus. Following that initial mailing a total of 58 questionnaires were returned. In accordance with the Dillman (1978)

method, approximately ten days later (June 26) a total of 242 postcard reminders were mailed to all non-respondents. A total of 22 survey forms were returned. Again, following the Dillman (1978) method, ten days later (July 7) a total of 220 survey forms were mailed to all non-respondents. A final cut-off date to receive completed and returned survey forms was July 31, 2006. A total of 112 survey forms out of the initial 300 were returned. Following the last mailing of the survey form, a total of 32 survey forms were returned. Of the cumulative total, 111 were deemed usable for the study.

Selection of Subjects

The subjects selected were residents of Tulsa, Oklahoma. Study participants from the general public were generated from public files obtained from the city of Tulsa, Oklahoma utilities department. Approximately one month prior to the study a written request was made to have a list generated documenting the names of utility customers that reside in the 74105 zip code. The 2000 U.S. Census Bureau noted that the 74105 zip code contained a total of 13,960 occupied housing units. However, the generated list noted that a total of 10,808 utility customers were in the 74105 zip code. Upon the generation of the list, beginning with the first name, every thirty-sixth person was selected (1, 36, 72, 108, etc.) until a total list of 300 participants had been compiled. The 74105 zip code was chosen because the Mohawk Water Treatment Plant services the middle (downtown), north, and west portions of Tulsa. This particular zip code was also chosen because of its proximity to downtown/midtown, west, and south Tulsa. Due to limited resources and time, random sampling procedures were not be exercised. Instead, availability sampling was implemented and surveys from 300 subjects were anticipated.

There was also an attempt to get subjects who range in age, gender, race, class, and income level since there is demographic diversity present in this portion of Tulsa.

Instrumentation

The instrumentation (Appendix H) for this research is a questionnaire developed by Craig Miller, Ph.D. (2003) which was based upon the Dillman Total Design Method (Dillman, 1978). The questions are all related to general knowledge of Tulsa water quality and different perceptions or attitudes people may have about water pollution and water quality.

Data Collection

Individuals selected to participate in the study were mailed a cover letter that explained the purpose of the study, a survey questionnaire, and a stamped return envelope. A copy of the cover letter can be found in Appendix G. Individuals on the list provided by the city of Tulsa utility services were assigned a number code that was only used to identify the participant on the mailing list. To ensure confidentiality, no name appeared on the questionnaire. As questionnaires were completed and returned the respondents were marked off the list by use of the number code. After ten days following the initial mailing of the survey cover letter, questionnaire, and stamped return envelope, a postcard reminder was mailed to all nonrespondents identified by the coded respondent list. Ten days following the postcard reminder, a second copy of the cover letter and the survey questionnaire, and stamped return envelope was mailed to all identified subjects that had not responded (Miller, 2003). Don Dillman (1978) developed the survey method used in this study.

The plan for collecting data for this research was reviewed and approved by the Oklahoma State University Institutional Review Board (IRB). A copy of the approval form may be found in Appendix A.

Data Analysis

After all of the data were collected from the subjects, the researcher examined the data for the purpose of removing any unusable questionnaires. Of the total 112 returned questionnaires only one was deemed not usable. None of the questions on the survey form were answered but rather, the lone questionnaire contained a comment about the length of the survey form and the possibility of not receiving any responses.

The first process in the data analysis was to record all of the relevant data onto a single page data matrix sheet designed by the researcher. A copy of the data matrix sheet can be found in Appendix J. The next step in the process was to input all of the data from the data matrix sheet into a Microsoft Excel program. Once the data were successfully input into the program it was transferred into an SPSS statistical package file. Accumulated responses contained "Yes/No", general forms of ranking, and numeric scale items (Miller, 2003). Items on the questionnaire that measured public attitudes by way of a Likert scale (a 5-point scale where 1= "Not at all important" and 5= "Very high importance") were analyzed using frequency distribution to determine particular grouping of variables.

First, the data were analyzed using SPSS to determine a frequency distribution of all of the scores and tally and group all of the race, gender, education, and income information obtained from the questionnaires. Once all of the frequency distributions

were accumulated and studied, several cross-tabulation analyses were performed using the SPSS statistical package to answer the guiding research questions and determine whether or not any differences existed. Additionally, a Chi-square analysis was utilized to extrapolate the nominal data and compare the proportions that were observed to the proportions that were expected. In this manner, significant distributions of data could be identified. For purposes of analysis, alpha was established at 0.05 for this study.

CHAPTER IV

FINDINGS AND ANALYSIS OF DATA

The purpose of this study was to identify the public's perception, in Tulsa, Oklahoma, of the water quality concerning the taste and odor across race, gender, income, and age lines. In addition, the purpose of the study was to discover Tulsa residents' general knowledge of drinking water quality in terms of participation and general knowledge of rules and regulations across race, gender, income, and age lines. Moreover, a final goal was to unveil the public's attitude regarding overall water quality. This chapter presents findings of the study in the following order: (1) assessment of the survey findings with regards to the number of surveys distributed, (2) description of the participants, (3) statistical analyses of Section One: Important Issues Facing Our Communities, (4) statistical analyses of Section Two: Drinking Water Quality, (5) statistical analyses of Section Three: Attitudes Toward Water Quality, (6) statistical analyses of the research questions, and (7) discussion.

Description of the Participants

The survey asked general demographic information about the participant. Of the total 110 respondents, 59 were male while 51 were female. The ages of the respondents ranged from 22 to 95. Of the total 111 respondents, one person declined to disclose any

demographic information. The highest number of respondents, six, were age 52 years while five people each from ages 57 years and 76 years responded. Additionally, there were four people each from the 27 years and 70 years of age range.

Ethnicity of the respondents revealed that 102 Caucasian, 3 Indian (Native American), 2 Hispanic, 1 Asian, and 2 people from other racial categories participated in the study. No participants of African American descent were respondents in the study. Respondents' answers to the highest level of education completed revealed that 1 person had less than a high school education. Seven people graduated from high school. Four people possessed some form of technical/vocational training. Twenty-two people had some college education. Eight people had an associate's degree. Thirty-one people held a Bachelor's degree. Thirteen people had completed some graduate study. Twenty-four people held graduate or professional degrees (Figure 2). Finally, of the 101 total respondents who disclosed his or her approximate total household income before taxes in 2004, 5 recorded less than $20,000. Twenty-two and 27 reported a yearly income of $20,000-$39,999 and $40,000-$59,999, respectively. Eleven participants noted that their total income for that year was $60,000-$79,999. Fourteen people disclosed that their income was between $80,000 and $99,999 for the year, while 22 people noted that their total income for that year was $100,000 or more (Figure 3). A copy of the General Household Information (demographic) questionnaire may be found in Appendix H.

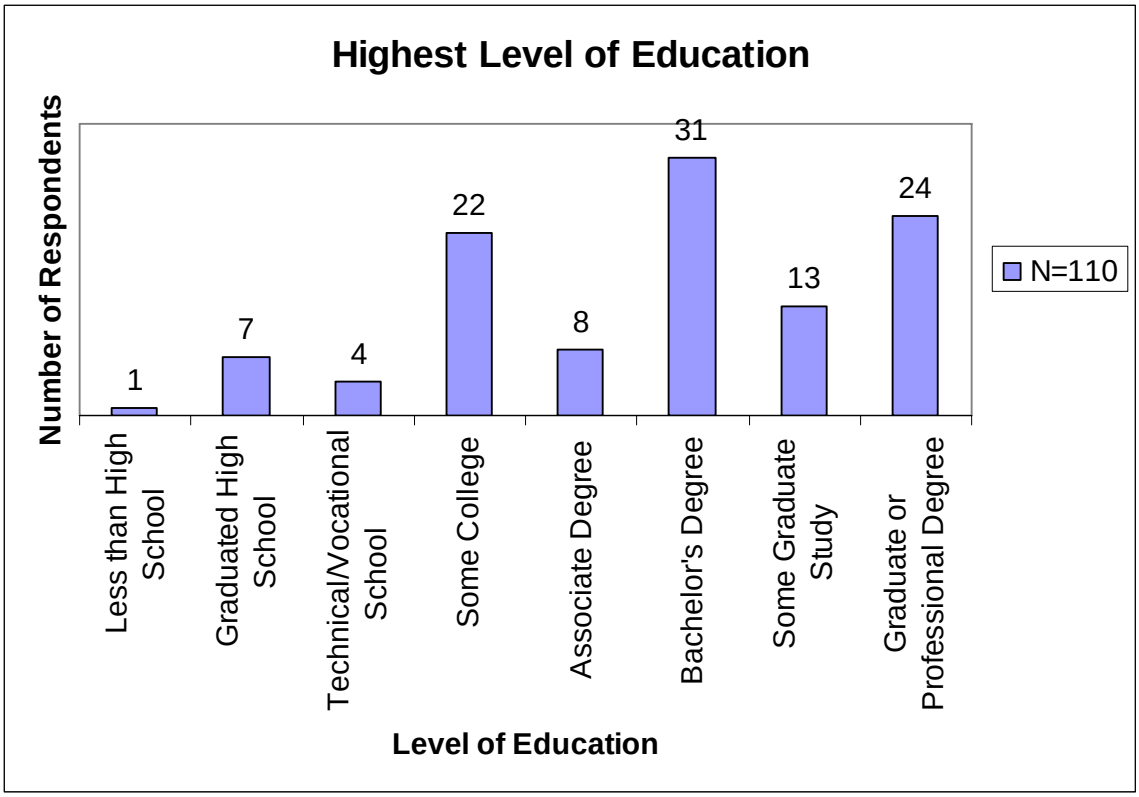

Figure 2. Education Level of Study Participants.

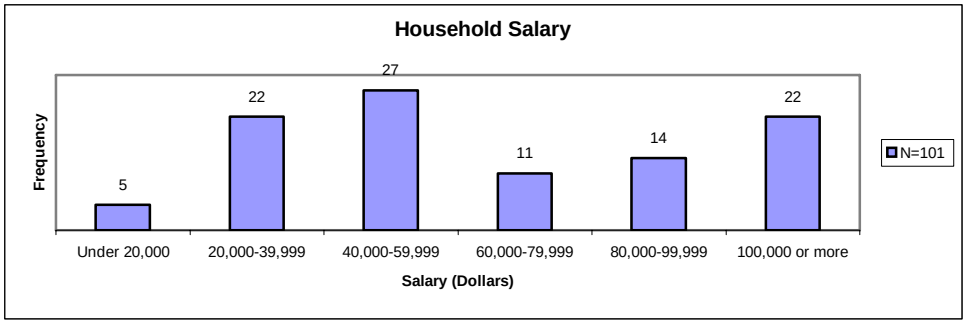

Figure 3. Household Salary of Study Participants.

Statistical Analyses of Section One

Important Issues Facing Communities

In this section of the questionnaire respondents were given a list of several concerns facing many communities throughout the state of Oklahoma. Listed among the concerns were issues such as “Protecting water quality,” “Improving public schools,” “Road improvements & maintenance,” “Preventing and reducing crime” and “Protecting wetlands.” They were asked to rate how important each issue was to him/her by circling the number 1 (Not at all important); 2 (Very low importance); 3 (Low importance); 4 (High importance); or, 5 (Very high importance). Using a weighted rating of importance, water quality was the top concern among ten possible concerns or issues for the members of this community as respondents to this survey. Water quality was rated higher than crime prevention, improving public schools, and improving air quality. All other items were rated lower than these four important concerns. These findings on the importance of crime prevention, public schools, and water quality are supportive of the notion that the respondents to this survey are concerned about the quality of water that they are offered by the city of Tulsa. A complete listing of the responses to each of the questions in Section 1: Important Issues Facing Our Communities can be found in Table 1.

