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The Value of Water in the Urban Watershed

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Ronald B. Linsky

During the reign of Emperor Justine (530 A.D.), the conceptual framework for a "Public-Trust Doctrine" was developed within the context of Roman law. The principal that *a government should hold in trust water resources for all present and future generations* has traveled from ancient Rome, throughout Europe and America, and continues to influence public policy worldwide. Its legacy — that a government is responsible for managing water resources through laws that focus on public health and safety — has been most apparent in the last 30 years of environmental rules and regulations.

In the U.S., the public-trust doctrine held positive attributes for a population that exhibited, at one time, limited demands on seemingly abundant resources. Water and other resources were perceived as "free" and available from a never-ending supply. But populations are not static, and neither are their appetites for resources to sustain growth and development. These appetites are continually reinforced when people turn a valve or spigot handle and, *voila*, water appears. As long as people assume resources are "free goods" that will always be available, resources will continue to be marginalized and, thus, abused and misused.

The Urban Setting

Today, 3 billion people live in crowded urban centers, the majority of which are located adjacent to oceans, lakes, rivers, or estuaries. Many of these centers overlay what were once recognizable watersheds. Over the last 50 years, the worldwide consumption of water has nearly tripled. For every second of every day, there are 4.2 births and only 1.7 deaths, which provides a net gain of 2.5 new persons per second worldwide, or 150 new water consumers per minute.

The classic definition of a watershed contains elements of ecology, hydrology, geology, and biology; however, more recent definitions include politics and economics. Unfortunately, "natural" watersheds are no longer identifiable. What was a river is now an open or closed channel of concrete; what was a meadow is now filled with houses or commercial facilities; and what were once streams are now curbs and gutters. Urban watersheds — nonporous environments designed to remove water as quickly as possible — lack the complexities of biologically driven ecosystems. They cannot adapt or respond to change.

Urban watersheds serve as sites for the economic engines of societies worldwide and are centers for food production, trade, recreation, and other activities required to maintain a vital society. As people continue to migrate toward these centers, urban watersheds will continue to increase in value to societies. The most overlooked and undervalued requirement of these centers is water. Not only is water the most critical element responsible for the growth and development of urban centers, it has also been the most critical factor of their demise.

A new predicament will be faced early in this century: Growth will exceed the ability of water utilities to provide sustainable water supplies. Water scarcity and increasing costs may ultimately impede the sustainability of urban populations.

The Value of Water

Faldenmark and Lindh (1993) describe three stages that a society undergoes in the development of water resources. The first stage is the pre-

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In this Issue...

NWRI to Publish Revised Ultraviolet Disinfection Guidelines

In December 2000, NWRI and the American Water Works Association Research Foundation jointly published *Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse*, which have impacted the design and performance of ultraviolet (UV) disinfection systems across the world.

The UV Guidelines Revision Subcommittee met at CH2M Hill in Oakland, California, to work on the second edition of the UV Guidelines. The Subcommittee includes: George Tchobanoglous, Ph.D., P.E., of the University of California, Davis; Richard Sakaji, Ph.D., of the California Department of Health Services; and Fred Soroushian, PE, of CH2M Hill.

Three years later, NWRI is preparing to publish a second edition of the *UV Guidelines*, which were created to provide a common basis for evaluating and implementing UV disinfection technologies for both drinking water and water reuse.

As part of the revision process, a subcommittee of the original authors of the *UV Guidelines* was organized to prepare the second edition of the guidelines. The second edition has been revised to:

- Reflect needed changes resulting from experience gained in applying the 2000 *UV Guidelines*.
- Clarify application issues.
- Incorporate additional guidance on UV lamp storage.

The second edition of the *UV Guidelines* cover seven topics for drinking water and water reuse applications. These topics include: (1) UV Dose; (2) Reactor Design; (3) Reliability Design, (4) Monitoring and Alarm Design; (5) Field Commissioning Test; (6) Performance Monitoring; and (7) Engineering Reports.

In addition, there is a chapter that provides a protocol to test and validate UV equipment performance. The protocol chapter covers (1) Test Facilities Requirements and Set-up; (2) Microbiological Testing; (3) Testing and Sampling Requirements; and (4) Data Analysis and Reporting.

