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Fireproofing the Lawn: Reclaimed Water and Polybrominated Diphenyl Ethers in Tampa Bay

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Fireproofing the Lawn:
Reclaimed Water and Polybrominated Diphenyl Ethers in Tampa Bay

by

Ryan C. Davis

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Arts
Department of Anthropology
College of Arts and Sciences
and
Master of Public Health
Department of Environmental Health
College of Public Health
University of South Florida

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Fireproofing the Lawn: Reclaimed Water and Polybrominated Diphenyl Ethers in Tampa Bay

Ryan Davis

ABSTRACT

Reclaimed water has increased in popularity as a means to recycle water and thus decrease the amount of wasteful water use. This process is widely used in Tampa Bay for watering of lawns. This increase in popularity and use has raised questions as to what contaminants are in the reclaimed water.

The purpose of this study was to analyze reclaimed water for contaminants believed to be detrimental to health and conduct interviews to ascertain perceptions of risk in the local population. As water reuse grows in popularity further research will need to be conducted to address potential human health concerns.

This research shows that there are potential health concerns related to reclaimed water when we use dioxin as a surrogate compound. Additionally, the research shows that local governments aren't doing enough to communicate information to local communities. Any policy that moves forward in regards to supplementing drinking water with reclaimed water must incorporate local communities in the decision making process. Decisions made in the absence of information can be misleading and the first feedback of these decisions is felt by local communities. With their input in the beginning, throughout the decision making process, and during the evaluation period, new

information will be generated. The incorporation of the community in the decision making process will make the reclaimed for drinking water initiative, more successful.

Chapter One: Introduction

Nearly 60 million gallons of treated wastewater is dumped into Tampa Bay every day. Before being dumped into the bay some of this treated wastewater is sent to residents to irrigate their lawns. In this thesis I outline research done during the summer of 2009 that investigated chemicals in reclaimed water in Tampa. The research also considered risk perceptions and risk communication between the public and government officials. These activities were carried out in the Tampa Bay area and included both St. Petersburg and Tampa.

The use of reclaimed water draws upon concepts of sustainability. The concept of reclaimed water is to recycle the water that is currently being used by humans. This recycling lowers the amount of ‘new’ water that needs to be drawn from aquifers and rivers. By recycling the water already in use we can limit the amount we pull from other sources and increase the likelihood that water will be available for future generations.

Sustainability is defined by the World Commission on Environment and Development as, “development that meets the needs of the present, without compromising the ability of future generations to meet their own needs” (WCED 1987). This definition, however, doesn’t take into consideration the broad implications for how humans interact with the environment and the value they place on the environment. These include the inequitable distribution of environmental resources creating the haves and have-nots. It also includes the social construction of values placed on the

environment that encourage people to decide what resources should be sustained and which should not. Sustainability is driven by the notion that we can find equilibrium between resource use and resource conservation that doesn't burden ourselves or future generations. This balance between resource use and resource conservation depends largely on changing our unsustainable lifeways. Sustainability has become a concern due to the unsustainable lifeways currently practiced in the U.S. and abroad. The overconsumption of goods and production of waste in the United States has many calling for these practices to be addressed (Lonngren and Bai 2008). These practices include consumption of fossil fuels and overuse of water causing health concerns related to smog and water scarcity concerns like those found in our local area (FDEP 2007b). These unsustainable practices are counter to efforts made that incorporate the concepts of improving our quality of life, protecting the environment and ensuring a future for our children that are mentioned above. Community gardening and farmers markets are among efforts being made to be incorporate sustainability at the local level. To confront the topic of sustainability, many are looking to technology as a way to improve our unsustainable lifeways. Current sustainability research is looking at alternative sources of fuel for vehicles such as solar power and electric (Roseland 2005; Weaver et al. 2000). Other research is looking at how to address natural resource scarcity such as drinking water.

This thesis centers on this topic of sustainability and more specifically on reusing wastewater for residential irrigation purposes. The reuse of wastewater highlights local sustainability practices by improving our quality of life through creation of a new source of water and protecting the environment by decreasing the amount of drinking water we

use for irrigation. It also ensures that the current drinking water supply will last longer into the future and thus benefit generations to come.

Wastewater reuse is one of the sustainable oriented mechanisms to manage the current water crisis. When we think of reusing resources, some might think of recycling aluminum cans, glass bottles and plastics. With global and local concern over the scarcity of this most valuable resource, sustainable resource use has become at the forefront to ways in which to address this crisis.

The research for this thesis focuses on one of the most important natural resources, water, through a political ecology framework (Pelling 2003). Anthropologists were essential in the development of this framework (Cole & Wolf 1974). Political ecology analyzes political, economic and socio-environmental attributes to understand the varying level of processes that occur on the global, national, regional and local levels (Pelling 2003:74). This framework focuses on the interaction between the complex web of political, social, economic and environmental factors. The political ecology framework is best suited to this research because there are social, economic and political factors that can impact water reuse and its perceptions. This framework is also suited for this research because of the ways in which environmental problems can be perceived. It is also established as a framework for analyzing the concepts of risk perception as well as risk communication as it relates to the natural environment. The environmental aspect of this thesis focuses on wastewater and the treatment process involved in producing reclaimed water for residential irrigation purposes.

To produce reclaimed water the wastewater must first be treated. This treatment process is an important step in maintaining sanitary levels of effluent, discharge from

treatment facilities (Drinan & Whiting 2001). Wastewater treatment is the process of treating wastewater to remove pathogens and toxics that could be harmful to the environment or human health. The local Tampa treatment plant discharges the treated wastewater back into the Tampa Bay or uses it as reclaimed water for cooling and irrigation (City of Tampa 2009b). The Tampa Bay ecosystem sustains not only plant and animal life, but human life as well. Tampa Bay is used for leisure activities such as recreational boating, hiking, and canoeing, but also as a food source for fisherman. In order to protect the public's health, treatment is performed on wastewater to ensure that pollutants, solids, nutrients and pathogens are removed prior to being discharged into the ecosystem.

The quality of wastewater is important because poor quality is considered to be that which doesn't meet the Environmental Protection Agency (EPA) standards to protect the health of the environment and the people. The Clean Water Act (CWA) and the Safe Drinking Water Act (SDWA) (EPA 1972; EPA 1974) outline these standards. The Clean Water Act created regulations for pollution of water ways such as rivers and lakes. The Safe Drinking Water Act ensured that there were public health standards for drinking water. These laws began the regulation of what chemicals are allowed to be put into bodies of water. The EPA, however, does not currently have any standards set for reclaimed water, but they do provide suggestions which are similar to the SDWA for states to follow (Parsons 2009:1). Wastewater quality can be seen as the presence or absence of pathogens and chemicals that would harm people and the environment (Drinan & Whiting 2001). However, the EPA standards for wastewater do not cover all the thousands of chemicals that are in the water supply. The purpose of this research is to

monitor and identify if polybrominated diphenyl ethers, an emerging contaminant of concern is a danger to public health in relation to wastewater.

Wastewater treatment plants (WWTPs) are charged with providing physical, chemical and biological procedures and testing of wastewater treatment to make sure that the resulting water is not harmful to populations and receiving water bodies (Drinan & Whiting 2001). The inflow is the water that is incoming to the treatment plant. There are three different types of treatment that can be conducted once the incoming water reaches the treatment plant (Drinan & Whiting 2001:117).

Physical treatment includes; removal of solids, turbidity, that can best be described as the particles that are suspended in the water, color, temperature and odor (Drinan & Whiting 2001:117). This type of treatment is not done in one single step, but is a progression that begins with the removal of the large solids. This type of treatment can be done through grate and sand filtration that doesn't require the addition of chemicals. Chemical treatment parameters include total dissolved solids which are comprised of metals, organics, inorganics, pH, chlorides and nutrients (Drinan & Whiting 2001:119). An example of chemical treatment would be the addition of ozone to kill pathogens. Biological treatment parameters include maximum levels of bacteria, viruses, algae, protozoa and worms (Drinan & Whiting 2001:123). The purpose of wastewater treatment is to remove potentially dangerous pollutants from the water to prevent harm to the environment and people.

The sources for wastewater include household, agricultural, industrial and storm water runoff. In Tampa household wastewater is all the water that leaves the home and includes water from the sink, toilet, dishwasher, and other such devices. With so many

sources of wastewater, the treatment methods need to be as broad as possible while also ensuring the removal of pollutants. However, pharmaceutical and personal care products (PPCPs) are difficult to remove from wastewater due to the large number of chemical compounds (Oppenheimer et al. 2007:2564). WWTPs are designed to handle specific elements and those are outlined in the parameters of biological, chemical and physical treatment. PPCPs are unique in that WWTPs do not test for them. This is because there are thousands of chemicals that have been created and no efficient way to test for all these chemicals. These PPCPs contaminants are discharged into the ecosystem and may cause harm. Polybrominated diphenyl ethers are one such contaminant that wastewater treatment facilities are not designed to handle nor is there testing of this compound within wastewater plants.

Research Settings

I entered graduate school at the University of South Florida to work with Dr. Linda Whiteford whose research included the same nexus of anthropology and public health that I was interested in. I applied to the dual master's degree program in anthropology and public health with the intent to focus on environmental health and anthropology specifically the nexus of these two disciplines on the topic of water. My original intent was to focus on waterborne diseases that are a focus of Dr. Whiteford's research (Whiteford & Hill 2005). I became involved in Dr. Whiteford's sustainable healthy communities grant on water, which focused on technologies and strategies to meet the United Nation's Millennium Development Goal on water and sanitation. This grant brought together researchers from engineering, public health and anthropology. The specific focus of this endeavor was on education and implementation of technologies

and strategies to meet the water and sanitation goal worldwide. The ultimate goal was to create a mechanism for on-going interdisciplinary collaboration to address complex social, geophysical, and political problems related water, health and sustainability. During the course of my studies my interest in water shifted from strictly focusing on the study of pathogens in water and grew to include issues of water treatment. Courses in water and wastewater treatment as well as classes on environmental risk assessment provided background for this thesis research. This interest culminated in forging a relationship with Dr. Jaward in the College of Public Health.

Dr. Jaward is an assistant professor of environmental and occupational health in the College of Public Health at the University of South Florida. His academic training is in environmental chemistry and his research interests are environmental chemistry, ambient air quality, and sources, fate and transport of persistent organic pollutants (POPs).

The project that I worked on was a continuation of research for an ongoing project by Dr. Jaward in the College of Public Health looking into polybrominated diphenyl ethers in the environment (Jaward et al. 2004). When I joined the project, the air sampling phase had already been completed and the project was moving into the wastewater sampling phase. The team consisted of Dr. Jaward and fellow graduate student Kristy Siegel. The roles of the research team included contacting Howard Curren Wastewater Treatment Plant located in the Port of Tampa and establishing dates/times when samples could be collected, collecting said samples, analyzing the samples in the lab and reporting the results. This process was repeated twice, the first being a pilot run. This pilot run allowed the team to become familiar with the methodology of collecting

and transporting the samples. During this process, Dr. Jaward supervised and served as a mentor if any problems arose. Dr. Jaward has been researching polybrominated diphenyl ethers in other media including air and thus this research serves as an extension of this interest.

USF was the primary location for the research and served as the location for storage and analysis of wastewater samples. Dr. Jaward's lab houses an industrial refrigerator for storage, necessary lab equipment for preparation of samples and a gas chromatography-mass spectrometry (GC-MS) machine that was used to analyze the samples. The project itself was primarily focused on collecting wastewater samples from around the area and testing them for the polybrominated diphenyl ethers. The health concern of this compound has increased in recent years and is believed to be a carcinogen and affect the reproductive, nervous, endocrine and immune system due to their similarity to a set of known toxic substances, polychlorinated biphenyls (Gómara et al. 2007; Domingo et al. 2006; Costa et al. 2008). While taking part in this portion of the project, I was also conducting interviews within Tampa Bay area neighborhoods on risk perception and risk communication.

The primary field location for sample collection was the Howard Curren Wastewater Treatment Plant. Wastewater samples were collected from this treatment plant using amber jars and following EPA protocol (2007). These samples were used in the analysis of polybrominated diphenyl ethers. Two neighborhoods in Tampa and three neighborhoods in St. Petersburg that had access to reclaimed water were chosen to conduct semi-structured interviews. The collection of interviews was my own independent research for my thesis and was separate from the group research on

polybrominated diphenyl ethers in wastewater. St. Petersburg and Tampa offered a unique opportunity to complete these interviews as the same neighborhoods have residents that use a variety of sources for irrigation, including reclaimed water. The neighborhoods in St. Petersburg were Historic Old Northeast, Snell Isle Property Owner's Association and Shore Acres Civic Association. The neighborhoods in Tampa were Beach Park and Carrollwood Village. These neighborhoods were chosen because residents had access to reclaimed water.

The setting for this research was chosen in part because of my research interests in water, but also because of the unique combination of environmental health and anthropology. This was an opportunity for me to further my experience and research in health issues related to water. The research focuses on wastewater a topic that I am familiar with and includes both public health aspects of environmental health as well as anthropological issues such as environmental justice.

Research Objectives

The fundamental purpose of this research is to build a nexus between anthropology and environmental health as it relates to wastewater. This nexus incorporates aspects of both fields creating an innovative approach that allows for a more holistic research perspective. Additional objectives of this research include; identifying risk perception and risk communication within Tampa Bay area neighborhoods, identifying polybrominated diphenyl ether concentration in wastewater, and identifying stages of the treatment process that remove concentrations of polybrominated diphenyl ethers for remediation techniques. Currently, there are gaps in the literature between these two disciplines which once bridged can only strengthen these two fields.

Environmental health looks to identify health hazards that are caused by ecological factors such as chemicals in wastewater. Anthropology calls attention to risk perception and the importance of risk communication. Each of these concentrations is important for the overall complex web of political, social, economic and environmental factors that center on wastewater. My research highlights the factors of political ecology and that a nexus needs to be built using tools from anthropology and environmental health that subsequent research can build upon. Political, social, economic and environmental factors are assessed through analysis of the semi-structure interviews.

This research specifically tests polybrominated diphenyl ethers or PBDEs in wastewater. This category of compounds is not tested for in WWTPs even though they are widely used and are a health concern. Polybrominated diphenyl ethers bioaccumulate in the blood, breast milk and fatty tissues and have been shown to be toxic to liver, thyroid and the neurodevelopmental system (CDC 2004). Polybrominated diphenyl ethers are compounds used as flame-retardants in plastics and textiles. The EPA is currently involved in the Voluntary Children's Chemical Evaluation Program (EPA 2009d) to inform the public of health concerns related to polybrominated diphenyl ethers.

This thesis research covers several parameters of wastewater reuse, or what is more commonly known as reclaimed water. This topic doesn't just concern itself with the treatment process, but also with the public perception and communication of risk associated with reclaimed water. The purpose of this research is twofold. The first objective is to collect data concerning individual's perceptions of risk of these contaminants and level of risk communication between residents and government officials. The second objective is to identify environmental health risks from wastewater

contaminants by collecting and analyzing wastewater samples in several of the local WWTPs. Another aspect of this objective is to investigate how much of the contaminant is removed and at what point in the treatment process it is removed. This type of analysis will propose a potential remediation technique if a deduction in polybrominated diphenyl ether concentrations can be found in a treatment step. It can be deduced that if a treatment step that's already in place at treatment plants can be identified as a technique to reduce polybrominated diphenyl ether concentrations there would be no need to install further equipment.

In summary, drinking water receives a lot of attention, but wastewater garners relatively little attention. The benefit of such a study would include drawing attention to the importance of wastewater as well as understanding the risk perception of people and communication of risk to the public. This is especially true when you consider the variety of treatment levels. These include primary, secondary and tertiary treatments that increase in standard rigor respectively. With much of the public attention on drinking water, there is less concern for what goes down the toilet. The public has a right to know if there are high levels of this compound being discharged that might affect their health if not the environment and as such this project extends itself into a discussion of environmental justice. The concept of 'right to know' falls under the environmental justice purview for the surrounding community of Tampa Bay.

The wastewater project addresses real world problems that affect local residents. Applied anthropology looks to take anthropological knowledge such as an understanding of risk and apply it to circumstances such as those incorporated into this research. This application of knowledge and theory is usually applied to benefit marginalized groups

such as those without the resources to defend themselves. In this instance the research operates on the value that residents have a right to know if wastewater is contaminated with these potentially harmful compounds.

I hope that this research contributes to applied anthropology as well as environmental health. I collected and analyzed data, both wastewater and interview data for my research. I also addressed gaps in the literature and began a discussion on the methodology of environmental risk assessments. The anthropological literature contains very little discussion on the environmental risk assessment process and what contributions anthropologists can make within the United States. In comparison the environmental health literature contains very few studies that contain qualitative methodology and an in depth discussion of perceptions of risk and community feedback regarding policy. This research fills the gaps of both these disciplines.

The research showed that by approaching this issue of reclaimed water from an environmental health and anthropological perspective the results were in greater detail than they would be individually. Creating this nexus allowed for the results on the wastewater and the results of the interviews to be combined simultaneously. Through this nexus it was shown that polybrominated diphenyl ethers appear to be of little human health concern in reclaimed water, but they do deserve further investigation. Additionally sludge appears to remove much of the contaminant and chlorine is also an effective mechanism in decreasing the concentration found in wastewater, but not to human health standards. Furthermore, the risk perceptions of the public indicate there is a knowledge gap and there isn't enough risk communication between government officials and residents.

Chapter Two: Fieldwork Settings

This chapter presents the locations where fieldwork was conducted for the research. This research took place in the Tampa Bay area as shown in figure 1; it is located on the Gulf Coast of Florida. A discussion of the settings, including the demographics of the neighborhoods and history of wastewater reuse in Tampa area, is essential in contextualizing the data that was collected. This is also important in the application of the political ecology framework because of the significance that social factors have in this theory. This significance is demonstrated by applying social factors such as socio-economic status, age and ethnicity to larger issues like access to resources. By analyzing social differences we are able to conduct a more thorough investigation into reasons why some have more access to resources than others. The demographic information presented below pertains to the cities of St. Petersburg and Tampa located in the Tampa Bay area. The specific neighborhoods of focus were Shore Acres, Snell Isle and Historic Old Northeast in St. Petersburg, and Carrollwood Village and Beach Park in Tampa (figure 1).

