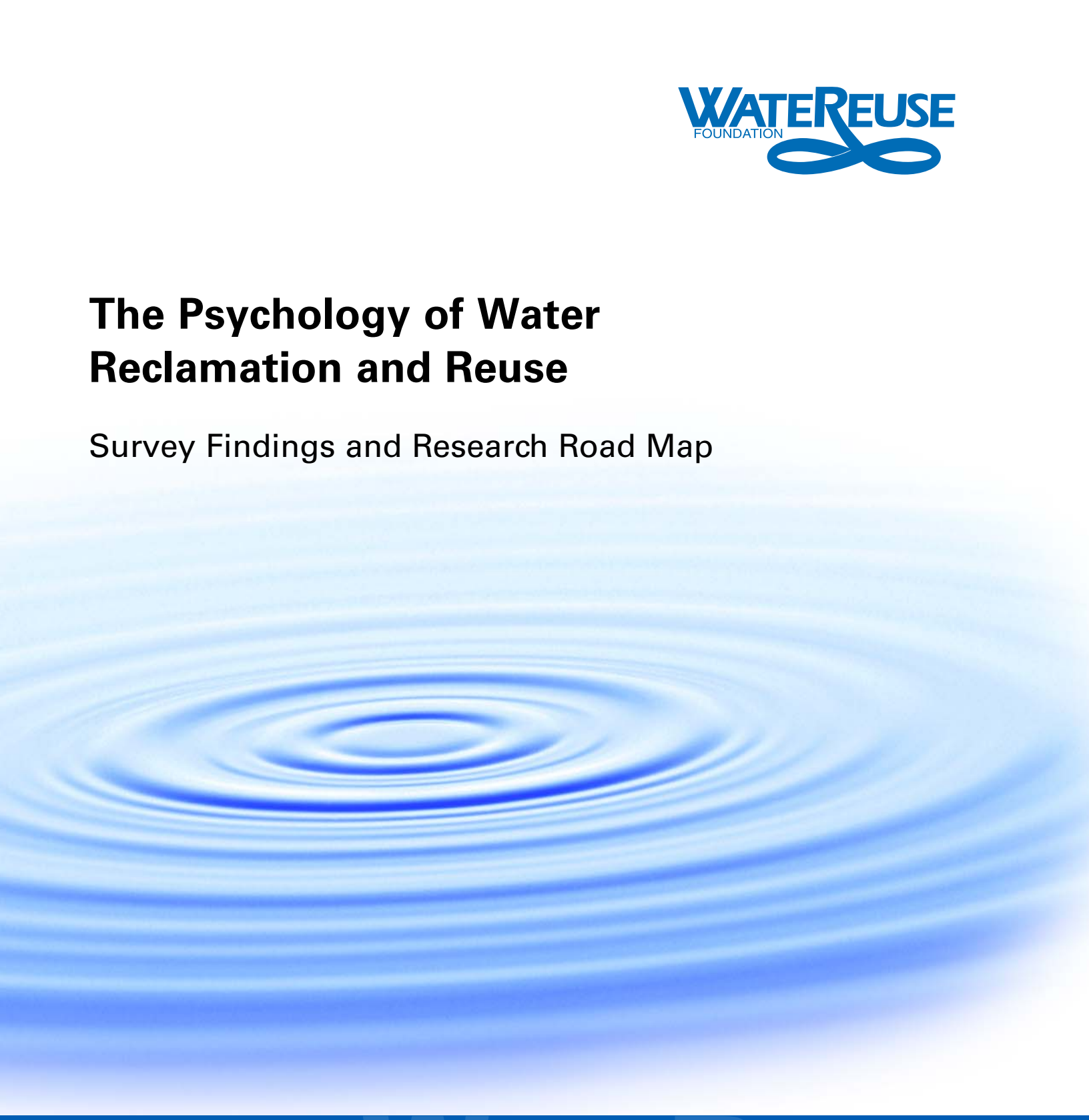
The Psychology of Water Reclamation and Reuse

Survey Findings and Research Road Map



WateReuse Foundation

The Psychology of Water Reclamation and Reuse

About the WateReuse Foundation

The mission of the WateReuse Foundation is to conduct and promote applied research on the reclamation, recycling, reuse, and desalination of water. The Foundation's research advances the science of water reuse and supports communities across the United States and abroad in their efforts to create new sources of high quality water through reclamation, recycling, reuse, and desalination while protecting public health and the environment.

The Foundation sponsors research on all aspects of water reuse, including emerging chemical contaminants, microbiological agents, treatment technologies, salinity management and desalination, public perception and acceptance, economics, and marketing. The Foundation's research informs the public of the safety of reclaimed water and provides water professionals with the tools and knowledge to meet their commitment of increasing reliability and quality.

The Foundation's funding partners include the Bureau of Reclamation, the California State Water Resources Control Board, the Southwest Florida Water Management District, the California Energy Commission, and the California Department of Water Resources. Funding is also provided by the Foundation's Subscribers, water and wastewater agencies, and other interested organizations.

The Psychology of Water Reclamation and Reuse

Survey Findings and Research Road Map

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FOREWORD

The WateReuse Foundation, a nonprofit corporation, sponsors research that advances the science of water reclamation, recycling, reuse, and desalination. The Foundation funds projects that meet the water reuse and desalination research needs of water and wastewater agencies and the public. The goal of the Foundation's research is to ensure that water reuse and desalination projects provide high-quality water, protect public health, and improve the environment.

A Research Plan guides the Foundation's research program. Under the plan, a research agenda of high-priority topics is maintained. The agenda is developed in cooperation with the water reuse and desalination communities including water professionals, academics, and Foundation Subscribers. The Foundation's research focuses on a broad range of water reuse research topics including:

- Definition and addressing of emerging contaminants;
- Public perceptions of the benefits and risks of water reuse;
- Management practices related to indirect potable reuse;
- Groundwater recharge and aquifer storage and recovery;
- Evaluation and methods for managing salinity and desalination; and
- Economics and marketing of water reuse.

The Research Plan outlines the role of the Foundation's Research Advisory Committee (RAC), Project Advisory Committees (PACs), and Foundation staff. The RAC sets priorities, recommends projects for funding, and provides advice and recommendations on the Foundation's research agenda and other related efforts. PACs are convened for each project and provide technical review and oversight. The Foundation's RAC and PACs consist of experts in their fields and provide the Foundation with an independent review, which ensures the credibility of the Foundation's research results. The Foundation's Project Managers facilitate the efforts of the RAC and PACs and provide overall management of projects.

The Foundation's primary funding partners include the Bureau of Reclamation, California State Water Resources Control Board, the Southwest Florida Water Management District, the California Energy Commission, Foundation Subscribers, water and wastewater agencies, and other interested organizations. The Foundation leverages its financial and intellectual capital through these partnerships and funding relationships.

The Psychology of Water Reclamation and Reuse identifies and explains research needs that will help the water reuse industry better understand the human response to water reclamation and reuse. Under this project, initial research into the human response to water reuse was also conducted and the findings are presented. The research focuses on attitudes, beliefs, choices and decisions and the multiple variables that influence them.

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This study would not have been possible without the insights, efforts, and dedication of many individuals and organizations. They include the members of the research team and PAC members (as identified below); the WateReuse Foundation's project manager, Josh Dickinson; and many key individuals at the participating utilities and related organizations.

The research team thanks the WateReuse Foundation for funding this applied research project, as well as thanking the following organizations for their in-kind contributions: City of Phoenix Water Services Department (AZ); Clean Water Services (OR); Florida Department of Environmental Protection (FL); Orange County Water District (CA); Public Works Services Department, Redwood City (CA); Stratus Consulting (CO); Southwest Florida Water Management District (FL); West Basin Municipal Water District (CA); and Central Basin Municipal Water District (CA).

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EXECUTIVE SUMMARY

A fair evaluation of proposed water reclamation and reuse (WRR) projects includes carefully considering what role such projects play in a region's water reliability, how they will be financed, how they fit with other aspects of regional water supply, what impact they have on water quality, what environmental impact they have, what risks they pose, and similar questions.

Some recent evaluations of WRR proposals, however, have not followed the kind of considered analysis a water agency would prefer. Rather, public sentiment appeared to turn against proposed projects based on apprehension at being exposed to water that had already passed through an urban system regardless of the human-health safeguards included in the project. WRR as a category of water-supply technologies and practices could acquire a generally negative public image—or even become stigmatized, thus vastly increasing the burden of proof on all agencies that identify WRR as a potentially valuable new supply.

Agencies recognized that there was room for improvement in their ability to communicate the safety of and risks posed by proposed projects. They further recognized the importance of understanding better the public they serve. In January 2004, the WateReuse Foundation sponsored a workshop titled "Integrating Human Reactions to Water Reclamation and Reuse into Reuse Project Design." The workshop identified the academic field of psychology, particularly two subfields (social psychology and judgment and decision-making), as one that could provide insights to water agencies considering WRR projects. The WateReuse Foundation then issued a call to develop a 3- to 5-year research program shedding light on these issues. This report summarizes the research program and provides early results.

Chapter 1 presents the project goals and justifies the importance of studying human beliefs about and attitudes toward WRR. This includes improving communications and policy processes that enable WRR projects to receive fair public scrutiny, building/retaining water agency credibility, and keeping WRR project costs to a minimum. Chapter 2 then introduces the fields of social psychology and judgment and decision-making and describes the research in these fields that is of interest to WRR and recent research that links WRR and psychology.

In Chapter 3, four research projects or studies have been identified as fundamental to improving agency–public communications on WRR. Of the four, the first, a nationwide survey of fundamental human reactions to water reuse, has been completed, with results presented in Chapter 4. The remaining research studies include:

- Undertaking experiments and surveys on the impact of direct experience with WRR on WRR acceptance;
- Understanding opposition to and opponents of WRR;
- Evaluating the connection between explanations of WRR technology and public acceptance; and

- Developing public education programs and/or evaluating current programs (for example, the extensive, active museum/exhibit at the Singapore NEWater facility and/or Orange County, CA).

Findings of interest to managers of water agencies include:

- Broad public willingness to use recycled water and open-mindedness to its use as a source of drinking water exist. Only 13% of survey respondents said they would be unwilling to drink certified safe recycled water.
- Independent (for example, university) scientists are the most credible sources of information on recycled water.
- Systems that include groundwater storage or reintroduction of certified safe recycled water to a river prior to use are slightly more favored than are systems without these features.
- At least in the short run (we did not test the long run), exposure to information about certified safe recycled water has an effect on willingness to use it.
- Roughly 30% of respondents are not interested in technical explanations, just in trustworthy assurances of the safety of certified safe recycled water.

Appendix 1 describes how surveys were taken. Appendix 2 includes the survey instrument, and Appendix 3 provides an annotated bibliography of recent research in this area.

CHAPTER 1

INTRODUCTION

1.1 PROJECT OBJECTIVE

The primary goals of this project are to identify and explain a 3- to 5-year research program evaluating the human response to water reclamation and reuse (WRR). We do so from the perspective of social psychology and judgment and decision-making (JDM), areas of psychology that focus on attitudes, beliefs, choices and decisions and the multiple variables that influence them. Both of these subareas of psychology are currently involved in evaluating the separate and often conflicting influences of emotional and cognitive factors in decision-making. The secondary objective of this project is to implement this research program to the fullest extent possible and report on initial findings.

1.2 WHY IT IS IMPORTANT TO UNDERSTAND THE HUMAN DIMENSIONS OF WATER REUSE

Technological advancements in water treatment have generated new opportunities for regions to efficiently manage their water supply. WRR are becoming an attractive alternative as their reliability grows, costs fall, and regional needs for reliable water sources expand. By removing polluting elements from water, they can also contribute to environmental improvement. In many sectors where technologies are changing rapidly, public acceptance and public policy lag behind the opportunities. The beneficial reuse of urban wastewater fits this model. If regions are to take full advantage of WRR, a deeper understanding of public perception is needed.

1.2.1 Reuse Projects May Not Be Properly Considered

Water agencies want WRR proposals to receive a fair evaluation by the public. A fair evaluation includes carefully considering the role such projects play in water reliability, how they are financed, how they fit with other actual and potential aspects of regional water supply, what impact they have on water quality, what environmental impacts they have, what risks they pose, and similar questions.

Some recent evaluations of WRR proposals, however, may not have followed the kind of considered analysis agencies prefer. Rather, public sentiment appeared to turn against proposed projects based on apprehension at being exposed to water that had already passed through an urban system regardless of the human-health safeguards included in the project.

1.2.2 Water Agency Credibility May Be Unfairly Impugned

Provision and management of a region's water supply are of fundamental importance to public health, economic vibrancy, and emergency preparedness. Monitoring water quality and quantity and communicating with the public are essential parts of an agency's role. Water agencies take very seriously the importance of the credibility of their public communications. The public's trust in and willingness to respond rapidly to agency communications could mean the difference between containing a potentially serious water-related problem and suffering a worse outcome. It is therefore very important to agencies not to take on, or be perceived to take on, a role of partiality or advocacy that diminishes their public perception as a reliable source of information.

While this is typically an easily accomplished goal, in some cases, agencies have responded to unscientific arguments or slogans used against WRR proposals. By emphasizing scientific, engineering, and economic arguments on behalf of proposed projects, but not answering the essence of the arguments of opponents, agencies may expose themselves to criticism that reduces their broader credibility. This is fundamentally a matter of communications, not of intent. A better understanding of the public and its interaction with recycled water will help agencies achieve their public-service goals.

1.2.3 Project Costs May Unnecessarily Grow Because of Delays and Additional Requirements

Undesirable outcomes of public decision processes include delaying a decision and/or reaching a suboptimal decision. Here, optimality refers to consistency with the criteria, ranking, and decision processes identified. Delay results in inflated project costs due to the need to update project plans and to account for increased financing costs. Delay also puts off the benefits a completed project provides to the region. While it is unreasonable to expect "perfect" results from any public-policy process, unnecessary restrictions and conditions on approved projects can limit their beneficial service to the public. That is, a region may place limits on a project's scope and/or require costly additional monitoring or additional reporting requirements that are not justifiable in terms of increased safety or achievement of other goals. Communications between water agencies and the public are crucial to the outcomes of these processes. Limits and conditions on projects and rejection of proposed projects may result from distrust emerging from communications problems rather than from fundamental aspects of the proposal. As such, an improved ability by water agencies to present information and respond to the public will enable regions to evaluate, select, and undertake projects more efficiently and reduce overall cost.

1.3 ROAD MAP TO THIS REPORT

Following this introductory chapter, the report provides in Chapter 2 background on the fields of social psychology and JDM and indicates how they can help water agencies improve their ability to communicate with and serve the public. A review of research already undertaken in this area is also presented. Chapter 3 then proposes a 3- to 5-year research plan that encompasses major issues that social psychology can shed light on with respect to WRR. This chapter also provides justifications for this approach. This research program has already been launched, and initial results have been identified. Chapter 4 presents the results of a nationwide survey of attitudes toward WRR, beliefs about water, and possible demographic and psychological predictors of attitudes toward WRR. It also explores some possible routes

to explain WRR to people and to persuade them to be more positive about it. These results provide both guidance to water agencies in their public communications role and justifications for the ongoing research project.

CHAPTER 2

HOW PSYCHOLOGY CAN INFORM WATER REUSE

2.1 WHAT IS PSYCHOLOGY?

Psychology is perhaps the most rapidly growing discipline in the academic world. It is the youngest of the natural sciences and, in the view of many, is poised to make the type of major advances in the 21st century that characterized molecular biology in the 20th century. Two major subareas of psychology are social psychology and JDM. Like all the areas of academic psychology, social psychology and JDM are based on a natural science model. The two subfields together have become more and more influential in the fields of economics, marketing, and management. Indeed, JDM is now a major department or subdepartment in business schools, and many individuals with Ph.D.'s in social psychology and JDM are on business school faculties. Both subareas of psychology emphasize objective and quantitative measurement. Experimentation is the favored means of testing hypotheses. Social psychology and JDM are the two major academic subdisciplines relevant to understanding the problem of acceptance of recycled water.

2.2 SUBFIELDS OF SOCIAL PSYCHOLOGY AND JDM OF INTEREST TO WATER REUSE

JDM, some decades ago, was a part of both social psychology and cognitive psychology. It is now clearly a subfield in its own right (as indicated by many new journals in the area and the formation of departments focused on JDM in some business schools). Paul Slovic is primarily identified with JDM, and Paul Rozin and Carol Nemeroff are partially in that field. Some relevant subfields of social psychology are the study of attitudes and social cognition, perception of groups, group dynamics, persuasion, and political psychology. In all of these areas, research is carried out by questionnaire, by experiments in the real world or in the laboratory, and sometimes by use of statistics from national surveys. The field emphasizes convergent measurement; that is, gathering data to support a particular claim from different methodologies.

In recent years, a great deal of attention has been devoted to the idea that humans use heuristics (simple decision rules) to make quick judgments but also have available a slower and more rational mode of decision-making. Recent work has also emphasized the importance of emotions in influencing how individuals perceive a situation and in directing decisions. That is, often people have a gut feeling about a particular issue and then construct reasons to support their feelings. Thus, Americans typically feel better about eating natural foods than they do about eating processed foods and justify this on grounds of health. However, research indicates that even when people are convinced in a particular case that there are no health advantages of a natural option, they still endorse it. Essentially, they feel that natural is inherently better but they try to come up with more "objective" reasons (Rozin et al., 1999). Similarly, they may think and respond as though there is contagion risk in a situation even though they know objectively that there is none (Nemeroff et al., 1994).