Table 1: Important Issues Facing Our Communities

Possible concerns or issues	Rating of importance
Protecting water quality	4.51
Preventing and reducing crime	4.43
Improving public schools	4.40
Protecting air quality	4.37
Managing growth & new development	4.20
Protecting forests	4.08
Road improvements & maintenance	3.86
Providing convenient public transportation	3.50
Protecting wetlands	3.45
Providing more recreation areas	3.39

Statistical Analyses of Section Two

Drinking Water Quality

The first question in section two asked respondents to identify the source of their water supply. Of the total 106 participants who submitted a response, most, 103 (93%) were aware that they received water from a municipal water supply.

An additional question asked participants if their water came from a municipal supply, what, then, was the source of that supply. Ninety-three respondents (84%)

(N=107) noted that they received their water from a dam, reservoir, or lake while 14 (13%) checked that they were not sure of the source of their water supply. An additional option (underground aquifer) was listed, but none of the 107 respondents checked that option.

Next, respondents were asked to rate the quality of their drinking water by checking a level that matched their opinion. One-hundred nine people responded to this question. Most respondents, 63 (57%), believe that their drinking water quality is good overall (Figure 3). Additionally, most men believe that their water quality is "Good" while most women were more likely to rate their quality of water as "Fair." Also, residents that make the lease amount of money per year, $0-#39,999 believe that they have "Fair" water quality while residents who make $40,000 or more per year believe that they have "Good" water quality.

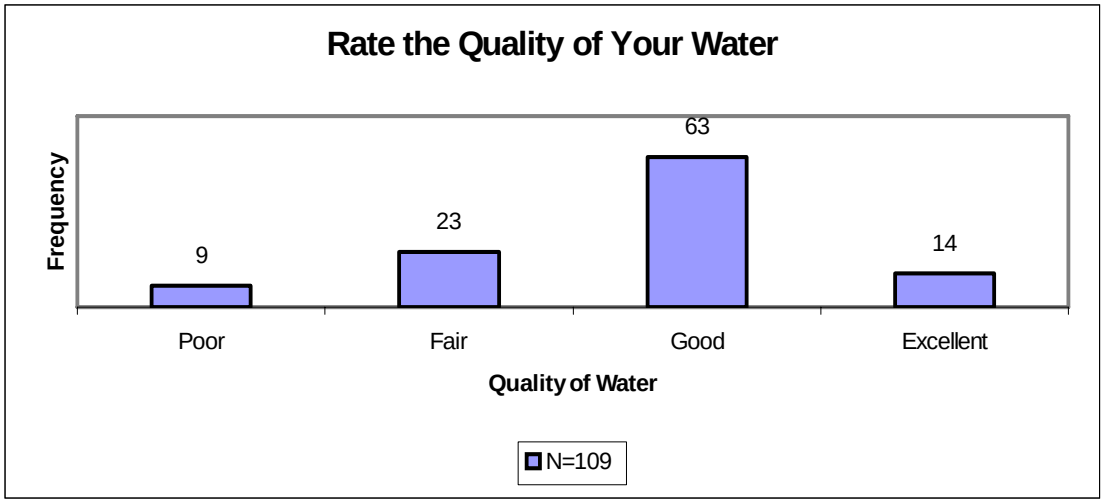

Figure 4. Opinion of Drinking Water Quality.

Further questioning asked respondents to check all of the following characteristics that apply to their tap water. Eighteen (18) checked that their tap water contained sediment such as rust, particles, etc. Thirty-eight (38) people checked that their tap water contained iron and was considered to be "hard" water. Eighteen (18) people checked that their tap water contained calcium and was considered "soft" water. Sixteen (16) people checked that their tap water contained sulfur or some other sort of unpleasant odor.

Only 23 people surveyed have actually had their tap water tested. Of those that responded, 4 found some sort of bacterial contamination; 2 found arsenic, 3 found nitrates, 3 found herbicides, 3 found pesticides, 5 found heavy metals such as mercury and/or lead, and, 3 found some other substance. A related question to water testing asked respondents to check 'yes', 'no', or 'I'm not sure', if any of the substances listed in question 6 were found. Of the sixteen respondents to this question, 6 (5%) were not sure; 9 (8%) replied that they did not find any of the substances; and 1 replied that one of the substances was found.

The next three questions pertained to whether or not participants had yet received a drinking water quality report from their supplier, if they took the time to read the report, and if they understood the information in the report. Sixty-six (60% of 106 in the sample) respondents checked that they had not received a report on their drinking water quality from their water supplier. Twenty-seven, or 24%, had received a report on their drinking water quality from their water supplier, while 13 (12%) were not sure if they had received a report. If respondents answered "Yes" to the first question, they were asked to indicate if they took the time to actually read the report. Twenty-seven respondents (71% of 39 individuals) answered that they did take the time to read the report. Ten (25%) answered

that they did not take the time to read the report while 2 were not sure whether or not they read the report. Finally, for those who answered "Yes" to reading the report, the survey directed them to give their opinion of the report by checking one statement that matched their response. A total of 34 participants responded to the question. Three thought that the report was unclear in some parts, or, not easy to understand, respectively. Twenty-two (20%) people thought that the report was easy to understand, and, 6 (5%) admitted that they did not read the report. Those that had a combined income of $40,000 or more per year actually were more likely to take the time to read the water quality report that they had received from their water supplier. Of those that read the report, most respondents' in the $40,000-$79,999 income range actually believed that the report was easy to understand.

Next, participants were asked if any of the following events had ever happened to them while they lived in Tulsa. They were given the option to check more than one answer. Of the responses, 5 people had to follow a "boil water" advisory; 1 person had a contamination advisory not to drink municipal tap water; 36 people had a strange odor come from their tap water; and, 5 people had some other occurrence.

Finally participants were asked to rate their opinion of the safety of their drinking water by checking only one response. Fourteen individuals (13% of 110 respondents) rated the safety of their water as excellent. Seventy-two (65%) rated the safety of their water as good. Eighteen (16%) rated the safety of their water as fair. Six (5%) rated the safety of their water as poor.

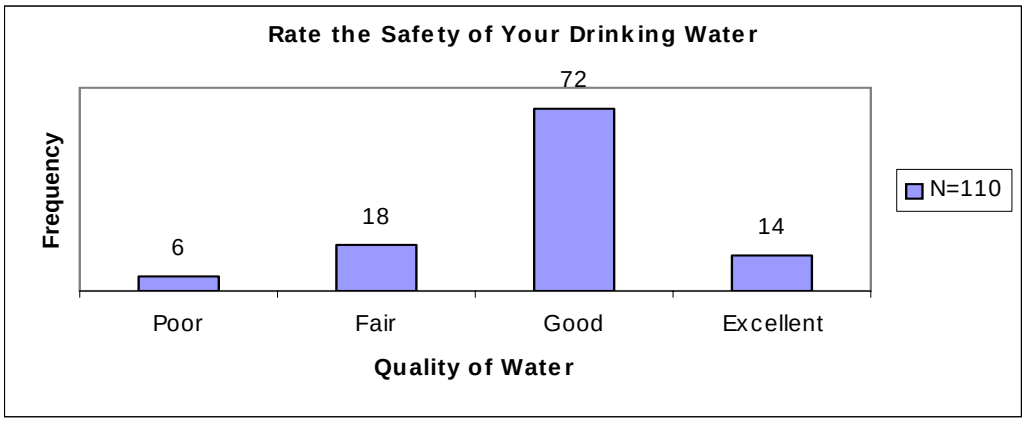

Figure 5. Opinion of Quality of Drinking Water.

Again, respondents were given the opportunity to respond to a category of questions. However, in this instance the questions related to how they perceived specific causes that possibly threatened the drinking water quality in the area where they live. Participants were asked to rate how important each issue was to him/her by circling the number 1 (Not threat at all); 2 (Very low threat); 3 (Low threat); 4 (High threat); or, 5 (Very high threat). For perceived threats to drinking water in the area in which they lived, most respondents rated bacteria from poultry operations highest among the 9 potential threats listed (Table 2). Despite recent media discussion of poultry operations in eastern Oklahoma, bacteria from poultry operations were perceived as being a low level threat for these respondents in their area. Chemical residue from pesticides was rated as being a low level threat, but less than that of bacteria from poultry operations. All other perceived threats were identified as being very low level threats or no threat in the area where these

respondents lived. A complete listing of the responses to each of the questions may be found in Table 2.

Table 2. Perceived Threats To Drinking Water in the Area Where You Live

Threat source	Not threat	Very low threat	Low threat	High threat	Very high threat	Total number (N=)	Weighted rating
Heavy metals	23	3	24	15	4	96	2.62
Bacteria/Poultry	17	17	19	33	15	101	3.12
Pesticides	11	18	39	27	4	99	2.95
Fertilizers	14	24	29	27	4	98	2.83
Herbicides	10	29	33	23	4	99	2.82
Septic	21	41	23	7	6	98	2.35
Silt	22	38	27	9	1	97	2.27
Urban Sprawl	19	29	29	13	7	97	2.59
Geese	32	31	25	7	3	98	2.16

A majority, 77 (70%) of the respondents felt that there was no threat of a drinking water shortage in the area where they lived (Figure 5). Most respondents, 59 (53%), used some form of water saving device in their homes. Only a 1 person difference existed between using (54 people) and not using (55 people) bottled water for drinking and or cooking. Lastly, most people, 71 (64%) do not use a water purification device to filter the tap water in their homes. Figure 6 illustrates participants' total responses.

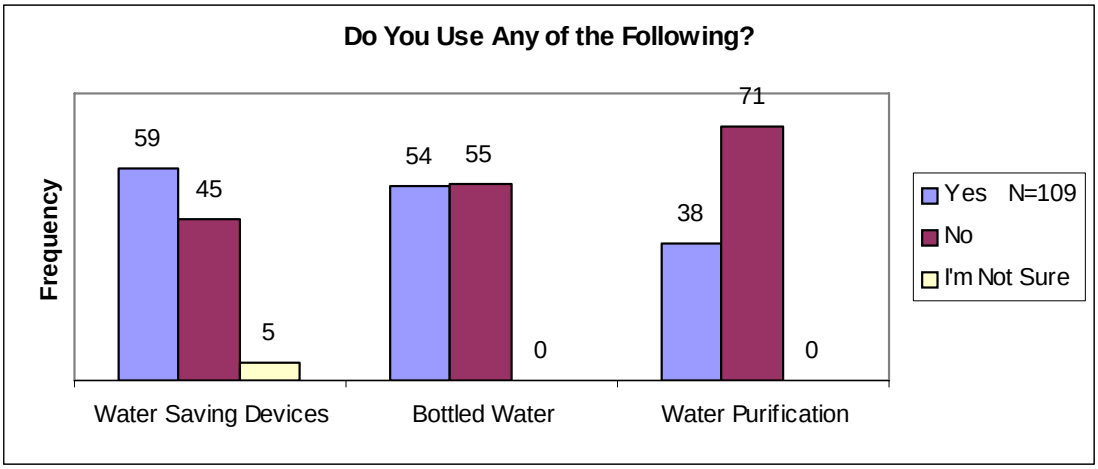

Figure 6. Perception of Threat of Drinking Water Shortage.

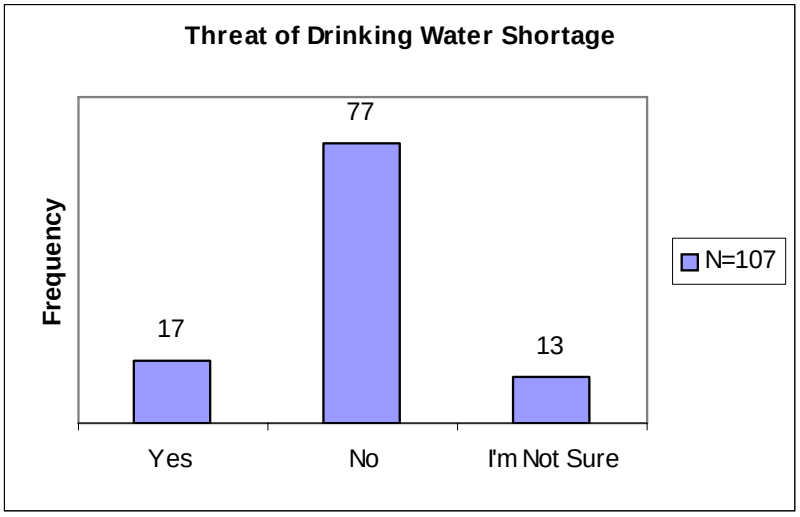

Figure 7. Use of Other Water Sources.