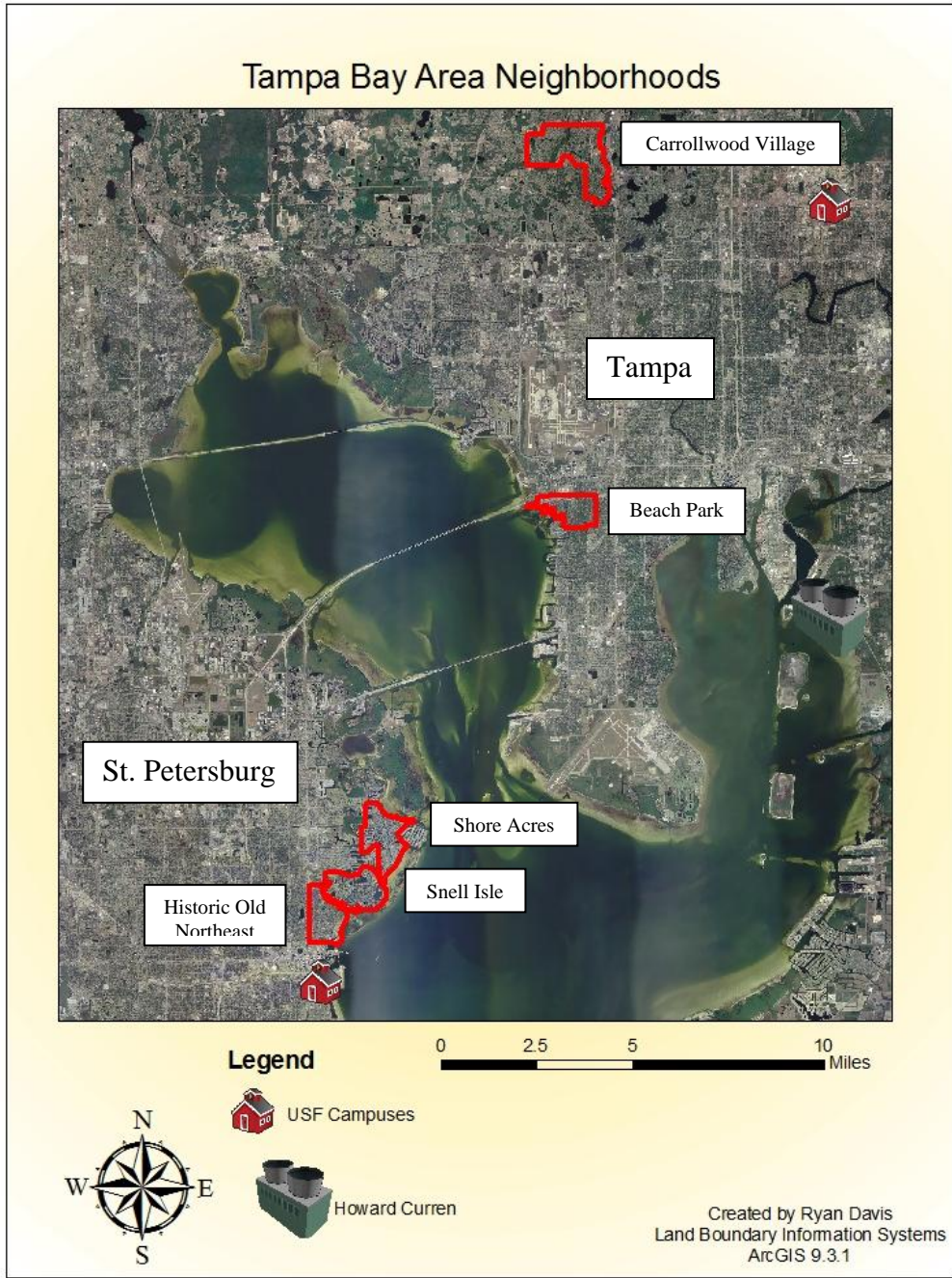


Figure 1: Tampa Bay Area Neighborhoods

It is also important to discuss environmental factors such as the treatment plant and its capabilities of providing reclaimed water to residents of Hillsborough County. An understanding of these capabilities in conjunction with the social factors of the areas may show inequitable access to resources by certain socio-economic or ethnic groups. The elements related to the fieldwork settings; demographic information, background on wastewater reuse and a detailed outline of the Howard Curren Wastewater Treatment Plant are reviewed. Appendix I & J shows a detailed representation of the treatment process and an overview of the Howard Curren Plant. What follows is a description of St. Petersburg and Tampa where the interviews were conducted as well as a description of the Howard Curren Wastewater Treatment Plant where the wastewater samples were taken.

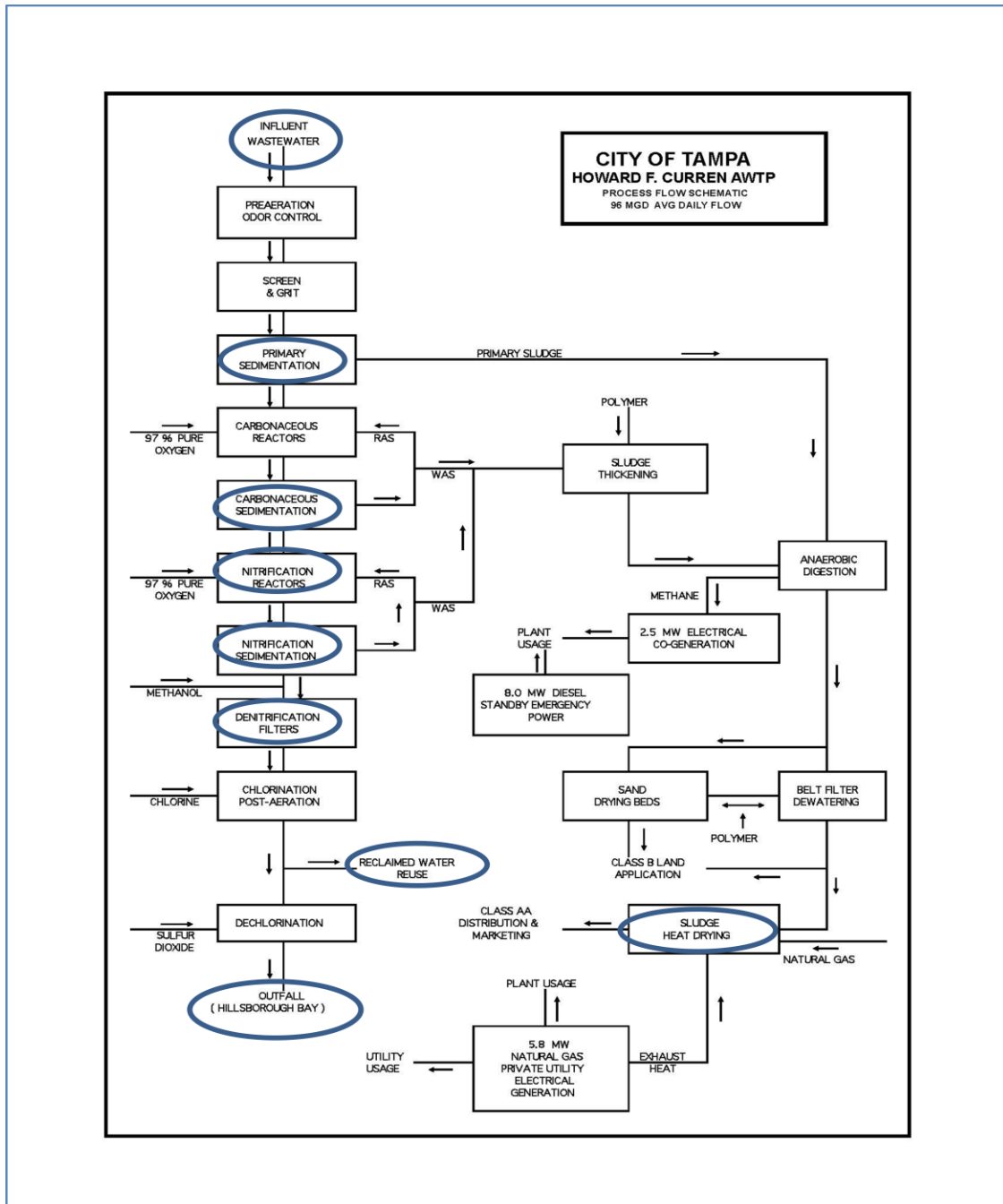


Figure 2: Howard Curren Wastewater Sampling Points

St. Petersburg

General John Williams, a Detroit native, envisioned a city with numerous parks and acted on this vision by travelling to the Tampa Bay area and purchasing 2,500 acres

in 1878 (Hartzell 2006). This was the first step in the founding of what would be called St. Petersburg. The name of the city, however, didn't occur with General Williams. Instead Pyotr A. Dementyev or more commonly referred to as Peter Demens was a Russian political exile that pioneered the building of the town which he later named St. Petersburg, after the Russian counterpart.

During the 1950's St. Petersburg was well known for its 8,000 green benches which city residents used daily to meet friends and conduct activities such as business deals (Deese 2006). It wasn't until the 1960's that the city council began to worry about the growing retirement population and the city become known as 'God's Waiting Room' than for its beaches and spas.

However, St. Petersburg was not very hospitable to minorities, especially blacks (Davis 2000). The popular green benches were off limits to blacks as well as several of the local beaches. In 1955 the National Association for the Advancement of Colored People (NAACP) stepped in and staged swim-ins at the public pool that was off limits to blacks as well. In 1956 the NAACP won a lawsuit forcing the city to desegregate the beaches and pools. The city reacted by closing both the pools and the beaches. Civil rights continued to be a theme in the city culminating with the infamous lunch-counter sit-ins.

This discrimination also affected the residential areas in St. Petersburg (Bus to Destiny 1999). The white population concentrated in the downtown areas as well as the Northeast portion of the city. There is no mention on the City of St. Petersburg's (2008) history website of these transgressions and the area previously publically mandated as the

‘white area’ now includes the neighborhoods of Historic Old Northeast, Snell Isle and Shore Acres (Bus to Destiny 1999).

This history shows both the political and social influences that have shaped the City of St. Petersburg today. Many of these inequalities still exist today as shown in Table 1. It is only by looking into the city’s past that we gain an understanding of the lack of racial/ethnic groups in the three neighborhoods where semi-structured interviews were conducted. The fact that the reclaimed water network is strongly concentrated in this area might also be a reflection of these inequalities. These social and political factors are key elements of the political ecology framework that this thesis is operating under (Cutter 1995). By identifying and understanding the reasons for these inequalities, discussion of reclaimed water can instead focus on risk perceptions and risk communication outlined as the purpose of the interviews.

Table 1. Racial and Ethnic Characteristics in Selected Areas of St. Petersburg and Tampa

Location (total pop.)	White (%)	Black (%)	Asian (%)	Hispanic* (%)
City of St. Petersburg ¹ (301,237,703)	223,965,009 (74.3%)	37,131,771 (12.3%)	13,164,169 (4.4%)	45,432,158 (15.1%)
Historic Old Northeast ² (7,792)	7,247 (93%)	234 (3%)	77 (<1%)	312 (4%)
Snell Isle ² (3,255)	3,157 (97%)	14 (<1%)	33 (1%)	130 (4%)
Shore Acres ² (6,649)	6383 (96%)	83 (1%)	105 (2%)	205 (3%)
City of Tampa ¹ (326,664)	217,941 (66.7%)	83,649 (25.6%)	10,072 (3.1%)	72,556 (22.2%)
Beach Park ³ (3,760)	3,459 (92%)	38 (1%)	37 (1%)	414 (11%)
Carrollwood Village ³ (10,618)	9,556 (90%)	425 (4%)	319 (3%)	1,380 (13%)

¹Data obtained from United States Census Bureau

²Data obtained from Florida Geographic Data Library

³Data obtained from Hillsborough Community Atlas (Not available for Pinellas County)

*Includes both white and non-white Hispanics

An additional characteristic that helps to contextualize the data collected is the reclaimed water system in St. Petersburg. The reclaimed water system is the largest distribution system in the United States (Asano et al. 2007). The reclaimed system was one of the first in the Country and was constructed in the late 1970s (City of St. Petersburg 2009a). Its original intent was to address the water stress the city was under due to depletion in water sources (Asano et al. 2007).

Since the issue of water stress was a local problem, however, in order to gain Federal funds the city council framed it as an environmental issue (Asano et al. 2007). As such, the city focused on reclaimed technology as a way to reduce wastewater discharge into surface water. Currently the reclaimed system is so popular that there are people on waiting lists to have access to this source for irrigation of their lawns (City of St. Petersburg 2009a). The system has grown to provide service for over 10,000 residents.

St. Petersburg's history of having a reclaimed water source for several decades and furthermore having the largest such network in the United States will be crucial in analysis of the respondent's remarks. The importance of a political ecology approach in the interaction of the political and social network of St. Petersburg with the environment, in this case the water supply, makes the analysis much stronger. This framework includes multiple factors that affect not only the answers given in the interviews, but also offers insight into what future strategies St. Petersburg might employ as government entities begin to address the current and future water crisis.

Tampa

The history of Tampa is intertwined with that of St. Petersburg since both are geographically close (Hartzell 2006). Both of the cities grew due to the expansion of the railroad into the surrounding area. General Williams, who is more notable for his significance with the City of St. Petersburg, purchased property on both sides of Tampa Bay.

Tampa had sporadic historical events worth mentioning such as the Union battleship that entered Tampa Bay and fired on the Confederate positions along the port

(HPS 2009). In the late 1880's phosphate was discovered near Tampa and this sparked an economic growth that continues to this day making the Port of Tampa the seventh largest port in the United States (City of Tampa 2009a). The growth of regions in Northern Tampa such as Carrollwood Village has resulted in younger residents on average compared to areas in South Tampa (Table 2). Furthermore, while Tampa and St. Petersburg share historical roots they diverge in the application of reclaimed water. Unlike St. Petersburg where the reclaimed water system was constructed in the later 1970's, Tampa began their reclaimed network in 2000 (City of Tampa 2009c). The city first offered the reclaimed water to residents on Davis Island, a well-known affluent area (Table 3). To ensure that the system would be used, the city gauged public interest. Four thousand two hundred homeowners and businesses responded that they would sign up for the service (City of Tampa 2009c). The system can currently service 8,700 people, but only 3,100 residents are currently hooked up.

Table 2. Age Group Characteristics in Selected Areas of St. Petersburg and Tampa

Location (total pop.)	Age Group*	Size (percentage)
City of St. Petersburg ¹ (301,237,703)	18-64	227,431,128 (75.5%)
	65 and older	37,980,136 (12.6%)
	5 and younger	20,672,826 (6.9%)
	Median Age	36.7 years
Historic Old Northeast ² (7,792)	35-49	2,104 (27%)
	18-34	1,792 (23%)
	65 and older	1,558 (20%)
	5 and younger	390 (5%)
Snell Isle ² (3,255)	35-49	814 (25%)
	65 and older	749 (23%)
	50-64	716 (22%)
	5 and younger	163 (5%)
Shore Acres ² (6,649)	35-49	1,293 (19%)
	18-34	1,201 (18%)
	5-17	1,164 (18%)
	5 and younger	399 (6%)
City of Tampa ¹ (326,664)	18-64	248,456 (76.1%)
	65 and older	36,848 (11.3%)
	5 and younger	22,551 (6.9%)
	Median Age	35.6 years
Beach Park ³ (3,760)	35-49	1166 (31%)
	65 and older	677 (18%)
	5-17	560 (15%)
	5 and younger	338 (9%)
Carrollwood Village ³ (10,618)	35-49	2,548 (24%)
	50-64	2,336 (22%)
	18-34	2,017 (19%)
	5 and younger	743 (7%)

¹Data obtained from United States Census Bureau

²Data obtained from Florida Geographic Data Library

³Data obtained from Hillsborough Community Atlas (Not available for Pinellas County)

*Only the top three age groups and the smallest age group were selected. The City level only had three age groups reported and the median age.

Table 3. General Demographic Characteristics in Selected Areas of St. Petersburg and Tampa

Location	Population	Households	Persons per square mile	Males (%)	Females (%)	Per Capita Income ²
City of St. Petersburg ¹	301,237,703	127,762,925	-	49.3	50.7	\$27,466
Historic Old Northeast ²	7,792	4,122	1,662	47.4	52.6	None Available
Snell Isle ²	3,255	1,484	2,725	46.4	53.6	None Available
Shore Acres ²	6,649	2,703	4,018	49.0	51.0	None Available
City of Tampa ¹	326,664	150,061	-	49.4	50.6	\$29,442
Beach Park ³	3,760	1,511	4,020	49.9	50.1	\$48,549
Carrollwood Village ³	10,618	4,719	3,054	46.9	53.1	\$25,840

¹Data obtained from United States Census Bureau

²Data obtained from Florida Geographic Data Library

³Data obtained from Hillsborough Community Atlas (Not available for Pinellas County)

Howard Curren Wastewater Treatment Plant

The Howard Curren Wastewater Treatment Plant is located in the Port of Tampa (City of Tampa 2009). The plant has a flow of 56.89 million gallons per day (MGD).

This is the average amount of wastewater that enters the plant. The capacity of the plant, however, is 96 million gallons per day. The plant also produces some of its own energy saving \$2,743 a day or over \$1 million annually. Howard Curren has a sludge drying facility on the premises that produces fertilizer from the treatment process. The plant can

dry 59 tons of sludge per day and can store 12 hundred tons until semi-trucks can transport the fertilizer to their destination. The plant also produces reclaimed water of which 5,040 gallons per day is used for irrigation purposes such as residential lawns, 7.68 million gallons per day is used on site and 3.25 million gallons per day is used for industrial purposes such as cooling.

The treatment process for the plant goes through six main stages including; preliminary treatment, secondary treatment, nitrification, denitrification, post-aeration, and the final result (City of Tampa 2009b). There are secondary stages that include the reclaimed water and sludge drying facility.

The preliminary treatment includes aerating the wastewater to remove hydrogen sulfide (H_2S) (City of Tampa 2009b). This compound is colorless, but is toxic and flammable and has the scent of rotten eggs (Drinan 2001:130). After the aeration, large biological materials, such as solids, are removed by a screen (City of Tampa 2009b). Once the large biological material is removed the wastewater goes through the primary sedimentation. In this process the solids in the wastewater are allowed to settle to the bottom of the tanks and these solids are referred to as sludge. This bottom layer is pumped to the sludge heat drying facility to be turned into fertilizer. The remaining wastewater then enters the secondary treatment.

In the secondary treatment the wastewater enters the carbonaceous sedimentation tanks (City of Tampa 2009b). Within these tanks microbes feed off of the biological material, breaking down the remaining solids. These tanks use high purity oxygen to then kill the microbes in the wastewater. The remaining solids that settle in these tanks are transferred to the sludge drying facility.

The process continues to the nitrification stage where ammonia (NH_4^+) is converted to nitrate (NO_3^-) (City of Tampa 2009b). This is a biological process where nitrifying bacteria convert the ammonia into nitrate. This is a crucial step to remove ammonia that would otherwise be harmful to fish. The next step is to transform the nitrate into nitrogen gas (N_2).

In the denitrification process, the nitrate is transformed into nitrogen gas that is then released into the atmosphere (City of Tampa 2009b). This release is not harmful since most of the atmosphere is comprised of nitrogen gas. This process uses methanol as a food source for the denitrifying microbes in an anaerobic environment. This type of environment lacks any free oxygen so an aeration step is necessary after this process has been carried out.

In the next stage, post aeration, chlorine is used to disinfect any remaining microbes (City of Tampa 2009b). During this process the wastewater is also dechlorinated before being discharged as effluent into the bay. Before this dechlorination step a portion of the wastewater, which still has chlorine in it, is pumped out and used as reclaimed water. The state requires that chlorine not be removed from reclaimed water due to concerns regarding microbes. The treatment plant uses reclaimed water, but it is also used by industrial and residential users. The remaining wastewater is dechlorinated by adding sulfur dioxide (SO_2). The effluent is then discharged into Tampa Bay.

The sludge that had been sent to the sludge heat drying facility is dewatered through a press (City of Tampa 2009b). This sludge is then sent to an industrial size rotary dryer that removes the remaining water. What are left are pellets of sludge that is then used for fertilizer.

In summary, the exploration of demographic factors is essential when using the political ecological framework. As discussed above, an understanding of social factors relevant to the research at hand helps to contextualize research problems. These social factors apply to the availability or, more appropriately the ability of residents to gain access to the reclaimed water provided by the Howard Curren Wastewater Treatment Plant. The interaction between social and environmental factors is extremely important and highlights the links between access to resources and demographic information. Discussion of the demographics of each county was presented as a comparison to the neighborhoods where the semi-structured interviews were conducted. It is important to note that these interviews were conducted in areas with the largest amount of piping for the reclaimed water network was located.

