Perspectives on Reclaimed Water among Urban Residents in Tampa, Florida

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Perspectives on Reclaimed Water among Urban Residents in Tampa, Florida

by

Jonathan Max Bloch

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science
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Date of Approval:
March 30, 2009

Keywords: water recycling, water conservation, environmental management, community attitudes, sustainability

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Acknowledgements

I would like to thank all those who made this thesis possible. Thanks to Dr. Pratyusha Basu, my academic advisor in the Department of Geography, who pushed me to tackle my doubts from the beginning, challenged me to rethink my assumptions throughout the writing process, and supported me with careful critiques and helpful suggestions right through to the end. Thanks to Dr. Robert Brinkmann and Dr. Jayajit Chakraborty, in the Department of Geography, for their significant contributions and helpful guidance in the revision of this thesis. Thanks to David Bracciano at Tampa Bay Water, for explaining the intricacies of water supply relationships in the county. Thanks to Dawn Ramos at the Hillsborough County Water Resource Services Department, and Bryan Zumwalt at Tampa Bay Water, for graciously providing me with detailed maps. Thanks to Jason Polk and Leslie North, who were willing, on innumerable occasions at day or night, to help me with formatting and revising this thesis. And a heartfelt thank you to all the residents of Carrollwood Village who so warmly welcomed me into their homes and took the time to thoughtfully respond to my questions. I hope my results can answer some of yours.
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Jonathan Max Bloch

ABSTRACT

Increasing urbanization coupled with increased domestic and industrial uses of water has made water conservation an important aspect of environmental management. Reclamation of wastewater is one way in which such conservation can proceed, and the aim of this thesis is to provide a case study about the perspectives of residents and officials involved in the use of reclaimed water in an urban development in Tampa, Florida. Using semi-structured interviews, it seeks to understand the range of opinions on the safety of reclaimed water, its potential prospects as an alternative drinking water supply, and its contribution to the sustainable use of water resources. While environmental concerns are often focused on controlling global warming through international policymaking, there are also smaller-scale local projects that are equally significant in terms of their potential contributions to long-term sustainability. By drawing attention to the local scale, this study underlines the value of focusing on environmental issues that are relevant to the everyday lives of community members, and hence enables an engagement with the ways in which conservation practices are already part of, and potentially can be further built into, the structure of urban neighborhoods.
Chapter I
Introduction

Research and development into sustainable uses of water is one of the most necessary tasks of the twenty-first century, a time in which the peril facing global water resources is beginning to be widely understood (Barlow 2007). In the United States alone, the overpumping of groundwater has been depleting vital sources of freshwater for decades. Schlager (2006) estimates that groundwater use in the United States increased by 14% over the period from 1985-2000, and states that such overuse may lead to local and national water crises. New policies in the field of sustainability and potential transformations in national energy objectives are likely to bring better solutions, but require a corresponding focus on using existing technologies and re-prioritizing the allocation of resources already present.

Public exposure and understanding of the environmental impacts of economic growth has grown steadily since the 1960s, so that environmental management has become both a growing subfield of environmental studies and a key function of governmental and non-governmental environmental organizations (Burke et al. 2000). Within this framework, concerns over global warming have become dominant in popular discourses of environmental change and hence served to produce policies oriented towards environmental management at the global scale (Intergovernmental Panel on Climate Change (IPCC) 2007). This study takes the position that it is also significant to understand the consequences of human impact on the environment at smaller scales, both because of the greater feasibility of intervening in local problems, as well as the ability of such local issues to illuminate the local understandings of wider environmental policies.

This thesis provides a case study of attitudes to reclaimed water among urban residents in the city of Tampa, Florida. Tampa Bay is one of the fastest growing metropolitan areas in the United States and is facing the consequences of overpumping of aquifers. Yet, it is also the site of water reclamation projects instituted by various county governments, which collectively saved Hillsborough, Pinellas and Pasco counties the better part of 23 million gallons per day (MGD) of potable water in 2008 alone (Tampa Bay Water 2009). The water shortages that are looming in the future of the region thus already have a potential solution, which makes it significant to focus on the extent to which residential users are aware of and open to various uses of reclaimed water. Furthermore, as public attitudes towards reclaimed water are not separate from their broader attitudes towards the environment, this study aims to locate these attitudes within the spectrum of environmental philosophies present in American culture and society.

Definition of Reclaimed Water

The term “reclaimed water” refers to municipal wastewater effluent treated for reuse. As defined by the Southwest Florida Water Management District, reclaimed water “is treated wastewater…a clear and odorless high-quality water source for industrial and
irrigation needs” (SWFWMD, undated website). This description serves three simultaneous functions: as definition, stating the origin of reclaimed water; as advertisement, praising its cleanliness; and as advice, describing its intended purposes. A definition that specifies a required level of treatment is provided by the Florida Legislature (1997, 1): “Reclaimed water is water that has received at least secondary treatment at a domestic wastewater treatment facility and is then reused.” A more universally applicable definition comes from the Water Science and Technology Board (1996, 1) of Australia: “when treated to acceptable levels or by appropriate processes to meet state reuse requirements, the effluent is referred to as ‘reclaimed water.’”

In this thesis, the terms “wastewater” and “reclaimed water” are used to mean different things. Wastewater is simply the final product of conventional wastewater treatment processes; reclaimed water is the same product destined for reuse.

Theoretical Framework: Meanings of Conservation and Sustainability

The ideological perspective of this study can be situated within the conservationist approach to the environment which can be considered the Middle Way among Western environmentalist views, walking a moderate path between the preservationist view on the one hand and the exploitationist view on the other. The preservationist view, also called “deep ecology ecocentrism” (Turner, R. 1988, 1) is a legacy of the naturalists and Romantic poets of the nineteenth century, among them John Muir and Henry David Thoreau, which advocates an acceptance of the intrinsic value of non-human nature, as opposed to its value in human terms (Pepper 1994). The exploitationist (although likely not called that name by any of its proponents) or technocentric approach came to prominence hand-in-hand with the Industrial Revolution (Pepper 1994). It measures the value of the environment in instrumental terms – that is, in terms of its use to humans – and defends the human right to exploit non-human nature for maximum profit by the reasoning that the market itself, working with technological innovation, will guarantee a plentiful or even increasing supply of natural resources over the long term.

The underlying ideologies of ecocentrism and technocentrism can be loosely allied with two other outlooks, referred to as Neo-Malthusian and cornucopian, which envision two divergent futures. The Neo-Malthusian outlook follows the argument laid out by the Reverend Thomas Malthus, whose “Essay on the Principle of Population" (Malthus 1826) maintained that populations tend to increase at a geometric, or exponential rate whereas food production can only increase at an arithmetic, or linear rate. The consequence, according to Neo-Malthusians, is the inevitable outrstripping of food supply as populations increase. The predictive Neo-Malthusian viewpoint can be allied with the ecocentric ideology of careful conservation of natural resources. This contrasts with the cornucopian viewpoint, which takes its name from the ancient Greek term for “horn of plenty”, an ancient symbol of abundance, which envisions a future of plentiful resources (Kashambuzi 2008). The economist Julian Simon, in his book The Ultimate Resource (1981), maintains that future supplies of resources are not only assured, but assured to increase. As human populations grow, resources become scarcer; scarcity drives up prices, which in turn creates opportunities for innovators and entrepreneurs to seek new ways of increasing supplies. According to Simon, the
increasingly efficient use of existing supplies and the creation of new supplies can continue forever, allowing potentially infinite human growth. The cornucopian viewpoint can be allied with the technocentric ideology, which embodies confidence in technological approaches to resource scarcity.

Between the extremes of the ecocentric and technocentric views lies the conservationist view, which was articulated by the forester Gifford Pinchot (Library of Congress 2004). It is concerned with pragmatic approaches and solutions and emphasizes the concept of sustainable yield; i.e. that humans can harvest natural products from the environment without compromising the health of the ecosystem (Turner, R. 1988). Since the middle often contains more nuances than either extreme, it may be more proper to see it as a spectrum of views, with “communalist ecocentrism”, a preservationist view that stresses the need for environmental constraints on economic growth, on the one hand, and “accomodating technocentrism”, a conservationist view that rejects the idea of infinite use of natural resources and instead cautions that growth must be environmentally sustainable, on the other (Turner, R., in O’Riordan and Turner 1983). The conservationist view, a heterogeneous blend of these views, is not limited by an ideology that necessarily prescribes certain actions and excludes others; rather it is flexible in considering various approaches that may feasibly work.

From the interaction between these different views and the growing environmental movements of the 1950s and 1960s, the concept of sustainability emerged and gained prominence as a definable movement (Sustainable Development Commission, undated website). It gained added legitimacy from contemporary works outlining the growing impacts of human development on the environment, such as the Limits to Growth report presented to the Club of Rome (Meadows et al. 1972). The sustainability movement gained international recognition at the 1972 United Nations Conference on the Human Environment in Stockholm, Sweden, and was recognized by world leaders as a significant challenge facing humanity at the 1992 United Nations Conference on Environment and Development in Rio de Janeiro (Sustainable Development Commission, undated website). The World Commission on Environment and Development, in their Brundtland report of 1987, projected the meaning of sustainable development over longer time scales: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987, 43). The sustainability concept, often used interchangeably with sustainable development, is here understood to mean that environmental protection and economic growth can be compatible instead of conflicting (Turner, R. 1988). Its basic principles are the construction of an economy which is both strong and socially just and which grows at sustainable rates, the protection of environmental health factors such as biodiversity, climate stability and natural resources, and the achievement of socially equitable distribution of resources, social services, and governmental accountability (Harris 2000).

Among the different alternative paths within sustainability, the implementation of locally-based reclaimed water projects is one option that meets the definition in the Brundtland report: recycling rather than developing new supplies. In the United States, reclaimed water is already used for irrigation and industrial purposes. The reuse of treated wastewater is a local environmental issue that is crucial to the health of human communities and natural ecosystems. Through the local use of reclaimed water,
communities can achieve a measure of sustainability by decreasing their reliance on groundwater reserves, increasing the recharge of groundwater to the aquifer and preventing saltwater from intruding into it, reducing the discharge of wastewater to rivers and lakes, and providing an irrigation supply that can be counted on even in times of drought (SWFWMD, undated website). Reclaimed water use is thus an important component of meeting the larger goals of sustainability. In addition, unequal access to water lies at the heart of many of today’s political conflicts. By relieving the pressure on groundwater reserves, the use of reclaimed water can free those reserves for the most vital uses, easing land conflicts that form around access to water.

Research Questions

In order to understand attitudes towards reclaimed water, this thesis asks three main questions. These questions deal with both the specific meanings of reclaimed water and the role of reclaimed water projects in the larger construction of the sustainable use of water resources.

1. **What are the perspectives and attitudes of urban residents toward the use of reclaimed water?**
   This question elicits the perspectives of urban residents on the safety of reclaimed water in its currently available forms and their potential willingness to drink reclaimed water if treated to a higher standard.

2. **How do urban residents compare reclaimed water to alternative water recycling projects in the region?**
   One of the major water recycling projects in Tampa is a desalination plant that was built between 1999 and 2007 in response to regional drought conditions. This question addresses public understandings of desalination as an alternative water supply to wastewater treatment, which bears significantly on the public support for reclaimed water projects in the region.

3. **How do urban residents position reclaimed water in the wider context of sustainable water resource use?**
   This question considers the broader environmental attitudes of urban residents and situates them within their concern for local and global environments. It thus focuses on perspectives regarding the role of reclaimed water in addressing water scarcity, augmenting domestic water supplies, and contributing to the sustainable use of water resources.

Contributions to Literature

This thesis will contribute to the interdisciplinary field of environmental science and policy in two ways. First, the study of wastewater reclamation provides insights into choices made regarding the approach to globally pertinent issues of water scarcity. Wastewater reclamation, as a measure for supplying water, takes a different tactic than measures which seek entirely new sources, such as the relocation of icebergs, desalination of seawater or deep drilling into confined aquifers, in that it taps into a
source that humans have already used and redirects it back to our use. Where the purpose of that reuse is irrigation, it relies on nature's hydrological cycle to recover the wastewater and integrate it back into groundwater aquifers. It is hoped that this study will further the public understanding of the significant differences between the development of new supplies and the conservation of existing ones.

A second important contribution of this study is its inclusions of grassroots perspectives in understandings of the environment. Although individual voices do speak loudly in that they often determine the eventual success or failure of such projects, they often go unheard in governmental and institutional debates on water issues. It is the aim of this study to make audible the words of ordinary people who use reclaimed water, to show precisely how those who are not professionally involved with water issues perceive their global relevance.

The remainder of this thesis is organized into four chapters. Chapter II provides an overview of existing studies on water reclamation within both the United States and internationally and introduces policies regarding water management in Florida. Chapter III introduces the study area and research methods. Chapter IV delves into the interviews that were conducted with urban residents in order to bring out the main strands of their thinking as well as the complexity that underlies their stated environmental positions. The concluding chapter readdresses the research questions in the context of participants’ attitudes towards reclaimed water.
Chapter II
Attitudes, Policies, and Processes of Wastewater Reclamation

This chapter outlines the main themes in existing research on reclaimed water by describing the potential environmental impacts of its use, enumerating the factors that shape individual attitudes toward its use, and describing elements that characterize the success and failure of water reclamation projects. It also introduces the broader context of water management policies in Florida and the United States as well as specific techniques for water reclamation employed in the Tampa Bay Area. This chapter thus comprises the background on which this thesis draws in the process of examining individual attitudes of urban residents towards the use of reclaimed water.

Studies of Reclaimed Water Users and Projects: Attitudes Shaping Acceptance

This section organizes existing understandings of reclaimed water on the basis of studies of specific projects and the relative acceptance or refusal of reclaimed water associated with them. These studies are then juxtaposed with the known environmental benefits and risks of reclaimed water use, focusing specifically on its land-based applications. This set of studies provides the larger background against which possible meanings attached to reclaimed water among urban residential users in Florida can be understood and evaluated.

The factors that shape acceptance of reclaimed water can be classified into areas related to knowledge and trust, user attitudes towards reclaimed water quality, and variations in access to reclaimed water across contexts. This section considers studies that provide insights into the ways in which these factors become pertinent in individual perspectives on reclaimed water and outcomes of water reclamation projects.

Knowledge and Trust

A popular theme in case studies of water reclamation projects is the role of knowledge and trust for the success and failure of various projects. An example of a successful project in California is the Monterey County Water Recycling Project. This project is outstanding for its use of wastewater to irrigate “high quality food crops” (Po et al. 2003, 7); such use is a rarity among water reuse projects, for obvious reasons. It is also noteworthy for a feature that it shares with projects in Florida, namely its intentional focus on using recycled water to decrease seawater intrusion into the aquifer resulting from groundwater pumping. The authors credit the success of the project to many years of planning, a five-year health study determining the safety of produce grown with recycled water, and a market study that showed support from regulatory agencies and determined that the produce would not have to be labeled as having been grown with recycled water “since the water had been treated to the acceptable standard” (Po et al. 2003, 7). This emphasizes the central role of trust in the successful use of recycled water, especially for such a contentious purpose as growing food. In such a case, a feeling of
trust in the authorities is the most important factor for acceptance by farmers and consumers. It may also be the only factor, since neither farmer nor consumer may have the time, knowledge or connections to understand and question the results of health studies or the details of “the acceptable standard.”

Another long-running successful recycled water project in California has been the Irvine Ranch Water Recycling Program, initiated in 1967 and delivering recycled water for agriculture in the Irvine Ranch Water District. The project is called one of the more successful of its kind; according to the authors, this success is due to the integration of recycled water into the community (supplying, at the time of writing, about 15% annually of the district’s water needs), and the long-standing “commitment [of the program] to inform and educate the local community about efficient water use and reuse” (Po et al. 2003, 6) with a focus on issues of conserving water, ensuring supply, saving money, and protecting the environment.

Among controversial projects undertaken in California is the San Diego Water Repurification Project. Despite comprehensive public outreach consisting of surveys, focus groups and interviews with San Diego residents and community leaders, the project was indefinitely halted by the San Diego City Council after political campaigns publicly aired their concerns about the potential health dangers of the recycled water, and about the city’s intention to “take wastewater from affluent communities to distribute as drinking water to those less affluent” (Po et al. 2003, 10-11), in a somewhat ironic spin on taking from the rich to give to the poor. This and two other projects mentioned (the San Gabriel Valley Groundwater Recharge Project and the Clean Water Revival Project, both in California) suffered because of public advertisements of concern that carried the slogan “Toilet to Tap” (Po et al. 2003, 11). Public relations challenges like these could also have brought any of the successful projects to a halt; the fact of their having arisen in regards to these particular projects may not reflect specifically on the integrity of the projects themselves, but merely on the different circumstances of each.

