PUBLIC and POLITICAL ACCEPTANCE of DIRECT POTABLE REUSE

Prepared for WateReuse California
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by

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ACRONYMS

CDPH	California Department of Public Health
CECs	Constituents of emerging concern
GWR	Groundwater Replenishment
mgd	Million gallons per day
OCWD	Orange County Water District
U.S. EPA	United States Environmental Protection Agency
WERF	Water Environment Research Foundation
WRF	WateReuse Foundation

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DEFINITIONS

As used in this document, the water reuse-related terms listed below have the following meaning:

***Direct potable reuse*:** The introduction of highly treated recycled water either directly into the potable water distribution system downstream of a water treatment plant (i.e., pipe-to-pipe), or into a raw water supply immediately upstream of a water treatment plant.

Environmental buffers: Environmental buffers are elements of planned indirect potable reuse projects that include assimilation/blending of the recycled water with the surface water or groundwater that is being augmented, natural attenuation that can occur as recycled water percolates through soil (for groundwater recharge) or *in situ*, and time for attenuation to occur as recycled water is stored (underground or in surface reservoirs) prior to use.

***Indirect potable reuse*:** Augmentation of a drinking water source of supply with recycled water in combination with one or more environmental buffers.

***Municipal wastewater*:** Used water treated at a municipal wastewater treatment facility, typically including domestic, commercial, and industrial wastewater and runoff.

***Nonpotable reuse*:** All water recycling applications that do not involve either indirect or direct potable reuse.

***Planned indirect potable reuse*:** The discharge of recycled water to a drinking water source of supply with the intended purpose of augmenting the potable supply.

Potable water: Water deemed safe for human consumption, food preparation, and drinking.

***Recycled water*:** Municipal wastewater that has been treated to meet specific water quality criteria with the intent of being used for beneficial purposes. Section 13050 (n) of the California Water Code defines recycled water as water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource [California Water Code, 2009].

***Unplanned indirect potable reuse*:** The discharge of treated municipal wastewater to a drinking water source of supply as a disposal method rather than as a purposeful means of augmenting a potable water supply.

***Water reclamation*:** The act of treating municipal wastewater to make it acceptable for beneficial reuse.

***Water recycling*:** The use of treated municipal wastewater (recycled water) for a beneficial purpose.

EXECUTIVE SUMMARY

Direct potable reuse is defined as the introduction of highly treated recycled water either directly into the potable water distribution system downstream of a water treatment plant (i.e., pipe-to-pipe), or into a raw water supply immediately upstream of a water treatment plant. This white paper addresses challenges related to public perception and acceptance of direct potable reuse in California, and identifies potential research areas and communication tools that will be necessary for direct potable reuse to gain wide public acceptance. It was developed based on 1) a review of prior studies regarding public opinion and strategies about potable reuse; 2) what we have already learned from successful and unsuccessful indirect potable reuse projects; 3) what we are beginning to learn about communicating with the public about constituents of emerging concern (CECs) such as pharmaceuticals, personal care products, and endocrine disrupting chemicals; and 4) recommendations from experts who have been on the "firing lines" of planning and implementing indirect potable reuse projects.

In examining the information reviewed, direct potable reuse projects are expected to face the same challenges faced by indirect potable reuse projects. However, in order to move forward, at least four challenges should be addressed prior to seeking public support for direct potable reuse.

- The water reuse community must itself support direct potable reuse. At the present time, support within the reuse community is not universal, which will confound efforts to seek public support.
- The water reuse community should develop a standard public involvement program for potable reuse that builds on lessons learned from indirect potable reuse projects, research regarding CEC risk communications, and current efforts to invest in simple, accurate, and easy to understand communications about water, including terminology and messages.
- The water reuse community needs to develop public outreach/participation tools to provide a complete picture of the water cycle, including the ubiquitous presence of CECs and their relative risk. This work would involve agreement among the water reuse community about recycled water as "new" versus "regenerated," incorporating the consensus into a framework of how water reuse fits into the water cycle, and to effectively communicate known and perceived risks.
- California will need to develop regulations for direct potable reuse before projects can move forward and be embraced by the public. Even if technology can be proven safe, technology in absence of controls can catalyze mistrust and fear.

Suggestions for research needed to advance direct potable reuse included these potential topic areas.

- Updated public opinion surveys to evaluate if changes in acceptance of recycled water for drinking and what measures would be effective in building confidence.
- Social research to better understand public perceptions of direct potable water reuse and the psychological factors governing decision-making particularly with regard to accepting or rejecting using recycled water for direct potable reuse.
- Develop key messages about the safety of using recycled water for direct potable reuse in the face of uncertainty.
- Develop and test outreach materials for the public and media for direct potable reuse.

INTRODUCTION

California is facing a water crisis that underscores the need to optimize all potential water resources in the state, including recycled water. The crisis is the result of the continued decline in the availability of fresh water resources for drinking and other uses as a result of growth/demand, droughts, water rights, restricted flows for habitat and wildlife protection, and climate change. Water recycling (i.e., the use of municipal wastewater that has been treated to meet specific water quality criteria with the intent of being used for beneficial purposes) for planned nonpotable and potable applications will play an integral role in helping to meet the state's water demands. To date, only indirect potable reuse projects have been approved by the California Department of Public Health (CDPH). These are managed aquifer recharge projects that supplement groundwater by introducing recycled water into groundwater by surface spreading or by creating saltwater intrusion barriers by direct injection. No existing planned indirect potable reuse projects in California involving surface water augmentation have been approved, although one project in the San Diego area is in the planning process. CDPH has developed draft groundwater recharge regulations for recycled water.

The question of the viability of direct potable reuse is being raised in California in response to the need for new water supplies in water-scarce areas. Direct potable reuse is defined as the introduction of highly treated recycled water either directly into the potable water distribution system downstream of a water treatment plant (i.e., pipe-to-pipe), or into a raw water supply immediately upstream of a water treatment plant. No direct potable reuse projects are currently operating in the United States. The only existing project in the world is in Windhoek, Namibia, which started in 1968 in response to the region's limited water availability. The Windhoek project provides 35 percent of the area's drinking water supply by adding highly treated recycled water directly into the water distribution network.

There is a new belief that the state of today's treatment technology makes implementation of direct potable reuse in California possible. It could provide greater flexibility to augment potable water supplies without the need for underground or environmental buffers. It could also result in significant environmental benefits, such as reduced discharge of wastewater to the ocean or surface waters, reduced extractions of water from underground aquifers and surface waters, and reduced energy use.

However, moving forward with direct potable reuse in California raises a number of issues and challenges including the following:

- Public perception;
- Public and/or community acceptance;
- Environmental justice issues (inequitable distribution of burdens to economically disadvantaged areas);
- Effectively conveying and portraying risk/benefit ratios to policymakers and their communities;
- Potential health risks;
- Technological capabilities (treatment, process reliability, disposal of treatment residuals, monitoring);
- Cost;
- Lack of established regulations or guidelines;
- Lack of resources to establish regulations; and
- Lack of a clear roadmap of when and how to develop direct potable reuse projects.

While these challenges are interrelated, this white paper addresses challenges related to public perception and acceptance of direct potable reuse. It also endeavors to identify research areas and potential

communication tools and practices that will be necessary for direct potable reuse to find wide public acceptance. A companion white paper is being prepared by the National Water Research Institute to address regulatory challenges.

WHERE DO WE START?

When contemplating how to address public perception and acceptance for direct potable reuse, where do we start? We know that over the past 40 years some work has been done with regard to public opinions about potable reuse and public relations strategies. We also know that some indirect potable reuse projects in California have faced major resistance by the public while others have not, resulting in a body of information on how to – and how not to – be successful. Also, constituents of emerging concern (CECs) in water and recycled water, such as pharmaceuticals, personal care products, and endocrine disrupting chemicals, have received heightened public and media scrutiny and appear to be a key issue regarding the public's concern about the safety of drinking water. Work has just begun on effectively communicating risks associated with CECs, even though we do not fully understand their health significance when detected in water. Perhaps the best place to start is with a review of what has already been looked at regarding public opinion and strategies about potable reuse, what we have already learned from indirect potable reuse projects, and what we are beginning to learn about communicating with the public about CECs.

PUBLIC OPINIONS ABOUT POTABLE REUSE

Public attitudes about water reuse are critical for the success of a program and vary depending on the water reuse application. Surveys conducted in the 1970's and 1980's regarding acceptance of various uses of recycled water indicated that the public was more willing to consent to direct contact with recycled water than drinking it (Bruvold, 1972; Bruvold, 1981; Lohman, 1987). Po et al. (2003) conducted a literature review of factors influencing perceptions of water reuse and identified many of the same topic issues noted by earlier researchers, including disgust or the "yuck" factor, how the water is to be reused, the source of the water, trust in the authorities and scientific knowledge, cost, and socio-demographic factors. One of the major conclusions of this 2003 review was that a standard framework has not been established to build successful and ethical public involvement programs for water reuse. This study also included a number of recommendations for social science research to better understand acceptance of the use of recycled water.