The importance of contextualizing data allows researchers to construct a more complex web of elements that interact with each other at various levels. This not only includes the social aspects, but background on the field settings as well. This chapter discussed, in more detail, the wastewater treatment process at Howard Curren. Also included was a representation of the technical aspects of the plant to incorporate the field settings where semi-structured interviews and wastewater sampling were conducted. This discussion also assists in identifying stages of the treatment process for remediation of polybrominated diphenyl ethers.

The following chapter will discuss the relevant literature to this thesis. A discussion of the political ecological framework will provide a better understanding of the theory by which this thesis has taken. Additional anthropological concepts such as

risk perception environmental health concepts such as traditional risk assessments will be presented.

Chapter Three: Relevant Literature

In this chapter I discuss literature related to the themes of risk and communication, water management and environmental health. The first section presents the guiding theoretical framework, political ecology, for this thesis as well as the significance of anthropology in this research. The second section discusses water management issues namely national and local laws as well as local availability. The third section refers to the issue of risk, more specifically the concept of risk in anthropological terms, the concept of risk communication, and the concept of risk perception. The fourth section discusses the nexus between the anthropological concepts of risk and the public health concept of environmental health. Finally, the last section discusses the state of the science of environmental health concepts, specifically of polybrominated diphenyl ethers and traditional environmental risk assessment.

Theoretical Framework

Throughout this paper I follow the political ecological framework. Such an approach is similar to Janice Harper's (2004) work on air pollution in Houston. Piers Blaikie et al. (1994) is also a pivotal figure in political ecology and has done extensive work on soil erosion and the strain farmers place on the environment.

Political ecology is the study of how political, social and economic factors impact environmental issues. This framework is the best suited to this research because of the environmental and social aspects involved in the research and the interaction of social,

economic and political factors on the environment. What makes this theoretical framework unique is the emphasis placed on the politicization of the environment. Analysis of political and socio-environmental attributes is used to understand the varying level of processes involved; global, national, regional and local, on the urban landscape (Pelling 2003:74). This is similar to the social ecology of health model which is a multiple level systems theory that describes mutual and interacting influences from the individual to the global level (Coreil 2009:12). Anthropology plays a pivotal role in this theoretical framework because the origin of this theory began with anthropologists John Cole and Eric Wolf (1974). Through this framework, which embeds humans and their environments within a political framework, we can analyze the issues surrounding water reuse and understand the concepts of risk perception as well as risk communication and how they relate to traditional environmental health risk assessments.

Our understanding of issues surrounding water such as management, sale and how we conceptualize this element, can be extended by working in the political ecological framework (Whiteford & Whiteford 2005:4). This framework allows links between social, political, economic and environmental factors to be displayed where they might not otherwise be (2005a:5). Whiteford (2004) shows how women and girls of Guayaquil, Ecuador are more at risk of contracting cholera. This is can be attributed to social factors, such as females being the primary water users, and how political and economic factors, such as being a marginalized community, put them at greater risk. This example displays how a political-ecological approach is beneficial in studying the interaction between humans and the environment. Another example of this theory is evidenced by the impact of climate change on the local weather pattern here in the Tampa Bay area

creating long term drought conditions and how these global influences are impacting national, regional and local policy (Whiteford 2005a:8). This water scarcity is a result not only of environmental factors, but also political, economic and social factors causing debate on using reclaimed water as a supplement for drinking water. Climate change and sustainability has caused a shift in how we not only think about issues, but also how we address the water-health interface (2005b:255). For the issues in this thesis the political ecological theory provides the best framework to conceptualize the inter-related factors affecting the issue of water in the Tampa Bay area. Political ecology allows the researcher to effectively see the management, health and policy issues surrounding water in a historical and global context (2005b:256). This theory extends the framework of political, social, economic and environmental factors that would otherwise be looked at individually (2005b:262).

Water Management

Water is a crucial element in sustaining life and as such it is protected for health reasons under the Environmental Protection Agency (EPA). Two of the most important laws dealing with water are the Clean Water Act of 1972 and the Safe Drinking Water Act of 1974 (EPA 1972; EPA 1974). These laws were part of a larger shift in environmental protection from the state level to the national level with the creation of the EPA in 1970 under the direction of President Nixon (EPA 1973).

The Clean Water Act began the national regulation of toxic substances into water bodies (EPA 1972). The CWA requires removal bacteria, such as *E. coli*, protozoa such as *Cryptosporidium* and viruses such hepatitis A, from being discharged into bodies of water. Furthermore this law regulated point sources of pollution. Point sources are

single sources that can be identified as the emitter of a substance. These types of sources include industrial facilities whose runoff pollutes water bodies; this requires a permit. This law, however, did not include non-point sources such as storm drain run off even if it were from agricultural, municipal or industrial runoff. In 1987, amendments were made to create permits for industrial and municipal storm water runoff, which also included amendments for agricultural runoff (FWS 1987). These amendments created section 320 of the Clean Water Act to protect estuaries from agricultural runoff through the best available technologies (EPA 1987). However, there is currently no enforcement for discharge of polybrominated diphenyl ethers into bodies of water.

The Safe Drinking Water Act established standards based on maximum contaminant levels (MCLs) which are enforceable and Maximum Contaminant Level Goals which are non-enforceable for each contaminant (EPA 1974). There are approximately ninety contaminants that are regulated by the Safe Drinking Water Act (EPA 2009b). These contaminants fall into six categories: disinfectants, disinfection byproducts, inorganic chemicals, microorganisms, organic chemicals and radionuclides. These include dioxins, *E. coli*, lead and radium. Polybrominated diphenyl ethers, the contaminant being tested for in this study, are ones not monitored or regulated by the safe drinking water act.

These national laws gave precedence for more stringent regulation of water supplies in the US. The states still play a major role in the management and regulation of water. One such example is the regulation of reclaimed water, which is not regulated by the EPA, but the EPA has established guidelines for states (Parsons 2009:1). The Florida Department of Environmental Protection has set reclaimed water standards for the State

of Florida (FDEP 2006). These include removal of *Cryptosporidium* and *Giardia* and *E. coli* from wastewater that is reused. It has been determined that reclaimed water can be used for fire protection, irrigation of the lawn, filling of ponds as well as wetlands, use in cooling towers and for edible crops (FDEP 2007a:34). Regarding irrigation of edible crops with reclaimed water, the crops must be peeled or cooked before eating if there is direct contact with the crop; if there is indirect contact such as drip-irrigation then the crops do not need to be cooked or peeled before consumption (Parsons 2009:2).

The State of Florida requires that reclaimed water be submitted to high-level disinfection, usually with the use of chlorine, before use (FDEP 2006). To satisfy health concerns, reclaimed water meets and in some cases exceeds the drinking water standards, but is not used as such due to public concern (Parsons 2009:3, 4). Reclaimed water is thus submitted to high-level disinfection that ground and drinking water may not have to undergo, however, because of the high-level disinfection process there is concern for disinfection by-products. Disinfection by-products result from the reaction of disinfectants with organic material (Drinan & Whiting 2001:89). This is not just a process that wastewater undergoes, and if necessary, drinking water will undergo disinfection if there is organics such as *E. coli*. The Howard Curren Wastewater Treatment Plant uses chlorine for disinfection and this process can form by-products such as chloroform which is a carcinogen (2001:95).

The use of reclaimed water in Florida has gained popularity as the state deals with a chronic drought (FDEP 2007b). To address the issue of drought, the State of Florida has developed a *Drought Action Plan*. The Southwest Florida Water Management District (SWFWMD), which includes Tampa Bay, the drought has been ongoing since

October 1998 with the year 2000 being the driest year on record (2007b:4). As a result artesian wells that many people have relied on dried up, thus in order to irrigate lawns people began turning to other sources. One of these sources is reclaimed water since the groundwater supply had diminished. In order to address this overall water shortage, the Southwest Florida Water Management District issued outdoor water use requirements that limited the amount of water for purposes such as irrigation (2007b:5).

More recently the three major water storage areas of the Southwest Florida Water Management District were approaching record low levels (2007b:8). This period of drought has also coincided with increased wind, lower humidity and lack of cloud cover that has increased the evapotranspiration rates above normal level. Reclaimed water has now become the dominant source of 'new' water for the State of Florida (2007b:17). Reclaimed water is considered a more drought resistant strategy because we are reusing the water that we already have access to and we are not relying on rains to bring fresh water. This has a huge impact when you consider that one half of the public drinking water supply in Florida goes to landscape irrigation that could otherwise be addressed through reclaimed water (2007b:20). Florida is committed to implementing reclaimed water networks in all local governments. St. Petersburg serves as an excellent example of reclaimed water use with it being not only the oldest such system in the U.S. being built in the 1970's, but it is still one of the largest (City of St. Petersburg 2009a).

In response to these issues the City of Tampa has put together a \$340 million plan to expand the existing reclaimed network that supplies approximately eight thousand seven hundred costumers to an additional nine thousand residents (Zink 2009c). Furthermore, Tampa is considering implementing the flush-to-tap concept where

reclaimed water would be injected into the drinking water (Zink 2009b). This proposal will be voted on by Tampa residents on the 2010 ballot (Zink 2009a).

Risk

Risk has many definitions and interpretations depending on its usage as a concept. For instance in engineering, risk can be defined as the probability of an event occurring multiplied by the consequence of that event. In anthropology, risk is a social construct while danger is a physical manifestation outside of the body (Paine 2001:68). In other words, risk is a cognitive process that conceptualizes the probability of a danger from outside the body occurring and what the result would be if the danger occurred. The conception of what might happen if the danger occurred is part of the cognitive formulation of risk.

The research focus of this project is centered in risk perception and communication as well as environmental health issues. Political ecology will serve as the theoretical framework for the ethnographic research. The reason for this is due to the variety of factors: political, economic, social and environmental that is all inter-related. Political ecology provides the best framework to approach these factors. Anthropological literature on the topic of environmental health concerns largely focuses on issues of risk. Anthropologists such as Barbara Johnston suggest that a healthy environment is a human right (1995:111-12). Furthermore, the risk associated with environmental health is a matter of social issues and in order to lessen risk, the dangers must be known or communicated to the community (1995:121). In essence this research is, “an analysis of the social creation of vulnerability” (Oliver-Smith 1996:314). This framework largely pertains to developing countries, but I believe that similar structural issues, namely access

to resources, are at play for the residents of Tampa Bay. As Torry posits, there is no ultimate cause when dealing with hazards, but instead these hazards are a result of a variety of societal issues (Torry 1986:17). These societal issues include corporations taking stances against regulations of environmental health hazards because it doesn't suit their interests.

The anthropological literature on risk has largely centered on developing countries and has not been so readily applied to developing areas within the United States. Olson, MacDonald & Iain, and Panter-Brick also discuss environmental risk and its connection to development, but from an international standpoint and focus on local communities outside of the U.S. (1987; 1998; 2002). The result of this research will look to contribute to the presence of applied anthropology in local environmental risk projects within the U.S. Such research has already been completed by anthropologists, but concerning air quality and not water (Harper 2004). Risk associated with societal issues and geography has been researched by those outside of anthropology (Cutter 2000) and recently took center stage with Hurricane Katrina (Colten 2006). Hurricane Katrina provided the opportunity for multiple disciplines to work together and research the political, social, economic and environmental factors that placed residents at risk. This conceptualization of risk incorporates indicators of risk such as socio-economic status (SES), as well as social amplification and integrated perceptions of risk, risk communication and response to risk (Cutter et al. 2006:189; Dow & Cutter 2006:231; Kaspersen et al. 1988:179).

The importance of risk cannot be stressed enough in this review. Reclaimed water is treated through a process that requires technological innovation. This

technology is meant to allow water to be reused, but questions arise as to how much risk should we assume before the given technology is deemed hazardous? Cutter (2006a:167-168) discusses the concept of risk acceptability and the subjective evaluation process that individuals and experts go through when establishing the safety of a given technology, or in this case if reclaimed water is hazardous what is our level of acceptance of such a hazard. The example of reclaimed water being hazardous is an example of analytical risk which should not be confused with risk acceptability which is based on risk perception. The key factor in determining risk acceptability is the human factor and this is not easily understood (2006a:168).

Douglas and Wildavsky (1980) classify risk perception as a social process under their concept, cultural theory of risk (1980:6). This social process is contrary to the environmental risk assessment performed by health officials. In this process acceptable risk levels are answered by analyzing nature and technology (1980:9). The reason for this is that traditional environmental risk assessments are based on economic indices rather than indices related to social processes. Risk perception occurs at the individual level, but it is society that determines what risks are important enough to deserve attention (1980:8).

Risk perception has played a pivotal role in how communities are approaching the health issues surrounding polybrominated diphenyl ethers. From Washington State (Stifler 2007) to Maine (Legg 2007), governmental bodies have taken up legislation to ban the use of polybrominated diphenyl ethers from manufactured goods. The legislatures in these states have highlighted scientific research and put pressure on the national government to look into the presence and human health concern of

polybrominated diphenyl ethers. This has obviously raised some debate most notably from the varying lobbying groups of polybrominated diphenyl ether manufacturer's such as the case in California where there is current legislation to ban this flame retardant from children's toys (Redmond 2009). The reasons for these new policies are associated with people's perceptions and how these perceptions have caused them to act on what they believe is a risk. The work in this thesis also looks into the importance of risk perceptions through resident's responses.

These communities are made up of individuals and as Douglas & Ney (1998:136) point out, perception of risk are based on an individual level. Individual's perception of risk is directly impacted by their life history and the experiences they have gone through. Communicating with the public and education campaigns were previously deemed as eventual failures, not because regulators or officials didn't address misperceptions properly, but because of the public failed to understand the actual risk (Douglas1985:31). These previous attempts failed to account for individual notions of risk. These individual notions of risk are largely driven by moral issues such as justice and fairness. For example, the perception of health risks is heightened if there is suspicion of a breach in moral principles (1985:5).

The human element in risk acceptability is a complex web of moral, political and economic factors (Cutter 2006b:135). Interacting moral, political and economic factors influence risk perception and risk communication. The experts that inform individuals or the layperson of a risk are affected by these factors as well. These experts typically report risk in very narrowly defined terms such as morbidity and mortality whereas the public extends risk beyond this purview (Dow & Cutter 2006:231). Risk for the public

includes the results of disturbances and other social elements related to a hazard. The hazards that result in the formation of risk might include below sea level geographic areas which are prone to flooding during hurricanes. An example of this is the lower ninth ward being flooded during Hurricane Katrina putting residents in this location at risk.

Major (1993) discusses how communication theory can be used to identify perceptions and their impact on environmental issues. In this article she posits that the efficacy of knowledge and communication is greater than solely relying on improving public image to have high involvement from the public (1993:264). To have a successful risk communication program, solutions must be given to address the problem, not just information about the problem (1993:266). Such solutions may include clean-up programs and other remediation steps. Without mitigation, the perception of risk may increase.

Risk communication is also subject to stigma which is closely aligned with perception, but is differentiated based on the principle that stigma is a result of inadequate communication (Gregory & Satterfield 2002:347). The problem with stigma is that it is poorly understood when it comes to developing regulatory policies (2002:357). To overcome this, Gregory and Satterfield suggest that narratives and stakeholder analysis be carried out to understand existing perceptions and how to communicate risk effectively. Without these narratives a grasp of the deep values and perceptions that individuals have would otherwise be overlooked.

If there is poor risk communication, respondents have been found to provide economic cost-centered answers (Satterfield & Gregory 1998:630). These respondents may have a general idea of the issues, but have not been fully informed to elicit value-

centered responses when questioned about their feelings toward a particular environmental issue. Eliciting value-centered answers are not the only way to better grasp risk perception and communication issues, but “decision pathways” must also be investigated (1998:639). These “decision pathways” are the cognitive processes that individuals undergo to establish their perception of risk. The interview methods should be used to contextualize the complexities of environmental issues and beliefs that people have (1998:643).

One of the largest most important underlying issues with risk communication is the treatment of the public as a homogenous group (Cutter et al. 2006:189). Individuals have different perceptions of risk based on gender, ethnicity, age, and so on yet the communication of this risk does not take into account this diversity. These differences, especially in respects to gender, are not very well understood (Cutter et al. 2006:190).

Nexus of Anthropology and Environmental Health

Others have called for a further understanding of the nexus between environmental health and societal issues (Farmer 2004). Environmental health doesn't just pertain to risk assessments, but incorporates all issues related to the physical condition of the environment. I attempt to bridge the gap between environmental health and anthropology by offering ways in which traditional environmental risk assessments can be improved through the addition of social science research. Anthropologists have researched risk and individual and community perceptions of risk, but they have not engaged with the quantitative analysis and methodology of environmental risk assessments. These traditional environmental risk assessments include hazard identification, dose-response assessment, exposure assessment and risk characterization.

Additionally, anthropologists have researched the political, economic, social and environmental variables that affect health, but have not combined these aspects with traditional environmental risk assessments on contaminants in wastewater. They have also not analyzed the varying contaminants and their health effects. The issue of traditional environmental risk assessments and wastewater has been well researched in the field of public health, but has not been adequately grounded by anthropological methods of ethnography.

Stern and Finberg (1996) call attention to the weaknesses of traditional environmental risk assessments. Environmental risk assessments must incorporate a political ecology framework. The inclusion of political, economic and social factors and how they interact with each other and the environment would strengthen the traditional environmental health risk assessment. A methodology like the one described would create a more holistic decision making process for government agencies and regulators in regards to environmental issues. The current tool used is risk analysis that evaluates the significance of hazards. However, weaknesses of this approach include inadequate techniques used, the uncertainty surrounding risk, and not understanding the complexity of risk characterization. Although residents may lack scientific knowledge of the risk, they are the most important stakeholders in any risk analysis and regulatory outcome. The problem is how to characterize risk in a manner that the public can understand that incorporates the complexities of society as well as the scientific knowledge of the risk in an effective manner (1996:13). This goes beyond “translating” and requires a new strategy behind risk characterization (1996:14). The strategy that Stern and Finberg suggest is one that allows greater control by the risk assessors, which will allow the

incorporation of contextualizing factors instead of an approach that takes into consideration factors that are community-specific.

Environmental Health

Environmental health issues have risen to the forefront with the epidemiological transition from acute diseases to chronic diseases that are caused by environmental factors, has occurred in the developed world (Whiteford & Whiteford 2005:11). Environmental health is associated with public health and the impact of the environment on the health of humans. The focus of this study is not the biological or physical environmental hazards, but rather the chemical hazards such as industrial waste and PPCPs (Munoz et al. 2009:1; Zorita 2009:2760). This is of concern for wastewater treatment because the treatment plants were designed to remove urban and industrial waste, not pharmaceutical and hormonal products. This is of concern especially with the growth of urban populations there is need for new regulations and innovative techniques to lessen the environmental health impact.

Environmental risk assessment specialists have reported on the health outcomes of wastewater contamination specifically with focus on endocrine disrupting compounds for decades (Richardson 2007). As you can see in figure 3, polybrominated diphenyl ethers are structurally similar to endocrine disrupting compounds (EDCs) such as dioxin and have been found in soil, air and water. Both compounds contain bromine and oxygen compounds. Endocrine disrupting compounds affect the secretion of hormones within the human body and can inhibit or stimulate biological processes such as the neuro-developmental process (2007:4306).