One project which contained both elements of success and controversy was the Virginia Pipeline Scheme – the largest horticultural reclaimed water project in Australia (Po et al. 2003). Launched in 2003 in Bolivar, South Australia, it received treated wastewater from the Bolivar Wastewater Treatment Plant and was “expected to supply over 20 billion litres of irrigation water a year…[to] more than 120 market gardens” (Po et al. 2003, 5). According to an analysis of stakeholders’ perceptions of risks involved, the public had concerns over the quality of the recycled water, its effect on food crops, and the potential of negative impacts on the environment. According to Thomas (2006), one of the major events leading to the creation of this project was the serious depletion of groundwater resources and consequent danger of seawater incursion into the aquifer. However, because “the analysis concluded that the likelihood of major public concerns to emerge as a result of the scheme was relatively low” (Po et al. 2003, 5), the implementation went ahead without a public information campaign. If, as concluded by the analysis, existing stakeholder concerns were not deemed crucial enough to merit a public information campaign, it is likely that this social factor was overridden, and the project pushed ahead by the environmental factor of the necessity to protect an already overdrawn aquifer. In the case of a project like this, the mix of support and controversy makes it impossible to determine success or failure.
In regard to the subject of public perception and acceptance, Po et al. show through different examples that most types of marketing, persuasion or even coercion are ineffective in convincing the public to use reclaimed water. A “traditional approach” described as “decide, announce and defense” (Po et al. 2003, 29), in which education and outreach are initiated only after the start of a project, is also described as ineffective. The implication is that such an authoritarian approach would also be culturally inappropriate in the United States. The alternate strategy, proposed in Po et al. (2003) as crucial for public acceptance over the long term, is to involve the community through outreach before the start of the project, the goal being to educate them about their different options for water supply. This, rather than an outreach campaign whose goal is to convince the public to accept reclaimed water, is proposed as the effective method, and “the authorities involved, and the process used to engage the community, have to be honest and transparent” (Po et al. 2003, 30).

When it is impossible to know the risks, the only recourse for most people is to place their trust in the authorities. The authors focus their assessment of public perception of sludge by defining their use of the word ‘trust’: “trust in government agencies, businesses and industry, and a belief that there is enough scientific evidence that the technology is safe” (Krogmann et al. 2001, 123). A study cited by the authors (Rodriguez and Peterson 1996, in Krogmann et al. 2001) contains the finding that “for those who support land application, trust is a more important factor than level of knowledge” (Krogmann et al. 2001, 123).

**User Attitudes toward Reclaimed Water Quality**

Many studies of wastewater reclamation show that the attitude of users towards reclaimed water, and not the demonstrated quality of the water itself, is the primary determinant of their willingness to use it. In other words, the attitudes on the demand side trump the solutions offered by the supply side where reclaimed water use is concerned. Moreover, in a context of free choice of water supply, people will only choose reclaimed water if they have a favorable attitude towards it. Thus, the eventual success or failure of water reclamation projects hinges on these user attitudes.

User attitudes in an environmental context are defined by Heidmets and Raudsepp (2001) as positive or negative judgments about an environmental phenomenon. Larson and Lach (2008) emphasize that the multifaceted nature of such attitudes is due to their intersections with multiple factors: physical landscapes, regulatory entities, and policy approaches. The diversity of specific factors influencing attitudes may result in the attitudes of one group not being representative of the attitudes of another or of the broader public. Especially when such attitudes are surveyed from within an organized group that shares common interests, the result may be that the interests themselves, rather than the individuals, may be the factors represented. Larson and Lach (2008) emphasize that the study of why some residents participate in groups and others do not has relevance for democratic processes, which seek to represent their constituents fairly. Given the difficulty of representing the attitudes of groups, findings from one community may not be easily generalized as representative of another.

In the absence of clear understanding of the safety of reclaimed water, people often use other standards, often personal environmental values, to evaluate the potential
consequences of its use. They avoid the use of reclaimed water because it may cause
them harm, it may do permanent damage to the environment, or they may not be able to
change their decision to use it later on; in general, because they cannot control the quality
of the water. A perceived potential for risk is often enough to prevent widespread use of
reclaimed water in places where it is available, since people foresee a future possibility of
negative consequences (Po et al. 2003). This “anticipated regret” (Po et al. 2003, 18) is
even to prevent people from switching to reclaimed water; they would rather forgo the
benefits and stay with their familiar service than risk the unknown. In cases where people
do decide to switch, they generally expect to pay much lower rates for the reclaimed
water (Po et al. 2003).

The contrasting facts about reclaimed water that users need to stomach often
appear incompatible; this is shown by comparing two survey opinions. 89% of
respondents to a 2002 survey in the UK agreed with the statement that “I have no
objection to water recycling as long as safety is guaranteed” (Po et al. 2003, 16), but 59%
of respondents in a 1999 survey in Sydney, Australia, agreed with the statement that “no
one can guarantee the safety of recycled water” (Po et al. 2003, 17). This may contribute
to a common dilemma that causes many water reclamation projects to fail. The
community may rationally accept the reasons for using reclaimed water but feel unable to
overcome the disgust they feel – commonly called “the yuck factor” – at the prospect of
using it themselves.

Po et al. identify the emotion of disgust as the major factor underlying the social
rejection of reclaimed water, which is well-recognized by the public relations executives
who give names to the projects – “repurified water” instead of “recycled water…[which
left] too much to people’s imagination” (Po et al. 2003, 15). The authors then ask how
people come to associate reclaimed water with feelings of disgust; one could ask instead
how the two could ever be dissociated. Indeed, it is not a mental association, but an
instinctively hardwired one. The authors cite the “fact that recycled water has been
treated to the highest standards” (Po et al. 2003, 16); one could point out that the issue of
standards in overcoming peoples’ gut reactions to a perceived lack of hygiene is a
complicated one, and that the gut reaction of disgust appears to be a culturally determined
feeling. In Western culture, water may be perceived as dirty whether it has been recycled
by human technology or by nature through the water cycle, and in both cases, a dose of
ignorance is crucial in securing trust in the cleanliness of the product.

In examining user willingness to pay for reclaimed water, the central factor is the
users’ own understanding of its quality, in which their perceptions play a major role.
Krogmann et al. (2001) investigate the perceptions of farmers of the risks of applying
treated sewage sludge to their cropland. According to the authors, those perceptions of
risk are mostly based on intuition rather than knowledge, and yet may be more complex
than scientific calculations of risk. The case study, conducted in New Jersey with fifty
fruit and vegetable farmers, set out to find their perceptions of the risk involved in using
(or not using) sewage sludge on their land, the reasons behind their choice, and the
information sources available to them in making the decision. The study found that thirty-
eight (out of a total of fifty) of the farmers had never considered the application of
sewage sludge to their fields, twelve had considered it and five had actually applied it,
but only one was continuing to apply it at the time of the study. Among the benefits they
cited as reasons to apply sludge were the fact that it is free, and that using it adds organic material to the soil and can increase crop yields. When asked about the potential advantages or drawbacks of sludge, farmers tended to focus on benefit or harm to their crop and to the public’s perception of their produce, not on potential benefit or harm to the environment. However, when asked to identify the environmental risk, twenty-four out of fifty maintained that there was no risk. The views held by the farmers are apparently correlated with the source of their information. The twelve who had considered the application of sewage sludge mainly got their information from sludge suppliers, whereas those who do not favor the practice got their information from “many sources” (Krogmann et al. 2001, 124).

Krogmann’s article points out that the perceptions of the farmers are almost evenly split between acceptance and disbelief of the potential risks. As stated above, although twenty-four of the interviewed farmers stated their belief that there is no environmental risk to land application of sludge, twenty-three of them “went so far as to suggest that [it]… is an unacceptable practice” (Krogmann et al. 2001, 122). Contrary to the implication in this language, there is nothing outlandish about these farmers’ claim that it might be dangerous to apply potentially toxic sludge to cropland. Indeed, the fact that the opinions were split evenly down the middle is revealing. The other half of the farmers, who are presumably just as pragmatically connected to their food and their customers, saw the land application of sludge as an acceptable way of dealing with a problem and getting something in return. In a sense, these farmers are better connected to their surroundings than those of the disbelieving group, who themselves have more in common with the average disconnected city-dweller. Whereas most city-dwellers might prefer to throw the sludge “away” in an attempt to spatially separate food-growing from landfills, these farmers appear to think more realistically even without understanding the risks. They are willing to consider a potential local solution to the problem instead of demanding that it be outsourced.

Given the primacy of such personal meanings, it is surprising that, according to Syme and Nancarrow, “there has been no comprehensive investigation to underpin planning in this area” (2006, 189). A study by the authors conducted in Australia presents data from personal interviews of a randomized sample of 720 Perth residents concerning the degrees to which they accepted different technological approaches to the use of reclaimed water. The study revealed a negative correlation between the degree of acceptance of reclaimed water and the possibility of ingestion or skin contact. This relationship is independently triangulated by other studies that used different techniques but came to the same conclusion. Although respondents to this and other similar surveys cited by Syme and Nancarrow overwhelmingly supported the use of reclaimed water for irrigation of vegetables, vineyards, or orchards, “as the proximity to body contact or ingestion occurs, acceptance dwindled” (Syme and Nancarrow 2006, 189). The authors present two contrasting conclusions drawn from these findings: firstly, that it may be preferable not to label produce as having been grown with reclaimed water to prevent an “unnecessary” amplification of risk and fear in the public, and secondly, that there is a possibility that not labeling such produce may itself be the risky strategy to be avoided.

In an interesting example of the use of reclaimed water, a project in Western Australia supplies “about 140,000 liters per day of reclaimed water…to a winery for
irrigation of grapes” (Turner, N. 2006, 31). This is a surprising use of reclaimed water, both because of the high level of discernment normally attributed to wine drinkers – who might not be happy seeing “grown with reclaimed water” on a wine label – and because of the strict standards to which wine-making is generally held. The wineries of Western and Southern Australia are well-known and respected internationally, so the practice may be supposed to have won widespread acceptance. Even though it may be based on necessity, due to the limiting factor of Australia’s dry climate, the achievement of acceptance in such a sensitive context shows that it is possible to build acceptance for reclaimed water use in broader contexts as well.

Region-Specific Factors

Attitudes towards the use of reclaimed water are not the same in all geographical regions, but depend on region-specific environmental and socioeconomic factors. According to Turner, N. (2006), the central drivers for reclaimed water use in Western Australia are a lack of water resources due to low rainfall, the high salinity of groundwater, the over-allocation of groundwater for industry, the collective environmental impact of wastewater disposal into the ocean and resulting nutrient over-enrichment of coastal waters, and pressure from local communities, who consistently view wastewater “as a resource that should be reused rather than disposed” (Turner, N. 2006, 30). In other studies, reclaimed water use is driven by the agricultural water needs of inland communities, both because these communities are often smaller and dependent on local agriculture, and because of drier climactic conditions prevailing inland (Anderson and Davis 2006). An additional driver in developing countries may be the high cost of fertilizer, so that for farmers who cannot afford it, wastewater becomes a valuable option (Abu-Zeid and Khaled 1998). All told, the central drivers are distributed among environmental, social, and industrial/economic factors.

Turner, N. (2006) also lists factors that act as barriers to reclaimed water use. In the case of Western Australia, these barriers are the easy availability of fresh groundwater at a low price, the costs of establishing reuse projects, which are between five and ten times as high as costs to discharge, the costs of dam construction for winter storage of wastewater, public concern over health impacts of contact with reclaimed water, and, in Southwestern Australia, a particular characteristic of sandy soils in the Swan Coastal Plain which produces a low capacity for absorption of phosphorous. Wastewater discharges to this area readily enrich the groundwater with excess phosphorous, which is then carried into other water bodies, causing eutrophication. Thus, it can be seen that both the drivers and barriers to the use of reclaimed water are not just in its price or availability, but also in the natural characteristics of soil and aquifer.

Most prominent among the obstacles to user willingness, as determined by Abu Madi et al. (2003) in a study among farmers in Jordan and Tunisia, are the price, quality and availability of reclaimed water. According to this study, “securing a market or users for the [reclaimed water] is the most critical factor to success of reuse projects” (Abu Madi et al. 2003, 115), because the price of the water is the greatest factor in a farmer’s decision to use it. Other influential factors are farmers’ concerns over the quality of reclaimed water, their latitude in deciding what they will use it for, and the comparative ease of their access to an existing freshwater supply. When reclaimed water is available
farmers. At high quality and low price, and freshwater less available or comparatively expensive, farmers are most willing to pay for it. However, they are reluctant to switch to reclaimed water if these conditions are not met and if they have concerns about its availability, quality, and potential effects on crop marketability. Farmers who have familiar and easy access to freshwater at low price are often under no pressure to switch to reclaimed water; therefore they are reluctant to pay anything but the lowest proposed price for it. The study tested separately for restricted versus unrestricted irrigation, or whether end uses of the water are predetermined or free for the farmer to designate. The factors found to be obstacles to farmer use of reclaimed water, in order of decreasing importance, were access to freshwater, distrust in water quality, concern about crop marketing, concern about health impacts, psychological aversion, religious prohibition, and concern about public criticism. From their finding that the greatest obstacle to willingness is the ease of freshwater accessibility at low price, the authors deduce that one way to make farmers use reclaimed water is to restrict their access to freshwater. Such a move could be called radical, dangerous and illegal, or progressive, necessary and inevitable, but in any case it is a moot point, since the authors suggest no way that it could be done. In any case, the low price of freshwater as compared to reclaimed water is insufficient to pay for the operation and maintenance of reclaimed water infrastructures. One could conclude that for reclaimed water projects to be implemented as viable alternatives at large scales, they may need to be subsidized. This may be the only way they could measure up competitively to privatized and governmental water supply systems.

Environmental Impacts of Using Reclaimed Water for Irrigation

The use of reclaimed water has a definite benefit in lowering human demand on fresh groundwater. This benefit is obvious in its global context: between 65 and 90 percent of global freshwater use for all purposes is for irrigation (Salazar 2006). The reuse of treated wastewater and sludge on land is often an alternative to simple disposal. Treated wastewater and sludge can provide plant nutrients, organic matter and water. Moreover, although the precise effects of reclaimed water on the environment are relatively unknown, its use for agricultural and industrial purposes has been demonstrated to be safe for human health (York 1995).

There are, however, problems associated with the indiscriminate application of wastewater and its byproducts on land. Nutrients in wastewater may be present in uncontrolled amounts that have not been balanced for plant needs. Using sludge at standard agronomic rates to meet plant needs for one nutrient may throw the levels of other nutrients into imbalance. Some of the better-documented among the known impacts of reclaimed water use are the impacts of heavy metals, chemical toxins and organic pathogens on the environment (Bond and Smith 2006). Among those that may act as nutrients for plant growth are nitrogen, phosphorous and potassium, as well as soluble salts such as sodium. When applied with excessive irrigation, in quantities exceeding the nutrient uptake capacity of the crops, these substances may either leach from the soil or accumulate and remain in it as contaminants. Excessive irrigation also exacerbates other problems common to Florida, such as high water costs and unsustainably rapid use of scarce water resources (Turcotte 1997). Among the studies that consider the impacts of using reclaimed wastewater for irrigation, most found such uses to be both beneficial and
problematic. A survey of agricultural projects using reclaimed water in California found no hint of deterioration in quantity or quality of crops; in fact the reverse was the case (Abu-Zeid and Khaled 1998). The authors point to the nutrients often present in wastewater, among them nitrogen, phosphorous and potassium, as supplying essential nutrition for crop growth. Thus, they defend the reuse of wastewater for agriculture as a way to recycle nutrients back into the soil. However, the authors also pointed out that nutrients present in reclaimed water can be present in amounts that are in excess of plant needs. These excessive nutrient levels may cause uncontrolled plant growth and inferior crop quality, and may also leach underground and pollute groundwater reserves. Thus they also caution that concerns regarding potential danger to public health and to the environment must be properly met to ensure the success of a recycled water program (Abu-Zeid and Khaled 1998).