Work in JDM by Slovic and others indicates that certain types of risks are exaggerated because of people's emotional reactions to them (Slovic, 1987, 1993). Risks that are potentially catastrophic and hidden and have a human (as opposed to "natural") cause are treated as much more threatening. The hysteria in Europe about mad cow disease, which has killed fewer than 200 people, is an example.

The field of JDM currently is a blend of social psychology, risk analysis, and economics. The great progress made in this area is evidenced by the fact that the leading psychologist in this area, Daniel Kahneman, received the Nobel Prize in Economics a few years ago (for example, see Kahneman and Tversky, 2000).

Too much of social psychology depends on studying Americans, particularly American college students. This is changing, promoted by the rise of a new subfield, cultural psychology. On the other hand, working primarily with American undergraduates, social psychologists and personality psychologists (along with sociologists) have made great progress in developing the science of questionnaires and laboratory experiments with humans, finding ways to ask unambiguous questions that are not leading questions, and to change controlled environments in ways that are not obvious to subjects. There is great care taken to determine whether effects result from expectations that subjects have about the aim of the study.

The idea of framing (promoted by Kahneman, among others) is particularly important. For example, individuals do not treat 95% fat free and 5% fat as equivalent. People react very differently to the same tax rule when it is described as an "estate tax" rather than as a "death tax." Another basic principle discovered in this field is that negative events have more potency than equivalent positive events; for example, a person who murders one person and saves five lives is rated as negative. A cup of juice touched briefly by a sterilized cockroach becomes extremely negative, but there is nothing that can be touched to a pile of cockroaches that makes the insects significantly better (reviewed by Rozin and Royzman, 2001). However, at least a subset of people show "positive contagion" effects, responding to positive characteristics as though they too are transmissible (Nemeroff and Rozin, 1994; Nemeroff and Rozin, 2000).

The classic work that sets the agenda for social psychology, broadly construed, is *Social Psychology* (Asch, 1952). A good summary of the present field can be achieved by consulting the textbook *Social Psychology* (Gilovich et al., 2006). A review of JDM is available in the undergraduate textbook *Thinking and Deciding* (Baron, 2000).

2.3 CONNECTING JDM AND SOCIAL PSYCHOLOGY TO WATER REUSE

The need for a more thorough understanding of the public's attitudes toward WRR has increased as WRR technologies have improved, costs have declined, and demand for reliable water supplies for urban, agricultural, and environmental uses has grown. Following the pathbreaking work of William Bruvold in the 1970s to 1980s, which focused on the taste and palatability of treated water, little research was undertaken until the early 2000s, at which point both US and Australian researchers began investigating policy barriers to the implementation of WRR projects, including public opposition.

2.3.1 Understanding Opposition to WRR Projects

Unexpectedly strong and effective public opposition to promising recent WRR proposals, including indirect potable reuse, has led water agencies to examine many aspects of public perception of urban WRR (Shaffer and Robinson, 2003; Sheppard, 2000). A 1994 assessment report on water reuse suggests two different categories of needed research:

- An acceptable water reuse program grows out of successive stages of study of the technical, legal/institutional, and financial aspects of reuse as they apply to a community. Just as crucial to successful program implementation are the participation, support, and encouragement, from the outset, of all stakeholders in the reuse project (Crook et al., 1994).

- The successes in introduction of recycled water in Orange County and Singapore (NEWater) have, in substantial part, depended upon educating the public and other public relations activities that build on psychological principles.

2.3.2 Parallel Research Tracks in Social Psychology

Recycled water's connection with wastewater, and therefore with human waste and contagion, has the potential to trigger a response of disgust or revulsion (Rozin et al., 2000). Psychologists have studied this human response in great detail in other contexts and have also investigated how and why individuals respond positively to "naturalness" (Rozin et al., 2004; Rozin, 2006; Rozin et al., 2008). This research, which is occurring at the University of Pennsylvania and elsewhere, has identified patterns of human perception, such as the seemingly irrational "rule" *once contaminated—always contaminated* (Nemeroff and Rozin, 1994). The role of intuitive rules or concepts has been investigated in health-related contexts in terms of how they can clash with or, alternatively, blend with, "expert scientific" models of those situations. Such clashes or blending can lead to apparently irrational or erratic decisions and behaviors and can even result in the development of experienced symptoms and physiological changes for which there is no objective basis (Nemeroff et al., 1994; Nemeroff, 1995; Comer and Nemeroff, 2001; Nemeroff et al., 2007).

Another insight is that people care more about the production process than about content when evaluating how natural (and therefore beneficial) they think something is (Rozin, 2005, 2006). In other words, if a production process is deemed to be "natural," people could have a more positive association with the resulting product, even if analytically the product is less pure or otherwise beneficial than one produced in a way perceived to be less "natural." For example, people rate a cocker spaniel as more natural than a wild strawberry with one gene inserted to increase its size (Rozin, 2005).

Through the formation of connections between leading researchers in these fields of human psychology and water system planners and engineers, potentially valuable new perspectives in the optimal design of reclamation and reuse systems, including indirect potable reuse, could be identified. There are promising avenues for reconsidering the design of reclamation and reuse systems. A fundamental insight is the importance of breaking the perceived nexus between the earlier state of the water (in the form of wastewater) and its subsequent posttreatment state. This can be undertaken, for example, in terms of the location of recharge zones, where treated water is reintroduced to surface water systems, use of bank seepage into

reservoirs, or other planned elements that break the connection between prior and subsequent uses of water.

The role of affect in individual risk assessment involving complex and potentially high-risk situations has been identified and advanced in recent years (e.g., Slovic, 1987; Slovic et al., 2002; Slovic et al., 2004). "Risk as feelings" refers to our first, instinctive, and intuitive reactions to danger, in contrast to "risk as analysis," which brings logic, reason, and scientific deliberation to bear on hazard management. Both ways of thinking about risk are important, though the intuitive, image-based, affective approach (risk as feelings) is the most common way that human beings evaluate risk. When our intuitive feelings and our scientific analyses clash, we have become painfully aware of a third reality . . . "risk as politics." Research has also demonstrated the importance of understanding people's "mental models" and cultural perspectives pertaining to risk issues, along with the importance of trust in those who are responsible for managing the risk and providing information about it (Slovic, 1993). These insights have been applied to the nuclear and chemical industries, from which a substantial literature on stigmatized products has emerged (Gregory and Slovic, 1995; Kunreuther and Slovic, 1998).

2.3.3 Earlier Research Directly Related to WRR and Public Reaction

Appendix A.2 provides an annotated review of recent research related to WRR and public perception. The research emerges primarily from the United States and Australia. Its originator was William Bruvald, a professor of public health at UC–Berkeley who helped define this field in the 1970s and 1980s. The field currently combines social psychology, JDM, and public policy, since the applied research question concerns how to improve communication between water agencies and the public over future water supply. The major issues surround what words to use to describe WRR, how to communicate science and scientific uncertainty, how a water agency can retain public trust when it is perceived to be or actually is supporting/promoting a particular water-supply project, and how to respond to opposition to a proposed project. Research is taking place in the government, at universities, and at private consulting firms. Members of this research team, working with the WateReuse Foundation, have developed a research program in this area (Haddad and Kelso, 2003; Haddad, 2004). Similar research focuses on how to gain stakeholder support through effective policy processes (Joint Task Force, 1998; Hartley, 2002; Ruetten, 2003; Wantland, 2002).

CHAPTER 3

A 3- TO 5-YEAR RESEARCH PROGRAM

3.1 PHASE ONE: SURVEY OF FUNDAMENTAL HUMAN REACTIONS TO WATER REUSE

The purpose of this survey is to identify baseline attitudes toward key concepts related to WRR and to explore the feasibility of a variety of possible interventions. They include:

- The connection of attitudes toward WRR with other demographic factors, including level of education, region, political views, gender, and other factors;
- The relationship between psychological attributes of individuals (for example, disgust or contagion sensitivity, attitudes toward technology, and trust in institutions) and the acceptability of WRR;
- Laypeople's beliefs about the origin of their water, about water decontamination, and about what operations on water most effectively increase acceptability;
- The role of hybrid natural–engineered systems in the acceptability of WRR;
- Links between exposure to WRR and acceptability; and
- WRR applications or interventions and acceptability.

This survey has been completed and is presented in Chapter 4. The survey was quite valuable in informing the rest of the research program. For example, the lack of regional and other demographic differences in attitudes toward WRR means that future experiments do not need to be repeated in different parts of the nation. This will reduce the cost of future WRR social-science research since experiments and surveys can take place in only one or two regions.

3.2 PHASE TWO: THE POWER OF DIRECT EXPERIENCE IN WATER REUSE ACCEPTANCE

Many people choose not to get a flu shot because they don't like getting the shot. In reaching this choice, they are weighing the nearer-in-time and certain discomfort of the shot—the needle poke, possible next-day soreness, and the low probability of allergic or other reactions —against the long-term benefits of the immunity. Long-term benefits include the possibility that a flu is actually avoided as well as the improved ability to plan without including a flu contingency and the sense of well-being knowing one is protected from the flu. Part of the calculation of choice is a weighing of how uncomfortable the shot will be and how long the discomfort will last. Judgment/decision psychologists have identified a general tendency to overestimate near-term harm, thus resulting in suboptimal choices not to take a course of action that offers net benefits to the individual or community. Similar topics include fears of heights, flying, enclosed spaces (such as elevators), and spiders or insects. In each case, short-term discomfort is weighed more heavily than long-term benefits. In addition, people tend to

overemphasize very low risks, such as the rare cases in which there is an adverse reaction to a flu shot. They may be reluctant to take a flu shot even if informed that the shot will save, say, 1000 lives for every one lost to an adverse reaction.

Two approaches are taken to treat such cases. One is incremental, in which individuals are exposed to what they fear little by little in controlled circumstances. A second approach is called "flooding," in which the individual is fully and rapidly exposed to what he fears, whereupon he realizes that his fears were overblown.

In the case of WRR, survey results indicate that successful, direct experience with WRR (ironically called "flooding" in clinical psychology) could reduce or eliminate an individual's discomfort or opposition.

This research project has two parts. The first part encompasses surveys in regions that have recently launched WRR projects. Questions will focus on what is the awareness of the WRR project, whether the respondent has used recycled water, and whether and how the respondents' attitudes toward recycled water have changed since the project came on line. The survey will probe whether the decision-making process could have substituted for direct experience and what the findings mean for extended decision-making processes.

The second part involves controlled experiments in which subjects first fill out questionnaires that measure their feelings about high-contact uses of recycled water. Subjects are then directly exposed to recycled water. Potable-quality recycled water will be used for washing of foods they will be asked to eat, for hand-washing, for drinking, and for other uses. A second survey will be taken immediately after these activities, and a third follow-up survey within 1 week will be taken. The extent to which direct use of recycled water changes acceptance attitudes will be measured.

In a third approach, people will be surveyed for their attitudes toward WRR before and after a tour of the facilities in either Orange County, CA, or Singapore (where there is an elaborate museum with interactive exhibits). We may also be able to modify the tours for some individuals to determine which types of exposure are most effective.

The value of this research project is that it will shed light on the value of extended public discussions of WRR and whether short-term direct experience with potable recycled water can more effectively answer public concerns. Insights in this area could reduce the time and cost of securing approval for a WRR project and provide keys to new approaches to public acceptance.

3.3 PHASE THREE: UNDERSTANDING OPPOSITION TO AND OPPONENTS OF WATER REUSE

Survey results revealed that the public in general is open and accepting of WRR. WRR has not been stigmatized. This fact, combined with case study research, suggests that opposition to WRR proposals takes the form of a relatively small, deeply invested subset of the public. The scenario of particular concern is one in which a relatively small group of opponents of a WRR proposal succeed at delaying or blocking the project by using arguments that appear to lack technical and scientific legitimacy. In this scenario, public information and public approval processes have not achieved their goal of enabling a well-informed discussion and decision on the proposal.

This research project has two goals: to better understand WRR-opposition groups and their leaders and to better understand the dynamics of relationships between the public at large and opposition groups.

To better understand opposition groups and their leaders, interviews will be undertaken. Subjects who were opponents to WRR projects will be identified and asked about their attitudes toward WRR as well as toward science, government, and government authority. Questions will also probe the basis of opposition and whether it is focused specifically on WRR or if WRR is a "case in point" for a broader agenda related to public health, the environment, the issue of the public versus the private sector, the issue of centralized versus decentralized provision of services, or other categories. Questions will further probe what aspects, if any, of the public information and/or approval process for WRR facilities were particularly vexing, why they were, and what improvements could be made to the process.

A second part of this study involves case studies that evaluate the public communications strategies utilized by water agencies and the extent to which scientific and technical arguments were unsuccessful in building public support for WRR proposals. Was the public concerned about the scientific and technical merits of the proposal, or was there a different set of concerns that was not fully addressed by agencies?

The benefit of this project will be the insights it generates into how to improve communications processes between water agencies and potential impassioned opponents of WRR. It will further give water agencies a deeper understanding of how to communicate technological and scientific data about a proposed project, including the potential risks of the project.

3.4 PHASE FOUR: RELATIONSHIP BETWEEN UNDERSTANDING OF WATER REUSE TECHNOLOGY AND PUBLIC ACCEPTANCE

A regular part of the dialogue between water agencies and the public involves the agency explaining the features and merits of the technologies it uses to treat water. These explanations appear in mailers, websites, and the public areas of water agencies. They also are part of public meetings. A clearer knowledge of the role of explanations of science and technology in decision-making could help agencies develop and provide useful data to the public.

There are numerous beneficial aspects of providing and explaining technical and scientific information:

- It demonstrates that the agency understands and has thought through the technical and scientific issues;
- It provides the public with the data necessary to form its own independent decision about a proposed course of action; and
- It creates opportunities for public feedback that could improve the proposal.

However, there are potential drawbacks as well:

- The complexity of the data could lead to skepticism that anything that complicated could also be safe and reliable;
- The technical and scientific details are not of concern to the public, but other issues are. A technical discussion therefore misses the point;
- The public doesn't have the ability to evaluate the risks described by the agency; and
- The agency lacks a credible spokesperson.

This research project examines the role and form that technical and scientific information plays in WRR proposals and management. It focuses on the extent to which explanations of the technology and science of WRR influence public acceptance. If opposition to WRR is not based on scientific evaluation but on affective impressions, then it is possible that detailed scientific and technical presentations will have no impact on WRR acceptability.

The study takes the form of survey-treatment-survey. The treatment involves an introduction to information about WRR. The information can take the form of touring a WRR facility, reading materials about WRR, watching a video introduction to WRR, and attending a meeting about WRR. The initial survey evaluates the initial level of knowledge and attitudes toward WRR. The subsequent survey evaluates the effect of the treatment both in terms of building knowledge about WRR and in terms of influencing acceptability of WRR. An ideal location for this survey is a region that recently opened a WRR facility that has a public outreach component. Two possible locations are the new water treatment facility in Orange County, CA, and the NEWater facility in Singapore. Preliminary contacts with officials in both locations are encouraging. In particular, we hope to be able to vary the tour (for example, as to whether the input water is observed) to determine what is the optimal tour for encouraging a fair evaluation of the merits of WRR.

CHAPTER 4

PHASE ONE SURVEY RESEARCH FINDINGS (P.I.: PAUL ROZIN, PH.D.)

4.1 SURVEY DESIGN

We used the phrase "certified safe recycled water" as a term that removed science-based health-risk concerns.

All of the questionnaires distributed were one page, two sides. The brevity is a consequence of the fact that respondents were solicited while they were waiting in train stations and other public places and so had relatively little time. Participation was rewarded with an inexpensive automatic pencil or other "gift" valued at about $0.50. Completion took a few minutes. Because of the brevity of the questionnaire, most questions (except those about demographics and a few others about acceptance of recycled water) were asked of only one-seventh of subjects. This limitation prevents our doing multivariate analysis to see how different predictors relate to one another but allowed data to be collected from a larger group of participants.

There were seven versions of the questionnaire. The first page was identical in all forms and constitutes the greater part of the results reported in this study. The page included standard demographic information and questions about willingness to drink recycled water, percentage of current water drinking from a bottle versus from the tap, current water intake (measured in 12-oz Coca-Cola cans), past exposure to information about recycled water, and experience traveling in developing countries (where drinking of tap water is usually avoided).

Questionnaires were distributed in five locations: Eugene, OR; Philadelphia, PA; Phoenix, AZ; San Diego, CA; and San Jose, CA. Note that the two sites in California and the Arizona site experience chronic water shortages and are in very dry climates, as opposed to Eugene or Philadelphia.

At each location, a different person or team of college-age students collected all of the data, except that the same person collected the data in Philadelphia and San Diego. Most of the data were collected at commuter and longer-distance train stations (Appendix 1). Individuals who were not engaged in interactions with another person were asked if they were willing to fill out a short questionnaire on their attitudes toward water. An automatic pencil or candy bar or other modest treat was offered as a token reward for participation. The questionnaire was anonymous, and the procedure and questionnaire were approved by the appropriate IRB (Institutional Review Board, the University-based administrative structure that must approve all research in terms of ethical treatment of subjects). The distributor would leave individuals with the questionnaire, providing a small lead pencil or pen if it was needed, and returned to collect the questionnaire in a few minutes. All questionnaires with at least a completed or almost complete first page were included in the sample.

The aim was to collect about 100 completed questionnaires for each of the seven forms of the questionnaire at each of the five locations. Results from Oregon and San Jose fell short of this aim, as can be seen in Table 4.1.

