PERCEIVED RISK AND THE SITING OF A CONTROVERSIAL WASTEWATER TREATMENT PLANT IN CENTRAL TEXAS

A Thesis

by

PAT MORRISON KULTGEN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF URBAN PLANNING

Chair of Committee,	Walter Gillis Peacock
Co-Chair of Committee,	Carla Prater
Committee Members,	James W. Mjelde
	Ming-Han Li
Head of Department,	Forster Ndubisi

August 2013

Major Subject: Urban and Regional Planning

ABSTRACT

This thesis is a participant observer case study that examined how three primary intervening variables (resources, trust, and risk communication) influenced the amplification and attenuation of perceived risk during a regulatory permitting process. The objective was to better understand the role of risk perception in a water policy decision, the issuance of a permit by the Texas Commission on Environmental Quality to the Waco Metropolitan Regional Sewerage System permitting them to discharge 1.5 million gallons of waste water effluent a day into Bull Hide Creek. The study took place between March 2008 and October 2009.

The plant, designed to serve the sewer needs of distant cities, was planned without the participation of the residents of the creek community. After being notified of the permit application, they organized to protest the issuance of the permit which they felt presented a serious risk to their community. It is the conclusion of this researcher that risk perception played a key role delaying the issuance of the permit and construction of the plant. When perceived risk attenuated to a mutually acceptable level for all stakeholders, the permit was issued.

It is postulated that if risk perception is recognized as a significant factor in potentially controversial urban and regional planning and policy decisions, implementation may be less difficult. The validity of this conclusion is constrained due to the fact this was a single case study and generalization is limited.

DEDICATION

I dedicate this thesis to that which has challenged me, tested me, frustrated me, confused me, enlightened me, saddened me, exhilarated me, gratified me, exhausted me, and strengthened me; for I have learned that in the midst of adversity lies great opportunity.

ACKNOWLEDGEMENTS

I would like to thank my committee Chair, Dr. Walter Peacock, who graciously offered to serve as my committee chair. He motivated me to complete this work with an insistence on excellence, dedication, work ethic, and a bit of fear. I am equally grateful to my co-chair, Dr. Carla Prater, for her patience, wisdom, and confidence throughout this entire process. She never faltered in her encouragement despite historic droughts, accidents, fires, surgeries, moves, job changes, illnesses and deaths. Gratitude is also extended to Dr. James Mjelde for his humorous firmness, directness, availability and guidance during times of confusion and stress. Finally, I am very thankful for the technical help and patient explanations I received from Dr. Li regarding wastewater and watershed management; he always greeted me with a friendly hello that calmed my self-doubts. The entire committee has helped me complete an undertaking that has challenged my personal limitations and tenacity.

Thanks also to the many friends, family, colleagues, instructors, and departmental staff who gave me so much help, support, patience throughout my years at Texas A&M University. Finally, I would like to extend a very special thank you to the University Writing Center and my classmates in the thesis/dissertation writing group. Not only did they provide editorial suggestions, they were also a source of inspiration, levity, and confidence.

NOMENCLATURE

BHCCWA	Bull Hide Creek Clearwater Alliance
CAFO	Confined Animal Feeding Operation
EPA	The United States Environmental Protection Agency
ETJ	Extra-territorial jurisdiction
LULU	Locally Unwanted Land Use
NIMBY	Not In My Back Yard
NPDES	National Pollution Discharge Elimination System
RFP	Request for Proposal
SARF	Social Amplification of Risk Framework
SOAH	State Office of Administrative Hearings
TBLLs	Technically Based Local Limits
TCEQ	Texas Commission on Environmental Quality
TPDES	Texas Pollutant Discharge Elimination System
WMARSS	Waco Metropolitan Area Regional Sewerage System
WWTP	Wastewater Treatment Plant

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION: THE ROLE OF PERCEIVED RISK IN WATER POLICY AND PLANNING

"Perception is an interesting phenomenon that changes no facts but all meaning."

Jonathan Ellis

Urban and regional planners are continually faced with difficult decisions related to controversial public policies associated with water use. These challenges are complex, dynamic, highly temporal, often geospatial, inevitably political, and profoundly economic. Frequently, these policies are controversial because they are perceived as risky, hazardous, economically unsound, socially undesirable, or environmentally disastrous by one or more stakeholders. Other stakeholders may believe the policies are equitable, sustainable, necessary, and encourage economic development. The challenges posed by these conflicts must be met to address future public needs, yet this process is often difficult as it requires integrating uncertainty, social constructs, public policy, budget constraints, and law. Private rights must be balanced with societal needs and institutional requirements while political power must be recognized.

Involved parties may use objective quantitative analysis and scientific data to support, or undermine, proposed projects, but a positive, quantitative cost-benefit analysis is often overruled by emotional responses fueled by perceived risks to home, health, property, community, and family. It, therefore, is hypothesized that the primary

source of conflict associated with policy development and implementation is not objective risk but perceived risk.

This thesis examines a policy decision to build a wastewater treatment plant designed to accommodate the projected sewer needs of a rapidly expanding suburban population. It is presented within a perceived risk framework comprised of three variables: trust, risk communication, and resources based on the Social Amplification of Risk Framework developed by Roger Kasperson, Ortwin Renn, Paul Slovic, Halina Brown, Jacque Emel, Robert Goble, Jeanne Kasperson and Samuel Ratick (Kasperson et al., 1988). It is hoped that this hypothesis-oriented, ethnographic study by a participant observer will result in a greater understanding of the role of risk perception in water policy and planning.

2. BACKGROUND: GENERAL ISSUES ASSOCIATED WITH WATER PLANNING AND WASTEWATER PROCESSING

As the world's population continues to grow, competition for water resources has increased accordingly (Fox, 2011; Kultgen, 1975; Ramana, 2011). Historical disputes over the use of ground water and in-stream flows may be manifestations of perceived risk involving distribution, availability, allocation, quantity and quality (Texas Commission on Environmental Quality, 2009). Necessary for human life, public health, ecosystem stability, manufacturing, food production, the generation of power, and social stability; water is a finite, high-value resource that is highly valued by both the public and private sectors. Because of its critical nature, philosophers, politicians, planners, concerned citizens, and economists debate whether access to water should be categorized as a basic human right, a critical human need, or a commodity to be privatized and traded on a free market.

Not only is water for human consumption purposes becoming scarcer, what is available is often contaminated as a result of human activity. Contaminated watersheds and waterways result from mining, confined animal feeding operations (CAFO's), agricultural activities, industrial activity, altered hydrology, urbanization, and waste disposal (Etnier et al., 2004; Rochelle, Castleberry, & Smith, 2006; The Brazos River Authority, 2011). Downstream flows frequently contain treated and untreated sewage which creates additional issues among those competing for water (Kelly, 2011; Talbert, 2008). This competition is not limited to traditional in-stream flows and affected ground

waters; disputes over return flows from wastewater treatment plants are becoming increasingly common. For example, in the state of Texas, the rights to wastewater return flows has been litigated and legislated for years (Beder, 1993; Rochelle et al., 2006).

As water supplies become more constrained, and conflicts more frequent, public policies addressing challenges associated with the management of water resources will need to be carefully developed and implemented. Some will be put in place through the use of raw political power. Others will fall victim to the skillful use of propaganda or persuasive political campaigns. A few will survive the rigorous gauntlet of public hearings, negotiations, legislation, and litigation; others will fail to become viable. Most will attempt to balance multiple needs and satisfy risk concerns pertaining to political, economic, environmental, and social issues.

Competing needs and perceived risks associated with public water projects are often controversial. Despite pressures associated with drought, population growth or aging infrastructure, public support for water projects may be weak and opposition strong. Recently, in the midst of the driest year on record, a change to the Texas constitution allowing the Texas Water Development Board to issue up to 6 billion in bonds for water projects barely passed, 51% for and 48% against (Cardona, 2011; Texas Legislature, 2011).

Despite assurances from political leaders that wastewater treatment plants will benefit local aquatic ecosystems, enhance residential attractiveness to potential homeowners by providing centralized community treatment which would improve land values, popular media reports indicate that most people do not consider the siting of a

wastewater treatment plant in their neighborhood positively. In fact, such processing plants are perceived as risky (Beder, 1993; Fox, 2011; Kelly, 2011; Talbert, 2008). The literature confirms that waste water treatment plants adversely affect discharge-receiving waterways and aquatic species through the addition of nutrients and chemicals that disrupt endocrine systems (Barigozzi & Levaggi, 2010; Caplin & Leahy, 2001; Loewenstein, 1987; Slovic, 1987; Starr, 1969), but there have been no published studies on the effect of wastewater treatment plants on local property values or residential attractiveness. Unlike hazardous waste facility siting, very little research has been done on the psychological, environmental, and social effects of the siting of non-hazardous, wastewater facilities in communities. Common concerns include offensive odors, health effects, disrupting noises, reduced property values, increased traffic, raw sewage spills, fish kills, degradation of recreational waters, and the disposal of toxic chemicals into local waterways.

Each of these issues was raised by the Bull Hide Creek Clear Water Alliance, an organization composed of people opposing the Bull Hide Creek plant, as well as other stakeholders. The members of the opposition also publicly complained that they were the victims of political disenfranchisement, environmental injustice, and a state environmental protection agency (TCEQ) that failed to comply with its own guidelines (Texas Commission on Environmental Quality, 2009). The proponents of the plant argued that each of these issues was being addressed and not only did the plant pose no risk to the Bull Hide creek community, it would be a benefit to the community and the "quality" of the creek would improve due to increased stream flow. During the 22 month

permitting process, a wide range of perceived risks were expressed and addressed within a social context that was influenced by risk perception. Despite the frequent use of strict financial based cost-benefit analysis, every public policy pertaining to water and wastewater is evaluated and implemented in a social context influenced by risk perceptions.

3. LITERATURE REVIEW

3.1. Uncertainty and Probabilistic Risk

Uncertainty is a reality of life and always has been. The vagaries of natural events and evils such as plagues, pestilence, earthquakes, floods, droughts, crop failures and social conflicts have been the source of public and private insecurities throughout history (Denney, 2005, p. 7). Industrialization in the nineteenth century and subsequent technological advances in the twentieth century produced additional uncertainties that were previously incomprehensible to non-industrialized societies, defined as "post modern risks" (Beck, 1992). These "post-modern risks" that contemporary societies face include, but are not limited to, instabilities because of international economic interdependence, threats associated with breaches in communication security, social destabilization due to regional political upheaval, political aggression based on technologies, religious terrorism, chromosomal damage from pharmaceuticals, diseases resulting from agricultural production, and social disequilibrium associated with advances in communication (Denney, 2005).

Individuals, institutions, and societies have responded to this uncertainty, and the possibility that one's actions may have undesirable outcomes, in various ways. They have attempted to: isolate themselves from global risks, implement private property rights, set up bureaucratic agencies, legislate statutes, promote the return to fundamental religious beliefs, establish insurance indemnification procedures, and develop analytical

models based on quantitative data designed to predict future uncertainty (Brody, Peacock, & Gunn, 2012; Camia, 1994; Erickson, 2001; Rogers et al., 2007; Ross, 2010).

But what is uncertainty? Douglas Hubbard describes uncertainty as follows: "Uncertainty: the lack of complete certainty, that is, the existence of more than one possibility. The 'true' outcome/state/result/value is not known" (2010, p. 50). Uncertainty induces insecurity, leading to the desire to pin down the future state. The quality of uncertainty is compounded by the uncomfortable reality that not only is it intrusive; its elusive quality frustrates all human attempts to reduce or control it. Many people desire a high degree of stability and predictability; however, humanity must nonetheless deal with uncertainty in all aspects of life. Webster's dictionary uses the following words to describe the uncertain state: indefinite, indeterminate, problematical, untrustworthy, dubious, and doubtful, while Dennis Lindley (Lindley, 2006, p. xi) observes that:

> There are some things that you know to be true, and others that you know to be false; yet, despite this extensive knowledge that you have, there remain many things whose truth or falsity is not known to you. We say that you are uncertain about them. You are uncertain, to varying degrees, about everything in the future; much of the past is hidden from you; and there is a lot of the present about which you do not have full information. Uncertainty is everywhere and you cannot escape from it.

The classic definition of risk comes from Frank Hyneman Knight (1921 paragraph 1.1.26), an economist who wrote his dissertation on risk and uncertainty. His work was published as "Risk, Uncertainty and Profit" in 1921

> But uncertainty must be taken in a sense radically distinct from the familiar notion of risk, from which it has never been properly separated. The term "risk," as loosely used in everyday speech and in economic discussion, really covers two things which, functionally at least, in their causal relations to the phenomena of

> economic organization, are categorically different… The essential fact is that "risk" means in some cases a quantity susceptible of measurement, while at other times it is something distinctly not of this character; and there are far reaching and crucial differences in the bearings of the phenomenon depending on which of the two is really present and operating.

As Knight posits, risk is generally understood to have a probabilistic, or measurable, component; there is a mathematical probability that a particular adverse event will occur within a well-defined range of time. This probability is used by a decision maker to assess if the risk is acceptable or not, and what actions may be taken to compensate for the projected risk if it is acceptable.

Simple risk management based on probabilities generally does not consider magnitude. A risk may be low in probability, yet the impacts of the event may be profound, and costly, for those affected. For example, the risk of dying in a plane crash is calculated by simply taking the population and dividing it by the numbers of deaths from plane crashes in any given year (Ropeik & Gray, 2002). The magnitude of the impact on those who die in plane crashes, and their families, is not estimated. To accommodate this, probabilistic risk may be multiplied by estimated magnitude. Similarly, risk analysis often fails to consider individual risk factors, and variables, such as whether or not a person flies frequently, the cumulative distance they fly, or whether an individual flies commercially or pilots a small private plane.

Traditional probabilistic risk analysis also fails to consider economic equity, the rights of future generations and spatial factors. For example, a political entity may decide to spray the interiors of buildings with DDT in an attempt to control the spread of malaria by killing or repelling mosquitoes that spread the disease. A simple comparison

of the known probabilistic risk from dying from malaria to the probabilistic risk from dying from DDT exposure would find a lower associated mortality with the later. However, this comparison would not take into consideration the secondary impact on avian species. Probabilistic risk also fails to consider that people may not respond to objective risk rationally or consistently; people have been observed to respond subjectively, emotionally, and dynamically. People have also been observed to not respond to risk at all or to use cost benefit analysis to assess acceptable risk. Using the previous example, individuals have been known to protest the use of wide spectrum insecticides to eradicate mosquitoes on the grounds that sensitive human populations will be negatively affected by neurotoxins. Yet others welcome the use of pesticides because of the decrease in mosquito populations and consider the risk acceptable

What is considered acceptable risk? Tom Tietenberg (2006, p. 497), a resource economist defines acceptable risk as "one that maximizes the net benefit" with net benefit being defines as the "excess of benefits over costs" (2006, p. 22); in many cases there is a time factor with both costs and benefits accruing into the future, therefore an adjustment for time sensitive monetary values of benefits and costs may be applied. Although objectivity is desired when evaluating acceptable risk, potential bias may be present as it is difficult to identify all benefits and costs. Acceptable risk has been linked to risk perception through three theoretical schools: the psychological, the cultural, and the interdisciplinary.

3.2. The Psychological Model of Risk Perception

The psychological model was developed in the early 1970's when it became apparent that people responded to environmental risks, especially atomic technology used for power generation, much differently than expected. Chauncey Starr, (Starr, 1969) a prominent nuclear engineer, examined this phenomenon and published his findings in *Science* in the article "Social Benefit versus Technological Risk." He concluded people were much more willing to accept voluntary risks than those imposed by society because they were able to control their exposure to risk. He also observed, "The social acceptance of risk is directly affected by public awareness of the benefits of an activity as determined by advertising, usefulness and the number of people participating in the activity" (p. 1237). A few years later, two psychologists, Amos Tversky and Daniel Kahneman (1979), collaborated in a scholarly investigation into human decision making, developing Prospect Theory. This theory challenged classic economic utility theory, which postulated people make decisions based on willingness to pay and used probabilities to measure potential economic/ monetary gains or losses. Prospect Theory weighs probabilities and assigns different weights to gains or losses depending on the relative position of the decision maker. Kahneman and Tversky (1979) noted that these probabilities are dependent on perception and the biases and heuristics that support those perceptions.

They expanded on their seminal work and studied how bias and heuristics affect risk perception and decision making, determining that people make choices by selecting the option that produces the highest potential economic gain (Tversky & Kahneman,

1981). A decision will also be influenced on how a choice is framed. Prospective gains or losses are assessed relative to dynamic conditions, with prospective losses being weighted heavier than prospective gains, and emotionally satisfying choices often being preferred over emotionally neutral ones that offered economic gains. This model, however, failed to explain why people frequently make choices that do not maximize economic personal gain; they act "irrationally" in the classical economic sense. Tversky, Kahneman and Slovic proposed that people evaluate utility within a social framework that considers happiness, social impacts, quantitative probability, and personal heuristics (Daniel Kahneman, Tversky, & Slovic, 1982). Classic economic utility theory was challenged by the concept that emotions influence rational decision making.

Caplin and Leahy (2001) found the desire to reduce anxiety resulting from uncertainty may lead to poor decision making as a person's desire to reduce their anxiety and fear may dominate a desire for economic gain. The role of emotions in decision making was also explored by Barigozzi and Levaggi (2010). In their work they discussed the role information plays in decision making and pointed out that physical costs are frequently outweighed by emotional costs associated with negative information. This leads people to prefer uncertainty based on paucity of knowledge to the distress associated with full information that confirms a negative outcome. Time is another factor that has been shown to be associated with decision making. Caplin and Leahy (Caplin & Leahy, 2001) studied the effect of time as a determinant on psychological expected utility, finding people preferred to reduce the amount of time associated with an uncertainty that is perceived with negative anticipatory emotions.

"Just get it over with because it's going to hurt" is preferable to "Let me delay my punishment as long as possible." Their findings complimented part of an earlier study which found people tend to delay a decision if positive anticipatory emotions are present (Loewenstein, 1987) but contradicted Lowenstein's findings that people will delay decisive actions if dread (the imagining of a terrible outcome) is present.

That same year, Paul Slovic (Slovic, 1987) published research in *Science* that demonstrated perceived risk could be quantitatively measured using psychometric factors. He affirmed that variables such as dread, loss of control, involuntariness, familiarity, presence of catastrophic potential, equity, risk to future generations, potential benefits, and global impacts were significant factors in how non-expert individuals perceive risk, risk benefit, and risk acceptance. He later addressed how experts measured riskiness in terms of annual mortality or injuries (Slovic, 1987). In 2005, he and his colleagues noted risk perception has an affective component: "Risk is perceived and acted on in two fundamental ways. Risk as feelings refers to individuals' fast, instinctive, and intuitive reactions to danger. Risk as analysis brings logic, reason, and scientific deliberation to bear on risk management" (Slovic, Peters, Finucane, & MacGregor, 2005, p. 35). Although risk managers and analysts have historically approached perceived risk from a methodical, systematic manner, psychological, affective and emotional factors clearly influence risk perception as well.

3.3. The Cultural Model of Risk Perception

An English anthropologist, Mary Douglas, and an American political scientist, Aaron Wildavsky, introduced the theory that risk perception was best explained by

culture (1982). Presented in *Risk and Culture: An Essay on the Selection of Technical and Environmental Dangers*, their work postulated that individuals act on perceived risks within an environmental and social context dependent on cultural constructs and behaviors. They emphasized that individuals make risk decisions based on moral values, political views, economic position, and social constructs rather than on assessments that are empirical, objective, evidential, and rational. In addition, societies determine what is identified as a risk, what risks are acceptable and "who should be allowed to take them" (Douglas & Wildavsky, 1982, p. 6). They noted people worry about things their societies collectively identify as dangerous and dismiss those things that are considered benign and/or acceptable.

In the postmodern world, concerns about environmental and technological safety dominate, yet fears of food scarcity, economic collapse, and political oppression could just as easily cause alarm in the general population. In searching for an explanation as to why environmental and technical risks were considered greater risks, Douglas and Wildavsky (1982) identified three qualities associated with such risks that were not associated with risks considered acceptable. Unacceptable risks included technological and environmental risks, which were considered to have hidden, irreversible, and involuntary threats to personal well-being. Such risks create feelings of vulnerability, helplessness, and fear.

Douglas and Wildavsky (1982) also note that moral judgments regarding risk are evaluated within the context of a social standard of normality. But what constitutes normal? In *Risk and Culture*, the authors consider normal risks to be those accepted by a

culture, those judged to be "normal" are more acceptable than those that are judged to be unusual. Those that are not acceptable are "blameworthy." Blameworthy risks may produce damages which can be mitigated and litigated in the legal arena. According to Douglas and Wildavsky (1982), damages can also be assessed and recovered if the risks and associated losses can be judged as unjust.