Next, participants were asked if they had water saving devices such as low-flow faucets, toilets, showerheads, etc. (N=109). Fifty-nine (53%) answered yes, 45 (41%) answered no, and, 5 (5%) were not sure. When asked if they used bottled water for drinking and/or cooking in their home (N=109) 54 (49%) answered "yes", 55 (50%) answered "no", and zero were "not sure." Lastly, participants were asked if they use a water purification device for their tap water (N=109). Seventy-one (64%) answered "no", 38 (34%) answered "yes", and no respondents chose the third option, "I'm not sure."

Again, respondents were given the opportunity to respond to a category of questions. In this instance the questions related to how they perceived specific causes that may threaten the drinking water quality in Oklahoma. Participants were asked to rate how important each issue was to him/her by circling the number 1 (Not a threat at all); 2 (Very low threat); 3 (Low threat); 4 (High threat); or, 5 (Very high threat). This series of questions replicated the earlier request for responses related to perceived threats in the area where respondents lived. While those responses revealed that all listed potential threats were low threats, very low threats, or not threats at all, the responses to perceived threats in Oklahoma were consistently higher than those perceived threats in the Tulsa area.

Of the 10 items listed on the perceived threats to drinking water quality in the state of Oklahoma most viewed bacteria from poultry operations as a high threat. A second level of threat sources, including pesticides, fertilizers, and herbicides, were rated between low threats and high threats. Heavy metals, septic systems, and urban sprawl were perceived as low threats. Finally, all other perceived threats were rated as being

below a low threat. A complete listing of the responses to each of the questions can be found in Table 3.

Table 3. Perceived Treats to Drinking Water in Oklahoma

Threat source	Not threat	Very low threat	Low threat	High threat	Very high threat	Total number (N=)	Weighted rating
Heavy metals		21	42	20	9	97	3.07
Bacteria/Poultry	4	5	9	48	34	100	4.03
Pesticides	4	8	27	43	16	98	3.60
Fertilizers	4	8	27	43	15	98	3.59
Herbicides	4	9	31	40	12	96	3.49
Septic	6	20	40	23	7	96	3.05
Silt	8	30	36	15	6	95	2.80
Urban Sprawl	9	18	38	21	12	98	3.09
Geese	17	27	35	11	4	94	2.55

Statistical Analyses of Section Three

Attitudes Related to Water Quality

In the final section of the questionnaire it was noted that Tulsa (Oklahoma) residents face or believe that they face a number of water quality issues. Participants were asked to give their opinion for each of the statements by circling the number that matches their specific opinion. They were asked to rate how important each issue was by circling the number 1 (Strongly disagree); 2 (Disagree); 3 (Unsure); 4 (Agree); or, 5 (Strongly Agree). Water quality issues that participants were asked to comment on included “There

is enough protection for drinking water in Oklahoma," "Water pollution laws are too tough in Oklahoma," "We need stronger federal laws to protect our water quality," "There is enough groundwater to support development in my area" and "Tough water protection laws hurt economic development."

The table on the following page presents responses to these questions on water quality issues using a weighted scale. Each of the ratings was multiplied by the number of responses for that rating, with the sum of weighted responses being divided by the total number of responses. Weighted totals closer to "5" indicate greater agreement with the statement on that issue, while weighted totals closer to "1" indicate lesser agreement with the statement on that issue. Full detail of all responses is shown in the appendix.

These respondents generally disagreed that access to rivers and streams for recreation is difficult. Whether the rivers or streams are in urban or rural areas in Oklahoma, access points are fairly common and fairly well marked.

A higher level of uncertainty or more dichotomous response was shown on the response to the statement regarding level of protection for drinking water in Oklahoma. This response group was distributed from strong disagreement to strong agreement, with 36% indicating they were unsure.

Table 4. Weighted Responses to Water Quality Issues.

Water Quality Issue	Weighted rating
Access to streams and rivers for recreation is difficult in Oklahoma	**2.28**
There is enough protection for drinking water in Oklahoma	**2.71**
Water pollution laws are too tough in Oklahoma	**2.06**
Economic prosperity depends on a healthy environment	**4.26**
More protection needs to be given to wildlife habitat along streams and rivers in Oklahoma	**3.55**
Water contamination from lawn-care products are a threat to water quality in my area	**2.94**
We need stronger federal laws to protect our water quality	**3.39**
Water contamination from poultry operations is a problem in Oklahoma	**4.24**
I am concerned about chemicals in my drinking water	**3.56**
Too much attention is given to wildlife in deciding how land is to be used in Oklahoma	**2.45**
I feel the Clean Water Act needs to be strengthened	**3.51**
Quality water is needed for strong economic growth	**4.24**
There is enough groundwater to support development in my area	**3.18**
Chemicals from agriculture are a threat to my drinking water	**3.19**
Brush and fallen trees are good for the ecological health of streams and rivers	**3.18**
Drinking water contamination is not a problem where I live	**3.26**
Not enough attention is given to protect water quality in Oklahoma	**3.44**
Tough water protection laws hurt economic development	**2.34**

These respondents disagree with the statement that water pollution laws are too tough in Oklahoma. This statement showed the highest level of disagreement, thereby indicating the respondents had more consistency of response on this item.

Conversely, the statement that economic prosperity depends on a healthy environment received the strongest agreement from this response pool.

More protection for wildlife habitat along streams and rivers in Oklahoma showed only slight agreement from this response group. The majority of respondents was unsure of their agreement or disagreement or was countered by an equal number of respondents from the opposite perspective.

Similarly, respondents were unsure of the threat caused by lawn-care products to the quality of water.

Respondents were only slightly more in agreement that we need stronger federal laws to protect water quality. The response pool was dichotomously balanced in their responses to this statement. Respondents' in the combined income range of $20,000-$39,999 salary range were unsure if "We need stronger federal laws to protect our water quality." Those in the combined income range of $40,000 or more agreed that we need stronger federal laws to protect our water quality.

A high level of agreement was shown related to concern about pollution from poultry operations. This response group believes that pollution from poultry operations is a problem for water quality in Oklahoma.

Slight agreement was shown for the statement of concern for chemicals in drinking water. However, those who agree with this statement were essentially counter-balanced by individuals who disagreed.

Conversely, slight disagreement was shown in response to the statement that too much attention is given to wildlife in decisions regarding how land is to be used in Oklahoma. Those who disagreed with this statement were essentially countered by individuals who agreed with the statement.

In the same manner, a dichotomous response was shown to the statement that the

Clean Water Act (CWA) needed to be strengthened. This response showed a level of uncertainly among the residents of this area in Tulsa. Most men strongly agree that the Clean Water Act needs to be strengthened while women were less intense in their agreement with strengthening the Clean Water Act. Consequently, more men were more intense in their position that the Clean Water Act needs to be strengthened.

No such uncertainly was shown in response to the statement that quality water is needed for strong economic growth. This response group almost entirely agreed or strongly agreed with that statement.

There was much more uncertainly as to whether there was enough groundwater to support development in this area of Tulsa. This statement received a weighted rating of 3.18, with 51% of respondents being unsure.

The next two statements received almost identical response distribution to the fore-going statement, with very similar weighted ratings. First, these respondents were unsure of their position on whether chemicals from agriculture were a threat to drinking water. Second, these respondents were unsure of their position on whether brush and fallen trees were good for the ecological health of streams and rivers.

Only slightly more agreement was shown in response to the statement that drinking water contamination was not a problem in this area of Tulsa. Since the statement was given in the negative, it can be concluded that, while there is uncertainly among these respondents, they tended to believe that there may be some contamination of drinking water in their area.

Slight agreement was also shown for the statement that not enough attention is given to protecting water quality in Oklahoma. It can be concluded from the responses

that these Tulsa residents tended to believe that more attention needs to be given to protecting the quality of water in Oklahoma.

Finally, these respondents tended to disagree with the statement that tough water protection laws hurt economic development. As a result, it can be concluded that this response group sees tough water protection laws and economic development as being possible at the same time.

Statistical Analyses of the Research Questions

The major research objective of this study was to examine public perception, attitudes, and general knowledge of the Tulsa water supply. By conducting this study the researcher also hoped to obtain information helpful in assessing the need for the public to know about the importance of being offered quality water. Further, given the significant results the researcher planned to use the results of the study to highlight the need for modes of transferring relevant information regarding water quality to all residents of Tulsa, Oklahoma.

The following research questions were developed as the basis of the project and provided the foundation on which the design was prepared.

1. What is the public's perception, in Tulsa, Oklahoma, of drinking water quality concerning taste and odor across race, gender, income, and age lines?
2. What is the public's general knowledge of drinking water quality in Tulsa Oklahoma in terms of participation and general knowledge of rules and regulations across race, gender, income, and age lines?

3. What is the public's attitude regarding water quality?

The first and second research questions are further defined and tested as hypotheses. These hypotheses are expressed in the null form, allowing the researcher to make a decision on each aspect of the hypotheses, thereby permitting a decision on the research question.

- H_o related to Research Question 1: There are no significant differences in perceptions of drinking water quality in Tulsa among residents as related to taste and odor across groups by race, gender, income and age.
- H_o related to Research Question 2: There are no significant differences in general knowledge of the drinking water quality in Tulsa among residents as related to taste and odor across groups by race, gender, income and age.

These hypotheses were tested using chi-square analysis on the CROSS-TABS command utilized in SPSS. This analysis allows for calculation of expected and observed frequencies between variables, with reporting of row, cell, and column percentages. Further, the CROSS-TABS procedure permits immediate calculation of a chi-square statistic based upon variation of the observed frequencies from the expected frequencies. Finally, CROSS-TABS reports the probability of the observed distribution allowing for a decision as to whether the relationship between two variables is significant. For this analysis, alpha was established at .05.

Bartz (1988) noted that there are five assumptions on which a chi-square analysis is based. The assumptions are: (1) the data must be in frequency format, (2) observations must be independent from one another, (3) sample size must be adequate, (4) categories of the data must be distinct and logically determined, and (5) the total sum of the

observed frequencies must be equal to the total sum of the expected frequencies. The data in this study satisfied all of these assumptions.

To thoroughly answer two of the three research questions, the frequency distributions of several of the questions on the survey form were cross-referenced against one another and chi-square analyses were conducted. In an effort to accurately present respondents' knowledge, perception, and attitude about the city of Tulsa water supply many of the questions contained on the survey form were referenced. A thorough list of the questions that were referenced to answer the research questions can be found in Appendix L.

Due to the lack of data from anyone of African-American ethnicity, and, the low participation rates from members of other racial backgrounds, none of the accumulated data was cross-referenced with ethnicity frequencies. Of the 111 respondents, 102 were of Caucasian ethnicity. The low accumulated numbers from members of other ethnic descent were not enough to give a true indication of the differences among racial lines.

Initial indications led to the belief that members of African-American descent were not adequately represented in the study because they reside in different areas of the city. Additionally, the possibility of environmental racism was considered as environmental justice cases throughout the nation usually have members of different ethnic groups that are often the target of the discrimination. However, this was ruled out because of the dynamics of the city of Tulsa and the growing communities that surround the city itself. To the south of Tulsa is the city of Jenks. Located just north of Tulsa is the city of Owasso. Both communities are flourishing and contain housing properties that are listed well above the $500,000 range. In order to bring more dollars into its community

the city of Tulsa sells water to both of these communities for a very reasonable profit.

The Owasso community receives water that has been treated at the Mohawk Water Treatment Plant, Tulsa's newest water treatment plant, and the Jenks community receives water that has been treated at the A.B. Jewell Water Treatment Plant. The lack of participation from members of African-American descent can be attributed to the researchers sampling method. According to Mertens (1988) African-Americans are generally scattered throughout particular areas and are generally hard to find utilizing this type of sampling method. The best way to obtain samples, she elaborates, is to utilize churches that are located in Black communities.