The purpose of the *UV Guidelines* is to provide the UV industry with a common procedure for designing and commissioning UV systems.

UV disinfection is significant to both drinking water and water reuse applications because UV can inactivate many waterborne pathogens, such as *Cryptosporidium* and *Giardia*, and help minimize disinfection byproducts. It is now more broadly accepted in the water industry as a dependable pathogen removal technology.

One of the impacts of the *UV Guidelines* is that both the water and wastewater industries, as well as the manufacturers of UV technology, are now creating a better and more consistent product — that of high-quality water.

For further information on the *UV Guidelines*, please visit the NWRI bookstore at www.NWRI-USA.org.

New NWRI Occasional Paper

Assessing Risk Information Concerning Coastal Runoff

Prepared by:

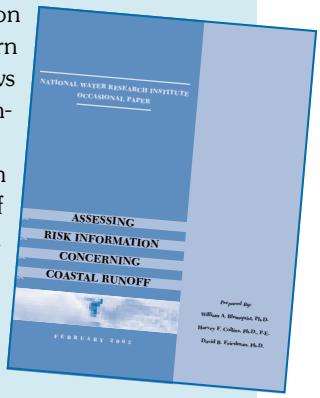
William Blomquist, Ph.D.,
Professor of Political Science, Indiana University-Purdue University at Indianapolis

Harvey Collins, Ph.D., PE,
Consulting Environmental Engineer

David Friedman, Ph.D.,
Consulting Economist

This report, which focuses on coastal urban watersheds in Southern California and Florida, examines news reports from the media and environmental organizations to determine:

- The accuracy of information pertaining to how urban runoff affects both ocean water pollution and human health.
- What impacts this information has on public policy.



This paper is available for $30.00 at the NWRI bookstore at www.NWRI-USA.org.

NWRI Conference Announcement

2nd International Riverbank Filtration Conference

September 17-19, 2003 • Cincinnati, Ohio USA

Significant progress has been made in the last 4 years that has established riverbank filtration as a legitimate pretreatment option in achieving water-quality goals and objectives. The First International Riverbank Filtration Conference, held in 1999, examined the principles of riverbank filtration. The Second International Riverbank Filtration Conference will now focus on the experiences of waterworks worldwide and address the issues currently faced by users of the technology, including (but not limited to):

- **Operational Experience**

  Siting issues; risk events; monitoring; costs

- **Microorganisms and Chemicals**

  Fate and removal; redox processes

- **Riverbed Dynamics**

  Riverbed scour and sediment deposition; clogging

- **Public Policy**

  Potential of RBF to enhance regional and sustainable water supplies; public information; treatment credits; public health

Held by:

- **National Water Research Institute**

Sponsored by:

- **Greater Cincinnati Water Works**
- **International Association of Waterworks in the Rhine Catchment Area**
- **Jordan, Jones & Goulding**
- **Louisville Water Company**
- **Stadtwerke Düsseldorf AG**
- **U.S. Environmental Protection Agency**
- **U.S. Geological Survey**

Conference Schedule:

Wednesday, September 17: 8:30 am to 5:00 pm
Thursday, September 18: 8:30 am to 5:00 pm
Friday, September 19: 8:30 am to 5:00 pm

Field Trip Options:

Greater Cincinnati Water Works / U.S. Geological Survey / Miami University Flowpath Study Tour: A tour of the Charles M. Bolton Well Field, including the Flowpath Study test site, in Cincinnati, Ohio. The Flowpath Study investigated the natural filtration of pathogenic protozoa and other contaminants from the Great Miami River to the Bolton production wells (10 vertical wells).

Louisville Water Company B.E. Payne Water Treatment Plant: A tour of the Louisville Water Company's 15-MGD horizontal collector well, which has been in operation since 1999 in Louisville, Kentucky. Exhibits will be available showing the next phases of the RBF project, which will initially add 45 MGD of additional capacity through a series of vertical collector wells connected to a centralized pump station by a tunnel installed in the bedrock.