The predicaments involved in the issue of reclaimed water are neatly summed up by Peverill and Premier (2006) who simultaneously indicate the potential nutrient benefits of wastewater for crops and the potential dangers of contamination. The benefits, as mentioned in the results of the six-year study (1977-1983), were twofold. Those nutrients that would ordinarily be supplied purposely, in infrequent but heavy targeted applications of fertilizer, came in smaller, more regular doses with the crop watering. The watering also applied those nutrients to foliage as well as roots, where they can be taken up by both. Smaller doses carry fewer of the dangers associated with standard fertilization, such as major loss due to leaching, damage to soil and microbial life, and evolving plant resistance.

Irrigating crops in sandy soils with reclaimed water also has particular benefits; for instance, a study by Kaddous et al. (1986, in Peverill and Premier 2006) in Victoria, Australia, showed that the boron content in the wastewater eliminated a common deficiency of crops grown in sandy soils. The same study also showed that the application of reclaimed water saved approximately 60% of nitrogen, 33% of phosphorous, and 40% of potassium that would have to have been applied as fertilizer. However, the authors mentioned drawbacks such as the potential for accumulation of heavy metals in the soil and bacteria and viruses on the crops, and the potential for nitrogen and phosphorous contamination of groundwater, particularly in sandy soils. It is worth mentioning that soils in Victoria, Australia share the condition of high sand content with soils in Florida.

A recent development in water reuse consists in injecting reclaimed water treated by reverse osmosis into confined aquifers, also known as aquifer storage and recovery. Since “modeling indicates that it would be hundreds or thousands of years before water would be abstracted for potable use” (Turner N. 2006, 32), it is possible that this could be a significant option for the replenishment of groundwater supplies. However, questions remain, such as whether confined aquifers are already being tapped for drinking water, and therefore whether the potable water currently being extracted may have been contaminated with the water being injected. The longer-term environmental implications of replenishing fresh groundwater supplies with treated wastewater.

Human responses to the use of reclaimed water are influenced by considerations of underlying psychological factors, trust in the authorities, understanding of the issues, and belief in scientific knowledge. A prevailing assumption concerning this issue is that
public trust in reclaimed water will rise the more the community knows and understands it. In reality, such knowledge alone may not lead to greater acceptance; trust is filtered through perceptions of benefit and risk. If people can perceive no special benefit from eating food grown with reclaimed water, but believe that it may be risky for their health, they are less likely to accept it (Syme and Nancarrow 2006). A more profound finding of this study is that while “to some, it may seem to be ‘unnatural’ that reclaimed water is used for irrigation of food; for others such recycling may seem to be a healthy advance in the utilisation of nature’s resources” (Syme and Nancarrow 2006, 191). This balanced view allows for a more holistic consideration of water recycling in general, in its original context in the natural world, where all water is recycled water.

**Wastewater Treatment Policies and Processes in Florida**

This section considers the water management regime in Florida, situating it within the wider national context as well as detailing the actual plant-level processes for reclaiming wastewater. This specifies the contextual structures of water reclamation within which the case study for this thesis is located.

**Regulations on Reuse of Reclaimed Water in the United States**

The practices of disposing of and reusing treated wastewater and sludge, the two main products of the wastewater treatment process, are governed differently at federal and state levels. The regulatory chain of command does not follow a simple top-down hierarchy from federal to state authority; on the contrary, states exercise their own jurisdiction in determining how to oversee disposal and reuse. Florida, along with California, Arizona and other states, has taken the initiative to develop stringent regulations aimed at ensuring a safe product, which in turn influenced the development of the national guidelines (York 1995). Federal regulations governing reclaimed wastewater reuse for lawn irrigation as treated in this study are the same as those governing the practice for more standard agricultural purposes. The growing of turfgrass is defined in the Farm Bill as agriculture (Morris 2006); therefore the regulations applying to agriculture apply to lawn irrigation as well.

Direct federal legislation of regulations on sludge disposal in the United States only came about in the 1970s. In 1993, the United States Environmental Protection Agency (EPA) published the Standards for the Use or Disposal of Sewage Sludge, known as the Part 503 Rule (EPA 1993), which defined acceptable limits for specific pollutants and pathogens in sewage sludge destined for application to agricultural land. In the context of this new federal ruling, which built on many existing federal and state requirements, the prevailing view of wastewater and sludge as toxic substances requiring disposal has expanded over time to include a view of them as potentially beneficial soil amendments. Options for ultimate use of municipal wastewater sludges are restricted to land-based disposal or reuse as per the Clean Water Act and the Ocean Dumping Ban Act. Land-based uses intended to be beneficial include application to agriculture, silviculture, parklands and urban landscapes, for reclamation of contaminated lands, and as landfill cover.

Although the 1993 rule governs the application of sludge to farmland, there is no overarching federal rule that directly governs the reuse of municipal wastewater (York
In lieu of a rule, the Environmental Protection Agency publishes guidelines covering this topic (EPA 1992). Because guidelines do not have the force of law, some states have undertaken to regulate wastewater application on their own, and they do so in different ways. Some regulate at the source, by requiring wastewater of high quality and low pathogen levels, thereby restricting the amount of pathogens that could come into contact with the soil, and others regulate at the point of use, by restricting application to certain sites and certain rotation times, thereby allowing pathogens to break down in the soil over time. Additionally, most states require stricter water quality levels for produce (or crop products that can be eaten raw) than for those that must be processed or cooked. For example, California allows reclaimed water to be used on produce crops, whereas Florida restricts its use to those crop products that will be processed and cooked prior to consumption (Water Science and Technology Board, in EPA 1992).

In Florida, reclaimed water may be used for various purposes, each of which is distinctively regulated under the Florida Administrative Code (FAC 2008). Chapter 62-610 of the FAC details the requirements for building, maintaining, and operating wastewater reuse systems producing reclaimed water for irrigation of public and residential areas and edible food crops. The reclaimed water may be used by industrial facilities for cooling or washing, at construction sites for dust control, and in other applications for the “washing of vehicles, roads, sidewalks, and outdoor work areas and mixing of concrete” (FAC 2008, Ch. 62-610). For landscape irrigation, the sprinkler or hose must be underground, and the system must be clearly labeled as carrying water that is not of drinkable quality. For irrigating edible crops, the regulations allow the application of reclaimed water directly to those crops that will be peeled or cooked before eating. For crops that are not processed in these ways, the water must be applied indirectly, either by drip irrigation, ridge and furrow, or by an underground distribution method. Reclaimed water may also be used for “aesthetic purposes…in decorative pools [or] fountains” (although not in pools where there is a risk of skin contact, such as swimming pools or hot tubs) and for “toilet flushing and fire protection” (FAC 2008, Ch. 62-610).

The FAC requirements were designed “to ensure protection of public health and environmental quality” (York 1995, 1), and in fact Florida’s regulations exceed federal standards on some counts. The Florida guidelines mandate that wastewater be treated to secondary levels, that there be no more than 5 mg/L of solid particles, or total suspended solids, in the wastewater, and that at least 75% of fecal coliform bacteria be less than the limit of detection, whereas the national guidelines mandate only that at least 50% be lower than detection. A study conducted by scientists at the University of South Florida on a water reclamation facility found that pathogen levels were reduced to a safe level and that there was no public health risk associated with the resulting reclaimed water (Rose and Carnahan 1992). The findings of this study agree with those of several major conferences on water reuse such as those hosted by the American Water Works Association and the Water Environment Federation in 1987 and 1992, respectively (York 1995). The comprehensive finding of these studies is that reclaimed water, when properly treated and disinfected, is safe for reuse.
Background of Floridan Hydrological Characteristics

Florida has a subtropical climate throughout much of its area, with rainfall ranging from fifty to sixty inches per year. Climate, coupled with geology, has given Florida abundant reserves of fresh groundwater. The peninsular-shaped state of Florida is surrounded by ocean along most of its border. The exposed land of the state is only the upper surface of the broader Florida Platform, which is over 300 miles wide and extends over more than twice the area which is exposed today. Composing this platform is a mix of porous carbonate sediments, mainly of Tertiary age, which contain the Floridan Aquifer and are responsible for its high productivity (Scott et al. 2004). The porosity of the carbonate rocks composing the aquifer creates a variably permeable system capable of rapid groundwater movement and recharge (Tihansky and Knochenmus 2007). The aquifer contains an estimated 19,000 cubic kilometers of water and supplies more than ninety percent of Florida residents with water for drinking, industrial purposes, and irrigation (Harley 2007). It is separated into the Upper Floridan Aquifer, which extends under parts of South Carolina, Georgia, Alabama and Florida and may reach a thickness of over 3000 feet in south Florida (Karst Research Group, 2008), contains mainly freshwater, and supplies the SWFWMD with the majority of its potable water supply, and the Lower Floridan Aquifer, which contains water of higher mineral content (SWFWMD 2006).

Figure 1. The Florida Platform
From http://water.usgs.gov/ogw/karst/kigconference/abt_karstfeatures.htm

Recent History of Water Management in Florida

In the 1960s, the agencies charged with environmental protection in Florida had not yet been consolidated into the agencies that exist at present. The Internal Improvement Trust Fund regulated coastal areas, state wetlands and water bodies, the Department of Natural Resources and the Game and Freshwater Fish Commission oversaw the recreational use of state parks, and the Department of Health regulated wastewater treatment and drinking water quality. In the late 1960s, the state
administration under Governor Claude Kirk created the Florida Department of Pollution Control, which in the 1970s gave rise to the Florida Department of Environmental Regulation (Florida Department of Environmental Protection 2009).

The Florida Department of Environmental Regulation was charged with expanded responsibilities relating to air and water quality and coastal and wetland management, and with this new authority began to oversee the five water management districts that encompassed the entire state: the Northwest Florida Water Management District, the Suwannee River Water Management District that borders it to the southeast, the St. Johns River Water Management District in the northeast of the state, the Southwest Florida Water Management District, and the South Florida Water Management District in the extreme south (Florida Department of Environmental Protection 2009). Each of these five districts had been invested by the Florida Water Resources Act of 1972, Florida Statute 373, with its own distinct authority to write policy and to regulate the management, storage and consumptive use of surface waters within the district. The passage of Statute 373 was brought about by a statewide need for a more comprehensive and inclusive water management approach, and it also put in place the landmark legislation that declared all Florida waters to be a resource held in trust by the state and managed in the public interest (Carriker 2006). Twenty-five years later, Statute 373 was amended by the Florida Legislature with an expanded policy goal: “to promote the availability of sufficient water for all existing and future reasonable-beneficial uses and natural systems” (Florida Legislature 1999, 1). This goal clearly shows that the current direction of water management policy in the District is toward the long-term sustainable use of water resources, and it marks a definite intersection of those goals with the broader objectives of sustainability movements.

In the mid-1990s, the Florida Department of Environmental Regulation, which had played such a pivotal role in regulating the water management districts, was merged with the even larger Department of Natural Resources to create the Florida Department of Environmental Protection (FDEP). The FDEP currently oversees many environmental functions for the state, including the regulation of air and water pollution, the use of wetlands and coastal areas, the siting of energy plants, pipelines and waste treatment facilities, the management of state recreation lands, the reclamation of mining lands, and the management of water resources through the five water management districts.

The Southwest Florida Water Management District (SWFWMD), which encompasses all or parts of sixteen counties, was created in 1961 in the context of maintaining and operating flood control systems in concert with the Army Corps of Engineers and constructing, regulating and permitting the drilling of wellfields. When Florida Statute 373 was passed by the Legislature in 1972, SWFWMD’s responsibilities grew beyond this scope to encompass a broader range of resource management and public service duties, including the permitting of consumptive water use, the establishment of minimum flows and levels, the mapping of floodplains, and the management, storage and improvement of surface water supplies. In the 1980s and 1990s the scope expanded yet further to include wetland protection, environmental resource permitting, water shortage and conservation planning, and the acquisition of state lands for outdoor recreation and natural resource protection. Thus it can be seen that under its stated mission to “manage and protect water and related natural resources” (Southwest
Florida Water Management District, undated website), SWFWMD’s duties now broadly include the management of water supply, water quality, resource use and the protection of natural systems of the district.

Water management in Florida thus has an integrated history of involvement by various state and local agencies converging on the objectives of long-term conservation, effective environmental regulation and responsible development, and ensuring a continuing water supply. The next section looks more closely at regulation of water supply in the Tampa Bay Area.

Regulation of Water Supply in the Tri-County Region

The government of the state of Florida treats water as a public resource and holds it in trust for everyone in the state. Although this system by no means guarantees peaceful and equal sharing of water resources, it should be noted that it differs significantly from water laws in many western states, which give landowners the primary rights to the water under their lands. The status of water as a public good in Florida may be fortunate, but it also helped create the ground for the “water wars” that have shaped the relationships among governments and residents of the region for decades.

From the 1960s through the present Florida’s west coast has experienced an explosion of population growth, centered especially in Hillsborough, Pasco and Pinellas Counties, also known as the tri-county region. The rapid growth of the coastal regions of Pinellas County, and the city of Saint Petersburg in particular, led to the overpumping of their own water supplies and the beginning of the intrusion of ocean water into the aquifer that remains a persistent problem in the region. This trend led Pinellas County and the city of Saint Petersburg to situate groundwater wells in areas of Hillsborough and Pasco Counties, which at the time were largely rural and agricultural. However, when people began to settle heavily in these counties, the increasing pumping led to problems such as the depletion of surface water supplies and land subsidence (Rand 2000).

In the 1970s, the conflict over water between Hillsborough and Pinellas counties escalated into the beginning of the “water wars” and eventually involved two organizations central to the allocation of water in the region: the Southwest Florida Water Management District (SWFWMD) and the West Coast Regional Water Supply Authority, which in 1998 was reorganized to become Tampa Bay Water (Hillsborough County Government Online 2008). SWFWMD is the agency that regulates the protection of water resources over the sixteen counties comprising the district, and Tampa Bay Water is the wholesale water supplier to the member governments of the tri-county region, i.e. Hillsborough, Pasco and Pinellas counties and the cities of Tampa, New Port Richey, and Saint Petersburg. The conflict between these two organizations over the allocation of water supplies was resolved – or perhaps merely incorporated into – the formation of Tampa Bay Water as the water supply utility for the region. Although SWFWMD still regulates the allocation of water and Tampa Bay Water still supplies it, the conflicts between them have largely been replaced by a more cooperative outlook and an interest in sharing water resources (Rand 2000). As one of the regions in Florida of greatest contest over water rights, Hillsborough County reflects a history in microcosm of the conflicts that occur over groundwater resources worldwide. Tampa Bay, as one of the
epicenters of the conflict, contains the historical experiences of people who were involved in the paths to resolution and the development of new supplies.

Regulation of Reclaimed Water Supply in Florida

The original impetus for reusing reclaimed water in Florida came from a growing need in the 1970s to find alternative ways to dispose of treated sewage that were safe for the environment. As stated in a publication of the Florida Legislature, “antidegradation requirements for wastewater discharge permits have historically been the primary driving force in implementing reuse” (Turcotte 1997, 2). In the late 1980s, the Florida Department of Environmental Regulation and the state legislature began to investigate and promote the reuse of reclaimed water as a way to offset the use of potable water (Turcotte 1997). By the mid-1990s, the FDEP (which had by then succeeded the Department of Environmental Regulation) began to regulate reuse policies under two separate programs: consumptive use permits and wastewater treatment facility permits. Reclaimed water reuse is classified as a consumptive use, is permitted under that program, and is required by the water management districts to be implemented by permittees located in Water Resource Caution Areas, or areas where “water supplies…are anticipated to become critical within the next twenty years” (Turcotte 1997, 3). The permitting of wastewater treatment facilities, on the other hand, is classified as an environmentally protective use, prohibits them from discharging effluent into some coastal areas and surface water bodies, and requires the preparation of feasibility studies to prove that impacts remain within allowed limits (Turcotte 1997).

The implementation of reclaimed water permitting within the consumptive use guidelines is relatively flexible and can be molded to fit changing water supply situations. Turcotte (1997, 4) declares that if water supply in a water management district were to become “sufficiently critical”, the district could restrict the county’s consumptive use permit and/or refuse the county’s permitted right to inject reclaimed water into deep wells, thereby shifting the reliance of its customers from groundwater to reclaimed water. Under a revision of Florida Administrative Code 62-610, which regulates the permitted uses to which reclaimed water is put, alternate water sources could be used to augment reclaimed water, for example by blending in the concentrated brine left over from desalination, or new purposes could be considered for its use, for example to recharge groundwater in the aquifer (Turcotte 1997). Reclaimed water permitting is thus flexible enough to allow it to evolve over time to better fit changing conditions and needs.

