

# RESEARCH OPPORTUNITIES AT THE YUMA WATER QUALITY IMPROVEMENT CENTER

Water Treatment Technology Program Report No. 25



July 1997

U.S. DEPARTMENT OF THE INTERIOR  
Bureau of Reclamation  
Technical Service Center  
Environmental Resources Team  
Water Treatment Engineering and Research Group

# RESEARCH OPPORTUNITIES AT THE YUMA WATER QUALITY IMPROVEMENT CENTER

Water Treatment Technology Report No. 25

edited by

**O. K. Buos**

Summary Report of a Seminar  
January 1997

jointly sponsored by

American Desalting Association  
U.S. Bureau of Reclamation

Water Treatment Engineering and Research Group  
Environmental Resources Team  
Technical Service Center

July 1997

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*Acknowledgments*

The American Desalting Association and the Bureau of Reclamation, **cosponsors** of this event, would like to thank all the moderators, presenters, receptionists, and facilitators that helped make this seminar a big success. The Bureau would especially like to acknowledge and thank the American Desalting Association, the National Water Research Institute, and the U.S. Department of the Army for its support in making this event and the Water Quality Improvement Center a reality. The joint planning committee+ made up of David Furukawa, Jack C. Jorgensen, Lisa Henthorne and Paul D. **McAleese**, all contributed many hours of time and effort to make the dedication and workshop possible.

This report was edited by ADA member, O.K. Buros.

David Furukawa and Jack Jorgensen  
Seminar Co-Chairmen

*Researcher Disclaimer*

The contents of this report represent our interpretation and analysis of information provided by individuals in the subject municipalities or agencies. It is not guaranteed as to accuracy or completeness.

## ABBREVIATIONS

ADA	American Desalting Association
AF	Acre-foot
AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
c w s	Clean Water Systems
DOD	Department of Defense
EDR	Electrodialysis Reversal
EPA	United States Environmental Protection Agency
EPRI	Electric Power Research Institute
IDA	International Desalination Association
IX	Ion exchange
JTU	Jackson Turbidity Units
MF	Microfiltration
mg/L	Milligrams per liter
mgd	Million gallons per day
MF	Microfiltration
NF	Nanofiltration
NSF	National Sanitary Foundation
NTU	Nephelometric Turbidity Units
NWRI	National Water Research Institute
NWSIA	National Water Supply Improvement Association
o s w	Office of Saline Water
OWRT	Office of Water Research and Technology
RO	Reverse osmosis
SDI	Silt density index
SDWA	Safe Drinking Water Act
TARDEC	Tank and Automotive Research and Engineering Center
TDS	Total dissolved solids
UF	Ultrafiltration
USBR .	United States Bureau of Reclamation
WQIC	Water Quality Improvement Center

## FOREWORD

This report has been produced by using materials submitted by the presenters and/or by transcribing and editing the presentations and comments of the participants.

The paper, "Desalting and the Simon Bill: Who Cares!" by Ron Linsky was printed as submitted by the author.

The remaining papers and discussions were composed by the editor using recordings of the presentations. This was supplemented in some cases by material supplied by the presenters. Each presenter was asked to review the presentation before it was included in this report.

The summary of the workshop breakout sessions in Section 4 was based on the materials supplied by the facilitators who worked with each of the groups.

In general, the editor annotated and modified the material to some degree so as to make it appropriate for printed rather than the oral presentation from which it was derived. The text presented in the report is meant to follow the general trend of what took place, but it is not a word-by-word duplication.

If during the editing process, there has been a change in meaning, it was not intentional. I offer my thanks to the presenters and others who reviewed this material and provided corrections, clarifications, etc., which improved the final product.

O.K. Buros, Editor  
Denver, Colorado

## EXECUTIVE SUMMARY

A one-day seminar was held on January 23, 1997, as part of the opening and dedication of the U.S. Bureau of Reclamation's Water Quality Improvement Center (WQIC) in Yuma, Arizona. The seminar was cosponsored by the U.S. Bureau of Reclamation and the American Desalting Association.

The one-day event had three purposes. One was to dedicate the WQIC, two was to discuss ways of encouraging desalting research using the new facility in Yuma, and three was to brainstorm research priorities under the Desalination Act of 1996. A major address on the new directions in water research by Reclamation was given by Eluid Martinez, Commissioner of the Bureau of Reclamation.

The major topics that were presented by other speakers were:

- National Centers for Water Treatment Technologies
- Water Quality Improvement Center in Yuma
- Technology problems and challenges
- Research at the Water Quality Improvement Center
- Water Desalination Act of 1996 (Simon Bill)

The goal of Reclamation's WQIC in Yuma is to become the facility of choice for the desalting industry for research, testing, and training.

In addition to the presentations, there was a workshop in which a number of small groups of desalination professionals and others discussed a several issues related to the use of the research center at Yuma and best way to implement the Water Desalination Act of 1996. The groups looked at six questions:

- What do you personally foresee as the three most significant problems in water treatment technology?
- What role can the WQIC play in solving the problems?
- What obstacles do you foresee in conducting research at the WQIC?
- From a national perspective, what are the highest priority needs or issues that must be addressed in order to make desalting readily implementable in the US?
- What balance should be sought for research versus demonstration investment?
- From a management perspective, what options are most attractive to implement the Simon Bill?

The responses to these questions are summarized in this report.



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# 1 .O Seminar Program

## 1 .1 Program Schedule

**January 23, 1997, Yuma, Arizona  
Water Quality Improvement Center**

### **Morning Session - Paul McAleese, Moderator**

9:00 - 9:05	Introduction - Gary Bryant
9:05 - 9:30	Keynote Address - Eluid Martinez
9:30 - 9:45	ADA Support - Ian Watson
9:45 - 10:00	National Centers - Stan Ponce
10:10 - 10:15	Water Quality Improvement Center - Charles Moody
10:15 - 10:30	Break
10:30 - 10:45	Inauguration of the WQIC as the First National Center
10:45 - 12:00	Tours of the Water Quality Improvement Center
12:00 - 1:00	Lunch

### **Afternoon Session - David Furukawa, Moderator**

1:00 - 1:20	Introduction - Lisa Henthorne Technology Problems and Challenges - Randy Truby Research at the WQIC - Dermis Kasper
1:20 - 2:20	Brainstorming Session
2:20 - 2:30	Break
2:30 - 2:45	Desalting and the Simon Bill: Who Cares? - Ron Linsky
2:45 - 3:30	Brainstorming Session
3:30 - 3:55	Presentation of Brainstorming Sessions
3:55 - 4:00	Wrap up and Adjourn



## **2.0 Water Quality Improvement Center**

### **2.1 Introduction to the Center**

*By Gary Bryant*

Thank you all for being here. I am impressed with the large turnout for this event. We in the Bureau of Reclamation in Yuma want the Water Quality Improvement Center (WQIC) located at our facility to be the facility of choice. The research center, the training center, the testing center of choice for you out in the industry. We have made a commitment that we will try to get cost sharing for all of our activities and that we will try to make the WQIC self-supporting to the best of our ability.

In order to do that, we plan to bend over backwards to give good service. We plan on not short-changing anyone who wants to come out to this facility and use it for any of their testing or research

I'd like to thank the American Desalting Association and the National Water Research Institute for helping to develop the idea and supporting us in actually building the facility. I would also like to thank all of the scientists, engineers, maintenance crews, Burns & Roe Service Company, White Gloves, and others in Yuma for helping to pull this thing together. This event has been in the works for several months, with crews working overtime to make sure that it came off so well.