They compare the perceived risk associated with nuclear power plants to the risk of dying from chicken pox. Although the risk of dying from a nuclear accident is much lower than the risk of dying from chicken pox, one is judged to be normal, and therefore more acceptable than the other, which is considered to be the result of technological failure and therefore, not a normal death. A death resulting from a nuclear accident is one in which blame and liability can be assigned. Unlike a death from a communicable virus, society has taken the position that someone is responsible for technological failures. There are others who reject technology because they believe the risks associated with the technology are not identified correctly, the true risks are minimized, the benefits of the technology are exaggerated, or the magnitude of the risks to individuals exceed the potential communal benefits that may be acquired through the technology.

Trust is also associated with technology and risk perception. Commonly, society assigns liability for harm resulting from technological failure in which there was a breach of trust. Did the person harmed give their consent? Were the risks imposed on an unknowing party by another person or agency that was considered trustworthy? Teuber (1990) emphasized that "modern" social morality requires that people should not have risks imposed on them without their consent. Obtaining the consent of people who are

research subjects is a concept that was developed post World War II due to the horrors of Nazi experimentation on human subjects (Wedeen, 2000). The first codified standard was the 1949 Nuremberg Code, with the Helsinki Declaration of 1964 and the Belmont Report of 1979 coming later. All concerned informed consent and ethics. In 1990-1991, the European Union and the United States adopted additional guidelines (The Common Rule) that concerned the use of individuals for the common good, this policy has been revised multiple times ("Codex, rules and guidelines for research," 2013; The United States Government, 2009). These guidelines established that people should not have risks imposed on them without their consent because to do so is unethical and unjust (Wedeen, 2000). What is considered to be unjust is a cultural construct reflecting temporal standards.

Justice and ethics are culturally defined concepts that originate and are maintained by social relationships, including institutions. The concept of justice is directly dependent on the contemporary cultural norm, which has been established by the international agreements, that it is unethical to subject people to risks they are unaware of or unable to resist. Berger and Luckmann (1966) argued that such norms are the result of human interactions; within these interactions, there is an assumption of common values. Common values between cultures and social consensus determine, to a large extent, what is considered a risk. “Social order is a human product, or, more precisely, an ongoing human production. It is only produced by man in the course of his ongoing externalization” (Berger & Luckmann, 1966, p. 52).

Dake also explored the role of society pertaining to personal risk perception in the early 1990's and argued in his dissertation and published studies that an individual's risk perception is not simply a function of the political, historical, and social context. He theorized that an individual's perception of the world will have an influence on his perceptions. He demonstrated that risk perception also corresponds to "worldviews" of society, technologies, and the environment and identified two main contemporary "worldviews" (Dake, 1991). Contemporary Worldview A, embraces a free market economy oriented toward business and materialistic goals, which encourages and emphasizes rapid technological development with an emphasis on individualism. Worldview B encourages environmental protection, redistribution of wealth, social responsibility, collectivism and non-materialistic values. According to Dake, a person's worldview will influence his perception of the risks associated with emerging technologies and the environment, as well as how they respond to potential hazards. He also researched how a person's cultural orientation and how they define social relationships may influence a person's attitude towards risk and found that a person's cultural bias/personality (hierarchal, individual or egalitarian) was correlated with societal risk taking or risk aversion. The correlations ranged from -.39-.60 ($p < .001$), thus verifying the theory that cultural orientation could be a valid predictor of risk perception (Dake, 1991). Dake believed this data, based on n=134, could be aggregated and extrapolated to the collective level.

Approximately ten years after his research was published, it was challenged by Rippl (2002, p. 154) who believed the correlations were weak and cultural biases of a

group cannot be measured using personality characteristics attributed to individuals. Thus leading Rippl to conclude Dake's quantitative work could not be used to explain the cultural theory of risk perception. Believing the theory was theoretically sound, but statistically weak, Rippl re-examined the premise using a structural equation model using item wording and factor analysis to identify and measure latent processes and connections between the four cultural orientations identified by Douglas and Wildavsky (hierarchy, egalitarianism, individualism, and fatalism). She found the explanatory power increased, leading her to conclude cultural theory can be used to explain risk perception. Essentially, her findings giving credence to the theory that an individual's cultural values play an important role in how individuals evaluate risk (Rippl, 2002).

Postmodernism, a cultural theory introduced by Ronald Inglehart in the 1970's has been compared to Dake's Worldview B. However, Inglehart hypothesized that as societies experience greater economic affluence and stability, societal values change pervasively and predictably. Specifically, postmodern economic security reduces basic survival concerns and there is an intergenerational shift from an "emphasis on economic and physical security, toward increasing emphasis on self-expression, subjective well being and quality of life concerns. Postmaterialist values emerge among birth cohorts that grew up under conditions that enable one to take survival for granted" (Ronald Inglehart, 2003, p. 130). Inglehart postulated when societal survival risks are reduced, risks associated with individual quality of life factors can now be addressed.

Inglehart based his work on the World Values surveys which were first carried out in 1981. They were again administered in 1990, 2000, 2005, 2006, 2010, 2011, and

will be conducted out again in 2013. These surveys examined and analyzed evolutionary cultural changes in 90% of the world's population (100 societies on six inhabited continents) and the impact these changes have had on societies (The World Values Survey, 2012). He concluded that changing cultural values have long lasting effects on beliefs and institutions; resulting in changing cultural values which subsequently affect risk perceptions. He also noted that individuals in societies which are post-materialistic, emphasize tolerance and self-expression, are happier, encourage interpersonal trust, imagination, environmental protection, and are more democratic. Interestingly, he observed that psychological stress associated with perceived risks is not only "culturally conditioned" but continues to be present in postmodern societies (Ronald Inglehart, 1997, p. 450).

Inglehart and Norris, in a more recent publication (2011), based on the World Values Survey, emphasized that empirically measuring personal risk perception in the context of culture is difficult as criteria may be value laden and highly complex. By utilizing factor analysis and ordinary least squares, they were able to identify specific cultural factors applicable to reducing risk. Among their findings was the positive impact increased security has on post-modern societies. They concluded that individual's risk perception on the micro, meso and macro levels is a significant factor driving human behavior; this has profound social consequences. In addition, these social changes do not necessarily produce better objective estimates of risk; people's risk perceptions are highly subjective (Wolfe & McGinn, 2005).

The importance of cultural biases and risk perception, and its relevance to policy development, has been the subject of the Cultural Cognition Project, located at the Yale Law School. This research group has sought to explain the polarization that frequently accompanies risk perception and associated policy disputes (Kahan, Braman, Slovic, Gastil, & Cohen, 2007). Their research is focused on a basic premise of cultural theory introduced and consistently reiterated by Kahan: "that individuals can be expected to form beliefs about societal dangers that reflect and reinforce their commitments to one or another idealized form of social ordering" (Kahan, 2012, p. 726). Cultural cognition is defined as: "the tendency of individuals to conform their beliefs about disputed matters of fact (e.g. whether global warming is a serious threat; whether the death penalty deters murder; whether gun control makes society more safe or less) to values that define their cultural identities" (The Yale Law School, 2013). Using an empirical approach they found cultural cognition can be used to measure, individuals' cultural worldviews and the social and psychological mechanisms that connect individuals. They showed that the worldview typologies Douglas and Wildavsky identified (hierarchical, egalitarian, individualistic and communitarian) were explanatory variables in risk perception and supported what Kahan had found earlier. That "individuals form factual beliefs that reflect and reinforce competing cultural orientations" (Kahan, 2008, p. 43). The four typologies were visually explained on a grid with two axes. One axis (x axis) measured how individualistic or communitarian a person was and the other (y axis) measured how hierarchal or egalitarian they were. The grid was then compared to respondents' answers to survey questions.

The research showed that people, who placed a high value on individualism tended to value business and industry, were inclined to trust political institutions, and believed that goods and services should be distributed according to clearly defined attributes such as wealth, education, ethnicity, and gender. Individualists tended to believe that people are responsible for securing their own well-being while those who were more egalitarian held that society should provide collective assistance. People who had views that were more egalitarian supported the distribution of goods and services equally, without regard for social ordering; communitarians are more inclined to support policies that place a higher value on societal interests over those of the individual (Kahan et al., 2007). For example, an egalitarian and communitarian would be more inclined to support policies protecting the environment than subsidies that encourage industrial extraction of natural resources. Kahan found, "These cultural orientations shape how individuals perceive risk" (Kahan, 2008 abstract). Thus, lending support to the concept cultural theory can be used to understand public risk perceptions as well as the origins of potential conflicts associated with policy development and implementation.

3.4. The Interdisciplinary Model: The Social Amplification of Risk Framework

Risk perception has also been examined within a multidisciplinary framework introduced by Roger E. Kasperson, Ortwin Renn, Paul Slovic, Halina Brown, Jacque Emel, Robert Goble, Jeanne Kasperson, and Samuel Ratick in 1988 and termed the Social Amplification of Risk Framework (SARF). This work identified and linked dynamic psychological, social, institutional, and cultural variables to risk perception,

with culture being considered a "super variable" affecting both social amplification and attenuation of risk perception (Kasperson et al., 1988).

SARF (Social Amplification of Risk Framework) is not considered a theoretical model by its developers; they consider it an interdisciplinary framework with two parts that, "aims to examine broadly, and in social and historical context, how risk and risk events interact with psychological, social, institutional, and cultural processes in ways that amplify or attenuate risk perceptions and concerns, and thereby shape risk behavior, influence institutional processes, and affect risk consequences" (Pidgeon, Kasperson, & Slovic, 2003, p. 2).

The first part (Stage 1) is analogous to the process an electrical signal travels that once activated passes through "stations" which act on the current, either amplifying or attenuating it. Some of the recognized stations are: filters that only allow partial information to reach the receiver; ones that decode, sort, and interpret the signal and others that affect the characteristics of the signal. When the signal leaves the stations, not only has its form been modified, it produces secondary effects. The SARF model terms these effects, Stage 2. Stage 2 may include economic effects, institutional changes, social changes and political actions. Perceptions are changed, opinions are challenged, laws are passed, conflicts arise, and settlements take place.

I found the framework provided an excellent structural model for examining perceived risk with a significant limitation; the framework does not "address the basic political, sociological, or psychological processes which might underlie amplification or

attenuation of risk signals and perceptions in any specific context" (Schattschneider, 1983, p. 4). The editors of The Social Amplification of Risk affirmed this and noted:

> As yet, there has been no systematic exploration of how SARF and the empirical results of the past fifteen years can be applied to various public policy matters. Yet there is an urgent need for social analysis of risk to suggest approaches and processes that have the potential to improve society's ability to anticipate, diagnose, prioritize, and respond to the continuing flow of risk issues that confront, and often confound, society's risk processing and management functions (Pidgeon et al., 2003, p. 41).

Although the frame work is limited, the two part structure of the SARF framework provides a useful platform for examining the role of risk perception in a specific policy analysis. It will be used in this paper to examine the permitting of a proposed wastewater treatment plant on Bull Hide Creek in Central Texas. The first part of the framework, Stage I, identifies variables, patterns, and relationships that may amplify or attenuate perceived risk and affect a Stage II outcome. This thesis examined three Stage I variables, resources, trust, and risk communication, which affected perceived risk pertaining to the proposed Bull Hide Creek wastewater plant, and how they may have contributed to a Stage II outcome. The conclusive Stage II outcome in this case was a regulatory decision to issue a permit to construct a wastewater treatment plant on Bull Hide Creek in McLennan County, Texas.

4. VARIABLES AND FRAMEWORK

In this case study, a framework based on the Social Amplification of Risk Framework incorporating three variables associated with risk perception was used to study a policy decision to build a wastewater treatment plant. The event triggering the perceived risk was considered to be the independent variable (the factor believed to influence the dependent variable). This was the filing of the application by WMARSS (Waco Metropolitan Area Regional Sewerage System) with the Texas Commission on Environmental Quality (TCEQ) to construct a wastewater treatment plant on Bull Hide Creek and discharge effluent. The dependent variable (the factor the case study sought to understand) was the issuance of the permit to operate the Bull Hide Creek wastewater treatment plant. The intervening variables (the factors believed to influence the dependent variable) used in this case were resources (power, money, political influence and social capital), risk communication, and trust. The objective of this case study was to examine a singular event in detail in an attempt to understand the interactions of the variables and their relationship with the stakeholders. Stakeholders were defined as those who were involved in the policy making process for they would be impacted by the outcome. Although this policy decision would affect numerous citizens in the area, only those actively involved in the conflict were included in the research as stakeholders.

This analysis has produced a level of understanding that the author feels can be applied to future water policy issues using the comparative method. As Hague, Martin and Breslin (1998, p. 276) point out, “In consequence, much comparative political

analysis takes the form not of relating cases to abstract political theory but simply of drawing analogies between the cases themselves."

4.1. Resources

In any policy decision process, effective utilization of resources has a significant influence on risk perception. Managing resources, however, is a complex, difficult, time consuming, competitive endeavor. The party, or parties, that are most able to accomplish the task with strategic tactics will most likely achieve their desired outcome. There are four significant resources that contributed to the amplification and attenuation of perceived risk in this case study: power, money, political influence, and social capital. Stakeholders competed for control of, and use of, these resources to influence both the process and outcome of the conflict. Of these four resources, power was perhaps the most important as it had the potential to acquire, control or mitigate others (money, political influence, and social influence). It should be noted that if there is a strong element of trust between the parties, competition for resources may be reduced due to increased efficiency of risk communication and productive negotiation.

4.1.1. Power

Power can be simply defined as the ability, or potential, to effect change. It is a recognized, complex, ubiquitous, relational force that is at times dynamic, or stable, equitable, or unequal, benign or destructive, collaborative or unilateral, coercive or persuasive, and overt or covert. For centuries, philosophers, psychologists, sociologists, anthropologists, and political observers from Plato to Flyvbjerg have studied and analyzed its characteristics and applications (Flyvbjerg, 1998; Plato, 380 BCE). For the

purposes of this thesis, the five types of power as described by Raven and French (1959) were used:

- Coercive - the use of punishment when non-compliant
- Reward - the ability to give rewards after compliance
- Referent - associated with identification or admiration
- Legitimate - inherent in the role or position and
- Expert - associated with expertise and knowledge.

Raven and French later added informational power to their model (Raven, 1965).

Understanding the types of power that exist, who or what possesses power and how it is exercised is critically important to understanding policy conflict and resolution. Each stakeholder in every policy conflict possesses power; whether they are able to muster enough additional power to change, or resist a challenge to, the status quo is the question. In addition, power is dynamic, transitory, and fluid; depending on how effective a stakeholder can acquire, maintain, or utilize resources, it may flow from one stakeholder to another.

One of the most useful resources used to acquire power is money; it is commonly utilized by those who wish to amplify or attenuate perceived risk.

4.1.2. Money

How to define money, the universal medium of exchange, is a topic that has been debated, analyzed, and discussed for centuries. One of the most cited definitions can be found in the 1844 writings of Karl Marx, Economic and Philosophic Manuscripts (Third Manuscript, chapter four: The Power of Money): “Money is the procurer between man’s

need and the object, between his life and his means of life" (Marx, 1959, p. unpaginated manuscript). Thus, it serves an economic function. Traditionally, this function has been viewed as meeting three social needs: a medium of exchange, a standard of measurement with established value, and a store of value. In the 20th century it was defined as, "The stock of assets that can be readily used to make a transaction" (Mankiw, 2010, p. 80).

Not only does money enable and support economic functions in society, people seek the acquisition of money as a means to an end; money influence a person's appearance and social standing. Karl Marx, examined the human relationship with money in his manuscript citing an early 1800's quote by Goethe which offered an explanation as to why money is so important to people.

> The extent of the power of money is the extent of my power. Money's properties are my, the possessor's, properties, and essential powers. Thus, what I *am* and *am capable of* is by no means determined by my individuality. I *am* ugly, but I can buy for myself the *most beautiful* of women. Therefore I am not *ugly*, for the effect of *ugliness* its deterrent power is nullified by money. I, according to my individual characteristics, am *lame*, but money furnishes me with twenty-four feet. Therefore I am not lame. I am bad, dishonest, unscrupulous, stupid; but money is honoured, and hence its possessor. Money is the supreme good; therefore its possessor is good. Money, besides, saves me the trouble of being dishonest: I am therefore presumed honest. I am *brainless,* but money is the *real brain* of all things and how then should its possessor be brainless? Besides, he can buy clever people for himself, and is he who has power over the clever not more clever than the clever? Do not I, who thanks to money am capable of *all* that the human heart longs for, possess all human capacities? Does not my money, therefore, transform all my incapacities into their contrary? (Marx, 1959).

Thus, it is recognized to have a secondary psycho-social economic value; those who possess it are perceived differently than those who do not. A recent Internet blog concerning an email containing "before and after" pictures of unattractive vs. attractive women addressed this phenomenon. Women were presented in a poverty state and then

were “changed” through expensive make-over’s; the conclusion announced, “There are no ugly women, only poor women” (Singer, 2010). The associated discussion affirmed the after pictures of the women were considered more attractive, confirming that money could be used to alter one’s attractiveness. Thus establishing a positive relationship between money and social attractiveness (Singer, 2010). Studies have affirmed money is associated with status, respect, autonomy, attractiveness, happiness, achievement, morality, goodness (or evil), and power (Engelberg & Sjöberg, 2007; Kasser & Ryan, 1993; Wernimont & Fitzpatrick, 1972); it can be used to win friends and influence people (Carnegie, 1937). Research has also shown it is a powerful tool used to acquire political power, which is essential to the formulation and implementation of public policy (Gordon & Hartmann, 2013).

Because money is a means of acquiring personal social status, attractiveness and political power; there are clear rewards to possessing money. There are also dangers. In Timothy 6:10 of the Bible, it is said, “For the love of money is a root of all kinds of evil” (*King james bible,*). Whether it functions as a tool, a status symbol, a simple method of exchange or a source of power, money is a critically important resource in any policy conflict.

4.1.3. Social Influence

Social influence may be defined as having the ability to effect a change in the attitudes, behaviors, emotions, or opinions of others within a social context. It is typically used in policy conflicts by people who are perceived as leaders in the group as a way of strengthening their negotiating position. Social theory holds that social

influence is derived from meeting various psychological needs of individuals. These needs include, but are not limited to:

- the desire to identify with someone who is popular, liked and respected,
- the psychological need to conform to what is perceived as a common belief or expectation,
- the need to fulfill expectations of others,
- the acceptance and internalization of a cultural opinion or belief,
- the need to be socially compliant,
- the need to establish independence from a social standard or group (anti-conformity),
- the association between compliance and reward associated with scarcity, and
- the need for social self-preservation (people do not want to be ostracized).

Along with the rewards inherent in these psychological needs, one must consider that individuals respond to social influence for various reasons (motivators) and have expectations of social gains when they do so (Kelman, 1958).

4.1.4. Political Influence

Political influence is a resource frequently used to moderate perceived risk. Influence is defined by the Miriam-Webster Dictionary as, "the power or capacity of causing an effect in indirect or intangible ways" with political being loosely defined as that which relates to political structure, government, and related public institutions (Merriam-Webster, 2012). For the purposes of this paper, political influence will be defined as the exercise of using persuasion (both direct and indirect) to determine "who

gets what, when and how" to affect changes in public policy development and implementation, in the direction preferred by the individual or group exercising the persuasion (Lasswell, 1958). It differs from political power in that those exercising political influence do not possess the ability to either make policy or implement it. They must convince those who do have the authority to make and implement policy that their position is paramount and should be supported. This may be accomplished, or attempted, through various means. One of the most famous examples of non-violent political influence is the campaign by Mohandas Gandhi in India in the early 20th century. This campaign encouraged and utilized the use of civil disobedience as a means to pressure political leaders to change policies. In contrast, violence is often employed by those who attempt to exercise political influence. For example, radical fringe groups use terrorism to call attention to, and influence, changes in political policies. The use of political influence may have immediate, latent or delayed effects, and may be subject to tangential events.

4.2. Risk Communication

The ability to effectively convey potential risk is a resource stakeholders may use to amplify or attenuate perceived risk. The National Research Council defines risk communication as: "an interactive process of exchange of information and opinion among individuals, groups, and institutions," rather than a one way message from experts to non-experts (Committee on Risk Perception and Communication, 1989, p. 2). Ideally, it is a dialogic, collaborative, two-way process that includes the public and all stakeholders, especially in environmental policy matters. At its best, good risk

communication produces honesty, transparency and a sincere desire to reach consensus; the result is improved decision making, increased public participation, better bureaucratic outcomes and healthier communities. At its worst, poor risk communication may result in restricted discourse, the suppression of dissent, concealed facts, dishonesty, hostile disagreement and an emphasis is on winning without regard for other stakeholders' losses.