Wastewater Treatment Methods

Municipal wastewater is the used water supply of communities, which when treated for reuse becomes reclaimed water. Its treatment in the United States follows a conventional pattern: raw wastewater undergoes preliminary, primary, secondary and sometimes tertiary or advanced treatment. The process consisting of these steps is referred to as conventional wastewater treatment. It has two main products: treated wastewater (a liquid effluent) and treated sludge (concentrated solids mixed with liquid).

Preliminary treatment is a purely physical process, being the removal of large bulky solids through screening and smaller, heavier solids, called grit, none of which are normally incorporated in the sludge product. Primary treatment is an additional physical
process involving the settling of solids and other constituents that may be contained therein, such as nutrients, pathogens, trace elements and organic compounds.

Secondary treatment involves biological processes. Microorganisms oxidize some of the organic material, producing carbon dioxide and other gases, digest the rest as food, and flocculate out of suspension in particles to form biological sludge. Secondary treatment can remove as much as 95% of the biological oxygen demand and total suspended solids, as well as some organic compounds and heavy metals (National Academies Press 1998).

Tertiary or advanced treatment involves chemical treatment of the effluent and disinfection to control pathogens and viruses, and produces effluent of higher quality than that produced by the preceding steps alone. Nitrate is removed through biological conversion to nitrogen gas and phosphorus is removed chemically or through the action of microbes; these measures attempt to keep nitrogen and phosphorous out of surface waters to prevent nutrient overenrichment. Chlorine is sometimes added to the treated water to kill pathogens and must then be removed by adding sulfur dioxide. Chlorine has the disadvantage of chemically combining with organic matter to form compounds dangerous to health; less dangerous alternatives involve the use of ozone and ultraviolet radiation. The sludge residues remaining after tertiary treatment are typically mixed with those from preceding stages. Stages in this process can vary by facility; for example, wastewater is sometimes confined in retention lagoons for long periods of time in place of primary or even secondary treatment.

In conventional wastewater treatment, many of the organic solids and organic and inorganic chemicals are removed from the wastewater and concentrated in the sludge (Water Science and Technology Board 1996). Typical uses of the treated wastewater are groundwater recharge and urban landscape irrigation; typical uses of treated sludge are landfill cover and agricultural soil amendment. The amounts of these products increase in proportion to the human population, making their disposal an increasingly contentious issue (Hari 2008). The restrictions placed on their disposal over the past few decades have stimulated their use in agriculture as a cost-effective alternative. However, the techniques were originally designed to process wastewater for discharge to surface waters, not for crop application. For discharge, secondary treatment is the national standard; for agricultural food crop application, wastewater is usually treated to at least this level or higher. Not all states require special treatment standards for effluent destined for agricultural use – effluents from conventional primary and/or secondary stages are used – but the most commonly used are disinfection and removal of suspended solids.

Alternatives to conventional water treatment methods, often referred to as natural methods, make fewer demands on human technology and financing. Examples are wastewater stabilization ponds, in which wastewater undergoes breakdown under aerobic and anaerobic conditions, land treatment techniques, nutrient film treatment techniques, and soil aquifer treatment techniques (Abu-Zeid and Khaled 1998).

**Alternative Water Recycling Technologies in the Tampa Bay Area**

Seawater desalination is the removal of salt and other minerals from ocean water in order to make it usable for drinking or irrigation. The desalination plant in Tampa Bay, Florida – the largest in the United States – uses reverse osmosis, in which pretreated
seawater is forced at extremely high pressures through semi-permeable membranes. The products of this process are freshwater, which is mixed with treated water from other sources and distributed to the member governments of the tri-county region, and brine, a highly saline solution of the minerals in seawater and the chemicals and heavy metals used in the plant (Barlow 2007). The plant also receives seawater, after being used for cooling, from the Tampa Electric Big Bend Power Station, and after desalination, remixes the resulting brine with water from the power plant for releasing into the bay. This measure is designed to dilute the concentration of brine in the water so as to not to throw out of balance the bay’s natural salinity. When the plant reaches its full capacity, it is expected to provide approximately 25 million gallons per day (MGD) of drinkable water, and about 19 MGD of brine (Tampa Bay Water 2008).

Tampa Bay Water, the agency that provides potable water to the tri-county region, has funded the desalination plant since the project’s inception, and describes it in detail on its website (http://www.tampabaywater.org). The section on the desalination plant is introduced in the following words: “Environmental protections, safeguards and monitoring ensure there are no adverse effects from the desalination plant” (Tampa Bay Water 2008). It goes on to enumerate the measures taken to evaluate the plant’s potential impact on the environment; from the initial permitting process conducted through the Florida Department of Environmental Protection, to the preemptive safeguarding mechanisms that measure the salinity of the post-processed seawater released back into the bay, to the ongoing programs that monitor the effects on water quality and the health of plants and animals in the nearby rivers and areas of Hillsborough Bay. There is no mention on the website of any other costs associated with the operation of the plant.

**Water Reclamation across Contexts and Scales**

As this chapter has shown, user perspectives on water reclamation are structured by the specifics of the program, personal attitudes towards water quality, and the context in which reclaimed water becomes a viable water supply. These perspectives are further shaped by water management policies in the context of Florida. This thesis examines the attitudes of urban users towards reclaimed water on the basis of this background material. As a prelude to examining these attitudes, the next chapter provides an introduction to the case study and the specific methods utilized in this research.
Chapter III

Study Area and Methodology: Neighborhood and Users

This chapter introduces the urban neighborhood that is the focus of this thesis – Carrollwood Village in the city of Tampa – and outlines the methodology used for this research. This thesis depends in a large part on qualitative methods for data collection and analysis, and the choice of methods was driven mainly by a need to understand the complexity of local user perspectives.

Study Area

The residential subdivision of Carrollwood Village (also referred to as “the Village”) was chosen as the geographical focus for this study because its residents have had access to reclaimed water longer than any other residents in the county (Hillsborough County Water Resources Department) (Figure 1). Due to the long tenure of reclaimed water services in the Village, its residential population includes people who were living in their homes prior to the advent of the service as well as those that moved in after. For this reason, this population was deemed likely to exhibit the largest range of perspectives on the service of any in the county.
Figure 2. Map of Carrollwood Village Study Area
The Carrollwood Village Reuse Project was the first project of residential reuse to be built not only in the Dale Mabry Service Area, but in the county as a whole. Originally planned by the county as a demonstration project for reclaimed water, it was eventually implemented through the combined efforts of several stakeholders: Hillsborough County, Carrollwood Village Phases 2 and 3 (Figure 1), and the Northwest Hillsborough Basin Board of the Southwest Florida Water Management District (SWFWMD). The Carrollwood Village Reuse Project operates with approximately 5.3 miles of transmission mains and 26 miles of distribution lines (transmission mains are the major arteries of reclaimed water and carry it in large-diameter pipes; distribution lines branch off from them and carry the water to individual residences). Like the larger Dale Mabry Advanced Wastewater Treatment Plant, the Carrollwood Village Reuse Project itself includes service to common areas, roadway rights-of-way, apartments and condominiums, for which the combined average daily rate of usage is approximately 700,000 MGD (LoPresti and Duncan 2008). Although the numbered phases of the Village do refer to the order in which they were constructed, the reclaimed water pipes were not laid in the same order. The Phases were constructed in order, from Dale Mabry Highway moving west to Casey Road approximately constituting Phase 1, then west from Casey Road to Brushy Creek approximately constituting Phase 2, and from Brushy Creek further west, to the residences on either side of West Village Drive south of its intersection with Ehrlich Road, approximately constituting Phase 3. Reclaimed water, however, was brought to Phases 2 and 3 first, between October 1993 and November 1994, and later to Phase 1, between February 1994 and fall of 1995.
Carrollwood Village contains a representative sample of each use of reclaimed water currently under implementation in the Master Plan Area as a whole: golf courses, commercial users and residential subdivisions. The Emerald Greens Golf Resort and Country Club in Carrollwood Village has used reclaimed water since May 1978 at an average rate of 100,000 gallons per day over approximately 81 acres (LoPresti and Duncan 2008). This golf course was by far the earliest in the Master Plan Area to connect to reclaimed water services; the other five were connected between 1982 and 2005. As a consequence of being first to connect, their supply is unlimited, although they must pay for the quantity used (Mr. Davidson, golf course manager).

Within Carrollwood Village itself, the only commercial use of reclaimed water is for the irrigation of common areas along the main transmission lines, with average usage totaling approximately 100,000 gallons per day over 98 acres (LoPresti and Duncan 2008). The remaining group of customers in the Master Plan Area comprises residential users, the “Reclaimed Water Improvement Units” (LoPresti and Duncan 2008, 3-3), among whom are the Carrollwood Village residents that are the focus of this study.
Carrollwood Village as a whole has a somewhat uniform appearance, possibly due to having been planned and built in three related construction phases. The Village is trisected by the intersection of two main roads, South Village Drive and West Village Drive, and most residential areas are connected directly, or nearly so, to these main roads. There are no gated areas in the Village, although several sections adjoining the larger streets are enclosed by walls that act as noise barriers. Streets in the Village are curvilinear, meandering around retention ponds and massed tree plantings. This, and the spacious yards separating the houses, makes it difficult to see beyond the immediately surrounding area; the vista is generally limited to the street one stands on. This sheltered feeling holds for nearly all of Carrollwood Village, but not of Northdale, the adjacent neighborhood to the north. A single resident of Northdale, Mr. Harvey, was solicited as a participant in the study to provide a contrast with the perspectives of Carrollwood residents, as Northdale has no reclaimed water service. In his words,

This neighborhood has more modest housing and residents than Carrollwood; it’s a demographic thing. Our cost of housing is lower…lower income-level people live here, and we don’t have the landscaping requirement that they do in a more upscale neighborhood.

On the streets in Northdale the houses are closer together, the yards are far smaller, and the general appearance is less affluent than Carrollwood Village. Indeed, compared to all other participants, Mr. Harvey’s house had the second-lowest property value (Hillsborough County Property Appraiser). Mr. Harvey’s participation was solicited on the advice of Mr. Connors, a friend of his living in the Village, who confirmed that because Northdale residents never had reclaimed water installed and instead rely on groundwater for irrigation, they are under county restrictions to water their lawns no more than once per week. The sprawling green lawns that characterize most of Carrollwood Village are nowhere in evidence in Northdale. As Mr. Connors emphasized, the lack of water causes their grass to turn brown in the dry season, which can depreciate the value of their homes.

Within Carrollwood Village itself there are a few sections without reclaimed water, where the pipeline simply passes by or ends before entering the area. Mr. Michaels, a resident of one of these sections interviewed because of his position on the Carrollwood Village board, stated that his section opted not to have reclaimed water installed because of the extra cost of tearing up the streets. He pointed out that although most members have since changed their minds, it is now too late to install the pipeline. Interestingly, his house had the third-lowest property value (Hillsborough County Property Appraiser) of all participants. It is likely that there is a relationship between property value and access to reclaimed water, as mentioned by Mr. Michaels and Mr. Connors, but the establishment of such a relationship lies outside the scope of this study.

**Methodology**

The success of water reclamation projects depends greatly on the acceptance of reclaimed water in the public mind, which has been shown to be contingent on perceptual factors. This complex field of attitudes is crucial to explore to understand how underlying
stances may influence larger societal acceptance. To this end, participants were asked a set of detailed questions concerning the safety of reclaimed water, its potential as an alternative drinking source, and its prospects for contributing to sustainability, and invited to expound on them in any relevant direction.

Primary research methods consisted of personal interviews mainly with residential users of reclaimed water, as well as with the few commercial users and Hillsborough County environmental and engineering specialists and wastewater treatment plant operators pertinent in the case study area. Secondary research methods consisted of background research on the history of water management in Florida and the county and on the functional details of wastewater treatment plant operations.

Interviews were solicited by delivering leaflets to every residence in Carrollwood Village, thereby eliminating any sample bias with the selected population. The only remaining bias lay in whether the respondents themselves chose to volunteer to be interviewed. Out of a total of 1,391 leaflets distributed, there were twenty-five residential respondents (four additional interviews were solicited by phone calls to the officials of the Hillsborough County Water Resources Department, and one by a phone call to the Emerald Greens Golf and Country Club). This relatively small rate of response (less than 2%) may be due to the nature of the solicitation method. A leaflet measuring 7” x 5½” tucked behind the flag on the outside of one’s mailbox is a relatively inconspicuous object, and much less obtrusive than a phone call or an e-mail message, which cannot be as easily ignored. However, this challenge was understood and planned for from the beginning. Since the interview questions called for a greater amount of depth in the responses, and required a correspondingly greater time commitment, than a standard survey with multiple-choice answers, the intent was to interview only those residents who had an interest in the topic. With these constraints taken into account it was decided to solicit a large population, the better to guarantee a total quantity of interviews adequate for research purposes.

After a participant responded to the request for an interview, a day and time was scheduled and the interview conducted in person at the participant’s home. There were a few exceptions: one interview was conducted in a restaurant, four over the phone, and seven at the participant’s place of work. The at-home interviews took place over the months of December 2008 and January 2009, with most falling on the first four consecutive Saturdays in January.

Interviews followed a semi-structured format. The semi-structured interview is a way for the researcher to deepen the understanding of a topic by exploring it in detail, organizing its component parts, identifying and exploring its unknown areas, and situating it in its context. The format consists of open-ended questions, which seek specific answers but allow the interviewee to expound on them in any relevant way. The qualitative approach of “semi-structured interviews with (mostly) open-ended questions” as applied to a study set of stakeholders to reveal their perspectives on reclaimed water use can be justified in terms of the intimate involvement these stakeholders have with the local environment (Krogmann et al. 2001, 117). In other words, the stakeholders represent a naturally self-selecting study set; their commitment to their own work and business ensures the meaningful integrity of their responses.
The semi-structured interview uses predetermined questions that may be open- or closed-ended to different degrees, and it can also be used to operationalize the elements under study into variables, to develop hypotheses, and to analyze them. The method of the semi-structured interview differs from that of an ethnography in its tighter focus and more restricted scope. The term “ethnography” refers to both the process and product of a sustained study of a group of people. It is foremost an attempt to put any interpretation of peoples’ actions in the context of what they themselves actually do and think. Interviews can form a component of an ethnography, but of themselves they do not constitute one.

The first research question of this study related to the safety of reclaimed water, which was defined as its level of harmful effect on the health of humans, animals, plants and the environment as a whole. Participants were asked to provide their opinions regarding the treatment of reclaimed water in terms of its effects on human health, both through direct skin contact and indirect long-term exposure to residual contamination in soil or groundwater, for example through the irrigation of agricultural goods with reclaimed water. Participants were also asked to evaluate its long-range effects and their implications on the health of animals, plants and the environment in general. Although these questions explore understandings of health and environmental impacts, their relevance is not limited to this topic. They bear significantly on the public acceptance of reclaimed water in general.

In terms of the second research question, on comparisons between reclaimed wastewater and alternative water recycling options, the topic of desalination was not included in the original interview questionnaire, but when the subject was raised by a number of participants, the idea of a comparison began to arise between desalinated and reclaimed water as drinking alternatives. When fifteen participants eventually did volunteer their opinions of desalination, a follow-up request was made to compare it to reclaimed water as a source for drinking.

To address the third research question on the role of reclaimed water in wider practices of sustainability, participants were asked whether they believe that water crises are occurring, or are bound to occur, nationally or globally, and whether they believe that humans will be able to achieve globally sustainable use of water. The purpose of this question was to determine whether they thought the use of reclaimed water could contribute significantly to this goal.

Although the interview used predetermined questions with multiple-choice answers, the participants were allowed to expound in greater detail on any question for which they had complex answers. This mixed format took into account the challenges inherent in interviewing, such as the need to keep the conversation on track, to push for clarification when needed, to follow leads that might not be logically apparent and to explain or link together ideas expressed by the interviewee into a coherent whole.

All interviews were electronically recorded, except for two. The operators of both the Falkenburg Wastewater Treatment Plant and the Dale Mabry Advanced Wastewater Treatment Plant requested to not be recorded, so detailed notes were taken instead. At the conclusion of the interview process, recordings were transcribed and a content analysis was performed on the transcriptions to identify commonalities and regularity as well as contradictions. Based on the content analysis, a selected number of topics and viewpoints that strongly represented the entire range were explored in detail. Participants’ answers to
the above questions were classified on a scale of relative agreement or disagreement, and are referred to either as supportive/in favor or as skeptical/opposed to the topic in question. These categories were chosen to reflect the nature of the pool of responses as a whole. Most responses fell clearly into one or the other of the categories – for some based on a direct yes-or-no answer; for others, based on an interpretation of their meaning. Where it was unclear into which category a response fell because it expressed views on both sides of the issue, or because it expressed views on neither side, the response was classified as ambivalent, the third category. To protect the privacy of the participants, all names used in this study have been changed.