Rozin led a multiple-city survey in the U.S. sponsored by the WateReuse Foundation (Haddad et al., 2009) examining baseline attitudes toward indirect and direct potable reuse. They identified that opposition to potable reuse was connected to distrust of technology and of government more broadly, and that roughly a quarter of respondents were strongly opposed to potable reuse, but that their opinions could change based on new inputs of information. Opponents were more likely to be interested in the technological details of treatment, but less likely to be convinced of their ability to protect the water. Two types of messages were tested, one theme was "all water is recycled and potable reuse is no different," and the other theme was "treatment technology cleans up water effectively." Both message themes increased willingness to drink recycled water. More than half of respondents were open to considering potable reuse.

Wilson and Pfaff (2008) conducted a study using a survey and a focus group to determine if groups in the eThekwini Municipality (formerly City of Durban) South Africa had religious or philosophical objections to the potable reuse of wastewater and to identify "show stopping" objections likely to emerge out of

Durban's diverse communities if water reuse was pursued. The main findings of the survey were that 1) no fundamental religious objections to potable wastewater reuse either internationally or locally were identified; 2) people were willing to think creatively about sustainability; 3) key concerns in Durban were emotional (the "yuck" factor) and/or related to concerns about technical competency; and 4) initiatives would be prone to politicization around equity/justice issues. In general, the people surveyed were not comfortable with the idea of potable water recycling, but were willing to consider the option if provided with more information, understanding, and satisfactory quality assurance. The focus group results showed that concerns gravitated to inequitable and unjust water allocation patterns (which is believed to be a residual from apartheid) to those who least benefited from the current system. Most people expressed a willingness to reject potable water reuse on the grounds that other options were possible that had better equity implications, such as starting with larger users like industries and not households. While one might argue that this work is not universally applicable to potable reuse in the United States, some important concepts should be considered for implementation of a program here, particularly issues related to equity and environmental justice, concerns regarding potential failure of technology, and lack of trust in government.

Dishman et al. (1989) recommended a strategy for gaining support for direct potable reuse that used tools from applied behavioral analysis, which is a discipline of psychology that focuses on intervening in society to solve socially significant problems. The strategy consisted of four steps: 1) conducting an initial market analysis to determine the wants, needs, perceptions, attitudes, and habits of the target population, particularly their knowledge about water and attitudes about water reuse; 2) segmenting the target population into groups according to degree of acceptance of potable reuse; 3) developing and applying a behavior-altering method; and 4) evaluating the effectiveness of the intervention and documenting the results of the strategy. The marketing plan was intended to discuss the proposed potable reuse project with the local community in which it was to be located, preferably using neighborhood meetings (government, church, professional, etc.) and assessing reactions to the proposal (including experts). The segmenting step was intended to identify groups opposed to the project for targeting resources more efficiently (e.g., not "wasting" resources on people who are already willing to drink the reused water). Two methods were suggested for behavior alteration. The first was the antecedent method. The theory is that the viewer will change his behavior after viewing someone else performing the target behavior. The authors suggested using a video with people participating in all forms of water reuse. The second was the consequence method utilizing incentives/rewards. The authors suggested using prize drawings where the game would seek volunteers from the public to drink the recycled water, and periodically one of the volunteers be selected as the prize winner. Finally, the authors determined that it was important to gradually increase water reuse over time (what was called the "foot in the door" approach) and to change terminology when talking about potable reuse to remove stigma. In retrospect, it might be argued that this 20-year-old strategy may not be the approach one would use in today's climate, based on lessons learned from implementation of indirect potable reuse projects, particularly the effectiveness of the recommended behavior-altering methods.

Some researchers believe that the focus on public acceptance as the cause of failure for reuse projects is counterproductive as it does not address issues relating to institutional arrangements and reinforces a disconnection between expert and lay groups (Stenekes et al., 2006). They argue that institutional change is needed to build opportunities for constructive public engagement. The failure to implement sustainable water use through recycling results from present cost structures for water, institutional conservatism, administrative fragmentation, and inadequate involvement of communities in planning. Achieving sustainable water use through recycling may require better coordination between agencies and integrated government policies and laws. The issue of a unified federal statutory framework for all water (drinking water, wastewater, recycled water, graywater) is once again under discussion,[1] and may be an important

[1] Personal conversation with Alan E. Rimer, Ph.D., Water Reuse National Practice Leader, Black & Veatch

factor that needs to be in place before direct potable reuse can feasibly be implemented in the United States.

LESSONS LEARNED FROM INDIRECT POTABLE REUSE PROJECTS

Case Studies

Indirect potable reuse can often be negatively received by the public, leading to unsuccessful implementation. The WateReuse Foundation (WRF)[2] sponsored a study to examine how people perceive the value of indirect potable reuse, including groundwater recharge, and how the messages and management practices of the sponsoring utility affect those perceptions (Resource Trends, 2004). The study found that successful projects have a number of characteristics in common:

- They are designed to improve water quality;
- They augment groundwater supplies or prevent seawater intrusion versus being designed to dispose of wastewater;
- They maintain a historical water quality database and conduct research to support success;
- They are managed by agencies with established experience; and
- They are managed by agencies that have gained the confidence of regulatory authorities that issue permits.

A second phase of the WRF project developed a set of Internet-based tools to help utilities better understand public perceptions of indirect potable reuse.[3] This body of work identified 25 best practices, including those considered the most "critical":

- Create and communicate improvement in water quality resulting from the project
- Clearly articulate the problem you are trying to solve
- Evaluate alternatives to potable reuse (do not make it the only alternative)
- Understand and try to avoid or resolve environmental justice issues
- Establish the utility as the source of quality
- Rename the water
- Communication equals collaboration about value
- Practice good leadership
- Identify and collaborate with key audiences
- Embrace potential conflict and opposition
- Establish relationships with the media

The WRF project also analyzed specific case studies representing projects around the country, including three case studies of successful projects and three case studies where indirect potable reuse was not approved. Of the successful case studies conducted, the one California example was the Orange County Water District's (OCWD's) Groundwater Replenishment (GWR) System.[4] The GWR System provides up to 70 million gallons per day (mgd) of advanced treated recycled water for use in a seawater intrusion barrier and for groundwater replenishment by surface spreading, with plans to expand to 130 mgd. The recycled water advanced treatment consists of microfiltration, reverse osmosis, and advanced oxidation.

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regarding University of North Carolina's water reuse workshop, February 3-4, 2010, "Extending the Nation's Water Supply: Overcoming Barriers to Innovative Water Infrastructures," in Chapel Hill, N.C.

[2] In May 2010, the WRF will become the WateReuse Research Foundation.

[3] See http://www.watereuse.org/water-replenish/index.html.

[4] See http://www.gwrsystem.com/.

OCWD developed a comprehensive planning strategy and public outreach effort for the project. The notable findings from the WRF case study were:

1. OCWD articulated a clear set of problems to be solved:
    - Seawater intrusion in the aquifer
    - Beach closures
    - Improved water supply reliability for Orange County

2. OCWD established itself as a trusted source of quality:
    - Established a clear water quality ethic
    - Provided multi-barrier treatment including reverse osmosis
    - Established a track record with a prior project (Water Factory-21, which used advanced technology for a seawater intrusion barrier)
    - Rapidly responded to issues (such as potential contamination)
    - Tested and conducted research to develop an approach for CECs
    - Increased knowledge about water needs, quality, and technology
    - Related the treatment to familiar processes

3. OCWD was diligent with its communications by continuously seeking out and interacting with key audiences.

In light of the successful project characteristics, it is also important to be cognizant of the characteristics of indirect potable reuse projects (both groundwater recharge and surface water augmentation) that have been unsuccessful to avoid similar consequences. The key characteristics of unsuccessful projects were that they were:

- Unable to address concerns about water quality and health
- Unable to address concerns about commercial product image[5]
- Perceived to facilitate growth by providing a mechanism for wastewater disposal
- Created a political rallying point
- Raised concerns regarding environmental justice (one part of the community was receiving the water and another was not)
- Provided insufficient public input/outreach – not enough, not started soon enough, and/or not implemented continuously
- Costly

For some of these unsuccessful projects, the true underlying issue was not raised by opponents (such as growth), but another issue was primarily used as the means to rally public and political opposition (such as health concerns regarding recycled water).

A common thread of successful indirect potable reuse projects is an emphasis on the opportunities and benefits of developing a new water supply source. These benefits include providing additional water supplies to meet existing and projected demands, reducing reliance on imported water supplies, and enhancing water supply reliability. This concept applies to potable reuse projects, and needs to be clearly thought out and articulated. Direct potable reuse could be a potentially viable option for meeting demand and therefore the economic, energy and environmental implications that apply to all potential sources in a utility's water supply portfolio should be considered.

[5] For example, one of the primary motivating factors in the Miller Brewing Company opposing the original San Gabriel Valley Groundwater Recharge Project were fears about rumors being spread about urine in beer.