Conference Registration:

Full Registration:	$395.00
One-day Registration:	$200.00
Student Registration:	$100.00
Choice of Field Trip:	$ 35.00

Early Registration! **Only $350.00** (Offer Good Until July 1)

Registration fees may be paid by check or purchase order, or an invoice can be mailed upon request. To pay by credit card, please register on-line at www.NWRI-USA.org (see "Events" section).

The **Second International Riverbank Filtration Conference** will be held at the **Hilton Cincinnati Netherlands Plaza**, 35 W. Fifth Street, Cincinnati, Ohio USA. Special conference room rates are $99.00 a night. Discounted government rates are available for $69.00 upon verification. To contact the Hilton Cincinnati Netherlands Plaza, please call (513) 421-9100 or (800) HILTONS. **Special room rates are available until Monday, August 11, 2003.** Please refer to the *Second International Riverbank Filtration Conference* when making hotel arrangements.

The Hilton Cincinnati Netherlands Plaza is 15 minutes away from the Cincinnati / Northern Kentucky International Airport. Please call (800) 990-8841 for shuttle reservations.

NWRI Holds Workshop for Elected and Appointed Water Officials

Each region and sub-region of California faces different challenges in developing strategies to provide high-quality drinking water and to manage effluent streams.Those who are responsible for addressing and overcoming these challenges are the elected and appointed officials of water and wastewater utilities.

Workshop speakers (from left): John T. Andrew of California Bay-Delta Authority; Bruce E. Rittmann, Ph.D., of Northwestern University; Paul R. Brown of Camp Dresser & McKee, Inc.; Mary F. McDaniel, DO, JD, MPH, of McDaniel Lambert, Inc.; Gary P. Westerhoff, P.E., DEE, of Red Oak Consulting; and R. Robert Neufeld of Cucamonga County Water District.

This March, NWRI held a workshop that was designed to assist Southern California water officials in gaining a broader understanding of the regulatory, financial, and public-policy implications of critical water-resource issues, such as emerging contaminants, as well as the technological options available to mitigate these problems.

The workshop was part of the *Thirteenth Annual West Coast Conference on Contaminated Soils, Sediments, and Water*, held by the Association for Environmental Health and Sciences Conference at the Mission Valley Marriott in San Diego, California.

Twenty-five members of the Board of Directors of various water utilities in Southern California attended the half-day workshop.

The purpose of the workshop was to strengthen the bridge between the decision-making process and the science and technology that utilities depend upon, and to bolster the level of understanding and confidence in science and technology.

The workshop included six guest speakers:

Gary P. Westerhoff, P.E., DEE, of Red Oak Consulting, a Division of Malcolm Pirnie, Inc.: Mr. Westerhoff, an expert in water resources planning and utility management, spoke of the many ways in which water and wastewater utilities can and are evolving to meet future water needs and challenges, including public perception. He is co-author of the new book, *The Evolving Water Utility: Pathways to Higher Performance*.

Paul R. Brown of Camp Dresser & McKee, Inc.: Mr. Brown has been a project leader for numerous California water resources planning projects for groups such as the City of San Diego and the Metropolitan Water District of Southern California. His presentation focused on building a public policy approach that looks at the relationship between water utility functions (like groundwater protection and stormwater management) and public health risks and benefits.

R. Robert Neufeld of the Board of Directors of the Cucamonga County Water District: An elected official himself, Mr. Neufeld discussed innovative ways in which the Optimum Basin Management Plan of the Chino Basin Watermaster was mitigating the impact of salinity and nitrate (resulting from agricultural practices) upon the groundwater basin.

Mary F. McDaniel, DO, JD, MPH, of McDaniel Lambert, Inc.: Ms. McDaniel, who is both a physician and lawyer, presented the various means that water utilities can communicate risk to the public. She examined the public's perception of risk versus the ways in which utilities can build trust and credibility among the public.

John T. Andrew of the California Bay-Delta Authority: An environmental and water resources engineer, Mr. Andrew gave a presentation on the California Bay-Delta Authority, which is implementing a long-term, comprehensive plan to restore the ecological health of the Bay-Delta system and to improve water quality and water supply reliability throughout the state.