The participants as a group were diverse in educational background and occupation; much less so in gender, age and ethnicity. All had some post-high school education, ranging from certain technical courses (one participant, a wastewater treatment plant operator), an Associates’ degree (one participant), to a Bachelor’s (nine participants), to a Master’s (fourteen participants, including one with a Master’s in Social Work and one in Business Administration), to a Doctorate and beyond (three participants, with degrees in Geochemistry, Electrical Engineering, and Law respectively). Participants’ occupations were: wastewater treatment plant operators (2), county water resource services employees (2), golf course superintendent (1), pesticide and chemical salesperson (2), geologist and environmental consultant (1), commercial real estate appraiser (1), librarian (1), dentist (1), physical therapist (1), school principal (1), and various professional positions in sales, finance and business. They were between 36 and 78 years in age, with most falling in the range between 40 and 60; twenty-three were men and seven were women. The operator of one of the wastewater treatment plants was black, but all the residents, without exception, were white. This racial homogeneity may correlate with the racial demographic of Carrollwood Village as a whole, although it would be necessary to take a statistically representative sample to determine.

Property values for the homes of participants in Carrollwood Village are in flux as of this writing. During a one-month period in February and March, 2009, market property values dropped on the average between ten and twenty thousand dollars, by the end of which period the values ranged from $190,096 to $462,415, with an average of $294,833 (Hillsborough County Property Appraiser 2009).

Carrollwood Village in its entirety lies in the center of the 33624 zip code area, which extends further to Van Dyke Road in the north and to West Linebaugh Avenue in the south. Demographics for this zip code area were pulled from the United States Census data for the year 2000 (United States Census Bureau 2000) and are presented in Appendix C for comparison with the study set of interview participants. Census data and study set data are presented, by number and percent, for the following characteristics: age, gender, ethnicity, educational level attained, home values and length of occupancy. Additional data on household size, housing unit ownership, and income levels in the 33624 zip code area are presented from census data, although these data were not collected from participants in the interviews.

The data for the interview study set and the census data for the larger zip code area differed in several variables. A comparison shows that the median ages, educational levels, and home values were higher for the interview participants than for the zip code area residents. The median age of the interview participants was 57.5, as opposed to 35.8
for the zip code area residents. Fully 23% of the interview participants were above 65 years old, while only 8.3% of the zip code area residents were above 65 years old. There was a similar difference among educational levels and home values. The majority of both populations had graduated from high school, but 90% of the interview participants had a bachelor’s degree or higher whereas only 37.6% of the zip code area residents had achieved the same degree. The median home value among the interview participants was $284,857, whereas among the zip code area residents it was only $113,000.

Interview participants were asked to give their length of occupancy in their current home as a way of comparing the numbers of residents who lived there before the installation of the reclaimed water pipeline with those who moved in after. These data are considered on their own terms, not as a comparison with the zip code area data, since Carrollwood Village has reclaimed water installed whereas other parts of the zip code area may not. The numbers showed that 52% of the interview participants had moved into their homes before reclaimed water was available to them, in the approximate period between 1981 and 1994, and 48% had moved in since, in the approximate period between 1995 and 2006 (see Appendix C).

Supply of Reclaimed Water to Study Area

Carrollwood Village is serviced in its entirety by the reclaimed water system of Hillsborough County. This countywide system is divided into the Northwest and the South-Central Reclaimed Water Master Plan Areas. The Northwest area services a wide range of users such as golf courses, residential subdivisions and commercial users, and while the South-Central area services that same range, the bulk consists of industrial users such as the Hillsborough County Resource Recovery Facility and the Tampa Electric Company (TECO) Big Bend Power Plant (LoPresti and Duncan 2008). The study area of Carrollwood Village lies within the Northwest Hillsborough County Reclaimed Water Master Plan Area, hereafter called the Master Plan Area. The Master Plan Area encloses approximately 115 square miles, and extends to the boundaries with Pasco County to the north, Pinellas County to the west, Hillsborough and Linebaugh Avenues to the south, and to the eastern boundary of Range 18 to the east (LoPresti and Duncan 2008).

The Master Plan Area is serviced by four wastewater treatment plants, each of which treats wastewater to different capacities. The Van Dyke Wastewater Treatment Plant, in the north of the Master Plan Area, is permitted for advanced secondary wastewater treatment with a design capacity of 1.7 million gallons per day (MGD). However, this plant is scheduled to be taken offline in 2012, and at that time the wastewater will be rerouted to the Northwest Regional Water Reclamation Facility for treatment. The Northwest Regional Water Reclamation Facility (so-called because of its position in the northwest of the county, although for the purposes of this study it lies in the southwest of the Master Plan Area) is permitted for advanced wastewater treatment with a design capacity of 6.0 MGD. As of October 2008 this facility was undergoing an expansion to increase its capacity from 6 to 10 MGD, including increased aboveground storage. The River Oaks Advanced Wastewater Treatment Plant, in the south of the Master Plan Area, is permitted for advanced wastewater treatment with a design capacity of 10.0 MGD. The Dale Mabry Advanced Wastewater Treatment Plant, which lies in the southeast of the Master Plan Area and directly serves Carrollwood Village, is permitted
for advanced wastewater treatment with a design capacity of 6.0 MGD (LoPresti and Duncan 2008). Both the River Oaks Advanced Wastewater Treatment Plant and the Dale Mabry Advanced Wastewater Treatment Plant, as can be seen by their names, treat wastewater to tertiary, or advanced levels (Mr. Evans, Dale Mabry plant supervisor). In other words, they both produce treated wastewater that is in theory drinkable, although signs posted throughout the study area clearly warn “Do Not Drink”.

In the Dale Mabry Advanced Wastewater Treatment Plant (also called “the Dale Mabry plant”), wastewater passes through a manual coarse screen and two mechanically-cleaned fine screens to remove grit and control for odor. After screening, wastewater moves through a conditioning tank with a volume of 137,626 gallons, two oxidation ditches with a total volume of 4,510,000 gallons, five clarifiers with a total volume of 1,370,000 gallons, five denitrification filters (for anaerobic bacterial decomposition) with a total surface area of 3,250 square feet, and two contact basins with a total volume of 158,202 gallons where it is disinfected with gaseous chlorine, after which it is moved to an effluent pumping station. Fully treated effluent is then aerated and the chlorine removed using sulfur dioxide.

Solid residue left over from the water treatment process is moved into two sludge holding tanks, one with a volume of 466,341 gallons and the other with 339,770 gallons, and onto three gravity belt thickeners. The resulting sludge, thickened by the further removal of liquids, is piped to the Hillsborough Northwest Regional Water Reclamation and Residuals Management Facility for final treatment and disposal (Florida Department of Environmental Protection 2008).
Figure 4. Dale Mabry Wastewater Treatment Plant Process Flow Diagram. From Dale Mabry Wastewater Treatment Plant
Fully treated wastewater effluent from the plant can be released to one of three destinations. It can be discharged to the surface waters of neighboring Brushy Creek, from where it can filter down into the aquifer or make its way into the Hillsborough River and other surface water bodies (Mr. Evans, Dale Mabry plant supervisor). It can be recycled for reuse within the facility or pumped to the Hillsborough County Resource Recovery Facility, also known as the Covanta Waste-to-Energy plant, on North Falkenburg Road in Tampa. Or it can be transferred to the Hillsborough County Reuse System for irrigation purposes, such as the Carrollwood Village Reuse Project that is the focus of this study.

Since the Dale Mabry Advanced Wastewater Treatment Plant is the main provider of reclaimed water to Carrollwood Village, an understanding of its direct chemical and biological effects on the surrounding environment may be relevant to its acceptance and usage in the Village. Detailed studies of the functioning of the Dale Mabry Advanced Wastewater Treatment Plant were conducted in 1997, 2003 and 2008. These studies, also called Fifth-Year Bioassessments, consisted in comparing samples of the water in Brushy Creek between a control site upstream and a test site downstream of the point of discharge from the plant. The objective of these studies was to investigate the possible effects of the discharged reclaimed water, or effluent, on the biota of Brushy Creek, and they were crucial for assessing changes in stream chemistry and biology due to discharge over the long term.

In the 2008 bioassessment, the total levels of phosphorous, nitrogen, orthophosphate and nitrate-nitrite were found to be within permissible limits. However, certain other elements of the study seem to render its results invalid for assessing the effect of effluent on stream conditions. Carbonaceous biological oxygen demand, total suspended solids, total nitrogen and total phosphorous are required to be determined from composite samples taken over a period of 24 hours, but “due to equipment malfunction, a grab sample was taken for these parameters” (Florida Department of Environmental Protection 2008, 3). Additionally, “scheduling conflicts” led the team to collect the effluent samples and the receiving water samples on different days. Since “the effluent was not discharging [from the plant] the day the receiving water samples were collected, the effects of the effluent on the Test Site cannot be determined” (FDEP 2008, 3). In other words, because the plant was not discharging on the day of testing, the data for the receiving water samples can only reflect residual levels of the parameters listed above remaining in the creek, and not any actual levels coming directly from the plant. Therefore, it is doubtful whether the resulting measurements of nutrient levels can be used to model the actual day-to-day effect of the effluent on stream biota, since these levels might well have exceeded permissible limits if the testing had been done on a day when the plant was discharging effluent. Indeed, since the plant has had “five total residual chlorine violations from April 2007 through January 2008, and a total nitrogen violation in December 2007” (Florida Department of Environmental Protection 2008, 3), it seems likely that regular testing is necessary. However, for testing on this occasion to return meaningful results, the protocol should have been followed more carefully to take full account of the potential effects of effluent on the stream.

The permit for the Dale Mabry Advanced Wastewater Treatment Plant’s reclaimed water system, authorized by the Florida Department of Environmental
Protection in November 2003, makes provision for a reclaimed water system “to provide AWT [advanced wastewater treatment] highly disinfected reclaimed water for public access irrigation in the areas within the service boundary” (LoPresti and Duncan 2008, 3-2); this boundary encloses Carrollwood Village in its entirety. This system currently provides reclaimed water for irrigation to over 3,000 single-family residences in subdivisions in the northwest part of the county. The plant also provides reclaimed water to golf courses, schools, apartments, condominiums, roadway rights-of-way, and common areas within the service area (LoPresti and Duncan 2008).

**Entering the Neighborhood**

As this chapter has shown, Carrollwood Village represents an appropriate case study of reclaimed water users both because of its typical suburban development characteristics and its longer-term and dependable presence of reclaimed water supply. The next chapter moves into an analysis of data collected through interviews.
Chapter IV
Discussions of Reclaimed Water

This chapter addresses the three research questions of this thesis. It outlines the range of opinions expressed about the meanings of reclaimed water and attitudes towards its quality, perspectives on the processing of seawater for domestic use as an alternative to reclaiming wastewater, and the connections between a neighborhood-level water reclamation initiative and the broader sustainability of water resources. The aim here is to present in detail the complexity of individual perspectives in order to draw out both similarities and differences and build a more complete understanding of local meanings of reclaimed water supply.

Research Question 1: Is Reclaimed Water Safe?

Participant views on the safety of reclaimed water ranged from supportive (eighteen participants) to ambivalent (seven residents) to skeptical (five participants, including one employee of the county water department). Believers in the safety of reclaimed water cited a history of usage generally free of adverse incidents and a list of beneficial effects of usage for society, economy and environment, while skeptics referred to the as-yet unknown long-term effects of reclaimed water usage on humans and the environment. The moderate group between these extremes expressed views falling in a midrange, and many admitted to not having strong opinions on the topic and/or lacking the information to form an educated opinion. They were often honest about their own ignorance of potential repercussions of reclaimed water use, explaining that since the practice seemed to be well-established and safe, they didn’t think much about it. Although they often professed not to have strong opinions about its safety, on the whole they supported its use, instead of, as might be expected, being ambivalent about the practice. Reclaimed water as a substance was for them “innocent until proven guilty.” In fact all participants, whether they viewed the practice of irrigating with reclaimed water favorably, skeptically, or with no strong opinion, supported the fact of its use. This is as might be expected from users of reclaimed water; their opinions one way or another about its implications do not change the fact that they use it as customers.

Eighteen participants expressed a strong belief in the safety of reclaimed water, and some of them had high levels of education or experience in relevant fields. Ms. Weston, a school principal, explained that her sense of trust in the safety of reclaimed water corresponded to her understanding that it had been scientifically determined to be safe. Mr. Brooks, a geochemist, explained that current use of gas chromatographic processes make it possible to determine the constituents of reclaimed water at levels as low as one part per billion and so to come to a relatively complete understanding of its chemical makeup. However, he also underscored the difficulty of detecting the residual presence of pharmaceuticals in reclaimed water and, by association, their consequent impacts on the environment:
To a degree, it’s the metabolized compounds in the sewage that would be present in the groundwater, rather than the original materials. You take a pill, and the pill you take is metabolized, and what you excrete…has undergone changes, and that compound is what you have to find as opposed to the original.

This admission introduces a potential complication into the prospect of treating reclaimed water to remove unknown contaminants. According to Mr. Brooks, it may not be a straightforward process, but may involve research to identify an unknown end product for each metabolized compound.

Mr. Brooks also believed that the reclaimed water coming from a wastewater treatment plant undergoes tertiary, or advanced treatment before being supplied to residents in the Carrollwood Village irrigation system. This belief was echoed by another resident, Mr. Williams, a chemical salesman and Village boardmember, who expressed certainty that reclaimed water is rated as potable. He added that such a treatment level is probably higher than necessary, since it is not legally allowed for use even in toilets; in other words, it may be overkill to treat water as potable that has little probability of contact with human skin. Their belief that reclaimed water may be potable was confirmed by Mr. Evans, supervisor of the Dale Mabry plant, who stated that the plant treats wastewater to tertiary levels. Mr. Evans clarified that it is primarily the removal of nutrients through deep bed filtration, and not the chlorine disinfection, that equates with tertiary treatment, and that the combination of these steps may indeed adequately prepare the water for drinking. This possibility is alluded to in the following section, in which a participant expresses her willingness to drink reclaimed water in its current state without having been treated to a higher standard.

Mr. Connors, a pesticide salesman, expressed his trust in the adequacy of reclaimed water treatment from a standpoint of legal liability:

They’ve been doing it for so long they’ve got it down to a fine art. Let me tell you, the state and the city is not going to jeopardize anybody’s health, because everybody wants to sue now. They’d open themselves up for a real lawsuit.

He makes the point that the treatment of reclaimed water may, in a practical sense, be regulated just as much by a fear of negative health and legal repercussions as by the guidelines set forth in the Florida Administrative Code.

Whereas the preceding speakers justified a belief in the safety of reclaimed water based on trust in scientific evidence for the safety of the treatment process and in the regulations protecting human health, another referenced a feeling of trust based on personal experience. Mr. Zimmer mentioned that since he works in his yard and gets sprayed with reclaimed water on a weekly basis, he feels he is entirely comfortable with it. He contrasted this feeling of familiarity with his entirely different feeling at the thought of drinking water from a stream, which scares him more, because “depending on what’s upstream, you don’t know what’s in there either.” His stance was unaffected by
the fact that reclaimed water is treated with chemicals whereas the stream is fed by rainwater. Since reclaimed water goes through a known process, and the stream has inputs of unknown origin, he places more trust in the former than the latter.

Among the moderate group of seven residents, one participant’s opinion straddled the line between trust and distrust of safety. Ms. Weston, who later expressed a willingness to drink reclaimed water without further treatment if a scientist told her it were safe to do so, stated her belief that while the contents of reclaimed water can be known, their implications for human health and the environment cannot. This statement also characterized the positions of other participants who felt that the use of reclaimed water carried negative consequences.