### **2.2 Keynote Address**

*By Eluid Martinez*

There must be something that draws people to Yuma in the wintertime. There are more people here than I found in Monterey, California, on a similar issue a number of months ago. I want to thank all of you for being here and the support of the ADA and the National Centers for Water Treatment Technology.

This place holds a special place in my memory as Commissioner of Reclamation in the fact that I got back to Washington on January 2, 1996, after I had been sworn in as Commissioner. On the 4th of January, I was sitting at the Howard Johnson Hotel that evening watching the news, and I was scheduled to fly out to Yuma on the 5th to meet with the regional staff and water users in the area. I'll never forget that a newscaster came on and said that there was a chance of snow flurries in the Washington area over the weekend. I left DC and the next day it snowed 30 inches. I left DC yesterday, and I hope that I go back without having the same occurrence.

It is not news that the Bureau of Reclamation has, and continues to, redirect its mission. This is for several reasons. When I came on as Commissioner of Reclamation about a year ago, I started to review the material on the Bureau's activities. When I was working with the State of New Mexico as a State Engineer in the Water Administration Office, I knew that the

Bureau existed but I didn't work with them on a daily basis. I had enough problems just trying to administer the water for the State and trying to determine who got permits for use of the water and who did not and defending New Mexico's position with respect to the other states on the Colorado River and the Rio Grande.

I knew the Bureau of Reclamation existed and that they were a large agency. I remember that when I was going to school in New Mexico State back in the 1960s we used a Reclamation publication for our work on design of earthen dams, so I knew that the Reclamation had a rich history and a history of civil works construction.

Little did I know, or paid attention to the fact, that the Bureau of Reclamation was in a stage of transition which it had initiated in the late 1980s. If you look back into the documents that Reclamation put out about 1987, it is evident that it began to search within its self on what its future mission should be. Some farsighted folks determined that the future, in terms of building projects, was on the way out and that the Bureau needed to look at an alternative mission.

The previous Commissioner, Dan Beard, had come from a position as a Congressional Committee staffer. He came with an agenda and he was very effective in carrying out that agenda. In my opinion, he seized on the opportunity that was presented by the fact that the Bureau had already been looking at reorienting their mission and he affected that change very quickly. Over the period that he was Commissioner of Reclamation, Reclamation downsized and restructured the way that it did business. It put out more authority to area managers and started to move away from activities dealing with the civil works construction, both inside and outside of the country. He started putting more emphasis on water conservation and the efficient management of water.

During that two year period, the Bureau of Reclamation came out with a number of publications, including a Blue Print for Reform, an initiative on facility transfers, an initiative on water conservation, and so forth.

During the middle of this period I was serving as State Engineer of New Mexico, and in December of 1994, I left as State Engineer and retired after 3 1 years in State Government and went to a well earned retirement doing my art, building a workshop, and doing what I really enjoy in life - painting and sculpture.

I got a call from the White House in February of 1995 that basically asked if I would be interested in a position in the Department of the Interior, and, coming by surprise, my first reaction was yes. In retrospect, had I known what I was getting myself into, I might have given it second thoughts.

My answer was yes for a couple of reasons. One, that to me, and it continues to be my feeling, is that I'm an engineer. I work in the water business, it has been my life and my career and to have been given the opportunity to be Commissioner of Reclamation was a

great honor for me and for engineers in general. Little did I realize that the Bureau of Reclamation had not been headed by an engineer, especially a registered engineer, for quite some time.

It was an honor, and I think it was like an attorney being called and asked if they were interested in becoming Attorney General of the United States. For a civil engineer in the water business, I thought I could bring something to the profession. On the other hand, another thing that attracted me to the position is that it was a wonderful opportunity because of my ethnic background. I was, fortunately, the first Hispanic State Engineer in the history of the United States, and I'm sure that was one reason why I was selected to be Commissioner of Reclamation.

This gave me the opportunity to become the first Hispanic Commissioner of Reclamation and probably the only one for quite a while, so I seized on the opportunity. Little did I realize what I was getting myself involved in. When I went back to Washington and got briefed for the confirmation hearings, I began to learn then what the Bureau was undergoing and perhaps where it was heading.

I remember meeting with Commissioner Beard at the time, and I asked for some words of wisdom. Basically, in summary, what he told me was, "Good Luck." He said he had done what he set out to accomplish, which was basically to turn the agency around from its former perspective, and now it was up to me to implement it. He said that implementation was something that he was not very good at doing. "I'm good at shaking things up but not very good at settling things down."

So my job, as I view it, is trying to implement what we are doing and where we are heading over the next couple of years. In that respect, we have made some accomplishments over the last year.

Let's get back to this business of waste water reuse. If you subscribe to the notion that in the United States we are not going to be building any large water development projects and we know that there is a limited supply of water, then we will not be creating any new sources of water. If this is so, then where is the supply going to come from to meet the increasing demand?

It has to come from a change in the type of use and place of use of water and this is the whole concept of water transfer and issues related to that subject. The other area you can deal with is water conservation, but in my opinion, there is only a limited amount of water that can be realized from that source. Then there is reuse of water - waste water reuse. I think that there is the great potential, and as you know, it just comes down to a question of economics.

I remember Steve Reynolds, some of you may have known him in his tenure as State Engineer of New Mexico, used to tell me that we have enough saline water in New Mexico, to supply the needs of New Mexico for the next two to three hundred years. The problem is in accessing that saline water and making it suitable for use. Some of you people remember there was a federally funded facility in Roswell, New Mexico, to remove salt from water.



That plant was up and running and getting funded and then it stopped. I asked the question of why did that plant go out of production. One of the old political icons in New Mexico told me that a Senator who had never lost an election in southeastern New Mexico ran again for office and lost support from that part of the state. Needless to say, that plant did not continue to get any further funding.

It is an interesting point, as the closing of the plant had nothing to do with the technology aspects. It was just a political reality. Let's just hope that this story does not bear fruit in other areas. The point is that you can have the best brains and technology in the world but you are often dependent on a financing source which sometimes cannot be counted on as well as we would like.

Where we are now? From my perspective, I see a lot of interest in waste water reuse, and this can be borne out by the fact that the Bureau is involved in five waste water reuse projects in Southern California under the old Title 16 legislation of 1992. In 1996, in the last Congressional session, Congress passed another piece of legislation which authorized our involvement with another 16 waste water reuse projects across the land and two demonstration projects, for a total of 18 projects. Authorized them, but did not provide any money for construction. For the projects in Southern California, the Federal commitment is for 25 percent of the total cost. The total Federal commitment for these projects is a little over \$300 million by the time they are fully built.'

The Bureau of Reclamation's Commissioner Beard, realizing that the amount of money that could be siphoned from the Bureau's project budget could be significant, placed a \$25 to \$35 million annual cap in the budget process on waste water reuse. When you look at \$35 million maximum per year that the Bureau can give for supporting those projects for waste water reuse, and there are five projects in Southern California for \$300 million, then it doesn't take a math expert to tell you that we are fully committed for many years to come as far as funding is concerned for these five projects. This is notwithstanding the 16 new projects that Congress has authorized which now Congress has placed a cap of \$20 million per project. So I am going to find myself in an interesting situation in the next couple of years when these new project sponsors come for funding to initiate their projects.

Most of these projects in California involve desalination technology. I remember going to the Orange County facility and walking through, and they told me it was a state-of-the-art facility in application of desalting technology. So I think you are going to see more and more emphasis and interest by the Bureau in desalting. As an example, the Bureau is going to be involved in desalination research in the Devil's Lake area in North Dakota, and I think there is a great future for this field.