Bruce E. Rittmann, Ph.D., of Northwestern University: Dr. Rittmann, a professor of environmental engineering, spoke of two biology-based emerging technologies in the areas of water and wastewater treatment. The first technology, the hydrogen-based membrane biofilm reactor, can mitigate the problem of biofilm fouling. The second, biofiltration, can be used to remove earthy-musty odor from drinking water — a common customer complaint.

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Abstracts from the *Workshop for Elected and Appointed Water Officials* are available for purchase at the NWRI bookstore at www.NWRI-USA.org.

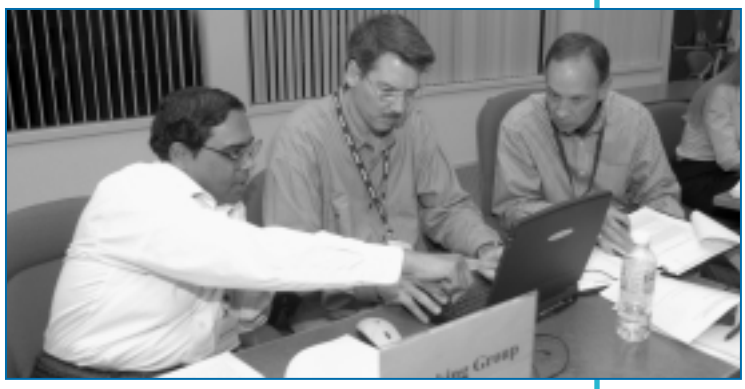
Workshop on Seawater Desalination Examines Opportunities and Challenges

Southern California is increasingly turning to seawater desalination as a viable option for creating water supplies in Southern California. Desalination — a membrane-based technology that removes salts and other dissolved solids from water — is considered a reliable and efficient water treatment process that produces high-quality drinking water.

High-quality drinking water is one of the many demands placed on water supplies by expanding urban centers like Southern California. Water utilities, such as the Metropolitan Water District of Southern California (MWD), which provides drinking water to nearly 17 million people in six counties, are interested in seawater desalination as a means to develop new water supplies.

MWD and its member agencies that are currently involved in developing desalination projects, namely the San Diego Water Authority, West and Central Basin Municipal Water District, Long Beach Water Department, Los Angeles Department of Water and Power, and Municipal Water District of Orange County, approached NWRI to hold a Nominal Group Technique (NGT) workshop that addressed the question: *What are the most critical issues that water utilities will face when planning and implementing seawater desalination projects to supplement drinking-water supplies?*

The NGT process allows workshop participants the opportunity to identify, prioritize, and develop approaches that best address the question. For this workshop, 31 participants — ranging from MWD and member agency representatives to various consultants and experts of desalination technology — determined that the most important issue was the need to develop a regulatory framework for large-scale seawater desalination projects.



Hari Krishna, Ph.D., P.E., P.H., of the Texas Water Development Board, Karl W. Seckel, P.E., of the Municipal Water District of Orange County, and Darryl G. Miller of West Basin Municipal Water District worked together to determine how best to provide funding for seawater desalination plants.

A large-scale seawater desalination plant project requires numerous permits and approvals from various local, state, and federal agencies before construction can commence and before a plant can be placed in operation. Since these permits are crucial in moving the project forward, it is necessary to have a regulatory framework that will address stakeholder concerns about project viability, provide a level of assurance that the project will have a minimum level of environmental impact, and reduce the costs and time associated with obtaining the required permits.

Workshop participants suggested several options for developing a regulatory framework, such as:

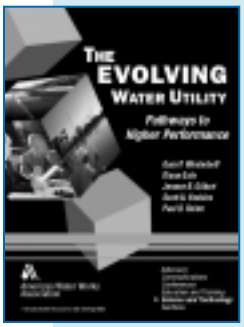
- Establish a clearinghouse for permit review at state and regional levels.
- Develop a comprehensive guidance document.
- Encourage legislation.
- Educate stakeholders
- Simplify administrative procedures.

There were nine other issues that workshop participants identified as crucial in developing desalination projects. These varied from concentrate management options to public information and outreach. The complete workshop report, *Seawater Desalination: Opportunities and Challenges*, is available for $15.00 at the NWRI bookstore at www.NWRI-USA.org.