Research Question 1 with Hypothesis 1

The first hypothesis focused on the public's perception of drinking water quality concerning taste and odor as perceived by respondents across race, gender, income and age. As indicated, the number of responses from minority groups did not permit analysis. No significant differences were identified based upon age. Income was combined into three categories rather than six groups to avoid cell counts below acceptable expected levels. As a result, the following analyses revealed significant differences among these respondents in perception of water quality.

The cross-tabulation analysis by gender of the respondents regarding their rating of quality of drinking water indicated that there is a difference ($x^2 = 7.816$, df =3, p=.05) between men and women and their perception of the quality of the water that is offered to Tulsa, Oklahoma citizens. Most of the men believe that their water quality is "Good" while most women were more likely to rate the quality of water as "Fair."

Table 5. Analysis of Perceived Quality by Sex of Respondent

Rating Group	Poor	Fair	Good	Excellent	Total Respondents
Men	7	7	37	8	59
Women	2	16	26	6	50
Total	9	23	63	14	109

$X^2 = 7.816$, df = 3, p = 0.05

In the income analysis cross-tabulation with question #4 (quality), the chi-square results ($x^2 = 17.795$, df = 6, p=0.007) indicated that a difference also existed. Thus, the residents of Tulsa, Oklahoma that make the least amount of money per year, $0-$39,999, believe that they have "Fair" water quality while residents who make $40,000 or more per year believe that they have "Good" water quality.

Table 6. Analysis of Perceived Quality by Income of Respondent

Rating Group	Poor	Fair	Good	Excellent	Total Respondents
$0 – 39,999	1	11	9	6	27
$40 - 79,999	6	5	24	2	37
> $80,000	1	6	23	6	36
Total	8	22	56	14	100

$X^2 = 17.795$, df = 6, p =0.007

The survey responses related to strengthening of the Clean Water Act revealed a chi-square total of 9.685 ($x^2 = 9.685$, df = 4, p = 0.046), and a difference was noted between men and women and their attitude toward the Clean Water Act. Most men strongly agreed with the statement while women were less intense in their agreement with strengthening the Clean Water Act.

Table 7. Analysis of Attitude toward Clean Water Act by Sex of Respondent

Rating Group	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total Respondents
Men	2	8	16	22	10	58
Women	0	3	26	11	8	48
Total	2	11	42	33	18	106

$X^2 = 9.685$, df = 4, p = 0.046

As a result of these differences, the researcher concluded that there are differences in perceptions of respondents in this group toward water quality based upon gender and income. Since these differences were identified, the hypothesis related to research question one was rejected. There are differences in perception on at least two demographic measures as identified in this study.

Research Question 2 with Hypothesis 2

The second hypothesis focused on the public's general knowledge of drinking water quality across race, gender, income, and age. Again, limited response from

minority groups did not permit analysis due to small sample size. No significant differences were identified based on age or gender. However, the following differences in knowledge of water quality were identified based upon income level.

In the cross-tab calculation of income (combined) several differences were found. With calculated chi-square analyses less than .05, it was revealed that a difference existed between those that had a combined income of $40,000 or more per year actually took the time to read the water quality report that they had received from their water supplier ($x^2 < 21.226$, df = 4, $p<.001$). It was also discovered that of those that read the report, most respondents' in the $40,000-$79,999 income range actually believed that the report was easy to understand ($x^2 = 22.359$, df = 6, $p<0.001$).

Table 8. Analysis of Reading Water Quality Report by Income of Respondent

Rating Group	Yes	No	I'm not sure	Total Respondents
$0 – 39,999	1	7	2	10
$40 – 59,999	12	3	0	15
> $60,000	10	0	0	10
Total	23	10	2	35

$X^2 = 21.228$, df = 4, $p < 0.001$

Table 9. Analysis of Ease of Understanding Water Quality Report by Income of Respondent.

Rating Group	Poor	Fair	Good	Excellent	Total Respondents
$0 – 39,999	1	1	0	5	7
$40 – 59,999	11	1	0	1	13
> $60,000	5	1	3	0	9
Total	17	3	3	6	29

$X^2 = 22.359$, df = 6, $p < 0.001$

The final analysis of gender, combined income, and age with several statements from question #18 revealed other significant differences. A difference was noted between income level and perception of whether or not federal environmental laws need to be strengthened ($X^2 = 20.708$, df = 8, p=0.008). Those persons with higher incomes tended to agree with the statement while those persons with the lowest incomes were more likely to be neutral on the issue of strengthening federal environmental laws. Therefore, opinions related to strengthening federal environmental laws were dependent upon income levels.

Table 10. Analysis of Strengthening Federal Environmental Laws by Income of Respondent.

Rating Group	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total Respondents
$0 – 39,999	2	1	14	5	4	26
$40 – 59,999	1	6	5	19	6	37
> $60,000	1	10	8	11	6	36
Total	4	17	27	35	16	99

$X^2 = 20.708$, df = 8, p = 0.008

As a result of these differences, the researcher concluded that there are differences in knowledge of respondents in this group regarding water quality based upon income. Since these differences were identified, the hypothesis related to research question two was rejected. There are differences in knowledge on at least two demographic measures as identified in this study.

Research Question 3

Research question number three was not tested for statistical significance through the use of hypotheses; however, frequency data showed that a majority of the public participants felt that their drinking water quality was good overall. Additionally, most respondents agree that we need stronger federal laws to protect our water quality. And, most respondents also agreed that drinking water contamination was not a problem where they live. Thus, it is concluded that overall, the public is happy with the quality of water they are offered in Tulsa, Oklahoma.

In summary, this study has shown that there are differences in perceptions of water quality among residents of this area of Tulsa based upon gender and economic status. In addition, there are differences in knowledge of water quality among residents of this area of Tulsa based upon gender and economic status. However, the overall attitude regarding water quality in Tulsa is one of satisfaction.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

This study was conducted to identify the public's perception, in Tulsa, Oklahoma, of the water quality problem concerning taste and odor across race, gender, income, and age lines. In addition, the purpose of this study was to discover Tulsa residents' general knowledge of drinking water quality in terms of participation and general knowledge of rules and regulations across race, gender, income, and age lines. Additionally, a final goal was to discover the public's attitude regarding overall water quality. This chapter includes a summary of the research and conclusions regarding the findings and recommendations for further study.

Conclusions

All three of the research questions were answered by the findings of this study. Research question one focused on public perception of the quality of drinking water in this area of Tulsa. Results of the frequency analysis indicated that overall, most people perceived that the quality of their water was "good" (63 out of 109 total respondents). Additionally, frequency tabulations also indicate that most (72 out of 110 total respondents) were inclined to believe that the overall safety of their drinking water was

”good”. Most people were aware of the overall “hardness” (38) of their water but very few (16) individuals noted that they were aware of an unpleasant odor coming from their tap water.

The study revealed that the top concern or issue from a variety of possible concerns was protection for the water quality in the Tulsa area. Protection of water quality was rated higher than prevention or reduction of crime and higher than improving public schools. Interestingly, these respondents rated protecting air quality and protecting wetlands to be quite low. In fact, there is a likely relationship between air quality, wetlands, and the quality of drinking water in most environments.

Bacteria and poultry bi-products were perceived as the number one threat in the area and statewide. With recent advertisements and news stories in the Tulsa area, this issue has received considerable public attention during the past year.

Real differences were identified in perception and knowledge of water quality issues among these respondents. First, those people with higher incomes perceive a higher quality to their drinking water than do persons with lower incomes. Men also perceive a higher quality to their drinking water than do women. Second, those people with higher incomes were more likely to read reports detailing the quality of their water and more likely to understand those reports. Similarly, those people with higher incomes favored strengthening federal laws protecting water. In addition, men were stronger in their support for the Clean Water Act than were women.

Finally, quite a few people are not sure (40 out of 107 total respondents) if there is enough protection for drinking water in Oklahoma. Likewise, several people (47 out of 108 total respondents) are concerned about chemicals in their drinking water. A majority

of them also agree (35 out of 108 total respondents) that we need stronger federal laws to protect our water quality yet, they do not believe that drinking water contamination is a problem where they live (50 out of 107 respondents agree or strongly agree). However, many view their drinking water quality and safety as "Good" overall.

Recommendations

Reflections on the results of this study have led to the following recommendations:

1. Given the dynamics of the city of Tulsa, survey questionnaires should be mailed to areas that are occupied by more members of different ethnic backgrounds. The researcher acknowledges that there may be differences that exist between members of different ethnic groups and their perception, attitude, and knowledge of the Tulsa water supply.
2. The researcher suggests that in future studies in areas similar to this research other measures to determine public knowledge, perception, and attitude toward water quality should be considered. It is believed that several participants neglected to complete parts of the survey because of the extensive length of the survey tool. Additionally, some of the language used on the survey tool should be adjusted as the researcher noticed that several participants commented on their understanding or misunderstanding of some of the words and phrases used to express feelings.
3. In future research more attention might be directed toward the development of a clear understanding of what quality water is on an operational level. In this

study, no definition of quality water or water quality was given, and the researcher was not convinced that each of the subjects fully comprehended the concept prior to completing the questionnaire. An informational mailing prior to the mailing of the questionnaire might be very beneficial.

4. Studies of the knowledge, perception, and attitude in regard to water quality in Tulsa, Oklahoma, of children that attend school in the Tulsa district would make interesting additions to the literature.
5. Reports on the quality of water provided through a public water supply are required annually. However, these reports are not presently of great assistance to particular members of the community. It is recommended that these reports be presented in a clearer, more understandable manner, especially for persons of lower incomes and lesser education.
6. Finally, it is difficult to obtain pertinent information that is representative of all of the zip code areas that make-up Tulsa, Oklahoma. However, a more effective procedure may be necessary to gather information from Tulsa residents that do not reside in the 74105 zip code area. The selection of a sample that is both cost effective and efficient is recommended.

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APPENDIXES

APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

Oklahoma State University Institutional Review Board

Date:	Thursday, May 18, 2006
IRB Application No	GU0613
Proposal Title:	Public Perception, Attitudes, and General Knowledge of the Tulsa Water Supply
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved **Protocol Expires: 5/17/2007**

Principal Investigator(s

Melissa J. Woolridge
Tulsa, OK

Lowell Caneday
184 Colvin Center
Stillwater, OK 74075

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

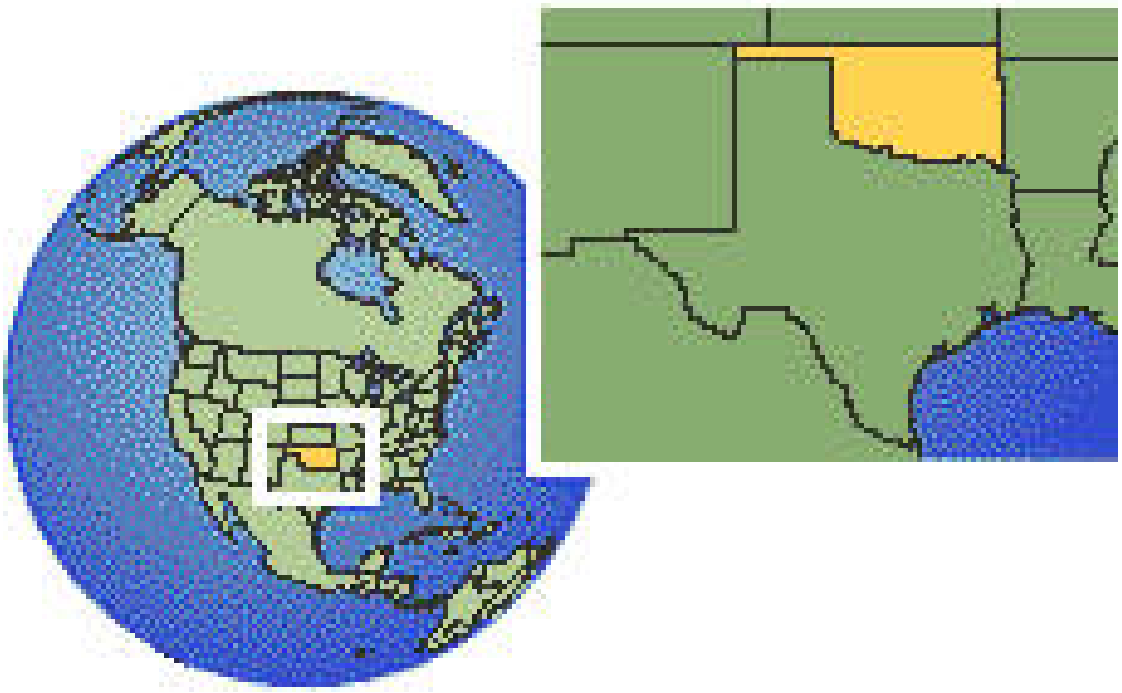
Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 415 Whitehurst (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Sue C. Jacobs, Chair
Institutional Review Board