Two participants in particular encapsulated, with a certain amount of unintentional irony, a common ambivalence about the safety of reclaimed water. According to Mr. Harvey, “They can analyze what comes out of the [wastewater treatment] plant to an infinite degree. They know precisely what’s in there… I would think.” One way of understanding this statement is that the speaker has an implicit sense of trust in the dependability of the wastewater treatment process, but doesn’t entirely trust his own sense of trust. While this may not reveal much about the robustness of wastewater treatment, it is an entirely honest and revealing assessment of the phenomenon of trust itself, in that trust can simultaneously provide a sense of security while transparently revealing a basis in belief instead of knowledge. Mr. Ericson reinforced the double-sided nature of trust in reclaimed water: “I trust it’s safe. You shouldn’t trust everything you hear.” Both these participants were truly ambivalent in their positions, stating them and undermining them in the very next sentence.

Only one participant, Mr. Carson, admitted total uncertainty about the safety of reclaimed water, neither affirming nor denying it: “What do I know? They tell me that it’s safe, and since I don’t drink it, I would probably agree. I only know what they tell me.” Mr. Harvey acknowledged the mysterious elements that are introduced when humans change the environment:

Is the unknown good or bad? I think the jury’s out on that kind of question. How much of global warming is a natural cycle versus an unnatural cycle? Even if things occur in nature that indicate significant change, how is that so different from what scientists do in the lab?

By comparing pollutants in wastewater to pollutants in the atmosphere, he forged a rational link between human-induced environmental impacts at wholly different magnitudes, enlarging the wastewater issue by association with global warming. He pointed out that when humans manipulate the variables in natural systems, we deal with an equation that has too many unknown quantities to solve: “the jury is out.” Still, he maintained that we cannot therefore conclude not to interfere in natural systems, because the unknown variables that we introduce may be no more significant in the global equation than those arising naturally.

The five participants who believed reclaimed water to be unsafe pointed to a lack of public knowledge of its precise constituents, to the potential negative effects of those constituents on humans and environment, and to the possibility for contamination of the
The strongest response came from Mr. Lundberg, a real estate agent, who declared that current wastewater treatment, far from being adequate to remove contaminants and protect him from harm, actually exposes him to harm through skin contact. Another strong opinion was voiced by Mr. Roberts, the water department employee quoted above:

I strongly disagree that we know everything that’s in the water at any particular time. If we know what we’re looking for we can find it, but if we don’t know what we’re looking for it’s hard to find. Now we can dial our detection down to one part per billion – that’s when they start finding all these drugs in our drinking water – but it’s not part of the normal process to test for pharmaceuticals, so they’re not removed.

These two participants expressed their understanding of the dangers that may be incorporated into reclaimed water before and during its treatment process. Other participants in the ambivalent and the skeptical groups gave more nuanced responses. Mr. Brown, a small business owner, touched on the difficulty of comprehensively detecting the contaminants in reclaimed water, while Ms. Miller, a social worker, expressed her suspicion that public outreach campaigns designed to defend the safety of reclaimed water also serve to assuage legitimate fears of contamination:

It allows people to go into denial and not think about what they just put on their lawns. When people deny things they have a much easier life; they don’t think about what’s in the water. For those of us who aren’t in denial, it’s much more complicated.

Ms. Miller’s depiction of the mechanism of denial can be broadly applied to public fears about food- and water-borne contaminants in general. She went on to indicate her belief that denial may play an integral role in encouraging the tacit public acceptance of new and unfamiliar substances in food and water. It could also be argued that a dose of denial is healthy, even essential, in enabling the public to cohabit with the multiple sources of pollution encountered daily in industrial society. Ms. Miller’s assertion supports the prominence of psychological factors in influencing the public acceptance of reclaimed water.

**Willingness to Drink Reclaimed Water**

When participants were asked if they would consider drinking reclaimed water if, in the future, it were to be treated to current drinking water standards, responses were often mixed. The participants who felt strongly, both in favor (nine) and in opposition (seven), about drinking reclaimed water couched their responses in complex terms and expounded at greater length than those who were more ambivalent about the possibility. This middle group (fourteen participants) was in fact generally supportive, expressing a willingness to drink (also called “willingness”) with the reservation that the participant would have to trust in the authorities who oversee the treatment process to do their job correctly. These participants often expressed their willingness in few words and often
added that, based on their lack of understanding of wastewater treatment processes, they couldn’t foretell the ultimate consequences of drinking reclaimed water. In other words, they gave their answers in simple terms and admitted uncertainty about the result. Among this more ambivalent group were four who acknowledged that, because of a lack of interest in or comprehension of the topic, they had no strong feelings either for or against drinking reclaimed water.

One participant, Mr. Phillips, a geologist and environmental consultant, based his reasons for willingness on rational grounds. According to him,

Nature doesn’t filter real well; man does. We can treat water until it’s safe – we can chlorinate the bejeezus out of it – and it might not taste good, but you can drink it and it won’t hurt you.

This response was unusual in that the speaker was able to justify his feeling, in this case by appealing to the dependability of technology as compared to the unpredictability of nature. However, he stood in the minority in being able to justify his confidence in wastewater treatment technology to produce a drinkable product. Irrespective of whether his reason was sound or not, he expressed grounds for his feeling.

Mr. Granger, an electrical engineer, gave a similar response, emphasizing that if he were to drink reclaimed water, he would want to see the parts-per-million data for every possible contaminant: “What it’s been reclaimed from isn’t important, as long as the parts-per-million data is okay.” This speaker placed his ultimate trust in the ability of scientific procedures to remove the contaminants from water, irrespective of whether the water was the runoff from streets or the effluent from houses. A third participant, Ms. Weston, a school principal, felt comfortable with the hypothetical possibility of drinking reclaimed water and said that she would trust the word of the scientists who analyze it. She also maintained that she would be willing to drink reclaimed water as is, except for the fact that its pipes are marked with a sign that reads “do not drink.” She assumed that the reason for the signage “…may be that it’s the straightest line through the curve; that it’s easier to put ‘do not drink’ and avoid lawsuits, than to try to defend yourself against people who drank.” Her understanding of the reason for the signage was not that it indicated constituents in the reclaimed water that made it inherently unsuitable for drinking as is, but that it acts as a precaution against incidents that might occur if people were to drink it.

Interestingly, only one supporter identified the connection between drinking reclaimed water and protecting groundwater sources. Mr. Strauss, a professor of law, justified his willingness on the grounds that it would be a way to protect the environment, maintaining that repurposing reclaimed water for drinking would constitute a more important use of it than for irrigating lawns. This conclusion fits within the meanings of locally sustainable resource use, all the more so because he recognized that he had an ability to contribute on a personal level.

Ms. Blake, a librarian, in justifying her willingness to drink reclaimed water, compared it to other sources of drinking water. As she expressed it,
As long as you can kill the things that might be harmful, who cares? We just have a squeamishness about certain things. They’re taking water out of the bay for desalination – and what do they think is in the bay, just out of curiosity?

This participant shared the ability to ground her feelings in reasons. In comparing different possible sources of drinking water, she perceived that no source can be guaranteed to be purer than another. According to her, the residues of agricultural chemicals, building materials and animal feces carried into the bay from surface water runoff make desalinated water a no more attractive source for drinking than reclaimed water. She attributed the public’s hesitance to drink reclaimed water to psychological factors – “squeamishness” – and due to the hesitance being merely psychological in origin, downplayed its relevance. This assertion is challenged by the responses of the seven participants who gave more rational reasons for their positions and yet were unwilling to drink reclaimed water. Ms. Adams, in justifying her conclusions, said,

I don’t think there’s anything that would make me feel okay about drinking it. It’s enough that they’re finding pharmaceuticals in our tap water, bacteria, e-coli; yeah, I think I would have to be in real survival mode to want to drink reclaimed water. I think it’s a psychological thing.

This speaker, in attributing her reluctance to psychological factors, nevertheless did not dismiss it as irrelevant, but accepted it as undeniable and inescapable. She also based her feelings on facts – “pharmaceuticals…bacteria, e-coli” – but the facts led her to the opposite conclusion; that because she cannot depend on the purity of a water source, she chooses not to use it for drinking. In the first case, uncertainty led to acceptance; in the second, to rejection.

The prospect of pharmaceuticals and other chemicals making their way into drinking water has a tendency to complicate opinions of its safety. Mr. Phillips, the same speaker cited above whose rational appreciation of technological competence supported his willingness, went further to clarify that his willingness was limited by his doubt in the capability of technology to remove all unknowns. He asked, “What are the long-term effects of all the excess medicines in our urine and feces that get flushed down the toilets and end up in wastewater?” He was not alone in referring to the persistence in wastewater of chemicals disposed of in peoples’ homes. Mr. Connors, whose longtime occupation was in pesticide and herbicide sales for the turfgrass and food crop industries, justified his reluctance to drink by referring to the residual pesticides that he felt would remain in the water after treatment. He mentioned that many newly constructed homes have garages with sinks built in, and worried aloud that the residents might be washing their sprayers in the sink after spraying insecticide on their yards. This participant’s reluctance came directly from his experience in the pesticide industry. Mr. Williams mentioned similar concerns pertaining to the viruses that he felt were too small to be removed by treatment. Ms. Miller, a social worker and self-professed “health nut”, expressed concern about possible effects on the body. She maintained that she would be unable to trust that
the water had truly been purified, and believed that “it could have a massive effect on the 
human body; you’ll get more cancers, and you couldn’t trace it.”

In contrast to the preceding speakers, four participants within the ambivalent 
group of fourteen were less able to justify their willingness or unwillingness in regard to 
external factors. These participants referred instead to an instinct, a feeling of trust or a 
hunch as their basis for deciding. Some admitted to being ignorant about or lacking 
interest in the topic, which seemed to preclude them from expressing strong feelings one 
way or another. Statements such as “I don’t think I really care to know. It’s not 
something I’m worried about” and “personally, I wouldn’t worry a hell of a lot about it” 
seem to express either disinterest or acceptance that the scope of the issue is beyond the 
understanding of the speaker.

Nine of the participants, when asked about the prospect of drinking reclaimed 
water treated to drinking water standards, referred to recent news stories of astronauts on 
the space shuttle reconditioning their own urine to drink. The story, as covered by 
Reuters international news media, tells of a new water reconditioning system aboard the 
space shuttle Endeavour that will enable the astronauts to “recover about 92 percent of 
the water from the crew’s urine and moisture in the air” (Reuters news media 2008). 
Those participants who mentioned the story communicated a feeling of trust that 
reclaimed water could be reconditioned for drinking, based on an implied comparison 
with the technology for reconditioning urine. They made the assumption that because the 
technology exists and is being used for urine, there should be no difficulty about using it 
successfully on reclaimed water. None, however, remarked on the possibility that the 
public visibility, funding and research applied to space-based water recycling technology 
may be vastly greater than that applied to residential water recycling technology. These 
factors, more than mere potential, may determine the purposes to which such 
technologies are applied.

Research Question 2: Reclaimed and Desalinated Water as Alternatives

Whereas before only nine out of thirty total participants had expressed a 
williness to drink reclaimed water, proportionally double that number (nine out of 
fifteen) gave desalinated water a positive review as a source for drinking. (The remaining 
five participants focused on the negative implications of desalination, and several 
participants crossed over significantly on both sides of the issue). Those participants who 
had expressed awareness of the potential dangers of drinking reclaimed water had been 
generally unwilling to support the practice, whereas most participants who portrayed the 
negative consequences of desalination concluded that it should be done anyway. This 
contrast reveals a dissonance between their concepts of the two prospects. The 
participants who were aware of the dangers of drinking reclaimed water opposed the idea, 
whereas those who were aware of the dangers of desalination still supported the practice 
as a necessary one.

Among the reasons given for supporting desalination were that the size of the 
oceans would seem to promise an unlimited supply, the fact that it follows nature by 
evaporating ocean water and turning it fresh, and what people perceived as a lack of 
harmful consequences. The first two arguments are difficult to dispute, but the third is 
very much in contention.
Two participants, both enthusiastic supporters of desalination, viewed its prospects from the standpoint of water scarcity. Mr. Lawson indicated that the mounting population pressures in Hillsborough County will require desalination as a way of offsetting the increasing amounts that must be pumped from the Hillsborough River for drinking. His attitude towards the new technology is that it is a last resort, but nevertheless necessary to forestall a worse outcome. Mr. Ericson expressed his view that global warming will lead to melting of the polar icecaps, reducing the amount of freshwater available worldwide and making it necessary to turn to desalination. These participants concluded that the anthropogenic problems of runaway population growth and environmental degradation will lead to widespread water shortages, and both homed in on desalination as the necessary antidote.

Two other participants compared the safety of desalinated water favorably with that of reclaimed. Mr. Harvey expressed that “in principle, desalinated water is the same thing as reclaimed, because you’re taking something that’s unpotable and making it potable.” Mr. Brown, a small business owner, stated that desalinated water may be cleaner than reclaimed, and therefore more easily adapted for drinking, because of having undergone natural filtration and exposure to the sun’s rays in the Atlantic Ocean. Mr. Brown mentioned having heard of concerns about the environmental impact of dumping the brine back into the bay, but wondered why it would present a problem, since “it’s not like you’re adding something that didn’t come from the ocean in the first place.” The remaining five participants supporting desalination expressed no reason for their support other than that they personally had no objection to the idea.

Among all participants, one gave a more mixed opinion of the effects of technological solutions to the challenges of supplying humans with water. Mr. Brooks, a geochemist, included both positive and negative views in his answer:

Without desalination, there is not enough freshwater for people; there’s no question about it. And this is definitely true in the Southwest…the human use of the Colorado River, in fifty years, has gone from a negligible amount to virtually emptying the river.

He emphasized the necessity of committing to desalination, and implied that one of the reasons for this necessity is the failure of the dams along the Colorado River to adequately provision humans with water. This opinion carries a nuanced view of large-scale technological applications, in that while they have the potential to provide new sources, they may also damage those that exist in the environment already.

Five participants focused on the negative implications of desalination. Mr. Strauss, a professor of law, emphasized the potential socioeconomic costs of desalination:

I’m generally not in favor of privatizing public resources. A company might decide that it’s just not efficient to pump water to a rural area, or the cost of the technology could make it unavailable to poor people. If you privatize it, you’d still have to have a huge amount of government regulation, and so you might as well keep it as a public utility, that’s my view. They’d need to price it to capture the cost of the externalities.
He highlighted the fact that there is something categorically different about providing water through desalination than from natural freshwater sources, something that turns it from a public resource into a private commodity. While the Tampa Bay desalination plant is a public not a private entity, being owned and operated by Tampa Bay Water, the costs involved in its construction – approximately $158 million from local property taxes (Tampa Bay Water 2008) – the costs of its ongoing maintenance, and the as-yet uncalculated costs of its environmental impacts are passed on to the consumer, resulting in higher drinking water costs overall.

Another participant, Mr. Bennett, also looked at the issue from the perspective of governance, expressing suspicion of the quality and extent of research done prior to implementation of the project: “They did enough research to sell you on the idea; as much as necessary. It’s like smoking; we hope that down the road there’s not problems or repercussions from using it.” He appealed to the trust that one must place in the authorities to take the necessary precautions, but revealed that, because he does not feel this trust, he is left with uncertainty at the prospect of “drinking salt water.”

Whereas Mr. Harvey and Mr. Brown had compared desalinated water with reclaimed to point out their similarities, Mr. Connors, a pesticide salesman, compared them to underline their differences. As he pointed out, while reclaimed water contains treated domestic wastewater alone, the ocean receives not only treated domestic wastewater but also stormwater runoff, resulting in higher drinking water costs overall.

In his explicit comparison between the sources for desalinated water and reclaimed, Mr. Connors’ response begged the question of why seawater should necessarily be seen as cleaner than wastewater. With thirty-five years of experience selling pesticides and fertilizers, he felt he had more to fear from their residues than from the residues of domestic wastewater.

Two participants referred to the environmental impacts of desalination. Mr. Zimmer mentioned that he had visited developing countries that rely heavily on desalinated water and had observed an unfortunate effect of the accumulation of minerals on nearby soils and water bodies. He reasoned that the addition of brine would likewise change the chemical structure of the seawater in Tampa Bay, which would in turn affect “the ecosystem which we, somewhere up the food chain, rely on.” He speculated that the long-term effects of such changes would be unknown, and concluded that relying on reclaimed water to a greater extent than desalinated would be a safer path. Mr. Williams maintained that the potential costs of desalination would outweigh the benefits:
We’re not going to solve the water crisis by creating new desalination plants, because we just create new problems. We just have to reduce consumption, and make every home more economically and environmentally sustainable. That’s the only direction we can take.