New Utility Management Book Available in June 2003

The Evolving Water Utility: Pathways to Higher Performance

Authors: Gary P. Westerhoff, Diana Gale, Jerome B. Gilbert, Scott A. Hoskins, and Paul D. Reiter



The Evolving Water Utility: Pathways to Higher Performance synthesizes the experience of water and wastewater utilities over the past 5 years and offers insights on how some of these approaches might work for a utility seeking to reach a higher level of performance. The book is divided into four parts: (1) The State of Change; (2) Creating an Adaptive Organization; (3) Implementing Operational Strategies; and (4) Implementing Strategies for Capital Facilities. It is a complement to the book, *The Changing Water Utility: Creative Approaches and Efficiency* (1998).

Please visit the American Water Work Association's bookstore at www.awwa.org for further details.

Meet Our Newest RAB Members

NWRI is the only privately funded organization of its kind devoted to water research. Its success rests on its Research Advisory Board (RAB), which not only reviews and evaluates proposed and ongoing research projects supported by NWRI, but also guides and enhances NWRI's research goals.

The RAB represents water-science expertise from across the nation. At present, there are 48 RAB members. NWRI is pleased to announce the addition of its newest members:

James B. Blackburn, Jr., J.D.

Attorney, Blackburn Carter (Houston, TX)

James B. Blackburn

An attorney for more than 30 years, Jim Blackburn is a partner in Blackburn Carter, a firm devoted to environmental law and planning. Cases include environmental impact, wetlands, wastewater, air and hazardous waste litigation; strategic environmental planning; toxic tort and flood-related litigation; and sustainable development and environmental dispute resolution. Blackburn is also an Adjunct Professor and Lecturer in the Department of Environmental Sciences and Engineering at Rice University. Among his honors, he received the National Conservation Achievement Award in 2001 from the National Wildlife Federation and the Bob Eckhardt Lifetime Achievement Award for coastal preservation efforts from the General Land Office of the State of Texas in 1998. He was also awarded an honorary membership in the American Institute of Architects for legal work associated with urban quality of life issues in 2003. His manuscript, *The Book of Texas Bays*, which focuses upon current environmental health of bays in Texas and the efforts undertaken to protect them, has been accepted for publication by Texas A&M press and is forthcoming in early 2004. Blackburn received both a B.A. in History and a J.D. at the University of Texas at Austin and an M.S. in Environmental Science at Rice University.

Steven L. Hoch, J.D.

Attorney, Hatch & Parent (Los Angeles, CA)

Steven L. Hoch

Steve Hoch has over 25 years of legal experience, most of which entailed taking the leading position in major and complex environmental matters and civil actions. Clients have included the Southern California Water Company, various municipal utilities, and Fortune 500 Corporations. He was also the lead PG&E counsel in the case made famous by the film, *Erin Brockovich*. Hoch's expertise extends to both federal and state environmental laws and regulations, mainly centering on groundwater and potable water issues, hazardous waste disposal, recyling alternatives, and soil and groundwater remediation issues. He also has provided guidance to developers, banks, and trusts on transactional issues involving contaminated property. Hoch has published several articles on environmental liability and has lectured on hazardous water utility issues, groundwater issues, products liability, toxic torts, and other environmental matters. He received a B.A. in History from New York State University and a J.D. from Boston University School of Law.

RESEARCH IN PROGRESS

OCWD Probes Fundamental Mechanisms of Organic Compound Rejection by Reverse Osmosis Membranes

Donald Phipps (Principal Investigator), Grisel Rodriguez (Project Manager), and her team at the Research & Development Department of the Orange County Water District in Fountain Valley, California, are using a numerical description of the structural characteristics (e.g., size, shape, charge, branching) of numerous organic compounds to determine the fundamental mechanism(s) of rejection of these compounds by several types of reverse osmosis membranes. Preliminary results (based on 31 compounds) suggest that rejection is closely related to molecular complexity (e.g., branching), which indicates that the physical interaction of organic compounds with the reverse osmosis polymer matrix is most likely a principal mechanism responsible for compound removal.