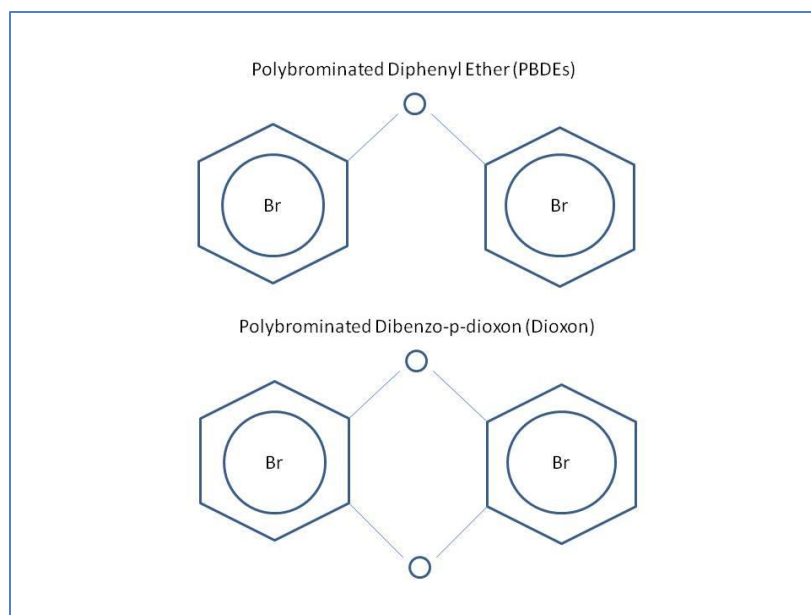


Figure 3: Structural Similarity of Polybrominated Diphenyl Ethers and Dioxins

Polybrominated diphenyl ethers are commonly used as a flame retardant and are found in electronics, building materials, textiles, cars and a variety of other products. There are 209 possible brominated diphenyl ether congeners, or types, depending on the number of position of the bromine atoms. 70,000 metric tons of polybrominated diphenyl ethers are produced each year and come primarily from the United States (2007:4313). These substances have shown to be linked to neuro-developmental problems in mice, but are also believed to be endocrine disrupting compounds. Furthermore, these substances are disposed of in domestic landfills and enter the environment through leeching or evaporation (Alcock et al. 2003)

Endocrine disrupting compounds are found to affect all levels of the food chain (Jackson & Sutton 2008). The transmission of these endocrine disrupting compounds into the environment comes from WWTP effluent, however, it has been shown that the source with the highest levels are in industry and these endocrine disrupting compounds

are then washed out when workers clothes are laundered and sent to WWTPs. The use of reclaimed water carries its own health risks considering the amount of endocrine disrupting compounds in the wastewater effluent (Xu et al. 2009). It is believed that the best removal process for endocrine disrupting compounds is concentrating them in the wastewater sludge (Hashimoto & Murakami 2009; Tan et al. 2007). This creates new problems for WWTPs that use this sludge as alternative resources for fertilizers and other uses.

Another alternative removal mechanism found that biotic processes play a critical role and small-scale shallow wetland constructions were efficient in removal of endocrine disrupting compounds (Song et al. 2009). Standard chlorination and biological treatment to remove polybrominated diphenyl ethers from wastewater proved to be inefficient (Peng et al. 2009), thus a more advanced treatment method is suggested such as membrane treatment. Reverse osmosis membrane usage in tertiary or advanced wastewater treatment has also been shown to efficiently remove endocrine disrupting compounds such as polybrominated diphenyl ethers (Zorita et al. 2009), however, this process is expensive and requires large amounts of energy.

Polybrominated diphenyl ethers are, as stated before, compounds used as flame retardants (CDC 2004). They have been shown to affect the thyroid and nervous system development in lab animals and are listed as a possible human carcinogen by the EPA. Great concern has been expressed over the bioaccumulation of polybrominated diphenyl ethers in humans and marine animals from WWTP effluent (Oros et al. 2005). Song et al. found that treatment plants are likely a major contributor to polybrominated diphenyl ethers contamination (2006:6241). They also note that polybrominated diphenyl ethers

often leech off the products they are found in because they are mixed and not chemically bonded. There is still little data on polybrominated diphenyl ethers and Clarke et al. (2008) conclude that further study needs to be done on possible human effects specifically concerned with wastewater reuse.

Munoz et al. (2009) developed such a risk assessment for reuse of wastewater and showed that there were low levels of polybrominated diphenyl ethers in WWTPs in Spain. However, Munoz et al. believe that there is an analytical risk to human health from polybrominated diphenyl ethers. In order to fully protect the public health advanced tertiary treatment such as membranes are needed. Furthermore, in the absence of wastewater reuse, polybrominated diphenyl ethers should be removed from wastewater due to the environmental impact and the possibility for human uptake (North 2004). Higher levels of polybrominated diphenyl ethers have already been reported in the Atlantic fishing stock and this is due to bioaccumulation as well as increased discharge of effluent (Shaw et al. 2009).

The growing concern over polybrominated diphenyl ethers is partially due to the rising levels found in North America (Betts 2002b:188). The conclusions of this study showed that the body burden of polybrominated diphenyl ethers in breast milk among mothers in North America was the highest in the world (2002:50A). For the years 1970-2000, the average concentration of polybrominated diphenyl ethers in the lipids of breast milk increased to 200 nanograms per gram. Concentrations of polybrominated diphenyl ethers have not only been found just in breast milk, but also in placentas and umbilical cord blood, meaning that there is pre-natal exposure to these compounds (Gómara et al. 2007). The rise of polybrominated diphenyl ethers concentrations are not just limited to

North America, but have been increasing in such places as the Arctic (Betts 2002a:189). The growing prevalence of polybrominated diphenyl ethers is of extreme concern given that these compounds are extremely stable and will remain in the environment at high levels for decades.

While the U.S. EPA has not specifically banned polybrominated diphenyl ethers, concern is being raised by the academic community. The structural similarity of polybrominated diphenyl ethers to polychlorinated biphenyls (PCBs), dioxin and furan is of great importance (Gómara et al. 2007; Domingo et al. 2006; Costa et al. 2008). These compounds are known to be toxic chemicals harmful to human health. Polychlorinated biphenyls are controlled under the Toxic Substances Control Act (TSCA) and were banned in 1979 (EPA 2009c). They are known carcinogens with effects on the reproductive, nervous, endocrine and immune system. However, polybrominated diphenyl ethers, a structurally similar compound, have yet to be regulated by the EPA.

Environmental Risk Assessment

Risk assessment is a methodology used by both anthropology and public health. This is determined through qualitative or quantitative values of risk or hazard to humans posed by activities such as policy programs to development projects. This tool could serve very useful if applied to an environmental/ecological policy, however, it is currently not being used adequately (Lackey 1996:48). As stated previously, anthropology has much to offer in the form of methodology for environmental policy and assessment. This research looks to bridge the gap in both fields not by working on them individually, but by combining both in the research design. Doing this will address the weakness in the environmental risk assessment by calling attention to societal and

political factors not currently being addressed by public health officials. Furthermore, risk assessment is highly politicized for it concerns several stakeholders (Douglas & Ney 1998:137). These various stakeholders will want to control risk communication to reflect their interests. These interests might include preventing implementation of regulations or trying to publicize risk for moral reasons. These issues are not formally addressed in the environmental risk assessment process; however, attention does need to be given to these powerful underlying factors.

There has been resistance to incorporating more societal and political analysis, largely due to an entrenched belief in positivist notions or the belief that for something to be true it must be observable (Lee 2002:141). Countering this resistance involves a multidisciplinary approach. This will be done by developing, “methodologies to measure public values, preferences and priorities; and to develop or improve ways to present decision consequences to the public in a decision-neutral manner” (Lackey 1996:48). The decision neutral manner is one that allows the public to decide the best course of action, not the policy makers.

These decisions are largely based on the environmental risk assessment performed by public health professionals. As previously stated, traditional environmental risk assessments include hazard identification, dose-response assessment, exposure assessment and risk characterization. The concerns of these assessments are with biological, physical and chemical agents that are harmful to human health. In this process there is emphasis on quantitative variables instead of qualitative ones. The result of traditional risk assessments is to inform policy decisions that are established

using a cost-effective approach. This type of approach requires what can be economically feasible with the given technology.

Risk characterization that does incorporate some aspect of social factors does so in a very economic cost-centered approach (Satterfield 2001:332). This analysis is the final stage in the traditional environmental risk assessment and estimates how risk potential. This process weighs heavily on factors that can be of quantitative significance, but not ethically derived. In response Satterfield coined the term *value literacy* in which voice can be given to the social, political and environmental values individuals may have. These values are not derived from strict survey format, but from allowing the respondents the allowance to express their knowledge and perceptions relating to an environmental concern.

Identifying the contaminant and moving towards a description of the traditional environmental risk assessment factors that adequately convey risk and addresses issues of misconceptions or lack of knowledge is important in this project design. Anthropologists have focused on structural issues while leaving the mediation up to public health and engineering specialists. For the purpose of this research, mediation can include treating the wastewater for these polybrominated diphenyl ethers as well as directing policy makers to address the possible issue of public knowledge. The research begins to address traditional environmental risk assessments as it intersects with contaminants using anthropological knowledge. This will help to fill a void in anthropological and traditional environmental risk assessment literature while also increasing the purview of both disciplines.

In summary, there is a knowledge gap in anthropology and environmental health that needs to be addressed. A nexus between these two disciplines will help to address the complex issues surrounding reclaimed water use. As shown throughout this literature review there is a complex web of social, economic, political and environmental issues. There are also weaknesses in an anthropological approach that relies too heavily on quantitative variables and an environmental health perspective that relies too heavily on analytical approaches. This nexus would support a balanced approach to the issue of reclaimed water use in the Tampa Bay area.

The efficacy of reclaimed water implementation needs to consider not just the current water situation, but the large pervasive issues of risk perception, risk communication and environmental health. The fields of anthropology and environmental health offer solutions to the issues facing the local area today and in the future. The nexus of these two disciplines is where the most benefit can be gained.

The importance of water cannot be stated enough and protection of this vital resource has gone a long way to ensure quality. This includes not only protection of our bodies of water, but also drinking and irrigation water standards. However, this protection only goes so far and now we are faced with climate change that has impacted the availability of water nationally and locally. This scarcity and concern for the environment has led to the implementation of the reclaimed water system and illustrates the importance of studying wastewater reuse.

The impact of polybrominated diphenyl ethers on health of the environment and humans, while still under investigation, has raised concern. The larger issue of environmental factors leading to the increasing amount of chronic diseases underscores

this concern. Endocrine disrupting compounds such as those found in PPCPs and other chemicals have created problems that wastewater engineers and public health professionals have not anticipated. This is of even greater concern with the increasing use of reclaimed water from treatment plants that were not designed to deal with PPCPs and other chemicals. Contaminants, specifically polybrominated diphenyl ethers, in wastewater are of importance not just because of the human health concern they pose, but also because of the impact they have on perceptions of risk. Understanding risk perception and risk communication is important in maximizing the potential of wastewater reuse and the acceptance of this resource.

The concern for wastewater reuse has also brought attention to the issues of risk including risk perception and risk communication. Risk is a social construct that impacts people's behavior and one way to address this perception is through the communication process. It is important that planners realize the importance of community participation during the management process and that transparency is a key element of communication. These anthropological concepts are part of a nexus with public health to address inadequacies in both disciplines. As far as I know there has been no anthropological research on risk perception and risk communication in regards to water reuse. For environmental health, traditional environmental risk assessments have historically been without input by the community and have overlooked important political ecological factors.

The importance of the political ecological framework is evident with the complexity of the factors involved in this research. Social, economic, political and environmental factors cannot be separated into distinct categories because they are all

inter-related. Some of these factors may be more prominent such as larger environmental issues when talking about diseases related to chemical exposure, but underlying this circumstance are also social issues.

The next chapter will discuss the methods employed in this research. As shown in this literature review, the issues surrounding reclaimed water are a complex web of laws, social issues, and environmental health concerns. Using both ethnographic and environmental health methods is a way to highlight the broader view of issues surrounding reclaimed water.

Chapter Four: Methods

This chapter has four main sections. The first section lays out the research objectives for the thesis project. The second section discusses the IRB approval process with details concerning ethical considerations. In the third section I go into detail about the semi-structured interviews including a discussion on the fieldwork sites, formulation of the interview script, collection, storage, analysis and limitations. The last section pertains to the wastewater sample research. In this section I discuss the field site, materials and methods, and limitations.

The anthropological and environmental health methods employed in this research are important to understanding the perception of risk, risk communication and environmental health concerns. Anthropology's strength is in ethnography which allows researchers to think from the bottom-up as well as the top-down (LeCompte & Schensul 1999a:16). A bottom-up approach looks at the smaller parts first such as a person and progresses to larger parts such as an organization. Top-down approaches do this in reverse. Environmental health methods such as risk assessments are significant in addressing potential human health concerns. This chapter states the variety of methods used and their importance.

This thesis research looked to obtain both wastewater and interview data using environmental health and anthropological methods. The objectives of this research project were to analyze perceptions of risk among Tampa Bay residents, evaluate the

level of risk communication between government officials and residents, and analyze reclaimed water for several compounds that might be a human health concern within a political ecological framework. This approach is similar to work done by Terre Satterfield (2002) on the perceptions of loggers and environmentalists. The methods utilized in this research project included semi-structured interviews and EPA methods for sampling and analyzing water for Polybrominated diphenyl ethers.

These research objectives dealing with analysis were done in two related parts. The first part pertained to risk perception and communication of risk. For this portion of the research semi-structured interviews were employed in Tampa and St. Petersburg. I performed this portion of the interview by myself. The last segment of the research objectives, field collection and laboratory analysis of reclaimed water for potential health concerns was completed using EPA methods for polybrominated diphenyl ethers in water (EPA 2007). This part of the research was team based and included Dr. Foday Jaward, Kristy Siegel and myself.

Ethical Considerations

While waiting for IRB approval to conduct interviews, I moved forward with the wastewater analysis since this portion of the research did not involve human subjects. The process of getting new IRB approval for my thesis research cost me valuable time during the allotment I had set aside for thesis research. It was not until the end of July that I received IRB approval and at that time I began to collect interviews with residents in Tampa and St. Petersburg. This additional time before the interviews were conducted allowed me to reflect on the ethical considerations for this research.

Ethical challenges are often unanticipated and result from poor research design (Whiteford & Trotter 2008). To address these potential problems there are many possibilities to consider. Ethical considerations of this internship project include interviewee confidentiality and informing residents of possible health concerns. Furthermore, additional problems may arise when following ethical considerations that infringe upon one another. An understanding of the stakeholders and conflicts that may arise from these individuals is an important consideration as well. The vulnerability of residents must be accounted for as well practicing beneficence towards all individuals involved in the research project. In this sense the principle of maximizing the good for the residents and minimizing the harm is of greatest importance especially concerning potential health hazards (Whiteford & Trotter 2008:46). This principle is also reflected in the COPH's mission to promote public health through research, education and service. Considerations of the right to privacy, voluntary participation, informed consent, addressing harm, control of data gathered and vulnerability must be addressed. Additionally, environmental justice issues of "right to know" is of importance especially if the residents are not fully aware of the water sample results.

Ethical guidelines from the Society for Applied Anthropology (SfAA), American Anthropological Association (AAA), the American Public Health Association (APHA) and the Internal Review Board (IRB) were followed. These principles allowed me to think and prepare myself for possible confrontations with ethical dilemmas during my research.

Conducting wastewater sampling and analyzing the data gathered is exempt from IRB approval. However, the ethnographic methods of the research project received IRB

approval. Prior to interviews, informed consent was required and confidentiality of the interviewees was exercised. Those individuals who took part in the interview data collection process were over the age of 18 and thus consenting adults.

Wastewater Research

Samples were collected from the Howard Curren Wastewater Treatment Plant in Tampa, FL and analysis of these samples for polybrominated diphenyl ethers was done under the supervision of Dr Foday Jaward in his lab in the College of Public. This portion of the research was team based and included myself along with another College of Public Health graduate student and an undergraduate from South Carolina University.

Eight locations were identified as sampling points along the treatment process. Each of the samples was taken at the end points of these processes in the following order: influent, primary settling, clarifier, nitrogen reactor, nitrogen settling, denitrification, reclaimed and the effluent. The influent is the incoming wastewater to the treatment plant. The influent is then carried to the air scrubbers where hydrogen sulfide is removed, then through screens to remove any grit. Next, the wastewater is moved to the primary settling tanks where solids settle to the bottom. This sediment is called primary sludge and is pumped to the sludge drying facility where it is turned into fertilizer. From the primary settling tank the wastewater is pumped into large reactors where pure oxygen, a disinfectant, is added and the remaining suspended solids are further removed in the clarifiers. After this stage, the wastewater nitrogen is added as a food source for the bacteria that assist in breaking down the organic compounds. The nitrogen is then removed by aerating the wastewater. After this denitrification stage, chlorine is then added to the wastewater. During this stage wastewater is pumped out as reclaimed water

and sent to residents for irrigation. The remaining wastewater is then dechlorinated in the last stage of the treatment process. This product is then pumped out as effluent into Tampa Bay. The sludge removed during the primary settling is sent to the sludge drying facility. This process removes most of the water from the sludge through high temperature dryers and the sludge is pelletized for distribution as a fertilizer.

This order reflects the treatment process at Howard Curren. The influent is the raw wastewater that enters the treatment plant directly from the sewage pipes. The reclaimed water is what remains after chlorination and the water that has been dechlorinated is the effluent and is discharged into Tampa Bay. The sampling was carried out using select locations along the wastewater treatment process.

Methodology for sampling and analysis of the wastewater from the Howard Curren was adapted from the Environmental Protection Agency's (EPA) method for brominated diphenyl ethers in water (EPA 2007). The first step in the method was to gather the materials. This included 1L amber sample jars that were used to collect and transport the samples from Howard Curren Wastewater Treatment Plant to the lab. Upon collection, the samples were stored in coolers with ice and thermometers to ensure they were in line with the EPA methodology (2007) of transporting and storing samples at less than six degrees Celsius. Transporting the sample in this way is important to ensure its quality and arrest any degradation of the polybrominated diphenyl ethers in the samples. Upon arrival at the lab, the samples were stored in an industrial freezer until preparation of the sample for extraction and analysis.

The wastewater samples were extracted using a separatory funnel. The two liters from each sample point were poured into two separatory funnels each funnel holding 1

liter for extraction preparation. The samples were then spiked with 25 microliter (μL) of the polybrominated diphenyl ether recovery standard 35 and 181 purchased from AccuStandard. Five milliliters of reagent water, purchased from Fischer Scientific, was then added to the empty sample jars, shaken and then poured into the corresponding separatory funnels. This step was then repeated with 60 mL of methylene chloride three times. The purpose of this step was to ensure that all the polybrominated diphenyl ether compounds were transferred into the separatory funnel.

The separatory funnels were then shaken and the organic layer containing the polybrominated diphenyl ethers was allowed to settle to the bottom and this portion was removed. The solution was then concentrated on the rotary evaporator to approximately 0.5 microliter (μL) and then micro-concentrated using a nitrogen blow-down system.

The samples were then cleaned using a column containing silica gel, alumina and sodium sulfate. The solution was then concentrated and micro-concentrated again in the same manner above to 0.5 microliters (μL). Upon completion of the micro-concentration the samples were transferred to GC vials for analysis. Mirex was used as the internal standard. The samples were analyzed using a gas chromatography-mass spectrometry instrument. The next step was to measure the concentrations in each sample.