On the other hand, in my opinion, it is important to make the technology accessible at a lower cost. Either that, or the Bureau needs to take the position that it will charge about ten-fold more for the water it provides across the West.

For a market-driven scenario under which waste water reuse takes place, one of several things need to happen. The price of water that comes off of Federal projects needs to increase, the marketplace drives the cost of existing water resources upward, or the cost of desalination comes down.

I want to remind you that I am not an expert in these desalting issues, but somebody was telling me that \$300 to \$400 per acre foot was the cost of treating the water with reverse osmosis. Now when you compare this to water supplies that are running from \$18 to \$75 per acre-foot, you began to see where human nature will go, and it is to the source of supply which is cheaper. So I don't know whether technology can bring us into a realistic possibility of reducing that cost of taking salt out of water to make it economically feasible. I think we need to advance the technology to reduce the cost.

That is one of the reasons why this facility was constructed to continue research and to plow new ground. From my perspective, I am supportive and will continue to be supportive of this initiative for several reasons. It will make the job of water administrators across the West a lot easier in the fact that some of the demand can be met by using sources that do not constitute a change in use from one type of use to another. It is always easier to make water decisions when you've got supplies. To the extent that waste water reuse can provide a new supply of water that does not create new water but that creates new opportunities to use that water, it will make the decisions of water officials a lot easier. So you have my support as the Commissioner of Reclamation in your activities.

Again, I appreciate that you asked me to be here, and I know the Gary Bryant is trying to do a good job here and will continue to put his best effort forward within the constraints and that he has the support of Dr. Stan Ponce, Reclamation's Research Director. As Commissioner of Reclamation, I have tried to bring the research component of our organization to a more visible role in our organization. I will continue to do that, and I think that it is important that Dr. Ponce is now in Washington, DC, instead of a cubicle in Denver where they didn't know he existed. Hopefully we will be more aggressive in this area.

### **2.3 Welcome from the American Desalting Association**

*By Ian Watson*

I am honored to be here today to participate in the dedication of the Yuma Water Quality Improvement Center and to welcome you all on behalf of the American Desalting Association. About 25 years ago, a small group of water resource and water supply activists met in Washington, DC, to establish a new organization dedicated to the ideal of water quality improvement by the application of desalination and other water sciences to the treatment of impaired water sources. These sources ranged from seawater to secondary effluent. I was privileged to participate in this meeting. This illustrious group was shepherded toward its goal by the late William E. Wame, surely one of the great men of western water.

The outcome of this meeting was the emergence of the National Water Supply Improvement Association • NWSIA.

About the same time, a small organization called the Caribbean Owners and Operators Association changed its name to the International Desalination and Environmental Association (IDEA), emerging as a significant voice in the international desalting scene.

For many years, NWSIA and IDEA competed for the small desalination audience, eventually merging to become the International Desalination Association - IDA. IDA was, and still is, the umbrella desalination organization, and NWSIA became its North American affiliate.

About five years ago, to better define its mission, NWSIA changed its name to the American Desalting Association • ADA. More important is the constant and common slogan of ADA, unchanged for 25 years, “Dedicated to Water Quality Improvement.”

ADA is very excited about the potential for this new facility. Both Bureau of Reclamation and the U.S. Army, with the assistance and cooperation of the National Water Research Institute, have established at this site a facility that has the potential to produce the kind of advances in water quality improvement and water treatment technology that can benefit not only the United States but has the potential to bring advances in simple but effective water treatment technology, including an education component, so desperately needed by the people of the developing nations. This is a place to which researchers can come, a place for serious focused research, a place for the demonstration of practical applied research.

This component of the National Centers for Water Treatment Technology is a vital part of the water supply puzzle, a concept become reality, and a tool to ensure maintenance of the leadership role of the United States in the management of the world’s most vital national resource. All parties involved are to be congratulated.

I know that you will all enjoy your time here today. Please participate **fully** in the seminars. Your input is central to the creation of appropriate and realistic goals for this and other centers to follow. We encourage you to speak up, and you can expect us to listen.

Again, welcome, thank you all for coming, and enjoy your time in Yuma.

## **2.4 The National Centers Program**

*By Stan Ponce*

It’s a pleasure to be here representing the Bureau of Reclamation’s Research and Technology Transfer Program and participate in this opening. I want to commend Gary Bryant, Paul McAleese, Lisa Henthorne, Chuck Moody, and all the others that were responsible for putting together this event today.

I want to speak with you very briefly about the National Centers for Water Treatment Technology. I will cover the history of the program, its concept, vision, specific goals, and accomplishments to date. In particular, I'd like to stress the opportunities for you to participate with the National Centers in the future.

#### **2.4.1 Concept**

The concept for the National Centers came about four years ago in a discussion that I had with Ron Linsky of the NWRI regarding desalination research and the future needs in this area. Our discussion focused on a programmatic point of view and what some of the obstacles were to moving this technology forward. In addition to the obvious one of money, the obstacle that really became apparent was that of facilities and their availability. There was a need for proper facilities for advancing this type of research.

We looked at what we had in our Denver laboratories, including the pilot plant facility, pilot plant and we looked at Yuma, Water Factory 2 1, and these other facilities. These were underutilized facilities, and we needed to move forward with a process to make these facilities more readily available for folks that operate them and others who want to use them, as none of these facilities are used 100 percent of the time.

So that was the underlying hurdle that led to the concept of the Centers. We took this concept to then Commissioner Beard and got his blessing to move forward, and off we went. As we started developing this idea, which was about two years ago, we learned of the activity of the U.S. Army with its Tank and Automotive Research, Development and Engineering Center (TARDEC) in pursuing partnerships and strategies for improving the efficiency and response of the Department of Defense water supply and treatment mission.

In 1996, the three entities, NWRI, the Bureau of Reclamation, and the U.S. Army agreed to unify their efforts into a single strategy for improving the U.S. water technology base. The result being the National Centers for Water Treatment Technologies.

We have developed a strategy on the National Centers. This strategy is quite direct - first, it is simply to optimize the use of the facilities in our nation for development of water treatment technologies. Secondly, it is to enhance the process to avoid duplication of research efforts. I think all of us involved in research find that it is a difficult task to try to preclude duplication, given all the activities across the country in universities, private sector, Federal, and other arenas.

We now have a financial opportunity, at least the authority, with the Water Desalination and Research and Development Act of 1996, which was passed in the last session of Congress. This act authorizes a significant amount of resources to support this technology, which is going to lead, in our viewpoint, to a programmatic approach.

It is really important to note that the act only authorizes money, about \$55 million; it does not appropriate those dollars. There has been some real confusion about this point, and we need to work hard to get these resources included in future appropriation bills so that we will have resources to support this technology. All we now have is the authority.

### **2.4.2 Goals**

The goals of the National Program Centers are six-fold. The National Centers will:

- Facilitate and integrate research, development and technology transfer to promote water supply, treatment and reclamation applications to increase access and improve the utilization of water technology facilities.
- Identify and establish a network of National Centers throughout the United States.
- Develop partnerships between **government** agencies, the private sector, and academia that will create an effective response mechanism utilizing the National Centers.
- Promote a more cost effective allocation of resources for water supply, treatment, and reclamation operations to include mobile capabilities, especially as they apply to Native American and small or remote communities.
- Provide increased opportunity for pilot scale and prototype demonstrations of new and innovative technology throughout the National Centers network.
- Establish and maintain information and data exchange systems to improve the coordination between engineering and technology applications.