Table 4.1. Description of the Sample[a]

	State/City, Overall Statistic, or ANOVA *p*						
Item	**CA/SD**	**PA**	**OR**	**CA/SJ**	**AZ**	**Overall**	**ANOVA *p* by Region**
N	674	627	305	432	655	2695	NA
Gender (% male)	61.7%	51.5%	40%	68.5%	35.0%	51.5%	0.000
Age in yr	33.9 (15.6)	37.1 (16.2)	48.1 (15.1)	34.5 (14.4)	40.4 (13.1)	37.9 (15.5)	0.000
Religiosity	1.63 (1.2)	1.60 (1.1)	1.78 (1.19)	1.39 (1.12)	1.76 (1.15)	1.63 (1.15)	0.000
Politics	2.11 (1.0)	2.29 (.9)	2.41 (1.0)	2.44 (0.95)	2.04 (0.95)	2.12 (0.97)	0.000
Yrs of education	13.78 (2.6)	15.5 (2.7)	13.9 (2.5)	14.8 (2.7)	15.5 (2.8)	14.8 (2.8)	0.000

[a]Numbers in last four rows are given as mean (SD).

There are some demographic differences in the samples, but these demographic variables seem to have very little influence on recycled water attitudes. They are unlikely to account for the few regional and other differences we report.

Religiosity was measured by asking respondents how religious they are. Response choices included Not at All, Slightly, Moderately, Very, Extremely. Answers were coded 0 to 4.

Politics was measured by asking respondents to select if they are Very Conservative, Conservative, Mixed, Liberal, or Very Liberal. The answers were coded 0 to 4.

4.2 SURVEY RESULTS

4.2.1 General Attitudes toward Recycled Water, and Demographic and Water Drinking Factors That Influence Recycled Water Acceptance

Given the contrast in the geographic areas under consideration, there are surprisingly few area differences in relation to water and recycled water (Table 4.2). There is not a significance regional difference in willingness to drink recycled water. All regions except San Diego and Arizona significantly differed on the percentage of bottled water consumed. Pennsylvania differed from all other regions in being less familiar with recycled water (only 44% had heard of it). Arizona differed significantly from all other regions in drinking more water.

Table 4.2. Basic Water Variables by Region[1]

	State/City							
Item	**CA/SD**	**PA**	**OR**	**CA/SJ**	**AZ**	**Overall**	***F***	***p***
% Bottled water consumed	61.4 (37.5)	48.9 (38.6)	25.1 (36.8)	49.2 (38.6)	64.5 (39.1)	53.1 (40.0)	65.76	0.000
Willing to drink RW[2]	1.21 (0.69)	1.29 (0.63)	1.22 (0.72)	1.23 (0.64)	1.26 (0.67)	1.25 (0.67)	1.24	0.292
Heard of RW	59%	44.1%	49%	59%	63%	57%	15.00	0.000
Daily water intake (12-oz cans)	3.8 (2.0)	3.82 (1.7)	3.86 (1.7)	3.92 (1.7)	4.30 (1.7)	3.96 (1.81)	8.12	.000

[1] Three-point scale: 0 = reject, 1 = uncertain, 2 = accept; Values in table are: mean (standard deviation)

[2] RW = recycled water.

Occupation and prior experience had some impact in a number of contrasts (Table 4.3). However, only two of the designated categories (engineer, businessman, environmentalist, activist, mother, father, and previous visitor to a developing country) had a significant effect on acceptability of recycled water (engineers were less willing and mothers more willing to try it [Table 4.3]). The biggest effects, of at least 10 percentage points (all at $p < 0.01$ or better), are that engineers have more frequently heard of recycled water as have environmentalists, and engineers drink a higher percentage of water from bottles. Water intake (mean ounces/day) did not differ markedly across occupations and experiences. The highest intake was 4.18 oz for activists, and the lowest, 3.88 oz, for those who had visited a developing country. (This latter group is unfortunately somewhat confounded, because it includes Mexican Americans, who generally traveled a short distance to do so, and others who had made long trips to developing countries around the globe. But all of these people had been in places where drinking tap water was risky.)

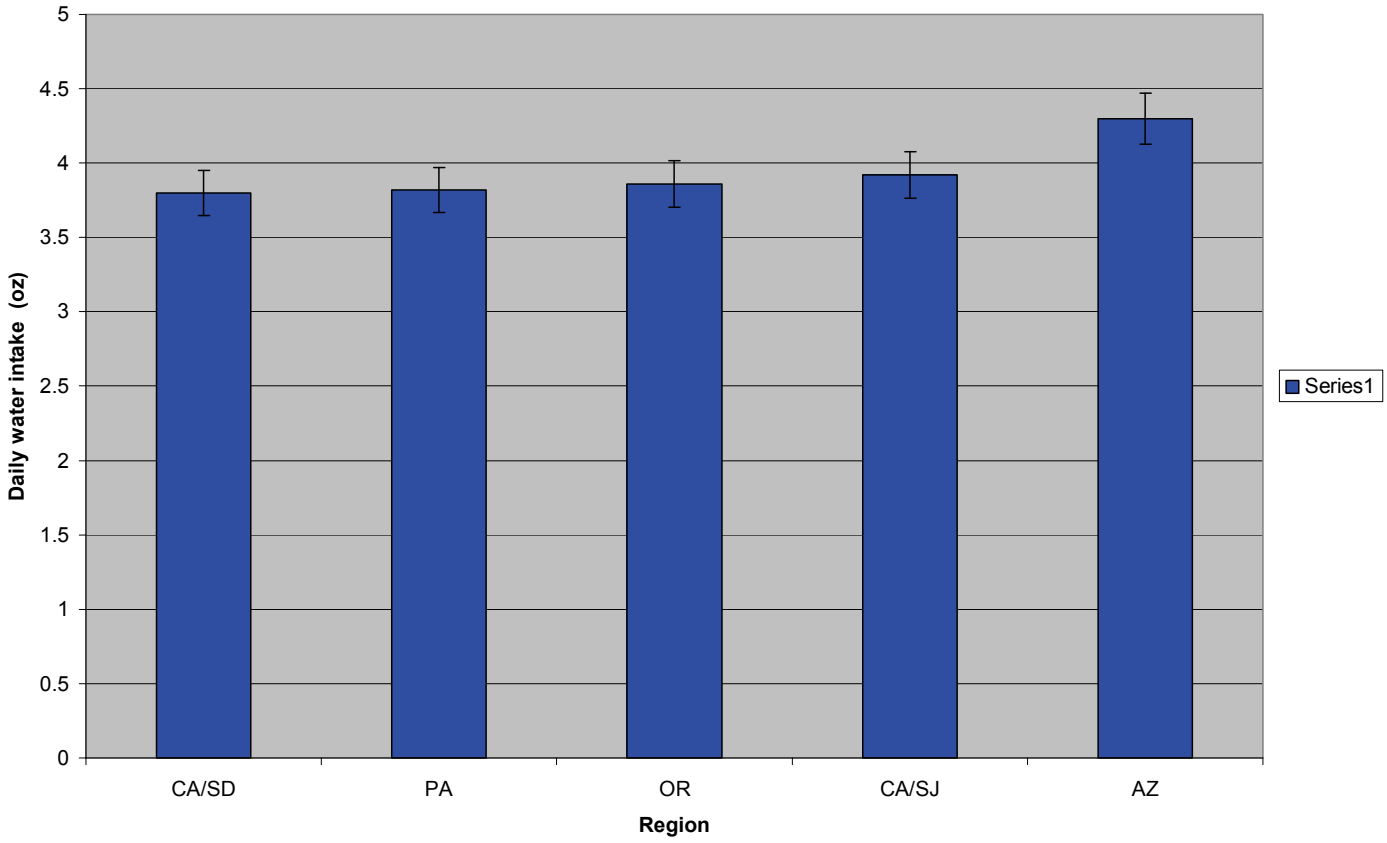

Figure 4.0. Daily water intake by region.

Table 4.3. Water Variables by Occupation of Respondent[1]

Position of Respondent	*N*		Willing[2]		Heard		Drank		% Bottled		Intake	
	T	C	T	C	T	C	T	C	T	C	T	C
Engineer	169	1774	30%	38%**	73%**	51%**	60%	54.9%	27%**	15%**	4.01	3.97
Business	638	1314	38%	38%	58%	64%**	56%	56%	18%	16%	4.03	3.95
Environmentalist	374	1575	34%	39%	66%**	55%	59%**	54%**	22%**	15%**	4.12**	3.92**
Activist	217	1732	36%	38%	56%	58%	58%	57%	22%	15%	4.18	3.95
Mother	489	1454	42%	37%**	56%	63%**	53%**	57%**	12%**	18%**	4.15	3.92
Father	372	1577	36%	38%	61%	54%	59%	55%	19%	16%	4.01	3.97
Visitor to developing country	1172	1446	40%	37%	62%**	53%**	53%	53%**	14%**	20%**	3.88**	4.10**

[1] (T = target category: the designated category in the first column ; C = controls [remainder of sample]);

[2] Willing to drink: score is percent of responses that are "2" on a scale of 0 = no, 1 = uncertain, 2 = yes.

**$p < 0.01$ by X^2. df = 1 except for willing, where df = 2.

Table 4.4. Relationship between Willingness to Drink Recycled Water and Demographic and Other Water Variables (One-Way ANOVAs)[1]

Item	*N*	*R* (Pearson's)	(ANOVA) *F*	(ANOVA) *p*
Region	2722	—	1.240	0.292
Gender	2731	-0.04	3.798	0.05 women less willing
Age	2736	0.01	1.126	0.224
Education	2647	0.03	1.060	0.382
Politics	2684	-0.02	5.707	0.001 both extremes less willing
Religiosity	2681	0.03	2.317	0.06
Race[a]	2662	—	0.777	0.588
Previous residence in developing country	2704	-0.02	0.502	0.605
% Bottled	2702	0.04	1.051	0.378

[1] Categories of race: Black, East/SE Asian/ Pacific Islander, Hispanic, Native American, South Asian/ Indian, White, other.

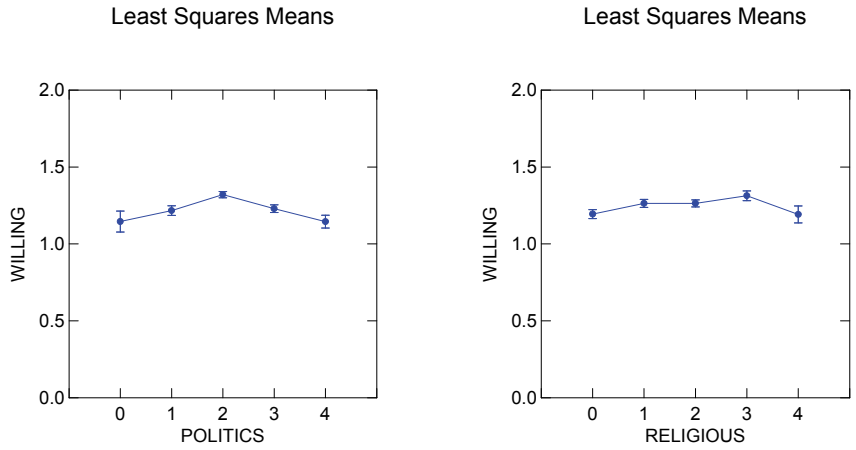

Figure 4.1. Acceptability of recycled water (willing to drink: 0 = no, 1 = uncertain, 2 = yes) as a function of politics and religiosity. Politics: 0 = very conservative; 4 = very liberal. Religion: 0 = not religious at all; 4 = extremely religious.

Table 4.5. Percentage of Bottled Water Consumed (ANOVA for Categorical Variables, Correlation Otherwise)

Item	*N*	*R*	(ANOVA) *F*	(ANOVA) *p*
Region	2722	—	65.761	0.000 (lowest in Oregon)
Gender	2731	-0.01	29.537	0.000 (men drink less)
Age	2736	-0.14	2.131	0.000 (older drink less)
Education	2647	-0.06	2.134	0.001(educated drink less)
Politics	2684	-0.02	5.402	0.000 (more liberal drink less)
Religiosity	2681	0.07	5.381	0.000 (less religious drink less)
Race[1]	2723	—	13.949	0.000
Residential experience in developing country	2704	0.00	0.053	0.817

[1]Categories of race: Black, East/SE Asian/ Pacific Islander, Hispanic, Native American, South Asian/ Indian, White, other.

A variety of demographic features (region, gender, age, education, religiosity, race, and previous residence in developing countries) did not have a significant ($p < 0.01$) effect on willingness to drink recycled water (Table 4.4). Most striking, the percentage of bottled water consumed did not show a significant effect. The only significant correlation was that with political stance, with, oddly, those midway between conservative and liberal being most accepting, by a modest amount (see Figure 4.1).

Unlike willingness to drink recycled water, degree of consumption of bottled water did vary by many demographic categories (Table 4.5). Most striking (see Figure 4.2 and Table 4.5), conservatives drink a higher percentage of bottled water, and individuals who are not religious drink substantially less of it. Men drink a lower percentage of bottled water, as do Oregonians, Native Americans, and South Asian Americans.

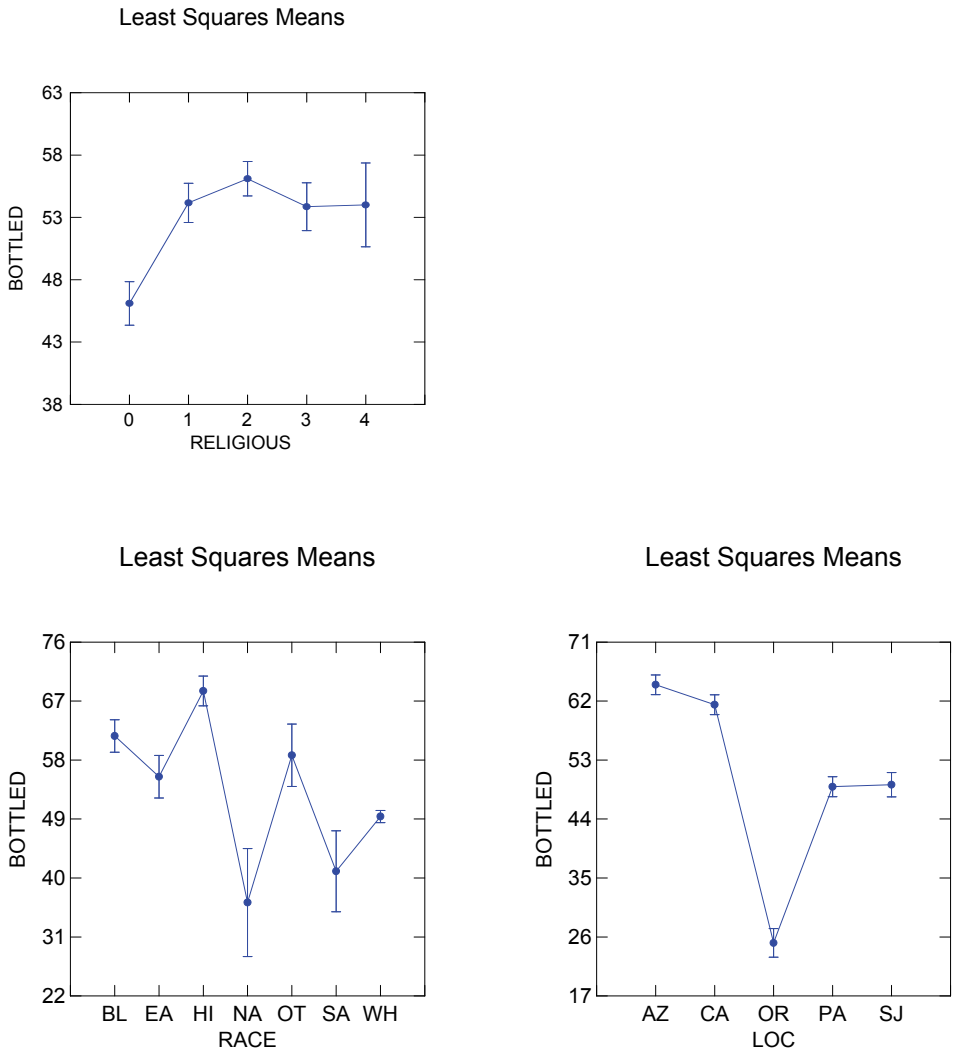

Figure 4.2. Percentage of bottled water consumed as a function of religiosity, race, and locality.

Table 4.6. Daily Water Consumption (Correlations and ANOVA for Categorical Variables)

Item	*N*	*R*	(ANOVA) *F*	*p*
Region	2722	—	8.285	0.000 AZ more
Gender	2731	-0.022	3.019	0.082
Age	2736	0.004	1.455	0.009 older less
Education	2647	0.049	1.404	0.091
Politics	2684	-0.010	0.851	0.493
Religiosity	2681	0.055	3.408	0.009
Race[1]	2723		4.013	0.001
Residential experience in developing country	2704	0.058	9.381	0.002 (more water)
% Bottled water drunk	—	0.045	1.079[2]	0.328
Willing	—	0.017	1.292[2]	0.275

[1]Categories of race: black, East/SE Asian/ Pacific Islander, Hispanic, Native American, South Asian/ Indian, White, other.

[b2] *t* values for correlation coefficient.

Daily water consumption does not differ greatly across most categories (Table 4.6). It is somewhat higher in Arizona (not surprising, given its desert climate) and somewhat lower in older people.

Summary of demographics

1. One question responded to by all subjects was: "Recycled" water is water that is separated from wastewater and highly treated so it can be used again. It is also called "reclaimed water" and "water reuse."