4.3. Trust

Uncertainty associated with limited information can be mitigated through social mechanisms. Information is important to our survival, but it is impossible to personally acquire comprehensive and complete information pertaining to risk, or any other subject. Therefore, the ability to obtain, or utilize, information through social relationships is critically important. This requires trusting the source of the information. Trust can be defined as, "an expression of confidence in another person…that you will not be put at risk, harmed or injured by [his/her] actions" (Cheng, 2009, p. 1). "Trust is based on confidence associated with the relationship as well as one's ability to effectively validate the source via direct or indirect experiential results" (Schattschneider, 1983, p. xvii). It is also a strategy for risk reduction that is dependent on multiple factors such as experience, perception, honesty, credibility, gender, and expertise (Bos, Terburg, & Van Honk, 2010; Pidgeon et al., 2003, p. 125:126). People who consistently exhibit integrity are considered more trustworthy; trustworthiness is also positively correlated to character, ethics, morality, and respect. Trust takes years to establish, yet it is fragile, ephemeral, and quickly destroyed or damaged by a lack of integrity, unethical behavior,

or betrayal. Once damaged, it is difficult to restore and some relationships never recover. A quote attributed to Abraham Lincoln states it concisely. “If you once forfeit the confidence of your fellow citizens, you can never regain their respect and esteem.”

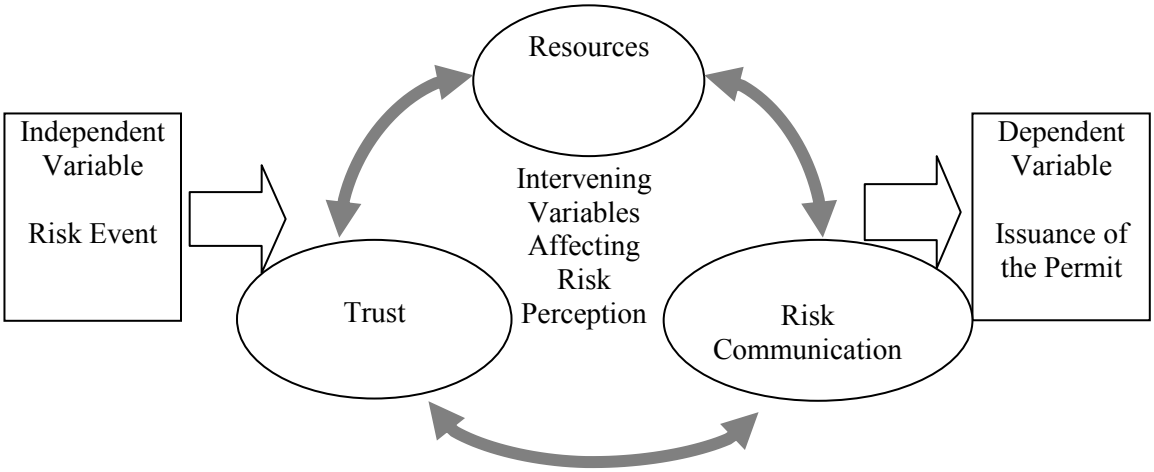


Figure 1: Variables and Framework

5. METHODS

5.1. Research Techniques

The research focus was acquiring information on the project, the role of the stakeholders and the factors affecting the outcome. The information was then examined within a theoretical framework in an effort to reach a general understanding of what had transpired. It is hoped that the synthesized knowledge can be applied to future policy development studies.

The primary method used to acquire information was participant observation. I attended and took notes at most of the public meetings, including the public hearing conducted by TCEQ, meetings of the Bull Hide Creek Clearwater Alliance (the grass roots organization founded to fight the proposed plant), numerous Lorena and Hewitt city council meetings, the meeting between representatives of the Bull Hide Creek Clearwater Alliance (BHCCWA) and the City of Waco at the state representative's office (Doc Anderson), a meeting between the legal counsel representing the BHCCWA and a BHCCWA representative, a meeting establishing which parties would be given standing for the SOAH process (State Office of Administrative Hearings), county commissioner's meetings, a press conference, and two fundraisers. At these meetings, I observed the interactions between the parties, the verbiage that was used, the physical environment and the emotional context and exchanges between the stakeholders and others. If notes were not taken at the actual meeting, they were written up upon returning home.

The secondary research method was examining pertinent written materials to the case study that were available. This included the contract (the Interlocal agreement between WMARSS and the City of Lorena, city council minutes, correspondence among, and between, participants, newspaper articles pertaining to the issue, litigation filings, legal rulings, and all official documents on file with TCEQ, such as the permits, the Agreed Order, historical City files (both Waco and Lorena), violations and enforcement actions, the public comments pertaining to the permits, and the SOAH documents. Electronic correspondence between stakeholders was also examined.

5.2. Role of the Researcher

Residents of the Bull Hide community were invited to a short presentation by representatives of the R.W. Beck Engineering firm at the local high school on March 20, 2008. To their surprise and dismay, they were informed that a regional wastewater treatment facility would be constructed in their neighborhood on the popular creek. Although the project had been planned for over ten years, this was the first time any of the residents had been contacted. They had not been included in the planning and their input has not been solicited. They were simply given a brief presentation as to what was going to transpire. Not surprisingly, they were enraged, offended, alarmed and quickly mobilized to hold a community meeting the following Tuesday. A friend of mine who lived close to the plant asked me to attend that meeting.

After that meeting, I decided to research the subject. Within a few days, I began the process of researching the permit status (the first permit had been filed in 2007 with a second permit being filed the previous week), reviewing contracts and RFP's (Request

for Proposal) through open records requests, looking at statistics, carefully reading environmental impact studies, and meeting with concerned citizens who had formed a grassroots organization opposing the plant. Three months after I began collecting data, I had a conversation with a member of the Lorena Chamber of Commerce. After 15 minutes of going over numbers and contracts which I thought clearly indicated that plant would be a negative financial investment for Lorena, she calmly looked at me and asked, "Why do you hate us?" I realized then there was an unknown element to the problem I was unaware of beyond a financial analysis, planning for future needs or trying to resolve an environmental problem. I then began to search for the unknown factor from an academic perspective. What unrecognized factors were present, how were they influencing the developing policy issue, what theoretical fundamentals were applicable and were there similar cases in the literature?

5.3. Case History and Background

This case examined the successful acquisition of a permit to dispose of municipal wastewater outside the city limits of the producing communities by a public water utility, despite the protests of the citizens of the receiving area. These two cities, Lorena and Hewitt, had experienced rapid growth (see Appendix E) as people moved to the area seeking good schools, low crime rates, affordable housing, new construction, open spaces, family-oriented neighborhoods, and close proximity to the City of Waco. Both cities, in an effort to conserve valuable developable land, exploit economies of scale, reduce costs, outsource management, and expand their treatment capacity joined a wastewater consortium established by the City of Waco, the Waco Metropolitan Area

Regional Sewerage System (WMARSS). The City of Waco solicited their participation and received benefits related to operating expenses, sales of energy, effluent, and other by-products, as well as funds from federal grants which were used to subsidize their share of the project. These direct advantages to the participating municipalities, as well as indirect advantages, such as the opportunity for WMARSS to externalize environmental and developmental costs to the receiving area, were significant.

Lorena was experiencing difficulty managing and maintaining their plant. They had reached maximum treatment capacity, were experiencing sewage spills, had ongoing mechanical problems at the plant, infiltration of rainwater and exfiltration of sewage due to leaking sewer pipe, and were under an enforcement order from the Texas Commission on Environmental Quality. In addition, they were operating under the terms of an Agreed Order which stipulated Lorena would address the problems associated with the plants and join a regional wastewater consortium by February 2010, the expected completion date of the Bull Hide plant. Opponents of the new plant believed once the problems at the plant and the sewer infrastructure were addressed a new plant would no longer be needed (J.B. Smith, 2009b). They also pointed out a sister plant operating in the City of Moody, Texas had no problems yet was the same age. It was also argued that the City of Lorena's plant site had room for expansion if the City vehicles being stored on the property were relocated.

A direct result of the regulatory sanctions imposed by TCEQ was the implementation of a construction moratorium by the city council; this moratorium created a wide range of negative impacts on the community (City of Lorena, 2009; J.B.

Smith, 2009b). This included a lawsuit filed by a developer who had been working with the city to develop a housing subdivision. The construction had been approved by the council and was well under way when the moratorium was implemented, resulting in significant financial losses to the developer (Court of Appeals of Texas, 2010). The lawsuit was not common knowledge in the community, but the Lorena City Council, the Lorena Chamber of Commerce, and WMARSS made a concerted effort to publicize the fact that the Lorena area could not capitalize on expected growth without joining WMARSS and acquiring additional treatment capacity (J.B. Smith, 2009b). The necessity for growth was intensely promoted to the community but growth was never clearly defined and the costs associated with growth were never identified (WMARSS, 2013).

In March of 2008, WMARSS sent out a letter to land owners living close to a section of Bull Hide Creek near the City of Lorena apprising them of a meeting. The meeting would be held at the local high school and would introduce the project. The letter sending notice of a public meeting, the filing of permit WQ0014889001, and the announcement of the purchase of the land all took place on the same day, March 20, 2008. Land owners in close proximity to the site, directors of the Levi Water Supply, and other stakeholders were never given an opportunity to participate in a collaborative decision making process and they reacted strongly to these events; they felt they had been excluded from decisions that affected them. When they found documents, and heard statements by City of Waco's officials, that confirmed discussions had been taking place for over ten years, they were angry, frightened, and alarmed (Clemons, 2012;

Gonzalez, 2009). When it became known that a previous permit to increase the wastewater effluent from the existing Lorena plant, had been filed with TCEQ on February 9, 2007, many Bull Hide creek residents were furious. Permit #WQ0014782001 would have expanded Lorena's current plant and continued to discharge effluent into Cow Bayou tributary. They felt this proved a history of excluding stakeholders in policy deliberations and clearly demonstrated there had been another option to the construction of the Bull Hide plant. However, because it involved an existing plant in Lorena, land owners on Bull Hide creek were not apprised nor included in any planning discussions. The suspicion that resulted from the filings was an unresolved issue for years and contributed to the amplification of perceived risk.

Contributing to the distrust was the lack of "explosion of growth" in Lorena after the City connected to the wastewater plant in 2012 as had been predicted (Shapiro, 2012). This may be partially explained because this was during one of the slowest housing construction periods in history and a national economy that was depressed (Evatt, 2012). Opponents, however, had insisted since March of 2008 that a new plant was not needed, simply better management and maintenance; man believed Lorena would not experience growth with a new plant due to higher taxes and utility rates resulting from costs associated with the new plant.

This conflict is typical of those found in areas of urban expansion. Like so many rural landowners, the Bull Hide community desired to maintain the status quo of their rural neighborhood and preserve the natural state of their local waterway. As in cases involving locally unwanted land uses (LULUS) the residents expressed concern about

the risks this plant would present to their well-being and feared the uncertainties they perceived.[1]

5.4. Stakeholders

As in many environmental policy conflicts, the evolution and resolution of the sewage treatment issue had significant impacts on multiple stakeholders. Not all stakeholders were satisfied with the outcome and it can be argued that the perceived risks and potential benefits were not equitably distributed. Contemporary planning procedures advocate an attempt should be made to integrate the needs of all stakeholders when making changes within or across watersheds and joint discussion sessions should be held. Like so many watershed issues, this one was further complicated because it crossed political boundaries. Because all the stakeholders were not included in the planning process, their needs could not be considered nor provided for. When opposition stakeholders organized, they became aware of separate communications and "deals"

[1] A LULU is a land use that is necessary for community welfare, yet few people want in their neighborhoods as it presents both real and perceived risks. The term LULU is an acronym introduced by Frank J. Popper in "The Environmentalist and the LULU" and has is associated with expanding population demands (Popper, 1985). Examples of LULUS include, but are not limited to, landfills, power plants, prisons, and as in this case, wastewater treatment plants. Typically, LULU's are sited in areas where the residents have limited political power and economic resources. However, studies suggest that this is due to the low cost of the land, not the economic status of the residents. Ways of overcoming the objections of local residents to LULU's include collaborative planning, compensation for the external costs associated with the LULU, distribution of benefits and incentives to local landowners and use of institutional resources to "win" the conflict. Some stakeholders, such as those in the Owens Valley in California resisting the diversion of their water to Los Angeles, have resorted to violence and sabotage (1924). Compensatory actions by governmental entities may include implementation of environmental regulations and legislation, monitoring of the objectionable project by a neutral party, the institutionalization of processes intended to deal with emerging issues, subsidies to those in the impacted area, zoning restrictions, escrow funding for future damages and tax incentives

offered by the City of Waco to individual stakeholders which led to a lack of trust, entrenchment, refusal to negotiate and costly legal action (J.B. Smith, 2009).

The stakeholders who are perceived to hold the most power will tend to dominate the negotiating structure and process (Wolfe & McGinn, 2005). In this case, the City of Waco was the principal stakeholder with the City of Lorena in a secondary role. The state environmental agency, TCEQ, was the strongest institutional stakeholder with the Bull Hide Creek Clear Water Alliance serving as the most powerful stakeholder from the Bull Hide Creek community. Other stakeholders included McLennan County (represented by the Court of Commissioners), the Levi Water System and a few affected citizens who chose to remain semi-independent from the Alliance. Although the City of Hewitt was a direct beneficiary of the project, it delegated its stakeholder status to the City of Waco along with the other municipalities in the WMARSS.

WMARSS was established in 2004 when the main sewer plant was acquired from the Brazos River Authority. According to the WMARSS web site (http://www.wmarss.com), it is "A joint wastewater treatment effort by the cities of Bellmead, Hewitt, Lacy Lakeview, Lorena, Robinson, Waco, and Woodway." By combining resources into a single wastewater treatment organization, "WMARSS has helped to reduce the environmental impact of multiple wastewater treatment facilities and protect and preserve our natural resources. The regional system has also helped to reduce the costs associated with treatment, thereby assisting WMARSS participating cities in maintaining affordable rates for customers" (The Brazos River Authority, 2011). This emphasis on economies of scale was a persuading point Waco used when Hewitt

and Lorena were considering wastewater alternatives. However, there were no studies done comparing the costs and benefits of local, centralized vs. de-centralized treatment or alternative treatment methods plants such as bio-digesters, co-digestion or gasification or the use of emerging technologies to address the treatment problems. All decisions were based on the advice of city engineers who advocated a conventional, centralized plant consisting primarily of an collection system of underground pipes that would feed into a processing plant utilizing aerobic digestion in settling tanks, removal of sludge, and discharge of chemically treated effluent (Bartlett, 2007; Craig, 2002). Coincidentally, all municipalities used the same engineering firm. Despite the assertions of the WMARSS representatives that the plant would incorporate the latest technologies, the recommended design has been the standard since the late 19th century and the regulations are written and enforced for systems that provide for the management of waste, rather than a potential water resource (Venhuizen, 2010).

Constructed in the early 1920's, the main regional plant was originally the treatment plant for the City of Waco. Forty years later, in 1965, the General Manager for the Brazos River Authority introduced a new concept to his directors; Col. Walter Wells advocated the construction of a regional wastewater treatment plant that would utilize economies of scale to reduce regulatory and treatment costs for the municipalities in McLennan County. Regionalization of wastewater treatment was a new idea and it required significant political persuasion on the part of the Authority's board to win the support of state officials at the Texas Water Development Board, The Texas Natural

Resources Conservation Commission, and members of the Waco City Council, to transfer municipal operations to the Brazos River Authority (Etnier et al., 2004).

According to J.H. Kultgen, who was a member of the board at the time of the decision, among their concerns was the loss of financial control over the operations and the cost of building the supporting infrastructure (Kultgen, 1975). The possibility that sewage sludge, or effluent, would ever be a valued resource was not considered nor was the environmental impact of a concentrated disposal site. The objective of Col. Wells was to integrate and comprehensively manage all the water resources of the Brazos River basin. In 1971, a regional wastewater system was implemented ownership and operations of the Waco plant was transferred to the BRA (The Brazos River Authority, 2006; WMARSS). In 1994, the Waco Area Metropolitan Regional Sewerage System was formed and the wastewater system was transferred to the quasi-public organization. This move freed up the financial and staff resources of the BRA for surface water supply management.

The City of Waco owns 79.234% of the consortium and their representative has six votes on the advisory board, all the other cities have one vote and a proportionate percentage of treatment capacity (WMARSS, 2007). The city administrators of Hewitt, Robinson, Lorena, Lacy-Lakeview, Bellmead, and Woodway and the Assistant City Manager of Waco constitute the Advisory Board, with the Assistant City Manager of Waco serving as the board chair (WMARSS, 2007). Meetings of the Advisory Board are not open to the public and minutes are not available; their deliberations and decisions are unknown.

Hewitt joined the Waco Metropolitan Area Regional Sewerage System in 1995 at the invitation of WMARSS. The City of Hewitt accepted as they were seeking economies of scale in processing their waste, as well as additional treatment capacity and the reduction of administrative costs associated with regulatory compliance (HDR, 2010b). The agreement involved collecting and sending their wastewater to the main regional treatment plant on the Brazos River via a system of lift stations and sewer force mains. As the Brazos plant approached allowed treatment capacity, Hewitt was forced to implement a development moratorium caused by the capped wastewater treatment capacity which directly impacted the development in the City (Doerr, 2008; United States Census, 2013).

The City of Lorena joined WMARSS in 2007 in hopes of resolving multiple problems with their wastewater treatment plant through the assistance of the City of Waco. Inadequate planning, substandard materials, poor maintenance, and financial constraints had resulted in an aging, dilapidated infrastructure that was allowing infiltration of ground water (Lorena City Council, 2009; Lyon, 2010; Moran; Smith, 2008a; J.B. Smith, 2009b). This resulted in the City exceeding the allowed 75% of its permitted treatment capacity and triggering the regulatory requirement that they begin planning for expansion (Texas Commission on Environmental Quality, 2012). Another concern was that if rainwater could seep in sewage could seep out (Lorena City Council, 2009).

Frequent fines from the Texas Commission on Environmental Quality for exceeding capacity, dumping untreated sewage in their discharge waterway, poor

effluent quality, improper testing protocols, and poor, missing, or inadequate records suggested possible mismanagement (Texas Commision on Environmental Quality, 2010, p. 385:474). As part of the regulatory enforcement, Lorena signed an Agreed Order with TCEQ that stipulated Lorena would address the problems associated with the plant and join a regional wastewater consortium by February 2010, the expected completion date of the Bull Hide plant. According to Ms. Anna Dunbar, the regional director for TCEQ in Waco, this provision was included at the request of Lorena, not WMARSS (*T.C.E.Q. Public hearing on the permit* 2009). Yet John Moran and other would later use the Agreed Order to publicly justify Lorena's participation in WMARSS, claiming TCEQ was forcing them into the consortium (Waco Metropolitan Planning Organization, 2010).

As a result of the constraints by TCEQ, the council was forced to pass a moratorium suspending the issuance of any additional sewer connections. This action resulted in numerous negative impacts on the community, similar to those being experienced by Hewitt (City of Lorena, 2009). Both cities sought to lift the moratoriums. In addition by sending their waste to a facility that would be constructed outside their city limits it would be possible to: maximize the amount of developable, taxable land, mitigate potentially offensive odors associated with sewage treatment, protect their local waterways, minimize potential spill risks, and reduce development costs by purchasing land in an undeveloped area.

The City of Waco was looking at multiple benefits if Lorena would join the consortium. Publicly, they promoted the economic benefits of scale for all parties that

would result from regional wastewater treatment management and operations but they stood to gain disproportionately because they were the majority voting member in the consortium (Stem, 2007). Not only would they benefit financially directly and disproportionately (see Appendix I, contract with Lorena), they would also be able to acquire secondary benefits via preferential government subsidies on behalf of a regional entity through the EPA and other federal agencies. Profitable effluent sales to a local power plant would also benefit Waco (WMARSS; Wolfe & McGinn, 2005). By constructing an additional plant with expansion potential, Waco would also decrease the treatment demand on their main plant, allowing for development of their inner city and river corridor, ironically the consulting planners recommended that any development outside their city limits be limited due to the costs associated with expanding required city services (The Wallace Group, 2001). At the time of the recommendation, approximately 30% of land within the City was undeveloped. Because of the demand for development outside the City, city management decided a satellite plant would be a wise investment. After evaluating growth trends, six potential sites for a future satellite plant were identified in the southern part closer to Hewitt, Robinson, and Lorena (the high growth areas in the county) of the county by WMARSS (Ingram). Simultaneously, WMARSS began seeking federal funding to expand the aging main plant (Stem, 2007, p. 278; Texas Commission on Environmental Quality, 2012).