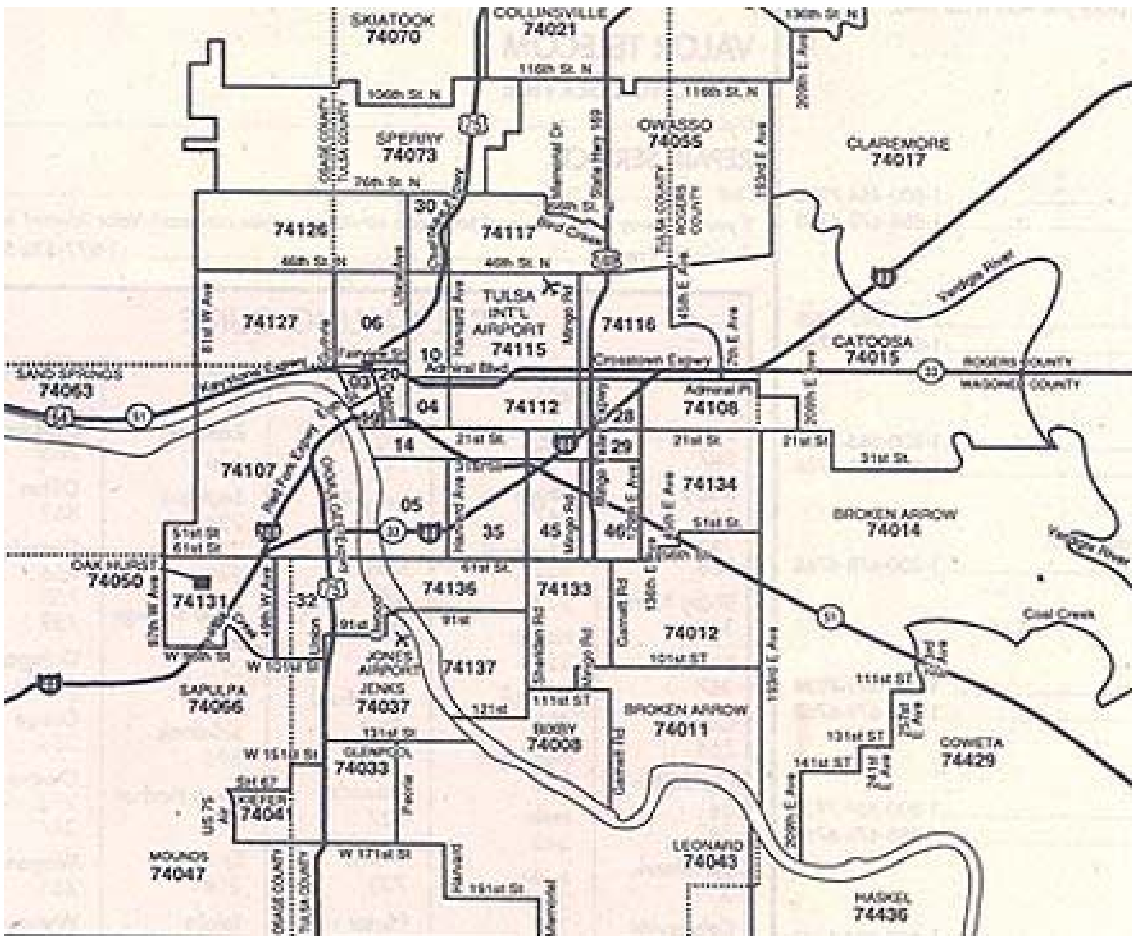
APPENDIX B

MAP OF OKLAHOMA



APPENDIX C

MAP OF TULSA, OKLAHOMA


SKIATOOK
74070
COLLINSVILLE
74021
SPERRY
74073
OWASSO
74055
CLAREMORE
74017
74126
74117
TULSA
INT'L
AIRPORT
74115
74127
06
74116
CATOOSA
74015
SAND SPRINGS
74063
74112
74108
74107
14
05
35
45
74134
BROKEN ARROW
74014
OAK HURST
74050
74131
74136
74133
74012
SAPULPA
74066
JENKS
74037
74137
BIXBY
74008
BROKEN ARROW
74011
COWETA
74429
GLENPOOL
74033
KIEFER
74041
MOUNDS
74047
LEONARD
74043
HASKEL
74436

APPENDIX D

TIMELINE OF MAJOR FEDERAL LAWS GOVERNING WATER

Timeline of Major Federal Laws Governing Water

1899 **Rivers and Harbours Appropriations Act, also known as the Refuse Act**

Prohibited the construction of bridges and other structures and other structures and the deposit of refuse matter without approval or a permit from the U.S. Army Corps of Engineers.

1948 **Federal Water Pollution Control Act (FWCPA)**

Allowed a court to grant relief from pollution after considering the practicability and economic feasibility of abatement. Revised by Congress in 1972.

1965 **Water Quality Act**

Provided for the adoption of water quality standards for interstate waters.

1974 **Safe Drinking Water Act (SDWA)**

Protects underground sources of drinking water and regulates contaminant levels in public drinking water systems. Amended in 1986and 1996.

1977 **Clean Water Act (CWA)**

Provides for the use of technology to prevent water pollution; encourage the conservation of nutrients; set maximum levels for pollutants.

1987 **Water Quality Act**

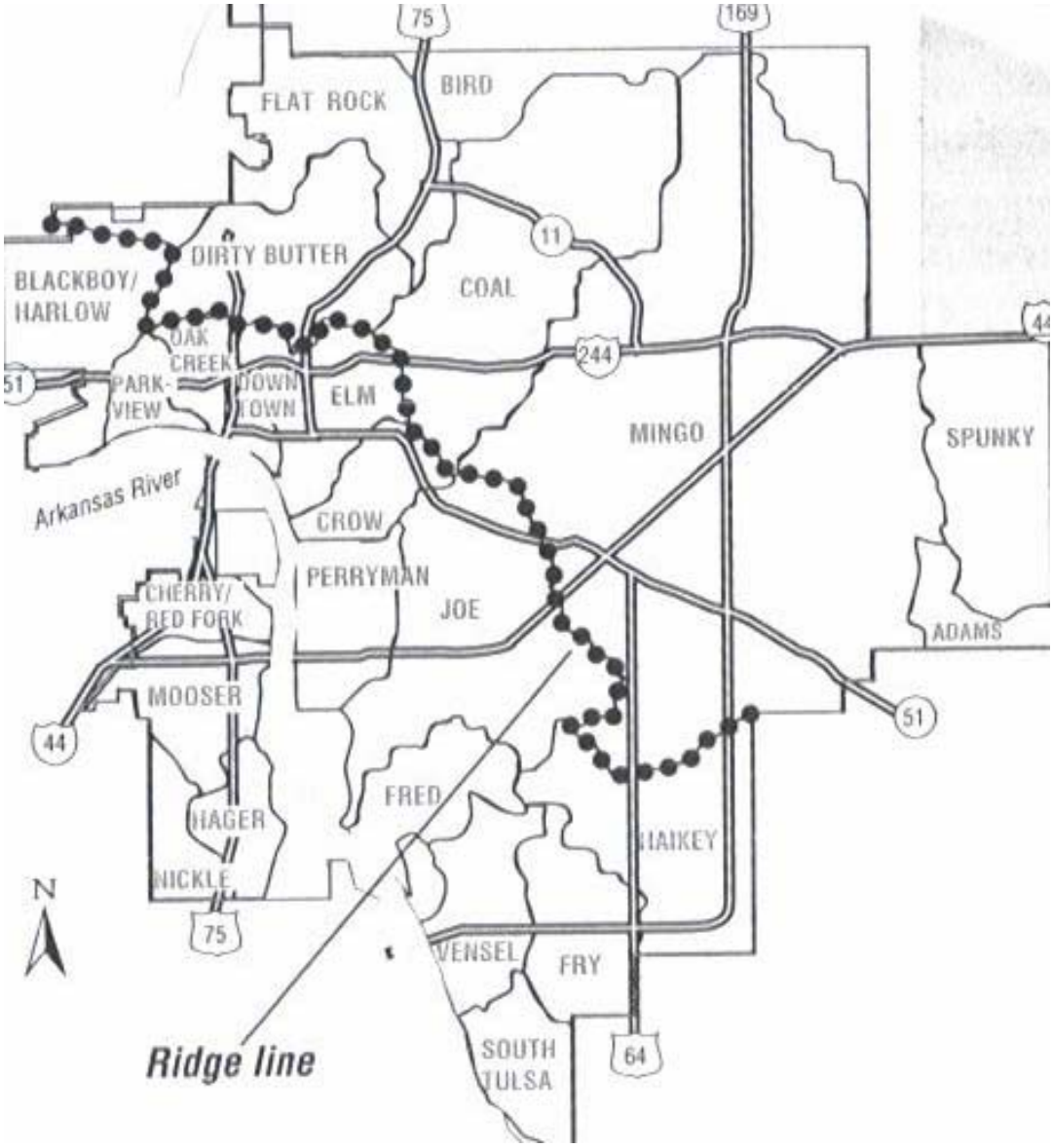
Granted more power to the Environmental Protection Agency (EPA) by allowing them to prosecute water polluters.

1996 **Water Quality Standards and Pollution Act**

Safe Drinking Water Act Amendments (SDWAA) included the regulation of specific drinking water contaminants; user right-to-know notification requirement; source water protection; funding to states for drinking water treatment plant improvements.