The Water Environment Research Foundation (WERF) sponsored an interdisciplinary and integrative social science study on public perception and participation on water reuse within the United States (Hartley, 2006). It included case studies, white papers from five different social science disciplines and public health and environmental engineering scientists, and a multi-stakeholder workshop. The case studies included examples of potable and nonpotable reuse, with elements of success and failure. The study identified five themes that were critical to building and maintaining public confidence in water resource management and water reuse decision-making:

- Managing information for all stakeholders
- Maintaining individual motivation and demonstrating organizational commitment
- Promoting communication and public dialog
- Ensuring a fair and sound decision-making process and outcome
- Building and maintaining trust

Millan (2007) advocates that understanding fears and perceptions about recycled water use has allowed the reuse community to better communicate and be responsive when implementing new projects and new uses. Perceptions that need to be considered include the following:

- People do not automatically trust the scientific premise that recycled water is safe
- Inherent distrust of government and scientists exists on every level of society
- Because of this, the "yuck" factor of wastewater is not easily overcome
- Yet, most people view recycled water use as an environmentally responsible thing to do
- No consistent, nationwide messaging regarding the use of recycled water currently exists, and thus perception from communities across the country varies greatly
- The Internet contains a considerable amount of misinformation about water reuse that is readily available, can be taken out of context (and used), and can create fear and misunderstanding of the science related to water reuse

Public Outreach/Participation Tools for Potable Reuse

The difference between "outreach" and "participation" (Metcalf & Eddy, 2007) is important to acknowledge. Outreach is a way of disseminating or collecting information to educate the public; participation implies a means for stakeholders to actively engage in and influence a plan. Techniques that can be used for outreach and participation, include the following (Metcalf& Eddy, 2007; Millan, 2007, Hartley, 2006; Khanand Gerrard, 2006):

- One-on-one communications
- Community relationship management
- Databases
- In-depth interviews
- Surveys
- Open house meetings
- Workshops
- Advisory committees/task forces
- Email broadcasts
- Blogging
- Social networking
- Consistent proactive notifications
- Call centers
- Project portals

One of the key changes in effective communication tools that needs to be taken into consideration is the use of the Internet, blogging, free social networking, such as Twitter, and microblogging services that enable their users to instantly send and read messages and information.

WRF is sponsoring a number of studies that will provide critical information for future public outreach efforts.

The first is WRF 07-03 "Talking about Water – Vocabulary and Images that Support Informed Decisions about Water Recycling and Desalination." Appropriate terminology and images are key themes that resonate with much of the research findings from public opinion and indirect potable reuse studies (and also CEC communication studies – see next section of the white paper). This project is assessing the influence of words, images and concepts on the public perception of recycled water. The research will also identify the community's preferred terminology to enable them to understand the different qualities of water available for recycling and feel confident about water recycling. It will also determine if improved knowledge and understanding of the water cycle, water science and technology improves acceptance. An outcome of the research will be a glossary (with simple explanations) of preferred terms associated with the different parts of the urban water reuse cycle. This work will be completed in 2010. Some preliminary information from the project highlights the importance of this work for direct potable reuse (see Attachment 1).

The second project is WRF 09-01 "The Effect of Prior Knowledge of 'Unplanned' Potable Reuse on the Acceptance of 'Planned' Potable Reuse." Often communities considering the use of recycled water for indirect potable reuse are unaware of other common water reuse occurrences such as unplanned or incidental reuse that may enhance their familiarity with water reuse. This project, which will be completed in 2012, aims to determine if communities considering the use of recycled water for indirect potable reuse would be more accepting of water reuse if they had prior knowledge and understanding of 'unplanned' water reuse via discharges of treated wastewater into water supply sources.

LESSONS LEARNED FROM RESEARCH REGARDING EFFECTIVE COMMUNICATIONS ABOUT CONSTITUENTS OF EMERGING CONCERN

Certainly an issue that will be of concern for any direct potable reuse project is the presence of CECs in recycled water, both the known chemicals and the "unknowns," those chemicals that have not yet been detected, but might be present. In the past decade, numerous studies have been conducted to characterize the occurrence and concentrations of CECs in surface waters, wastewater, and recycled water, often accompanied by heightened media attention. The mere presence of these compounds has raised public concern and spurred research efforts to evaluate the magnitude of this potential health problem. While some information is becoming available with regard to guidelines and safe screening thresholds (Bruce et al., 2010; Environment Protection and Heritage Council et al., 2008; Snyder et al., 2008; Schwab et al., 2005), the absolute answers are still under investigation. People are concerned about the safety and quality of their drinking water, the ecological health of streams and rivers, and the degradation of groundwater quality. Media coverage can be alarming, increasing public concern, particularly when the public is not presented with enough background or context about water quality. Water and wastewater utilities are often uncertain how to communicate with the public on this particular issue, how to identify and alleviate unnecessary fears, how to clear up misconceptions, and how to build public confidence in water quality. As previously noted, this communication is constrained by uncertainty based on the limited scientific understanding of the human health effects of these compounds. Uncertainty about health effects information makes generalized reassuring statements about safety open to debate. Additional information on acknowledging and dealing with uncertainty is presented in Attachment 2.

WERF sponsored a research project that synthesized the state-of-knowledge regarding effective risk communications, public perception, and message effectiveness related to CECs (Hawley et al., 2008). This study 1) conducted a focused literature review of communication materials published in the environmental industry; 2) reviewed documents describing risk communication practices in other industries (nuclear energy, chemical manufacturing and the pharmaceutical industry), which culminated in several "lessons learned" that are relevant to CECs; 3) coded and analyzed approximately 25 media articles pertaining to CECs with a focus on vocabulary and imagery, key messages, and the articles' likely impact on the public; and 4) conducted interviews with water and wastewater utility representatives to better understand their existing communication and outreach programs, interaction with the public and media and perspectives on communications needs.

The results of the literature review showed that research conducted related to social psychology and risk perception can provide a helpful context for better understanding and anticipating people's mindsets, decisions, and reactions to messages. Decisions are often based on affective or emotional response, which in turn can be based on past experiences or fears. Trust is critical in conducting smooth communications. Terminology and imagery are critical in communications. People's opinions and ideas about contamination, water resources, and other environmental issues are amplified and directed by media coverage, and information provided to the media needs to be prepared in formats that are accessible to the media with more detailed information available in other formats (such as web pages). Utilities need to prepare communications plans on how to respond to the media and public that involve all staffing levels so that the messages disseminated are uniform and precise. A key finding was that there is no uniformity of key messages for communicating with the public regarding CECs nor is there a consensus on what the key messages should be, particularly when communicating in the face of uncertainty. This area was cited as a specific research need.

A study currently under way, WRF 09-07 "Risk Assessment Study of PPCPs in Recycled Water to Support Public Acceptance," may help provide additional information on CECs. The objective of this research is to provide quantitative human health risk assessment results for CECs in recycled water for a representative set of non-potable use cases and then develop a message delivery effort to present the results to the general public. The research team is utilizing key findings of current landmark projects on toxicological relevance of CECs and applying that information with quantified exposures of typical non-potable recycled water applications to assess risks specifically associated with CECs in recycled water. The message delivery effort will make the results of the risk assessment easily understandable and meaningful to utility management, project stakeholders and the general public by using language and graphical references that the general public can comprehend more easily than scientific jargon and jargon of the reuse industry. Upon its completion this project will enable water reuse agencies and municipalities to better respond to public opposition to recycled water projects due to perceived health risks.

Other industries (nuclear power, chemical manufacturing and pharmaceuticals production) have faced serious public opposition and communication challenges. The WERF study identified six lessons learned from the experiences of these industries:

- Pay attention to risk communication. Organizations that do not conduct risk communication allow their reputations to be defined by others. Information gaps will be filled with peoples' worst fears. Communication in the face of uncertainty is therefore particularly important.
- Build trust. Trust can be built by emphasizing transparency, honesty, personal control, and community participation/oversight. Trust is particularly important when communicating about accidents and other uncertain topics.
- Poll perceptions before designing a public relations campaign and during the campaign. This practice can save money, identify and focus the campaign on key messages, and gauge or predict the campaign's effectiveness.

- Emphasize benefits. Although risk and benefit are typically positively correlated in society, people tend to classify risks and benefits as being negatively correlated (Slovic, 1999). This perceived inverse relationship is attributed to people's affective evaluations when making risk and benefit judgments. That is, if people have an overall unfavorable reaction to a technology or activity, they will rate it as low-benefit and high-risk. If they have a favorable reaction, they will rate it as high-benefit and low-risk (Slovic, 1999). Emphasizing benefits and value, thereby increasing positive associations with a technology or activity, will result in a lower perceived risk. In the face of uncertainty, lower perceived risk will not be as alarming.
- Adopt inclusive decision-making processes**.** People prefer having some decision-making power when a technology or activity involves risk, particularly when risks are not fully understood.
- Recognize the role and implications of stigma**.** The concept of stigma may be useful in understanding social opposition to things that are perceived to be dread or dangerous (Haddad, 2004). Kunreuther and Slovic (2001) describe six strategies for dealing with stigma, which can be used to address risk communication on CECs and other environmental issues in the face of uncertainty.

The review of the selected set of news articles by the WERF study indicated that overall the press portrayed detection of CECs as an emerging problem. The researchers concluded that the articles:

- Point to findings of gender-related changes in fish that create an unsettling feeling and send a signal of potential serious consequences to humans.
- Indicate that regulatory agencies are not doing an adequate job.
- Indicate that CECs are uncontrollable, create involuntary exposure with dread consequences, and are poorly regulated by authorities.
- Made few attempts to educate the public about broader issues related to water or to inform the public about modern water treatment techniques to make water reuse safe and beneficial.

The five recommendations for utilities stemming from the WERF research were:

- Talk with stakeholders to develop a perspective of their values, interests, concerns, and priorities; their understanding of CECs and other water quality issues; their attitudes towards the utility; trusted information sources; suggestions for addressing their concerns; and other topics. This information can be used to fill gaps in information or perception and can fuel changes in key messages, programs and practices.
- Understand the media's needs and tailor communications accordingly.
- Collaborate with other organizations, including university or health professionals, to increase trust and support.
- Involve staff in the communication process to create uniformity in message development and dissemination.
- Define the utility's communication vision on CECs by having a communication plan that includes development of key messages, partnerships, program changes, and other communication plan elements.