Their first choice was a site located in the City of Robinson. The leaders of that city, however, were averse to a treatment facility in their municipality and the owner of the proposed site fought a successful political and legal battle causing City of Waco

administrators to consider alternative sites. Of the remaining possibilities, three sites were located in the extra-territorial jurisdiction (ETJ) of Waco and adjacent to the City of Lorena's ETJ. Because of the proximity to Lorena, representatives from the City of Waco contacted the City of Lorena city manager and suggested that Lorena become a member of WMARSS (WMARSS).

Although Lorena officials publicly acknowledged they were joining WMARSS for help in managing their wastewater and desired to move their treatment facility. Wiley Stem, the assistant city manager of Waco, emphasized the mutually beneficial aspect of the agreement. "We are not putting this here because Lorena's system is in trouble. We are putting this here because Lorena is at capacity and so is the rest of the WMARSS system" (Ingram). Documents show the City of Waco had been planning to put in a wastewater treatment plant (WWTP) in or near Lorena for years before asking Lorena to join WMARSS. In fact, in 2006 and 2007, the City Manager of Waco testified before the United States Senate sub-committee on water resources stating the satellite plant would benefit the Waco metropolitan area and, in particular, the rapidly growing communities adjacent to I-35. "As opposed to expanding the central wastewater treatment located in a remote, downstream area, the expansion will be accomplished with "satellite" wastewater treatment plants that will be located in areas near the high growth corridors (Groth, 2007, p. 2). He was in Washington to request for federal funds for the project.

Waco sought funding for the project citing that effluent would be reclaimed for multiple uses, freeing up surface water supplies. Federal funding for the project was officially opposed by the Bureau of Reclamation on the grounds that funding was not

available (*Statement of larry todd, deputy commissioner bureau of reclamation on hr 609*, 2007; *Statement of larry todd, deputy commissioner of the bureau of reclamation*, 2006). Funds were later received through the EPA from monies originating with the 2009 American Recovery and Reinvestment Act.

The cities were opposed by a grass roots organization named the Bull Hide Creek Clearwater Alliance, the Levi Water System and three families that were aligned with the Alliance but retained individual standing for legal purposes: Mr. and Mrs. Felipe Reyna, Mr. and Mrs. John Brodine and Mrs. Edna Hughes and her family. The Levi Water System maintained their separateness throughout the process, but supported the Alliance by allowing them to use their community building, gave them access to their membership list and shared information with them. Like many grass roots movements, the formation of the opposition coalition was the direct result of what was perceived to be a failure on the part of local government to behave appropriately. Grass roots organizations are formed by concerned citizens who feel compelled to respond to a perceived threat; they are political and publicize their cause through the community in an effort to gain support and redress The term comes from the fact that grass roots movements grow spontaneously, naturally and without the support of established organizations, similar to the spreading of native, wild grass roots.

In this case, the residents of the Bull Hide community felt a major decision affecting their community, their lives and their property had been made without their input and they reacted strongly. The filing for the permit and the community notification of this action took place at a meeting held at the local high school on Thursday, March

20, 2008. Upon learning that the development and planning for the wastewater treatment plant had been going on for years, attendees were shocked. The situation was made worse when the consultants presenting the proposal refused to answer questions. Immediately following the meeting, angy community members organized a meeting to be held at the local water company on the following Tuesday.

Notification of the Tuesday meeting was disseminated through the community via direct personal contact, email or phone. This meeting was attended by over 100 people who were confused, worried and uncertain. However, they quickly organized and by within two hours had a steering committee, a name, a membership list and a time and date for the next meeting. The "core" group (steering committee) would lead the opposition through the next 18 months. This group noticeably evolved in the 18 month period between the filing of the permit and the signing of the agreed settlement.

One of the most difficult challenges facing the Alliance was determining who would lead. Judge and Mrs. Reyna, due to their standing in the community were asked to serve, and they accepted. Gary Penny, a quiet, non-confrontational man assumed the role of peaceful organizer. The Helpert brothers, Kevin and Keith, along with their brother-in-law, Todd Christianson, actively and helped the Reyna's effectively coordinate multiple tasks for over a year. As in all organizations, the primary leadership was supported by secondaries. People set up a web site, wrote press releases, organized fund raisers, did research, contacted elected political officials and educated non-affiliated members in the community about the issue. As the organization developed, the Bull Hide Creek Clearwater Alliance, and leadership, established legitimacy in the

community and among the other stakeholders, including the cities. The relative proximities of the municipalities can be seen in Figure 2.

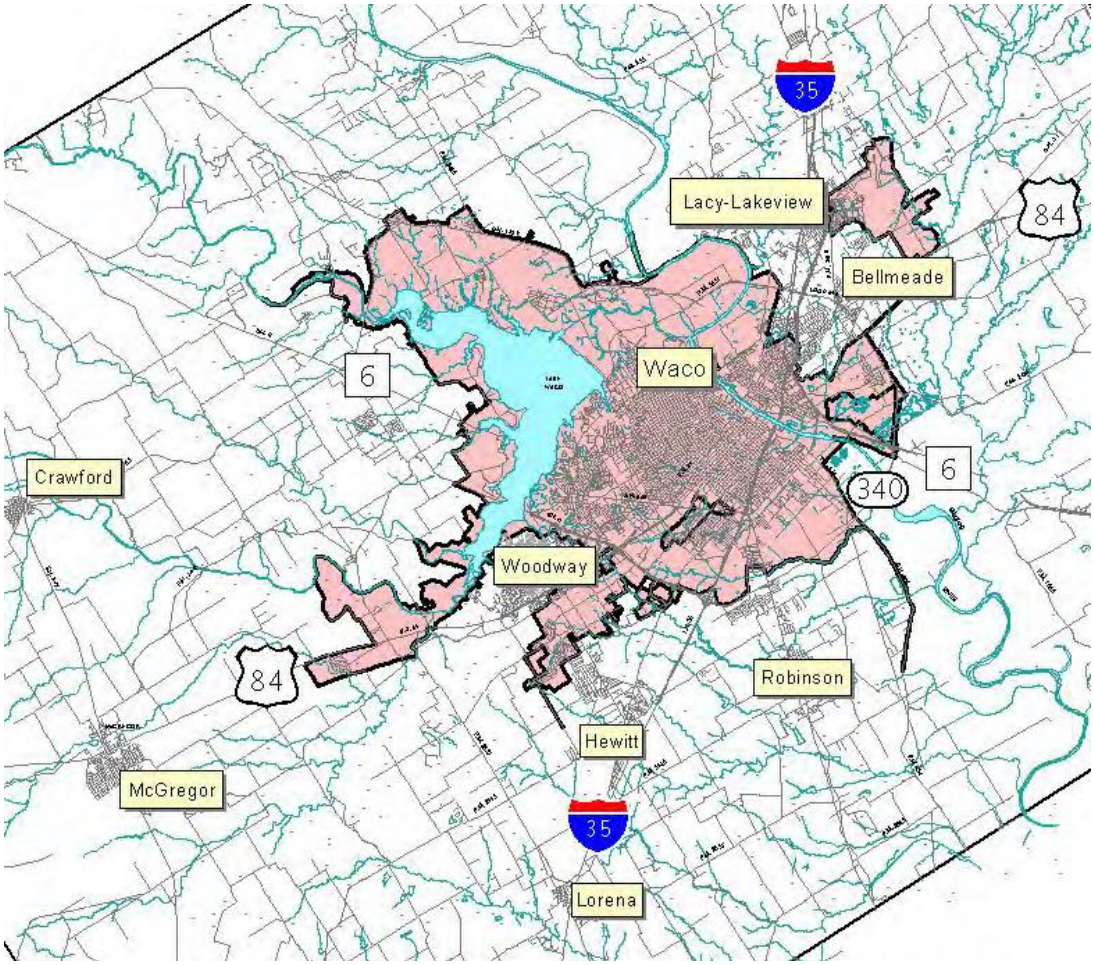


Figure 2: Proximity of Lorena to the City of Waco and other WMARSS entities

(All municipalities are located with McLennan County, Texas)

5.5. Bull Hide Creek

According to the Handbook of Texas Online, Bull Hide creek:

> rises three miles south of Woodway in south central McLennan County (at 31°23’ N, 97°01’W) and runs southeast for 19 miles to its mouth on the Brazos River, four miles east of Golinda in Falls County (at 31°28’ N, 97°15’W). The stream in intermittent in its upper reaches and has springs, pools and steady flows south of the proposed plant site. It was named for a bull hide that was hung on a tree by a hunter in the late 1800’s. The creek crosses flat to rolling prairie with locally steep slopes, surfaced by expansive clays and clay loams that support juniper, oak, mesquite, and grasses in its upper and middle reaches and water tolerant hardwoods and conifers downstream (Texas State Historical Association, 1999). Figure 3 shows the area of the creek that will receive the discharge from the wastewater treatment plant. This picture was taken during the winter drought and the limestone floor and banks of the creek are visible.

Figure 3: Bull Hide Creek at Cooksey Lane, February 24, 2009

(Looking downstream toward the plant site from Cooksey Lane during a dry period.)

The creek, according to an environmental assessment conducted by James Miertschin and Associates (the Austin engineering firm filing the permit on behalf of WMARSS), is "entirely characteristic of the Blackland Prairie" (James Miertschin and Associates & Paul Price Aquatic Ecology, 2007). In close proximity to the proposed plant, on the Warren Farm across the creek from the plant site, lies an undisturbed section of Blackland Prairie which supports extensive native wildlife and flora. According a representative of the Native Prairies Association of Texas, who visited the site, less than 3,000 acres of undisturbed Blackland Prairie remain out of an original 12,000,000. One of the concerns of the Warren family was that WMARSS was not only unaware of this unique ecological system; they planned on destroying a large section of it in the process of laying pipe to the City of Lorena. When the large Warren family protested, both verbally and in writing to the City of Waco, they were told, in writing, that if they did not cooperate, the land would be condemned through eminent domain, leading them to seek legal counsel. Ultimately, after being advised by their attorney that they could not prevail, the sold three acres of their native prairie land for an easement; a large section of the prairie was disturbed when the land was excavated for the sewer pipe and used for equipment storage. It was not restorated. A contributing factor to the family's strong opposition to the plant was the fact that they had been approached by McLennan County a few months before the filing of the permit and asked to donate land needed to upgrade an old iron bridge crossing Cooksey Lane. Although this upgrade was necessary to carry the weight of the trucks that would be hauling sludge from the Bull

Hide plant, this fact was never shared with the Warren's. The family was furious when it was discovered they had been deceived into donating land that they felt would have a negative impact on their family farm. They attempted to cancel the donation, but ownership of the land had already been transferred to the county (Bull Hide Creek Clear Water Alliance, 2008).

The creek is a second order stream in the vicinity of the proposed plant with springs providing pools in most conditions except extreme drought. At the Cooksey Lane crossing, Austin Chalk limestone is exposed. About a mile downstream the creek narrows just below the proposed plant site in response to changing geology and at this point there is a low water dam that has created a swimming and fishing hole with heavy riparian vegetation. Below the dam, the creek bed narrows, becomes deeper and supports an extensive ecosystem that contains what the state considers to be "a highly rated aquatic life" (James Miertschin and Associates & Paul Price Aquatic Ecology, 2007). The creek's ecosystem supports cougars, bobcats, fox, Great Horned owls, bass, perch, vultures, blue birds, and numerous migrating species in the fall and spring.

The creek is easily accessible in the stretch between Cooksey Lane and Rosenthal Parkway from a narrow, paved, creek side road. Easy access due to limited fencing, an iron bridge with a historical marker and well, maintained, 19th century cemetery make this stretch a popular destination and gathering spot in the summer for cycling enthusiasts, hikers, picnickers, and waders (Garrett, 2003). The quiet, heavily wooded, rural environment attracts bird-watchers, individuals seeking solitude, and

families on the traditional, Sunday afternoon drive who wish to spend quiet time in the country.

The negotiated settlement provides that 40 acres of the 243 will be dedicated for 99 years to a future park with community recreational facilities (see Appendix G, page 3). According to the county commissioner, Kelly Snell, the park will serve as a "county precinct park" and be located upstream from the wastewater treatment plant (Gonzalez, 2009). It is part of the 2010 county wide master park plan adopted by the commissioner's court and recommends a park that will include a sports complex, a playground, concession stands, recreational vehicle spaces, a fishing area, horseback trails, hike and bike trails, a water sports area, camping facilities, and picnic areas (Mundo and Associates, 2010). Although the Bull Hide site was not identified as the future park in the plan, the 40 acres has been designated.

A recreational area adjacent to the creek was insisted upon by stakeholders who were concerned that the plant site would be used as a future regional landfill. This possibility was conveyed to the author by the staff member at the Heart of Texas Council of Governments in charge of regional solid waste planning but the City of Waco denied the allegation on the grounds they projected 15 years remaining space in their landfill. An employee in the solid waste division of TCEQ, however, told the author that while Waco had 15 years capacity remaining in 2009, the six county region was expected to reach landfill capacity before 2018 (Mann, 2008).

Table 1. Events Pertaining to the Bull Hide Creek Wastewater Treatment Plant

Date	Event
February 13, 2007	Application for a permit for Lorena to discharge effluent into Bull Hide creek (WQ0014782001) and construct a new wastewater treatment plant
June 16, 2007	Resolution by the City Council of Lorena agreeing to construct at WWTP near Bull Hide Creek, the last municipality to do so
July 3, 2007	Lorena and WMARSS sign an Interlocal Cooperation Agreement conveying the Lorena WWTP and existing operating permit to WMARSS and the terms of the agreement
September 10, 2007	Contract between the City of Waco, representing WMARSS, and Mrs. Dorothy Smith for a 90 day purchase option on 235 acres of land
February 5, 2008	Agreed Order stipulating Lorena will repair deficiencies in their plant, remove contaminants from the discharge waterway, file missing reports, and divert all wastewater to the new regional wastewater plant
March 14, 2008	Smith property closed on, letters to affected land owners mailed out informing them of meeting on March 20, 2008
March 20, 2008	First permit withdrawn (WQ0014782001) Second permit (WQ0014889001) filed (11:28 A.M.), meeting with affected land owners at the Lorena High School later that night
April 1, 2008	Complaint filed with the EPA concerning hazardous materials at Bull Hide plant site. Estimated cost of removal, $115,000
May 20, 2008	Wiley Stem, Chairman of the WMARSS advisory board, requests meeting with Felipe Reyna in an email. "The WMARSS staff would appreciate an opportunity to meet with you and discuss your concerns relative to the Bullhide Treatment Plant. Since we have never had the opportunity to directly provide you any information about this project…"

Table 1, continued

Date	Event
June 10, 2008	Representatives from the City of Lorena, the City of Waco and the Bull Hide Creek Clearwater Alliance meet in Rep. Doc Anderson's office with WMARSS representatives at the request of Rep. Anderson. Not all stakeholders are included.
August 5, 2008	Official request filed with TCEQ for public meeting and contested case hearing for the application of Permit WQ0014889001 by Felipe and Cheryl Reyna
September 17, 2009	The Memorandum of Agreement of Principle between WMARSS and the stakeholders is signed. This negotiated settlement addressed the concerns of the stakeholder
January 6, 2010	Permit WQ0014889001 issued to discharge effluent from Bull Hide Creek WWTP
February 2, 2012	Bull Hide plant online, Lorena plant converted to collection facility
April 1, 2012	Engineers for the Bull Hide plant publish a paper detailing problems with the plant stating: it is underutilized by over a million gallons per day causing operating and treatment problems, the plant is polluting the creek with nutrients, there were maintenance problems in the Lorena plant that were not addressed, improper testing protocols by the City of Lorena resulted in inaccurate reporting and conclusions, the design for the plant was based on a model that did not allow for dynamic inflow conditions, sludge treatment is a problem, and there are problems controlling odor and bacteria (Paul Wood P.E., 2102). This report was not shared with stakeholders.

6. FINDINGS

In the permitting process pertaining to of the Bull Hide Creek wastewater treatment plant multiple issues were present which were influenced by risk perception. The perceived risk associated with the filing and issuance of permit WQ001488900 was a present and influential, yet unidentified factor, which affected the process. Risk perception was developed, enhanced, amplified, mitigated, and attenuated through the utilization of three intervening variables: resources, risk communication and trust. This section discusses how.

6.1. The Role of Resources

In this case, as in so many conflicts, the resources stakeholders had access to, and how they were used, were critical to accomplishing the desired objectives. There were two main stakeholder groups, those aligned with the BHCCWA and those aligned with the WMARSS entities. Strong opposition mobilized by the stakeholders against the Bull Hide plant was made possible by accessing and utilizing resources which were used for two main strategic objectives. The first objective was to consume resources of WMARSS, the City of Lorena, and the City of Waco. By causing WMARSS to spend use resources to fight a battle, the tangible and intangible costs to WMARSS would rise. The leadership felt that when the costs rose sufficiently, WMARSS would be more inclined to negotiate, leading to the second strategic objective. This was identified as getting the WMARSS entities into a negotiating situation that would result in an agreed settlement. WMARSS entities wished to expedite the permitting process to bring the

plant online as soon as possible. Schattschneider (1983) has observed, competition for resources is not only a source of conflict but competition for resources may escalate with continued conflict. Competition for resources played an integral role and contributed to the conflict surrounding the permitting of the plant.

This conflict was highly emotional and contentious. Although the stakeholders aligned with the BHCCWA wanted to stop the construction of the plant, most individuals believed it was highly unlikely this could be accomplished. A negotiated settlement was preferable to a protracted legal battle that would consume more resources than they had or believed they could obtain. This was not as critical an issue for the WMARSS entities as not only did their combined resources far exceed those of the opposition, they were more experienced in using them to achieve desired policy implementation. However, both sides were aware that they were competing for political and social influence.

Each side wanted to avoid a long, drawn out battle but for different reasons. Waco was well aware that time "was not their friend" because it would delay construction of the plant, raising costs significantly. This position was based on the knowledge that delays are costly for many reasons: interim financing costs may increase, costs to purchase easements may increase, inflation may affect the cost of materials, actual construction costs will rise due to extended fixed costs (employees, buildings, insurance, utilities, payroll, equipment) but delayed revenue, delays may require expensive rebidding processes, top sub-contractors may take on other projects, there may be unrecoverable opportunity costs, possible legal fees related to hearings and litigation,

and related intangible costs such as loss of momentum or key parties. Time is, literally, money (Harder, 2002; Scott, 1993)

Opponents of the permit for the plant took different positions. Encouraged by two prominent lawyers (Texas 10th District Court of Appeals Justice Felipe Reyna and his wife Cheryl), the leadership of the Alliance deliberately delayed negotiations intentionally whenever possible to raise WMARSS costs. They consistently held their public position there would be no compromise, which put additional temporal pressures on WMARSS creating anxiety and increasing perceived risk. Privately, core members of the Alliance discussed the disparity in resources with other opposition stakeholders, and what they would be willing to compromise on when resources became scarce. When resources dwindled, grass roots opponents "threw in the towel" because they couldn't continue the fight, a typical outcome in environmental conflicts (The Yale Law School, 2013).

The Levi water supply company and other individual stakeholders supported the Alliance's leadership position. Although the water company, Charlie Montgomery, Mr. Dewey Jackson, and his mother, Mrs. Edna Hughes, were given standing at a procedural hearing, they did not have the financial or emotional resources to maintain a separate legal conflict with the City of Waco. As a result, all the stakeholders worked together to obtain and employ the same legal firm and consultant. This proved to be an advantage for the City of Waco, as they were able to direct their efforts at one primary opponent and minimize the points of conflict.

Individuals, government agencies, and institutions prefer to function in the absence of conflict as it consumes resources, and threatens a system's stability. Conflict, however, may provide a stimulus for fundamental or incremental change. Due to its very nature, conflict results in the exercise of power as well as an opportunity for opposing groups to acquire additional power In the pursuit of power, institutions, as well as individuals, are assumed to rationally consider the costs and benefits associated with the use of resources in the pursuit of, and acquisition of, power. It is, however, recognized that power may not only be a means to an end, but an end in itself.