Grisel G. Rodriguez, Microbiologist

The Value of Water Is Immeasurable

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industrialized "free gift" period when water resources are abundant and few impacts occur. The second stage occurs when populations expand and water resources are exploited to sustain development — this is where strategies, such as dams and water transfers, are introduced. The third stage appears when significant economic investments are made to ensure the availability of resources. It is in this latter stage that non-traditional technology, like desalination and reuse, are introduced to sustain population growth and development.

In the majority of western societies, water remains a mystery. Water utility managers have been so successful in providing high-quality water 24 hours a day that their customers are unconcerned about the process of treating and delivering water. When questioned about where water comes from, many people will respond that it comes from the faucet, the sky, or a pipe. Modern societies appear only to be concerned about water when threatened by drought or shortages.

The value of water should be separate from its price or cost. The price for water is generally considered the cost of supplying water to users, or the "cost recovery basis." Some economists, however, feel that there is little or no relation of the value of water to the user or potential users (Dumsday, 2001). The real value of water, on the other hand, is best related to the services it provides. It may also have several values depending on where and when the service is provided. For example, the highest value of water can be to sustain life. Sustaining life, however, can apply to both man and the environment, and water may be used for both purposes at different times in its history.

A value can also be assigned to water that is not used for a specific purpose. Water kept in groundwater aquifers or reservoirs can be likened to leaving money in a bank account, providing interest and protection for future needs. Water should be viewed as an asset that provides services that have value to the user and requires investments to be maintained. Water is part of a portfolio of natural capital products, like trees, minerals, and cultivated crops. It is not so much that available water supplies are becoming scarce, but that the valued services water provides are rapidly becoming limited to growing populations. Kasnakoglu and Çakmak (1997) have suggested that water should not be treated as a commodity reacting to supply and demand equations, but more realistically in terms of social and economic welfare.

The World Wide Web has contributed significantly to the rapid globalization of national economies. Consumers are marketed electronically every day. As a result, market strategies are based on the common global perception of the real or anticipated values of products. Whether these products are a pair of jeans or the Sunday newspaper, they all depend on water for production and delivery. Unfortunately, the focus continues to be on the final product and not on the raw materials that create the value associated with the final product. Water utilities recognize the value of water when attempting to reduce water consumption or raise rates. When revenues decline, a traumatic atmosphere arises within the organization.

Webster's Dictionary defines *value as "the quality of something that makes it more or less desirable, useful, and a thing of quality having intrinsic worth."* If water remains unique to earth and is the penultimate substance for sustaining life, then why is it perceived as having little or no value? One might speculate that its lack of value is the basis for why it is misused or abused by mankind.

In a 1996 survey by the U.S. Fish and Wildlife Service, the value of water-based recreation in the U.S. was estimated to be $101.2 billion.

Over the last century, treatment technologies have evolved to produce product waters of extraordinarily high quality. These technologies (e.g., reverse osmosis and microfiltration membranes) produce a product from wastewater that exceeds the water-quality standards set forth in the U.S.'s Safe Drinking Water Act. Unfortunately, the engineering community too often becomes enamored with the technology and fails to recognize the value of the products created by the technology. Water utilities must determine the value of the product they are responsible for creating. For instance, what is the value of the product water when the total dissolved solids have been reduced or removed from the source waters? Does the value of water increase when harmful nitrates or *Cryptosporidium* have been removed? What is the value of water used to create wetlands or recreational bodies of water or when stored for energy production? These questions are not asking for the costs and benefits of water, but its value.

Traditionally, guidance to investment decisions for water projects is based on the principles of benefit-cost analysis. This typical engineering approach starts with describing the conditions, as they exist at present, and providing one or more scenarios under alternative conditions. The differences between the "with and without new conditions" are measures of the benefits of the project. The bottom-line financial variables, either positive or negative, generally prompt the decision-making process.

The move away from the more traditional approach will require the acceptance of the concept of total economic valuation that relies upon a broader

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The Value of Water Is More than Money

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range of benefits, both monetized and non-monetized, than are captured in the traditional benefit-cost analysis. Because it is typically not possible to measure the actual economic benefits in terms of value output of goods and services as theory dictates, several techniques can be used to capture estimates of the value of economic outputs. These include:

- Willingness to pay for water produced where additional water supplies may be valued on the basis of actual simulated market prices.
- Increase in net income to an industry.
- Costs of the most likely alternative means of obtaining the desired output are used to approximate the total value when willingness to pay or changes in net income cannot be used.