   •A. Would you be willing to drink certified safe recycled water? YES, UNCERTAIN, NO." Thirty-eight percent said they would be willing to drink certified safe recycled water, 49% were uncertain, and 13% said they would refuse.

2. There were no major differences among the four geographic areas, even though two are areas in which drought cycles are common. The biggest difference had to do with the percentage of water consumed as bottled water, ranging from 61% in San Diego to 25% in Eugene, OR.

3. The average participant reported drinking 3.8 12-oz bottles/glasses of water per day. About 50% of the water consumed was from bottles and about 50% from the tap. Fifty-five percent had heard about recycled water.

4. None of the following factors—age, gender, religiosity, politics (conservative to liberal), or education—predicted acceptability of recycled water. In general, demographics were a poor predictor of attitudes toward recycled water. Nor was there a major effect from occupation (engineer, businessman, etc.)

4.2.2 General Attitudes toward Recycled Water and Water Drinking as a Function of Psychological Variables

One of the aims of this research is to identify those individuals who are most and least accepting of recycled water. By understanding those who are most skeptical, we can develop communications strategies that improve agencies' public communications and public understanding of proposed projects.

We have found that neither standard demographic measures nor indicators of water drinking habits show substantial correlations with willingness to drink recycled water. We turn now to more "psychological" aspects of individuals. We explore a number of individual difference variables that, from the point of view of common sense, should affect recycled water acceptability.

Disgust, contagion, and recycled water acceptability

One set of variables has to do with responsiveness to the effective motto of recycled water opponents: "toilet to tap." The effectiveness of this motto obviously varies, since a majority of individuals are either uncertain or willing to drink recycled water. Psychologically, there are two individual differences that may predict the power of "toilet to tap" and hence recycled water rejection. One is basically how compelling the toilet imagery is. This quality can be gauged by what is called disgust sensitivity. Disgust is a human emotion that is related to decay, foul odors, and body products (Rozin et al., 2000). Sensitivity varies greatly among Americans; just as an indication, some would not mind eating locusts, while others will not blow their nose in a piece of brand-new toilet paper. The disgust sensitivity scale (DScale) is the most widely employed measure of disgust (Haidt et al., 1994). It is a 32-item scale; we used a shortened eight-item version in this study.

The second variable that might influence the effectiveness of "toilet to tap" is contagion sensitivity. It is the origin of recycled water in toilets that may be disturbing in the sense that past contact with a toilet has contaminated the water (Rozin and Nemeroff, 2002). That is, some people may believe that even brief contact between a disgusting entity and a neutral entity will pass along the disgusting properties. Additionally, some may believe that this transmitted "essence" is indelible (spiritual contagion) as opposed to removable (material contagion) (Nemeroff and Rozin, 1994). We used the Perceived Vulnerability to Disease scale to measure sensitivity to contagion (Park et al., 2003). This scale includes two subscales: personal susceptibility to disease (PVDSusc8) and attitudes toward and behavior concerning interpersonal contact (PVDAtt8). (See scale items in Appendix 2.)

Table 4.7. Full Sample Scores on Disgust and Perceived Vulnerability to Disease

Scale	*N*	Mean	SD	Range
DScale8	421	2.68	0.68	1–4
PVDSusc8	432	3.22	1.15	1–7
PVDAtt8	433	4.12	1.22	1–7

One of the seven forms distributed had the eight-item disgust scale and the PVD scale on the second page. Table 4.7 shows the scores of our total sample on these three scales.

Not surprisingly, the three measures correlate positively with one another (Table 4.8), but the correlations are modest enough to justify looking at the three scales separately as predictors of recycled water acceptability and other water habits. Modest but significant correlations are observed between recycled water willingness and disgust sensitivity (r = -0.16, more disgust-sensitive individuals are less accepting) and attitudes toward interpersonal contact (contagion; r = -0.14; again higher contagion sensitivity predicts less recycled water acceptability). There is not a significant relationship between perceived susceptibility to disease and willingness to drink recycled water. Similar results appear if we examine the mean scale scores for individuals who are unwilling, uncertain, or willing to drink recycled water (Table 4.9). As one might expect, there is a positive correlation, 0.20, between interpersonal contagion and disgust (0.16) and percentage of water consumed from the bottle, since bottled water would be thought to be "purer" and to have had less contact with humans.

Table 4.8. Correlations of Recycled Water and Other Water Variables with Disgust and Contagion (*N* = 415)

	Correlations for:		
Measure	**DScale8**	**PVDSusc8**	**PVDAtt8**
DScale8	—	0.48***	0.22***
PVDSusc8	0.48***	—	0.25***
PVDAtt8	0.22***	0.25***	—
Willing	-0.16**	-0.08	-0.14**
% Water drunk from bottle	0.16**	0.01	0.20***
No. of cans	-0.02	-0.01	0.16**

** = $p < 0.01$; ***= $p < 0.001$.

Table 4.9. Willingness to Drink Recycled Water and Susceptibility to Disgust and Contagion

	Correlations for:			
Scale	**Unwilling**	**Uncertain**	**Willing**	**ANOVA**
DScale8	2.86[a]	2.74	2.57[b]	$F(2,418) = 5.291$**
PVDSusc8	3.41	3.24	3.14	$F(2,429) = 1.381$
PVDAtt8	4.41[a]	4.22	3.94[b]	$F(2,430) = 4.378$**

** = $P < 0.01$.

[a, b]According to a Scheffé test, in any row, items labeled [a] are significantly different from items labeled [b] at the $p < 0.05$ level.

World views: protechnology and traditional in relation to recycled water acceptability

Recycled water in its modern form is the product of high technology and occurs in a "high-technology" facility. In the public's view, water came from pure streams or underground sources traditionally, but now it goes through all kinds of equipment and tests. It is likely that discomfort with advanced technology and attachment to traditional values would both have substantial (and opposite) influences on recycled water acceptability.

Siegrist (1999) has created two scales, one indicating support of technology and another indicating attachment to tradition. The items are listed in Appendix 2. One of the seven forms contained the items from both scales. The two Siegrist scales' correlation was -0.12 (N = 434).

The survey form that contained the Siegrist scales on its second page also included a second measure of willingness to consume recycled water. The question was

"Rate your willingness to drink recycled water that has been certified as safe and good-tasting by a panel of water scientists appointed by the National Academy of Sciences.

Willingness (0–10) _____"

We present both the three-item willingness question and the 11-point willingness scale in our analysis of the Siegrist scales. As we expected, there is a modest and significant correlation between protechnology attitudes and willingness to drink recycled water by either measure (Table 4.10). Surprisingly, there is not a significant relationship with the protradition subscale. That the latter scale measures something like what it is supposed to is supported because protradition feelings correlate substantially with political conservatism (r = 0.38). Table 4.11 presents the results in terms of mean scores for each of the three willingness categories.

Table 4.10. Correlations of Water Variables with World View Subscales (*N* = 434)

	Correlation for:	
Measure	**Protech subscale**	**Protradition subscale**
Willingness (3-point scale)	0.14	0.00
Willingness (0–10 scale)	0.14	0.05
% Water drunk from bottles	0.04	-0.06
Politics	-0.09	0.38***

*** = $p < 0.001$.

Table 4.11. World View Subscale Scores as a Function of Willingness to Drink Recycled Water

Scale	Unwilling	Uncertain	Willing	ANOVA
Protech subscale score	3.00[a]	3.17	3.30[b]	$F(2,445) = 4.789$**
Protradition subscale score	3.47	3.38	3.49	$F(2,439) = 0.778$

**$p < 0.01$.

[a, b]According to a Scheffé test, in any row, items labeled [a] are significantly different from items labeled [b] at the $p < 0.05$ level.

Judged risks and benefits of recycled water

Slovic and his colleagues (2004) have identified an important relationship between risks and benefits that bears on attitudes toward recycled water. They found that with respect to ratings of new technologies (such as nuclear power), lay respondents showed a negative correlation between perceived risks and benefits. On the other hand, expert respondents showed a positive correlation, indicating that in the experts' opinion, most promising technologies also bear higher risks (Slovic et al., 2004). On Form 6 we asked respondents the following items:

Using a scale from 0 (not at all risky) to 10 (extremely risky):

_____26. Overall, give your opinion about the risks of using recycled water

Using a scale from 0 (not at all beneficial) to 10 (extremely beneficial):

_____27. Overall, give your opinion on the benefits of using recycled water

In accordance with the work of Slovic and others, ratings of the risks and benefits of recycled water correlated negatively, -0.20; to a modest degree, the greater the benefits, the lower the risks and vice versa. We expected, on the grounds of greater sophistication of those willing to try recycled water, that the correlation would be less negative (closer to the expert value) in the willing subsample, but this was not the case (Table 4.12, bottom row).

Table 4.12. Mean Risks and Benefits: Scores of the Three Willingness Groups

	Data for:			
Characteristic	**Overall**	**Willing**	**Uncertain**	**Unwilling**
N	373	201	131	40
Risk	4.67	3.76	5.40	6.80***[1]
Benefit	6.83	7.62	6.22	4.73***[2]
Risk minus benefit	-2.16	-3.86	-0.82	2.07***[3]
Risk plus benefit	11.453	11.43	11.61	11.61[4]
Correlation of risk and benefits	-0.20***	-0.11	0.01	0.00

***= $p < 0.001$ by ANOVA for first four lines and *t* test for last line;

[1] for risk $F(2,379) = 37.065$;

[2] for benefit $F(2,381) = 31.856$;

[3] for risk-benefit $F(2,378) = 65.432$;

[4] for risk+benefit $F(2,378) = 0.129$.

Trust in institutions and scientific information and environmentalism

A factor analysis of 14 original items designed to inquire into feelings about water and recycled water revealed four distinct factors, three of which seemed useful to analyzing attitudes toward recycled water (Table 4.13). One factor related to trust items, one to cynicism, and one to proenvironment items. The fourth was basically negativity to the consequences of using recycled water. All factors were substantially related to willingness to drink water.

Here are the items that constituted each factor, all rated on a standard scale of 1 (strongly disagree) to 5 (strongly agree). Loading on the principal factor is indicated after the capitalized variable name.

TRUST3 Factor 1 (15% of variance)

CORPS (0.82) 2. Corporations in the field of water treatment are aware of their responsibilities

MUNICS (0.71) 3. Municipalities that operate water treatment plants can be trusted

CONTROLS (0.64) 1. I trust that the recycling of drinking water can be placed under adequate controls through appropriate regulation

CYNIC3 Factor 2 (18% of variance)

SCIENTISTS (0.79) 5. Scientists working in the field of purification of sewage water for drinking are hardly able to estimate or predict the consequences of their work

PROFITS (0.71) 6. Recycled water only increases the profit made by industry or local governments and is not beneficial to mankind at all

AUTHS (0.62) 4. The authorities cannot sufficiently monitor whether water purification plants uphold legal regulations and restrictions

PRORW4 Factor 3 (18% of variance)

NATURAL (0.76) 8. Thanks to use of recycled water, natural waterways can be kept intact

QUALITY (0.73) 9. Thanks to the purification of water, the quality of life of humanity rises

ASPECTS (0.68) 10. If we take all aspects into account, we can say that our society profits from making good drinking water from sewage water

UTILIZE (0.63) 7. It is irresponsible not to utilize recycled water, if it as safe as spring water and prevents damage to the environment

Table 4.13. Correlations among Trust, Cynicism, and Pro-Recycled Water Factors and Major Water Measures (*N* = 367)

	Correlation for:		
Item	**TRUST3**	**CYNIC3**	**PRORW4**
TRUST3	—	-0.38***	0.47***
CYNIC3	-0.38***	—	-0.40***
PRORW4	0.47***	-0.38***	—
Education	0.03	-0.17**	0.12
Willingness	0.47***	-0.35***	0.39***
% Water drunk from bottle	-0.15	0.13	-0.09
Risk	-0.36***	0.45***	-0.35***
Benefit	0.44***	-0.34***	0.48***
Risk-benefit Difference	-0.51***	0.53***	-0.52**

*** = $p < 0.001$; ** = $p < 0.01$.

Table 4.14. Correlation of Risk and Benefits (*N* = 367)

	Correlation for:		
Item	**Risks**	**Benefits**	**Risk-Benefits**
TRUST3	-0.36***	0.45***	-0.52***
CYNIC3	0.43***	-0.32***	0.49***
PRORW4	-0.34***	0.47***	-0.52***
Age	0.01	-0.04	0.02
Education	-0.01	0.08	-0.06
Religiosity	0.18**	-0.07	0.15**
Politics	-0.07	0.09	-0.10
% Water drunk from bottle	0.20**	-0.12	0.20**
Willingness	-0.40***	0.38***	-0.51***

*** $p < 0.0001$; ** $p < 0.001$.

There are substantial correlations between any two of the three factors, but none is sufficiently high (all less than 0.50 [Table 4.13]) to suggest combination of the factors into a single measure. As would be predicted, Trust, Cynicism, and Pro-recycled water all correlated highly significantly with willingness to use recycled water. The Pro-recycled water factor correlation is virtually redundant, and so the correlation is not surprising.

However, the 0.39 correlation between willingness to drink recycled water and Pro-recycled water is lower than the correlation between willingness and trust. Relationships between the three factors and percentage of bottled water consumed are much weaker, but relations to perceived risks and benefits are strong and in the predicted direction, as would be expected (Table 4.14).

Trust and source

We asked individuals to indicate their trust in different sources of information about recycled water.

"On a scale of 0–10, where 0 means don't trust at all and 10 means trust completely, rate each form of certification that the water coming out of a particular municipal treatment plant is safe to drink.

The produced water is certified as safe by

_____15. A private firm hired by the water treatment facility

_____16. The staff of the water treatment facility

_____17. Engineers/inspectors from the state government

_____18. Engineers/inspectors from the federal government

_____19. The manager of the water treatment facility

_____20. An actor or athlete you admire hired to represent the water treatment facility

_____21. A qualified scientist from a nearby university

_____22. Someone who has drunk recycled water for years

_____23. A doctor who lives nearby

_____24. A board made up of engineers and other representatives of the community

_____25. Your neighbor

We arrange the trust scores in order from least to most trusted in Table 4.15 and Figure 4.3. Scientists and engineers received the highest trust scores from all three willingness groups, while actors earned the lowest scores. The pattern of trust is similar across the three willingness groups, but trust is generally lowest in the unwilling and highest in the willing.

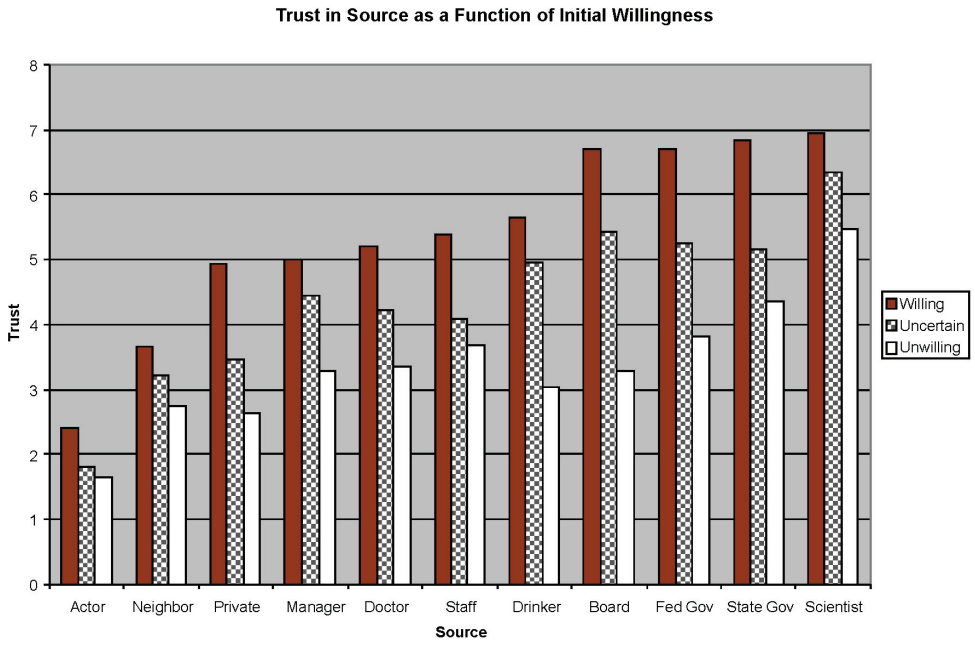

Figure 4.3. Trust in source as a function of initial willingness to drink recycled water.

Table 4.15. Trusted Source of Information on Recycled Water Safety (0–10 Range): Overall and by Willingness to Drink Certified Safe Recycled Water [1]

	Scores for:			
Source of Information	**Overall[1]**	**Unwilling[2]**	**Uncertain[2]**	**Willing[2]**
An actor or athlete you admire hired to represent the water treatment facility	2.14	1.05	1.79	2.54
Your neighbor	3.20***	2.30	2.83	3.64
A private firm hired by the water treatment facility	4.11***	2.55	3.40	4.87
The manager of the water treatment facility	4.62***	3.00	4.07	5.27
Staff of the water treatment facility	4.67	3.32	4.00	5.36
A doctor who lives nearby	4.68	3.65	4.00	5.33
Someone who has drunk recycled water for years	5.06**	3.18	4.60	5.74
A board made up of engineers and other representative of the community	5.70***	3.48	5.05	6.58
Engineers/inspectors from the federal government	5.88	3.78	5.02	6.85
Engineers/inspectors from the state government	5.95	4.02	5.09	6.86
A qualified scientist from a nearby university	6.59***	5.15	6.25	7.08

[1] The items are arranged from top to bottom in terms of increasing trust for the full sample (overall). Significance (** or ***) indicate that the value starred is significantly different from the item immediately above it.