Christian Daughton, a scientist with the U.S. Environmental Protection Agency (U.S. EPA), who has conducted numerous studies on CECs, published an article on communication challenges for use of recycled water for groundwater recharge (Daughton, 2004). Some of the key views he presents include the following, which have noteworthy implications for direct potable reuse:

- Regardless of how safe recycled water can (and proven to) be made, all that matters is whether the public will embrace it. In communicating risk, perception is reality. When technology

advances faster than society can formulate mental pictures for its acceptance (or guidance or regulatory frameworks for its control), the public can reject the technology, regardless of its purported or proven advantages. Daughton uses the example of genetically engineered organisms and how these advancements rapidly evolved before guidance and controls acceptable to the public could be formulated, and that even food-poor countries shunned the opportunity to use this type of food. He states that technology in the absence of controls can catalyze mistrust and fear.

- Regardless of how sound the science may be, its influence on the perception of risk may be minimal. The public is capable of disengaging its concern for issues that are measured as representing real and significant hazards (such as driving automobiles, cigarette smoking, poor nutrition, not exercising). All that matters in the final analysis is how the product is valued by the buyer (not the seller), which is a testament to the power of perceived value and the sometimes inferior influence of demonstrated, objective data (the sound science approach).
- Psychologists and social scientists who are risk communication professionals need to serve as translators across the interface between science and the public.
- The public's incomplete picture of the water cycle is a source of confusion. Daughton believes that the public's level of psychological discomfort regarding the types of use for which recycled water can be employed is undoubtedly related to the hydrologic distance between the water's origin as waste and its use for personal activities (especially drinking), as well as to the number of natural or artificial barriers (processes that remove contaminants) existing along the way. He states that public rejection of the direct (purposeful) recycling of sewage, especially for drinking water, sometimes derives from incorrect understandings of basic science. For example, public rejection sometimes stems from the perception (and misconception) that the actual water molecule is somehow tainted by its origin from waste - that water molecules can somehow carry a memory of their history, which results from inaccurate communication of science. When scientists speak of contaminated water, they do not actually mean that the molecules themselves have been physically altered. What they actually mean by contaminated water is that it harbors molecules of other (non-water) types of substances from the universe of chemicals. Once these intermingled contaminants are removed, the remaining bulk water is compositionally identical to the original pristine water. There are absolutely no lasting or even ephemeral effects from prior contact with the contaminants. Water cannot retain some sort of memory of its past. He further notes that statements often made such as "Water is a finite resource," or "There is no such thing as 'new' water," perpetuates two common public misconceptions. First, the amount of water on earth is an absolute constant, and second, water is immutable, i.e., new water cannot be created. These two seemingly trivial misstatements may lie at the root of the public's view that water can be tainted or stained by its past, and they therefore could have profound ramifications regarding the public's acceptance of water reuse because the consumer can only conclude that all water is old and clearly holds the potential for harboring stigma. He recommends engendering a philosophy whereby water is viewed as self-regenerating, readily capable of losing any perceived taint or imprint from prior association with dirty processes. With the help of advanced technologies for removal of contaminants, the ability of water to regenerate could be viewed as revitalization or re-juvenation, thereby facilitating its healthy reuse. Moreover, the public responds favorably to the idea of natural purification of water as opposed to artificial cleansing processes.
- Efforts to improve public communication might also benefit from a new lexicon, one that greatly simplifies and clarifies the existing proliferation of terms (often loosely used with different meanings) for describing the treatment of municipal wastewater, which only adds to public confusion (wastewater that has been reclaimed, reused, recycled, or repurified, and then further obfuscated with modifiers such as unplanned versus planned, indirect versus direct, or potable versus nonpotable). The combinations and permutations can be mind-numbing to the public. He suggests alternatives such as regeneration, renewal, revival, rejuvenation, or revitalization. These

terms could convey the fact that water is not simply being reused (with its obvious connotation of being old), but that it has also been subjected to a process that returns it to its natural state, making it suitable and safe for drinking.

- As analytical capabilities improve (our ability to detect new contaminants and more sensitive analytical limits), we might approach that hypothetical point where any chemical can be detected anywhere. He recommends that by routinely demonstrating the omnipresence of a plethora of chemicals in all waters, regardless of source, perhaps the public could gain a better appreciation that the occurrence of trace chemicals in water supplies is a ubiquitous phenomenon and one that can never be avoided or eliminated. Eventually, perhaps success could be achieved in the public's acceptance that these chemicals will forever constitute an inescapable background in our everyday lives.
- Resistance to reuse of sewage for drinking water emanates in large part from the emotional level and could be largely reduced, if not eliminated, if the sewage was reused on-site, as this approach would avoid one of the largest elements of the unknown; namely, contamination from other people's sewage. Driven by self-interest, on-site reuse would also encourage individuals to modify their behaviors and actions to partly control the quality of their own sewage.

WHAT DO THE EXPERTS SAY ABOUT MOVING FORWARD WITH DIRECT POTABLE REUSE?

To help gain insight on how to move forward with direct potable reuse, we contacted a number of experts who have been on the "firing lines" of planning and implementation of indirect potable reuse projects to provide input on 1) what these experts considered to be the four to five most significant public/political acceptance challenges/issues that would have to be addressed by a utility wanting to plan/implement a direct potable reuse project; and 2) their suggestions/ideas for the types of research that would have to be undertaken to support implementation of direct potable reuse. The results were interesting. First, some experts were not optimistic that direct potable reuse is feasible in California. Second, there were areas where experts were in general agreement and some areas where they were not. Two of the experts, Linda Macpherson with CH2M HILL and Paul Slovic with Decision Research, provided a thoughtful technical memorandum, which is provided in Attachment 1 that presents what they consider to be the four key challenges. A summary of input from all of the experts contacted is provided below in terms of 1) obstacles, 2) approaches, 3) areas where experts may disagree, and 4) suggested research.

Obstacles

- The experts noted that there is disagreement in the water reuse community about pursing direct potable reuse. Some of this is based on 1) skepticism that it is a viable option, 2) concerns about potential negative backlashes on ongoing indirect potable reuse projects, 3) concern that this effort will direct needed funds away from nonpotable reuse projects, and 4) a belief that it's not safe to directly drink recycled water. The overriding concern is that if there is divisiveness in the water reuse community, how can we even begin to move forward with attempting to gain public acceptance?
- California still requires signage for "purple pipe" nonpotable reuse systems stating that the water is not safe to drink. Thus, the public may have an ingrained concept that recycled water is not a good source of drinking water, which will make outreach and gaining public acceptance very difficult even with advanced technology and blending.
- Some public outreach experts believe they are still battling the 1998 National Research Council's "indirect potable reuse is an option of last resort" comment (NRC, 1998). It should be noted that

even though many consider this statement to have been taken out of context[6] by the media and others from the executive summary of the report (Crook et al., 1999), it still resonates in the public when talking about potable reuse. The National Research Council is currently conducting a study that is evaluating the role of recycled water in addressing future water demands, including an updated review of nonpotable and potable reuse. The report will be available in 2011.

- There are disagreements in the scientific community about the safety of recycled water used for indirect potable reuse, such as CECs or discharges from industries, such as biotechnology companies.
- For some communities, outreach has not been able to convince people that safeguards are in place for potable reuse projects. People still ask "What if something goes wrong?" and "What if there's something bad in the water we don't know now but find out about in ten years?" This fear may be exacerbated by distrust or skepticism about the effectiveness of government agencies that would be operating and monitoring potable reuse systems.
- Another key issue is how we can assure the public that any treatment failure would be detected immediately and unsafe water never reach consumers? Everyone knows that accidents happen and failures occur. This issue becomes even more pronounced if you add in distrust of the governmental agencies operating the treatment systems (see the previous bullet). What happens when the system fails?

Approaches

- The experts suggested the approaches that have been used for indirect potable reuse should be/may be the same as those used for direct potable reuse, building off of the lessons learned. Some experts were more certain than others on the direct applicability of the value of those approaches. Some of the important tactics suggested included the following:
    - The need to invest in water resources. Even though concerns may center on public health and water quality, the context for the dialog should focus on the need for developing water supplies.
    - People associate water quality with its physical source and history. The history of recycled water is yucky. This means that a successful potable reuse proposal needs to establish the utility as the "source of quality." This perception is achieved by building a strong water quality brand, in part by employing multi-step purification processes and a comprehensive, diligent, and conservative testing program. Thus, the focus should be on technology, not the source.
    - The sponsoring utility should be a water utility, not a wastewater utility or sanitation agency.
    - Behaviors that undermine trust in the utility's staff make it more difficult to establish the source of quality brand. These behaviors include being unclear about the need for water resources and viable alternatives, being overly technical in communications, or being defensive when responding to those who have concerns about potable reuse.
    - Every element of the outreach process should be planned while recognizing that decisions are made by elected or appointed policy makers. They will do the right thing if they have sound information and know that community leaders are behind them. Therefore, utility communication efforts should have a single objective. The goal should be to build relationships with community leaders, those that policy makers look to for support, or those that they look to for gauging public opinion.