To measure the concentration of polybrominated diphenyl ethers in each sample the areas of the standards (table 4) were used to create a calibration curve (equation of the best-fit line) was created using the scatter plots as seen in figure 4. Identification and quantification was carried out against five polybrominated diphenyl ether calibration standards of known concentrations. From this calibration, concentration of polybrominated diphenyl ethers in the wastewater samples were calculated using the area

of the samples as 'y' and solving for 'x'. Once the area is calculated you then adjust for the two liters (L) taken from each sample location. To do this, we must divide the equation by 2 million microliter since there are 1,000,000 μL in 1L. The equation to calculate the concentration in each sample was:

$$x = \left(\frac{y + 80.237}{3.5783} \right) \times \frac{1}{2,000,000 \text{pg}/\mu\text{L}}$$

Table 4. Areas of Standards and Mass

Area	Mass (pg)
42	25
96	50
201	100
503	150

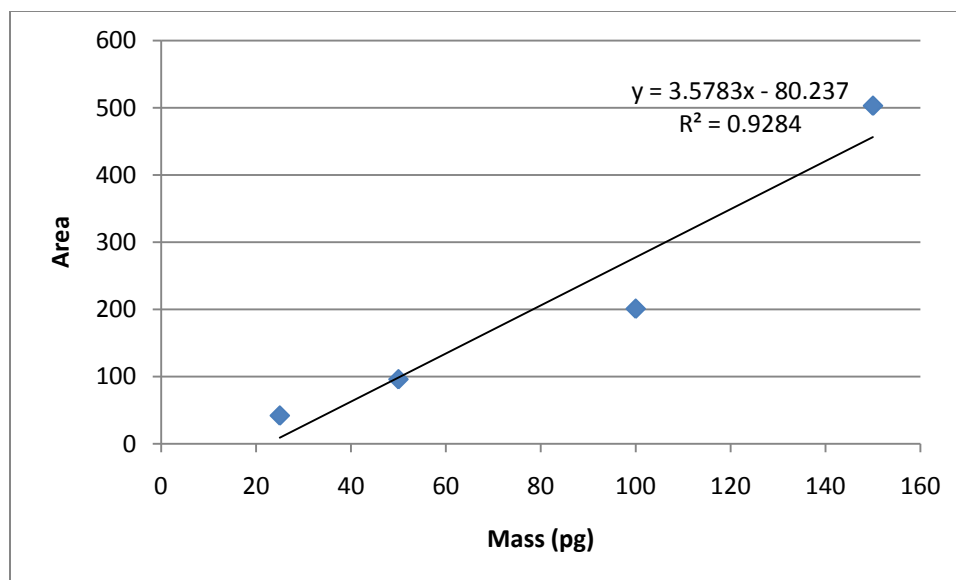


Figure 4: Polybrominated Diphenyl Ether 47 Equation of the Line

Once the concentration values were identified using the GCMS instrument they were analyzed to answer the research questions. The questions were: what is the concentration of polybrominated diphenyl ethers in the wastewater if there are detected concentrations and is there a stage in the treatment process that removes this compound?

To ensure quality sampling and analysis, a practice run was performed. This involved travelling to the treatment plant, sampling, transporting the samples, preparing the samples for analysis and analyzing the samples. This followed the EPA protocol and it allowed the group to alter some of the steps in the methodology. All the alterations to the EPA (2007) method were done in the preparation of sample and analysis stage. Changing methodology is common practice to explore more efficient and sound steps. The revision to the methodology was to use two liters of water at each of the eight sampling steps instead of the one liter listed in the EPA (2007) method. The reason for this alteration is that it was believed concentrations of polybrominated diphenyl ethers

would not have detectable levels at one liter. At the end of the analysis this doubling of the recommended sample was accounted for.

All the procedures discussed above were monitored for assurance and quality control. The calibration curve peaks produced by the GC-MS instrument were only reported as peaks if the signal-to-noise ratio was \geq three. That is if the signals were three times higher than the surrounding undulations or noise, they were identified as polybrominated diphenyl ether peaks. If they were not three times greater they were reported as non-detectable or ND. From these peaks concentrations of polybrominated diphenyl ethers were calculated.

As with all research this study had limitations as well. The limitations of the study were considered prior to research, but there were several issues that arose which created additional limitations in the research. As with most research time is one of the largest limiting factors. This proved to be true for this thesis research as well.

For the wastewater research I had originally planned to collect samples from several of the surrounding treatment plants. However, due to the time intensive process of sampling, preparation, extraction, cleaning and analysis the research team was only able to perform collection and analysis on the Howard Curren Wastewater Treatment Plant. The intent was to collect wastewater samples beginning in the summer of 2009 and continuing to the Spring of 2010. The reasoning for this was to account for any potential seasonal variability. This would be ideal to capture differences in the contaminant load as well as completing a time series analysis and time series forecasting that might be beneficial to local WWTPs if it is decided to remove contaminants from the

effluent. However, research was halted after the summer session due to unforeseen issues affecting a fellow research team member.

Interview Research

Fieldwork for this project occurred in Tampa and St. Petersburg. Interviews were conducted in both cities and the wastewater analysis took place at the Howard Curren Wastewater Treatment Plant in Tampa. All these locations were chosen for specific reasons.

A total of fourteen semi-structured interviews took place in the Tampa Bay area, more specifically, the City of St. Petersburg and the City of Tampa. Initially the research proposal aimed for 20 interviews; however, due to time constraints on the research from additional IRB approval this number was reduced to 14. The research was conducted from June 14th to August 2nd. Prior to conducting interviews, maps were accessed from the Southwest Florida Water Management District's (SFWMD 2009) website detailing where reclaimed water was accessible to residents. This was the primary inclusion criterion for the interview sample. Individuals were collected through door-to-door canvassing throughout the areas with reclaimed water. Once areas with reclaimed water access were located, it was assumed that the areas with the largest concentration of reclaimed lines put down would also be the highest concentration of users. As you can see in maps of the reclaimed network in Hillsborough (figure 5) and St. Petersburg (figure 6) provided below the areas with the highest visible reclaimed network density were chosen for interview collection. Further discussion of the interview data will occur later in this chapter.

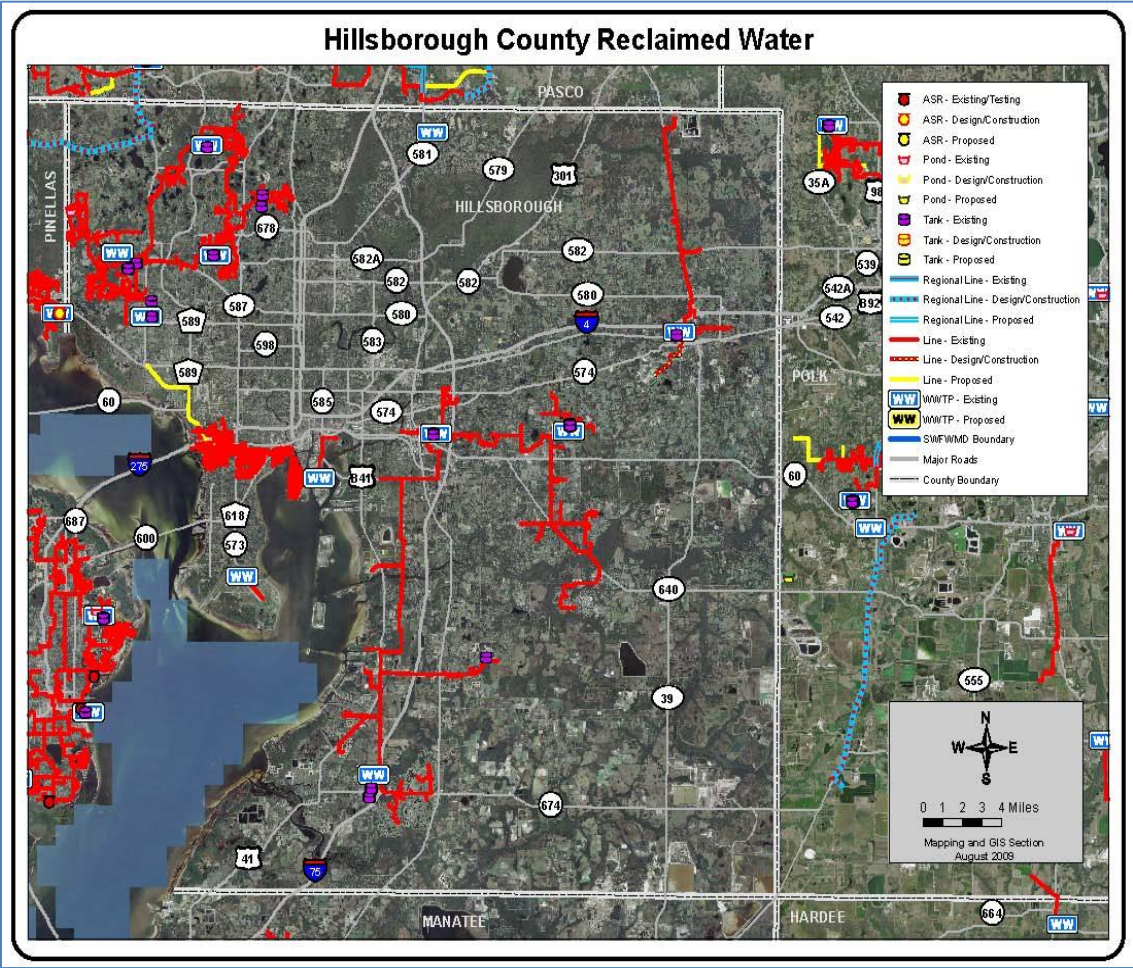


Figure 5: Hillsborough County Reclaimed Water Map

(SWFWMD 2009)

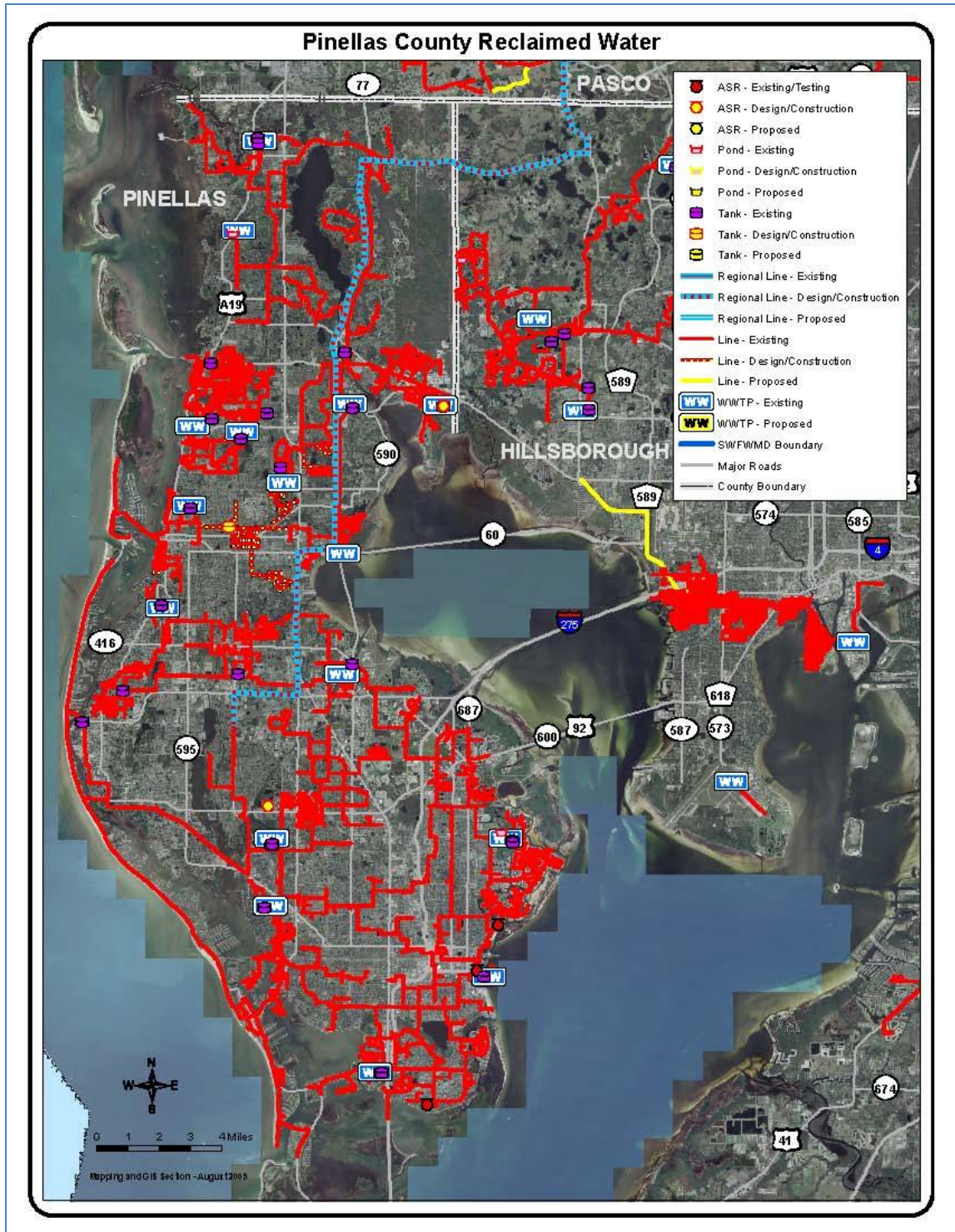


Figure 6: Pinellas County Reclaimed Water Map

(SWFWMD 2009)

From these maps, two neighborhoods in Tampa; Beach Park in South Tampa and Carrollwood Village in North Tampa, were used to collect interviews. Beach Park is located West of Lois Avenue and South of Kennedy Blvd. Carrollwood Village is located West of Dale Mabry and South of Ehrlich Road. Three neighborhoods in St. Petersburg; Historic Old Northeast, Snell Isle Property Owner's Association and Shore Acres Civic Association all in the Northeast quadrant of the city below the Howard Franklin Bridge, were used to collect interviews. These neighborhoods were chosen after looking at maps provided by the Southwest Florida Water Management District and locating areas with the highest visible concentration of reclaimed water pipes. Once this process was completed interview scripts were created.

Literature reviews were conducted on reclaimed water on a local as well as national level and on risk perception, risk communication and polybrominated diphenyl ethers to help in the creation of the interview script. Documents on reuse programs as well as the efficacy of risk communication came from disciplines including ecology, biology, environmental science and policy, as well as political science (Cutter 2006a; Cutter 2006b; Cutter et al. 2006; Dow & Cutter 2006; Major 1993; Kaspersen et al. 1988). Anthropology and geography provided background on risk perception (Gregory & Satterfield 2002; Satterfield & Gregory 1998; Douglas & Ney 1998; Douglas 1985; Douglas & Wildavsky 1980).

The literature came from a variety of sources including academic peer-reviewed journals and texts as well as newspaper articles and publicly accessible information on the reclaimed treatment plants in the local area. These documents were located by searching through freely accessible Internet databases such as Google. Google provided

newspaper articles on reclaimed water both locally and nationally. Subscription based databases such as JStor, Science Direct and Web of Science provided more of the technical and academically viable information on risk communication and risk perception. Specific journals dealing with environmental health and anthropology such as environmental science & technology and human ecology were individually searched. Searches began with general terms such as environmental health and then were refined to include more accurate terms such as polybrominated diphenyl ethers, wastewater, risk perception and risk communications.

Local and national newspaper articles were collected regarding reclaimed water programs and human and environmental health concerns (Redmond 2009; Zink 2009a, b, c; Legg 2007; Stifler 2007). Academic journals provided the basis for archival research on polybrominated diphenyl ethers as well as additional information on potential human health concerns (Shaw et al. 2009; Costa et al. 2008; Gómara et al. 2007; Domingo et al. 2006; Oros et al. 2005; North 2004; Betts 2002a, b; Munoz et al. 2009). Texts offered technical insight into the reclaimed water treatment process such as that carried out at the Howard Curren WWTP as well as information on risk perceptions and risk communication (Drinan & Whiting 2001).

The background information from risk communication and risk perception helped in the creation of the interview outline questions, such as designing this research to investigate what risks people thought about when it came to using reclaimed water. Archival research on risk communication, cited above, further assisted in formulating questions that look at residents' knowledge of risk as well as their knowledge of the

treatment process. This preceding research is important in ensuring proper data collection.

The collection of data occurred through semi-structured interviews. These interviews were carried out, in the neighborhoods listed previously, by going door-to-door. Prior to entering the neighborhoods I made attempts to contact neighborhood leaders. The reasons for this contact was to inform leaders what I would be doing in the neighborhoods, but also attempt to create the introduction into the neighborhood smoother for the purposes of collecting interviews.

First, neighborhood organization presidents or neighborhood watch group representatives were contacted. The City of St. Petersburg updates a list of neighborhood organization representatives every year (2009b). From this list I contacted representatives of the Historic Old Northeast, Snell Isle Property Owner's Association and Shore Acres Civic Association. I attempted to contact these individuals over the phone from the numbers listed in the City of St. Petersburg document (2009b) and left brief message stating who I was, about the project I was working on, what I hoped to accomplish in their neighborhoods and asked if they could be of any assistance. I only had one individual return my phone call and was told that they had no means of communicating with residents other than at neighborhood meetings that they have every month. I was told that I should try to come to the meeting, which I was unable to do because of transportation limitations. I asked what a good time to do door-to-door interviews would be and was told that most people are home on Sunday afternoons.

For the two neighborhoods in Tampa, Beach Park and Carrollwood Village, I attempted to contact neighborhood organization leaders as well. This proved to be more

difficult as no contact information was provided for the Tampa neighborhood organization leaders. Since I was unable to contact any such neighborhood leaders I proceeded with the door-to-door interviews.

The interviews conducted in Tampa and St. Petersburg followed the same guidelines and interview script that were submitted to IRB. Semi-structured interviews were used so as to allow as much flexibility in answering questions as well as pursuing concepts that were brought up during the interview process (LeCompte & Schensul 1999b:154). Due to this flexibility, the use of probes to investigate topics brought up during the interviews. These interviews were designed to look at the respondent's perception of risk as well as whether risk communication was effective. The topic of risk perception is widely regarded as an important factor in dealing with environmental issues since risk is social construct (Paine 2001; Douglas & Wildavsky 1980). Anthropologists such as Johnston (1995) and Torry (1986) have shown that risk is based on a variety of social issues and that this concept of risk is based on the individual level (Douglas & Ney 1998). Since the research was looking at potential environmental hazards it was appropriate to also look into risk perception by interviewing residents one on one.

The communication of risk is noted by Major (1993) to be the most successful with people are not just told about an environmental issue, but are informed of it as well, thus, for there to be effective risk communication, residents must have an understanding of the hazard. For this reason, questions about residents' knowledge on the reclaimed water system were asked. Stigma is also a concern since it is a byproduct of poor communication (Gregory & Satterfield 2002). The issue of risk perception and communication of risk are inseparable.

The interview script was designed to touch on these topics; however, as stated they were not limited to just these topics. This interviewing technique is ideal for situations in which the person is interviewed once (Bernard 2006:212). With this technique I was able to probe into topics that the participant talked about during the interview. The interviews lasted anywhere from five minutes to as long as 45 minutes. Nine of the fourteen interviews were conducted in St. Petersburg with three interviews being collected in each of the three neighborhoods. The Beach Park neighborhood only produced one interview and the other four came from Carrollwood Village.

The informal structure was centered on themes relating to public knowledge of reclaimed water, risk perception of residents, communication of risk by local government agencies and reasons for using reclaimed water. All effort was given to make the interviews as free-flowing as possible. Participants could choose whether to give consent for the interviews to be audio-recorded and if consent to be recorded was given no notes were taken during the interview. However, if consent was not given for the interview to be audio-recorded, notes were taken during the interview, but not in as great of detail to make the participant feel ignored or that they had to slow down or repeat what they were stating. After leaving the homes of interview participants, I took detailed notes of the interview and reflected on them. Notes included answers and themes that the participants emphasized that could not be derived from the audio recordings. The interviews were then transcribed and coded. Themes were drawn from the transcriptions and will be discussed in subsequent chapters.