### **2.4.3 Accomplishments to Date**

Significant accomplishments to date include sponsoring a National Centers Survey, which was published in 1994 and updated in 1996. This work was done by David Furukawa. This study summarizes the facilities nationally that have been made available through the Center's program for individuals to utilize to carry out research for this technology.

In addition, the U.S. Army, the Bureau of Reclamation, and the NWRI have set aside some funding to help support research at these types of facilities. If you don't have the financial resources to obtain time at these facilities, then resources are available for qualified projects.

### **2.4.4 Water Quality Improvement Center**

Today is a very bright moment in the Bureau of Reclamation's research program and the National Center's program in general. Today, we will be dedicating the Water Quality

Improvement Center (WQIC) as the first National Center in our Center's program. It is a milestone. I am pleased to be a part of this event and look forward to the dedication of a series of National Centers during 1997. The WQIC epitomizes the fundamental beliefs of the National Centers program, which are to welcome partners from industry, academia, and government, to push the state-of-the-art of water treatment in order to ensure a **safe**, reliable, and environmentally responsible water supply to the American public.

This facility, as well as others, is available to researchers across the globe. It is an opportunity for all of you and others to develop ideas leading to enhanced water treatment technologies.

From a Bureau of Reclamation perspective, I truly see this as a flagship facility. I will work with Gary Bryant to assist you or others to help develop effective partnerships to carry out work at this very fine facility.

## **2.5 The Water Quality Improvement Center in Yuma**

*By Charles Moody*

The American engineer's "can do" approach, as projected by both government and private industry (represented by the Burns & Roe contract staff), is very much in evidence at the WQIC.

On behalf of the staff that has put together this facility, I want to welcome you to Reclamation's Water Quality Improvement Center (WQIC). It's been created to serve both Reclamation testing needs and the training and testing needs of the water treatment community. Our mission statement is as follows:

The purpose of the Water Quality Improvement Center is to provide a state-of-the-art water treatment facility for advancing the development and transfer of water purification technologies through field tests and hands-on-training.

So why did we build the WQIC? We built it to explore processes for improving water quality. Water quality is important for public health, and this involves both water and waste water treatment. Certainly if we intend to reuse water, it really needs to be treated well.

Water quality is also important for industry. Power utilities often have zero discharge limitations; semiconductor manufacturing plants need very pure water, as does the pharmaceutical industry.

Pilot systems can be very important for achieving a high degree of water quality. As you know, real operation on real waters is absolutely critical for exploring and evaluating water treatment processes and developing schemes for operation.

One of the key pieces of equipment in the WQIC is a small test unit called a "clean water system" (CWS). Commissioned by Kurt Frank and built by Bill Boegli, each of its three

CWS units has two RO vessels with two elements per vessel. One vessel on each unit has the capability to have ultrafiltration (UF) ahead of it. We designed the system to utilize UF product as a particulate free, or “clean water,” control for testing various pretreatment methods for reduction of particulate fouling. We worked with Paul Laverty and Jim Lozier on a similar concept in the early 1980s on a project for evaluating pretreatment processes at Yuma.

In the 1990s, we used this test equipment to determine why the 1 -mgd Pilot System No. 1 was losing salt rejection so quickly. We had a number of expert opinions on the cause but, without that test unit, there was no way to evaluate their suggestions. Expert opinions are important, but they are important only as hypotheses to start from, and these opinions require testing to be proven. The tests we ran on the clean water system unit helped us rapidly to narrow down the possibilities and find the causes of the problem.

This unit proved to be so valuable in our own work that we decided to expand the test units to include pretreatment processes. Along with this, automatic process controls for accurate operation and minimizing operator requirements were added. From the onset, there was a conscious decision by Gary Bryant to make this testing and training equipment available to the water treatment community ▪ manufacturers, engineering firms, and end users.

We want to acknowledge that at the WQIC we hope to continue the progress made by others, including the Office of Saline Water (OSW), the Office of Water Research and Technology (OWRT), the Department of Defense (DOD), the Electric Power Research Institute (EPRI), the American Water Works Association (AWWA), the AWWA Research Foundation (AWWARF), the National Water Research Institute (NWRI), and the Yuma Desalting Plant designers and equipment suppliers.

We intend to work with these entities, where they still exist, and with your participation we can continue their efforts to improve water quality.

The WQIC is for your use. It is available for testing and training. Additional equipment can be installed. Testing possibilities include testing new products and evaluating existing products using the range of feedwaters shown in table 2.5.1.

Table 2.5.1 .-Yuma **WQIC** feedwater sources

Water source	TDS (mg/l)
RO product	250
Colorado River	800
Brackish wells	1,500
Irrigation return flow ▪ without treatment	3,200
Irrigation return flow ▪ with lime softening	3,000
RO reject	10,000

The Colorado River water is similar to what would be received in many areas of Southern California and would be a useful test feed for many of the entities in that area.

The WQIC can be used for a number of things besides testing. These include hands-on training and education of engineers, managers, operators, and elected officials. There are now many potential and actual applications for membranes around the country. Florida now uses membranes for softening. A number of small communities in the mid-west are considering ways to use membranes to remove agricultural herbicides that might be in the water. Tucson desires to maintain its historically high water quality heretofore obtained from ground water, and there is the potential to use nano-filtration for improving the Colorado River water supplied through Reclamation's Central Arizona Project.

The variety of support facilities available at the WQIC is shown in table 2.5.2.

Table 2.5.2.—WQIC support facilities

- 
1. Secure process, laboratory and office areas
  2. All utilities except steam
  3. Warehouses for shipping, receiving, and storage
  4. Engineering (chemical, civil, installation, data reduction, and data analysis) support, for design, installation, data reduction, and data analysis
  5. Operation by **24-hour** licensed operators
  6. Maintenance support, including instrumentation, electrical, mechanical, machine shop, certified welders, and **24-hour** licensed operators
  7. State-certified water analysis laboratory
- 

When you consider using the WQIC for your project, we want you to know that you have the complete, enthusiastic support of all staff here, from managers and engineers who will schedule and monitor your project to the operators and maintenance people who will run and keep your project functioning.

The staff here (mostly Burns & Roe personnel) has played a major role in building the WQIC. They took an existing building and added a **40-ft** expansion to the north. This was serviced by connecting needed utilities and other services available on the site. They installed all of the test equipment, together with the control panels. They fabricated the stainless steel gravity filters, which include large sight glasses for observation of the action of the filter media. Most of the interconnecting piping inside the building is installed in trenches, which helps to keep the test areas free of obstacles.

The basic feed water for the Yuma Desalting Plant comes from a main outlet drain extension from the Wellton-Mohawk canal. Once this water enters the plant, it goes to a grit chamber and then partial lime softening which enables the membranes to get high recoveries and removes **particulates**.

Figures 2.5.1 and 2.5.2 illustrate two potential pilot system schemes that could be used for testing in the WQIC. In Pilot System 1, the water from the grit chamber goes to a solids



contact reactor and then a dual media filter with the effluent then going to a clear well before entering the membrane evaluation research units. In Pilot System 2, the water from the grit chamber goes to a series continuous stirred tank reactor, to a solids contact reactor, and then through gravity filters before going to feed tanks for the membrane evaluation research units.

These flow diagrams illustrate some of the basic flexibility that has been built into the WQIC for testing. As stated previously, the facility is meant to be flexible in equipment, feedwater, and staff in serving the needs of the users of the WQIC. We hope to work with you in the near future so that you can use the facility to advance water treatment technology.