[6] After this general conclusion, the report states that indirect potable reuse should only be adopted after other measures have been evaluated and rejected as technically or economically infeasible.

    - Strong advocates often start out as opponents, but change their mind because the utility's staff takes the time to understand their concerns and pursue a relationship. The best way to create opponents is to hold a public meeting with no intention of listening or taking people's concerns seriously.
    - Conduct tours of facilities.
    - Establish a program so that your politicians sign up to support the project and publicize the list. This effort often turns into a self-evolving process when one politician sees that another has signed on to support a project.
    - Aggressively seek awards for your project from quality organizations.
    - Use the philosophies of Peter Sandman (http://www.psandman.com/) to guide your outreach/participation efforts.
- The water reuse community must invest in simple, accurate, and easy to understand communications about water prior to a discussion about potable reuse.
- Saying that a technology works in one area does not always convince another area that it will work there (even within the United States). In particular, do not apply what has been done at Windhoek, Namibia (direct potable reuse) or Singapore Public Utilities Board (indirect potable reuse via surface water augmentation). These countries are in a different political, cultural and environmental setting and following their lead may not have credibility or viability in the United States.
- Do not "trash" the current water supply to achieve your project goals.
- For direct potable reuse to be successful overall it should be done by agencies that are qualified to pull it off – we don't need failures.
- Direct potable reuse should be limited to areas where it is truly needed (states like California), and not created as a universal application.
- Use a credible movie star (like Morgan Freeman or Matt Damon) to make a short film about water, its importance, and where it comes from, and unplanned versus planned reuse. People really do not know where their water comes from and if they understood that in many places they were drinking water mixed with wastewater that does not undergo much treatment versus direct potable reuse that would undergo extensive technological treatment, it would really open minds to why this is an option.[7]
- Get the advanced treated recycled water in people's hands. One suggestion was to allow bottling of the advanced recycled water; however in California, this approach requires obtaining legislative authorization.
- Develop a white paper on the health and safety of advanced treated recycled water and get a large number of health experts to sign it.
- The idea of storing the water, testing, and then distributing the water for direct potable reuse may be an important approach to help with public acceptance, since on-line testing may not come into fruition for quite some time.
- NEVER stop your outreach efforts even if the project is successfully under way.

Areas Of Possible Disagreement

- Some of the experts deliberately use the term "development of new" water to describe potable reuse, while others believe this is furthering a misconception about the water cycle (e.g., there is no new water), and instead we should be describing potable water reuse as a self-generating process.

[7] The Rozin survey (Haddad et al., 2009) suggested that people wouldn't trust a star's opinion about potable water reuse.

- The importance of environmental buffers. Direct potable reuse projects will only utilize blending as a buffer in contrast to indirect potable reuse projects that may use attenuation, dilution, and retention time as buffers. Some experts believe the lack of a full suite of environmental buffers will be a significant challenge since the buffer-concept relates to natural treatment, which has been shown to be a confidence builder. This issue may be aided by real-time monitoring or controls to document safety. However, other experts believe environmental buffers are detrimental. They argue that these buffers make the almost pure recycled water dirtier. Some contend that the insistence on an environmental barrier gives the negative message that there must be something wrong with the water so that the product water needs blending. For indirect potable reuse projects, the use of the word "diluted" is misleading because it is used to indicate that the purer water is "diluted" by water of a lesser quality in groundwater or reservoir.
- Social science research. Some experts believe it is worthwhile for furthering communications; others think it is a waste of time and project proponents just need to get out and talk to people.

Suggested Research

- The only research topic explicitly recommended was to update public opinion surveys to see if there has been a change in acceptance of recycled water for drinking and what measures would be effective in building confidence when there is a very short time between water purification and the tap. However, many of the experts have participated in the WRF and WERF research projects previously discussed in the white paper, all of which have suggested research needs that have been identified.

WHAT DO WE DO NEXT?

In examining the information we reviewed, there were a number of philosophies, ideas, and suggestions that seemed to rise to the top in terms of addressing what our next steps might be for moving forward.

- The water reuse community itself must support direct potable reuse prior to seeking public support. Internal education efforts may be needed to achieve this.
- The water reuse community needs to develop a standard framework to build successful and ethical public involvement programs for direct potable reuse. The framework should use and build on lessons learned and outreach/public participation tools from successful and unsuccessful indirect potable reuse projects and research that has been conducted for communicating about CECs in water.
- California will need to develop regulations for direct potable reuse before projects can move forward. Even if a technology can be proven safe, technology in absence of controls can catalyze mistrust and fear. For the public to embrace direct potable reuse, we will need regulations.
- The water reuse community must expand upon its current efforts and continue to invest in simple, accurate, and easy to understand communications about water prior to a discussion about potable reuse, including terminology and messages.
- Public outreach/participation tools need to be developed/used to provide a complete picture of the water cycle and the ubiquitous presence of CECs and their relative risk. This work would involve agreement among the water reuse community about recycled water as "new" versus "regenerated," incorporating the consensus into a framework of how water reuse fits into the water cycle, and to effectively communicate known and perceived risks.
- Individual agencies must develop outreach and communications plans that involve all staffing levels so that the information presented is uniform and precise.

- The water reuse community could consider developing guiding principles for direct potable reuse projects drawing on the experience of successful indirect potable reuse projects in gaining public acceptance. A similar approach was used by the California Water Desalination Task Force in recommending 10 guiding principles for designing, evaluating and developing environmentally and economically acceptable desalination projects (California State University, 2008).
- It may be necessary to have a unified federal statutory framework for all water (drinking water, wastewater, recycled water, graywater) in place before direct potable reuse can feasibly be implemented in the United States.
- It will be important to ensure that utilities participating in direct potable reuse projects are capable of providing information to the media in formats that are amenable for use by the media. People's opinions and ideas about contamination, water resources, and other environmental issues are amplified and directed by media coverage, and utilities need to be in control of information dissemination content and utility.
- Project sponsors of direct potable reuse projects need to emphasize the benefits and value of a project in comparison to other water resource alternatives, thereby increasing positive associations with a technology or activity. This approach will result in a lower perceived risk for direct potable reuse projects.
- WaterReuse California should consider sponsoring legislation that allows for advanced treated recycled water to be bottled and provided to the public as part of public outreach/participation programs.
- The water reuse community should sponsor the development of a white paper on the health and safety of advanced treated recycled water that can be reviewed by health experts (and hopefully endorsed by them).

SUGGESTED RESEARCH AREAS

A goal of the white paper is to identify areas where further work or dedicated research is needed to advance direct potable reuse. Based on the information reviewed and input from experts, listed below are some potential topic areas.

- Update public opinion surveys to evaluate changes in acceptance of recycled water for drinking and what measures would be effective in building confidence when time between water purification and the tap is very short.
- Undertake social research to better understand public perceptions of direct potable water reuse and the psychological factors governing decision-making particularly with regard to accepting or rejecting using recycled water for direct potable reuse, examination of people's sensitivity with regard to the disgust emotion or "yuck" factor, understanding why uses of recycled water can influence people's decisions to accept recycled water; identification and development of strategies for dealing with possible environmental justice issues that can affect willingness to use recycled water.
- Social research directed at behavior. One specific recommendation was to examine the effectiveness of using Ajzen's model of Planned Behavior in understanding factors that influence people's willingness to use recycled water for direct potable reuse (Po et al., 2003). This model was developed from Fishbein and Ajzen's Theory of Reasoned Action, which postulates that if people evaluated the suggested behavior as positive (attitude), and if they think their significant others wanted them to perform the behavior (subjective norm), this results in a higher intention (motivation) and they are more likely to do so. A high correlation of attitudes and subjective norms to behavioral intention, and subsequently to behavior, has been confirmed in many studies (Sheppard et al., 1988). Some behavioral intention cannot be the exclusive determinant of behavior where an individual's control over the behavior is incomplete. Thus, Ajzen introduced the Theory of Planned Behavior by adding a

new component, "perceived behavioral control." By this, he extended the Theory of Reasoned Action to cover volitional behaviors for predicting behavioral intention and actual behavior.

- Development of key messages about the safety of using recycled water for direct potable reuse to be used for communicating in the face of uncertainty. These messages should be based on public understanding and respond to specific issues related to direct potable reuse. This would build on research recommended by Hawley (2008) for trace organics, where effective communication methods for describing detection and concentrations, potential human health concerns, and the effect of different partial solutions (e.g., advanced treatment, pharmaceutical take-back programs) on the public's perception of risk. This work could also address messages for the "what if" types of questions (e.g., what if the treatment system fails, what if a compound is in the water that we later find to be dangerous, etc.).
- Breaking the "toilet-to-tap" chain. Haddad (2004) and Haddad et al. (2009) have recommended a research project that would look for ways to break, modify, or minimize the importance of the perceived use-chain of water from indirect potable reuse. The study would involve a survey that allows individuals to evaluate physical design options for (in this case) direct potable reuse projects in terms of their ability to frame out links with prior urban use. Other approaches, such as explanations of existing process designs, would also be tested. The study would also seek to clarify causes for the stigmatization of indirect potable reuse water by sorting out the roles played by health concerns and the "yuck factor," and how to deal with them.
- Understanding the core opposition to indirect potable reuse. Haddad (2004) recommended conducting a study that would develop a mental model of the most active public opponents to indirect potable reuse, who would be identified and interviewed on a voluntary basis. The purpose of the research is to broadly understand the attitudes and perceptions of active opponents to indirect potable reuse, as well as how they connect with their less-engaged but sympathetic supporters and the public at large, in order to develop alternative project designs or communication approaches that would satisfy their concerns.
- Develop templates or sample media and public outreach materials for direct potable reuse, such as press releases, brochures, a "how-to" guide for working with and responding to the media, an in-house training guide for technical staff, a summary of key articles and ongoing research, and a brief (five-minute) video about direct potable reuse. Such tools would require testing to ensure that they were beneficial for utilities and the public.