6.1.1. The Role of Power

Power is a critically important element in policy development and risk perception. In any conflict, the party that possesses power will be able to limit who can participate in the process, who has access to the media, what negotiating structures are adopted, and who is considered to be a credible participant; in essence, strategically controlling the conflict, expansion of the conflict, and the associated perceived risk. The weaker party in a conflict can increase their power by recruiting others to their side, thereby widening the conflict and making it more difficult for the stronger party to dominate and control the participants involved in the conflict (Schattschneider, 1983). This may include neutral parties, such as media representatives, who serve as intermediary recruiters. With the expansion of the conflict, the power balance, and relative risk perception, may shift, resulting in re-evaluation, re-organization, and renewed negotiations.

Early in the planning process, the City of Waco exercised their legitimate power as the largest political entity in the area by threatening the owner of the land they wished to acquire for the wastewater treatment plant. Mrs. Smith, an elderly widow had owned a gas station with her husband in Waco for decades but it had been closed for many years. The couple had stored petroleum waste products and old tires on the land out of convenience; the majority of the materials were put there prior to the establishment of environmental regulations or hazardous waste dumps. Knowing the materials were there, the City used them to pressure Mrs. Smith into selling her land by giving her two choices. Either she could sell the land to the City of Waco or they would contact the regulatory agency in charge of illegal dumps and hazardous waste. Being in poor health, with dwindling funds, and limited access to supporting friends and family, Mrs. Smith sold her land to the City of Waco under duress, to attenuate her perceived risk as much as possible, responding to the use of coercive power on the part of the City of Waco . Shortly after acquiring the land from Mrs. Smith, an anonymous tip was submitted to the EPA and the City was notified that regulatory action was being taken concerning the hazardous materials. Although the City officially stated they had been unaware hazardous materials were on the land, records obtained by the BHCCWA through open records requests confirmed this was not the case; they mentioned the debris in their correspondence with Mrs. Smith (Kultgen, 2008a).

Members of the Alliance notified the reporter covering the story and the local paper did a major story reporting the City of Waco expected to spend over $100,000 cleaning up the Smith property (J.B. Smith, 2009a). Despite an intense effort by the City

of Waco to determine who had notified the EPA or called the reporter, they were never able to identify the source. One of the core leaders of the Alliance confidentially confirmed it was one of their members but because he had not been arrested by the City of Waco for trespassing (pictures documenting the waste were provided to the EPA), they were confident his identity was unknown. Local television stations picked up the story and numerous negative comments about the City of Waco were received by the media via letters to the editor and electronic postings-effectively expanding the referent power of the Alliance.

The members of the Bull Hide Creek Clear Water Alliance were aware of the power imbalance and utilized various compensatory tactics. As the most visible and powerful opposition stakeholder, this grassroots organization exercised legitimate, coercive, reward, and expert power throughout the conflict. As the largest group they possessed the greatest combined resources which gave them legitimate power as the leader of the stakeholders. They were also able to employ the use of reward power by promising political support to the involved politicians. By publicizing the combined stakeholder's opposition through press conferences, letter writing campaigns, fund raising events, protests at city council meetings, soliciting the support of public officials, and television interviews, they utilized referent power to appeal to the public's sense of fairness to strengthen their position. This was done by emphasizing:

- the decision had been made without input from the landowners in the area,
- there would be adverse effects to the water quality of the creek,
- Waco had a reputation for being fined for sewage spills,

- the landowners would not benefit in any way from the treatment plant,
- it was a poor economic decision for Lorena but it would benefit the City of Waco,
- representatives of the City of Waco and the City of Lorena had been deceptive by withholding information and lying to the press and stakeholders, and
- this was a classic fight between the big, bad guy and the little average little guy.

The Alliance leadership exercised coercive power in numerous ways; at times very public, at other times less obvious. The most obvious coercive power use was to continually threaten the City of Waco and other WMARSS entities with a protracted legal fight in public. Individual members of the Alliance wrote angry letters to the editor of the local newspaper, the Waco Tribune-Herald and the state regulatory agency (TCEQ), demanded a contentious public hearing attended by hundreds, and gave many interviews with the media. Coercive power was also utilized in private with phone calls, emails, texts, and at closed meetings. For example, at a tense meeting arranged by the local state representative, "Doc" Anderson, Waco's assistant city manager was told by Mrs. Felipe Reyna that she would "fight them to the day she died" and was willing to spend considerable money in the process (WMARSS representatives & BHCCWA representatives, 2008).

Not so obvious threats utilizing coercive power came by raising public fears (perceived risk) and appealing to community emotions through impassioned letters to the editor campaigns, professional videos, websites, a facebook page, community fund raisers, and the distribution of satirical posters throughout the area. Waco's assistant city

manager was directly threatened by Alliance leadership with a extensive legal battle in a private meeting with political representatives (WMARSS representatives & BHCCWA representatives, 2008). Being willing, and able, to use coercive power to publicly threaten the City of Waco and other WMARSS entities with costly litigation, possible loss of funding, and loss of face gave the Alliance a positional advantage over WMARSS as WMARSS was unwilling to publicly threaten the Alliance.

Like coercive and legitimate power, referent power is a social construct. By necessity, people trust, and defer, to "experts" because it is not possible to seek out, acquire and process infinite information pertaining to common activities. But what constitutes an expert? An expert can be defined in various ways. One of the best definitions is from Schattschneider (Schattschneider, 1983, p. xvi): "…an expert is a person who chooses to be ignorant about many things so he may know all about one". Every day, people are required to place confidence in pharmacists, surgeons, pilots, bank clerks, engineers, plumbers, technicians, lawyers, and others more knowledgeable than them (Schattschneider, 1983).

Not only do people rely on the opinions of experts when making decisions in their private lives, they often seek the security proffered by those they trust in positions of power in social or political institutions when confronted with uncertainty or risk (Cheng, 2009). An expert may not understand the complexity of the situation or the personal vagaries pertaining to the problem at hand, but people will defer to an expert if they trust him, or her (Schattschneider, 1983). Early in the conflict, members of the Alliance sought out and deferred to "experts" they trusted. Daryl Knowles, a wastewater

instructor at the local technical college was hired to examine the permit and challenge the technologies, design specifications, treatment parameters, and technically based local limits (TBLLs). Despite reservations about his competency, expressed privately to this researcher and based on his physical appearance and dress, the group selected Mr. Knowles over other applicants because of his geographic accessibility, lower fee, and the recommendation of their legal firm. The recommendation of their attorney, whom they trusted, was clearly the most important factor. If trust is present, expert power is enhanced and perceived risk is attenuated (Jenkin, 2006). In this instance, the expressed reservations pertaining to his competency may have indicated some individuals felt his selection was risky.

At times, multiple types of power were used simultaneously. For example, the Levi Water Supply used both coercive and legitimate power when they challenged WMARSS at the public hearing. They reminded TCEQ representatives that TCEQ regulations specifically forbid the placing of a well "within 300 feet of a ditch containing waste from sewage treatment systems" and the Levi water system had a well within 75 feet of the creek (*Public hearing on the permit no. Wq0014889001*, 2008). Waco used a combination of legitimate and expert power when they used a well-known environmental consulting firm, James Miertschin and Associates of Austin, Texas to prepare the environmental component of the report and answer questions from TCEQ pertaining to the environmental impact on the creek (James Miertschin and Associates, 2008). The Alliance used a combination of expert and legitimate power during the public hearing when their expert, Daryl Knowles, challenged the efficacy of the proposed

treatment on behalf of the combined opposition stakeholders (*Public hearing on the permit no. Wq0014889001*, 2008).

Although the BHCCWA leadership never directly mentioned how the power balance and flow changed during the conflict, they consciously strategized on how to deal with Waco's power. At times, tactical strategies were direct and formal (such as press conferences). At other times, they were informal, collaborative, and discreet. They met privately with county commissioners, representatives, and WMARSS officials. They collaborated with, and recruited, supporters from environmental organizations and the local University (Texas Prairie Association and Baylor Department of Environmental Sciences), as well as, former residents of the area and members of other groups who had environmental conflicts with the City of Waco (The Texas Association of Dairymen). Alliance members also worked together to set up a web site, research information, obtain information through Open Records requests pertaining to Waco's environmental violations, to attend bid openings for the design and construction of the plant, and set up various committees (publicity, fundraising, legal and technical) which increased their group cohesiveness. Because the Alliance was able to preserve cohesiveness they were able to maintain sufficient power which directly influenced their ability to acquire money.

6.1.2. The Role of Money

Money is used by individuals, institutions and groups to acquire and enhance culturally based positional power, enhance egos, influence others, and manipulate perceived risk. For example, it can be used to buy advertising, divert resources, retain

legal assistance, access expertise, send out information or misinformation (propaganda), challenge the legitimacy of information released by other stakeholders, reward compliance, recruit and acquire the support of others, or punish. In addition, it can be used directly or indirectly in exchange for tangible or intangible items.

The City of Waco and WMARSS had significant monetary resources that dwarfed those of the Bull Hide Alliance and aligned stakeholders. For example, the wastewater budget for the City of Waco 2008-2009 showed wastewater revenues of over $20 million (City of Waco finance department, 2009, p. 94). Compare this to a budget of less than $20,000 acquired through: garage sales, personal contributions, dedicated percentages from a few small, local horse shows, passing the hat at meetings, and dances at the local VFW hall. The sheer magnitude of the difference in financial resources, and the amount that WMARSS could devote to winning the conflict, presented a major risk to the Alliance; the core leadership felt they could not raise the funds necessary to sustain a protracted fight and they consistently conveyed to their members that money was necessary to successfully fight the permit.

WMARSS had access to public funds that could be spent without the approval of elected officials or the voting public. The city managers who represented their entities on the WMARSS board are appointed by the respective city councils. In this case, the majority of the members fully supported their city managers' expenditures, with one exception. Robert Braswell, a representative on the Lorena City Council repeatedly challenged John Moran's reports and spending recommendations to the council. Although he drew attention to discrepancies in bids and actual costs, without the support

of other council members, his complaints were not included in the council minutes. It is possible that this was due to the fact the decision to construct the plant had already been made years earlier in private work sessions and his objections were moot. Although members of the Alliance attended both Lorena and Hewitt Council meetings and gave public comments objecting to the expenditures of public funds for the construction of the Bull Hide plant, the councils politely ignored them. It was postulated they were ignored because they were not eligible to vote in either city.

Another financial factor was that WMARSS entities could utilize professional in house legal, clerical, environmental and technical experts without incurring additional expenses or opportunity costs; the Alliance was required to pay for these services. Because WMARSS had these in-house services, they were effectively able to attenuate their perceived risk.

In contrast, the Alliance and the Levi Water Supply were accountable to their members for how the funds were spent. Because funds were critically low, disagreements as to how they should be spent were frequent. Leaders withheld financial information from the group to avoid dissent among the members for not only did the leadership consider the financial inequality an external threat, they recognized it had the potential to become in internal problem as well.

To compensate for financial disparities, the Alliance strategically drained financial resources of WMARSS by using both political and social influence, regulatory requirements of TCEQ, forcing public hearings, requesting a state ordered administrative hearing, challenging the validity of WMARSS expert's reports, and intentionally "being

a thorn in the side" of all possible public officials. Despite the gross difference in financial resources, these Alliance tactics had an impact on WMARSS which was perceived as increased risk and anyone identified as being associated with the Alliance was perceived as a risk to the project. Approximately mid-way through the process, I sent a request for permission to attend a WMARSS meeting to the Assistant Waco City Manager, Wiley Stem. His surprising response was, "No, not only no but, hell no. You've cost us over a million dollars." His comment supported the observation that, in this case, money was a strong variable, both amplifying and attenuating risk perception.

6.1.3. The Role of Social Influence

Social influence was exercised discreetly, and competitively, by both sides to amplify and attenuate perceived risk. The most obvious use of social influence was the successful recruitment of the publisher, and the editor, of the Waco Tribune-Herald by the City of Waco to support their position. Although all the articles pertaining to the conflict in the news sections of the paper met journalist standards for truthfulness, accuracy, objectivity and fairness, editorials were written supporting WMARSS. The first editorial emphasized that great care had been taken to protect the creek and the importance of the plant to the growing communities of WMARSS, effectively communicating low risk ("Bull hide," 2008). An unexpected consequence of this was the refusal of the Waco paper to accept advertising from the Alliance. A number of people expressed frustration and concern as a result of the paper's actions. As a result of the newspaper's refusal to carry advertising opposing the plant, various members of the Alliance felt they were deliberately being denied news coverage towards the end of the

conflict. However, this may be attributed to the "short life" of stories dealing with public concerns. It is a documented phenomenon the public gets bored with media coverage of events after about two weeks of coverage unless interest is created by loud, public conflict, new information, related stories, or changes in public opinion (Peters & Hogwood, 1985; Sides, 2012). The Bull Hide creek WWTP story received coverage from March 21, 2008 through February 10, 2012, far beyond what could have been expected.

Members of the Alliance sought out personal friends and family who could be recruited "for the cause." Letters were written to TCEQ protesting the permit application, contesting the validity of the information it contained, sharing personal stories of childhood memories, and family histories. Other members appealed to powerful relatives and acquaintances. Ms. Hal Pledger publicly and angrily told Wiley Stem (the Assistant City Manager of Waco) one of her cousins had been the Chairman of the Texas Water Development Board and that he was extremely unhappy with Waco's actions (Morales, 2011). She then confronted Mr. Stem with a book on Mr. Beecheral, Jr. and asked, "Do you know who this is? He's my cousin and his wife grew up on Bull Hide Creek." Mr. Stem politely, and in a low voice, replied, "I know who he is, I've been to his ranch" (WMARSS representatives & BHCCWA representatives, 2008). Mr. Beecheral subsequently made numerous phone calls to influential members in the water community expressing concern over the plant. These concerns resulted in phone calls to City of Waco administrators and effectively raised WMARSS' level of perceived risk that the plant may not be permitted.

Another member of the Alliance recruited a well-known local engineer who shared his knowledge of the historical and current wastewater and environmental problems Waco was struggling with at an Alliance meeting; his comments were then shared via mass emails. Still another member recruited a retired high level TCEQ employee to explain regulatory procedures and rules. Both of these speakers simultaneously increased and decreased the perceived risk. People who previously had paid no attention to media reports of Waco sewage spills now worried about what would happen to their creek if WMARSS discharged sewage effluent into it (increasing their perceived risk). However, their conversations revealed they felt Waco's history of problems and enforcement actions, including a 5 million gallon raw sewage spill, would present an opportunity to call for increased restrictions on the proposed plant which attenuated their perceived risk (Smith, 2008b).

Similarly, the audience listening to the former regulator was initially discouraged by his presentation because they were bluntly told WMARSS had experience and substantial resources, resulting in increased risk perception. Various members publicly expressed that it was not possible to win in a fight with Waco. However, during the question and answer period, Alliance members were told they could capitalize on the procedural structure of the permitting process and delay the issuance of the permit, leading to a commitment to acquire more resources and capitalize on regulatory processes that protected public interests. This led to a discussion on the upcoming public hearing, the plans for the SOAH and a possible lawsuit in an Austin District Court,

which improved morale and decreased risk perception (Bull Hide Creek Clear Water Alliance, 2008).

6.1.4. The Role of Political Influence

Both major stakeholders in the Bull Hide Creek Wastewater plant controversy used their political influence to amplify and attenuate risk perception by recruiting political actors. Some of these actors were elected politicians; others were individuals who were active in local politics. The most striking example of the use of political influence was the resolution passed by the McLennan County Commissioners Court opposing the plant on June 30, 2009 with only two dissenting votes. Commissioner Kelly Snell introduced the resolution because he felt the residents in the Bull Hide creek area had been left out of the political process. Lester Gibson, a commissioner voting for the resolution told a local reporter, "There was not a complete discussion of that the entire impact of this was going to be and I'm learning more now than what has ever been disclosed to us." Ironically, representatives of WMARSS, the mayor of Waco, and the city manager of Hewitt strongly objected to being excluded from the court's decision to issue the resolution or being invited to the meeting where it was introduced and passed. Charges of political influence peddling were made and the County Judge made it clear that there could be political retaliation toward the county by the WMARSS entities as a result (Dennis, 2009). Retaliation came, but it was in the form of a local editorial in the Sunday paper strongly condemning the Commissioner's action. "How nice of McLennan County commissioners to awaken, Rip Van Winkle-like and take an interest in complex affairs that have occupied others for years" wrote the editor. In addition, "if

commissioners had wanted to learn more, they could have walked two blocks over to City Hall (sic) or picked up a phone." The editorial objected to Mr. Snell's comments that "there needs to be better communications about everything that's going on with this project" and his suggestion that a joint work session with all the stakeholders would be productive. The editorial concluded by praising two members of the commissioner's court for voting against "this probably irrelevant, Johnny-come-lately resolution" (Dennis, 2009). The majority of the comments pertaining to these two articles on the Internet supported the resolution and the opponents of the Bull Hide plant. Informal conversations with Alliance members indicated that this effective use of political influence dramatically decreased their perceived risk.

Justice Felipe Reyna and his wife exercised their political influence to increase the perceived risk to WMARSS. They spent countless hours contacting active Republican Party members, and elected officials, soliciting their support for the Alliance. Their first success was the meeting Waco state legislator, Doc Anderson set up in his office between the adversaries. WMARSS representatives reluctantly attended the meeting but did so due to Doc's status . The Reynas were also successful in recruiting state senator Kip Averitt, whose district included Bull Hide creek.

Throughout the conflict, Waco and the WMARSS entities used limited political influence. The most notable was at the public hearing on September 18, 2009. This meeting was attended by hundreds of people and held at the Lorena High School Performing Arts Center. City council members from Hewitt, Lorena, Woodway, Waco, and other WMARSS entities made numerous public comments to TCEQ moderators

emphasizing that not only did their communities need the plant, issuance of the permit would pose little, or no risk, to the hosting community or receiving waterway. At times their comments were met with loud opposition due to the presence of the people opposing the plant. As an observer, the dichotomy between the "suits of the politicians" and the "boots and jeans" of the rural residents was striking. The politicians were clearly more poised and confident, but they were outnumbered by those who felt their community, homes, and way of life was at risk if the permit was issued.

6.2. The Role of Risk Communication

The risks associated with building, or not building, the wastewater treatment plant were communicated through various sources, perceived, interpreted, amplified or attenuated, and responded to. This process was iterative and dynamic as the responses themselves were interpreted and responded to-thus contributing to subsequent amplification or attenuation. Eventually, the "ripple effects" dampened as risks on both sides reached acceptable levels and the intensity of the conflict decreased.

As it has been noted, the cities of Waco, Hewitt, and Lorena used their influence to gain access to the newspaper owners (Waco Tribune-Herald). Editorials were written minimizing the risks of the plant to the creek but emphasizing the risks to the general community if the permit was denied. Based on letters to the editors, this resulted in community support for the project from unaffected county residents. In response, Alliance activists increased their efforts resulting in more coverage of the conflict in the news section of the paper. Based on the published letters to the editors and posted online comments pertaining to the online newspaper articles, support for the Alliance from

unaffected county residents increased. This may have been partially due to the historically strong distrust for Waco found in the surrounding communities.

6.3. The Role of Trust

Trust is difficult to establish and easily lost, yet it is a necessary condition of life that people trust others. This critically important aspect of human relationships affects risk perception, public policy development, negotiations associated with public policy, and implementation of public policies. Ancient cultural texts contain references to the value of trust and contemporary negotiating theories prominently emphasize the importance of trust in relationships (Fisher, Ury, & Patton, 1991). Specifically, when trust in the level of expertise, the morality and the ethics of the other party, or parties, is present, there is a greater probability that mutually beneficial transactions, and agreements can be reached more efficiently than when it is absent or diminished (Cvetkovich & Lofstedt, 1999, p. xii).

In the past, the siting and construction of waste disposal facilities in Waco was a decision made by authoritarian decision makers; public opinion, local impacts, and potential risks were irrelevant with the result being a profound lack of trust on the part of the public. Primarily as the result of large environmental disasters, the public demands, and has been legally allowed, a larger voice in the siting of waste facilities. When there is a high level of trust afforded to those involved in the project planning and implementation, positive outcomes are more likely because of the lower perceived risk. In this case, trust was absent from the beginning and perceived risk on the part of the

Bull Hide residents was high. Had their been no perceived risk, there would not have been opposition to the proposed plant.

The lack of trust between the WMARSS and stakeholders opposed to the sewer project was a frequently mentioned topic. One of the most outspoken members of the Alliance, Justice Felipe Reyna of the Texas 10th Court of Appeals, repeatedly accused Waco of being unethical and untrustworthy ("lying deceitful, hypocritical scoundrels") and others repeated the same charge that Waco could not be trusted (Doerr, 2008;"City's key concession's on Bull Hide creek," 2008). The following comments were typical of those found online and indicate strong perceived risk and lack of trust. All comments are from letters to the editor of the Waco Tribune-Herald. Spelling and grammar are as in the original.