## **2.6 Dedication of the WQIC**

*By Ron Linsky*

Mr. Linsky (NWRI) was joined in the dedication ceremony by Janet Hall (U.S. Army) and Gary Bryant, Stan Ponce, and Paul **McAleese** (Bureau of Reclamation) in unveiling a plaque that was placed on one of the buildings at the WQIC.

Good morning, I want to greet all of you on behalf of the NWRI and its colleagues, the U.S. Army and the Bureau of Reclamation. We are pleased to be here to witness this event. It's hard for all of you to see the tremendous work that has gone on over the past two years to achieve this. This was not only the work of development but it was the work of what I call biopolitics. We spent two years of biopoliticing to reach this day.

It gives us a great deal of pleasure to designate this Water Quality Improvement Center in Yuma as the first National Center of what we hope will be a great multitude of centers across the United States which will improve and move forward the technology of water quality improvement.

# Yuma Desalting Plant

## Water Quality Improvement Center

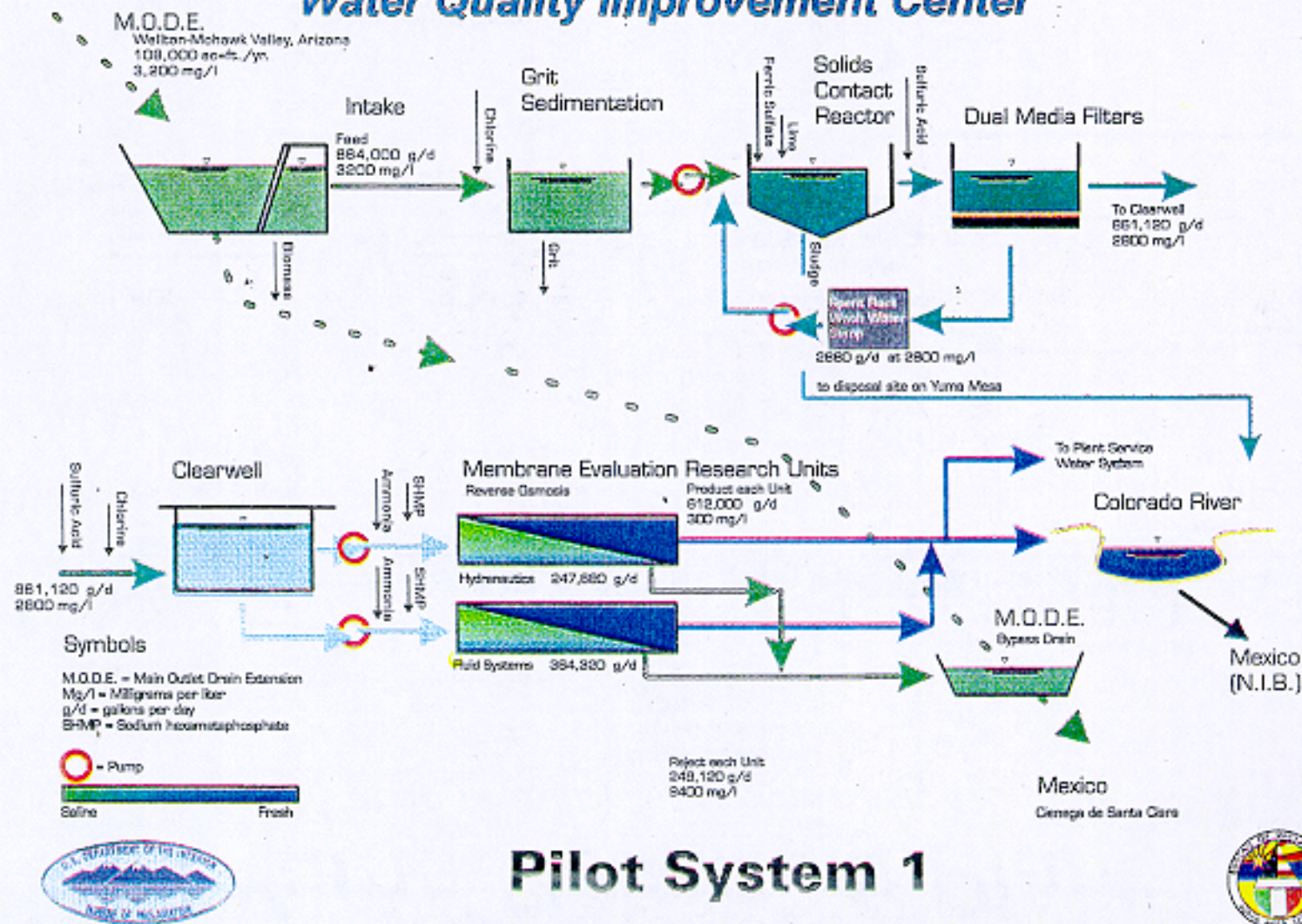
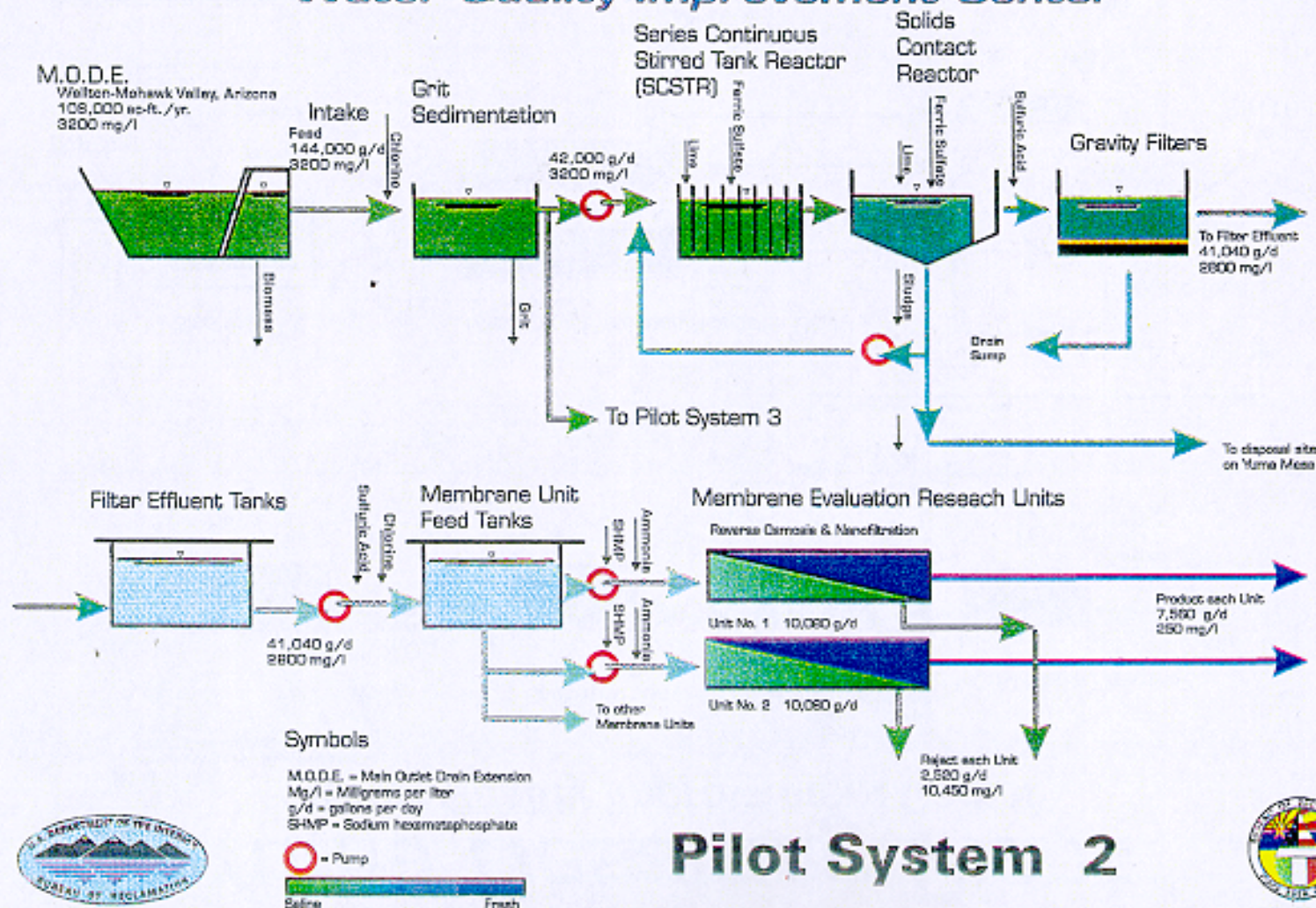


Figure 2.6.1.—Pilot System No. 1.