REFERENCES

Bruce, G. M., Pleus, R. C., Peterson, M. K., Nellor, M. H., Soller, J. (2010) (in press), *Development and Application of Tools to Assess and Understand the Relative Risks of Drugs and Other Chemicals in Indirect Potable Reuse Water Final Project Report.* WateReuse Foundation, Alexandria, VA.

Bruvold, W.H. (1972) *Public Attitude toward Reuse of Reclaimed Water*, Contribution No. 137, University of California Water Resources Center, Los Angeles, CA.

Bruvold, W.H. (1987) Public evaluation of salient water reuse options. *Proceedings of Water Reuse Symposium IV*, 1019-1028, Water Research Foundation, Denver, CO.

Crook, J., MacDonald, J.A., and Trussell, R.R. (1999) Potable use of reclaimed water. J. AWWA **91**: 40-49.

California State University. (2008) *California Desalination Planning Handbook*. Prepared for the California Department of Water Resources. CSU Center for Collaborative Policy, Sacramento, CA, February 2008.

Daughton C.G. (2004) Groundwater recharge and chemical contaminants: challenges in communicating the connections and collisions of two disparate worlds. *Ground Water Monitoring & Remediation*, **24**:127-138; available at: http://www.epa.gov/nerlesd1/bios/daughton/water-reuse.pdf.

Dishman, M.C., Sherrard, J.H., and Rebhun, M. (1989) Gaining support for direct potable water reuse. *J. Profl. Issues in Engrg. Educ. and Pract.* **115**: April 1989.

Environment Protection and Heritage Council, the National Health and Medical Research Council and the Natural Resource Management Ministerial Council, (2008) *Australian Guidelines for Water Recycling Augmentation of Drinking Water Supplies*, March.

Haddad, B.M. (2004). *Assessment Workshop:Human Reactions to Water Reuse*, WateReuse Foundation, Alexandria, VA.

Haddad, B., Rozin, P, Nemeroff, C., and Slovic, P. (2009) *The Psychology of Water Reclamation and Reuse: Survey Findings and Research Roadmap.* WateReuse Foundation, Alexandria, VA.

Hartley, T.W. (2006) Public perception and participation in water reuse. *Desalination*. **187**: 115-126.

Hawley, E.L., Means, E.G., Deeb, R.A., Macpherson, L., Slovic, P., and Samson, J. (2008) *Communication Principles and Practices, Public Perception, and Message Effectiveness*. Water Environment Research Foundation, Alexandria, VA.

Khan, S.J. and Gerrard, L.E. (2006) Stakeholder communications for successful water reuse operations. *Desalination* **187:** 191-202.

Kunreuther, H. and Slovic, P. (2000) Coping with stigma: Challenges and opportunities. Reprinted as Chapter 21 in Flynn, J. Slovic, P. and Kunreuther, H. (Eds.) "Risk, Media and Stigma," Earthscan Publications Ltd, London, UK.

Lohman, L.C. (1987) Potable wastewater reuse can win public support. *Proceedings of Water Reuse Symposium IV*, 1029-1044, Water Research Foundation, Denver, CO.

Metcalf & Eddy. (2007) *Water Reuse Issues, Technologies, and Applications.* New York, NY: McGraw Hill.

Millan, M. (2007) Can what we don't know hurt us? Public acceptance: what's working, what isn't? WRA California Section Annual Conference Proceedings, Palm Springs, CA March 4-6, 2007.

NRC. (1998) *Issues in Potable Reuse: the Viability of Augmenting Drinking Water Supplies with Reclaimed Water.* National Academy Press, Washington, D.C.

Po, M., Kaercher, J.D., and Nancarrow, B.E. (2003). *Literature Review of Factors Influencing Public Perceptions of Water Reuse.* CSIRO Land and Water Technical Report 54/03, December 2003.

Schwab, B.W., Hayes, E.P., Fiori, J.M., Mastrocco, F.J., Roden, N.M., Cragin, D., Meyerhoff, R.D.,

D'Aco, V.J., and Anderson, P.D. (2005) "Human pharmaceuticals in U.S. surface waters: a human health risk assessment, *Regul. Toxicol. Pharmacol.* **42:** 296.

Sheppard, B.H., Hartwick, J., and Warshaw, P.R. (1988) The theory of reasoned action: a meta-analysis of past research with recommendations for modifications and future research. *J. Consumer Research*. **15**: 325.

Slovic, P. (1999) Trust, emotion, sex, politics and science: Surveying the risk-assessment battlefield. *Risk Analysis*, **19**(4): 689-701.

Snyder, S.A., Trenholm, R.A., Snyder, E.M., Bruce, G.M., Bennett, E., Pleus, R. C., and Hemming, J.D.C. (2008) *Toxicological Relevance of EDCs and Pharmaceuticals in Drinking Water.* Water Research Foundation, Denver Colorado.

Stenekes, N., Colebatch, H.K., Waite, T.D., and Ashbolt, N. J. (2006) Risk and governance in water recycling. *Science, Technology & Human Values.* **31:**107-134.

Resource Trends Inc. (2004) *Best Practices for Developing Indirect Potable Reuse Projects: Phase I Report*. WRF-0104. WateReuse Foundation, Alexandria, VA.

Wilson, Z. and Pfaff, B. (2008). Religious, philosophical and environmentalist perspectives on potable wastewater reuse in Durban, South Africa. Desalination, 228: 1-9.

ATTACHMENT 1 – MEMORANDUM – PUBLIC AND POLITICAL ACCEPTANCE CHALLENGES TO "DIRECT POTABLE REUSE"

TO: Margie Nellor/Nellor Environmental
Mark Millan/Data Instincts

FROM: Linda Macpherson/CH2M HILL and Paul Slovic/Decision Research

DATE: February 23, 2010

You have asked us to suggest 4 to 5 challenges to the public and political acceptance of 'direct potable reuse' (DPR). We have provided the following analysis of the issue and hope that it is helpful. Our analysis can be attached to your White Paper.

1. The Water Industry Itself Must Support Direct Potable Reuse Prior to Seeking Public Support

The wastewater and water industry have been fragmented historically and as such the availability of ultra-purification water treatment technologies is relatively new to many who are just coming to understand indirect potable reuse, integrated water resources management and now direct potable reuse (DPR). Consequently terminology has yet to evolve to capture the new relationships between highly treated purer-than-drinking water and the more traditional drinking water sources.

Before it will be possible to convey the benefits of DPR to the public it will be essential that the water industry professionals, advisors to politicians and water industry professions as well as regulators (especially public health regulators) themselves accept DPR's benefits and demonstrate a united and unequivocal front in support of its use to convince political decision makers and the media. It is unlikely that the public will come forward in favor of a concept that is not supported by the water industry. In this regard it would be important to set the context for the public to understand the issue and reframe their mental model away from source of water to quality of the water. We have a way to go in this regard but we can and should start now. No amount of branding or rhetoric regarding trust in the industry will substitute for this understanding.

2. The Water Industry Must Invest in Simple, Accurate and Easy to Understand Communication about Water Prior to a Discussion of Direct Potable Reuse

Preliminary research results from WRF 07-03 *"Talking about Water: Words and Images that Can Enhance Public Acceptance of Water Recycling and Desalination"* have shown that the greatest change, with knowledge about water quality, was the acceptance of **direct potable reuse**. Regrettably, water industry communications are full of technical jargon and fail to put water use and reuse in perspective. This creates a situation where it is easy to stigmatize water's quality by

the history of where it once was rather than the fact that it is safer than drinking water. To reframe mental models will require a robust and imaginative education programs for the industry and public. We need to have programs that simplify water industry concepts into easy to understand, fun and exciting images. If we can employ the best available engineering technology to create water we should also be able to use the best available communication approaches – approaches that are imaginative and stimulating- to all learning styles. We can use modern communication techniques – not just social media – but also computer visualizations that are accurate, dynamic images and exhibits, visitor centers – small to large and even mobile units, and other creative materials that put the issue into context.

Discussions about 'indirect potable reuse' and 'presumably direct potable reuse' typically start with the processes used to purify the water. Discussions really need to start with knowledge of water and, in particular, how wastewater is treated for various uses. The public and politicians will not be able to understand and accept direct potable reuse until there is a holistic understanding of water.

3. The Environmental Barrier --- A Barrier to Rational Thinking about DPR?

The distinction between direct and indirect potable reuse rests upon the notion of an environmental barrier – a rather ethereal process whereby water that is purer than drinking water is mixed with a source of water that is far less clean but presumed to be natural or blessed by sunlight as another disinfection technique. An assumption has been made that the public will be more accepting of recycled water if it has been subjected to natural treatment processes. To the more informed, the insistence on an environmental barrier gives the negative message that there must be something wrong with the water – that the plant will malfunction and the operators err – so that the product water needs blending. There is even misleading use of the word "diluted" that is used to indicate that the purer water is "diluted" by water of a lesser quality in groundwater or reservoir.