All data gathered were stored properly according to IRB requirements. The integrity of the interview data was controlled by making all data obtained available only

to me. If permission was given, the interviews were recorded, and then transcribed. At no point, however, was a name given or address written down. The interviews and surveys were coded and stored on computer with password access where I was the only person with access to it. Each participant was given a code so there would be no personal identifiers and the signed informed consent documents were kept in a locked room. These forms are kept in a separate file from the transcriptions and codes. The data is being monitored regularly to ensure that it is still there and intact. After a period of five years the data will be destroyed if there is no further use of them for research purposes. Furthermore, the data collected will only be used for research purposes outlined in this thesis.

Once the data was gathered analysis began with deductive coding. The deductive analysis was to divide data according to the concepts that the interview script laid out as well as include field notes in this process. The purpose of the deductive coding was to build a framework from which I can support my results and conclusions (LeCompte & Schensul 1999c:45). Deductive coding works from the general to the more detailed or what might be also referred to as a bottom-up approach.

This data was coded using ATLAS.ti 5.0. This tool allowed the coding process to be easier, but also more efficient. The transcribed interviews were first coded using repeating topics outlined in the interview script; risk perception and efficacy of risk communication. Additional topics that were coded included political, social, economic and environmental. The transcriptions were then coded for additional themes that respondents brought up through probing. This process was not without its limitations.

Interviewing over the course of a year would be ideal as it would allow for a comparison of responses that occur when there are not water restrictions in place. Interviewing also proved to be complex since neighborhood leaders were difficult to reach and residents were prone to either not answer the door or say they were busy and couldn't take part in the interviews. I was also limited to when I was able to collect interviews, as I had no reliable transportation. Additionally due to the late IRB approval reaching the original goal of 20 interviews was also not achieved and instead 14 were collected. Furthermore there was no baseline data available to ascertain background levels of polybrominated diphenyl ethers in the environment nor were there any published reports about residents that dealt with risk perception and communication of risk.

In summary, one of the defining characteristics of anthropology is the application of its methodology to real world issues. As shown, a variety of methods were employed including deductive coding and environmental hazard detection to ensure a holistic approach to the issue of reclaimed water in the Tampa Bay area. The implementation of reclaimed water systems needs to consider not just the environmental hazards, but also the social, political and environmental factors. The political ecological framework allows researchers to use multiple methods when exploring a far-reaching issue such as this. The choice of methods is important in research design. Those chosen for this research project were done so for specific reasons such as choosing methods that would be ideal for the singular contact I would have with participants (Bernard 2006). Additionally, a deductive approach offers a way to work from the bottom up with the environmental hazards analysis representing a narrower focus on a single compound.

The combination of both wastewater analysis and interview data represents a holistic approach to the problem of drinking water contamination. Applied anthropology entails addressing real world problems, such as wastewater contamination, and addresses these issues in an engaged manner. However, challenges do arise during the research process and these cannot all be anticipated.

The following chapter will discuss the results of the research. I will discuss what the methods described above have shown about risk perception, risk communication and potential environmental health concerns. Anthropological and environmental health methods have been used to provide a broader understanding of reclaimed water issues in the Tampa Bay area.

Chapter Five: Results & Discussion

This chapter presents the results and discussion from the wastewater analysis as well as the interviews. The wastewater analysis was the primary focus of this research, but the interviews play an important role in contextualizing the issue of reclaimed water. Even if the concentration of polybrominated diphenyl ethers in reclaimed water is not a human health concern, the perception people have about reclaimed water could ultimately decide whether it is used as a supplement to drinking water.

Wastewater

The purpose of the wastewater analysis was to measure polybrominated diphenyl ethers in the wastewater samples and to assess the level of human health concern. There were eight samples taken at varying points along the treatment process. The analysis of wastewater samples was to show two things: the concentration of polybrominated diphenyl ethers at the varying stages and thus show if there is a human health concern and to investigate how much of the contaminant is removed and at what point in the treatment process it is removed. This is important in the discussion of ways in which to remove this contaminant from wastewater that is reused for irrigation purposes. The EPA currently has no set MCLs for polybrominated diphenyl ethers. However, we assume the MCL for dioxin, a structurally similar compound, will be similar to levels for polybrominated diphenyl ethers. The GC/MS assisted in identifying the concentration of this compound.

From the calibration curve provided by the GC/MS instrument we can establish an equation of the line provided. From this equation, provided in the methods section, we calculate the concentration of polybrominated diphenyl ethers for each sampling location. The mean polybrominated diphenyl ether concentration of the eight samples taken from Howard Curren Wastewater Treatment Plant was 42.4 picograms per microliter (pg/ μ L) or 42,400 part per billion (ppb). Parts per billion describe the proportion of one substance to another. An example would be one orange in a box of 1 billion oranges. Table 5 shows that the range of the polybrominated diphenyl ether concentrations from the samples was $8.23e^{-4}$ to 247.04 picograms per microliter (pg/ μ L). Table 5 also shows that the remaining samples; nitrogen reactor, nitrogen settling, denitrification, reclaimed and effluent had concentrations of 2.99, 2.40, 1.15, $8.23e^{-4}$ and 1.05 picograms per microliter (pg/ μ L) respectively. These sampling points correlate with the progression of the wastewater treatment process beginning with the influent and moving through the primary settling, clarifier, nitrogen reactor, nitrogen settling, denitrification, reclaimed and effluent stages. As you can see there is a drastic decrease of the polybrominated diphenyl ethers found in the influent (247.04) over the course of the treatment process. The only discrepancy is the increase of the polybrominated diphenyl ethers in effluent (1.05 picograms per microliter (pg/ μ L)) when compared to the reclaimed ($8.23e^{-4}$ picograms per microliter (pg/ μ L)).

Table 5. Concentration (pg/ μ L) of Polybrominated Diphenyl Ethers in Wastewater Samples from Howard Curren Wastewater Treatment Plant

Sample	Area	Concentration (pg/ μ L)
Influent	1.768e ⁹	247.04
Primary Settling	ND	ND
Clarifier	ND	ND
Nitrogen Reactor	2.141e ⁷	2.99
Nitrogen Settling	1.719e ⁷	2.40
Denitrification	8.297e ⁶	1.15
Reclaimed	5603	8.23e ⁻⁴
Effluent	7.58e ⁶	1.05

Table 5 shows the concentrations of polybrominated diphenyl ethers from the eight sample points: influent, primary settling, clarifier, nitrogen reactor, nitrogen settling, denitrification, reclaimed and effluent. The concentration found in the influent was 247.04 picograms per microliter (pg/ μ L). This is the concentration coming into the treatment plant. The primary settling and clarifier results were non-detectable because the associated peaks didn't pass the quality control standard of being three times higher than surrounding peaks.

There was a decrease in the concentration of polybrominated diphenyl ethers in the influent, 247.04 picograms per microliter (pg/ μ L), compared to the effluent, 1.05 picograms per microliter (pg/ μ L). During the first two stages of the treatment process (primary settling and clarifier) we have non-detectable levels. Sludge is only removed

during these first two stages of the treatment process which explain the large decrease in polybrominated diphenyl ether concentrations and this is consistent with the findings of Harrison et al. (2006) and later Gevaio et al. (2008). In their findings polybrominated diphenyl ethers were found concentrated in the sludge, thus, when this sludge is removed during the treatment process so are most of the polybrominated diphenyl ethers.

As the treatment process progresses the wastewater is treated with chlorine and prior to dechlorination, reclaimed water is pumped out. The remaining wastewater is then dechlorinated and the effluent is discharged into Tampa Bay. The results show that keeping the wastewater in contact with chlorine reduces the concentrations of polybrominated diphenyl ethers. This is counter Peng et al.'s (2009) findings that chlorine was not effective in treatment for polybrominated diphenyl ethers.

The results also show that the concentration of polybrominated diphenyl ethers in the reclaimed water was $8.23e^{-4}$ picograms per microliter (pg/ μ L). This amount is lower than that of the effluent and this raises a significant question, why is there a higher concentration of polybrominated diphenyl ethers in the reclaimed than the effluent? The answer is the additional step of dechlorination after the reclaimed is sampled and before the effluent sample is taken. As discussed previously, the chlorine in the effluent is removed before being pumped out to the bay while the reclaimed water still has chlorine in it when it is pumped to residents for irrigation.

The EPA has no established reference dose, or maximum established dose, for polybrominated diphenyl ethers. However, the Department of Health and Human Services does have guidelines for dioxin, a structurally similar compound to

polybrominated diphenyl ethers, which has a limit of 1-4 picograms per kilogram per day (pg/kg/day) (CDC 2008).

Since the Federal government has left the standards of reclaimed water up to states, the State of Florida has decided that the effluent must be dechlorinated while the reclaimed must contain chlorine (Parsons 2009). These standards are established by the Florida Department of Environmental Protection. It is my belief that the reason for the lower concentration is that the reclaimed waters sample has a longer contact time with the chlorine increasing the amount of time chlorine is able to break down the polybrominated diphenyl ethers. This longer contact time with chlorine may be a treatment technique to lower the concentration of polybrominated diphenyl ethers being sent to residents for reclaimed water irrigation. This would be especially useful in meeting human health and environmental standards for polybrominated diphenyl ethers when they are established.

We can compare the concentration values of polybrominated diphenyl ethers found to MCL of dioxin set by the EPA. Dioxin can be used as a surrogate to establish MCLs for polybrominated diphenyl ethers in reclaimed water. Beginning in 1993, waters suppliers were required to monitor dioxin levels every 3 months for an entire year (EPA 2006). If dioxin was found to be above five parts per trillion (ppt) those water suppliers were required to continue monitoring. If those levels were above the MCL they had to implement remediation technology such as granular activated charcoal, which is recommended by the EPA.

The MCL set by the EPA (2009a) for one type of dioxin in drinking water is $3e^{-8}$ mg/L or what equates to $3e^{-5}$ picograms per microliter (pg/ μ L):

$$\frac{3 \times 10^{-8} \text{ mg}}{1 \text{ L}} \times \frac{1 \times 10^9 \text{ pg}}{\text{mg}} \times \frac{1 \text{ L}}{1 \times 10^6 \text{ }\mu\text{L}} = 3 \times 10^{-5} \text{ pg}/\mu\text{L}$$

This amount is well below all the values in Table 5. Both reclaimed water and effluent are out of compliance if we use dioxin MCL for drinking water as a surrogate for polybrominated diphenyl ethers. Since Tampa is considering using reclaimed water as a supplement for drinking water, attention to chemicals of similar structure to polybrominated diphenyl ethers and their MCLs are important. There are no set standards for polybrominated diphenyl ethers in WWTPs because these plants are concerned with the removal of pathogens and nutrients, not necessarily with chemical compounds. While the concentration of polybrominated diphenyl ethers is of concern there are concerns for other factors including disinfectant byproducts. The reaction between contaminants in the water and chlorine produce these byproducts. One such byproduct is chloroform, a known human carcinogen.

From a quantitative risk point of view polybrominated diphenyl ethers pose a risk to humans. The results show that it is not just the reclaimed water concentrations of polybrominated diphenyl ethers that we should be interested in. This compound has the ability to bioaccumulate, and the concentration found in the effluent is of concern because it enters the aquatic environment. Once in this environment the compound bioaccumulates in the food chain leading to higher concentrations in fauna, such as fish, and eventually creating another exposure route for human beings. The director of the EPA, Lisa Jackson, has recently noted the emerging concern of polybrominated diphenyl

ethers and made the recommendation that it is a toxic compound that should be regulated (Avril 2009).

Also of concern is the additional sample taken from the Howard Curren Wastewater Treatment Plant for future analysis. It is possible that additional concentrations of polybrominated diphenyl ethers could be found in the commercial fertilizer pellets made from dried sludge. Edible flora such as zucchini, have shown the ability to uptake polybrominated diphenyl ethers from soil particles creating additional exposure routes (Mueller et al. 2006:6662). A sample was taken from the sludge drying facility (City of Tampa 2009b), and while this sample is not for the purposes of this research, it deserves future analysis to determine whether concentrations of polybrominated diphenyl ethers are present and at what levels.

As a comparison, the effluent concentration of polybrominated diphenyl ethers at the Howard Curren Wastewater Treatment plant were higher than the effluent from the Palo Alto, CA WWTP (North 2004). The concentrations from the Palo Alto plant ranged from as low as 4×10^{-9} to a high of 2.9×10^{-5} picograms per microliter (pg/ μ L). The Palo Alto plant and the Howard Curren Wastewater Treatment Plant both use tertiary technology making them similar in treatment techniques. Therefore, the concentration of polybrominated diphenyl ethers in the effluent at Howard Curren (1.05 picograms per microliter) is far higher than those at other treatment plants. This fact raises questions as to what other harmful compounds are higher in concentration at the Howard Curren plant than other reclaimed water treatment facilities.

In summary, this section presented the results and discussion of the wastewater analysis. MCLs for dioxin were used as a surrogate for polybrominated diphenyl ethers

for purposes of comparison. The concentration of polybrominated diphenyl ethers in the reclaimed as well as the effluent were found to be above the MCL of dioxin. This raises concern for human health with the City of Tampa's possibly using reclaimed water as a supplement in drinking water. It has been recommended that the EPA needs to establish regulations for emerging contaminants such as polybrominated diphenyl ethers, and the concentrations found in the samples emphasize the need to monitor and regulate this compound.

The following section presents the results and discussion of the interviews. Quotes from the interview are used as the results and are imbedded within the discussion to contextualize the data. Discussion includes issues of risk perception and risk communication. The chapter also discusses themes of environment, cost, behavior and politics.

Interviews

This chapter presents both the data from the interviews as well as discussion of this qualitative data. Quotes from the interviews are imbedded within discussions of their significance. The interview data is representative of residents from St. Petersburg and Tampa. Residents were asked probing questions on several themes including risk perception and risk communication. Since this research was conducted under a political ecology framework questions also were constructed to probe the interaction between humans and the environment including social, economic and political factors. The interviews were conducted to contextualize the reclaimed water topic in the Tampa Bay area and were not intended to serve as quantitative data. There were a total of 14 interviews carried out in the Tampa Bay area with nine from St. Petersburg and five from

Tampa. Themes from the interviews include risk perception, risk communication, environmentalism, economics, behavioral change and politics.

Issues concerning wastewater reuse do not end with identifying chemicals that pose a risk to human health, but extend to perceptions of risk and the communication of risk held by members of the Tampa Bay communities. Viewpoints held by a community are not always homogenous. The semi-structured interviews allow for both overlapping and contrary viewpoints to be presented. There were a total of 14 interviews conducted in two communities in the Tampa Bay area. These interviews provided valuable insight on water reuse.

However, it should be noted that the interviews were conducted in areas with the highest concentration of reclaimed water pipes. These neighborhoods were also predominantly white, above the average for the respective cities of St. Petersburg and Tampa. The fact that these neighborhoods have the highest concentration of reclaimed pipes falls in line with the Tampa Bay area's history of segregation. These neighborhoods are given resources that other neighborhoods are not. While a further analysis would need to be completed, remnants of white privilege still appear to exist.

The interviews were formulated to gather residents' perception of risk and risk communication. The semi-structured nature of the interviews also allowed for the respondents' descriptions of economic, environmental, social and political factors to be expressed. These factors were essential in conducting research through a political ecological framework. The discussion below helps to contextualize the issue of reclaimed water in Tampa Bay. Furthermore, it allows researchers to better understand the political ecology of reclaimed water and allows planners to better understand

residents' perceptions. This is of growing importance not just for environmental policy in general, but also for the future of Tampa which currently has a 2010 ballot initiative to supplement drinking water with reclaimed water. The perception that the public has on reclaimed water will decide whether this initiative is carried out.

Risk perceptions have already been established as a result of social processes within anthropological research. However, individuals have different societal inputs that affect their cognitive processes. As Douglas and Wildavsky (1980) stated, people react differently to risk based on a variety of social inputs. These input variations change how individuals may react to a risk. People's beliefs impact how they would perceive reclaimed water.

As discussed in the literature review chapter, risk is a cognitive process. This cognitive process is affected by life events of individuals, such as social, political and economic factors, facets of the political ecological framework (Douglas & Ney 1998:136). All these factors influence the way an individual reacts to a hazard, such as their perception of risk.

When one resident was asked what they thought about reclaimed water they responded by saying:

I am ignorant to everything that is in it. From local folklore my understanding is that it is not for consumption.

Another stated:

I've heard it has certain properties in it that would corrode a car and stuff like that.

It appears that people are coming to decision about reclaimed not based on their own specific personal experience, but include the experience of others. As Douglas and Ney

(1998) point out, individual's perception of risk are based on local level experiences, which would include communication and interaction with neighbors. The use of "local folklore" and what they've heard from others is not a unique behavior. It speaks to the power of communication to address such perceptions. These perceptions of risk are also based on how safe people believe the reclaimed water to be and what they believe the health concerns are.

The safety of reclaimed water is an important aspect of risk perception as pointed out by Paine (2001:68). In this case, risk is a social construct based on how safe something from outside the body is. The interviews showed that some people thought the reclaimed water was safe. St. Petersburg, more so than Tampa residents seemed to feel that reclaimed water was fairly safe:

I... just from experience from using it, I feel like it, the water is treated pretty well. If no one told me not to drink it or touch it, then I might have, because it looks really clean. It comes out just as clean as my tap water. I don't notice that it smells, I don't notice that it's discolored, dirty or anything. It looks like very clean water.

Other St. Petersburg residents thought not only was it safe for their lawn, but also for food. One resident was asked about their vegetable garden in the backyard and what they use to water the area with they said:

I use water that is reclaimed... I would rather prefer the rain water, but sometimes it's hard to get it.

On this same line of thought, another resident said:

I would say that reclaimed concerns me most, but I am not concerned about it. If they told us it was ok to drink I would drink it.

However, the feeling that reclaimed water was safe was not homogenous among St. Petersburg residents. One resident not only felt that reclaimed water was not safe, but that other water sources were not either. They said:

I don't drink the regular water, I drink the bottled water. I don't drink it out of the faucet. I am sure there is nothing wrong with it, but I just think it's safer to drink the spring water.

Some residents were more specific about their reason for feeling that reclaimed water wasn't safe. The reasons for this varied from concern for themselves to animals and even their cars. Tampa residents were not as comfortable with the safety of reclaimed water. This concern was primarily about the 'source' of the reclaimed water and the effect it had:

I think everyone knows that it's not for consumption and not for personal use. Don't just use it to clean your drive way and wash your car. Try and avoid contact with skin and stuff like that. Most people know about stuff like that. It's the source that makes you think about it.

Another Tampa resident said:

I am concerned about reclaimed... because it's human wastewater.

When asked what concerns they had one resident responded:

I do worry about reclaimed water because it's used water, I mean it's used water!

Others were concerned about what effect the water might have:

I've heard it has certain properties in it that would corrode a car and stuff like that.

I do wonder about pets if they get into it, after you water and you know it's still on the grass. So I wonder about that and they run it in the house.

I prefer the public water, because it's clean and I don't have to worry about being careful of it getting in my eyes or skin.

Concern for pets was prevalent throughout the interviews in St. Petersburg and Tampa:

I have cats that roam around out there and they drink it and my dogs will walk and lap it up. I guess I would probably wonder, I just don't think about it because I just think of it as on my grass.