# Yuma Desalting Plant

## Water Quality Improvement Center



## Pilot System 2

Figure 2.6.2.—Pilot System No. 2.

## 3.0 Desalination Research Workshop

### 3.1 A New Era in Desalting Research

*By Lisa Henthorne*

On behalf of Reclamation, I want to welcome you to the workshop where we will discuss the new era in desalting research at the Yuma WQIC. We are going to transition from the speeches and tour we had in the morning to putting you to work this afternoon.

I'd like to kickoff this workshop by providing you with a perspective as to what we would like to accomplish here this afternoon. During the last few years, Reclamation has co-sponsored a number of interactive workshops such as the one we are holding now. Many of these were in cooperation with the American Desalting Association.

Reclamation has sponsored these workshops for two key reasons. Primarily, these were held because Reclamation highly values the input that it gets from the desalting and water treatment community. In order to have a sound research program, Reclamation believes that it must be based on today's needs. To do that, Reclamation must be in constant touch with each of you to get the feedback to make sure that our program is based on the highest priority needs of what is needed by the desalting community out there.

Secondly, Reclamation believes that these workshops provide a good forum for technology transfer by exchanging points of view. It gives the opportunity for people to hear what other people are doing and thinking in industry and the marketplace today.

The day long event we are holding today has a two-fold purpose. One is that we are celebrating the opening of country's first National Center, the WQIC located here in Yuma. In keeping with that, the first half of our workshop will focus on looking at what roles the WQIC can play in furthering the development of water treatment technology. We will be looking to you to give us some direction as well as telling us what are some of the concerns that you might have in coming here to conduct research. We would like to have that feedback now so that we can start to address some of those issues.

The second half of the workshop will be devoted to the Simon Bill. On September 27, 1996, the Congress passed the Water Desalination Research and Development Act of 1996. When this bill passed, Reclamation began formulating a program on how we would move forward with a research and development program.

Many of you know that Reclamation has sponsored a research program at a much lower level of funding than the Simon Bill authorizes; this is called the Water Treatment Technology Program. The program was created in 1992 and was meant to be the predecessor to the Simon Bill program if, and when, it ever passed. This program provided the foundation for Reclamation to begin to develop the procurement process and mechanisms needed, and to start to look into the research that Reclamation wanted to have up and running by the time that the Simon Bill passed.

What we want from you in the second **half** of the workshop is feedback on where you feel the Simon Bill funds should be directed, how the funding should be balanced between research and demonstration projects, and how you believe the program could be best managed.

As part of the second half of the workshop, we have invited Mr. Ron Linsky, of the National Water Research Institute, to give you an overview of the bill and to lead a motivating and inspirational discussion of the Simon Bill's features and projected research and development program.

All of the information that we gather today will be in a report. Each of you attending this workshop will get a copy of the report so that you will have an overall understanding of the outcome of this workshop today. We look forward to your active participation in the important brainstorming at the breakout sessions.

### **3.2 Technology Problems and Challenges**

*By Randy Truby*

This paper will be an overview of some of the things that could be done at the WQIC facility in Yuma that will help the desalting community with some of the technology problems and challenges that it faces in the future. This will include some of the things that need to be done by the industry that could be tied into a demonstration or study.

In talking about desalting, the word will be used in its the broad sense of the term. Some people think that desalting applies only to seawater. Webster's New Collegiate Dictionary says that to desalt means "to remove salt from \_\_\_," and they leave the **from** blank. For us, the blank in the definition could be filled in by using seawater, brackish water, or waste water. The equipment in Yuma's WQIC could be used to very efficiently remove salt **from** brackish water and waste water.

In Dr. Moody's mission statement for the WQIC, he did a very nice job and identified it with a broad statement about water purification that went beyond just desalting. When you move into the breakout session after these talks, one of things that you **want to** think about is subjects that can be studied here other than desalting. Things that would fall under water purification: microfiltration, chemical studies, that sort of thing as they have facilities to do all of that in Yuma.

Desalting applications are very broad, and they have expanded rapidly since the successful introduction of membranes. These applications include municipal drinking water which can be treated using evaporation, electrodialysis-reversal (EDR), reverse osmosis (RO), ultrafiltration (UF), nanofiltration (NF), microfiltration (MF), and ion exchange (IX). Ultrafilters and microfilters are not really a direct **part** of desalination technologies, but they would fall under Dr. Moody's purification definition. They can, and should be, studied here and evaluated to see how they might function under various circumstances of water purification.

Waste water reclamation is an important application, and that could be looked at in Yuma using the drainage effluent from the Welton-Mohawk canal. Some of the industrial applications for desalting include process and wash water for electronics, boiler feed, mining, beverages, and pharmaceuticals.

### 3.2.1 Technology Challenges

There are a wide number of technology challenges that could be investigated at the WQIC. The facilities here with the variety of feedwaters, instrumentation, operation options, and staffing would be very useful in carrying out research, testing, and evaluation. Table 3.2.1 lists some possibilities for testing and research at the Yuma WQIC.

Table 3.2.1 .-Areas for testing or research at the WQIC

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Membranes - flux, rejection, fouling and chemical resistance
Membranes - selective rejection
Membrane elements - configuration, spacers, turbulence
Membrane construction - adhesives and disposal
Chemicals - biocides, cleaners, inhibitors, and corrosion
Membrane vessel design - recovery, fouling, and capacity
Pretreatment systems
Reclamation applications - waste water, landfill leachate, and agricultural drainage
Hybrid system optimization
Energy efficiency
Alternative energy sources
High temperature membrane operation
High pressure membrane operation
Differential pressure optimization
Parametric studies on cost (operating goals and comparative)
Applications optimization of MF, NF, and UF for virus, organic, and fouling control
Materials of construction
Disposal - concentrate, sludges, elements

---

There have been a number of surveys done at IDA and ADA conferences over the years on research or development needs in desalting. One, which was done by Neil Cline at a Washington IDA conference, identified the number one need in the industry to be a new chlorine resistant polyamide membrane. The polyamide membranes available today are sensitive to chlorine. A chlorine resistant membrane would have tremendous application in controlling membrane biofouling.

Another desalting component that would have a wide application would be special selective rejection membranes that are capable of removing a smaller particle, like atrazene, but pass hardness ions. There is a need for this in places like Holland and France where pesticides containing atrazene are heavily used and the atrazene is finding its way into the public water

sources. They would like to remove atrazene, with perhaps a removal rate of 98 percent. However at the same time they want sufficient hardness to remain to stabilize the water in the pipe network. These membranes are being developed in one form or another today and they will need a place to be evaluated.