A need exists to incorporate the value of water to both its quality and quantity. The opportunity to apply technologies to desalt impaired waters can provide additional waters for new uses, including ecosystem restoration, with possibilities for developing impaired land and water for recreational uses.

Utilities will have to address resource needs based on the value of water from various sources, different quality requirements, and different applications. They should also determine the cost of producing water of alternative qualities. Turning the spigot on and understanding the processes that cause the water to reach one's lips is a reasonable first step in understanding the value of water.

Value should be looked upon as a tool that provides a crosscutting approach linking the cost of the technology with variable quality products. In many respects, water utilities are not unlike the manufacturing sector that depends upon natural resources to create products that have value.

Assigning value to water can be an effective tool in allocation strategies. The Intel Corporation recycles nearly 86 percent of its water. Armco's steel plant in Kansas City reuses water at least 16 times, which allows it to take in only 3.5 million gallons a day even though it uses 58 million gallons a day. The recognition of the value of water has allowed these companies to compete in the marketplace and to retain market share and profitability.

The University of Maine at Orono recently completed a study that examined property values of shorefront homes on 34 lakes in Maine from 1990 to 1994. The results indicated that within a group of lakes of varying water quality, the homes along lakes with lower clarity also had lower property values. The university's research indicated that a 1-meter difference in average minimum clarity over 10 years was associated with a property value decline of $3,000 to $9,000. In a 1996 survey by the U.S. Fish and Wildlife Service, the value of water-based recreation in the U.S. was estimated to be $101.2 billion.

To make the shift from where we are today to where water is accepted as having value will take time and effort. One must remember that while water starts out "free," by the time it reaches its ultimate destination, whether a manufacturing plant or your glass, investments were made to provide a product of high quality.

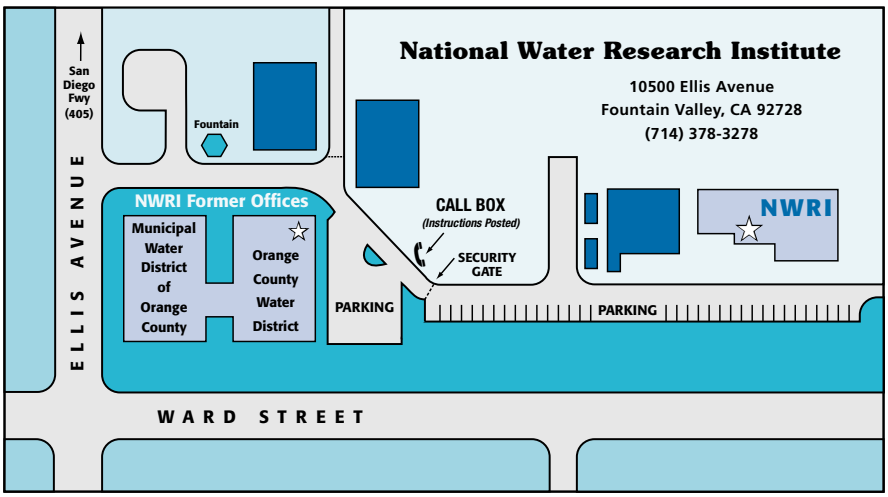
Previously published by IDA at the Water Reuse & Desalination Conference in Singapore, February 25-26, 2003. The unabridged version of this presentation can be found in the Conference Proceedings. Please visit www.idadesal.org for contact information.

References

Dumsday, R.G. (2001). *The value of water and implications for its allocation.* Unpublished presentation to Melbourne Water.

Faldenmark, M., and G. Lindh (1993). *Water and economic development: Water in crisis.* Pacific Institute for Studies in Development, Environment, and Security, Stockholm Environment Institute.

Kasnakoglu, H., and E.H. Çakmak (1997). "Economic value and pricing of water in agriculture." *Options Mediterraneennes,* A(31).



NWRI Has Moved!

NWRI is still located at 10500 Ellis Avenue in Fountain Valley, California; however, NWRI has switched offices. NWRI's address and telephone/fax numbers remain the same.

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