The health concerns that residents raised were for themselves, but also their pets. The health concerns over reclaimed water revolved around the perception of it being 'human waste' and the affect the water has on surfaces it touches such as skin. The level of risk people associated with reclaimed water seemed to be based upon their location. St. Petersburg residents were more comfortable with reclaimed water while Tampa residents had some concerns. Tampa residents seemed to have the perception that reclaimed water is wastewater. This belief was found in the majority of interviews with few exceptions. These exceptions appeared when residents knew something about the treatment process. Knowledge about the reclaimed water treatment process was lacking across the Tampa Bay area, however, St. Petersburg residents did seem to know more about the reclaimed process than Tampa residents. All residents were asked if they knew how reclaimed water was treated. If the respondent indicated they knew about the reclaimed treatment process follow-up questions probed how extensive this knowledge was. The resident with the most detailed knowledge about reclaimed water was from St. Petersburg and they had this to say:

I know that there are 7 steps at the reclamation center, I went on a fieldtrip there and that's how I know. If I didn't go on a fieldtrip when I was in school I probably wouldn't know.

This same person also said:

As long as you don't drink it you're fine. If they told us to drink it I probably would. I don't because they tell us not to, but I think it is fine.

Another St. Petersburg resident said they knew how it was treated and when they were asked what the treatment process is:

I know there are steps in treating the water. They have to remove some of the larger shit that's in and they add chemicals to it. I know they use chlorine and that there are some salts in the water because there are certain plants that you can't grow with that water.

This same person went on later to say how comfortable they were with reclaimed water:

I use it to fill my swimming pool sometimes and I usually use it to wash my car. We used it a couple of weeks ago for my daughter's birthday where we had slip and slides.

Tampa residents weren't as familiar with the treatment process. One resident thought that the wastewater used in reclaimed water was:

They use the Hillsborough River water for our drinking water and the water that has been sitting around for a while and is dirty they allow us to use for reclaimed.

This type of comparison shows that knowledge about the reclaimed treatment process seems to relax some of the heightened health concern perceptions that people may have. Those that were not as knowledgeable about the treatment process (i.e. Tampa residents) seemed to be more concerned about such things as damage to their cars and the destructive nature of reclaimed water. Those that had more knowledge about the treatment process (i.e. St. Petersburg residents) were more comfortable using reclaimed water not only for irrigation, but other purposes as well. These purposes would have increased their contact and the contact of others with the reclaimed water. One of the quotes above shows that there was contemplation of using the reclaimed water as a drinking source.

The distinction between St. Petersburg and Tampa residents is most likely due to the history of reclaimed water in the region. St. Petersburg has had a reclaimed water

network for decades and it is a very extensive network. Tampa, however, only began offering reclaimed water for irrigation in 2001 to residents. St. Petersburg residents have much more experience with reclaimed water than do Tampa residents.

Most residents, however, didn't appear to have an extensive knowledge of how the reclaimed water system works. Many did not know they had access to such a source. Four of the interviews conducted resulted in my telling the residents that they have access to reclaimed water. This was found in both St. Petersburg and Tampa. I had to show them the reclaimed water network map (SWFWMD 2009) so that they could see the availability throughout the Tampa Bay area including their neighborhoods. I made sure that they understood that by having access to the reclaimed water source that meant the pipes had been laid down and they had to hook them up to their irrigation system. Even with this explanation there were comments such as:

I use my water (public water) now because I don't have reclaimed. If I did I would definitely use it because it's cheaper.

Another said:

I used to have it but then the City took it away. My neighbor still uses it, but I don't know why I can't anymore.

I was shocked to hear these statements from residents. They both in fact were using reclaimed water. I knew this because of the purple symbol on their irrigation pump. Purple markers are also used on curbs to signal that a residence is hooked up to reclaimed water. Purple pipes are also used at the Howard Curren Wastewater Treatment Plant to signify the reclaimed water pipes.

It turned out the residence was a rental property and all the bills go to the landlord. The person occupying the house had this to say:

I wish I would have known that I was using reclaimed water. I don't have a problem with it, but I would have liked to know so I could learn what I am putting on the lawn.

The resident who did not know that they had reclaimed seemed worried and asked if I had any information on reclaimed water. I had to tell them to contact the treatment plant and they could access the treatment plants website online. This interview and the other showed that there is a knowledge gap. It appears that the majority of perceptions on reclaimed water were based on limited knowledge and those that did have additional knowledge perceived reclaimed water to be less of a risk. Furthermore, the interviews provided insight into what residents knew about availability and whether they were using reclaimed water or not. This apparent lack of knowledge does not just include the treatment process, but other tangential factors. Communication by the local government agencies should be addressing the issue of educating the public on reclaimed water. The interviews also provided insight on how residents perceive this communication.

As discussed above the majority of residents knew very little about reclaimed water and in one case the resident did not know they were using it at all. Major (1993:266) states that to effectively communicate risk to a population solutions must be given not just information. In this case the residents receive very little information on reclaimed water. Residents did receive some information, but this came from other sources than the local government agencies. There were slight differences in what respondents had to say about risk communication based on their location. When a St.

Petersburg resident was asked what type of information they get from the city and how informed they feel one resident had this to say:

My neighborhood association gives us information about the reclaimed water. It's really popular in my neighborhood and most people know about it.

Other St. Petersburg residents said:

I don't hear much from the city, but I think they will tell us if we need to know something. At least I hope they would tell us if there is something wrong with it. I just don't know anything about it and I have lived here for 25 years.

It appears that the information about reclaimed water is coming from neighbors and the social networks inside the communities. Residents have a relaxed demeanor in regards to reclaimed water and feel that they are told what they need to know.

The answers regarding risk communication were slightly different with Tampa residents' responses:

When the system (reclaimed pipes in the area) was first put in there were newsletters and notices and ties strapped to the thing (valve to turn on reclaimed water) saying don't use for personal use, but that's the only time I have seen any information on it.

The only time I heard about it was when they started restricting water usage. A lot of people started talking about using reclaimed instead.

Generally residents were not impressed with the communication efforts by the government agencies:

I don't think I am all that informed on reclaimed water. It's kind of hard to make heads or tails on it.

These comments just don't reflect a lack of knowledge, but a lack of communication by the local governments to inform residents. These residents are using reclaimed water, but can only recall local governments giving information on it when system were first installed if at all. This recollection is based on location. Tampa has recently installed

reclaimed water pipes in the area while St. Petersburg has had them for several decades. This was reflected in residents' recollection of whether there was risk communication. The Tampa residents that did recall information being given out felt that it was done so impersonally and through notices. Most of the residents gained their knowledge through neighbors. This lack of communication impacts not just what residents know about reclaimed water, but what answers may be given when asked questions. It has also been suggested by Satterfield (1998:630) that if there is poor risk communication, respondents have been found to provide economic cost-centered answers.

Residents were asked reasons why they chose their particular source (i.e. public water, reclaimed, natural, well) for irrigation. The comments provided were general remarks found in most of the interviews regardless of their location in St. Petersburg or Tampa. Satterfield's (1998) finding that cost-centered answers were highly prevalent when risk communication was low was true in this case as well. Economic factors do play an important role in what decisions people make and this is seen in the quotes below:

I don't have to pay as much for reclaimed water and whenever I can I try to use it.

I never had reclaimed until I moved into this place. I think it's great. If I had known how cheap the bill is I would have found a place with it sooner.

I really like reclaimed because it's cheaper than running my well pump.

I was going to get reclaimed, but I decided not to because I use rainwater for my lawn. Now that it's dryer I wish I would have had it installed.

These quotes show cost-centered answers for why they chose or didn't choose reclaimed water. It should be noted that there was no discussion or statement made in any of the

interviews regarding the benefits of reclaimed water. Residents that have reclaimed water are not held to the same watering restrictions that non-reclaimed users are. The non-reclaimed users periodically experience limits set by the Southwest Florida Water Management District on when and how long residents can water their lawn for.

Those that use reclaimed do not have to abide by such restrictions. They typically have much more freedom in when and how long they water their lawns for. When asked about reasons for using reclaimed the monthly water bill being lower was the most frequent response. However, none of the interviewees mentioned the hook-up fee for the reclaimed water. There is a cost associated with being tied into the reclaimed water network. The hook-up fee for the City of Tampa (2009 c) is \$375 for the City of St. Petersburg (2009a) the amount is \$295. Residents seemed to be focused on their monthly bills and did not include tangential factors for why they chose or did not choose reclaimed water.

Cost was not the only answer given for why they chose the source of water for irrigation they did. There were some who felt that it was more environmentally sound to be using reclaimed and in some cases no irrigation system at all. The environmental concerns were based on what impact using drinking water for irrigation had on the environment. One resident said:

I don't like using the public or well water because it's bad for the environment... It has to affect the aquifer level.

Others said:

Rainwater is the best... water my lawn with rain water if I was able to I would do that, but reclaimed is the best option for me right now. I'd be interested in these rain barrels because it makes sense to use water that's already there.

You have got to be crazy to use your regular drinking water. I think that's, talk about a water shortage. I mean why would you do that? I am sorry, I don't know if I would water my lawn if I didn't have reclaimed.

I don't think it really is cheaper to use reclaimed... I don't run it enough to earn my money back, but we're in a water shortage and I don't want to be like Phoenix.

I use rain. You know why? Because it's free! Let nature water your lawn.

Residents do use reclaimed not just because it's cheaper and in one case there was no monetary return because they didn't run it enough. The underlying theme behind these statements is the environmental impact that using drinking water has. The environmental and economic factors, as highlighted by the political ecology framework, are influencing people's behavior. Concerns about the aquifer and the drought correlated to use of alternative water irrigation supplies such as reclaimed or rain water. In these statements residents show their concern for drinking water supplies and their environmentally inclined actions. This concern led some of the residents to discuss changes in their behavior.

For a few residents that were interviewed using reclaimed water was not just about saving money or conserving water, but about larger behavioral changes. These changes in behavior included a decrease in the consumption of resources such as water, but also electricity and food. Residents varied in how their behavior had changed some consumed less and some changed how they performed activities:

I have started to water early in the mornings. I heard that it's better since the grass has longer to soak up the water before the sun hits it. I just hear all this stuff about water shortages on the news and it's kind of scary.

I am going to show you my water book (retrieves water bills). It shows on the bottom, this is the new one, right there 59 gallons compared same period last year 173 gallons/ day.

There were others who had taken this change a step further:

My air conditioner it leaks, but I have a bowl under that and I take it and dump it on my lawn. It's only a bowl of water, I am not a miser, I just figure what the heck I might as well spend my 30 dollars on something else instead of giving it to the water company and wasting the water. It's just a mission of mine.

I shut my hot water heater circuit breaker off and I turn it on for about an hour in the morning and I turn it off before I go to work and there is enough to take a shower and if I have to wash some dishes.

And ah... it's just a lil conscious, we all take so many things for granted, we just don't care, we don't care. You know and, not that my lil bit makes a difference to anybody else, today it makes sense.

For many changes in behavior such as when they water their lawns and how much water and electricity they use makes sense to them. An understanding that resources are not infinite has led many residents to shift their focus to more sustainable living practices. Sustainability as discussed in previous chapters is not only improving the quality of life for people now, but also ensuring that future generations have the same, if not better, standard of living (Roseland 2005). For residents there were definite social factors influenced their behavior such as concern for future generations. As one resident put it:

I just think that it's scary to not have water or elec[tricity], it's silly... in the long run it's costing everybody and I don't want that to happen to my grandchildren. I think how awful things would be for them.

The stimulus for these changes, concern for water and electricity usage, is clear. Part of this concern surely has to do with how much people are spending on their utility bills.

The poor state of the economy was a concern when these interviews were conducted and this point should be factored into this discussion. However, people truly felt that it was more than cost-savings. They felt that it was a responsibility they had to assess the level of affluence and think how wasteful they are in their everyday lives. For some the

tipping point was concern for the current drought. Heavy restrictions had been placed on residents' irrigation habits with the exception of reclaimed water users. Even so, there was concern about the water shortage among reclaimed water users. As one respondent noted, there has been a lot of discussion on the news about the water shortage. This discussion has raised the level of awareness with regards to consumption of resources. People are beginning to understand that it makes sense to be less wasteful, but attention to their political views should not be overlooked.

Political factors are an integral part of the political-ecology framework. Their importance can't be understated in the outlook people have on issues. This is true for reclaimed water use in the Tampa Bay area as well. In almost any case there are always opposing political views and an understanding of these views is important in the political ecology framework. The use of water restrictions was political from some of the respondents. For some the political influences were going too far and infringing on their freedoms:

I don't support them using people's money for certain issues. Why should my tax dollars go to people having reclaimed water?

I am a libertarian and I don't believe that at any time the government should be able to anything from anyone and everything should be communal efforts... as we say in the libertarian community, 'when we give away our responsibilities we give away our freedom'.

For others the influence of the government should go further and not only offer assistance for low income residents but also implement water rationing:

They should have something where they help the people change it. You know some kind of scholarship or something. Some kind of a program.

I do think that they should make it (reclaimed water) mandatory but they have to make it affordable or give an allotment or a reimbursement or something or each

home gets a certain amount, raise the taxes a penny, I know everyone yells about the taxes but what's the difference between 7 cents on the dollar and 8 cents on the dollar?

I just think, start limiting people, you know. I don't know you got 8 people living in your house then maybe you use your allotted water and that sounds like communism, but you have to have a balance... you have to be realistic that when you go over your certain amount it's on you.

These opposing political views represent the variety of opinions individuals have on how much control governments should have in implementing such projects such as a reclaimed water network. All the quotes above came from respondents who were reclaimed water users. The respondent above who said they were libertarian made comments that may seem contradictory since the reclaimed network he is on was funded and implemented by the local government. However, his views should not be cast aside. These political influences represent barriers to implementation of a wastewater reuse program.

In summary, the data from the discussion show some distinction between Tampa and St. Petersburg residents on issues of risk perception and risk communication. This seems to largely be due to experience with reclaimed water. St. Petersburg has decades of experience over Tampa. The distinction between St. Petersburg and Tampa ended here and it was clear that residents with more experience and knowledge regarded reclaimed water as less of a risk. The additional themes regarding environmental, economic and political factors were similar regardless of location. A consensus of the themes among the communities in Tampa Bay will make it easier for governmental agents to model a risk communication program.

More and more people are becoming concerned for the environment and this view is shared among the communities sampled. Community members are balancing their perceptions of environmental, economic and political factors in decisions involving reclaimed water usage. These factors affect risk perception, but as shown above experience and knowledge will play a vital role in the success or failure of using reclaimed water as a supplement for drinking water in Tampa.

The next chapter discusses the integrative approach taken in this research. There will also be a discussion on the integration of the results and discussion from the wastewater analysis and interviews.

Chapter Six: Integration of Wastewater and Interview Results

This chapter takes the discussion of the results a step further and speaks to the application of an integrative approach and combination of the results of these approaches. The interview data was meant to provide cultural and opinion data to contextualize the issues of risk perception and risk communication while the wastewater data was a quantitative measure of health risk.

This research is characterized by the integration of two research approaches, anthropological and environmental health, on the same issue of wastewater reuse in Tampa Bay. Incorporating these two approaches builds a more holistic view of the wastewater reuse picture. Wastewater reuse encompasses a variety of factors including social and environmental. The political ecology framework is grounded in the integration of these factors along with political and economic to prevent a narrow perspective. The use of the environmental health or quantitative approach and the anthropological or qualitative approach strengthens the research through a combination of methods that address the same issue, an understanding of wastewater reuse in Tampa Bay.

An understanding of the issue of reclaimed water is an important one in light of the potential supplementing of drinking water with reclaimed water by the City of Tampa. This research looks at both the potential human health impact by calling attention to an emerging contaminant of concern and by analyzing the perceptions of community members in the Tampa Bay area. The integration of these approaches

strengthens the research design and creates a more holistic perspective on the issue of reclaimed water in the Tampa Bay area through an integration of results.

The wastewater analysis has presented evidence for high levels of polybrominated diphenyl ethers in the influent and above MCLs for dioxin (a surrogate) in the reclaimed and effluent. This raises a risk concern on the fate and transport of these compounds in the wastewater treatment process. The concept of risk also extends itself to community members perception of risk and the communication of risk by local governments need to be addressed.

Furthermore the interview results show an interesting interaction between political, social, economic and environmental factors in influencing people's decisions. These factors of the political ecology framework show how decisions impact the human-environment interactions. It is interesting that the neighborhoods with the most extensive availability to reclaimed water also have low proportions of minority residents. This is a continuation of the racially segregated history in the Tampa Bay area. This continues on the theme of lack of access to resources for those most in need. It is not the wealthy communities that need a lower water bill every month; it is community groups who can't afford the water bill they already have.

While St. Petersburg and Tampa share the characteristic that the reclaimed water service is concentrated in more affluent areas of the cities it is interesting that Tampa unlike St. Petersburg is not operating at full capacity. One of the underlying themes in this research is the idea of sustainability and use of the reclaimed system is indicative of the public's interest in such an approach to resource use. How the residents of Tampa interact with the environment is an important factor to consider in the political ecology

framework. Perceptions of sustainability and a desire to act are tangibly related. The political ecology framework can help to discern why these differences exist as well as what course of action might be taken to address these differences.

The purpose of this research centered on the use of reclaimed water in Tampa Bay. The results of these approaches merge in their recommendations. Both approaches make identical recommendations that there is a need to create a broader and deeper knowledge base. For the wastewater this includes further understanding of polybrominated diphenyl ethers and creation of regulations to protect human and ecological health. For the interviews a more effective communication mechanism needs to be implemented by governmental agencies to broaden and deepen the knowledge base of residents.

In summary, the results and discussion of these approaches presents multiple perspectives on the issue of reclaimed water. Both approaches complement each other and strengthen the discussion of the results. These results show a need for a broader and deeper knowledge base among resident and government officials. Communities are unaware of health concerns and government officials are unaware of community risk perceptions.

The following chapter presents the conclusion of this research including further discussion of recommendations locally and nationally. Importance factors such as the contribution of this research and its importance are outlined. Political features including policy, funding and power and my personal opinions are communicated in this chapter as well.

Chapter Seven: Conclusion & Recommendations

When the well is dry, the value of water is known.

-Benjamin Franklin

During the summer of 2009, I conducted research on wastewater reuse in the Tampa Bay area. This research had two components. The first was to analyze reclaimed water for polybrominated diphenyl ethers, an emerging contaminant of concern. In this first component the research looked to answer two questions, how much polybrominated diphenyl ether is found in the wastewater and how much is removed.

The second component was to analyze perceptions of local community members on the issue of wastewater reuse. This included the perception of risk as well as risk communication. This research was meant to draw attention to the importance of local risk perceptions and risk communication, but also the importance of researching reclaimed water for any potential human health threats. This research became more important during the course of investigation because of the City of Tampa's plan to place an initiative on the 2010 ballot to supplement drinking water with reclaimed water.

The wastewater analysis showed high concentrations of polybrominated diphenyl ethers in the incoming wastewater stream. The analysis also showed levels of polybrominated diphenyl ethers in the reclaimed water higher than MCLs for surrogate compound (dioxin), indicating potential health concerns. However, there was a decrease in the concentration of polybrominated diphenyl ethers in the reclaimed compared to the

other processing stages. The likely cause of this is the amount of time chlorine was in contact with the reclaimed water.

The research showed that there are a multitude of factors that affect how people perceive risk. These factors include political, economic, social and environmental beliefs. For most residents these issues were largely swayed by the information they were receiving. Ideally, the communication of risk should come from governmental agencies and be supported by research, but instead risk was communicated by word of mouth amongst neighbors.

This chapter discusses the contributions of this research to the disciplines of anthropology and environmental health. The chapter also outlines recommendations both locally and nationally including issues of sustainability and environmental policy. I also present reflections and a summary of the research findings and their importance.