There are a number of other areas that are worth some effort to develop for the industry. Spiral wound elements are used in about 90 to 95 percent of the RO systems in the world. They are also used in many of microfiltration and ultrafiltration systems. I think that it would be worth the effort to improve that packaging configuration so that you could operate with a lower differential pressure so that you could reduce energy usage. It could help with **biofilm** inhibition if you had an alternative spacer. For example, there is presently work going on to develop a spacer in an RO element that is impregnated with a biocide of some sort to keep the membrane surface clean as the element is being used. Improved turbulence promotion by modifying the spacer design would also help to keep the membrane surface clean.

Some other membrane packaging issues that could be looked at that which would have some industrial significance would be related to overall recovery. The pressure vessels in the Yuma Desalting Plant operate at about 50 percent recovery per vessel. That means that half the water that goes in the vessel comes out as product and half as concentrate.

It would be a big advantage if you could run each of those vessels at a higher recovery. A number of companies are looking at ways of tailoring and staging the membranes inside the pressure vessel so that you can run a single vessel at 80 percent recovery. The WQIC would be an ideal place to demonstrate and evaluate a system of this sort.

High pressure operation has a real potential for things like the reclamation of landfill leachate. A high pressure, 2000 psi system or element of any configuration would be valuable in processing this type of feedwater.

Some other application optimizations that would be worth some effort in investigating would be organic removal with nanofilters, microfilters, or ultrafilters. Yuma is an excellent place to study fouling control as over the years it has been demonstrated that the feedwater for Yuma has a pretty high potential for fouling, hence the elaborate pretreatment works. With this history of fouling, a researcher can take water at any step in the pretreatment process, including directly from the canal, and do work on pretreatment, fouling control, and cleaning studies.

The idea of process optimization that gets talked about a lot but still needs work is brine disposal. What do you do with the waste products from a desalting or purification plant? In a lot of places in the world, the limiting factors over whether you can use desalting is the disposal of the concentrate.

There are some other things that are not included in table 3.2.1 that you might think about. One of them is certification. If you install an RO drinking water system for municipalities in France, your RO elements have to go through a French certification process. You have to give the French government parts of the system (like the elements) and they take them apart

and they look at all materials. They even look through some of your manufacturing process steps - including some data that you might consider as confidential information. They will not allow you to put the plant on line until you pass their certification.

If you put your plant in the United Kingdom, you have to meet with the Drinking Water Inspectorate and do the same thing. You have to give them the elements, tell them how you made it, the chemicals used, and they test, and they do leaching studies and that sort of thing.

If you sell a system in the United States, you don't have to do anything. You sell it, you install it and you run it. There are no certifications - there are no limitations on them, and the manufacturers are on their good behavior. They do a good job, but they don't have to go through the same rigorous control that they have to do in other countries, and I think it is something that might be looked at that might have some benefit. Remember, there is the National Sanitary Foundation (NSF), and all the manufacturers are now looking at ISO 9000 so that they are all doing things, but there is nothing like the regulations that exist in Western Europe.

Environmental impact studies could be an important part of studies here; although environmental impact is somewhat location sensitive, there may be some things about disposal - including solids disposal, that could be done in **Yuma**. An example of this is what do you do with a worn out element - right now they fill the landfills up with the things. Although presently it is a small problem, it could develop into something more significant as membrane processes increase in use.

The Department of Interior was very instrumental in developing some of the membrane products that are in wide use around the world today. Two of the major innovations, spiral wound elements and the thin-film polyamide membrane, were essentially developed under government sponsorship. The government did a tremendous job in developing and nurturing these researchers. I think that this WQIC facility can be a follow on to that success in the past and provide help and leadership in the industry. This will assist us all in improving water quality in the United States.

### **3.3 Research at the WQIC**

*By Dennis Kasper*

We need to look at this center from a users point of view • representing either the design engineer or the ultimate owner of an RO plant. What are their needs in terms of what is available here. One of the things is the variety of waters, as shown in table 3.3.1, that are available at the WQIC. These can be used to simulate a variety of situations for testing.



Table 3.3.1 .-Yuma **WQIC** feedwater sources

Water source	TDS (mg/l)
RO product	250
Colorado River	800
Brackish wells	1,500
Irrigation return flow • without treatment	3,200
Irrigation return flow • with lime softening	3,000
RO reject	10,000

One of the most important of these is the Colorado River water. While the main plant was not designed to treat Colorado River water, it is here and available at the facility. This source can be used to simulate the drinking water supplies for about 30 to 40 million people in the Western United States.

There are a wide range of processes that are used in water treatment. If we look at the different objectives in potable water treatment in table 3.3.2, we see that it goes from organic removal to disinfection byproduct precursors.

Table 3.3.2.—**Membrane** treatment processes

Objective	RO	EDR	NF	UF	MF	IX
Organic Removal	X		x	x	x	x
TDS Reduction	x	x	x			X
Disinfection byproduct precursors	X		X			X

If a particular contaminant present in your water supply is not in the sources supplying the WQIC, then it is possible that the feed can be spiked to simulate the treatment of that water. Aside from the Colorado River water studies, using any of the other five water sources can be evaluated at this site.

Agricultural drainage is of great interest. Selenium and its removal from water is a major problem in a significant portion of the Western United States where there is agricultural drainage. This can be evaluated here not only by membrane processes but by other physical, chemical, and biological processes.

Selective brackish water research and development is another potential for study here at the WQIC. Blends can be put together from the various sources that could be compatible with the natural feed waters from many other locations. Simulated water studies are another area of research. If an industry today has to meet some of the hazardous waste and the hazardous materials management rules, they are generally trying to go into recycling. One of the first processes that these industries are going to try will be membranes. The systems available

here can be set up to where you can operate them to try different recycling streams, although there may be some permitting difficulties relative to disposal, depending on what the constituents are in the recycled materials.

The most important question when I meet with people and talk about desalting is dollars. About 90 percent of the people that I talk to think the major problem with desalting is its high cost. Very often, they want to talk about pretreatment requirements, the disposal of brine, and about the rate of recovery. In some membrane systems for agricultural drainage, 70 percent of the water is recovered, leaving 30 percent that must be disposed of as concentrate. It is this 30 percent that causes the problems. However, there are ways being developed, or will be developed, to operate that will allow higher recoveries. This generally requires the use of special chemical feeds, and these chemicals need to be carefully tested. That evaluation can be done at the WQIC.

Membrane systems are amazing things. I never cease to be amazed at all of what goes into RO systems. Table 3.3.3 is a collection of little known minutiae that gives you an idea of some of the small items that are in a typical 5-mgd RO system.

Table 3.3.3.—Some components of a 5-mgd RO plant

Elements	1500
O-rings	3000
Membranes	11 acres
Glue lines	30 miles

By contrast, the Yuma Desalting Plant has a capacity of about 70-mgd (14 times this example), and it is operated a little differently, but it gives you an idea of the complexity and, really, the potential for changes and improvements in the process to increase its long term reliability.

One more item • this has to do with the last group of studies that could be evaluated here. This could be different types of mechanical systems as membranes aren't the only things of interest to a manufacturer or end user. One might want to try new pumping systems with membranes where you want to compare them against something. This could also be testing long term reliability for membranes, instrumentation and controls, **antiscalant** chemicals, cleaning chemicals, etc.

Regulatory compliance for both the drinking water and waste water reclamation regulations bring up other situations. An example of this might be where a regulatory agency's defines something like, 'a membrane processes shall remove four logs of viruses' and then asks someone to prove that a system has this type of capability.