April 13, 2008

Writer #1

> I wonder if there is a more sinister plan here by the City of Waco. If you have not noticed pay close attention because over the past 10+ years the City of Waco has pushed its greedy fingers out to every middle to upscale neighborhood from China Spring, to McGregor, to Speegleville, with future plans to annex parts of Chalk Bluff. I don't know the answers but I will pose these questions. Would this City owned property allow Waco to begin annexing from there or make it easier to move their City limits out to that area because they already own the land? And, would that land give them an ETJ? If this gives Waco priority on any front then Cities beware.

Writer #2

> We heard how the sewer was going to be put by Big Creek Construction, but Big Creek nixed that. WE heard that it was going to be placed close to Larry Groth's home place, and he nixed that. Now they bought 234 acres that was not for sale, closed on it, then told people about it two weeks after closing. Talk about "dirty dog tricks" and "good ole boy system," this project is the epitome.

> We will do everything we can to stop it. If not, I will make it my mission in life to try & sue the city of Waco and all the others for no less than $750 million. The city of Waco has a lot of other places in industrial areas, not residential, where this could be put. Why not over by Lipsitz Recycling on Loop 340 and use the state easement there? Our location is a horrendous idea.

During the 18 month period from the filing of the permit to the signing of the negotiated settlement, the level of distrust among the parties remained high and volatile. However, after the signing of the agreement, Alliance principals reluctantly accepted the level of perceived risk and provisional trust that had evolved through months of conflict and negotiations (The Yale Law School, 2013). Should an incident arise that requires re-negotiations, it is likely trust will have to be re-established between the parties before a successful agreement can be reached again (Kunreuther, Slovic, & MacGregor, 1996). As of April 2013, negotiations have not re-opened among the parties.

7. DISCUSSION AND CONCLUSIONS

This case study examined the effect of three intervening variables on the amplification and attenuation of perceived risk within a model based on the Social Amplification of Risk Framework. SARF is an interdisciplinary model developed by Kasperson et al. (1988) used to explain the subjective amplification or attenuation of risk perception. Risk in this context was considered to be the fear and uncertainty associated with something that is considered to be a threat; a threat was defined as something that may lead to an undesired consequence. Inherent in risk perception is the belief there are options and choices that may minimize or increase losses associated with that consequence. These options and choices are derived from risk information that individuals, institutions, and groups process through filters and then respond to rationally, minimizing the perceived risk as much as possible.

The application for a permit by WMARSS to discharge wastewater from a proposed sewage treatment plant created a threat to the community where the proposed plant was to be located. This risk event was defined as the independent variable. Three filters (resources, trust, and risk communication) were identified and categorized as the significant intervening variables affecting the responses of the stakeholders. A dynamic process affected by these three variables led to a policy outcome that minimized the total perceived risk for all stakeholders to an acceptable level. Opposition stakeholders were able to negotiate changes in the plant design, protection of public water supply lines, future construction of a public park on the site and monies for monitoring and debt service as well as other considerations (see Appendix G). WMARSS was satisfied with

the guarantee that no legal action opposing the plant would be taken until after the plant was operational and the general membership of the Alliance was relieved to return their normal lives. With the conflict resolved,TCEQ issued the permit to discharge wastewater (the dependent variable).

It is important to consider the influence perceived risk plays in the development and implementation of public water policy as it is a variable. However, because it is difficult to quantify, complex, and dynamic, public officials, and institutions may fail to fully consider its importance. In this case, the failure of the Waco Metropolitan Area Regional Sewer System to consider risk perception in their planning proved to be a costly mistake. Had they considered addressing and mitigating the potential, negative perceived risks, and concerns, of the Bull Hide community, the process may not have been as contentious or expensive. As it has frequently been observed, "perception is reality" and people respond to their perceived risks.

Woodrow Wilson wrote over a hundred years ago, "Public administrators, at least in theory, are responsible for conducting the public's business, acting in the public's interest, and conscientiously balancing formal agreements with the wisdom to do the right thing." Urban and regional planners have an additional responsibility-to responsibly balance the needs of those who are affected by policy decisions. They can only accomplish this objective through diligent inquiry based on moral integrity, democratic principles, and a sincere desire to consider the needs of private individuals as they strive to provide for public needs. Without exception, every project will have an element of perceived risk associated with it. Those planners and public officials who can

recognize, comprehend and successfully accommodate the perceived risk inherent in policy conflicts will be able to resolve and implement efficient, effective public policy among stakeholders.

"*It's not what you look at that matters, it's what you see."*

Henry David Thoreau

REFERENCES

Barigozzi, F., & Levaggi, R. (2010). Emotional decision-makers and anomalous attitudes towards information. *Journal of Risk and Uncertainty, 40*(3), 255-280. doi: 10.1007/s11166-010-9092-y.

Bartlett, T. (2007). Decentralized wastewater treatment: Promoting watershed health, recycling water upstream. http://www.ecoworld.com/other/decentralized-wastewater-treatment.html.

Beck, U. (1992). *Risk society:Towards a new modernity* (M. Ritter, Trans.). London, U.K.: Sage Publications.

Beder, S. (1993). From sewage farms to septic tanks: Trials and tribulations in Sydney. *Journal of the Royal Australian Historical Society, 79*(1 and 2), 72-95.

Berger, P., & Luckmann, T. (1966). *The social construction of reality: A treatise in the sociology of knowledge* (1st ed.). Garden City, N.Y.: Doubleday.

The Brazos River Authority. (2006). Timeline of the Brazos River Basin. http://www.brazos.org/brazosHistory.asp.

The Brazos River Authority. (2011). How many wastewater treatments are run by the BRA? *Waterschool.* Retrieved June 2, 2011, 2011, from http://waterschool.brazos.org/post/How-many-wastewater-treatment-plants-are-run-by-the-Authority-and-whom-do-they-serve.aspx.

Bos, P., Terburg, D., & Van Honk, J. (2010). Testosterone decreases trust in socially naive humans. *Proceedings of the National Academy of Sciences of the United States of America, 107*(22), 9991-9995.

Brody, S., Peacock, W., & Gunn, J. (2012). Ecological indicators of flood risk along the Gulf of Mexico. *Ecological Indicators, 18*(July), 493:500.

Bull Hide. (2008, April 6). Editorial, *Waco Tribune-Herald*.

Bull Hide Creek Clear Water Alliance. (2008). *Monthly meeting minutes*. Personal communication with Gary Penny, Lorena, TX.

Camia, C. (1994). Legislators draw in the reins on environmental rules. *Congressional Quarterly Weekly Report, 52*(17).

Caplin, A., & Leahy, J. (2001). Psychological expected utility theory and anticipatory feelings. *Quarterly Journal of Economics, 116*(1), 55-79. doi: 10.1162/003355301556347.

Cardona, C. (2011, October 18). More bad news about Texas drought: End not in sight, *The Texas Tribune*. Retrieved from http://www.texastribune.org/texas-environmental-news/water-supply/more-months-drought-ahead-texas/.

Carnegie, D. (1937). *How to win friends and influence people* (27th ed.). New York, N.Y.: Simon and Schuster.

Cheng, Y. K. (2009). Power and trust in negotiation and decision making: A critical evaluation. *Harvard Negotiation Law Review*. http://www.hnlr.org/2009/09/power-and-trust-in-negotiation-and-decision-making-a-critical-evaluation/.

City of Lorena. (2009). *Moratorium on sewer connections*. (152). Lorena, TX: City of Lorena Retrieved from http://www.ci.lorena.tx.us/DocumentView.aspx?DID=152.

City's key concessions on Bull Hide Creek. (2008, October 5). Editorial, *Waco Tribune-Herald*.

City of Waco Finance Department. (2009). *Comprehensive financial report*. Waco, TX.: City of Waco Retrieved from http://www.waco-texas.com/pdf/budget/Comp%20Annual%20Finance%20Report%202009.pdf.

Clemons, B. (2012,February 10). New sewer plant online, City Manager's report, *Lorena Leader*.

Codex, rules and guidelines for research. (2013, January 23). Retrieved March 26, 2013 from http://www.codex.vr.se/en/forskningmanniska.shtml

Committee on Risk Perception and Communication, N. R. C. (1989). *Improving risk communication*. Washington, D.C.: National Academy Press.

Court of Appeals of Texas, (2010). BMTP, L.P. v. City of Lorena, Appellee. No. 10-09-00146-CV. *http://www.supreme.courts.state.tx.us/ebriefs/11/11055403.pdf*.

Craig, L. (2002). Decentralized wastewater treatment: Community building and watershed agenda. *Water Engineering & Management, 149*(5), 14-20.

Cvetkovich, G., & Lofstedt, R. (Eds.). (1999). *Social trust and the management of risk*. London, U.K.: Earthscan.

Dake, K. (1991). Orienting dispositions in the perception of risk: An analysis of contemporary worldviews and cultural biases. *Journal of Cross-Cultural Psychology, 22*, 61-82. doi: DOI: 10.1177/0022022191221006.

Denney, D. (2005). *Risk and society*. London, U.K.: Sage.

Dennis, R. (2009, July 1). McLennan county commissioners speak out against Bull Hide creek sewage plant, *Waco Tribune-Herald*. Retrieved from http://www.wmarss.com/Forms/07-01-2009-McLennan%20County%20commissioners%20speak%20out%20against%20Bull%20Hide%20Creek%20sewage%20plant.pdf.

Doerr, D. (2008, April 30,). Judge wades into fight, *Waco Tribune-Herald*.

Douglas, M., & Wildavsky, A. (1982). *Risk and culture: An essay on the selection of environmental and technical dangers*. Berkeley, CA.: University of California Press.

Engelberg, E., & Sjöberg, L. (2007). Money obsession, social adjustment, and economic risk perception. *Journal of Socio-Economics, 36*(5), 686-697. doi: 10.1016/j.socec.2007.01.005.

Erickson, B. (2001). Gene transfer in the environment. *Environmental Science & Technology, 35*(1), 20A-22A. doi: 10.1021/es012232j.

Etnier, C., et al. (2004). Overcoming barriers to evaluation and use of decentralized wastewater technologies and management *Wastewater treatment and reuse* (pp. 182). Alexandria, VA.: Water Environment Research Foundation.

Evatt, R. (2012, February 12). 2011 rough year for home builders, *Tulsa World.*

Fisher, R., Ury, W., & Patton, B. (1991). *Getting to yes: Negotiating agreement without giving in* (Second ed.). New York, N.Y.: Houghton Mifflin.

Flyvbjerg, B. (1998). *Rationality and power: Democracy in practice*. Chicago, Ill.: The University of Chicago Press.

Fox, G. (2011). Sewage plant foes, fans organize, *The Pasco Tribune.* Retrieved from C:\Users\Owner\Desktop\Sewage plant foes, fans organize TBO_com.mht.

Garrett, G. (2003). *Cycling: A novel* (1st ed.). New York, N.Y.: Kensington.

Gonzalez, B. (2009). County commissioners weigh in on water plant controversy, *Waco Tribune-Herald*. Retrieved from http://aistom/ynn.com/content/top stories/ 245165/county-commissioners-weigh-in-on-water.

Gordon, B. R., & Hartmann, W. R. (2013). Advertising effects in presidential elections. *Marketing Science, 32*(1), 19-35. doi: 10.1287/mksc.1120.0745.

Hague, R., Harrop, M., & Breslin, S. (1998). Comparative method *Political science: A comparative introduction* (2nd ed., pp. 272-287). New York, N.Y.: Bedford/St. Martin's.

Harder, R. (2002, October 23). Get out and vote for Measure C. *Council Corner.* Retrieved from http://www.fostercity.org/city_hall/council/Get-Out-and-Vote-For-Measrue-C.cfm.

HDR. (2010a). 2011 Brazos G regional water plan (pp. 2-1:2-42). Austin, TX.: Texas Water Development Board.

HDR. (2010b). Wastewater reuse (pp. 74). Austin: Texas Water Development Board.

Inglehart, R. (1997). Modernization, postmodernization and changing perceptions of risk. *International Review of Sociology, 7*(3), 449-459. doi: 10.1080/03906701.1997.9971250.

Inglehart, R. (2003). *Human values and social change*. Boston, MA: Brill.

Ingram, E. (2008, March 21). Sewage plant plan draws fire, *Waco Tribune-Herald*.

James Miertschin and Associates. (2008). *Response to TCEQ regarding tpdes permit no. Wq0014782001*. Austin, TX.

James Miertschin and Associates, & Paul Price Aquatic Ecology. (2007). Biological surveys of Bullhide Creek and North Fork Cow Bayou, McLennan county (pp. 20). Waco, TX.: Waco Metropolitan Area Regional Sewer System.

Jenkin, C. (2006). Risk perception and terrorism: Applying the psychometric paradigm. *Homeland Security Affairs, II*(2).

Kahan, D. (2008). Cultural cognition as a conception of the cultural theory of risk. In S. Roeser, R. Hillerbrand, P. Sandin & M. Peterson (Eds.), *Handbook of risk theory: Epistemology, decision theory, ethics, and social implications of risk* (2012 ed., pp. 1206): Springer Netherlands.

Kahan, D. (2012). Cultural cognition as a conception of the cultural theory of risk. In S. Roeser, R. Hillerbrand, P. Sandin & M. Peterson (Eds.), *Handbook of risk theory* (pp. 725-759): Springer Netherlands.

Kahan, D., Braman, D., Slovic, P., Gastil, J., & Cohen, G. (2007). The second national risk and culture study: Making sense of, and making progress in, the American culture war of fact. *Cultural Cognition Project* (pp. 20): Yale Law School.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), 263-291.

Kahneman, D., Tversky, A., & Slovic, P. (Eds.). (1982). *Judgment under uncertainty: Heuristics and biases*. Cambridge, U.K.: Cambridge University Press.

Kasperson, R., et al. (1988). The social amplification of risk: A conceptual framework. *Risk Analysis, 8*(2), 177-187.

Kasser, T., & Ryan, R. (1993). A dark side of the American dream: Correlates of financial success as a central life aspiration. *Journal of Personality and Social Psychology, 65*(2), 410-422.

Kelly, O. (2011, August 26). Huge public opposition to Portrane sewage site, *Irish Times*. Retrieved from http://www.irishtimes.com/newspaper/ireland/2011/0826/1224303004869.html

Kelman, H. C. (1958). Compliance, identification, and internalization: Three processes of attitude change. *The Journal of Conflict Resolution, 2*(1), 51-60.

King James Bible. Retrieved from http://www.kingjamesbibleonline.org/1-Timothy-6-10/.

Knight, F. (1921). Risk, uncertainty, and profit. Boston, MA.: Hart, Schaffner and Marx; Houghton Mifflin Co.

Kultgen, J. H. (July 10, 1975). [The history of the BRA wastewater program as told to Pat Kultgen].

Kunreuther, H., Slovic, P., & MacGregor, D. (1996). Risk perception and trust: Challenges for facility siting. *Risk Health, Safety and Environment, 7*, 109-118.

Lasswell, H. (1958). *Politics: Who gets what, when and how*. New York, N.Y.: Meridian.

Lindley, D. (2006). *Understanding uncertainty*. Hoboken, N.J.: Wiley-Interscience.

Loewenstein, G. (1987). Anticipation and the valuation of delayed consumption. *Economic Journal, 97*(387), 666-684.

Lorena City Council. (2009). Minutes. City of Lorena, TX.

Lyon, S. (2010). *Affidavit of steve lyon*. Austin, TX.

Mankiw, G. (2010). *Macroeconomics* (7th ed.). New York, N.Y.: Worth.

Mann, D. (2008, June 13). Solid waste. (Ed.). *TCEQ headquarters*. Austin, TX.

Marx, K. (1959). The power of money. *Economic and Philosophic Manuscripts of 1844.* Retrieved August 10, 2012, from http://www.marxists.org/archive/marx/works/1844/manuscripts/preface.htm..

Merriam-Webster. (2012). Influence. Retrieved August 26, 2012, from http://www.merriam-webster.com/dictionary/influence.

Moran, J. (2009, June 19). Letter to the editor, *Lorena Leader*.

Mundo and Associates. (2010). 2011-2021 McLennan county parks, recreation and open space master plan (pp. 205). Waco, TX.: McLennan County Commissioners Court.

Peters, G., & Hogwood, B. (1985). In search of the issue: Attention cycle. *The Journal of Politics, 47*(1), 238-253. doi: 10.2307/2131074.

Pidgeon, N., Kasperson, R., & Slovic, P. (Eds.). (2003). *The social amplification of risk*. Cambridge, U.K.: The Press Syndicate of the University of Cambridge.

Plato. (380 BCE). *The Republic* (B. Jowett, Trans.). Mineola, N.Y.: Dover.

Popper, F. (1985). The environmentalist and the lulu. *Environment, 27*(2), 6-11.

Public hearing on the permit no. Wq0014889001, TCEQ (2008) (Lorena, TX.).

Ramana, M. V. (2011). Nuclear power and the public. *Bulletin of the Atomic Scientists, 67*(4), 43-51.

Raven, B. (1965). Social influence and power. In I. D. Steiner (Ed.), *Current studies in social psychology* (pp. 552). New York, N.Y.: Holt, Rinehart and Winston.

Rippl, S. (2002). Cultural theory and risk perception: A proposal for a better measurement. *Journal of Risk Research, 5*(2), 147-165. doi: 10.1080/13669870110042598.

Rochelle, M., Castleberry, B., & Smith, M. M. (2006). Wastewater wars: Reuse projects in Texas (pp. 8). Austin, TX.: Water Environment Foundation.

Rogers, M., et al. (2007). The role of religious fundamentalism in terrorist violence: A social psychological analysis. *International Review Of Psychiatry, 19*(June:3), 253:262.

Ropeik, D., & Gray, G. (2002). *Risk: A practical guide for deciding what's really safe and what's really dangerous in the world around you*. Boston, MA.: Houghton Mifflin.

Ross, G. A. (2010). The basics of indemnification. *Intellectural Property Litigation, 21*(3), 7:8.

Schattschneider, E. E. (1983). *The semisovereign people*. Ft. Worth, TX.: Holt Rinehart and Winston, Inc.

Scott, S. (1993). The nature and effects of construction delays. *Construction Management & Economics, 11*(5), 358.

Shapiro, M. (2012, February 3). Bull Hide creek plant opens, clearing way for lorena development, *Waco Tribune-Herald*. Retrieved from http://www.wacotrib.com/news/money/138622119.html.

Sides, J. (2012). Mass shootings, gun control and short attention spans. Retrieved from The Monkey Cage website: http://themonkeycage.org/blog/2012/12/16/mass-shootings-gun-control-and-short-attention-spans/.

Singer, S. (2010). Retrieved from http://susansingerart.blogspot.com/2010/10/there-are-no-ugly-women-only-poor-women.html.

Slovic, P. (1987). Perception of risk. *Science, 236*(4799), 280-285.

Slovic, P., Peters, E., Finucane, M., & MacGregor, D. (2005). Affect, risk, and decision making. *Health Psychology, 24*(4, Supplement 1), S35.

Smith, J. B. (2008a, September 3). Residents speak out against sewer plant, *Waco Tribune-Herald*.

Smith, J.B. (2008b). Sewage spills give plant opponents ammo, *Waco Tribune Herald*.

Smith, J.B. (2009a, February 4). Bill to clean up debris along Bull Hide creek: $115,000, *Waco Tribune-Herald*. Retrieved from http://www.wacotrib.com/news/content/news/stories/2009/02/04/02042009wactires.html.

Smith, J.B. (2009b, March 22). Lorena judge wants to end city manager post, be mayor, *Waco Tribune-Herald*.

Smith, J. B. (2009c, February 22). New landfill near contested sewer plant?, *Waco Tribune-Herald*.

Starr, C. (1969). Social benefit versus technological risk. *Science, 165*(3899), 1232-1238.

Statement of Larry Todd, Deputy Commissioner Bureau of Reclamation on HL 609, United States Senate 110 (2007).

Statement of Larry Todd, Deputy Commissioner of the Bureau of Reclamation, United States Senate, July 27, 2006 109 Sess. (2006).

Nonpoint source pollution: The impacts of agriculture on water quality, United States Congress, 110 Sess. 381 (2007).

Talbert, S. (2008). Sewage plant complaint filed with epa. *2011 WorldNow*. http://www.kxxv.com/story/8555877/sewage-plant-complaint-filed-with-epa?clienttype=printable&redirected=true.

Testimony of Larry Groth, City Manager of the City of Waco, United States Senate Committee on Energy and Natural Resources. Washington, D.C. August 1, 2001.