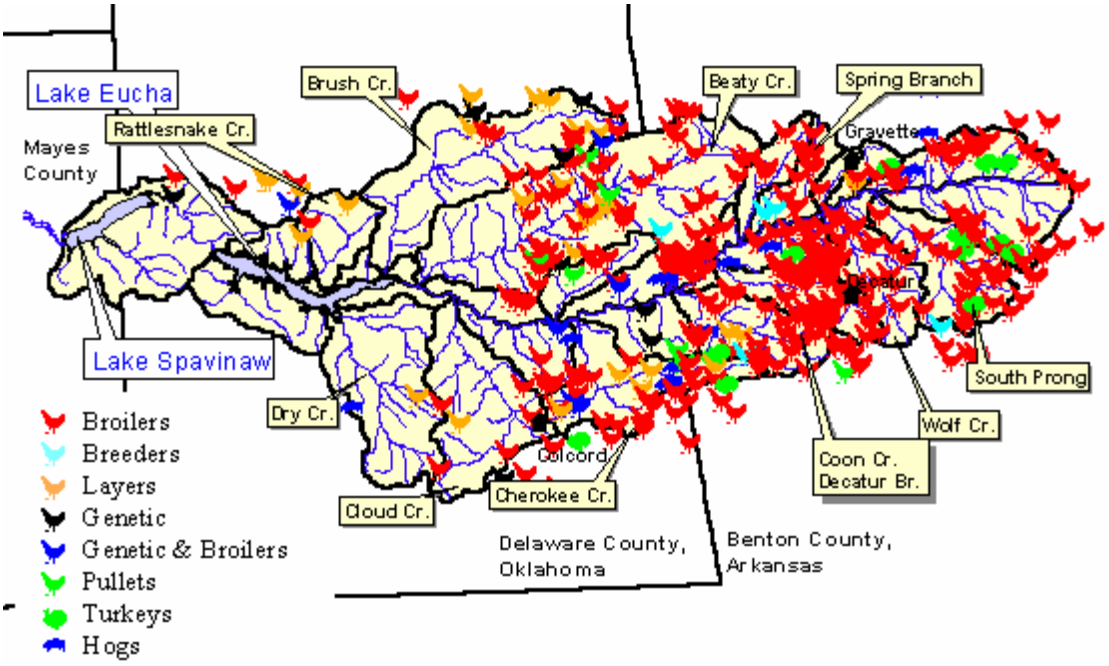
APPENDIX E

MAP OF THE RIDGELINE THAT DIVIDES THE CITY OF TULSA


75
169
FLAT ROCK
BIRD
11
DIRTY BUTTER
BLACKBOY/
HARLOW
COAL
OAK
CREEK
244
51
PARK-
VIEW
DOWN
TOWN
ELM
MINGO
SPUNKY
Arkansas River
CROW
PERRYMAN
CHERRY/
RED FORK
JOE
ADAMS
MOOSER
44
51
FRED
HAGER
NICKLE
N
75
VENSEL
FRY
Ridge line
SOUTH
TULSA
64

APPENDIX F

MAP OF THE CHICKEN FARMS THAT ARE ALLEGEDLY POLLUTING CITY OF TULSA WATER


Lake Eucha
Rattlesnake Cr.
Mayes
County
Brush Cr.
Beaty Cr.
Spring Branch
Gravette
Decatur
South Prong
Wolf Cr.
Coon Cr.
Decatur Br.
Lake Spavinaw
Dry Cr.
Colcord
Cherokee Cr.
Cloud Cr.
Delaware County,
Oklahoma
Benton County,
Arkansas
Broilers
Breeders
Layers
Genetic
Genetic & Broilers
Pullets
Turkeys
Hogs

APPENDIX G

COVER LETTER

School of Applied Health and Educational Psychology
180 Colvin Recreational Center
Stillwater, Oklahoma 74078
405-744-9337; Fax: 405-744-6507

TULSA WATER
QUESTIONNAIRE COVER LETTER/DIRECTIONS

June 1, 2006

Dear city of Tulsa resident:

The following survey is being distributed to several Tulsa residents that reside in the 74105 zip code. The purpose for conducting this study is to find out how citizens feel about the overall quality of their drinking water and to encourage them to believe that it is important that their voices be heard.

As a participant in this descriptive study you will not be asked to identify yourself. Your response to the questionnaire is voluntary and will not be viewed or utilized by anyone other than myself. By participating in this study you will be granted the opportunity to become more aware of the quality of water that you are offered as a citizen of the city of Tulsa. Additionally, this research may serve as a basis for city leaders to enhance their effort to teach Tulsans about the quality of water that they are currently afforded. Of particular interest to me is your opinion about the taste, odor, and overall quality of the water that comes out of the tap.

Once you have completed the questionnaire, please place it in the enclosed self-addressed envelope provided. All questionnaires will be shredded approximately six months following the completion of the study.

Thank you in advance for your participation in this descriptive study. Should you have any questions please feel free to phone me at (918) 720-5728.

Sincerely,

Melissa Woolridge

Melissa J. Woolridge
Oklahoma State University
Graduate Student

Lowell Caneday

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Professor of Leisure Studies
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APPENDIX H

TULSA WATER SURVEY

Public Perception, Attitudes, and General Knowledge of Water Quality in Tulsa (Oklahoma)

You have been randomly selected to participate in this study of water quality in Tulsa. This research is part of a doctoral dissertation being completed at Oklahoma State University. Your responses to this survey will assist in our understanding of public perception, attitudes and knowledge of water quality in Tulsa. Your responses will not be personally identifiable and will be treated in aggregate only. If you have questions about your rights as a volunteer in the research, you may contact Dr. Sue C. Jacobs, IRB Chair, Oklahoma State University, 415 Whitehurst Hall, Stillwater, OK 74078, 744-1676 or irb@okstate.edu.

Please take 15 minutes of your time to complete this questionnaire. Your responses will tell us more about how Tulsa (Oklahoma) residents feel about important water quality issues.

Section 1: Important Issues Facing Our Communities

1. Listed below are several concerns facing many communities throughout the state of Oklahoma. How important is each issue to you? [Circle one number for EACH concern].

Possible concerns or issues	Not at all important	Very low importance	Low importance	High importance	Very high importance
Protecting water quality	1	2	3	4	5
Improving public schools	1	2	3	4	5
Managing growth & new development	1	2	3	4	5
Providing more recreation areas	1	2	3	4	5
Road improvements & maintenance	1	2	3	4	5
Protecting air quality	1	2	3	4	5
Protecting forests	1	2	3	4	5
Preventing and reducing crime	1	2	3	4	5
Protecting wetlands	1	2	3	4	5
Providing convenient public transportation	1	2	3	4	5

Section 2: Drinking Water Quality

2. What is the source of your water? Please check (√) one.

	Private well
	Municipal water supply
	Rural water district well
	I'm not sure

3. If your water comes from a municipal supply, what is the source of that supply? Please check (√) one.

☐	Underground aquifer
☐	Dam, reservoir, lake, or river
☐	I'm not sure

4. Please rate the quality of your drinking water by checking (√) the level below that matches your opinion.

☐	Poor
☐	Fair
☐	Good
☐	Excellent

5. Which of the following apply to your tap water? Please check (√) all that apply.

☐	Sediment (rust, particles, etc.)
☐	Iron or "hard" water
☐	Calcium or "soft" water
☐	Sulfur or other unpleasant odor

6. Have you ever had your water tested for any of the following? Please check (√) all that apply.

☐	Bacteria	☐	Herbicides
☐	Arsenic	☐	Pesticides
☐	Nitrates	☐	Heavy metals (mercury, lead, etc.)
☐	Other (please identify):		

7. If you had your water tested for any of the above, were any of these substances found? Please check (√) all that apply.

☐	Yes
☐	No
☐	I'm not sure

8. Have you received a report on your drinking water quality from your water supplier?

☐	Yes
☐	No
☐	I'm not sure

8a. If "Yes," did you take the time to read the water quality report?

☐	Yes
☐	No
☐	I'm not sure

9. If "Yes," please give your opinion of the report by checking (√) the statement that matches your response.

☐	The report was easy to understand
☐	The report was unclear in some parts
☐	The report was not easy to understand
☐	I did not read the report

10. Have any of the following ever happened to you while living in Tulsa? Please check (√) all that apply.

☐	Had to follow a boil water advisory
☐	Had a contamination advisory not to drink municipal tap water
☐	Had a strange odor come from your tap water
☐	Other (please specify):

11. Please rate your opinion of the safety of your drinking water by checking (√) the rating that matches your opinion.

☐	Poor
☐	Fair
☐	Good
☐	Excellent

12. Please rate the following as to how you feel they threaten drinking water quality IN THE AREA WHERE YOU LIVE. Please circle the number that matches your assessment of each threat to your drinking water quality.

Possible threats to drinking water IN THE AREA WHERE YOU LIVE	Not a threat at all	Very low threat	Low threat	High threat	Very high threat
Heavy metals (mercury, lead, arsenic, etc.)	1	2	3	4	5
Bacteria from poultry operations	1	2	3	4	5
Chemical residue from pesticides	1	2	3	4	5
Fertilizers from agricultural operation	1	2	3	4	5
Chemical residue from herbicides	1	2	3	4	5
Bacteria from septic systems	1	2	3	4	5
Silt from construction	1	2	3	4	5
Development/urban sprawl	1	2	3	4	5
Bacteria from geese	1	2	3	4	5

13. Do you feel there is a threat of a drinking water shortage in the area where you live?

☐	Yes
☐	No
☐	I'm not sure

14. Do you have water-saving devices (low-flow faucets, toilets, showerheads, etc.) installed in your home?

	Yes
	No
	I'm not sure

15. Do you use bottled water for drinking and/or cooking in your home?

	Yes
	No
	I'm not sure

16. Do you use a water purification device for your tap water?

	Yes
	No
	I'm not sure

17. Please rate the following by how you feel they threaten drinking water QUALITY in Oklahoma. Please circle the number that matches your response.

Possible threats to drinking water IN OKLAHOMA	Not a threat at all	Very low threat	Low threat	High threat	Very high threat
Heavy metals (mercury, lead, arsenic, etc.)	1	2	3	4	5
Bacteria from poultry operations	1	2	3	4	5
Chemical residue from pesticides	1	2	3	4	5
Fertilizers from agricultural operation	1	2	3	4	5
Chemical residue from herbicides	1	2	3	4	5
Bacteria from septic systems	1	2	3	4	5
Silt from construction	1	2	3	4	5
Development/urban sprawl	1	2	3	4	5
Bacteria from geese	1	2	3	4	5

Section 3: Attitudes Toward Water Quality.

18. Tulsa (Oklahoma) residents face a number of water quality issues. Please give your opinion for each of the statements on the following page by circling the number that matches your response.

Water Quality Issue	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
Access to streams and rivers for recreation is difficult in Oklahoma	1	2	3	4	5
There is enough protection for drinking water in Oklahoma	1	2	3	4	5
Water pollution laws are too tough in Oklahoma	1	2	3	4	5
Economic prosperity depends on a healthy environment	1	2	3	4	5
More protection needs to be given to wildlife habitat along streams and rivers in Oklahoma	1	2	3	4	5
Water contamination from lawn-care products are a threat to water quality in my area	1	2	3	4	5
We need stronger federal laws to protect our water quality	1	2	3	4	5
Water contamination from poultry operations is a problem in Oklahoma	1	2	3	4	5
I am concerned about chemicals in my drinking water	1	2	3	4	5
Too much attention is given to wildlife in deciding how land is to be used in Oklahoma	1	2	3	4	5
I feel the Clean Water Act needs to be strengthened	1	2	3	4	5
Quality water is needed for strong economic growth	1	2	3	4	5
There is enough groundwater to support development in my area	1	2	3	4	5
Chemicals from agriculture are a threat to my drinking water	1	2	3	4	5
Brush and fallen trees are good for the ecological health of streams and rivers	1	2	3	4	5
Drinking water contamination is not a problem where I live	1	2	3	4	5
Not enough attention is given to protect water quality in Oklahoma	1	2	3	4	5
Tough water protection laws hurt economic development	1	2	3	4	5

Section 4: General Household Information

The following information is helpful to describe different groups of households. Your answers will be used for statistical purposes and will not be identified with you personally.

1. Are you: (Please check one)

☐	Male
☐	Female

2. How old are you? (Fill in blank)_____ years old

3. What is your zip code? 741_____

4. What is your ethnic/cultural group? (Check one)

☐	Caucasian/White	☐	Hispanic
☐	African-American	☐	Native American (American Indian)
☐	Asian-American	☐	Some Other Race

5. What is the highest level of education you have completed? (Please check one)

☐	Less than high school	☐	Associate degree
☐	Graduated high school	☐	Bachelor's degree
☐	Technical/Vocational school	☐	Some graduate study
☐	Some college	☐	Graduate or professional degree

6. What was your approximate total household income before taxes in 2004? (Please check one)

☐	Under $20,000	☐	$60,000-$79,999
☐	$20,000-$39,999	☐	$80,000-$99,999
☐	$40,000-59,999	☐	$100,000 or more

Please fold the completed survey form so that the self-addressed label and stamp are visible. Seal the survey with tape and place in the mail.
THANK YOU FOR YOUR HELP AND COOPERATION

FOLD

ATTENTION:Melissa Woolridge
Oklahoma State University-Tulsa
700 North Greenwood
Tulsa, OK 74106-0700

FOLD

APPENDIX I

POSTCARD REMINDERS TO SURVEY PARTICIPANTS

Have you completed the Tulsa Water Survey that you received in the mail a couple of weeks ago?