His opinion brings the issue full circle with a radically different viewpoint. Participants quoted above saw desalination as the only solution to a global problem of water scarcity. Instead, Mr. Williams saw conservation as the only workable solution in a global situation of water abundance. He maintained that the best option is to not create new sources but to conserve the ones we have.

Research Question 3: Water Crises and Sustainable Water Resource Use

Few participants, even among those highly supportive of reclaimed water usage, expressed curiosity about its original source or the path it took before reaching their homes. Many made no distinction between stormwater, or the precipitation that runs off from soil and impervious surfaces, and domestic wastewater, or the used water that comes from bathrooms, kitchens, washing machines and dishwashers. When this distinction was explained, some expressed a preference that reclaimed water be compounded from domestic sources only, but less for fear of danger to their own safety than for danger to the health of the environment. As Mr. Phillips, a geologist and environmental consultant, said,

It’s just not on the radar. You turn the faucet and water comes out and that’s all people think about. They don’t care where their source of water is; they just expect it to be there and expect it to be what they want.

Reclaimed water is thus not readily understood by the public as a contributor to the sustainable use of water resources. In the year 2008, although it saved the tri-county region nearly 23 MGD of groundwater by offsetting an equal amount that would otherwise have been pumped from the aquifer (Tampa Bay Water 2009), it did so quietly, without making a fuss about the conservation of water resources. Residents generally irrigate with reclaimed water because they want to save money, not because they want to conserve groundwater. Additionally, both sources are combined in the same water bill, so that residents stop noticing reclaimed water after a while.

Nevertheless, interview participants had complex attitudes toward the role of reclaimed water in terms of sustainability of water resources, and the large scope of this question produced several answers too complex to characterize as either belief or skepticism. Mr. Henderson addressed the problem from various angles:

As populations grow, water becomes more scarce and more valuable. I don't know if technology will be able to identify every contaminant. Will different societies have the technology available and the economic means to test all their water sources? It looks like there is no answer.
This response is notable for including demographic, ecological, technological and social aspects of the problem in one sentence, and for admitting in the next that there is no simple solution. Most responses focused more narrowly on one or another of the factors of population, technology, politics and human behavior. Many expressed the view that, since they could give no answer backed by scientific expertise, the problem as a whole was beyond their comprehension.

Mr. Brooks, a geochemist, had implied in his discussion that one of the factors making it necessary to commit to desalination is the failure of water control structures – such as the approximately fifty dams along the Colorado River and multiple levees and diversions throughout the Florida Everglades (Rothfeder 2001, and NRDC 2004) – to adequately provision humans with water. There is irony in the view that the negative impacts of large-scale water-control structures necessitate the implementation of yet more large-scale water-control structures, a view which depends on the basic assumption that, as he stated it, “there is not enough freshwater for people.”

Six participants addressed human population as a constraint. Mr. Brooks held that "water will be a limiting factor from here on out, because the population is going up, if not exponentially, at least semi-exponentially." Mr. Connors, a pesticide salesman, linked increased population to a concomitant increase in demand for material goods, emphasizing that water resources will be overstressed in attempting to meet that demand. Mr. Zimmer referred to water crises occurring around the globe and indicated that these affected regions may be "a microcosm of what's to come for the whole world." He also questioned the wisdom of using reclaimed water for irrigation of lawns, arguing that there are other uses more pressing for human survival. Three of the participants who weighed in on the issue of population concluded that increasing population pressures will make it impossible to achieve long-term sustainable water resource use. Ms. Miller, a social worker, dismissed the prospect of achieving sustainable water resource use as too idealistic and explained that, to make this prospect a reality, populations would have to decline. Mr. Carson, a military pilot, linked population increases in the last century to a corresponding proliferation of industrial wastes over the same period, which he maintained has already foreclosed the future potential to achieving sustainable use of water. Mr. Ericson agreed, declaring that while industry as a whole could be made sustainable on a small scale, at its present level of proliferation it “has already made impossible our long-term ability to live on this planet.”

Other respondents weighed more evenly the benefits and drawbacks that technological solutions bring to the issue. Mr. Lundberg, a real estate agent, stated that the sustainable use of water resources is a goal that can be attained, but only through the pursuit of desalination technology on a global scale. Ms. Saunders, a physical therapist, suggested that while water supplies themselves are not in danger of drying up, implementation of more efficient distribution systems is needed to move water from areas of the United States with surpluses to those that experience regular droughts. In her words: "They built the Great Wall of China way back when; why can’t they build more aqueducts now?" These two favored solutions that would continue to provide water at current levels well into the future.
Four participants pinpointed the political process as a force equal to or more significant than science in setting boundaries for water use. Mr. Strauss, a professor of law and a supporter of technological solutions, tempered his approval with a reminder of the often problematic role that politics can play:

I'm a believer in technology. Science will always involve uncertainty, but scientific research that errs on the side of caution, by exploring worst-case scenarios, can encourage conservation. But getting the people and the politicians to listen – to me, that's the hardest part.

This viewpoint identifies the fact that science seldom follows a direct path when it comes to changing policy; instead it is often political factors that influence decision-making and bear more directly on prospects for sustainable water use. Mr. Granger, an electrical engineer, suggested that if the price of drinking water were to be dramatically increased, it would send a signal to the public to conserve more. As he put it, "It's not an economic problem, it's not a scientific problem; it's just political." He maintained that if the federal government were to make the sustainable use of water a national priority, it would probably have ample technological knowledge at its disposal to do so. Mr. Brown, a small business owner, surmised that only the palpable effects of serious drought may have the power to motivate such decision-making at the national level. Regions that experience no water shortage at present, he maintained, are unlikely to undertake measures to conserve water in the near future. Ms. Weston, a school principal, tied policymaking at the governmental scale to the everyday habits of ordinary people. She highlighted the importance of proper education in teaching self-discipline and in guiding the public to conserve, while at the same time despairing of changing the behavior of the public in the near term. "I think we have a better shot, quickly, with technology, than we do with changing the habits and the mindsets of people."

Although most of the participants believed that the use of reclaimed water can substantially relieve freshwater demands on aquifers, they raised many doubts about the likelihood of achieving globally sustainable water withdrawals in the near future. On the whole they regarded technology as both a solution and a problem, and understood that the political will to implement technological solutions is essential but unreliable.

Mr. Williams, a chemical salesman and Carrollwood Village boardmember, diverged from most in offering a significantly different approach to the issue. Instead of focusing on large-scale trends in human population, technology, or politics, he addressed human behavior at the local scale:

If you were to set up every home to collect, generate and reuse its own water, then you still solve the problem using technology, but instead of going macro you go micro. You reverse the way you apply the technology. To me that’s the solution.
This vision integrates the factors of population, technology, and politics into a more manageable proposition. It reflects a currently growing understanding of the potential for localized “green” movements to collectively change the direction of energy and resource use in this country by implementing solutions for households as well as at the national level. These actions may seem insignificant, but they conserve water supplies while protecting the forests, rivers and coastal areas that border many cities. In turn, these protected ecosystems can filter water and hold it in the landscape, helping to maintain clean supplies of surface water into the foreseeable future. Thus the benefits of conserving natural ecosystems accrue not only to the habitats themselves; ultimately they benefit humans as well.

Urban Landscapes and Water Crises

The seriousness of the crisis facing Tampa Bay’s water supply was revealed in a recent public meeting I attended between county resident representatives and water supply agency boardmembers (Tampa Bay Water board meeting, 2/16/09). Repeatedly during the meeting the tenuous status of water supplies in the tri-county region was emphasized, and the point was made that the county, upon taking historical, meteorological, and behavioral factors into account, is considering upgrading the status of the water supplies in the region from “extreme” or phase 3, to “critical”, or phase 4 (Figure 3). In another meeting I attended, between Tampa Bay Water and the representatives of the county member governments which it serves, it was stressed that the move to phase 4 was not taken without every effort still being made to provide users with acceptable levels of freshwater: “on the supply side, all stops have been pulled” (unidentified speaker, Tampa Bay Water Conservation Coordination Consortium meeting, 3/11/09). However, a caveat was made that although Tampa Bay Water and the member governments take this status upgrade seriously, it “means nothing to the public” unless the media can express the direness of the situation in a positive, even humorous way (unidentified speaker).
Figure 5. Seven counties under an Extreme Water Shortage Alert
From: http://www.swfwmd.state.fl.us/news/article/1189
Under the phase 3 conditions, the governing board of SWFWMD had voted on October 28, 2008 to impose tightened watering restrictions on the entire tri-county region, mandating that residents water their lawns only once per week, and then only between 6:00 in the evening and 8:00 in the morning (SWFWMD 2008). (Reclaimed water customers are not limited by these restrictions, but can use as much of the reclaimed water as they want due to the nature of their original agreement with the county. As proclaimed on Tampa Bay Water’s website, “the use of reclaimed wastewater is not restricted; however its use must not be wasteful and unnecessary” [Tampa Bay Water 2008]. Indeed, because of drought conditions current as of the time of this writing, residents may be using more reclaimed water than usual as evidenced by lower levels in the storage tanks at the Dale Mabry plant [Mr. Evans, Dale Mabry plant supervisor]).

Among the water-saving tips for residents posted on SWFWMD’s website are to take shorter showers, to install low-flow showerheads, and to fix leaks around the home. The website also promotes Florida-friendly landscaping, including planting Florida native plants and using mulch and compost.

Both the water management district and the water supply utility are well aware of the gravity of the water shortage affecting the entire tri-county region, and freely publicize many ways for residents to save water. However, all these ways are predicated on the questionable necessity of covering yards, street medians and public planted areas with Saint Augustine grass, a non-native whose water requirement far outstrips that of Florida native plants. Most of SWFWMD’s water-saving tips concern alternative ways to care for this grass species, from cutting it at the highest possible height to applying fertilizers sparingly. If public outreach were focused instead on giving incentives to plant yards entirely with Florida natives, a tremendous amount of water, both fresh and reclaimed, would be saved for other needs. The water-saving tips, instead of trying to fine-tune a use of water that is purely cosmetic and has no regard for local ecology, could focus on types of conservation which contribute directly to the lives of native plants and animals. As Mr. Williams pointed out, residents can still have green yards, even grass, without irrigation, the difference being that the species chosen must be Florida natives.

During the 1980s there was agreement between SWFWMD and Tampa Bay Water that environmental problems in the region, such as the depletion of surface water supplies and land subsidence, were caused by a lack of rainfall. Then, between 1987 and 1993, SWFWMD conducted a study that came to a different conclusion: it was an excess of wellfield pumping, not purely environmental factors, which was the major cause of the depletion of water resources and associated problems. Tampa Bay Water, which at that time was still the West Coast Regional Water Supply Authority (Hillsborough County Government Online 2008) disagreed with this conclusion, maintaining that the problems were due to “ditching, damming, drought, or other development problems” (Rand 2000, 13). Contrary to overwhelming evidence since that date pointing to overpumping as the major factor, this viewpoint still persists. On the homepage of the Tampa Bay Water website, a “Water Shortage Alert”, in bold red headlines, asks: “due to below-normal rainfall and reduced surface water over the summer rainy season, please reduce outdoor water [use]” (Tampa Bay Water 2008). This sends a direct message that the reason residents must curtail their water use is because nature has failed man, when the truth is the other way around.
According to the SWFWMD, “up to 50 percent of [drinkable] water pumped to homes in the Tampa Bay area is used for landscaping and irrigation” (SWFWMD 2008, 2), which represents an increasing threat to the long-term stability of regional freshwater supplies. An alternative source, either for drinking or merely for selected indoor uses, could be provided by treating reclaimed water with the same reverse osmosis process that is used for desalinating seawater. As has been seen from the literature and from the results of this study, the obstacles to implementing such an alternative are largely perceptual – “the yuck factor” – and societal, in that the supplies of reclaimed water are already allocated for other purposes. It is unlikely that the obstacles are technical; the reverse osmosis process may be more than adequate if applied to reclaimed water. This point was confirmed by Mr. Roberts, an environmental specialist with the Hillsborough County Water Department:

Reclaimed water technology has been around for a while; we’re just now starting to see more of its potential. We’ve used it for industrial and irrigation purposes; can we treat it to the point of it being potable water again? I most certainly think we can. It just takes one more process. The biggest problem is getting the public to deal with that.

The use of reclaimed water is a model for the wise use of water resources in general. It is not concerned with creating new solutions that may in turn create new problems, but with finding a solution within existing patterns of water use. Even so, the possibility should be considered that water, even recycled wastewater, may be too valuable to be used for primarily aesthetic purposes. Mr. Williams, a Carrollwood Village boardmember, called into question the entire practice of using water for irrigation: “Florida is one of those states where there’s a ton of water everywhere, and a water shortage. The problem is we waste it. I mean, we’re still putting it on lawns.”

Mr. Williams’ critique of lawn irrigation brings the local issue of reclaimed water full circle with its origins. The original aim of the county in financing, building and maintaining reclaimed water pipelines was to provision its neighborhoods with a dependable irrigation source. Property values in Carrollwood Village depend greatly on “curb appeal”, or the overall appearance of the exterior of a home from the street, and a large, well-kept green lawn contributes positively to a potential buyer’s impression of a home. As Mr. Connors, a pesticide salesman, put it, “lawns have the value of curb appeal. When I pull up to a house I can tell right away whether I’d be interested in it or not”.

Lawns, by contrast, are nonexistent in a typical middle-class neighborhood in New York or Boston, where the streets are laid out in grids, residents live in tall apartment buildings, and public transportation is accessible from nearly every corner. One such neighborhood might easily fit the entire population of Carrollwood Village in a few metropolitan blocks. In contrast, the lawns in Carrollwood Village are large, and their size is related to the physical layout of the neighborhood. Streets in the Village are wide and sprawling, with most public amenities accessible only by car. The spacious planning of this suburban landscape is largely responsible for the size of the lawns, and therefore for the need for irrigation water. The combined factors of the extent of asphalt,
the size of lawns, and the consequent use of water to irrigate may have far larger cumulative effects than easily perceived. As Mr. Williams said,

> If you look at the way that climate change happens, it’s greatly influenced by the amount of surface water that’s not in the landscape anymore but that runs off of cement and rooftop. We have changed the cycle just by a massive amount of development and disregard for leaving green space.

Mr. Williams’ comment demonstrates the larger interrelation between the effects of lawn irrigation, urban development and global climate change. Decisions made at the individual level, like the decision to grow a lawn, can have cumulatively large effects if they are common throughout an entire culture, and over time may make necessary more drastically corrective action than was ever intended.
Chapter V
Conclusion

By soliciting views on reclaimed water from both operators and users, the aim of this research was to provide a more complex understanding of the meanings of reclaimed water in its local institutional and community contexts. The broader objective of this research was to underscore the relevance of research on small-scale conservation efforts to the field of environmental studies today. While such local movements may seem a mere “sideshow in worldwide contests about the fate of the environment…the reverse, however, must be argued” (Robbins 2004, 974). By investigating the popular understandings of human action and environmental impact as they exist in local communities, it becomes possible to participate in a more direct relationship with the environment. The facts of environmental degradation can be confronted more honestly by concentrating on local problems rather than on global crises that are more impressive but also comfortably out of reach of individual responsibility.

The findings of this study show that the makeup of the human psychological response to reclaimed water is as complex and heterogeneous as the makeup of the water itself. Syme and Nancarrow (2006) refer to the “idea of disgust” (190), the “[theoretic] association between body waste disgust and consumption of food associated with reclaimed water” (192), and whether “feelings of disgust actually dominate over more ‘rational’ beliefs (193)”. However, the disgust they refer to is not an irrational idea but a universal human distinction between excrement and food. In contrast, more “rational” beliefs are based on trust in the governmental and scientific authorities to prove the safety of reclaimed water. When even thorough scientific study cannot account for the contents of reclaimed water, trust in the authorities becomes a vital ingredient in the public’s willingness to use it.

It is the aim of this study to give voice to the opinions of ordinary people, to understand how trust interacts with knowledge in their perception of reclaimed water and in its relevance in the larger context of sustainable water supply. The opinions of participants on these topics were mixed. Most trusted in the safety of reclaimed water and many were willing to entertain the prospect of drinking it, but their levels of conviction were different in each case. On the whole, participants did not demonstrate an emotional response to the topic of the safety of reclaimed water, but merely stated their level of agreement or disagreement with it in fairly direct terms based on its history of safe and beneficial usage. In contrast, they stated their level of willingness or unwillingness to drink reclaimed water with more conviction and in more complex terms, and their answers showed an emotional response to the issue. There were also a substantial number of ambivalent responses to both questions.