[2]By willingness: ANOVAs on all rows for trust as a function of membership in the three groups are significant at $p<.001$.

** = $p<.01$, *** = $p<.001$

Conclusions: Disgust and contagion (PVDAtt8) are higher in those more unwilling to drink recycled water. There is a smaller but similar effect for susceptibility to disease (PVDSusc8). Risk and benefits relate highly to the trust and cynicism factors. The cynical factor corresponds with high risk and low benefit ratings. The trust and proenvironment factors go with low risk and high benefit ratings. Although trust and cynicism are correlated (inversely), there is evidence that these are separable concepts. Data from this form provide a promising beginning for developing a rational decision-making framework through which to understand willingness to drink recycled water.

Making water psychologically safe: attitudes and beliefs about "decontamination"

We turn now to a different approach. The first two phases of the results attempted to identify properties of those who support or oppose recycled water. We now attempt to discover how Americans think about water and the purification process. This basic information on lay attitudes toward water and water treatment could obviously relate to willingness to drink

recycled water, and we will examine that as well. But a main interest here is in discovering lay thought patterns and beliefs and what might be psychologically more and less potent ways of making water acceptable. In many respects, our analysis here follows Rozin's (Rozin et al., 2004, 2005, 2006) analysis of why Americans prefer natural to commercially processed foods and the lay concept of natural.

Before we do the decontamination analysis, it is important to realize that acceptability of recycled water depends to some degree on what is meant by acceptability. In our basic questions on willingness and comfort, we specify drinking of recycled water. But the great majority of processed water is not consumed directly and has other uses instead. In one form of the questionnaire, we asked individuals to rate willingness to engage in different types of uses of recycled water. The scale used was:

"Please rate your willingness on a scale of 0 to 10 (0 = totally unwilling; 10 = totally willing)."

The stem of the eight questions that followed was "1. How willing are you to use this water …" The eight designated uses were as follows, in the order of presentation of the questions: " to irrigate vegetable farms, to water lawns in a park where children play, to give to your pets, to use for bathing and showering, to use for cooking pasta, to serve as drinking water to yourself and your family, to water your own lawn, to water your vegetable garden?"

Not surprisingly, there is a gradient of acceptability (willingness) with drinking being the least acceptable, followed by cooking. The results, organized by increasing willingness ratings, for the three groups of respondents (unwilling, uncertain, and willing to drink recycled water) are presented in Figure 4.4.

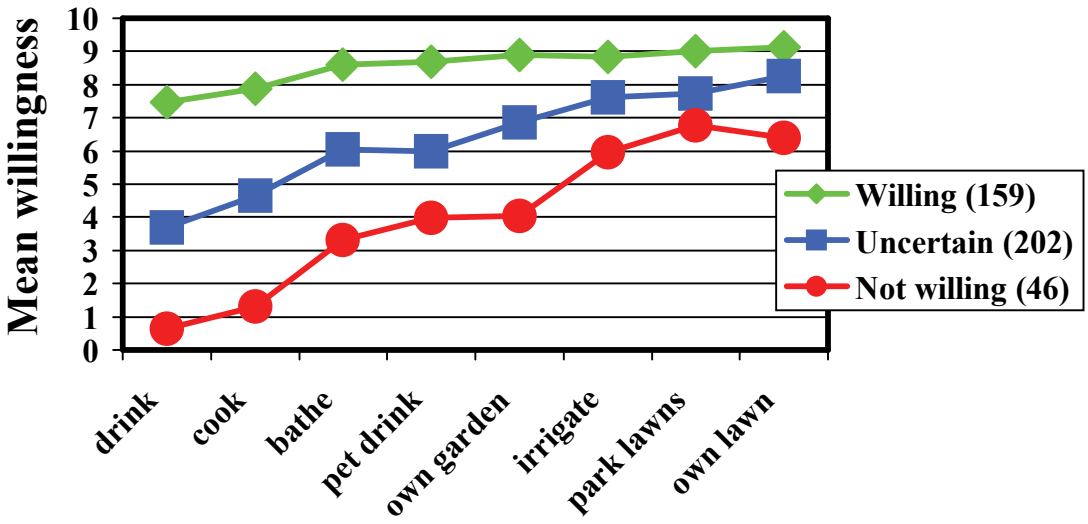

Figure 4.4. Willingness to use recycled water for different purposes.

The critical measure for decontamination is a series of designated operations on sewage water (see Appendix 2). Respondents rate their willingness to consume the designated water on a scale of 0 to 10. (Subjects who were equally willing to drink bottled spring water and raw sewage and those who rated their willingness to drink sewage over 1 were eliminated.)

The decontamination findings indicate that some manipulations are considered to be much more effective than others. Our questions mixed delivery means (tap water, bottled water, filtered tap water, and bottled spring water) with treatment means (boiled, filtered, etc.), and respondents were much more comfortable with tried-and-true delivery means as an assurance of quality than with descriptions of water treatment. Note that the willingness to drink tertiary-treated, additionally processed water (described in the questionnaire), which is equivalent in quality to normal tap water, is only 4.12 on the 11-point scale; that is, the treated water is not really acceptable on average. Dilution of this with pure water (1:1000) has almost no effect on acceptability (4.82). Also note that boiled, evaporated, and condensed water, essentially pure water, is rated only 5.04, well below tap water (6.98). Therefore, no explanations of treatment really make sewage water acceptable for the average subject. It is particularly notable that none of the purification processes have much effect on the unwilling respondents (Table 4.16, Table 4.17, Figure 4.5). Extensive processing of sewage has a surprisingly small effect on the uncertain respondents.

Table 4.16. Willingness to Drink (on a 0–10 Scale) Various Types of Water[1]

Type of Water	*N*	Mean	SD
Raw sewage	419	0.46	1.715
Skim**	418	1.175	2.251
Soil filter**	417	1.969	2.72
Mesh filter	417	2.844	3.157
1:1000 raw sewage	404	3.074	3.493
Boiled**	412	3.369	3.326
Tertiary urban	405	4.017	3.564
Tertiary	412	4.053	3.57
Tertiary nature	407	4.115	3.624
Tertiary 1:1000**	403	4.816	3.91
Boiled-evap-condensed**	410	5.044	3.779
Tap**	419	6.983	3.209
Bottle filtered tap**	419	8.422	2.616
Bottled spring**	419	9.148	2.121

[1] Significance of paired *t* test between a row and the row immediately above it. Paired *t* test because the unit is the difference between one rating and the one above it for each subject.**, $p < 0.01$.

Table 4.17. Subjects' Willingness to Drink (on a 0–10 Scale) Various Types of Water as a Function of Willingness to Drink Recycled Water (on a 3-Point Scale)[1]

	Data for:		
Type of Water	**Unwilling**	**Uncertain**	**Willing**
Raw sewage	0.38	0.28	0.63
Skim	0.29	0.84	1.64
Soil filter**	0.21	1.43	2.78
Mesh filter**	0.74	1.94	4.04
1:1000 Raw sewage**	1.31	2.37	3.98
Boiled**	0.93	2.76	4.24
Tertiary urban**	0.98	2.62	5.66
Tertiary**	1.48	2.86	5.56
Tertiary nature**	0.9	2.7	5.78
Tertiary 1:1000**	1.6	3.46	6.48
Boiled-evap-condensed**	1.29	4.03	6.54
Tap	5.31	6.51	7.75
Bottled filtered tap	6.69	8.2	8.95
Bottled spring	8.95	8.73	9.43

[1] Significance of difference between willingness groups on acceptability of each transformation by ANOVA. ** = $p < 0.01$ or higher.

In terms of the taxonomy of contagion described by Nemeroff and Rozin (1994), it looks like the unwilling respondents and some of the uncertain respondents treat the effect of contact of water with sewage as indelible, or "spiritual," contamination. This finding means that further processing or more details about processing may be an ineffective strategy. This conclusion is subject to two caveats. We note that reverse osmosis treatment was not considered as an option in this study. It may have some particular potency, though this possibility is doubtful since boiling/evaporating/condensing was not very effective. Also, some other approach to removing the perception of permanent contagion may be identified for water that is in fact fit for its intended use.

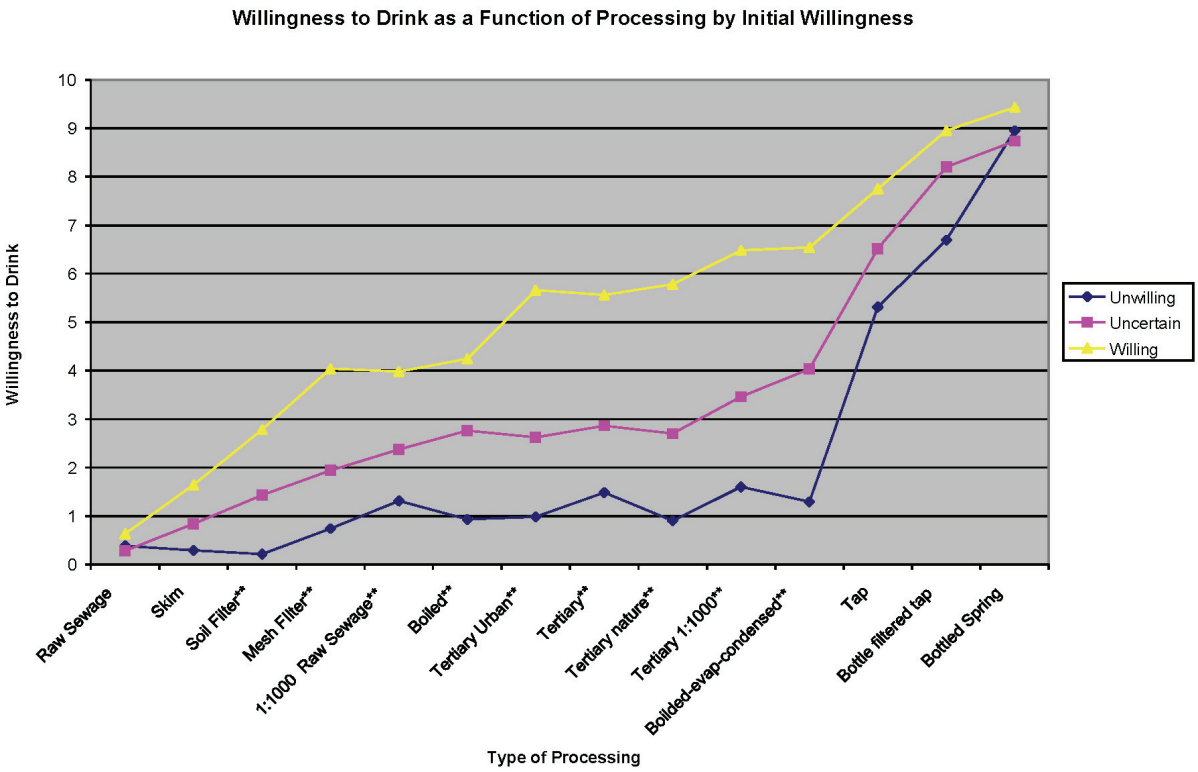

Figure 4.5. Willingness to drink recycled water as a function of processing and delivery methods, according to willingness to drink certified safe recycled water (willingness scale from 0 to 10).

The effects of time and distance traveled

Time and distance can be considered alternative modes of decontamination. The time variable was a comparison:

"Rate how **comfortable** (0 [not comfortable at all] to 10 [completely comfortable]) you would feel about drinking recycled water that has been certified safe for drinking and then undergoes the following additional treatments: (one question specified 1 year; another version of the otherwise same question specified 10 years)."

"Leaving the water treatment plant, the water is deposited in a lake or reservoir for (1 year/ 10 years)."

"Leaving the water treatment plant, the water filters through an underground aquifer for (1 year/10 years)."

Thirty-nine percent of subjects showed an increased willingness to drink water after it had been in an aquifer for 10 years versus 1 year, as opposed to 14% who found 10 years less acceptable than 1 year. Comparable values for the reservoir are 25% and 17%. There is a significant increase in comfort for the aquifer (mean for whole sample = 0.59, SD = 2.11, $t[397] = 5.581$, $p < 0.001$). There is a smaller but significant enhancement from 10 years in the reservoir (mean for whole sample = 0.30, SD = 2.08, $t[396] = 2.819$, $p < 0.01$).

The means for willingness to drink recycled water are presented in Table 4.17. A direct comparison of these means is not warranted, because many of the 187 willing respondents already have a maximum comfort score of 10 for drinking certified safe water before storage. Also, the increased value of 9 extra years of storage cannot be easily gauged across the three willingness groups, since the groups start at different comfort levels. Nonetheless, examination of Table 4.18 suggests both that time in aquifer is more effective than time in reservoir (aquifer change minus reservoir change mean = 0.32, $t[394] = 2.473$, $p < 0.05$) and that, as in other measures, the unwilling group is moved least by extra storage.

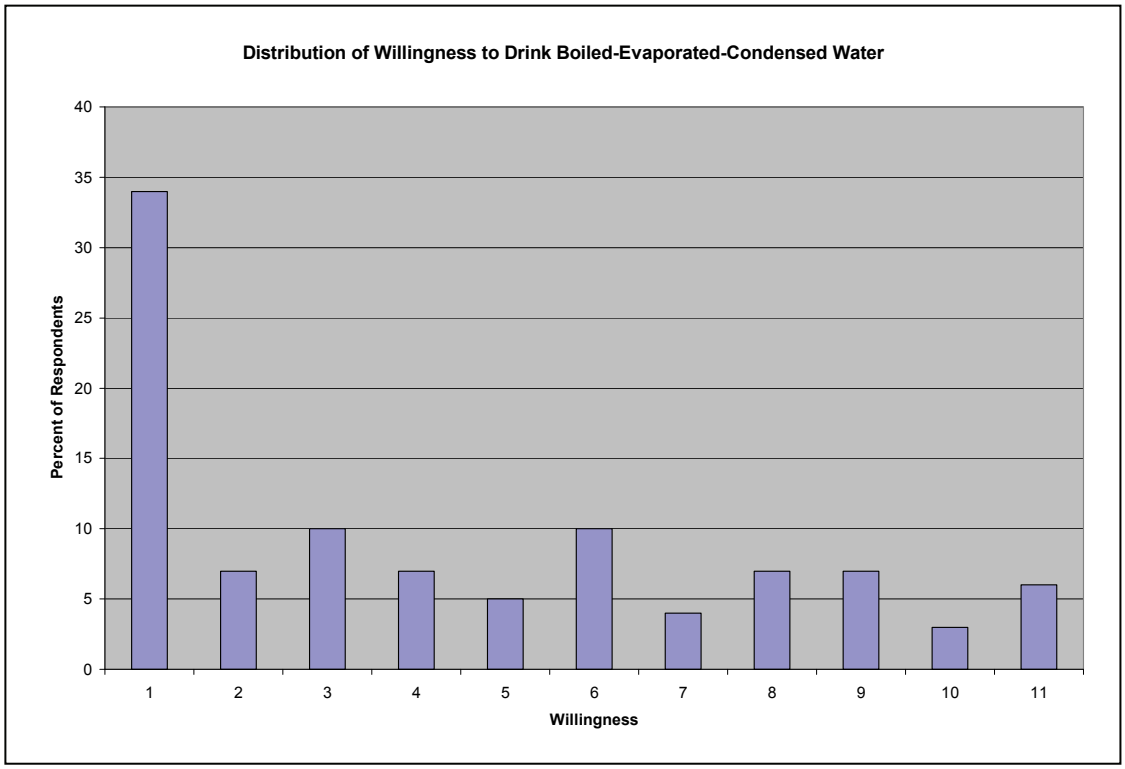

Figure 4.6. Distribution of willingness reactions to drinking boiled-evaporated-condensed sewage water.

Table 4.18. Change in Comfort Drinking Water That Had Been in a Reservoir or Aquifer for 1 Versus 10 Years, by Willingness to Accept Recycled Water (*N*/Mean/SD)

	Amount Improved in All Subjects		Amount of Improvement in Subjects Who Expressed Willingness of <10 at 1 Year		% of Subjects Whose Willingness Was < 10 at Start Who Showed Improvement	
Reaction	**Aquifer**	**Reservoir**	**Aquifer**	**Reservoir**	**Aquifer**	**Reservoir**
Willing	187 0.48 (2.02)**	186 0.20 (2.07)	138 0.74 (2.12)***	156 0.24 (2.56)	47%	29%
Uncertain	165 0.78 (2.10)***	165 0.49 (2.08)**	145 0.93 (2.16)***	159 0.51 2.12**	50%	27%
Unwilling	0.44 0.39 (2.54)	44 -0.02 (2.15)	39 0.69 (2.08)	39 0.22 1.58	41%	22%

**= $p < 0.01$; *** = p<.001. Significance level refers to significant difference from 0 by two-tail *t* test.

The distance traveled measure was instantiated by three questions, all rated on the same comfort (0–10) scale as above.

_____ The water travels through a pipe **directly** from the wastewater treatment plant to the pipes that supply water to your city (no additional treatment).