Contributions of Research

This research explored issues of risk perception and risk communication among community members in the Tampa Bay area. The findings show that there is concern among residents about reclaimed water use and that residents are not as informed as they should be by governmental agencies with regards to reclaimed water. This research integrates anthropology and environmental health to strengthen how reclaimed water issues are researched. An approach of this type attempts to investigate innovative ways to look at issues of sustainability both from a social and ecological point of view.

Anthropological literature on environmental risk confines itself to issue of risk perception and this study extended the research design to include risk communication as well. This research found similar findings to Douglas & Ney (1998) on risk perceptions

and failure in effective risk communication. Political, economic, social and environmental factors impacted the way residents viewed reclaimed water, and more specifically, how they viewed the health hazards surrounding reclaimed water, as was seen by Satterfield (1998).

The research showed that risk was in fact a perception built upon the community member's individual experiences, as stated by (Paine 2001). The results also supported the literature findings that communication of risk and knowledge is essential in addressing misperceptions or lack of knowledge held by the public (Douglas 1985). Residents received most of their information from their neighbors and not from governmental agencies. This lack of governmental communication led community members to support false perceptions and stigmas about reclaimed water, as was also found by Gregory and Satterfield (2002). This research took the recommendations of Gregory and Satterfield (2002) to include narratives in order to understand the perceptions of the public.

Previous research conducted on environmental risk has been carried out by anthropologists, but in an international context (Olson 1987, MacDonald & Iain 1998, and Panter-Brick 2002). However, research on environmental risk in the United States by anthropologists is limited. There has been research on this topic, but not to the degree that there should be.

Traditional environmental health assessments are supposed to incorporate qualitative and quantitative approaches especially with concern to policy recommendations. Lackey (1996) has found that there is a lack of qualitative and quantitative approaches in environmental health. The research here compensated for the

lack of community involvement and serves as a foundation to change more traditional environmental risk assessments from a positivist view to one that incorporates political, economic, social and environmental factors.

The wastewater analysis calls for more attention to be paid to emerging compounds of concern such as polybrominated diphenyl ethers and other endocrine disrupting compounds. This research supports previously published literature (Hashimoto & Murakami 2009; Tan et al. 2007) in finding that the polybrominated diphenyl ether concentration was reduced in the wastewater stream once the sludge was removed. Previous research looked at just the concentrations of polybrominated diphenyl ethers in the sludge and effluent. This study looked at the polybrominated diphenyl ether concentrations along the entire treatment process, filling this gap in the literature.

This new process in sampling and analysis of polybrominated diphenyl ethers sheds light on the steps that would be most useful in removing as much polybrominated diphenyl ethers from the reclaimed water stream. Previous suggestions for removal of polybrominated diphenyl ethers included reverse osmosis (RO) membrane technology by Zorita et al. (2009). The research here shows there is a possibility that such an expensive and energy consuming process may not be needed since the chlorine showed signs that it did lower the polybrominated diphenyl ether concentrations. The findings that chlorine contributed in the breakdown of polybrominated diphenyl ethers is counter to the argument by Peng et al. (2009) that chlorination is not an efficient means to remove polybrominated diphenyl ethers. The results of this research show that further study of polybrominated diphenyl ethers needs to be conducted.

An integrated approach was used that draws on anthropology and environmental health to address issues of sustainability and creative water strategies in the Tampa Bay area. Through this approach, future researchers have a foundation to build upon that bridged of these two fields. Each discipline can see that an approach using multiple methods creates more holistic findings.

Recommendations

During the research it became apparent that community members were receiving their information about reclaimed water from neighbors rather than official agencies related to water use and reuse, which affected their perception of risk. This transmission of knowledge between neighbors is similar to what Douglas and Wildavsky (1980) and Douglas (1985) find. Their research shows that there was little communication between the public and government officials and thus allowing for misconceptions about issues. Below are recommendations for increased awareness of reclaimed water and its part of the hydrologic cycle, communication of risk to community members, and ways in which to mediate future water scarcity.

Residents that had some knowledge and experience of reclaimed water seemed to be more at ease with reclaimed water use than residents who were not familiar with it. In this sense it is not so much the communication of risk that is of concern, but the communication of knowledge about reclaimed water to residents. Residents were sometimes not aware that they had access to reclaimed water. The community members' understanding on the use of reclaimed water centered on cost savings and there was little discussion on topics such as the chronic drought or sustainability.

Some respondents replied that they did not know anything about reclaimed water; however, others stated that it was reused water and only one could state that there were seven steps. Residents shouldn't be expected to know the technical aspects of wastewater treatment, but a general knowledge of the process was not seen. This indicates that for this sample of interviews there is not an effective channel of communication between the residents and officials. Responses describing reclaimed water as polluted water indicate a limited understanding of the larger water cycle. Responses of this nature place water in a narrowly defined open system disregarding the larger cycle. This lack of communication and lack of knowledge shows that there needs to be more involvement. Residents who say reclaimed water is reused water have a more holistic understanding of how reclaimed water fits into the hydrologic cycle.

This research highlights the need for local governmental agencies to communicate often and effectively with community members on the subject of reclaimed water. The communication of knowledge needs to also include discussion of issues such as the hydrological cycle and those that affect water quality and quantity such as the long-term drought in the Tampa Bay area.

An understanding that reclaimed water is not the end of a cycle would create awareness that the water we flush down our toilets re-enters back into the water cycle. An understanding of where water goes once the consumer is done with it is imperative. Water is not static and it moves through the hydrologic cycle. Seeing water in a holistic perspective might change people's perceptions of risk. The reclaimed treatment that occurs at the wastewater plant has been created to mimic nature's natural cycle. In the natural hydrologic cycle, water is discharged into the bay, heated by the sun until it

evaporates forming clouds and then eventually returns to the land surface as rain. Along the way water is 'cleaned' of contaminants such as solids found in wastewater. This process is similar for the treatment plant, it is just done mechanically.

Both processes are not completely enclosed. There is water loss in both natural and mechanical treatment. Not all the water that enters the bay is returned to the immediate land area. Some of this water transfers to other locations. The goal of reclaimed water is to try to close this cycle of loss and reuse the water that we have already obtained instead of sending it out to the bay especially when there are falling water levels. The mission of reclaimed water is to reuse the water we currently have immediate access to in a sustainable manner.

There is obvious interest in usage of reclaimed water. Some residents are waiting for their properties to be hooked up to the reclaimed network. With the increasing water restrictions placed on residents who use public drinking water for irrigation, reclaimed water is becoming a more attractive alternative irrigation source. With this increased interest there will also need to be further expansion of the existing reclaimed water network in the Tampa Bay area.

Reclaimed water use for watering purposes alone will not fully address the water shortage found in the Tampa Bay area. Additional creative water strategies are needed especially in light of the human health concern that polybrominated diphenyl ethers in reclaimed water may present. The possibility of using it as a supplement for drinking water will be asked at voting precincts in Tampa on the 2010 ballot. The use of reclaimed as a drinking water source is already in place in such places as Orange County California as well as other municipalities across the U.S.

Local officials must communicate not only risk to residents, but also general knowledge about reclaimed water. This knowledge cannot present water as static; instead, the communication must describe the hydrologic cycle so that residents can begin to understand that reclaimed water is not untreated wastewater. They perceive reclaimed water as a health threat, but only because they see reclaimed water as wastewater. If this logic holds true than drinking water holds a threat as it is wastewater. All water at some point in time has come in contact with waste. An understanding of the hydrologic cycle would explain that water moves through the environment and is cleaned along the way. Officials must communicate sustainable practices through a variety of channels based on the current knowledge of the communities.

A goal for sustainability is to ensure that future generations have the resources available to meet their own needs (WCED 1987). Sustainability does not only concern itself with environmental resources, but also encompasses social, political and economical factors and how these forces are all grouped together.

Traditional approaches to water resource management as it pertains to agriculture were constructing dams and using pumps and drilling wells that affected the water table and destroyed ecosystems and impacted local societies. Some have called for reduction in water use instead of just relying on development of new technologies (Gleick 2003).

In the coming decades there will be increased pressure on water resources. This is a result from increasing population rates and uneven distribution of population and water. This scarcity leads to a multitude of social problems including water conflicts, food shortages, health concerns as well as environmental concerns including ecosystem destruction (Postel 2000). Rural communities are the most vulnerable for these concerns

and wastewater reuse for agriculture is an important action that is underway in providing an empowering option for communities.

Environmental health is as much about addressing issues as it is about anticipating health concerns. This important component was exercised in this thesis by analyzing polybrominated diphenyl ethers a potential health concern. To mediate a potential health concern such as this environmental health would place controls, either societal controls or control limits.

Societal controls are those that would create policy dealing with the issue of reclaimed water. Such policy might continue to be regulated at the State level, which is the case now, or influence federal agencies such as the EPA to create national policies. The other type of societal control measure would be what public health calls behavior modification. This would result in advising residents to perform a different action than they currently do such as using reclaimed water as drinking water or eliminating reclaimed water for irrigation purposes. Control limits are standards set forth by policy. These standards would include MCLs that would be used to test and regulate reclaimed water.

These controls present a top-down approach where public health/government officials influence factors affecting the public, however, these approaches effectively leave out the public from this decision making process. The public's concerns are not usually heard in this process and thus important factors such as risk perception are ignored. Community involvement in the decision making process will allow community members to learn more about the environment and would allow officials to address potential conflict by addressing community perceptions.

Environmental Policy

Environmental policy establishes rules for how humans can interact with the environment. These include restrictions on what and how the quantity of chemicals that can be dumped into the environment as well as whether land can be developed. The breadth of environmental policy includes not just water policy, but land and air management policies. Both collective and individual power plays an important role in the formulation of environmental policy. The issue of power is also of extreme importance when communicating risk to the community. Power is not necessarily held in just the hands of government officials, but often times this is the case regardless of participatory planning and it is this distribution of power that often times determines the success or failure of a project (Masuda et al. 2008:360). Masuda et al. (2008) used Foucault's concept of 'governmentality' and power to describe the relationship between environmental planners and community members.

There are many levels of participatory engagement by communities in making decisions with environmental implications. Often participation by the community is controlled by environmental planners and repeatedly for the purpose of neoliberal development programs (Masudo et al. 2008:361). This is done through controlling the recruitment of community members into the planning process to ensure only certain opinions are expressed, developing a plan prior to contacting the community and defining knowledge (Masudo et al. 2008:374). By establishing criteria that allows policy makers to selectively recruit only certain segments of the population are included in discussions. The individuals invited may only be landowners and therefore excluding renters.

Developing a plan before contacting the community, planners are placing community members in a reactionary role. This does not allow the building of a plan to occur, but rather limits the valuable perceptions and knowledge community members may have. The issue of knowledge is of importance because if planners only recognize technical knowledge and not local knowledge this limits the discussion of alternative plans to drought and water reuse programs. These communities feel the feedback of policy decisions at a faster rate than those making the decisions. Local communities provide a unique knowledge of the environment in which they live and disregarding this knowledge leads to enacting policy that is misguided.

President Obama recently announced his intention to spearhead legislation that would broaden the regulatory power of the federal government for toxic chemicals (Avril 2009). Moreover, this broadened regulatory power would revamp the current policy process to ban or restrict the use of a chemical. The current process puts more emphasis on the cost effectiveness and less burdensome remediation techniques at the expense of human and ecological health. Under the Toxic Substances Control Act the EPA must show that the health risk must outweigh the economic or societal benefits (EPA 1976). Asbestos is probably the best example of where the burden and cost of addressing this public health issue was placed first over public health concerns.

The current EPA administrator has stated that new tougher laws are needed and with these laws one of her first concerns would be regulation of polybrominated diphenyl ethers (Avril 2009). Furthermore, the Chemical and Water Security Bill recently passed a House vote and will move to the Senate (U.S. T&I 2009). This bill would allow the EPA and DHS to determine what risks are associated with storage of chemicals at

wastewater and drinking water treatment facilities as well as recommendations of alternate chemicals and treatment processes to ensure safety.

Policy has not been occurring at the congressional level (McGrory Klyza & Sousa 2008:3), but it is occurring through Presidential orders, court ruling and state/local initiatives. Communities are beginning to be incorporated in environmental planning and have a say in the direction. We need to emphasis the need for individual responsibility but also collective action. Community involvement is essential in developing environmental policy.

What is required in the US to create a more sustainable water infrastructure is a future challenge that will require above all else financial investment. The funding that is available right now for water and wastewater alike is hundreds of billions of dollars below the estimated cost of increasing water sustainability (Mihelcic & Zimmerman 2009:14).

This funding remained without an increase from 1995-2004 with a range of \$1.2 to \$1.35 billion/year (ASCE 2005). For the 2005 fiscal year Congress reduced the budget for WWTPs to \$1.1 billion and President George W. Bush submitted a proposal to Congress to reduce this funding for fiscal year 2006 to just \$730 million. A 2002 needs assessment completed by the EPA (2002) stated that the US must invest \$390 billion over the next 20 years in wastewater treatment infrastructure in order to ensure the gains that have been made in sanitation since the Clean Water Act (EPA 1977) are not lost. This investment, however, produces an overall net cost of \$23 to \$37 billion because of the increase in efficiency in the treatment process (CBO 2002). The initial cost is extreme;

however, many of these treatment plants are approaching the end of their design lives (ASCE 2005).

Reflections

Reclaimed water is more than a cheap alternative to using drinking water for irrigation. It is a creative water strategy towards a more sustainable future. Sustainable solutions will require an integrated approach that combines political, social, economic, environmental and technological factors.

Population growth as well as inequitable access to resources strains the available resources such as water. Population increasingly puts pressures on the available resources because the more individuals there are the more resources are required. This is of concern when we consider the water scarcity issue that the Tampa area is experiencing through the chronic drought. There will be less and less water available and this will be more evident as populations in the area continue to grow. Inequitable access to resources also creates a problem. This factor plays a substantial role in sustainable development. There are some that continue to consume large amounts of resources while leaving very little for others.

Additionally, the issue of where the reclaimed network is offered to residents serves as an example of inequitable distribution of resources. While there is a fee for reclaimed water 'hook up', the money saved outweighs this in the long run. Residents of lower socioeconomic neighborhoods would benefit from more access to reclaimed water. If the goal is to create an environment of sustainable development resources should be offered to all on an equal basis not just a select few.

To address these issues there needs to be a moral economy approach where the collective good is put ahead of the individual good. There also needs to be sustainable governance. We can no longer sacrifice our resources for the benefit of a few. We can no longer sacrifice future generations for the comfortable living many have today. We can change how we interact with the environment. We must use an integrative approach that looks at issues of sustainability from multiple perspectives and offers suggestions for creative water strategies.

This research explored perceptions regarding reclaimed water in the local communities. The research also looked at possible human health concerns from polybrominated diphenyl ethers. With the City of Tampa potentially moving towards expanding reclaimed water's role to include drinking water, we must ensure that compounds found in wastewater are at appropriate levels. Social factors such as the perception of risk and communication of risk play directly into the acceptability by the City of Tampa residents to the use of reclaimed water as drinking water. Economic factors such as cost of using drinking water versus reclaimed and capital, the amount of money to operate a reclaimed facility affects the feasibility and the acceptability of a reclaimed water network in the Tampa Bay area. Political factors such as government support of reclaimed water and the unequal access to reclaimed water affects represents unequal power relationships and how these relationships affect the environment. Political ecology is a framework that incorporates the social, political, economic and environmental factors, and contributes not just to the understanding of how this complex web operates, but more specifically how these factors affect environmental policy and governance.

Environmental programs must be carried out on a more egalitarian basis if these issues are going to be resolved. Planners must move beyond an economic scope and realize the societal implications of programs as well as accept the legitimacy of local knowledge. Community members must also accept the technical knowledge of planners. Environmental concerns are sometimes more difficult to understand when there is no visible cause such as with pathogens or heavy metals in water. Finally all those associated with environmental issues must realize that power allows people to get involved and all concerns should be heard not just of those invited in the planning process. Community members must control the power of decision making and there must be respect for community generated knowledge.

This research is done as a precautionary measure to ensure that wastewater, to the best of our knowledge, is not harmful to the ecological environment or humans. In this light such a study presents findings that need to be addressed before reclaimed water is used a drinking water supplement. It is important that future research includes the ecological environment because of the interaction between humans and their environment as illustrated by the political ecological framework.

In summary, the importance of this research is an underlying notion to incorporate environmental health with environmental sustainability. The data from wastewater analysis and interviews are not separate from each other. They are two approaches to the same issue of wastewater reuse in the Tampa Bay area. What is important is the use of environmental health and anthropological methods that strengthens the research results through a mixed methods approach.

Using these approaches local communities can play a larger role in the policy decision making process. If there is little or no community input then decisions that are made will be missing key pieces of information. The findings show that incorporating anthropology, which looks at the local community, and environmental health, which looks at human health hazards, we can address the concerns surrounding drinking water shortages in the Tampa Bay area. This approach can lead to successful attempts at sustainability initiatives and increase the resilience of the local area to future droughts.

We need environmental policy that stresses sustainability for we have no alternative. We will need to tax ourselves more to ensure for the future. We cannot continue to burden the future generations with our reluctance to be responsible.

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Appendices

Appendix A: Interview Script

- 1) Do you live in Tampa or St. Petersburg?
- 2) What do you use to water your lawn? (i.e. drinking, reclaimed, natural, none, etc.)
- 3) Do you have a preference for one you aren't using?
- 4) What do you know about reclaimed water in general?
- 5) What do you know about how the reclaimed water treatment works?
- 6) How informed do you feel about using (drinking, reclaimed, natural, no water) for your lawn?
- 7) Do you feel that there is a health concern related to the water you are unaware of?
- 8) Do you have any health concerns about any option you have for irrigation?
- 9) Which one concerns you most?
- 10) Which is the primary reason for choosing the water you use for lawn care?
- 11) Where do you have your information on irrigation sources from?

Appendix C: IRB Approval Letter



DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

July 15, 2009

Ryan Davis
Anthropology
14233 Shiloh Woods Court
Tampa, FL 33613

RE: **Expedited Approval** for Initial Review
IRB#: 108158 G
Title: *Treating Wastewater: A Closer Look at Polybrominated Diphenyl Ethers, Bisphenol A and Estradiol*
Study Approval Period: 07/14/2009 to 07/13/2010

Dear Mr. Davis:

On July 14, 2009, Institutional Review Board (IRB) reviewed and **APPROVED** the above protocol **for the period indicated above**. It was the determination of the IRB that your study qualified for expedited review based on the federal expedited category number **six (6) and seven (7)**.

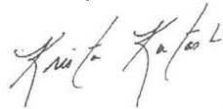
Approval included with adult minimal risk informed consent form.

Please note, if applicable, the **attached informed consent/assent documents are valid during the period indicated by the official, IRB-Approval stamp located on page one of the form**. Valid consent must be documented on a copy of the most recently IRB-approved consent form. Make copies from the enclosed original.

Please reference the above IRB protocol number in all correspondence regarding this protocol with the IRB or the Division of Research Integrity and Compliance. In addition, you can find the [Institutional Review Board \(IRB\) Quick Reference Guide](#) providing guidelines and resources to assist you in meeting your responsibilities in the conduction of human participant research on our website. Please read this guide carefully. It is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-2036.

Sincerely,

A handwritten signature in cursive script that reads "Krista Kutash".

Krista Kutash, Ph.D., Chairperson
USF Institutional Review Board

Cc: Anna Davis/cd, USF IRB Professional Staff
Linda Whiteford, PhD