The topic of desalination of seawater provoked responses that were more polarized in both directions, with almost no ambivalence about the practice. Supporters of desalination, whose ideological positions could be broadly characterized as technocentric,
spoke of a seemingly unlimited supply of seawater and a lack of harmful consequences for the environment, and demonstrated an ideological commitment to the appropriateness of desalination technology. Detractors of desalination, whose ideological positions could be broadly characterized as ecocentric, referred to its potential socioeconomic and environmental costs and expressed a belief in the need for conservation-based alternatives to desalination technology.

The topic of sustainable use of water resources drew responses that were difficult to categorize due to the complexity of the issue. Most participants referred to growing human populations and lack of political will as obstacles to achieving sustainable use. Other participants expressed support for contrasting technological approaches to the problem, with some favoring solutions on a large scale, such as desalination and redistribution, and others favoring solutions on a smaller scale, such as household-level water conservation. These approaches, too, could be understood to correspond with the contrasting ideologies of technocentrism and ecocentrism, although the fit is not perfect. Highly technological approaches to conserving water supplies are often applied at the household level, such as the use of soil moisture sensors to gauge the need for irrigation, and ecocentric approaches can be applied at large scales, such as the growing practice of using mulches to build soil and conserve moisture on large agricultural operations. Additionally, both practices fit into the sustainable development model of innovation that enables progress while protecting the environment. However, there remain significant differences across contexts between the effects of developing new supplies at large scales and conserving existing supplies at local scales, and it is hoped that this study will further the public understanding of these differences. Many participants in this study expressed the importance of using water resources sustainably, and the very diversity of the approaches they favored demonstrates the inclusiveness of the sustainable development model, which is one of its greatest and most creative strengths.

Arguments in the literature lead to a common assumption that there is something wrong with reclaimed water, and that people who use it are disposing of it as a favor to the wastewater treatment plants. This assumption may have been accurate when reclaimed water was first brought to the Carrollwood Village community, but it is no longer. Although the participants in this study demonstrated complex and varied opinions of reclaimed water, they overwhelmingly approved of its use. In fact, reclaimed water in the county is in short supply, which shows how far it has come from originally being considered a waste product.

At the inception of the Carrollwood Village Reuse Project, in the early to mid-1990s, residents were offered the service by the county for free (Mr. Evans, Dale Mabry plant supervisor). Now, fifteen years later, reclaimed water is seen as an attractive asset by most residents. Most residents perceived early on that using reclaimed water for irrigation would be much cheaper than using groundwater; what differentiated them was how they perceived this solution within the context of their opinions on water supply, water usage, and human impact on the environment. Because of its popularity, reclaimed water is fast becoming the primary source for irrigation in the tri-county region.

The use of reclaimed water addresses part of the issue of water supply, but larger problems of potable water supply still remain for the Tampa Bay Area. The ongoing commitment of Tampa Bay Water to the desalination plant through years
of technological setbacks demonstrates a commitment to a prevalent view of water scarcity in the region. Mr. Brooks, a geochemist, expressed this view when he stated that “there is not enough freshwater for people.” The prevalent paradigm of scarce freshwater is built on the received wisdom which states that only three percent of all water on Earth is fresh, and of that three percent, around two-thirds is locked away in glaciers and polar icecaps, leaving only one percent of the total accessible from rivers, lakes and groundwater (USGS 2008). As one source explains: “Life on Earth survives on what is essentially only a ‘drop in the bucket’ of Earth's total water supply” (USGS 2008). While this graphic image has undeniable relevance and charisma, its power arises from the particular point of view – in the literally physical sense – that it takes. This is the point of view of the Earth from space, as first depicted in the historic photograph taken by the astronauts aboard Apollo 8 on the first flight to the moon in December of 1968 (Fisk 2008). This photograph introduced into prevailing worldviews a nascent understanding of the Earth as a finite object alone in space.

Seen from this perspective, and taking into account the contemporary social demand for global economic growth and corresponding potential for global environmental impact, freshwater on Earth is indeed scarce. More precisely, it becomes scarce for a society that chooses to allocate large amounts to grow grass for ornament and grains for corporate profit. These choices, which benefit industry through economies of scale rather than communities through local commerce, have contributed to a widespread belief that freshwater is scarce. The ecocentric view of water resources, however, takes an opposite outlook: global freshwater exists in abundance, but our access to it will depend on whether we distribute it equitably and conserve it correctly (Shiva 2002).
References


Morris, Kevin. 2006. In Support of Restoration of Funding for the Full-Time Turfgrass Research Scientist in the Budget for the Agricultural Research Service (ARS) & a Request for Funding Support for the National Turfgrass Research Initiative. Paper Presented to the Appropriations Subcommittee on Agriculture, Rural Development, and Related Agencies, United States Senate.


Unidentified speaker. Tampa Bay Water board meeting, February 16, 2009, in Tampa, Florida.

Unidentified speaker. Tampa Bay Water Conservation Coordination Consortium meeting, March 11, 2009, in Tampa, Florida.


United States Environmental Protection Agency. 1993. Standards for the Use or Disposal of Sewage Sludge (Part 503 Rule). Accessed 10/10/08 from Internet at http://www.biosolids.org/docs/1index.PDF.


Appendices
### Appendix A: List of Resident Participants

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Occupation</th>
<th>Education</th>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Home value</th>
<th>Moved in</th>
<th>Interview location</th>
<th>Interview date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ms. Adams</td>
<td>Budget management</td>
<td>MA</td>
<td>46</td>
<td>F</td>
<td>White</td>
<td>$190,096</td>
<td>2006</td>
<td>phone</td>
<td>8-Jan</td>
</tr>
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<td>Mr. Bennett</td>
<td>Automobile industry</td>
<td>BA</td>
<td>57</td>
<td>M</td>
<td>White</td>
<td>$217,864</td>
<td>1994</td>
<td>home</td>
<td>17-Jan</td>
</tr>
<tr>
<td>Ms. Blake</td>
<td>Librarian</td>
<td>MA</td>
<td>61</td>
<td>F</td>
<td>White</td>
<td>$368,171</td>
<td>1988</td>
<td>USF</td>
<td>5-Jan</td>
</tr>
<tr>
<td>Mr. Brown</td>
<td>Business owner</td>
<td>BA</td>
<td>50</td>
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<td>White</td>
<td>$462,415</td>
<td>1996</td>
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<tr>
<td>Mr. Carson</td>
<td>Military pilot</td>
<td>MS</td>
<td>69</td>
<td>M</td>
<td>White</td>
<td>$280,390</td>
<td>1996</td>
<td>home</td>
<td>3-Jan</td>
</tr>
<tr>
<td>Mr. Connors</td>
<td>Pesticide sales</td>
<td>BA</td>
<td>71</td>
<td>M</td>
<td>White</td>
<td>$248,399</td>
<td>1985</td>
<td>restaurant</td>
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<tr>
<td>Mr. Ericson</td>
<td>Insurance</td>
<td>BA+</td>
<td>75</td>
<td>M</td>
<td>White</td>
<td>$279,500</td>
<td>1981</td>
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<td>Mr. Granger</td>
<td>Electrical engineering</td>
<td>PhD</td>
<td>78</td>
<td>M</td>
<td>White</td>
<td>$335,106</td>
<td>2006</td>
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<td>10-Jan</td>
</tr>
<tr>
<td>Ms. Grant</td>
<td>Independent contractor</td>
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<td>F</td>
<td>White</td>
<td>$394,795</td>
<td>1990</td>
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<td>Mr. Harvey</td>
<td>Product marketing</td>
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<td>64</td>
<td>M</td>
<td>White</td>
<td>$196,777</td>
<td>1986</td>
<td>home</td>
<td>24-Jan</td>
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<td>Mr. Henderson</td>
<td>Photography</td>
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<td>48</td>
<td>M</td>
<td>White</td>
<td>$265,713</td>
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<td>17-Jan</td>
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<tr>
<td>Mr. Lawson</td>
<td>Consulting</td>
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<td>57</td>
<td>M</td>
<td>White</td>
<td>$310,190</td>
<td>2005</td>
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<tr>
<td>Mr. Lundberg</td>
<td>Real estate appraiser</td>
<td>MBA</td>
<td>60</td>
<td>M</td>
<td>White</td>
<td>$300,569</td>
<td>2003</td>
<td>home</td>
<td>3-Jan</td>
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<tr>
<td>Mr. Martin</td>
<td>Dentist</td>
<td>MS, DDS</td>
<td>64</td>
<td>M</td>
<td>White</td>
<td>$278,890</td>
<td>1985</td>
<td>workplace</td>
<td>23-Jan</td>
</tr>
<tr>
<td>Mr. Michaels</td>
<td>Military</td>
<td>MA</td>
<td>75</td>
<td>M</td>
<td>White</td>
<td>$207,072</td>
<td>1989</td>
<td>phone</td>
<td>10-Jan</td>
</tr>
<tr>
<td>Ms. Miller</td>
<td>Clinical social worker</td>
<td>MSW</td>
<td>58</td>
<td>F</td>
<td>White</td>
<td>$326,417</td>
<td>1998</td>
<td>home</td>
<td>10-Jan</td>
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<td>Ms. Moore</td>
<td>Sales</td>
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<td>61</td>
<td>F</td>
<td>White</td>
<td>$301,649</td>
<td>1981</td>
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<td>Ms. Saunders</td>
<td>Physical therapy</td>
<td>MA</td>
<td>52</td>
<td>F</td>
<td>White</td>
<td>$283,900</td>
<td>1987</td>
<td>workplace</td>
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</tr>
<tr>
<td>Mr. Stevens</td>
<td>Law enforcement</td>
<td>BA</td>
<td>56</td>
<td>M</td>
<td>White</td>
<td>$286,942</td>
<td>1997</td>
<td>home</td>
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<td>Mr. Strauss</td>
<td>Law professor</td>
<td>PhD</td>
<td>49</td>
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<td>White</td>
<td>$364,735</td>
<td>1996</td>
<td>home</td>
<td>17-Jan</td>
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<tr>
<td>Ms. Weston</td>
<td>School principal</td>
<td>MS+</td>
<td>71</td>
<td>F</td>
<td>White</td>
<td>$360,225</td>
<td>2004</td>
<td>home</td>
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<tr>
<td>Mr. Williams</td>
<td>Chemical sales</td>
<td>MS</td>
<td>49</td>
<td>M</td>
<td>White</td>
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<td>Mr. Zimmer</td>
<td>Sales</td>
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<td>41</td>
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<td>$254,670</td>
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Moved in before installation of reclaimed water pipeline
Moved in after installation of reclaimed water pipeline
## Appendix B: List of Operator Participants

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<thead>
<tr>
<th>Pseudonym</th>
<th>Occupation</th>
<th>Education</th>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Interview location</th>
<th>Interview date</th>
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<tr>
<td>Mr. Davidson</td>
<td>Superintendent, Country Club</td>
<td>AS</td>
<td>36</td>
<td>M</td>
<td>White</td>
<td>workplace</td>
<td>15-Dec</td>
</tr>
<tr>
<td>Mr. Evans</td>
<td>Supervisor, Dale Mabry AWWTP</td>
<td>Diploma</td>
<td>44</td>
<td>M</td>
<td>Black</td>
<td>workplace</td>
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<tr>
<td>Mr. Harris</td>
<td>Supervisor, Falkenburg WWTP</td>
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<td>41</td>
<td>M</td>
<td>White</td>
<td>workplace</td>
<td>15-Dec</td>
</tr>
<tr>
<td>Mr. Lewis</td>
<td>Engineering Specialist, County</td>
<td>BS</td>
<td>51</td>
<td>M</td>
<td>White</td>
<td>workplace</td>
<td>12-Dec</td>
</tr>
<tr>
<td>Mr. Roberts</td>
<td>Environmental specialist, County</td>
<td>BA</td>
<td>47</td>
<td>M</td>
<td>White</td>
<td>workplace</td>
<td>19-Dec</td>
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### Appendix C: Comparative Demographics

#### Demographics of Zip Code Area 33624

<table>
<thead>
<tr>
<th>Personal Characteristics</th>
<th>Number</th>
<th>Percent</th>
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<tr>
<td>Total Population</td>
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</tr>
<tr>
<td>Male</td>
<td>21,501</td>
<td>47.7</td>
</tr>
<tr>
<td>Female</td>
<td>23,564</td>
<td>52.3</td>
</tr>
<tr>
<td>Median age</td>
<td>35.8</td>
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</tr>
<tr>
<td>0-24 years old</td>
<td>14,890</td>
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</tr>
<tr>
<td>25-64 years old</td>
<td>26,414</td>
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</tr>
<tr>
<td>65 years and older</td>
<td>3,761</td>
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#### Ethnicity

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Number</th>
<th>Percent</th>
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<tr>
<td>White</td>
<td>37,674</td>
<td>83.6</td>
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<tr>
<td>Black</td>
<td>2,894</td>
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<tr>
<td>Native American</td>
<td>106</td>
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<tr>
<td>Asian</td>
<td>1,707</td>
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</tr>
<tr>
<td>Pacific Islander</td>
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<td>0.1</td>
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<td>Other ethnicity</td>
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<td>1,200</td>
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#### Education

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<th>Education</th>
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<th>Percent</th>
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<tr>
<td>High school graduate or higher</td>
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<tr>
<td>Bachelor's degree or higher</td>
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#### Home Ownership

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<tr>
<th>Home Ownership</th>
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<th>Percent</th>
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<tbody>
<tr>
<td>Median home value</td>
<td>$113,000</td>
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</tr>
<tr>
<td>Home value $200,000-$299,000</td>
<td>772</td>
<td>6.7</td>
</tr>
<tr>
<td>Home value $300,000-$499,000</td>
<td>232</td>
<td>2</td>
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#### Household Characteristics

<table>
<thead>
<tr>
<th>Household Characteristics</th>
<th>Number</th>
<th>Percent</th>
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<tbody>
<tr>
<td>Average household size</td>
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</tr>
<tr>
<td>Total housing units</td>
<td>18,549</td>
<td></td>
</tr>
<tr>
<td>Owner-occupied housing units</td>
<td>12,759</td>
<td>71.6</td>
</tr>
<tr>
<td>Renter-occupied housing units</td>
<td>5,069</td>
<td>28.4</td>
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<tr>
<td>Vacant housing units</td>
<td>721</td>
<td>3.9</td>
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#### Income in 1999

<table>
<thead>
<tr>
<th>Income in 1999</th>
<th>Amount</th>
</tr>
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<tbody>
<tr>
<td>Median household income</td>
<td>$53,565</td>
</tr>
<tr>
<td>Median family income</td>
<td>$61,471</td>
</tr>
<tr>
<td>Per capita income</td>
<td>$26,611</td>
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#### Demographics of Study Population

<table>
<thead>
<tr>
<th>Personal Characteristics</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Population</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>23</td>
<td>77</td>
</tr>
<tr>
<td>Female</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>Median age</td>
<td>57.5</td>
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<tr>
<td>0-24 years old</td>
<td>23</td>
<td>77</td>
</tr>
<tr>
<td>25-64 years old</td>
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<td>23</td>
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#### Ethnicity

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<tr>
<th>Ethnicity</th>
<th>Number</th>
<th>Percent</th>
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<tbody>
<tr>
<td>White</td>
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<td>97</td>
</tr>
<tr>
<td>Black</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Native American</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Asian</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>Other ethnicity</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Two or more ethnicities</td>
<td>2</td>
<td>7</td>
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#### Education

<table>
<thead>
<tr>
<th>Education</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school graduate or higher</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Bachelor's degree or higher</td>
<td>27</td>
<td>90</td>
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#### Home Ownership

<table>
<thead>
<tr>
<th>Home Ownership</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median home value</td>
<td>$284,857</td>
<td></td>
</tr>
<tr>
<td>Home value $200,000-$299,000</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>Home value $300,000-$499,000</td>
<td>10</td>
<td>40</td>
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#### Length of Occupancy

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<th>Length of Occupancy</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
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<td>Homeowner moved in 1981-1994</td>
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<td>52</td>
</tr>
<tr>
<td>Homeowner moved in 1995-2006</td>
<td>12</td>
<td>48</td>
</tr>
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</table>
Appendix D: Photographs

Reclaimed Water Sign
From: http://www.tampagov.net

Reclaimed Water Main
in Carrollwood Village

“Do Not Drink” Signs
in Carrollwood Village

(photos by the author)
Houses in Carrollwood Village

(photos by the author)