_____ Leaving the water treatment plant, the water travels **1 mi** down a swift river.

_____ Leaving the water treatment plant, the water travels **100 mi** down a swift river.

Of the subjects, 39.7% showed an increased willingness to drink water after it had traveled for 100 mi versus 1 mi. Mean advantage of the extra 99 mi for all respondents was slight (including those already at the maximum of 10) was 0.29 (SD = 2.39; $t[395] = 2.252$, $p < 0.05$). If one eliminates all respondents who expressed the maximum comfort (10) at mi 1, the mean rises to 0.40 unit on the scale of 0–10 (SD = 2.30; $t[369] = 3.353$, $p = 0.001$). As indicated in Table 4.19, there are no major differences across willingness to consume recycled water, with about 30% in each group showing some increase in acceptability after 99 additional mi of travel down a swift river.

Table 4.19. Effect of Distance Traveled down a Swift River on Willingness to Drink Recycled Water (Comfort at 100 Mi minus Comfort at 1 Mi on a 10-Point Scale) (*N*/mean/SD) [1]

Reaction	Amount Improved in All Subjects	Amount Improved in Those Who Had Willingness of <10 at 1 Mi[2]	% of Subjects Whose Willingness Was < 10 at Mi 1 Who Showed Improvement
Willing	188 0.06 (2.51)	168 0.22 (2.47)	32%
Uncertain	162 0.38 (2.29)	146 0.48** (2.13)	27%
Unwilling	44 0.80 2.18	0.43 0.81 (2.21)	30%

[1]Mean improvement (comfort at 100 mi minus comfort at 1 mi);

[2]Includes only subjects with a possibility for improvement: i.e., comfort was < 10 at mi 1;

** = $p < 0.01$.

Adaptations to drinking recycled water (time and awareness)

Individuals deciding whether they are willing to try recycled water (or almost any other choice) consider their current situation. However, in many ways what is most relevant is how they will feel with multiple exposures. There is considerable evidence that individuals underestimate the actually substantial effects of adaptation (Frederick and Loewenstein, 1999). In the current situation, this means a willingness judgment does not take into account getting used to recycled water.

Our data suggest clearly that people greatly underestimate the degree to which they will become accustomed to drinking recycled water. In two questionnaires, we asked about adaptation to drinking recycled water for 1 day versus 1 year.

In one form, we asked about willingness to drink, as follows:

"How willing (0 = totally unwilling; 10 = totally willing) are you with the following:

What would happen if you had no choice but to drink recycled water (that is certified safe)? Of course you would drink it, to stay alive. After drinking this water for 1 day, how willing would you be to drink it?

After drinking this water for 1 year, rate how willing you would be to drink it."

The second version, on a different form of the questionnaire, offered the same two questions, but the rating scale was:

"Rate how comfortable (0 [not comfortable at all] to 10 [completely comfortable]) you would feel about drinking tap water that has been certified safe for drinking if you had the following knowledge about the water." The word "willing" in the sample above was changed to "comfortable.")

Respondents showed very little sense that they would accommodate to recycled water. The mean change in rating was 0.41 (SD = 1.76; $t[391] = 4.459$, $p < 0.001$), significant but very small. Only 26% of respondents indicated increased willingness. These numbers are somewhat biased because some respondents (essentially from the willing group) already rated themselves as having the maximum willingness (10) to drink the recycled water on the 1st day. If we eliminate respondents who begin at 10, the mean increases to 0.92 (SD = 1.89; $t[226]=7.373$, $p < 0.001$), with 46% showing an increase. Of course, we have no actual data on what these values would be with a year of exposure, but all indications from other research are that there would be massive adaptation, just as we are adapted to breathing used air. For the comfortable version, 28% of respondents showed an increase in comfort after 1 year, and the mean change in rating was 0.075 (SD = 2.30; $t[399] = 6.547$, $p < 0.001$). Again, after elimination of those whose initial comfort rating was 10, 29% show increased comfort and the mean increases to 1.10 (SD = 2.31, $t[311] = 8.421$, $p < 0.001$).

Beliefs in adaptation are portrayed by willingness in Table 4.20. Even though the potential for increasing adaptation is much higher in the unwilling group, given that it starts at a lower base of willingness or comfort and has few if any respondents at the ceiling of 10, the unwilling group does not reliably show the highest tendency to acknowledge adaptation (actually, it charts lowest for willingness and highest for comfort).

Table 4.20. Change in Willingness/Comfort from a Year's to a Day's Exposure

	Data for:		
Statistic	**Unwilling**	**Uncertain**	**Willing**
N	37/39	120/143	77/122
Mean day	2.24/2.82	5.07/4.86	6.62/6.057
Mean yr	2.49/4.15	6.26/5.97	7.62/7.15
Difference	0.54/1.33	1.18/1.13	1.0/1.03
T, *p*[1]	$t(38) = 3.441$** $t(39) = 2.947$**	$t(108) = 5.566$*** $t(144) = 5.853$***	$t(73) = 6.212$*** $t(124) = 5.322$***
% Drop	8%/8%	7%/7%	4%/11%
% No change	67%/42%	43%/39%	45%/36%
% Increase	25%/50%	50%/54%	51%/53%

[1] Initial *t* measures willingness; *t* below it measures comfort.** = p<.01, *** p<.001 2-tailed

Conclusions: The data indicate that individuals who are willing to drink recycled water may think differently about the purification process of water. The largest discrepancies in the groups were for all the stages of processing between sewage and tap water. That is, those less willing to consume recycled water show the smallest effect from added stages of purification of sewage water. More unwilling people seem to make a more categorical distinction between unacceptable drinking water and acceptable drinking water. More willing individuals find acceptability grows incrementally with more processing. The majority of unwilling individuals find a major difference in acceptability between bottled water and boiled/evaporated/condensed sewage water. The results suggest that familiarizing unwilling individuals with water-processing techniques may not be profitable as a means to convince them. The same may hold for increasing storage or travel time. As a group, all respondents greatly underestimate the effect of adaptation to recycled water over time. Perhaps if they were exposed to the testimony of people who had been drinking it for years and who were initially negative, they would be persuaded.

Persuasion: what interventions may encourage acceptance?

In this section, we explore ways to make recycled water more acceptable. First, we consider two explicit interventions, each in the form of a paragraph about recycled water. One of the paragraphs focuses on the purity of recycled water, while the other, somewhat akin to the "flooding" procedure in behavior therapy, develops the idea that all water is contaminated. The persuasive paragraphs were on different forms, so that no respondent received both.

"Flooding" in clinical psychology means fully exposing a subject to something he or she fears or dreads for purposes of reducing his concerns. The paragraph explained in some detail that the contamination of all water is inevitable. That is, all water is "toilet to tap."

Respondents were asked to rate willingness to drink recycled water on the scale used commonly in these surveys: "Rate on a scale of 0 to 10 (0 = totally unwilling; 10 = totally willing)" just before and just after reading the following paragraph.

"Every time you take a breath of air, "used" air goes into your body. The molecules in this air were just breathed out by the people around us and have gone in and out of lungs for thousands of years. Yet we manage to breathe it easily and not to be bothered by it. Every drop of water in this world is recycled, just like our air, whether it is used to bathe, drink, cook, or irrigate. Every water molecule, or its hydrogen and oxygen atoms, has been around since time immemorial and will stay here long after we have gone. Every time we take a sip of water, the molecules that have passed through millions of people, including the likes of Adolf Hitler, pass through our own bodies. At an earlier point, rainwater that lands in a river was flushed down a toilet. By comparison, recycled water can be so pure after it has been processed that minerals have to be restored to stop the water from drawing minerals out of water pipes."

This paragraph alone changed rated willingness to drink certified safe recycled water from a mean of 6.99 to 7.37 (mean difference = 0.29, SD = 1.10, $t[383] = 5.185$, $p < 0.001$) (Table 4.21). Overall, 76% of subjects showed no effect, and 20% showed greater acceptance. On the one hand, the exposure here was to only one paragraph, but on the other hand, the change recorded occurred immediately after reading of the paragraph. We do not know if this effect is sustained. Nonetheless, the findings are encouraging.

However, as indicated in Table 4.21, the unwilling group showed the smallest amount of change, even though it had the most change "potential."

Table 4.21. Persuasiveness of Flooding (All Water Is Toilet to Tap) Paragraph (0–10 Willingness Scale)

Group	*N*	Mean Change in Willingness	SD	*T* (significance)
All	384	0.29	1.10	5.185 ***
Willing	195	0.14	0.97	2.059
Uncertain	147	0.54	1.25	5.231***
Unwilling	42	0.12	0.99	0.777

*** = p<.001

The purity message read as follows:

"Recycled drinking water is pure and safe. It is the product of natural processes and human ingenuity. Scientists discovered how rivers, springs, and sunlight purified water and then engineers re-created the same processes at water treatment facilities. But we humans took it a step farther. We minimized the variation and risks in the natural processes. And we installed multiple barriers and warning systems so that we could stop dangerous water from reaching people's homes. The result is pure, safe, recycled drinking water."

The same willingness (0–10) scale was used as with the flooding paragraph. However, through an error in assembling the particular form on which this paragraph appeared, the instructions anchoring the scale (0 = totally unwilling; 10 = totally willing) were omitted. Respondents were just told to use a scale of willingness from 0 to 10. Examination of the results indicates that the scale was used as intended.

This paragraph alone changed rated willingness to drink certified safe recycled water from a mean of 6.16 to 6.50 (mean difference = 0.34; see Table 4.22). Overall, 74% of subjects showed no effect, and 21% showed greater acceptance. Results overall, by willingness, are similar to those for the flooding paragraph, with perhaps a larger persuasive effect on the willing (Table 4.21). Again, there is a significant but modest persuasive effect.

Table 4.22. Persuasiveness of Purity-of-Recycled-Water Paragraph (Willingness Scale of 0–10)

Group	*N*	Mean Change in Willingness	SD	*T* (significance)
All	442	0.34	1.37	5.149***
Willing	225	0.13	1.06	1.818
Uncertain	141	0.52	1.39	4.476***
Unwilling	73	0.53	1.93	2.635

*** = p<.001

Five items of relevance to persuasion

Five particular items on one of the forms bear on persuasiveness and are reported here. The items are listed in full, along with results in Table 4.23. All items were answered on a standard scale between "disagree strongly" (0) and "agree strongly" (5). We report percent agreement (scores of 4 or 5).

Overall, 35% of respondents agree that "If recycled water is part of my drinking water supply, as long as it is safe, I'd rather not know the details." This preference for ignorance, presumably coupled with trust, is highest in the willing group and lowest in the unwilling (Table 4.23). Resistance goes with a desire for more knowledge of process.

Overall, 30% of respondents agree that "Being assured by someone I trust that my water is safe is more important than being given all the facts." This trust, coupled with a preference for ignorance about process (these two items correlate [0.49]), is also highest in the willing group and lowest in the unwilling (Table 4.23). Resistance goes with less trust in information.

Perhaps the most striking result with respect to opposition to recycled water is that, overall, 26% of respondents agree that "It is impossible for recycled water to be treated to a high enough quality that I would want to use it." Presumably, agreeing with this statement suggests that one is not going to be responsive to most persuasive messages. This opposition to recycled water is highest in the unwilling group and lowest in the willing (Table 4.23) and shows the most substantial and significant group differences of the five questions being considered. This impossible item does not correlate with the ignorance ($r = 0.01$) and trust ($r = 0.03$) above. It does correlate substantially ($r = 0.26$, $r = 0.35$, respectively) with the next two items, about the inherent superiority of "natural" water.

The final two questions suggest an inherent superiority of water from "natural" sources, though the items do not explicitly state that recycled water would be rejected. About one-quarter of the sample holds this view (Table 4.23).

Table 4.23. Agreement with Questions about Recycled Water That Bear on Persuasiveness (% Agreement: Score of 4 or 5 on 5-Point Agreement Scale) (Statistics Are Based on One-Way ANOVA on Three Categories of Willingness: Using the Full 1–5 Agreement Scale Scores)

Group (*N*) Item	Overall 375–381	Unwilling 43–44	Uncertain 160–167	Willing 170–179	ANOVA
If recycled water is part of my drinking water supply, as long as it is safe, I'd rather not know the details.	35%	14%[a]	36%	39%[b]	5.737**
Being assured by someone I trust that my water is safe is more important than being given all the facts.	30%	23%	26%	35%	4.152
It is impossible for recycled water to be treated to a high enough quality that I would want to use it.	26%	48%[b]	28%[b]	19%[a, 1]	22.492***
All-natural water treatment (rivers, lakes, aquifers) produces higher-quality water than do water treatment plants.	27%	28%	33%[a]	22%[b]	7.300***
All-natural water treatment (rivers, lakes, aquifers) is more reliable in producing water than are water treatment plants.	28%	33%	28%	26%	2.566

[a, b]Cells with different numbers if read across are significantly different by Scheffé test at $p < 0.01$ or better. Thus, for example, for the first item, "unwilling" and "willing" are significantly different at p<.01 or better.

[1] No one willing to drink recycled water should agree with this statement. Most of the willing subjects who endorse this score (4) agree rather than agree strongly (5). Also, this question is stated in terms of "wanting" to use recycled water, whereas the willingness question is about willingness to use it. Some of this disparity may be due to subject inconsistency or inattention, but some may be due to the difference between wanting and willing.

* ** = p<.01, *** = p<.001

4.3 SUMMARY OF INSIGHTS FOR WATER AGENCIES

This study, while intended to lay groundwork for more applied research in this field, already provides useful information to water agencies. They include the following:

- There is broad willingness to use recycled water.
- Independent (for example, university) scientists are the most credible sources of information on recycled water. Government scientists are also credible.
- Systems that include groundwater storage or reintroduction of certified safe recycled wastewater to a river prior to use are slightly more favored than systems without these features.

- At least in the short run (we did not test the long run), exposure to information about certified safe recycled water has an effect on willingness to use it.

- Roughly 30% of respondents are not interested in technical explanations, just in trustworthy assurances of the safety of certified safe recycled water.

- Although the effects are often weak, the person most likely to *reject* certified safe recycled water is someone who is:

    - Disgust and contagion sensitive;

    - Self-identified as not politically moderate;

    - Less trusting in institutions and science;

    - Less protechnology;

    - More interested in knowing about the history of water he drinks; and,

    - Less impressed by successively more effective water treatment technologies.

- The certified safe recycled water least likely to be rejected is

    - Certified safe by scientists;

    - Stored underground or introduced into a river following a long period of treatment;

    - Highly processed; and,

    - Used in some natural way for some period of time.

- The individuals most likely to accept and use certified safe recycled water have these characteristics. They have been

    - Exposed to the idea that all water is used;

    - Exposed to statements about the purity of certified safe recycled water;

    - Forced to use certified safe recycled water, after which it becomes acceptable; and,

    - Confident they will get used to certified safe recycled water over time.

4.4 HOW SURVEY RESULTS INFORM THE LARGER RESEARCH PROGRAM

Phases two, three, and four of the 3- to 5-year research program (Chapter 3) emerge both from the results of the survey and from WRR questions currently facing water agencies. Phase two focuses on the finding that respondents believe, but scarcely so, that they will grow

used to certified safe recycled water soon after they start using it. We believe that acceptance would be quicker as regions come to appreciate WRR as a reliable water source. We further think that research in this area could develop approaches to public concerns based on squeamishness or unsubstantiated fear of contamination. We therefore seek to undertake experiments and surveys that test whether acceptance of WRR after the fact is more rapid and complete than predicted.

Phase three draws upon the finding that opposition to WRR is not widespread and that the vast majority of people are either positively disposed to WRR or are neutral. This finding is inconsistent with the vehemence of some opposition to proposed WRR systems and calls into question whether the process of communications with program opponents and the public can be improved.

Phase four emerges from survey findings that public acceptance may not be closely linked to technical/scientific explanations of proposals. If so, water agencies may be able to alter their communication approaches in beneficial ways.

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APPENDIX 1

Survey Delivery Methods

In-person survey designs and Human Subject Protocols were reviewed and approved by the University of California–Santa Cruz Internal Review Board.

Eugene

This survey was part of a Pfizer-sponsored data collection that occurred in November 2006. It was a convenience sample of 306 Eugene residents recruited by Northwest Survey Data Services and was run at the First Christian Church. The sample was 60% female; mean age was 48.4 years, ranging from 18 to 88. Subjects were paid $20 to do a series of paper-and-pencil tasks lasting roughly 1 h.

Philadelphia

Data collection took place at the Amtrak station located at 2955 Market St., Philadelphia, PA 19104. Collection times ranged from 9 a.m. to 8 p.m. but were most typically from 3 p.m. to 7 p.m. during peak traffic times. Participants were asked to complete the survey in most situations—eating, person-to-person conversation, or silent cell phone usage (texting or browsing) was not cause for exclusion. The response rate was in the 50% to 60% range.

Phoenix

Data collection took place in a public area. Adults were approached and asked to fill out the survey.

San Diego

Data collection took place at the San Diego Trolley stop at Mission Valley Mall, 1640 Camino Del Rio North, San Diego, CA 92108. Collection times ranged from noon to 8 p.m. Participants were asked to complete the survey in most situations—eating, person-to-person conversation, or silent cell phone usage (texting or browsing) was not cause for exclusion. English was used first; if a participant exhibited language difficulties, the form in Spanish was used instead. In a few cases, participants of minor age completed a survey because they looked older. The response rate was in the 30 to 40% range.

San Jose

Data were collected at the San Jose Diridon Train Station on weekends between 10:00 a.m. and 4:00 p.m. Participants waiting for trains were approached and asked to fill out forms. Participants were offered a new pen in exchange for filling out the forms. The option of a Spanish-language form was given. The response rate was in the 50% range.