The promotion of DPR would make it easier for the water industry to explain "inadvertent" and "unplanned" reuse (something that is presently very confusing to the public). "Not-so-well" treated effluent discharged from an upstream town from exposure to sunlight and natural bacteria benefits from processes that occur in waterways before it becomes the drinking supply source for a downstream town where the water treatment plant is designed to manage water of that quality. Water that is purer than drinking water does not need these processes.

There must also be more information about monitoring. We must demonstrate to the public that environmental barriers are not the most effective way of spending money and energy (especially given pumping costs) and demonstrate other effective ways to monitor water quality and protect public health.

4. Trust in Treatment and Monitoring is Critical

Research undertaken as a part of WRF 07-03 has demonstrated that the public considers the source of the water to be the least important factor in the provision of safe drinking water.

In order for the public to trust direct potable reuse they must have confidence in those who are providing it. As noted above this means that water, wastewater and reuse professionals must use

the same facts. They must stress that it is the utility that provides the technology and service to treat the water – not the source (pure water untouched by humans is a marketing myth). Nor is "nature" the purifier, as is implied by putting highly treated water back into a much more pollutant laden reservoir, groundwater or stream.

Communications that fail to convey the fact that water is used and reused throughout the world deprive the public and decision makers of critical perspective and context within which rational policy choices can be made and will impede acceptance of direct potable reuse as a safe and sustainable strategy to address impending scarcity of new water supplies.

ATTACHMENT 2 - ACKNOWLEDGING UNCERTAINTY

by Peter M. Sandman
http://www.psandman.com/col/uncertin.htm

This is the sixth in a series of risk communication columns I have been asked to write for *The Synergist*, the journal of the American Industrial Hygiene Association. The columns appear both in the journal and on this web site. Only the first third or so of this column appears (more or less identical except for copyediting details) in the November 2004 issue of *The Synergist*, pp. 21–22, 41. The section on "Being Precise about Uncertainty" wasn't published in *The Synergist*.

Most people hate uncertainty. They'd much rather you told them confidently and firmly that A is dangerous or B is safe, C is going to happen or D isn't, E is a wise precaution or F is a foolish one.

Of course anything you tell them confidently and firmly that turns out false generates outrage (fear, anger, or both). With some justice, people will feel you misled them. The result will certainly damage your credibility, and thus your ability to manage this situation and future situations. Perhaps worse, people's mistrust of you will rub off onto their attitude toward the risk itself.

But that doesn't keep them from pressuring you beforehand to sound more certain than you are. In fact, the pressure comes from all sides: affected industries, politicians, regulators, your employer, your peers, your audience, and yourself. Everyone wishes you knew more, and everyone (consciously or unconsciously) pushes you to pretend you do. It isn't easy to hold onto your uncertainty, to insist you're not sure.

To some extent, people's response to uncertainty depends on their attitude toward the hazard, and on yours. Outraged people get more outraged when the experts' reassurances come with uncertainty attached. "How dare you make me an unwitting subject in your risky experiment!" Apathetic people, on the other hand, get more apathetic when warnings are admittedly uncertain. "If even the experts aren't sure it's dangerous, why should I wear that uncomfortable respirator?"

Similarly, the pressure is usually strongest to make your reassurances more confident, to say "everything will be fine" when you really ought to be saying "we hope we get through this okay." If your message is a warning, tentativeness is more tolerable. But not always. Consider the pressure on the intelligence community to make its WMD warnings sound more certain, to justify going to war. Or consider the pressure on industrial hygienists to make safety warnings sound more certain, so employees won't have an excuse not to take the recommended precautions.

Finally, the cost of confident warnings that turn out false is lower than the cost of confident reassurances that turn out false. Not that it's good to be seen as The Boy Who Cried Wolf, whose prophesies of doom are no longer credible. But it's better than being seen as the management toady who hid serious risks and let people get hurt.

These asymmetries aside, the bottom line is the same for warnings and reassurances, for apathetic audiences and outraged ones. You will be tempted to suppress your uncertainty and sound

confident. And things will turn out better if you resist the temptation. Over-confidence rings false, undermining everyone else's confidence even if you turn out right. It provokes acrimony, making those who disagree much more contentious than they would be if you sounded less cocksure. And it devastates your credibility and your ability to lead if you turn out wrong.

Tips on Sounding Uncertain

1. **Ride the risk communication seesaw.** Someone is going to point out the uncertainties. Ideally that someone should be you, leaving us free to occupy the more confident seat on the seesaw. Acknowledge uncertainty up-front before you are confronted with it.

2. **Try to replicate in your audience your own level of uncertainty.** Tell people what you know for sure, what you think is almost but not quite certain, what you think is probable, what you think is a toss-up, what you think is possible but unlikely, and what you think is almost inconceivable. Put bounds on the uncertainty: What range of possibilities is credible? Clarify that you are more certain about some things than others.

3. **Avoid explicit claims of confidence.** Reserve the word "confident" for things you'd bet your mortgage on. "Hopeful" is a better word for desirable outcomes that are likely but not certain. And don't imagine that hedge words let you off the hook. "At this point in time we are 100% sure the emissions are safe to breathe" is still unacceptably overconfident, despite the introductory phrase. Where appropriate, point out explicitly that you are not confident. Even better, predict that some of what you now think is true will probably turn out wrong. This is the best way to keep changing circumstances from being seen as earlier mistakes – or, worse yet, earlier lies.

4. **Convert expert disagreement into garden-variety uncertainty.** When experts disagree about a risk, the rest of us get very nervous. But faking an expert consensus that isn't there is sure to backfire. Your best bet is to report everybody's risk estimates, even those of your critics: "The company says X; the regulators say Y; the activists say Z." By framing the risk in terms of the range of expert opinions, you avoid the risk communication worst case scenario: equally confident experts with antithetical judgments going head-to-head.

5. **Make your content more tentative than your tone.** Confidently telling us you could well be wrong inspires trust even as it alerts us to the genuine uncertainties of the situation. The reverse combination, claiming to be sure in a tone that sounds very unsure, is disastrous.

6. **Show your distress at having to be tentative – and acknowledge ours.** You wish you could be sure but you know you can't; despite the uncertainties, you are able to make necessary decisions and recommendations. This models the reaction you want us to have. Show you are aware that the uncertainty distresses us as well as you and show you think we can bear it too.

7. **Explain what you have done or are doing to reduce the uncertainty.** Don't perpetuate uncertainty; if there are ways to answer the question that you should be pursuing, say so, and pursue them. But if the remaining uncertainty is very small or very difficult to reduce further, say that. Don't over-promise.

8. **Don't equate uncertainty with safety – or with danger.** Never say "there is no evidence of X" when you haven't done the study that tests the possibility; never imply that the absence of definitive proof that something is dangerous proves it's safe; never imagine that risks are innocent until proven guilty. On the other hand, think hard before you buy into the widespread assumption that most industrial products and processes are hazardous whether the experts know it or not.

9. **Explain how uncertainty affects precaution-taking.** The greater the uncertainty, the more justified the precautions – not because you're sure the risk is serious, but because you're not sure it isn't. How far to take this precautionary response is always debatable. Sometimes there is no reasonable choice other than bearing that uncertain-but-probably-small risk in preference to one that may be better understood but is probably more serious. Other times there are options that are both safer and less uncertain. Sometimes it is easier to reduce an uncertain risk than to measure it more certainly.

10. **Don't hide behind uncertainty.** If the risk is probably significant, despite lingering quality control problems, say so. If it's probably trivial, despite some unanswered questions and weird exceptions, say that. Most of the time, uncertainty should be something you discuss reluctantly, acknowledging that it weakens your case. If you find yourself asserting that uncertainty strengthens your case, pause and reconsider your case.

11. **Expect some criticism for your lack of confidence.** The only alternative is criticism for overconfidence, often from the same critics. That's worse.

12. **Don't go too far.** You could come across as bumbling, timid, indecisive, or terminally self-deprecating. But this problem is rare. The more common problem is coming across as arrogant and overconfident. Your goal is the middle, but you can safely aim for the opposite extreme. You won't overshoot.

Take heart. The research on acknowledging uncertainty shows that it does diminish people's judgment of your competence (though not as much as sounding certain and turning out wrong). But it actually increases people's judgment of your trustworthiness! Since sources of risk information typically score higher on competence than on trustworthiness, this isn't such a bad trade-off.

Being Precise about Uncertainty: How Uncertain Do You Want to Sound?

Absolutely certain statements about risk are almost by definition mistaken. Like any scientific statement, a risk statement must always be qualified in principle by the possibility of new data. The full range of science is from almost impossible to almost a sure thing. When the topic is a controversial risk, of course, most sound statements are closer to the middle. Sources who don't want to say anything until they're certain will seldom have anything to say. (See "It Is Never Too Soon to Speculate.")