Teuber, A. (1990). Justifying risk. *Daedalus, 119*(4), 235-254.

Texas Commission on Environmental Quality. (2009). *Public hearing on the permit*.

Texas Commision on Environmental Quality. (2010). *Annual enforcement report*. Austin: Retrieved from http://www.tceq.state.tx.us/compliance/enforcement/reports/AER/annenfreport.html.

Texas Commission on Environmental Quality. (2009). Executive director's response to public comment (pp. 84). Austin, TX.: Texas Commission on Environmental Quality.

Texas Commission on Environmental Quality. Definitions and permit standards. TCEQ. (2012). Title 30 Texas Administrative Code (TAC) Chapter (§) 305.

Texas Legislature. (2011). Texas water development bonds amendment, proposition 2. *Ballot*Pedia.* Retrieved November 16, 2011, 2011, from http://ballotpedia.org/wiki/index.php/Texas_Water_Development_Bonds Amendment,_Proposition_2_(2011).

Texas State Comptroller. (September 2002). The Central Region outlook. *Window on state government.* Retrieved April 24, 2012, from http://www.window.state.tx.us/ecodata/regional/central/counties/mclennan.html.

Texas State Historical Association. (1999). Bull Hide creek. *The Handbook of Texas Online*, 1. http://www.tshaonline.org/handbook/online/articles/rbbnb.

Tietenberg, T. (2006). *Environmental and natural resource economics* (Seventh ed.). Boston, MA.: Pearson Education.

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science, 211*(4481), 453-458. doi: 10.1126/science.7455683.

The United States Government. (2009). 45 cfr 46. Retrieved March 26, 2013, from http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.html#46.111.

United States Census (Cartographer). (2013). Map of texas. Retrieved from http://quickfacts.census.gov/qfd/maps/texas_map.html.

United States Census Bureau. (2012). State and county quick facts. from http://quickfacts.census.gov/qfd/states/48/48309.html.

Venhuizen, D. (2010). Pat Kultgen. *Decentralized wastewater treatment* (pp. 2).

Waco Metropolitan Planning Organization. (2010). *McLennan county future land use study*. Waco, TX.: City of Waco.

The Wallace Group. (2001). *Comprehensive plan 2000*. Waco, TX.: City of Waco Retrieved from http://www.waco-texas.com/planning.asp.

Wedeen, R. P. (2000). Consent in epidemiology: Implications of history for public policy. *Archives Of Environmental Health, 55*(4), 231-239.

Wernimont, P., & Fitzpatrick, S. (1972). The meaning of money. *Journal of Applied Psychology, 56*(3), 218-226. doi: 10.1037/h0058484:10.1037/h0033107.

WMARSS. (2012). History of the Waco Metropolitan Area Regional Sewerage System. Retrieved September 10, 2012, from http://www.wmarss.com/history.htm.

WMARSS (2013). Aerial of Bull Hide Creek WWTP (Vol. 1.8 mb). Waco, TX.: City of Waco water utility services.

WMARSS representatives, & BHCCWA representatives. (2008). First negotiation between parties. Texas State House Rep. Doc Anderson's office.

Wolfe, R., & McGinn, K. (2005). Perceived relative power and its influence on negotiations. *Group Decision & Negotiation, 14*(1), 3-20. doi: 10.1007/s10726-005-3873-8.

The World Values Survey. (2012). Retrieved June 28, 2012, from http://www.worldvaluessurvey.org/index_html.

The Yale Law School. (2013). The cultural cognition project. Retrieved March 20,2013, from http://www.culturalcognition.net/.

APPENDIX A

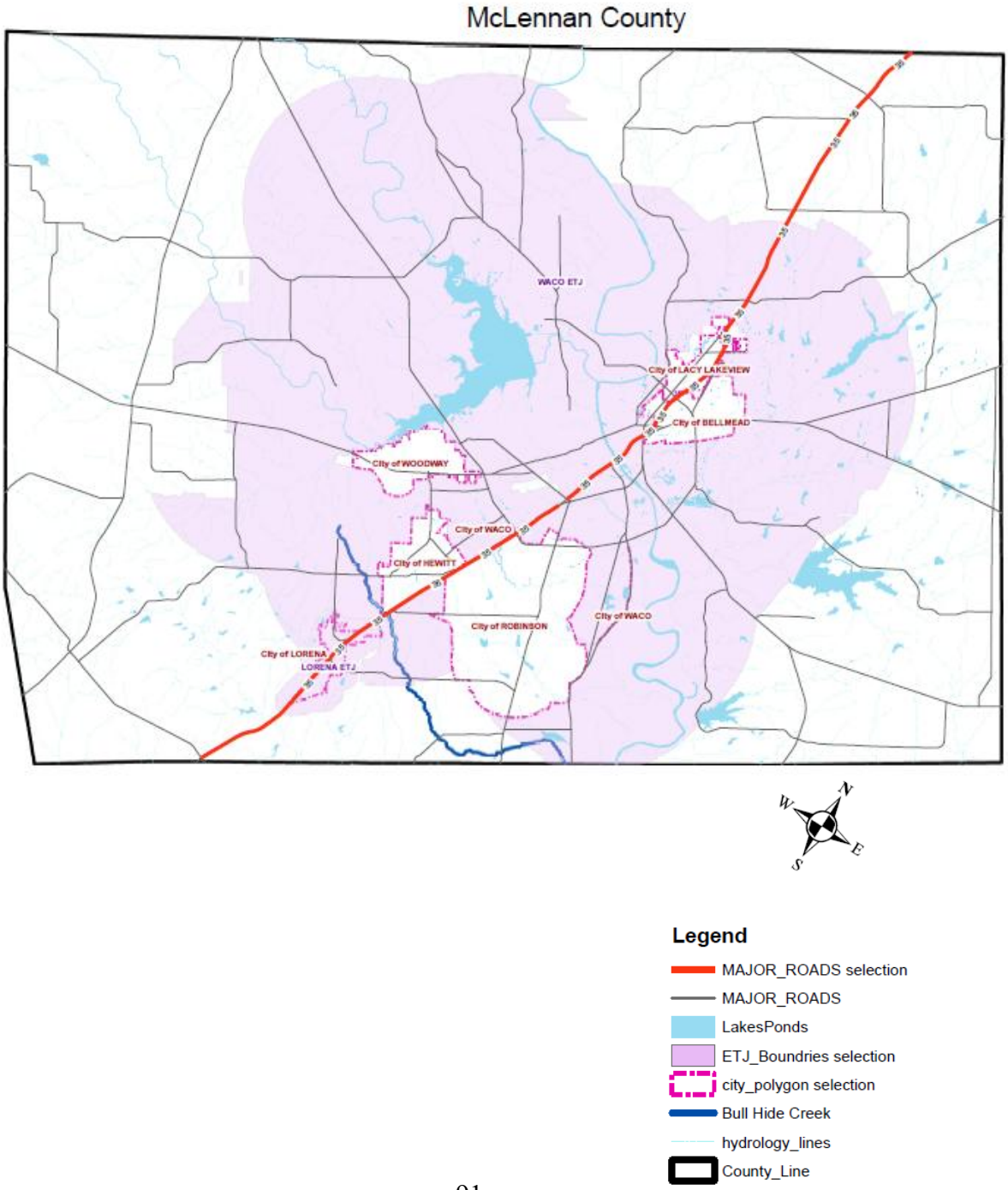
LOCATION OF MCLENNAN COUNTY IN TEXAS

(UNITED STATES CENSUS, 2013)

APPENDIX B

LOCATION OF BULL HIDE CREEK IN MCLENNAN COUNTY

(GANDESBERY & KULTGEN, 2011)



APPENDIX C

LOCATION OF WASTEWATER TREATMENT PLANT ON BULL HIDE CREEK

(WMARSS, 2013)

APPENDIX D

BULL HIDE CREEK WASTEWATER TREATMENT PLANT, 2011

(WMARSS, 2013)

APPENDIX E

DEMOGRAPHICS OF MCLENNAN COUNTY

(Texas State Comptroller, 2002; United States Census Bureau, 2012)

Population	**2000**	**2010**
McLennan County	213,517	234,906
Population Density Per Square Mile	205	226.5
Ethnicity		
Percent White	72.17%	69.80%
Percent Hispanic	17.91%	23.60%
Percent African American	15.19%	14.80%
Percent American Indian and Alaska Native	0.49%	0.60%
Percent Asian	2.00%	1.40%
Percent Native Hawaiian and Other Pacific Islander	0.05%	0.00%
Other	9.21%	13.40%
Age		
18 and under	26.60%	25.40%
20-24	9.70%	9.89%
25-64	46.00%	47.86%
65 and Older	12.90%	12.50%
85 and Older	1.70%	1.80%
Median Age	31.9	32.7
Income		
Per Capita Income - Texas Comptroller	$22,878.00	$20,652
Household	$78859	$82,998
Median Household Income	$33,560.00	$39,620
Median income for males	$30,906.00	$34,568
Median income for females	$21,978.00	$27,680
Percent of Population in Poverty	17.60%	21.30%
Percent of Population under 18 in Poverty	20.70%	29.40%
Unemployment Rate	4.20%	7.40%
County Finances		
Total County Tax Rate	$0.4407	$0.4643
Total Market Value	$6,889,188,625	$14,215,702,244

APPENDIX F

PROJECTED GROWTH OF HEWITT, LORENA AND WACO

HDR 2011 Brazos G Regional Water Plan (HDR, 2010a, p. 2.7)

	Hewitt	Lorena	Waco
1990	8,983	1,158	103,590
2000	11,085	1,433	113,726
2010	12,667	1,640	121,355
2020	14,262	1,849	129,046
2030	15,606	2,025	135,528
2040	16,999	2,207	142,247
2050	17,884	2,323	146,514
2060	19,170	2,491	152,715
pct. Growth	0.92%	0.93%	0.94%

My calculations resulted in different predicted growth percentages for the 70 year period.

Hewitt: 113.40%

Lorena: 115.11%

Waco: 47.42%

APPENDIX G

NEGOTIATED SETTLEMENT

SOAH DOCKET NO. 582-09-1149;
TCEQ DOCKET NO. 2008-1742-MWD
BULL HIDE CREEK TPDES APPLICATION NO. WQ0014889001
MEMORANDUM OF AGREEMENT IN PRINCIPLE
SEPTEMBER 17, 2009

This entire document represents the agreement of each and every one of the Aligned Protestants and the Applicant Cities (the "Cities"), as reflected in the signature block below (collectively, the "Parties")(this "Agreement"). This Agreement reflects the consideration of the mutual promises, covenants, obligations, and benefits between and among the Parties, to resolve disputes pending before the State Office of Administrative Hearings based on the settlement conference on September 17, 2009. The Parties agree to recommend this Agreement be approved by their respective family members, governing board(s) or city council(s) no later than October 9, 2009. Upon adoption by the respective family members, board(s) and city council(s), this Agreement shall become an enforceable contract and a Rule 11 Agreement pursuant to the Texas Rules of Civil Procedure.

The Parties agree to provide a status report to SOAH by October 13, 2009. If this Agreement is not fully executed by October 9, 2009, the Parties will cooperate to schedule remaining depositions and pretrial events, and continue preparations for a hearing on the merits during the week of October 26, 2009. Contemporaneous with approval by all of the Parties and their respective family members, governing board(s) and council(s), the Parties agree to file a joint motion to dismiss this matter from SOAH and remand the application that is the subject-matter of the pending SOAH hearing to the TCEQ Executive Director for issuance of a final permit. Each and every one of the protestants agree not to seek, prior to December 31, 2012, to impair the progress of the permitting and any and all other activities associated with the WMARSS cities' Bull Hide Creek Wastewater Treatment Plant (the "Bull Hide Plant").

1. <u>Construction of off-channel wetland, revised permit limits for phosphorus and "nitrate-nitrogen," and reuse water</u>

a. Wetland

The Cities acknowledge they will construct a wetland (a/k/a "bonus feature" or "open splice") at the Bull Hide Plant site, subject to further conditions stated in this paragraph. The Aligned Protestants are hopeful that the Cities will seek input from Baylor University. The Cities will send effluent through the wetland for additional polishing prior to discharge to Bull Hide Creek. The Cities' agreement and this Agreement are contingent on (1) TCEQ's decision that the addition of the wetland will not impact significantly the terms and conditions of the current draft permit or cause an unacceptable delay in the issuance of the permit and (2) authorization by the Corps of Engineers, if necessary. It is the Parties' position that the wetland would not be considered a part of the treatment process pursuant to the permit, that the point of compliance (i.e., sampling) occurs before the effluent moves through the wetland and into the creek, addition of a wetland will not cause a significant change in the terms and conditions of the

draft permit or cause an unacceptable delay in permit issuance, and there is no commitment by the Cities to monitor or specify the level of nutrient removal from the wetland. It is recognized that this wetland will serve as a buffer for any upsets or overflows and be capable of holding three days' average-day flow of treated effluent.

b. Reuse Water for Irrigation.

The Cities agree to make available reuse water from the Bull Hide Plant for irrigation of the ball fields or other recreational areas that may be constructed on property to be provided to the County as a park (see item 5 below), provided, however, that this does not include the costs of designing, permitting and constructing the infrastructure necessary for such reuse and that the reuse water will be billed at a reasonable rate to be approved by the Cities.

2. Minimizing noise, light, odors, and sludge processing

The Cities agree to include the following design specifications minimizing light, noise and odor impacts that are consistent with maintaining adequate safety, security and operations at the facility:

a. Control and minimize broadcast lighting and use directional lighting in lieu of broadcast light, except where necessary for operational activities, access/egress and ingress, and the security of the site.

b. Minimize sound from operations by housing those mechanical operations that are reasonably capable of such.

c. It is recognized that the design and sludge disposal authorized by the draft permit will in and of itself help control odor. Sludge handling will occur within an enclosure, and plant head works will be designed to maintain negative air pressure over the flows.

d. The Cities will not process or dispose of wastewater treatment plant sludge at the Bull Hide Plant site, other than insofar as it is necessary to handle sludge generated at that plant so that it may be economically transported to other WMARSS sites for treatment and disposal or sale.

3. Cash consideration

The Cities agree to make five (5) annual payments to the Aligned Protestants to fund instream nutrient monitoring of Bull Hide Creek at three locations. Unless counsel for the Cities

receives from counsel for the Aligned Protestants on or before October 2, 2009, a written objection, the annual payments will be $10,000 each. The first payment shall be made approximately 60 (sixty) days prior to plant coming on-line and able to discharge, and in each of the following four (4) years payments shall be made no later than January 20th. Payments to the Aligned Protestants shall be made to Levi Water Supply Corporation and the Bull Hide Creek Clear Water Alliance (the "Alliance"), who agree to receive these funds on the Aligned Protestants' behalf. Levi WSC and the Alliance will receive and utilize such funds as agreed to by the Aligned Protestants, presumably for the purposes of instream monitoring, provided however, the Cities will place no limitations on the purpose and ultimate recipients of these funds. It is recognized that the Cities will have no responsibility related to instream monitoring. It is also recognized that the Cities will have no duty or responsibility, other than any that would be imposed by TCEQ or EPA, to modify, amend or otherwise alter the Bull Hide Plant or the final permit to be issued by TCEQ for the plant, or take any other action based on any instream monitoring results collected by Levi Water Supply Corporation and/or any of the Aligned Protestants.

4. Replacement of Levi WSC well and water lines

The Cities agree to case (or provide other modifications mutually agreed to by the Parties) Levi WSC's water distribution lines that run beneath Bull Hide Creek at Rosenthal Parkway (2) and Levi Parkway (2). This Agreement does not affect financial responsibility for relocating Levi WSC's well, were that to become necessary because of decisions of TCEQ pursuant to 30 TAC Sec. 290.41(c)(1)(B).

5. 230-acre tract deed restrictions, use as a park, and possible conveyance of acreage adjacent to Brodine Family's property

The Cities will agree to file deed restrictions for property that will not to be used for the Bull Hide Plant that will limit land use to agricultural, parkland, residential use, and/or greenbelt. The Cities also agree to offer a long-term lease to McLennan County for approximately 40 (forty) acres with some frontage on Cooksey Lane for a community park project; provided, however, that the County must adopt a new resolution supporting the project as modified by the terms of this mutually acceptable settlement proposal prior to the Cities executing such a lease. If it is necessary to secure grant funding for the park's development, the Cities agree to participate in good faith with the County in seeking the grant funding. The Applicants agree to place on the agenda for consideration to their respective governing board and council(s) to convey at a reasonable, mutually agreed price some portion of acreage on the west side of the creek (across from the Bull Hide Plant) to the Brodine Family.

6. Plant staffing

The Cities can agree to having an appropriately licensed operator within 20 (twenty) minutes of the Bull Hide Plant at all times, and that the design will include telemetry equipment standard in the industry.

7. Severability; Waiver

If any provision of this Agreement is illegal, invalid, or unenforceable, under present or future laws, it is the intention of the Parties that the remainder of this Agreement not be affected, and, in lieu of each illegal, invalid, or unenforceable provision, that a provision be added to this Agreement which is legal, valid, and enforceable and is as similar in terms to the illegal, invalid or enforceable provision as is possible.

8. Waiver

Any failure by a Party to insist upon strict performance by the other Party of any material provision of this Agreement will not be deemed a waiver of that or of any other provision, and a Party may at any time thereafter insist upon strict performance of any and all of the provisions of this Agreement.

9. Applicable Law and Venue

The interpretation, performance, enforcement and validity of this Agreement is governed by the laws of the State of Texas. Venue will be in a court of appropriate jurisdiction in McLennan County, Texas.

10. Entire Agreement

This Agreement contains the entire agreement of the Parties. There are no other agreements or promises, oral or written, between the Parties regarding the subject matter of this Agreement. This Agreement can be amended only by written agreement signed by the Parties. This Agreement supersedes all other agreements between the Parties concerning the subject matter.

11. Dismissal of SOAH Docket

The Aligned Protestants, collectively and individually agree that the Cities may file the attached executed letter at Exhibit A withdrawing their protests of the Application, upon the full execution of this Agreement.

EXECUTED IN DUPLICATE ORIGINALS by the following representatives duly authorized by their respective governing board(s) and council(s):

APPLICANT CITIES BELLMEAD, HEWITT, LACY LAKEVIEW, LORENA, ROBINSON, WACO AND WOODWAY

By: CITY OF WACO, as contract operator and participating city in the Waco Metropolitan Area Regional Sewer System

By: _____
Wiley Stem, III, Assistant City Manager
Chair, WMARSS Advisory Board

ALIGNED PARTIES

By: _____
Janet Brodine

By: _____
John Brodine

By: _____
Cheryl Reyna

By: _____
Felipe Reyna

BULL HIDE CREEK CLEAR WATER ALLIANCE

By: _____
Kevin Helpert, Its Chairman

LEVI WATER SUPPLY CORPORATION

By: _____
Purdis Medlin

By: _____
Jim Sheffield

EDNA HUGHES

By: Dewey Jackson

Counsel for Applicant Cities

Counsel for Bullhide Creek Clear Water Alliance and Levi WSC and Designated Representative for other Aligned Protestants

EXHIBIT A

Ms. LaDonna Castañuela, Chief Clerk
Texas Commission on Environmental Quality
Office of Chief Clerk MC-105
P.O. Box 13087
Austin, Texas 78711-3087

Re: SOAH Docket No. 582-09-1149; TCEQ Docket No. 2008-1742-MWD

Dear Ms. Castanuela:

Based on the attached settlement agreement, _____ withdraws its protest in the above-referenced proceeding with prejudice. The listed parties no longer wish to be a party in this proceeding. Thank you for your time and attention to this matter.

Sincerely,

Enclosure: Copy of Settlement Agreement

cc: Attached Service List

The copy of the settlement agreement sent to me under the Texas Public Information Act is above. It did not show a signature or date.

APPENDIX H

ENGINEER'S REPORT ON PLANT PROBLEMS, APRIL 2012

BULL HIDE CREEK WASTEWATER TREATMENT PLANT CHALLENGES AND STARTUP OF THE STATE'S NEWEST PLANT WITH PHOSPHORUS LIMITS

Paul Wood P.E., Sarah M. Berkey P.E., Meredith G. McCullough P.E., Michael Jupe
Lockwood, Andrews & Newnam, Inc.
2925 Briarpark Drive, Suite 400
Houston, TX 77042

OVERVIEW

The Bull Hide Creek Wastewater Treatment Plant (WWTP) is located in Lorena, Texas, and is owned and operated by the Waco Metropolitan Area Regional Sewer System (WMARSS), a joint wastewater treatment effort established by the Cities of Bellmead, Hewitt, Lacy Lakeview, Lorena, Robinson, Waco, and Woodway. By sharing centralized service facilities among its member cities, WMARSS has helped to reduce the potential environmental impacts associated with the development of multiple wastewater treatment plants, each dedicated to a single entity.