APPENDIX 2

Survey Instrument

Respondents were provided two forms, the common form and one of the other forms. The questions below are formatted differently from the actual survey forms, which were compressed into one sheet each. The themes of the forms are as follows:

1. Knowledge of water origins

   Page 1 is common core

   Page 2 is knowledge of and experience with water treatment

2. Acceptability of different types and uses of water

   Page 1 is common core

   Page 2 is

   - Acceptability of use of recycled water in different contexts
   - Persuasion paragraph saying that all water is recycled

3. Water transformations

   Page 1 is common core

   Page 2 is

   - Transformations of sewage water and their acceptability
   - Can anything be done that makes it as good as spring water? (open-ended)

4. Predictors

   Page 1 is common core

   Page 2 is predictors

   - Schaller infection
   - Brief disgust scale

5. Message

   Page 1 is common core

   Page 2 is

   - Persuasive message on quality of recycled water
   - Judgment about adaptation to recycled water
   - Siegrist world view scales
   - Similarity sets, judging whether process or content is important

6. Trust

   Page 1 is common core

   Pages 2–3 are

   - Siegrist trust scale revised for water
   - Credibility scale for certifying water safety
   - Siegrist perceived risk scale revised for water
   - Siegrist perceived benefit scale revised for water
   - Two questions assessing risks and benefits overall
   - Acceptability and naturalness indicators

7. Engineering and naturalness

   Page 1 is common core

   Page 2 is

   - Naturalness and engineering
   - Certainty of presence of recycled water
   - Mixing natural and recycled water

Common Form

"Recycled" water is water that is separated from wastewater and highly treated so it can be used again. It is also called "reclaimed water" and "water reuse." It has become an important political issue nationwide, such as in the American West, where there is a shortage of "natural" water, such as the Colorado River. Recycled water has ecological and economic advantages over other sources of water, but some people object to its use as drinking water. This survey is an attempt to understand the nature of this objection and is part of a research program carried out jointly by scientists at the University of California at Santa Cruz, the Universities of Pennsylvania and Oregon, and Arizona State University. The questionnaire is anonymous. Your name does not appear on it.

Some information about you:

1. Your gender (circle one) : FEMALE MALE

2. Your age in years: _____

3. Race/ethnicity (circle one or more):

   BLACK EAST/SE ASIAN/PACIFIC ISLANDER HISPANIC

   NATIVE AMERICAN SOUTH ASIAN/INDIAN WHITE OTHER

4. Your religion (circle one):

   ATHEIST/AGNOSTIC BUDDHIST CATHOLIC

   HINDU JEWISH MUSLIM

   PROTESTANT (non-Catholic Christian, e.g., Baptist, Episcopalian, Methodist, etc.)

   OTHER

5. Your highest level of education (in years, 12 = high school graduate) _____

6. How religious are you? (circle one)

   NOT AT ALL SLIGHTLY MODERATELY VERY EXTREMELY

7. Your occupation: _____

8. What state (or country) were you born in? _____

9. Where do you live now?
   City, town, or county _____ State _____

10. Your political views (circle one):

    VERY CONSERVATIVE CONSERVATIVE MIXED

    LIBERAL VERY LIBERAL

Your water drinking

11. In a typical week, how much of bottled vs. tap water do you drink?

    _____% bottled _____% tap

12. Using a 12-oz Coke can as a standard, about how much water do you drink a day? (circle one)

    LESS THAN ONE CAN ONE CAN TWO

    THREE FOUR FIVE MORE THAN FIVE

13. Have you ever spent time in a developing country where you could not drink the water?

    YES NO

14. Would you be willing to drink certified safe recycled water?

    NO UNCERTAIN YES

15. Had you heard about recycled water before taking this survey? YES NO

16. Have you ever knowingly drunk recycled water? YES NO

Form 1

1. Where do you think your home's tap water comes from?

2. Please define recycled water for us.

3. What do you think happens to wastewater that comes into a water recycling plant? Please explain the path it takes from its source to its becoming drinkable water again. What processes do you think are used on wastewater? Few people actually know what happens, but we want you to tell us what you THINK happens. Try to indicate what happens in order, from wastewater to drinking water.

1.

2.

3.

4.

5.

6.

4. Has any community in which you have lived had a discussion or debate about its sources of water?

YES NO

5. If yes, provide some details about your exposure to the debate. For example, what did it focus on: water quality? Cost? Don't recall?

Form 2

Let's assume that recycled water from a municipal water treatment plant has been provided to you. This water is certified as safe by a panel of water scientists appointed by the National Academy of Sciences and has a good taste. On a scale of 0 to 10, how willing are you to use this water for each different application listed below?

Please rate your willingness on a scale of 0 to 10 (0= totally unwilling; 10 = totally willing).

____ 1. How willing are you to use this water to irrigate vegetable farms?

____ 2. How willing are you use this water to water lawns in a park where children play?

____ 3. How willing are you to use this water as drinking water for your pets?

____ 4. How willing are you to use this water for bathing and showering?

____ 5. How willing are you to use this water for cooking pasta?

____ 6. How willing are you to use this water as drinking water for yourself and your family?

____ 7. How willing are you to use this water to water your own lawn?

____ 8. How willing are you to use this water to water your vegetable garden?

How willing (0 = totally unwilling; 10 = totally willing) are you concerning the following:

_____ 9. What would happen if you had no choice but to drink recycled water (that is certified safe)? Of course you would drink it, to stay alive. After drinking this water for 1 day, how would you feel about drinking it?

_____ 10. After drinking this water for 1 year, rate how willing you would feel about drinking it.

Rate on a scale of 0 to 10. (0 = totally unwilling; 10 = totally willing):

11. Rate your willingness to drink recycled water that has been certified as safe and good-tasting by a panel of water scientists appointed by the National Academy of Sciences.

Willingness (0–10) _____

Every time you take a breath of air, “used” air goes into your body. The molecules in this air were just breathed out by the people around us and have gone in and out of lungs for thousands of years. Yet we manage to breathe it easily and not be bothered by it. Every drop of water in this world is recycled, just like our air, whether it is used to bathe, drink, cook, or irrigate. Every water molecule, or its hydrogen and oxygen atoms, has been around since time immemorial and will stay here long after we have gone. Every time we take a sip of water, molecules that have passed through millions of people, including the likes of Adolf Hitler, pass through our own bodies. At an earlier point, rainwater that lands in a river was flushed down a toilet. By comparison, recycled water can be so pure after it has been processed that minerals have to be restored to stop the water from drawing minerals out of water pipes.

12. Again, rate your willingness to drink recycled water that has been certified as safe and good-tasting by a panel of water scientists appointed by the National Academy of Sciences.

Willingness (0–10) _____

Form 3

Now we are going to ask you about your reaction to a set of different kinds of water. In each case, assume you are thirsty and that an 8-oz glass of the water described is available for you to drink. Assume all the waters below except raw sewage water and boiled sewage water look and taste the SAME.

Rate on a scale of 0 to 10: how willing you are to drink each type of water described (0 = totally unwilling/uncomfortable; 10 = totally willing/comfortable)?

_____1. How willing are you to drink commercial bottled water (from a spring)?

_____2. How willing are you to drink raw sewage water?

_____3. How willing are you to drink commercial bottled water (filtered tap water)?

_____4. How willing are you to drink tap water?

_____5. How willing are you to drink sewage water that has been kept still so lighter things float to the surface and heavier things sink to the bottom, after which all these things are removed?

_____ 6. How willing are you to drink sewage water that is filtered through soil to remove remaining living microbes?

_____ 7. How willing are you to drink sewage water that is passed through tightly meshed filters to remove any microbes and unwanted chemicals?

_____ 8. The combination of the three treatments above in order (waste is [1] skimmed off bottom and top, [2] filtered through soil, and [3] passed through tightly meshed filters to remove any remaining microbes and unwanted chemicals) is called tertiary treatment. How willing are you to drink sewage water that has been subjected to tertiary treatment?

_____ 9. How willing are you to drink sewage water that has been boiled enough to destroy all microbes?

_____ 10. How willing are you to drink sewage water that has been boiled enough to destroy all microbes and then is evaporated and then condensed and collected as pure water?

_____ 11. How willing are you to drink sewage water subjected to tertiary treatment in an attractive natural setting outside town?

_____ 12. How willing are you to drink sewage water subjected to tertiary treatment in an urban water treatment plant?

_____ 13. How willing are you to drink 1 part sewage water mixed with 1000 parts pure mountain spring water?

_____ 14. How willing are you to drink 1 part tertiary treated sewage water mixed with 1000 parts pure mountain spring water?

15. If you scored less than 10 for willingness to drink tertiary treated water (see question no. 8), what could be done to the tertiary water so that you would be as willing to drink it as you are the bottled spring water?

Form 4

Answer the following 18 questions using the scale: 1 = Strongly Disagree ... 7 = Strongly Agree

_____1. I am comfortable sharing a water bottle with a friend.

_____2. I suffer quite intense symptoms when I do get sick.

_____3. It really bothers me when people sneeze without covering their mouths.

_____4. I don't like to write with a pencil someone else has obviously chewed on.

_____5. My past experiences make me believe I am not likely to get sick even when my friends are sick.

____ 6. I prefer to wash my hands pretty soon after shaking someone's hand.

_____7. I dislike wearing used clothes because you don't know what the past person who wore it was like.

_____8. If an illness is "going around," I will get it.

_____9. I don't worry about contamination if I touch an animal.

____10. In general, I am very susceptible to colds, flu, and other infectious diseases.

____11. I think day care centers are breeding grounds for bacteria and germs.

____12. I am more likely than the people around me to catch an infectious disease.

____13. My hands do not feel dirty after touching money.

____14. I am unlikely to catch a cold, flu, or other illness, even if it is going around.

____15. It does not make me anxious to be around sick people.

____16. My immune system protects me from most illnesses that other people get.

____17. I avoid using public telephones because of the risk that I may catch something from the previous user.

____18. I have a history of susceptibility to infectious diseases.

Please indicate how much you agree with each of the following statements, or how true it is about you. Please write a number (1, 2, 3, or 4) to indicate your answer:

1 = Strongly disagree (very untrue about me)

2 = Mildly disagree (somewhat untrue about me)

3 = Mildly agree (somewhat true about me)

4 = Strongly agree (very true about me)

____ 19. I try to avoid letting any part of my body touch the toilet seat in a public restroom, even when it appears clean.

____ 20. It would make me uncomfortable to hear a couple making love in the next room of a hotel.

____ 21. It would bother me tremendously to touch a dead body.

____ 22. Even if I was hungry, I would not drink a bowl of my favorite soup if it had been stirred by a used but thoroughly washed flyswatter.

How disgusting would you find each of the following experiences? Please write a number (1, 2, 3, or 4) to indicate your answer:

1 = Not disgusting at all, 2 = Slightly disgusting, 3 = Moderately disgusting, 4 = Very disgusting

(If you think something is bad or unpleasant, but not disgusting, you should write "1.")

____ 23. You take a sip of soda and then realize that you picked up the wrong can, from which a stranger had been drinking.

____ 24. You hear about a 30-year-old man who seeks sexual relationships with 80-year-old women.

____ 25. While you are walking through a tunnel under a railroad track, you smell urine.

____ 26. You accidentally touch the ashes of a person who has been cremated.

Form 5

Rate your willingness to drink recycled water that has been certified as safe and good-tasting by a panel of water scientists appointed by the National Academy of Sciences.

Willingness (0–10) _____

Recycled drinking water is pure and safe. It is the product of natural processes and human ingenuity. Scientists discovered how rivers, springs, and sunlight purified water and then engineers re-created the same processes at water treatment facilities. But we humans took it a step further. We minimized the variation and risks in the natural processes. And we installed multiple barriers and warning systems so that we could stop dangerous water from reaching people's homes. The result is pure, safe, recycled drinking water.

Rate your willingness to drink recycled water that has been certified as safe and good-tasting by a panel of water scientists appointed by the National Academy of Sciences.

Willingness (0–10) _____

Answer the following 7 questions according to the following scale

1 = disagree strongly, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = agree strongly

____ 1. An industrialized, highly technological society is the best guarantee of successfully eliminating poverty

_____ 2. Economic growth and technological advances ensure that humans may realize their own personal goals

_____ 3. In our society, decisions should be based on rationality

_____ 4. The advantages of a highly technological society, as compared to the alternatives, are obvious

_____ 5. Movements within our society that oppose the predominance of materialistic values deserve our support

_____ 6. The answer to our energy and resources problems lies in giving up our consumer-oriented lifestyles and returning to a simpler and more frugal style of living

_____ 7. Wealthy nations such as the United States should consume less and limit their use of resources

For questions 8 and 9 , you will be presented with sets of THREE items. In each case, you are to UNDERLINE the item that is MOST DIFFERENT in your opinion. For example:
CAR TOMATO BUS or SPOON FORK HOUSE

8. a. pure water from a natural spring containing no minerals

b. same as “a” but with 0.1% natural minerals added

c. same as “a” but with 0.1% natural minerals added and then removed

9. a. pure water from a natural spring containing 0.1% minerals

b. same as “a” but with 0.1% natural minerals removed

c. same as “a” but with 0.1% natural minerals removed and then added back

Form 6

Answer the following 14 questions according to the following scale:

1 = disagree strongly, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = agree strongly

_____ 1. I trust that the recycling of drinking water can be placed under adequate controls through appropriate regulation.

_____ 2. Corporations in the field of water treatment are aware of their responsibilities.

_____ 3. Municipalities that operate water treatment plants can be trusted.

_____ 4. The authorities cannot sufficiently monitor whether water purification plants uphold legal regulations and restrictions.

_____ 5. Scientists working in the field of purification of sewage water for drinking are hardly able to estimate or predict the consequences of their work.

_____ 6. Recycled water only increases profits made by industry or local governments and is not beneficial to mankind at all.

_____ 7. It is irresponsible not to utilize recycled water if it as safe as spring water and prevents damage to the environment.

_____ 8. Thanks to use of recycled water, natural waterways can be kept intact.

_____ 9. Thanks to the purification of water, the quality of life of mankind is increased.

_____ 10. If we take all aspects into account, we can say that our society profits from making good drinking water from sewage water.

_____ 11. Recycled water could become dangerous to mankind.

_____ 12. Recycled water can cause irreversible damage to the environment.

_____ 13. Water treatment is a technology like many others. The risks should not be overdramatized.

_____ 14. Recycled water is disgusting.

On a scale of 0–10, where 0 means don't trust at all, and 10 means trust completely, rate each form of certification that the water coming out of a particular municipal treatment plant is safe to drink.

The produced water is certified as safe by:

_____15. A private firm hired by the water treatment facility

_____16. The staff of the water treatment facility

_____17. Engineers/inspectors from the state government

_____18. Engineers/inspectors from the federal government

_____19. The manager of the water treatment facility

_____20. An actor or athlete you admire hired to represent the water treatment facility

_____21. A qualified scientist from a nearby university

_____22. Someone who has drunk recycled water for years

_____23. A doctor who lives nearby

_____24. A board made up of engineers and other representatives of the community

_____25. Your neighbor

Using the scale 0 = not at all risky to 10 = extremely risky:

_____26. Overall, give your opinion about the risks of using recycled water

Using the scale 0 = not at all beneficial to 10 = extremely beneficial:

_____27. Overall, give your opinion about the benefits of using recycled water

Form 7

Rate how comfortable (0 [not comfortable at all] to 10 [completely comfortable]) you would feel about drinking recycled water that has been certified safe for drinking and then undergoes the following additional treatments:

_____ The water travels through a pipe directly from the wastewater treatment plant to the pipes that supply water to your city (no additional treatment).

_____ Leaving the water treatment plant, the water travels 1 mi down a swift river.

_____ Leaving the water treatment plant, the water travels 100 mi down a swift river.

_____ Leaving the water treatment plant, the water filters through an underground aquifer for 1 year.

_____ Leaving the water treatment plant, the water filters through an underground aquifer for 10 years.

_____ Leaving the water treatment plant, the water is deposited in a lake or reservoir for 1 year.

_____ Leaving the water treatment plant, the water is deposited in a lake or reservoir for 10 years.

Rate how comfortable (0 [not comfortable at all] to 10 [completely comfortable]) you would feel about drinking tap water that has been certified safe for drinking if you had the following knowledge about the water.

_____ You are certain that at least some of the water was treated at a wastewater treatment plant.

_____ It is possible that none of the water has come from a wastewater treatment plant, and there is no way of knowing for sure.

_____ You are certain that none of the water comes from a wastewater treatment plant (no recycled water as a source).

11. _____What would happen if you had no choice but to drink recycled water (that is certified safe)? Of course you would drink it, to stay alive. After drinking this water for 1 day, how would you feel about drinking it?

12. _____After drinking this water for 1 year, how comfortable would you feel about drinking it?

Answer the following questions according to the following scale:

1 = disagree strongly, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = agree strongly

13._____ If recycled water is part of my drinking water supply, as long as it is safe, I'd rather not know the details.

14._____ Being assured by someone I trust that my water is safe is more important than being given all the facts.

15._____ I would prefer to mix highly treated recycled water with natural water (for example, in a reservoir) even if the recycled water has a much higher quality than the natural water before mixing.

16_____ All-natural water treatment (rivers, lakes, and aquifers) produces higher-quality water than do water treatment plants.

17._____ All-natural water treatment (rivers, lakes, and aquifers) is more reliable in producing drinking water than are water treatment plants.

18._____ I would like to see highly treated recycled water stored in a lake or reservoir before it is used even if the treated water has a higher initial quality than the lake or reservoir.