If you have already completed and mailed the voluntary survey form please disregard this postcard. Thank you for your participation.

Sincerely,

Melissa

APPENDIX J

DATA MATRIX

Survey form #:_____
_____Sex _____Age _____Zip code _____Race
_____Education _____Income

N-Not important
VL-Very low
L-Low threat
H-High
VH-Very high

Section 1:

1._____Protecting water quality
2._____Improving schools
3._____Managing growth
4._____More recreation
5._____Road improvements
6._____Protect air quality
7._____Forests
8._____Crime
9._____Wetlands
10.____Public transportation

Section 2:

1._____
2._____Source of water
3._____Source of supply
4._____Quality of water
5._____Apply to tap water
6._____Water tested
7._____Substances found
8._____Water report
8a.____Read report
9._____Opinion of report
10.____Happened while
11.____Water safety
12.____Area where you live:
    1._____Heavy metals
    2._____Bacteria-poultry
    3._____Residue-pesticide
    4._____Fertilizers
    5._____Residue-herbacide
    6._____Bateria-septic
    7._____Silt
    8._____Urban sprawl
    9._____Bateria—Geese
13.____Threat of water shortage
14.____Water saving-device
15.____Bottled water
16.____Water purification
17.____Oklahoma
    1._____Heavy metals
    2._____Bacteria-poultry
    3._____Residue-pesticide
    4._____Fertilizers
    5._____Residue-herbacide
    6._____Bateria-septic
    7._____Silt
    8._____Urban sprawl
    9._____Bateria—Geese

Section 3:

1._____Access to streams/rivers
2._____Enough protection
3._____Water pollution laws
4._____Economic
5._____Protect wildlife
6._____Water/lawn care
7._____Federal laws
8._____Poultry operations
9._____Chemicals
10.____Attention wildlife

11.____Clean water act
12.____Qualitryeconomic
growth
13.____Groundwater to
support development
14.____Chemicals/
agriculture
15.Brush and fallen trees
16.____Drinking water
contamination
17.____Not enough attention
18.____Tough water
protection

APPENDIX K

ACCUMULATED SURVEY DATA

Public Perception, Attitudes, and General Knowledge of Water Quality in Tulsa (Oklahoma)

You have been randomly selected to participate in this study of water quality in Tulsa. This research is part of a doctoral dissertation being completed at Oklahoma State University. Your responses to this survey will assist in our understanding of public perception, attitudes and knowledge of water quality in Tulsa. Your responses will not be personally identifiable and will be treated in aggregate only. If you have questions about your rights as a volunteer in the research, you may contact Dr. Sue C. Jacobs, IRB Chair, Oklahoma State University, 415 Whitehurst Hall, Stillwater, OK 74078, 744-1676 or irb@okstate.edu.

Please take 15 minutes of your time to complete this questionnaire. Your responses will tell us more about how Tulsa (Oklahoma) residents feel about important water quality issues.

Section 1: Important Issues Facing Our Communities

1. Listed below are several concerns facing many communities throughout the state of Oklahoma. How important is each issue to you? [Circle one number for EACH concern].

Possible concerns or issues	Not at all important	Very low importance	Low importance	High importance	Very high importance
Protecting water quality	**1**	**2**	**3**	**33**	**61**
Improving public schools	**4**	**2**	**5**	**28**	**61**
Managing growth & new development	**1**	**4**	**15**	**49**	**29**
Providing more recreation areas	**5**	**11**	**41**	**26**	**17**
Road improvements & maintenance	**1**	**2**	**4**	**48**	**46**
Protecting air quality	**1**	**2**	**6**	**42**	**50**
Protecting forests	**3**	**3**	**13**	**46**	**36**
Preventing and reducing crime	**1**	**1**	**2**	**28**	**68**
Protecting wetlands	**7**	**12**	**27**	**32**	**21**
Providing convenient public transportation	**5**	**13**	**34**	**30**	**16**

Section 2: Drinking Water Quality

2. What is the source of your water? Please check (√) one.

0	Private well
103	Municipal water supply
1	Rural water district well
2	I'm not sure

3. If your water comes from a municipal supply, what is the source of that supply? Please check (√) one.

0	Underground aquifer
93	Dam, reservoir, lake, or river
14	I'm not sure

4. Please rate the quality of your drinking water by checking (√) the level below that matches your opinion.

9	Poor
23	Fair
63	Good
14	Excellent

5. Which of the following apply to your tap water? Please check (√) all that apply.

18	Sediment (rust, particles, etc.)
38	Iron or "hard" water
18	Calcium or "soft" water
16	Sulfur or other unpleasant odor

6. Have you ever had your water tested for any of the following? Please check (√) all that apply.

4	Bacteria
2	Arsenic
3	Nitrates
3	Other (please identify):
3	Herbicides
3	Pesticides
5	Heavy metals (mercury, lead, etc.)

7. If you had your water tested for any of the above, were any of these substances found? Please check (√) all that apply.

1	Yes
9	No
6	I'm not sure

8. Have you received a report on your drinking water quality from your water supplier?

27	Yes
66	No

13	I'm not sure

8a. If "Yes," did you take the time to read the water quality report?

27	Yes
10	No
2	I'm not sure

9. If "Yes," please give your opinion of the report by checking (√) the statement that matches your response.

22	The report was easy to understand
3	The report was unclear in some parts
3	The report was not easy to understand
6	I did not read the report

10. Have any of the following ever happened to you while living in Tulsa? Please check (√) all that apply.

5	Had to follow a boil water advisory
1	Had a contamination advisory not to drink municipal tap water
36	Had a strange odor come from your tap water
5	Other (please specify):

11. Please rate your opinion of the safety of your drinking water by checking (√) the rating that matches your opinion.

6	Poor
18	Fair
72	Good
14	Excellent

12. Please rate the following as to how you feel they threaten drinking water quality IN THE AREA WHERE YOU LIVE. Please circle the number that matches your assessment of each threat to your drinking water quality.

Possible threats to drinking water IN THE AREA WHERE YOU LIVE	Not a threat at all	Very low threat	Low threat	High threat	Very high threat
Heavy metals (mercury, lead, arsenic, etc.)	**23**	**30**	**24**	**15**	**4**
Bacteria from poultry operations	**17**	**17**	**19**	**33**	**15**
Chemical residue from pesticides	**11**	**18**	**39**	**27**	**4**
Fertilizers from agricultural operation	**14**	**24**	**29**	**27**	**4**
Chemical residue from herbicides	**10**	**29**	**33**	**23**	**4**
Bacteria from septic systems	**21**	**41**	**23**	**7**	**6**
Silt from construction	**22**	**38**	**27**	**9**	**1**
Development/urban sprawl	**19**	**29**	**29**	**13**	**7**

Bacteria from geese	**32**	**31**	**25**	**7**	**3**

13. Do you feel there is a threat of a drinking water shortage in the area where you live?

17	Yes
77	No
13	I'm not sure

14. Do you have water-saving devices (low-flow faucets, toilets, showerheads, etc.) installed in your home?

59	Yes
45	No
5	I'm not sure

15. Do you use bottled water for drinking and/or cooking in your home?

54	Yes
55	No
0	I'm not sure

16. Do you use a water purification device for your tap water?

38	Yes
71	No
0	I'm not sure

17. Please rate the following by how you feel they threaten drinking water QUALITY in Oklahoma. Please circle the number that matches your response.

Possible threats to drinking water IN OKLAHOMA	Not a threat at all	Very low threat	Low threat	High threat	Very high threat
Heavy metals (mercury, lead, arsenic, etc.)	**5**	**21**	**42**	**20**	**9**
Bacteria from poultry operations	**4**	**5**	**9**	**48**	**34**
Chemical residue from pesticides	**4**	**8**	**27**	**43**	**16**
Fertilizers from agricultural operation	**4**	**8**	**27**	**43**	**15**
Chemical residue from herbicides	**4**	**9**	**31**	**40**	**12**
Bacteria from septic systems	**6**	**20**	**40**	**23**	**7**
Silt from construction	**8**	**30**	**36**	**15**	**6**
Development/urban sprawl	**9**	**18**	**38**	**21**	**12**
Bacteria from geese	**17**	**27**	**35**	**11**	**4**

Section 3: Attitudes Toward Water Quality.

18. Tulsa (Oklahoma) residents face a number of water quality issues. Please give your opinion for each of the statements on the following page by circling the number that matches your response.

Water Quality Issue	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
Access to streams and rivers for recreation is difficult in Oklahoma	**22**	**53**	**17**	**13**	**3**
There is enough protection for drinking water in Oklahoma	**14**	**29**	**40**	**22**	**2**
Water pollution laws are too tough in Oklahoma	**32**	**43**	**29**	**0**	**3**
Economic prosperity depends on a healthy environment	**4**	**2**	**6**	**46**	**50**
More protection needs to be given to wildlife habitat along streams and rivers in Oklahoma	**3**	**15**	**28**	**42**	**19**
Water contamination from lawn-care products are a threat to water quality in my area	**6**	**26**	**48**	**22**	**5**
We need stronger federal laws to protect our water quality	**4**	**21**	**30**	**35**	**18**
Water contamination from poultry operations is a problem in Oklahoma	**0**	**2**	**16**	**43**	**45**
I am concerned about chemicals in my drinking water	**0**	**25**	**17**	**47**	**19**
Too much attention is given to wildlife in deciding how land is to be used in Oklahoma	**22**	**37**	**30**	**16**	**3**
I feel the Clean Water Act needs to be strengthened	**2**	**11**	**42**	**33**	**18**
Quality water is needed for strong economic growth	**0**	**4**	**8**	**54**	**42**
There is enough groundwater to support development in my area	**1**	**14**	**57**	**27**	**4**
Chemicals from agriculture are a threat to my drinking water	**3**	**20**	**41**	**41**	**3**
Brush and fallen trees are good for the ecological health of streams and rivers	**2**	**18**	**50**	**35**	**3**
Drinking water contamination is not a problem where I live	**5**	**17**	**35**	**45**	**5**
Not enough attention is given to protect water quality in Oklahoma	**3**	**13**	**40**	**36**	**15**
Tough water protection laws hurt economic development	**17**	**51**	**28**	**10**	**2**

Section 4: General Household Information

The following information is helpful to describe different groups of households. Your answers will be used for statistical purposes and will not be identified with you personally.

19. Are you: (Please check one)

59	Male
51	Female

20. How old are you? (Fill in blank)_____ years old

21. What is your zip code? 741**05 111**

22. What is your ethnic/cultural group? (Check one)

102	Caucasian/White	**2**	Hispanic
0	African-American	**3**	Native American (American Indian)
1	Asian-American	**2**	Some Other Race

23. What is the highest level of education you have completed? (Please check one)

1	Less than high school	**8**	Associate degree
7	Graduated high school	**31**	Bachelor's degree
4	Technical/Vocational school	**13**	Some graduate study
22	Some college	**24**	Graduate or professional degree

24. What was your approximate total household income before taxes in 2004? (Please check one)

5	Under $20,000	**11**	$60,000-$79,999
22	$20,000-$39,999	**14**	$80,000-$99,999
27	$40,000-59,999	**22**	$100,000 or more

Please fold the completed survey form so that the self-addressed label and stamp are visible. Seal the survey with tape and place in the mail.
THANK YOU FOR YOUR HELP AND COOPERATION

APPENDIX L

LIST OF SURVEY QUESTIONS REFERENCED TO ANSWER RESEARCH QUESTIONS

Cumulative data to answer research question number one was generated by cross-referencing the frequency tabulations of gender, income (combined), and age against the following survey questions:

Question number four:

- Please rate the quality of your drinking water by checking (√) the level below that matches your opinion (Poor, Fair, Good, Excellent).

Question number eleven:

- Please rate your opinion of the safety of your drinking water by checking (√) the rating that matches your opinion (Poor, Fair, Good, Excellent).