Further, its regionalization efforts have contributed to the protection and preservation of numerous natural resources. Finally, the planning and development of regional facilities has resulted in a reduction in the costs associated with wastewater collection, treatment and disposal, which has assisted the WMARSS member entities in maintaining affordable rates for their customers.

As the newest addition of the WMARSS system, the Bull Hide Creek WWTP began operation in February of 2012. The facility serves the cities of Lorena and Hewitt and allows a portion of the load previously treated at the WMARSS Central WWTP, as well as the City of Lorena's existing WWTP (which is being decommissioned), to be offloaded. The facility was designed to treat an average daily flow rate of 1.5 million gallons per day (MGD) and a peak two-hour flow rate of 4,167 gallons per minute (GPM).

The plant's current Texas Pollutant Discharge Elimination System (TPDES) effluent discharge permit, issued by the Texas Commission on Environmental Quality (TCEQ), contains a daily average phosphorus limit of 1.0 mg/l and CBOD/TSS/NH3N limits of 7/15/3 mg/l, respectively. The plant is designed to obtain the stipulated phosphorus limits biologically, with chemical backup.

Several challenges were encountered during plant startup, and in the early stages of facility operation. One of these difficulties involved identifying and transporting sufficient quantities of water suitable for equipment and systems testing. Another concern stemmed from the actual flows initially received at the plant, which equated to approximately eight (8) percent of the assumed 1.5 MGD design flow, as compared to the one-third originally estimated during design. This drastic reduction in flows impacted the number of units required to be on-line to facilitate actual treatment, as well as the schedule for performance testing of the entire plant.

Another challenge associated with the plant's startup was the overall fine-tuning of the treatment process to achieve full compliance with the mandated TCEQ discharge permit requirements. Finally, the facility's unique sludge processing concept necessitated the implementation of an iterative procedure during startup to confirm sludge concentration and transport capability. Ultimately, the aforementioned factors, in conjunction with the initial phosphorus treatment results and their comparison to predicted performance proved to be of particular interest.

KEYWORDS

Wastewater, Phosphorus, Startup

INTRODUCTION

Lockwood, Andrews & Newnam, Inc., (LAN) was originally retained by WMARSS to lead a master planning effort for the entity's wastewater systems. Wastewater planning needs were predicated using the service area limits of the existing system, in conjunction with the projected growth of the member cities. Chief among its findings, the master plan recommended that a portion of the system flow be offloaded, and subsequently treated at a new satellite wastewater treatment facility, in order to adequately service anticipated future growth.

Several locations for the satellite plant were considered as part of the master planning process. Ultimately, a location at the south end of the system near Bull Hide Creek was decided upon, as it allowed the most southern portions of the system (Lorena and a part of Hewitt) to be served. The location of the proposed facility proved to be somewhat contentious. This was clearly demonstrated by its formally protested permit, and the lengthy litigation process that followed.

The permit for the proposed Bull Hide Creek WWTP was ultimately issued by the TCEQ; however, several concessions were made by WMARSS to alleviate the concerns expressed by the protestants during the permitting process. These included:

- Elimination of onsite sludge processing

- Inclusion of a bonus feature (pond area, similar to a wetlands, following the plant discharge location, but not part of the treatment train)
- Provisions to treat phosphorus to 1 mg/l concentration levels (despite the fact that modeling by TCEQ indicated that phosphorus discharge at normal effluent limits was not a concern in the receiving waters)

In addition, the plant was designed to be instrumented to a fairly high level, allowing for remote monitoring and control from the existing Central WWTP, as it was the desire of WMARSS that the facility be manned at a minimal level, requiring infrequent operator attention.

PLANT STARTUP

A number of challenges were encountered during the startup of the proposed Bull Hide Creek WWTP, the first of which was identifying a sufficient source of water for use in equipment testing. As a grass roots facility, the plant did not have a supply of treated effluent available for the contractor's use in filling basins and conducting operational testing. Moreover, the plant's potable water service is supplied by a local water system provider known as the Levi Water Supply Corporation, whose small size meant that it did not have sufficient capacity to supply the quantity of water needed to facilitate startup testing.

A connection to another water supply system owned by the City of Waco was also considered; however, this service stopped approximately a mile away from the plant, making it uneconomical. Ultimately, a small existing well located on the new plant property was used to fill the basins over an extended period of time. By recycling the well water, the general contractor was able to conduct all equipment tests required to demonstrate mechanical operation and enable operator training.

Another impact to plant startup operations arose from the physical transport of wastewater flows from the cities of Lorena and Hewitt to the new facility. In particular, two sanitary sewer interceptor projects, each slated to accomplish the conveyance of flow from Lorena and Hewitt, respectively, were being completed by separate general contractors in parallel with plant construction.

The original timing of the interceptor projects was supposed to allow for their completion prior to that of the plant; however, delays to both ultimately resulted in the plant being competed first. The Lorena interceptor was completed first, with the Hewitt interceptor following by approximately six weeks. This resulted in a very low initial flow to the plant during its startup phase.

The contract documents for the treatment plant project required a continuous 14 day performance test of the facility, in order to ascertain its ability to comply with the provisions specified in its TPDES effluent discharge permit. To accomplish this

requirement with only the initial flow provided by the Lorena interceptor, adjustments to the expected plant startup operations became necessary.

Specifically, the existing Lorena plant was drained by pumping flow directly from the facility's secondary clarifier to the new interceptor line through a newly constructed onsite lift station, which was completed in conjunction with the interceptor project. Flow to the Lorena plant was approximately 120,000 GPD during this period. Based on the installed lift station capacity, it was estimated that the entire Lorena plant volume and incoming flow could be transferred by continuous pumping within two to three hours.

The available flow from Lorena proved to be quite a challenge, considering that the total combined volume of the new wastewater treatment plant's biological nutrient removal (BNR) basins is approximately 1.13 million gallons (divided between two process trains). Moreover, each secondary clarifier has a volume of approximately 405,000 gallons, and the facility's tertiary disc filters and ultraviolet light (UV) disinfection system also have basins necessitating flow.

Ultimately, based on the available flow and required basin volumes, it was determined that it would take more than a week to fill the required process units of a single treatment train with wastewater flows coming only from Lorena. Therefore, it was decided that plant startup would be undertaken with the basins still full of the well water used by the contractor for equipment testing and training.

Running a single train reduces the plant's capacity by half, or to 0.75 MGD; however, the startup flow (and thus the facility loading) was only 16 percent of that capacity, which is extremely low. To maintain a treatment regime that was somewhat workable, wasting was carefully controlled,
in order to sustain a reasonable food to mass (F/M) ratio within the treatment process, and to maximize phosphorus removal. Despite these measures, the low influent load resulted in the production of very thin mixed-liquor sludge.

In addition, the low flow within the process meant that the water was moving extremely slowly though the operational treatment train. This generated concerns that there might be issues with algae growth in the anoxic basins, secondary clarifiers, and disc filter basins where the water would be fairly quiescent. Provisions for alternate internal recycle points were implemented by partially opening plant drains to return flow to the onsite lift station, to allow the plant operators to keep the water within the plant circulating.

BioWin 3.1 process modeling conducted in advance of plant startup to simulate the modified influent flow conditions, indicated that some phosphorus removal could be achieved within the biological process, despite the non-ideal regime; however, the model results also implied that the mandated discharge limits for phosphorus could not be

achieved by biological treatment alone. Fortunately, an alum system was also provided as a chemical backup to the biological process for phosphorus removal.

In addition to controlling phosphorus, the use of the alum system also aided the clarification process. Further, the tertiary filtration system facilitated effluent solids removal and compliance with established discharge permit limits. As only one treatment train could be run at a time due to the low initial flow, two sequential 14 day performance testing periods, one for each train, were required to fully comply with the contract terms.

Wastewater flows from Hewitt began treatment at the Bull Hide Creek WWTP approximately six weeks after those from Lorena. The entity's initial flow was approximately 310,000 GPD. However, as smaller lift stations in the southern part of city are taken offline, and their flow diverted to the new Hewitt lift station, which transports flow via the new interceptor to the plant, the municipality's total flow contribution is estimated to increase to 660,000 GPD by the summer of 2012. This will bring the total plant flow up to approximately 0.78 MGD.

PROCESS MODELING

A limited analysis of influent constituents was conducted in conjunction with the proposed Bull Hide Creek WWTP design. The results of this analysis are presented in Table 1 that follows.

Table 1 – Bull Hide Creek WWTP Influent Data

Sample Location	BOD_5 (mg/l)	TSS (mg/l)	NH_3-N (mg/l)	TKN (mg/l)	Total P (mg/l)	O&G (mg/l)
Lorena Bar Screen	235	204	22.1	35.1	8.22	40.2
Lorena Bar Screen	207	212	43.5	61.0	10.11	36.1
Lorena Bar Screen	225	170	33.1	58.0	7.50	36.8
Hewitt Lift	204	220	23.7	35.0	5.51	37.3
Hewitt Lift	178	72	22.5	36.5	5.93	18.7
Hewitt Lift	153	92	27.1	38.6	6.06	31.6

Table 1 Legend:

- BOD5 = Five-Day Biochemical Oxygen Demand
- TSS = Total Suspended Solids
- NH3-N = Ammonia Nitrogen
- TKN = Total Kjeldahl Nitrogen
- Total P = Total Phosphorus
- O&G = Oil and Grease
- mg/l = Milligrams per Liter (concentration of a particular wastewater characteristic)

It is notable that previous influent BOD testing for Lorena had indicated abnormally high results. Based on this information, it was originally thought that there may have been an issue with unauthorized dumping within the sewer system; however, subsequent investigations by the city determined that the method in which grab sampling was being conducted was having a
significant impact on the analytical results.

With the aforementioned Lorena BOD loading issue clarified, reasonably conservative values were selected, using the data from Table 1 as a guide, as the influent concentration characteristics for the proposed Bull Hide Creek WWTP. These values were as follows:

- Five-Day Carbonaceous Biochemical Oxygen Demand (CBOD5) = 250 mg/L
- TSS = 250 mg/L

- Volatile Suspended Solids (VSS) = 195 mg/L
- TKN = 40 mg/L
- Total P = 12 mg/L

Using these influent parameters, as well as basin sizing information derived using the TCEQ's prevailing Chapter 217 wastewater treatment plant design criterion, a BioWin 3.1 process model was constructed for the proposed facility. The model was subsequently used to analyze the plant's anticipated performance under varying flow and loading conditions.

In particular, a sensitivity analysis was performed wherein flow, clarifier underflow to overflow ratio, internal recycle, wasting rate, and temperature were all varied, in order to assess the plant's ability to perform under different circumstances. In addition, this analysis provided insight with regard to the optimal conditions for plant performance.

In addition to the influent characteristics discussed in the previous paragraphs, consideration was also given to the assumed kinetic values to be incorporated into the model. As the proposed Bull Hide Creek WWTP is a grass roots facility, and neither the existing WMARSS Central WWTP nor the Lorena WWTP, which could have been used as a source for seed bacteria, operates as a BNR facility, it was determined that the standard default kinetic values supplied with the BioWin package should be utilized when running the various model simulations.

While it is understood that good predictions of actual effluent concentrations cannot be expected without thorough and iterative fine-tuning of the model, this was not the intention of the sensitivity analysis. Its purpose was to establish a relative level of comfort that the proposed treatment facility could reliably achieve nutrient removal to a degree that would comply with the removal goals stipulated by TCEQ.

An additional point of note is that only steady state models were run when conducting the previously described sensitivity analysis. The basis for this decision again stemmed from the overall goal of the modeling effort, which was not to predict the precise quality of the plant's effluent, but rather its general ability to achieve consistent permit compliance.

Realistically, precise effluent quality results cannot be achieved without the existence of actual influent data for the facility. In the case of the proposed Bull Hide Creek WWTP, there was no profile available that documented how the influent constituents varied with time, nor was there adequate data demonstrating how the flow would vary with time. The viability of a dynamic model constructed based on such limited data would essentially be null.

With this in mind, an excerpt of the sensitivity analysis results performed in conjunction with the proposed Bull Hide Creek WWTP design are provided in Table 2 that follows.

Table 2 – Summary of Bull Hide Creek WWTP BioWin Process Model Results

Model Name	QInf. (MGD)	Qo / Qu	Qr (MGD)	Temp. (°C)	SRT (day)	Basin MLSS (mg/l)	RAS MLSS (mg/l)	WAS TSS (lb/d)	BOD Eff. (mg/l)	TSS Eff. (mg/l)	Phos. Eff. (mg/l)	NH_3 Eff. (mg/l)
BH 6	0.75	0.40	1.50	15	5.58	3141	10985	1407	1.02	0.3	0.38	0.55
BH 7	0.75	0.50	1.50	15	5.24	2940	8811	1403	1.00	0.3	0.41	0.28
BH 8	0.75	0.60	1.50	15	4.93	2794	7445	1416	1.02	0.3	0.36	0.32
BH 9	0.75	0.75	1.50	15	4.55	2605	6074	1433	1.05	0.3	0.30	0.41
BH 10	0.75	1.00	1.50	15	4.03	2350	4696	1459	1.10	0.3	0.18	0.60
BH 11	0.75	0.40	1.50	30	5.57	2963	10363	1327	0.79	0.3	0.20	0.03
BH 12	0.75	0.50	1.50	30	5.23	2801	8395	1337	0.81	0.3	0.19	0.03
BH 13	0.75	0.60	1.50	30	4.93	2658	7081	1346	0.82	0.3	0.19	0.03
BH 14	0.75	0.75	1.50	30	4.54	2472	5764	1360	0.84	0.3	0.19	0.03
BH 15	0.75	1.00	1.50	30	4.03	2223	4442	1380	0.87	0.3	0.19	0.03
BH 16	0.75	0.60	0.75	15	4.92	2801	7463	1419	0.94	0.3	0.11	0.27
BH 17	0.75	0.60	1.50	15	4.93	2794	7745	1416	1.02	0.3	0.36	0.32
BH 18	0.75	0.60	2.25	15	4.94	2786	7423	1412	1.08	0.3	0.67	0.37
BH 19	0.75	0.60	3.00	15	4.94	2785	7421	1411	1.12	0.3	0.72	0.41
BH 20	0.75	0.60	0.75	30	4.91	2671	7115	1353	0.77	0.3	0.07	0.03
BH 21	0.75	0.60	3.00	30	4.94	2648	7054	1341	0.92	0.3	0.50	0.03
BH 22	0.75	0.60	0.75	15	7.95	4216	11236	1325	0.85	0.3	0.26	0.11
BH 23	0.75	0.60	0.75	15	10.37	5286	14089	1274	0.81	0.3	0.59	0.09
BH 24	0.75	0.60	0.75	15	32.11	6960	14652	542	33.44	123.3	8.36	0.10
BH 25	0.75	0.60	0.75	15	11.24	5654	15070	1258	0.80	0.3	0.79	0.08
BH 26	0.75	0.60	0.75	15	11.25	4796	12784	1067	0.81	0.3	1.82	0.08
BH 27	0.75	0.60	0.75	15	7.95	3635	9687	1142	0.85	0.3	0.69	0.11

Table 2 Legend:

- BH = Bull Hide
- QInf. = Influent Flow
- Qo = Clarifier Overflow
- Qu = Clarifier Underflow
- Qr = Internal Recycle Flow
- Temp. = Temperature
- SRT = Solids Retention Time
- Basin MLSS = Mixed Liquor Suspended Solids Concentration from BNR
- RAS MLSS = Mixed Liquor Suspended Solids Concentration in Return Activated Sludge
- WAS TSS = Total Suspended Solids Concentration in Waste Activated Sludge
- BOD Eff. = Biochemical Oxygen Demand Concentration in Effluent
- TSS Eff. = Total Suspended Solids Concentration in Effluent
- Phos. Eff. = Total Phosphorus Concentration in Effluent
- NH3 Eff. = Total Ammonia Nitrogen Concentration in Effluent

As demonstrated by the results of model runs BH 6 through BH 10, as compared to runs BH 11 through BH 15, increased temperature within the BNR basin (15°C versus 30°C) resulted in better phosphorus removal, as would be expected. Furthermore, the impacts of the clarifier overflow to underflow ratio largely become negligible, in terms of the phosphorus effluent concentration, at the higher 30°C temperature, when all other variables are held constant.

The effects of internal recycle, with regard to phosphorus concentration were also studied. It was determined that a moderate internal recycle (75% of the influent flow rate) produced a minimum effluent phosphorus concentration. Wasting was then varied, as illustrated by the resulting SRT values, and as expected a higher wasting rate (shorter SRT) resulted in lower phosphorus effluent concentrations.

SLUDGE PROCESSING

As no sludge processing is allowed to take place at the Bull Hide Creek WWTP, based on the stipulations of its discharge permit, all sludge is hauled to the existing WMARSS Central WWTP for treatment. To reduce the costs associated with its transportation, sludge is concentrated using a rotary drum thickener (RDT) prior to hauling.

There were several issues considered when developing and implementing the liquid hauling scheme for the proposed plant. These included:

- Provisions for consistent wasting with sludge thickening system
- Provisions for temporary thickened sludge storage

- Provisions for alternative sludge hauling method
- Recognition of potential odor generation
- Recognition of limited solids concentration to which sludge may be thickened

As demonstrated by the model, a key requirement for a BNR system designed to accomplish phosphorus removal is consistent solids wasting. The basic function of a biological phosphorus removal system is to accumulate phosphorus in the sludge and remove it along with the wasted sludge stream. Holding the sludge longer than necessary will result in a re-release of the phosphorus into the liquid phase; therefore, provisions for consistent wasting must be provided.

To address this wasting issue, the design called for waste activated sludge from the secondary clarifiers to be discharged to a flocculation tank prior to the thickener, within which it is conditioned with polymer. Sludge then enters the thickener where the free water is separated from the flocculated sludge. Sludge is subsequently discharged to a large vertical tube which serves as a pump take point.

Sludge is then pumped by a double disc pump, and directed to one of three roll-off vacuum containers for temporary storage, prior to its transfer to a WMARSS vacuum truck for transport to the existing Central WWTP for processing. The use of roll-off vacuum containers was elected as a cost savings measure, in lieu of concrete storage tanks.

The use of the roll-off containers also provides an alternative means of sludge hauling. Under this emergency transportation method, an empty roll-off container could be loaded onto a truck designed for handling roll-off containers, and subsequently used to transport liquid sludge offsite for further processing.

The contents of the roll-off containers will not be aerated, though their contents could be re- circulated using the double disc pumps; therefore odor generation was a concern. To remedy this potentially negative situation, an odor control system was provided to allow air to be swept through the headspace of the containers. Vent piping was dry fit to allow for its removal and reinstallation should the containers be required for use as sludge transport containers.

The startup of the facility's sludge thickening operations will require numerous trial and error attempts to establish an optimum polymer addition rate. Of particular concern are the extremely thin mixed liquor solids anticipated during the plant's initial low flow operational regime. Ultimately, the optimal polymer addition rate must facilitate sludge thickening, while still producing a product that will flow by gravity (or with some pumping assistance); such that it may be transferred from the roll-off containers to the WMARSS vacuum truck.

It is widely acknowledged that there is a threshold above which thickened biological solids will not easily flow due to a change in their fluid properties. Generally, the fluid properties of a thickened sludge are most often characterized as being a pseudoplastic - thixotropic plastic. Pseudoplasticity is defined as the point at which the fluid's resistance to flow decreases with an increasing rate of shear stress, while thixotropicity is the point at which a fluid's viscosity changes over time at a constant shear rate.

In an attempt to visually establish these limits and how they relate to sludge concentration, limited testing was performed during the project design phase. In particular, existing dissolved air floatation (DAF) thickened sludge from the WMARSS Central WWTP was used to confirm the concentration at which the thickened sludge would actually flow out of the vacuum truck. Ultimately, the desired concentration for the thickened sludge was determined to be six percent.

While solids concentration is known to be an important component in determining the rheology of thickened sludges, other factors, such as high concentrations of filamentous bacteria, can also have important impacts. All such variables must be considered by when establishing the exact thickened sludge concentration that can reliably and cost-effectively be obtained. Moreover, it is likely that such optimization will not be fully realized until the plant reaches steady state operations.

RESULTS

As the Bull Hide Creek WWTP is just entering into its startup operations as this paper is being submitted, extensive operational data is not available for inclusion in this report document. However, all data accumulated prior to the date of the April 2012 conference presentation will be reported, and made available upon request.