19._____ It is impossible for recycled water to be treated to a high enough quality that I would want to use it.

20._____ We should keep wastewater treatment separate from water treatment before it enters the urban system. That means different agencies and different approaches to oversight.

APPENDIX 3

ANNOTATED SUMMARY OF RESEARCH PAPERS RELATED TO THE HUMAN DIMENSIONS OF WRR

A.2.1 DIRECTLY RELATED RESEARCH

The following papers involve water reuse issues and offer analysis of what factors contribute to the public's acceptance or rejection of reused water. An online, searchable, larger bibliography that was co-funded by the WateReuse Foundation as part of this project can be found at http://www.ciwr.ucsc.edu.

Atwater, R. Engaging communities of practice for risk communication in the Hawkesbury Water Recycling Scheme. *Action Res.* 2005, *3,* 193–209.

This paper focuses on the creation of risk management strategies, including how to involve the public and people from varied backgrounds in decision-making.

Baggett, S.; Jeffrey, P.; Jefferson, B. 2006. Risk perception in participatory planning for water reuse. *Desalination* 2006, *187,* 149–158.

This research focuses on the differences in risk perception of water reuse in four stakeholder groups (regulators, researchers, managers, and domestic customers). This knowledge can be applied to understand the viewpoints and expectations of the different groups for future discussion and policymaking.

Bruvold, W.H. Affective response toward uses of reclaimed water. *J. Appl. Psychol.* 1971, *55,* 28–33.

This article outlines research done in California to categorize attitudes toward water reuse. Focusing on palatability, the methods and conclusions are meant to establish a scale that can be used for future research on the public perception of water reuse.

Bruvold, W.; Ongerth, H. Public Use and Evaluation of Reclaimed Water. *J.—Am. Water Works Assoc.* 1974, *66,* 294–297.

This study involved surveying Californians to determine their level of acceptance of different uses of reclaimed water.

Craig, A. Expertocracy through Sustainable Development: the Case of Wastewater. Presented at the 16th LAPS Conference, Paris, France, July 2000.

This paper touches on strategies that make reused water more acceptable. People are much more likely to accept risks if they are voluntary and associated with a trustworthy source and if they also believe that there is fairness in the distribution of risk in the water-planning process.

Dolnicar, S. Public Perception of Desalinated versus Recycled Water in Australia. http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1145&context=commpapers (accessed July 2009), 2006.

A section of this paper reviews public perception of potable reused water. The main concerns listed are public health, endocrine disruptors, quality, cost, and suspicion towards politicians and organizations that supply the water. People were found to be 10 to 20% more likely to accept using desalinated water rather than recycled water for potable and "close body" activities.

Friedler, E.; Lahav, O.; Jizhaki, H.; Lahav, T. Study of urban population attitudes towards various wastewater reuse options: Israel as a case study. *J. Environ. Manage.* 2006, *81,* 360.

This paper outlines the public response to water reuse as intensity of contact with water varies among low contact, medium contact, and high contact. Results show that a high proportion of the participants supported medium-contact reuse options such as sidewalk landscaping (95%), domestic WC flushing (85%), and firefighting (96%). Higher-contact reuse options such as domestic laundry (38%), food preservation (13%), and potable aquifer recharge (11%) found much less support. Less than expected support was found for low-contact reuse options, with 86% for field crop irrigation, 62% for aquifer recharge for agricultural irrigation, and as low as 49% for orchard irrigation. People who supported water reuse listed the most important reason for support as "water saving," followed by "minimization of importing water from abroad." These were followed by "infrastructure cost saving" together with "environmental improvement." This research found that there is no correlation between education level and trust in authority or acceptance of reused water, unlike the findings of Po et al. (2005) (see below).

Greene, L. Controversy swirls around toilet-to tap project. *Environ. Health Perspect.* 2000, *108*, A447.

This is a popular article that suggests that even experts do not think that there is enough research to show that reused water is safe for human consumption. The article suggests that the most important reason people do not accept recycled water is that they do not think there has been enough testing to make sure it is safe.

Hartley, T. Public perception and participation in water reuse. *Desalination* 2006, *187,* 115–126.

This article is a review of three case studies and what contributed to the success or failure of the projects.

Hills, S.; Birks, R.; McKenzie, B. 2002. The Millennium Dome "Watercycle" experiment: to evaluate water efficiency and customer perception at a recycling scheme for 6 million visitors. *Water Sci. Technol.* 2002, *46,* 233–240.

Part of this study involved surveying visitors of the Millennium Dome to understand whether reused water was acceptable and if they had a preference for different types of uses (agriculture, toilets, etc.). People were 95% accepting of reused water in the public sphere but were more opposed to the idea of the reused water being used in their homes. They showed

greater acceptance if they had seen the educational signs in the restrooms or the Watercycle exhibit.

Hurlimann, A.C.; McKay, J.M. What attributes of recycled water make it fit for residential purposes? The Mawson Lakes experience. *Desalination* 2006, *187,* 167–177.

This Australian case study examines what factors contribute to public acceptance of household recycled water use and what purposes respondents accept. Results show that as uses become more personal, such as clothes washing, it becomes increasingly important that the aesthetic levels of color, odor, and salt increase. Lack of color and odor ranked very important for clothes washing but not as much for toilet flushing and gardening. The authors suggest that similar surveys should be conducted prior to implementing a reuse scheme so that the needs of the specific community are met.

Ingram, P.C.; Young, V.; Millan, M.; Chang, C.; Tabucchi, T. From controversy to consensus: the Redwood City recycled water experience. *Desalination* 2006, *187,* 179–190.

This paper is a case study of the steps taken to involve the community in creating solutions for water management and, in the process, assuage the community's concerns about recycled water. The city council formed a community task force in order to instill a sense of power in the community—which led to greater communication and mutual understanding concerning water issues.

Jeffrey, P.; Jefferson, B. Public receptivity regarding "in-house" water recycling: results from a UK survey. *Water Sci. Technol. Water Supply* 2003, *3,* 109–116.

This research examined people's willingness to drink recycled water. Turbidity was identified as a key concern.

Kracman, B.; Martin, R.; Sztajnbok, P. The Virginia Pipeline: Australia's largest water recycling project. *Water Sci. Technol.* 2001, *43,* 35–42.

Surveys in Australia revealed a high demand for reused water, yet respondents considered the water to be inferior and were not willing to pay prices equivalent to the cost of groundwater supplies. The marketing strategy was to show customers at public meetings the clean-looking water after treatment and to have the product endorsed by the South Australian Health Commission. Within 3 years, public perception had changed and people considered the water to be comparable in safety to groundwater.

Leviston, Z.; Porter, N.; Nancarrow, B. *Interpreting Household Preferences to Evaluate Water Supply Systems—Stage 3;* CSIRO Land and Water: Canberra, Australia, 2006.

This research study uses community surveys to examine preferences for different types of reused water (from own building, neighborhood, or city) as well as the type of water management. The analysis explores issues of trust, fairness, and perceived risk.

Marks, J.S. Negotiating Change in Urban Water Management: Attending to Community Trust in the Process. http://www.wsud.org/downloads/Info%20Exchange%20&%20Lit/WSUD_04_Conf_Papers/WS040098.PDF (accessed July 2009), 2004.

This research shows guidelines for community outreach and conversation related to issues concerning water reuse. It emphasizes the importance of community involvement in the decision-making process as a way to overcome initial opposition to recycled water. Communication and responsiveness to the community's concerns are more valuable than an approach that focuses on one-way education.

Marks, J.; Cromar, N.; Fallowfield, H.; Oemke, H. Community experience and perception of water reuse. *Water Sci. Technol. Water Supply* 2003, *3,* 9–16.

This research shows that those who currently use reused water are most supportive of using recycled water because of the monetary savings associated with using a cheaper water source and that water conservation and other environmental concerns play a secondary role.

Menegaki, A.; Hanley, N.; Tsagarakis, K. The social acceptability and valuation of recycled water in Crete: a study of consumers' and farmers' attitudes. *Ecol. Econ.* 2007, *62,* 7–18.

This articles researches the willingness to use recycled water on tomato and olive oil crops, as well as the amount people are willing to pay for the water. The researchers show that environmental awareness and economic factors influence attitudes toward the acceptability of recycled water.

Nemeroff, C.; Rozin, P. 1994. The contagion concept in adult thinking in the United States: transmission of germs and interpersonal influence. *Ethos* 1994, 22, 157–186.

This is a review of psychological and anthropological perspectives about the "magical" laws of contagion. It discusses the adaptive significance of contagion as a way for people to avoid microbial infection from one another. The concept of "self" and "not-self" is key to understating the laws of contagion, because contact with something becomes increasingly dangerous if it is associated with "not-self." This supports the papers that show that people have a stronger aversion to using water that comes from a city-wide reclamation facility than to using water from a building-wide reclamation facility. This paper also provides background support for the disgust people feel at the thought of reused water. Even brief contact with something that is considered dirty can leave a permanent association of dirtiness.

Po, M.; Kaercher, J.; Nancarrow, B.E. *Literature Review of Factors Influencing Public Perceptions of Water Reuse: Report to Australian Water Conservation and Reuse Research Program;* Technical Report 54103; CSIRO Land and Water: Canberra, Australia, 2003.

This paper provides a review of research into the psychological attitudes towards recycled water. The paper cites more than 20 other papers on the topic of public perception of water use. It also details past projects in Australia, California, and Singapore. Most successful water reclamation projects in Australia are small scale and nonpotable. Some potable projects used the mechanism of mixing the reused water with reservoir water to make it seem less risky to the public. Persuasion is ineffective in changing people's minds on this issue, and only

extensive, active participation will lead to acceptance of reused water. The key elements that make reused water unacceptable are (1) the "yuck" factor; (2) perceived risk; (3); the source; (4) choice; and (5) trust. The disgust or "yuck" factor has been attributed to the mental imagery of raw sewage.

The paper also discusses strategies for implementing new products and gives examples including the Singapore NeWater project, where recycled water was named NEWater to convey a new mental image of clean and fresh water. Also, in California, respondents reported that water called "purified water" was much more appealing than reclaimed or recycled water. Lack of trust in authority, especially in the US Department of Energy, is a major contributor to the public's resistance to recycled water.

Po, M.; et al. *Predicting Community Behaviour in Relation to Wastewater Reuse: What Drives Decisions to Accept or Reject?;* CSIRO Land and Water: Canberra, Australia, 2005.

This article describes what demographics and factors contribute to acceptance or rejection of reused water. For example, people with less education are less likely to trust experts' statements about water safety. Also, it emphasized how different schemes influence attitude—people are much more likely to accept reused water from their home than from a neighborhood or citywide scheme.

Robinson, K.G.; Robinson, C.H.; Hawkins, S.A. 2005. Assessment of public perception regarding wastewater reuse. *Water Sci. Technol. Water Supply* 2005, *5,* 59–65.

This research involved telephone surveys in hopes of understanding how people feel about reused water and how population demographics may influence those feelings. Seventy-eight percent of people did not support using reused water for drinking or close-contact purposes (laundry, bathing), and women were significantly more opposed to reused water entering the groundwater supply than men were. Seventy-five percent to 85% did support reused water use for purposes that were not associated with close contact, such as golf-course irrigation.

Russell, S.; Hampton, G. Challenges in understanding public responses and providing effective public consultation on water reuse. *Desalination* 2006, *187,* 215–227.

This paper describes the need for policymakers to have a greater understanding of a community's needs and reactions to water reuse. It suggests greater community involvement and education and outlines ways in which decision-makers can facilitate discourse among experts, authorities, and the community.

Shafer, A.; Beder, S. Relevance of the precautionary principle in water recycling. *Desalination* 2006, *187,* 241–252.

The main fears people have about reuse of water concern the effect on male sperm counts, extinction of threatened species, images of drinking excrement, and a lack of trust. The lack of trust stems from risk uncertainty and lack of testing of health and environmental impacts of recycled water projects. The authors state that scientists are waiting until there is evidence of harm before investigating whether contaminants, such as endocrine disruptors, found in recycled water are a threat to public health.

The article outlines a strategy for involving the public. “Firstly, public concerns are important in identifying potential risks. Secondly, the community has a right to decide the level of environmental and health protection they will live with. Thirdly, measures taken to mitigate likely harm need to be evaluated to ensure that the impact of the measures are [sic] not worse than the impact of the harm they are seeking to mitigate.”

Stenekes, N.; Colebath, H.; Waite, T.D.; Ashbolt, N. Risk and governance in water recycling. *Sci. Technol. Hum. Values* 2006, *31,* 107–134.

This article suggests that institutional change is necessary to facilitate increased communication and understanding with the public, especially involving the public in conversation and leadership. The failure to implement sustainable water use through recycling can be understood as the result of several factors including present cost structures for water, institutional conservatism, administrative fragmentation, and inadequate involvement of communities in planning. (We had access only to the abstract.)

A.2.2 OTHER RELATED RESEARCH

These articles focus on the nature of risk perception and disgust but not necessarily when those qualities pertain to recycled water. A common theme that runs throughout these papers in the need for people to feel in control and involved in the decision-making process. Authors recommend that policymakers provide an education program, take public concerns seriously, and involve the community in making changes to a project so that it can be considered acceptable. Risk is subjective and can be influenced by many factors such as word framing and mental imagery. For example, framing a situation by giving the likelihood of a benefit or success is considered less risky than giving the likelihood of a negative outcome.

Ahearne, J.F. 2002. Risk, media and stigma: understanding public challenges to modern science and technology. *Risk Anal.* 2002, *22,* 186–188.

This article was cited in some of the other papers. We were not able to obtain a copy of it.

Beecher, N.; Harrison, E.; Goldstein, N.; McDaniel, M.; Field, P.; Susskind, L. Risk perception, risk communication, and stakeholder involvement for biosolids management and research. *Environ. Qual.* 2005, *34,* 122–128.

This research outlines the process of stakeholder involvement in policy decisions and understanding what factors contribute to feelings of disgust.

Curtis, V.; Aunger, R.; Rabie, T. Evidence that disgust evolved to protect from risk of disease. *Proc. R. Soc. London, Ser. B* 2004, *271,* S131–S133.

This is a study that provided subjects with different mental images and asked them to rate their level of disgust. Images that contained the potential of disease were correlated with the largest disgust response. Bodily fluids from strangers evoked a much stronger disgust response than did bodily fluids of relatives (related to contagion).

Daughton, C. Non-regulated water contaminants: emerging research. *Environ. Impact Assess. Rev.* 2004, *24,* 711–732.

This paper describes the actual and perceived risk of chemical pollutants in reused water. State and international water quality standards do not evaluate certain chemicals, and people perceive this gap as a major health risk. This attitude is related to a lack of trust in authority and to a possibly irrational fear of certain contaminants.

Fallon, A.E.; Rozin, P.; Pliner, P. The child's conception of food: the development of food rejection with specific reference to disgust and contamination sensitivity. *Child Dev.* 1984, *55,* 566–575.

Children under the age of 7 do not understand the concept of trace contamination, and young children (2 to 3 years old) do not show disgust when presented with food items an adult would consider disgusting. This finding supports the view that development of disgust is not an innate response but rather involves culture and learning.

Jones, M.O. What's disgusting, why, and what does it matter? *J. Folkl. Res.* 2000, *37,* 53–71.

This paper outlines the nature of disgust and what factors contribute to feeling disgust. The feeling of revulsion is a distinct emotion coupled with characteristic physical reactions (facial expression, salivation, etc.). Disgust leads to aversion and usually is related to a fear of illness. Disgust is a product of nature, culture, and cognitive development—not of genetics. Animal products elicited the highest disgust response when survey participants were asked to list things that they find disgusting.

Kunreuther, H.; Slovic, P. Science, values, and risk. *Am. Acad. Pol. Soc. Sci.* 1996, *545,* 116–125.

Experts and risk evaluators see risk as a quantifiable measure of loss, whereas it can also bee seen as a subjective tool invented by people to ensure self-preservation. The lay public often has a distorted notion of what actually poses the most risk, which is based on an emotional response to perceived risk. A major component in having a community accept a situation that it believes poses a risk is for it to have trust in the authorities and to have an active role in measuring the risk, as well as the positive and negative components of a potential project.

Lazarova, V.; Levine, B.; Sack, J.; Cirelli, G.; Jeffrey, P.; Muntau, H.; Salgot, M.; Brissaud, F. Role of water reuse for enhancing integrated water management in Europe and Mediterranean countries. *Water Sci. Technol.* 2001, *10,* 25–33.

This article touches on factors that make water reuse acceptable and suggests that trust in testing and the existence of international safety standards make reused water more acceptable.

Miller, W.H.; Sayre, I.M. Face to face—Denver's reuse demonstration plant: forerunner of the future? *J.-Am. Water Works Assoc.* 1985, *77,* 13–14, 19–20, 22.

This is an interview with the manager of the Denver Water Department discussing public opinion of water reuse as well as of cost.

Slovic, P. Perception of risk. *Science* 1987, *236,* 280–285.

This article focuses on the psychological aspect of risk. People use heuristics (simple decision rules) to make judgments, which can cause large biases in risk assessment. If a person believes that an activity or situation is very risky, education and the presentation of new evidence will have little effect on that person's attitude. Someone resistant to changing opinion will dismiss new information as unreliable. Those who do not have very strong opinions about the risk of a situation are much more likely to accept an activity if it is shown to have a high benefit. The themes of control, equity, and knowledge are presented. Policymakers will be much more successful in having the public accept new technologies if they try to give the people a sense of control and a voice in the situation.

Advancing the Science of Water Reuse and Desalination



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