Selected statements from question number eighteen:

- Tulsa (Oklahoma) residents face a number of water quality issues. Please give your opinion for each of the statements on the following page by circling the number that matches your responses.
- There is enough protection for drinking water in Oklahoma (Strongly Disagree, Disagree, Unsure, Agree, Strongly Agree).
- Economic prosperity depends on a healthy environment (Strongly Disagree, Disagree, Unsure, Agree, Strongly Agree).
- Water contamination from poultry operations is a problem in Oklahoma (Strongly Disagree, Disagree, Unsure, Agree, Strongly Agree).
- I am concerned about chemicals in my drinking water (Strongly Disagree, Disagree, Unsure, Agree, Strongly Agree).
- I feel the Clean Water Act needs to be strengthened (Strongly Disagree, Disagree, Unsure, Agree, Strongly Agree).
- Quality water is needed for strong economic growth (Strongly Disagree, Disagree, Unsure, Agree, Strongly Agree).
- Drinking water contamination is not a problem where I live (Strongly Disagree, Disagree, Unsure, Agree, Strongly Agree).
- Not enough attention is given to protect water quality in Oklahoma (Strongly Disagree, Disagree, Unsure, Agree, Strongly Agree).

Data to answer research question number two was generated by cross-referencing the frequency tabulations of gender, income (combined), and age against the following survey questions:

Question number two:

- Listed below are several concerns facing many communities throughout the state of Oklahoma. How important is each issue to you? (Circle one number for EACH concern).
- Protecting water quality (Not at all important, Very low importance, Low importance, High importance, Very high importance).
- Protecting wetlands (Not at all important, Very low importance, Low importance, High importance, Very high importance).

Question number eight:

- Have you received a report on your drinking water quality from your water supplier? (Yes, No, I'm not sure).
- If "Yes," did you take the time to read the water quality report? (Yes, No, I'm not sure)

Question number nine:

- If ”Yes,” please give your opinion of the report by checking (√) the statement that matches your response (The report was easy to understand, The report was unclear in some parts, The report was not easy to understand, I did not read the report).

Question number twelve:

- Please rate the following as to how you feel they threaten drinking water quality IN THE AREA WHERE YOU LIVE. Please circle the number that matches your assessment of each threat to your drinking water quality.

Finally, to answer the third research question, previously tabulated frequencies accumulated from question #4, “Please rate the quality of your drinking water by checking the level below that matches your opinion—Poor, Fair, Good, Excellent—were referenced.

APPENDIX M

ADDITIONAL COMMENTS FROM SURVEY PARTICIPANTS

ADDITIONAL COMMENTS

Survey #2
Section 1 Providing more recreation areas. *Providing for funding of park swimming pools so that all pools will be open for use.*

Section 1 Providing convenient public transportation. *If public transportation can function as a pay-for-ride service.*

Section 2 Which of the following apply to you tap water? Please check all that apply. *I understand "calcium" or lime makes water hard.*

Section 3 Access to streams and rivers for recreation is difficult in Oklahoma. *Not public areas.*

Section 3 There is enough protection for drinking water in Oklahoma. *Never too much.*

Section 3 Water contamination from lawn-care products are a threat to water quality in my area. *Any area.*

Section 3 We need stronger federal laws to protect our water quality. *And state.*

Section 3 Water contamination from poultry is a problem in Oklahoma. *So I read.*

Section 3 There is enough groundwater to support development in my area. *Water not from groundwater.*

Section 3 Not enough attention is given to protect water quality in Oklahoma. *Always need to be attentive.*

Survey #3
Income My lawyer advises against giving this information. It is not relevant.

Survey #13
Section 2 If you had your water tested for any of the above, were any of these substances found? Never had water tested.

Section 2 Have any of the following ever happened to you while living in Tulsa? Please check all that apply. Flood Fall 1986.

Survey #33
Section 2 Bacteria from poultry operations. *This is what we all fear.*

Section 3 Water contamination from poultry operations is a problem in Oklahoma. *_!*

Survey # 48
Section 2 Have any of the following ever happened to you while living in Tulsa? Please check all that apply. *Weird taste.*

Survey # 51
Section 2 Have you ever had your water tested for any of the following? Please check all that apply. *Not individual.*

Survey # 59
Section 2 Have any of the following ever happened to you while living in Tulsa? Please check all that apply. *In past at times.*

Survey # 65
Section 2 Have any of the following ever happened to you while living in Tulsa? Please check all that apply. Had contamination advisory not to drink.

Survey # 73
Section 2 Bacteria from septic systems. *Don't know.*

Section 2 Silt from construction. *Don't know.*

Section 2 Bacteria from geese. Don't know.

FYI=I purchase @ 5.00 in bottles Propel each day for me and my son.

Thanks, Good luck © your project & God Bless.

Survey # 93
For additional info about unfair practices related to water usage in Tulsa send me your email and I'll send you additional info. *A return email address was listed but due to confidentiality issues it was not included in this public dissertation.*

Survey # 98
Section 2 Have you ever had your water tested for any of the following? Please check all that apply. *New resident.*

Section 2 If "Yes," please give your opinion of the report by checking the statement that matches your response. *Need a report.*

Survey # 100
Race Celtic

Section 2 Have you ever had your water tested for any of the following? Please check all that apply. *Not tested.*

Survey # 103

Section 2 What is the source of your water? Please check one. *I do have a well on my property.*

Survey # 121
Section 2 Have any of the following ever happened to you while living in Tulsa? Please check all that apply. *Dark sediment.*

Section 2 Do you have water-saving devices (low-flow faucets, toilets, showerheads, etc. installed in your home? *Some.*

Survey # 138
Section 2 Have you ever had your water tested for any of the following? Please check all that apply. *Not had it tested.*

Section 2 Have any of the following ever happened to you while living in Tulsa? Please check all that apply. *Broken city line so water was cloudy, muddy looking—not clear.*

Section 2 Do you have water-saving devices (low-flow faucets, toilets, showerheads, etc.) installed in your home? *Toilet.*

Section 2 Do you use bottled water for drinking and/or cooking in your home? *Drinking—some.*

Survey # 142
Section 2 Which of the following apply to your tap water? Please check all that apply. *Moderate hardness.*

Oklahoma has a serious lack of enforcement w/regards to CERCLA, Safe Drinking Water Act and Clean Water Act. It's not a lack of adequate env. regs. but a lack of enforcement. This also true with air regulations.

Survey # 147
Section 1 Managing growth & new development. *I object to omission of "middle" category.*

Section 2 Have you ever had your water tested for any of the following? Please check all that apply. *No, we personally have <u>not</u>—but the city of Tulsa has.*

Section 2 Question 17 (chart) Please rate the following by how you feel they threaten drinking water QUALITY in Oklahoma. Please circle the number that matches your response. *I object to omission of "middle" category.*

Survey # 156
Race Caucasian/Asian

Section 2 Do you use bottled water for drinking and/or cooking in your home? *Sometimes-we drink mostly tap because drinking water can get very expensive (do not drink soda) and also for the fluoride and other minerals not found in bottled water.*

Survey # 159
Section 2 Do you use bottled water for drinking and/or cooking in your home? *Occasionally.*

Survey # 197
Race Native American

Survey #206
Survey was returned without cover letter instructions and page one. The first page was not included in the initial mailer. This was an error committed by the researcher.

Survey # 223
Section 2 Have any of the following ever happened to you while living in Tulsa? Please check all that apply. *Dirty, rusty*

Survey # 250
Section 2 Which of the following apply to your tap water? Please check all that apply. *Bad taste when the water "rolls over" and algae dies!!!*

Section 2 Have any of the following ever happened to you while living in Tulsa? Please check all that apply. *Have had to buy water—algae a problem.*

Section 2 Please rate your opinion of the safety of your drinking water by checking the rating that matches your opinion. *Have had to buy water—algae a problem. Too much chicken _ _ _ _! Waste*

Section 2 Do you use a water purification device for your tap water? *When algae gets bad I use one.*

Survey #260
Section 2 Have you ever had your water tested for any of the following? Please check all that apply. *Have not yet been tested for any reason.*

Section 2 Have any of the following ever happened to you while living in Tulsa? Please check all that apply. *Have not yet received any report or read any report from municipal water advisory.*

Section 2 Question 12 (chart) *Have no knowledge of any of the above.*

Section 2 Question 17 (chart) *Have no knowledge of any of the above.*

Survey # 271
When sending a questionnaire—limit your inquiring to 1 or 2 pages. Very few people will take the time to complete 6 pages I have my doctorate in research therefore I know a little about research.

Survey #999
Section 3 Economic prosperity depends on a healthy environment. *New York is proof.*

Section 3 Quality water is needed for strong economic growth. *Never thought about it.*

I've never known anyone who died from tap water, or even made them sick.

Survey #999
Section 2 Question 12 (chart) *Who is they? How do I know?*

VITA

Melissa J. (Furch) Woolridge

Candidate for the Degree of

Doctor of Philosophy

Dissertation: PUBLIC PERCEPTION OF, ATTITUDES TOWARD, AND GENERAL KNOWLEDGE OF THE TULSA WATER SUPPLY AND ITS QUALITY

Major Field: Environmental Science

Biographical:

Education: Graduated from Booker T. Washington High School, Tulsa, Oklahoma. May, 1987, received Bachelor of Science Degree in Biological Science with a minor in Chemistry from Kentucky State University, Frankfort, Kentucky, December of 1991. Received Master of Science Degree in Curriculum and Instruction with a specialization in Secondary Science Education from Oklahoma State University, Stillwater, Oklahoma, December of 1996. Completed the requirements of the Doctor of Philosophy Degree at Oklahoma State University in December, 2006.

Experience: Principal Intern, George Washington Carver Middle School, Tulsa Public Schools, August 2005 to June 2006. Dean of Students, Grover Cleveland Middle School, Tulsa Public Schools, August 2002 to June 2005. General Science Classroom Teacher, Eli Whitney Middle School, Tulsa Public Schools, August 1995 to May 2002. Laboratory Technician, Oklahoma Animal Disease Diagnostic Laboratory, Oklahoma State University, Stillwater, Oklahoma, June 1992 to June 1995.

Name: Melissa J. (Furch) Woolridge Date of Degree: December, 2006

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: PUBLIC PERCEPTION OF, ATTITUDES TOWARD, AND GENERAL KNOWLEDGE OF THE TULSA WATER SUPPLY AND ITS QUALITY

Pages in Study: 131 Candidate for the Degree of Doctor of Philosophy

Major Field: Environmental Science

Scope and Method of Study: The purpose of the investigation was to identify the public's perception, attitudes, and general knowledge of the water quality for the city of Tulsa, Oklahoma. Additionally, public perception was examined in terms of knowledge of the risks of contamination to drinking water. The attitudes of people were studied as they related to taste, odor, and interest in water quality, and the attitudes regarding the taste and odor of the drinking water. The goal, in terms of subject selection, was to get members of the general public who have varied interest in water quality as well as a balance of the members of the public regarding their gender, age, race, and economic status.

Findings and Conclusions: Overall, most of the city of Tulsa residents that reside in the 74105 zip code (63 out of 109 total respondents) perceived that the quality of their drinking water was "good." Additionally, frequency tabulations also indicated that most (72 out of 110 total respondents) were inclined to believe that the overall safety of their drinking water was "good." The study also revealed that residents' top concern was protection for the water quality in the Tulsa area. Bacteria and poultry bi-products were perceived as the number one threat in the area and statewide. People with a higher income perceive a higher quality to their drinking water than do people with lower incomes. Men also perceive a higher quality to their drinking water than do women; and, men were stronger in their support for the Clean Water Act than were women. Finally, a considerable amount of people (47 out of 108 total respondents) agree that we need stronger federal laws to protect water quality but they do not believe that drinking water contamination is a problem, where they live (50 out of 107 total respondents Agree or Strongly Agree).

ADVISER'S APPROVAL: ____Lowell Caneday_____