Saying you're uncertain, in other words, is a good start, but it isn't enough. Your goal should be to communicate as precisely as you can what you think so far and how uncertain you are.
Of course the best way to do that is with numbers. If you have a statistical estimate of the

probability of some outcome, give it. Even without defensible statistics, numbers can help clarify your hunch – though of course it's important to stress that a hunch doesn't magically turn into valid quantitative data just because you choose to express it in numbers. (In other words, you need to be clear about how certain or uncertain your estimate of the uncertainty is!) Still, we live with numerical hunches all the time. Everyone knows guesstimated odds of 1-in-a-million mean it's not going to happen; 1-in-a-hundred means it's a real long shot but it could happen; 1-in-10 is still unlikely but nobody will be all that surprised if it happens; 9-in-10 and 99-in-100 and 999,999-in-a-million are similar seat-of-the-pants estimates at the other end of the probability distribution.

We all know what 50-50 means too – but in this case it's helpful to clarify whether you're saying that the evidence is pretty evenly divided, or that there isn't any relevant evidence on which to base a judgment.

Absent numbers, you can do a lot with words. "We can't prove X conclusively" sounds like you're fairly sure X is true. "We can't rule it out conclusively" sounds like you're fairly sure it isn't true. Both acknowledge uncertainty while sending clear signals which side you think the smart money is on.

"We have no evidence of X" also sounds like you're fairly sure X isn't true. This is a favorite locution of corporate spokespeople, and it is often used to mislead. If there have been no studies looking for a link between dimethylmeatloaf and pancreatic cancer, the claim that there is no evidence of such a link is technically accurate but intentionally misleading. If there have been lots of relevant studies and none of them found a link, you'd naturally want to back up your claim by saying so.

There are phrases to match any level of uncertainty. They may be wordy, but they communicate clearly enough. "The weight of the evidence suggests that X is likelier than not, but there is still plenty of room for doubt." "We're almost sure that X is not happening, and we are proceeding on that assumption, but we're continuing to monitor the situation so we'll be able to change course if it turns out we're wrong." "We think it's probably X or Y; Z is less likely but still a contender; we'd be shocked if it's anything else."

I'd love to see more research on people's actual responses to these and similar phrases. No doubt some phrases are genuinely ambiguous, provoking too wide a range of responses to be useful. Other phrases communicate better. But even without this research, being precise about uncertainty is easy enough to do. If you set out to clarify in the mind of the audience exactly what's in your own mind, you can usually come up with language that does the job.

The problem is that we often don't try. At least four biases keep us from trying.

1. **The bias against sounding ignorant.**
   In some ways the most important uncertainty claims are the ones that provide no guidance whatever – except the crucial information that there is no sound guidance available. "I have no idea whether the side effects of the smallpox vaccine are safer or more dangerous than the risks of going unvaccinated. It all depends on the probability of a smallpox attack – and nobody has any data to estimate that." "I have seen studies that suggest these industrial chemicals might cause birth defects in mammals, and other studies that show no such effect, even at high doses.

The evidence is mixed and very confusing." Statements like these are far rarer than they should be. Experts don't like to sound ignorant, so they don't often say, flat-out, that they don't know something. They focus instead on what they do know, or think they know.

They are joined in this bias by journalists, who also prefer to report what is known rather than what isn't. S. Holly Stocking of Indiana University has done a decade's worth of research on "ignorance claims." Some of it is online (do a Google search for "Stocking ignorance") and it's well worth reading. Reporters like to feel and sound in the know; they avoid reporting that they couldn't find something out, that their sources didn't seem to know the answer. (This is part of my rationale for being willing to speculate; if you decline to say anything because you're not sure, reporters will find some less scrupulous source instead.)

2. **The bias against being precise and assertive about uncertainty.**
When risk experts and risk managers do acknowledge their uncertainty, they tend to do so vaguely. It's almost as if the acknowledgment were somehow shameful, as if they felt they ought to be more certain. Maybe I should change the title of this column from "Acknowledging Uncertainty" to "Proclaiming Uncertainty." That's what's called for, really: a paradoxically confident assertion of your absence of confidence. Part of job is to be more precise about your uncertainty – what's pretty sure but not absolutely sure, what's a hunch but you wouldn't bet the farm on it, what's a wide-open question, what's a long shot. And part of the job is to be precise with flair – to offer as ringing a declaration of your uncertainties as of your certainties. Maybe then journalists would publish the uncertainties too.

3. **The bias toward sounding more certain than you are.**
This is the core of the problem. Even when they do try to precise about their level of uncertainty, risk experts and risk managers tend to "round off" in the direction of greater certainty. If they're sixty percent sure, they end up sounding ninety percent sure. Or they simply don't talk about the things they're only sixty percent sure of. At its worst, the result is a dangerous dichotomy – if it's too uncertain to say with near-certainty, you don't say it at all; if it's too important to leave out, you say it with more certainty than it deserves.
Scientists rightly complain that reporters tend to make them sound more certain than they are (by downplaying caveats, for example). Scientists are less likely to notice that they also tend to make themselves sound more certain than they are, especially when talking to nonscientists. Many experts who are a model of tentativeness when they're addressing their colleagues become markedly more dogmatic when talking to the rest of us. As Stocking points out, when most scientists sound overconfident, science itself can end up sounding contradictory, arbitrary, and self-serving. Two researchers looking at different aspects of the same problem report results that trend in opposite directions. They may know and respect each other's work and share a sense of the complexity and uncertainty of the larger issue. But when they talk to the media they focus on their own findings, and what little they say about the uncertainties is less than quotable. So the news coverage may report each as if the other didn't exist (two equal and opposite overconfident stories), or it may report both together as if they demonstrated a fundamental disagreement (converting scientific uncertainty into dueling Ph.D.s).

4. **The bias toward over-reassurance.**
Optimistic bias is a fundamental human characteristic. Research by Neil Weinstein of Rutgers

University has documented that most people think they are less likely than others, and less likely than they actually are, to get cancer, get mugged, get fired, etc. There is a contrary tendency, dubbed "defensive pessimism" by Julie Norem of Wellesley College, but optimistic bias is the biggie. So risk experts and risk managers, like most of us, see the world of risk through rose-colored glasses. Likely bad outcomes tend to be seen as not as bad as they really are; unlikely bad outcomes tend to be seen as even more unlikely than they really are. Uncertainty, in other words, isn't symmetrical. We don't just come across as more certain than the situation justifies; we come across as more optimistic as well. This state of affairs lasts right up until the bad outcome is too obviously imminent to ignore. That's when the general public switches to the other side and "over-reacts," rehearsing for the crisis to come by imagining it is here already. And that's when risk experts and risk managers experience the strongest temptation to keep on over-reassuring – no longer because they're feeling optimistic, but because they're under pressure.

The pressure to over-reassure comes from all sides – from management, from peers, from politicians, from affected industries, from the public itself, from one's own inner fears. When we're facing serious risks, they over-reassure us because they fear we might panic. When we're facing tiny risks, they over-reassure us because they fear we'll seize on any admission whatever to keep on worrying about nothing. I've written enough about over-reassurance elsewhere, so I won't belabor the point here. (See for example "Fear of Fear" and "Worst Case Scenarios.")

There is a fifth bias – on the public's part, not the source's – that is critical in deciding how to cope with the other four. When people belatedly find out that a company or government agency has been overconfidently over-reassuring, they become mistrustful and alarmed. In fact, even before they find out, people often react to overconfident over-reassurance in accordance with the risk communication seesaw; they smell a rat and they become mistrustful and alarmed. Overconfident over-reassurance routinely backfires.

Here's how it plays out.

Let's say you're charged with managing avian influenza in your corner of the world. One of the things you're monitoring is human-to-human transmission (known in the field as h2h). There still aren't any absolutely certain cases of bird flu h2h transmission. There are cases where someone with no known contact with birds came down with bird flu after nursing a relative who was sick with bird flu – but it's always possible they encountered the feces of a passing bird. So you think h2h is probable but not certain. But you also think h2h is less dangerous than it sounds; a human flu pandemic would require not just h2h but *efficient* h2h, and so far there's no evidence at all of that. You're worried that acknowledging that h2h has probably happened already might unduly frighten people. So you accurately but misleading assert that there is no conclusive evidence of h2h. Some people are falsely reassured. Some sense that you're trying to con them, and get more frightened instead.

Then (and this hasn't happened yet, but odds are it will) more and clearer cases of h2h start cropping up. The people who were falsely reassured feel betrayed and get more frightened; the people who didn't buy your reassurances in the first place feel vindicated and also get more frightened. Now you say what you should have said in the first place – that you're not surprised that

h2h can happen, it was probable all along, but it's not too alarming to you as long as the cases are isolated and the transmission isn't efficient. Because it contradicts your prior overconfident over-reassurance, this fails to convince. Mistrust, fear, and anger keep escalating. This begins to frighten and anger you too. Your poultry industry is suffering; you're afraid people may be on the brink of panic; they're ignoring what you consider the crucial information that so far the h2h is inefficient and therefore incapable of launching a serious human outbreak (let alone a pandemic).

Instead of blaming yourself for having said misleading things, you blame the media for sensationalizing and the public for over-reacting. This predictably increases the public's alienation, mistrust, anger, and fear. That increases your disdainful conviction that people invariably over-react, which justifies your decision to be overconfident and over-reassuring, continuing the vicious cycle. Your ability to provide accurate reassurance that there is no crisis so far has been undercut by your own overconfident over-reassurances. And so has your ability to lead people through the crisis that may yet emerge.

So here's a procedure for being precise about uncertainty:
Step 1 – Decide what you think and how uncertain you actually are.
Step 2 – Review the five biases and decide again.
Step 3 – Choose language that captures what you've decided.