What could happen in the future is that one or two manufacturer's systems will be shown to meet a specific performance requirement and this establishes a standard. Anyone else that wants to come in with a new system would then have to compare against that benchmark. Those types of studies could be done at this facility.

Finally, instrumentation and control system development, such as the automatic SDI monitor used at the WQIC, can be done here.

This afternoon when you go to the workshop, you really need to do some brainstorming so that we can get the information from you as to what you think might be able to be tested here. This might be a specific problem that you are facing or some ideas that are based on your experience in the industry.

### **3.4 Desalting and the Simon Bill: Who Cares!**

*By Ron Linsky*

We have witnessed during the last three decades the continual weakening of an American enterprise that for over two centuries has been one of the primary foundation stones of this country's greatness.

In schools, we teach our children about the numerous women and men who have contributed to this country's greatness as a global leader in science and technology. Teachers all across the country describe the discoveries of the early inventors and researchers like Whitney and Edison and continue on into the twentieth century from the Wright brothers to Salk.

Nevertheless, does anyone bother to explain to these young minds what research means and how it contributes to our quality of life and more importantly the role it serves as precursor to expanding economic development.

Senator Paul Simon will be best noted for his many years in the United States Senate and his interest and accomplishments in foreign policy, health care, and agriculture. He will also be noted for tenacity. Because of his tireless efforts to move this country back into research as a prized national enterprise, his legislation aimed at encouraging research to improve desalting technology was signed into law in 1996.

Senator Simon fully recognized that water is the imperative of the next century not only for this country but in the world. But who cares besides Senator Simon?

The water research community cares and so does the desalting community. However, these communities are very small when compared to nearly 260 million Americans that rely upon a dependable supply of high quality water to sustain the lives and livelihoods. Unfortunately, I do not believe the larger community cares. Water is really recognized by a very few persons as the singularly most important substance for sustaining life, producing food, and

manufacturing those marvelous little microprocessors. Where would Silicon Valley be today if the Santa Clara Water District could not insure the availability of a high quality, continuous water supply?

To the general public, the tax paying public, this precious resource is perceived as having no value. Water is probably the most undervalued product in the United States, if not the world. Why is this?

I suggest one reason is that the public has no perception or understanding of what water is, does, or how it affects their lives. This is probably true of politicians too. Another is that American water supply managers have been so good at what they do that the general public has become insensitive to the value of water.

It is only since the 1960s that water began to be looked upon as something other than a nuisance by many. Since then, books have been written, oil spills happened, movements began, and in general, the public started to ask questions about environmental issues. Emotionalism became a vital part of those early strategies to protect resources. Unfortunately, in many cases, man's egocentrism became more important than the resources.

With the growth of the environmental movement over the last 25 years, one would think that research would have grown too. Not so! If you examine the national investment in research as a percentage of Gross Domestic Product, you will find that the United States invests less than 30 percent of what Europe invests and less than 50 percent of what Asia puts into research. How can the United States expect to compete in the global market place if the primary engine of economic development is in reverse.

When President Clinton placed his signature on the Simon Bill it was a very important event that few people noticed. Few noticed that the Bill was signed into law with no appropriation attached. The passage of the Bill might have appeared to some as more of a parting gift to an out-going Senator than a bill to strengthen the nation's research enterprise. The language of the bill is included in Appendix D.

If we really care about research, if we really care about the future of water resources in the United States, then we in the water research and technology communities have to aggressively advocate that funds be allocated to the Simon Bill if its full intent is to be met in 1997 and beyond.



## 4.0 Workshop Results

### 4.1 Significant Problems in Water Treatment Technology

After listening to the information summarized in Sections 3.1, 3.2, and 3.3, the workshop attendees were divided into several breakout sessions which spent time discussing and brainstorming three specific questions. The attendees were asked to provide responses to each of the questions. These responses were gathered, and the responses to the question, “What do you personally foresee as the three most significant problems in water treatment technology?” are summarized below. For the summary, the responses were divided into six categories and duplicate responses were eliminated. The order of listing has no significance.

#### 4.1.1 Education

- Education about desalting technology for the public, elected **officials**, and regulators to promote understanding and acceptance.
- Some common misconceptions are that: desalting technologies relate only to seawater, and the price is too high.
- The current success of the membrane technology is unknown.
- There is a fear that the capital cost, operation and maintenance expenses are too high.
- There is a need to educate the public, educators, regulators, etc., as to current state of desalting technologies, terminology, and the progress made in the last 20 years.
- Water treatment technology is not a high priority in the public view.
- An understanding of how to effectively educate the public to the use and value of desalting technologies. .
- The need to educate the public that water cost is subject to the forces of supply and demand.

#### 4.1.2 Disposal

- Cost of concentrate and brine disposal.
- Regulatory and environmental problems related to concentrate disposal.
- Need better techniques for inland disposal of concentrate, including RO and NF.

- What is the real effect on the environment - Tampa Bay example.
- Waste disposal from desalination plants - environmental and regulatory issues related to them.
- Better understanding of the regulations and effect of sludge disposal in landfills.
- Beneficial uses for concentrate and brine.
- Public acceptance of the need for concentrate or brine discharges and disposal.
- Reuse of concentrate, such as irrigation of salt tolerant plants.
- Desalting by-product (concentrate) reuse, disposal, and classification by regulators.
- Residuals handling and compliance testing.
- Disposal of membrane elements.

#### **4.1.3 Public Health**

- The problem of absolute virus and/or micro organism removal.
- The resistance by the public to drink regulated water.
- Cryptosporidium oocytes breaking through by leakage and ruptures in the membranes.
- Regrowth of microorganism on the product side of membranes.

#### **4.1.4 Regulation**

- Development of procedures for the regulatory approval of processes.
- Certification of processes, components (membranes), and water treatment technology.
- Deciding when good is good enough, i.e., deionized water is not healthy to consume over a long time period.
- There is a need to match required water quality with needs. “One size does not fit all” and as such, excessive water treatment is performed for much of the water used.
- Environmental regulations may do away with chlorination. May be the need to evaluate impacts of other disinfectants on membranes on a pilot scale.

- Changing water quality standards and over-regulation.
- Treatment requirements and standards are often moving targets.
- Over-regulation of the water industry.

#### **4.1.5 Research**

- Duplicate research among researchers in the industry is a problem.
- Research costs are high, there needs to be more cooperative research within the industry.

#### **4.1.6 Costs**

- The need to reduce the cost of desalting by reducing chemical, power, labor, membrane, and concentrate disposal costs.
- Hidden subsidies are skewing cost **comparisons** to alternative supplies.
- Need to look at economics of scale and efficiencies with larger plants.
- Membrane life affects cost • increased life would have a significant impact on operating cost.
- Better (more effective) pretreatment would extend life of membranes.
- How real is the cost issue.
- Cost of concentrate disposal is significant relative to operation and maintenance.
- How to reduce the cost of desalting and concentrate disposal.
- Treatment costs and public's willingness and ability to pay.
- How to economically meet regulatory treatment requirements.

#### **4.1.7 Technology**

- Surface water treatment to minimize fouling of membrane systems.
- Groundwater cleanup is a major problem which requires additional evaluation.



- There are many water quality improvement needs, including general work (pesticides, organics, heavy metals) and removal of specific chemical species.
- Work on the impact of alternative disinfectants on membranes and mechanical systems.
- Lack of long-term reliability testing of processes.
- Makeup of Yuma test facility can address only a finite spectrum of technology problems - i.e., those dealing with membranes or instrumentation.
- Clientele pursuing these technology questions are limited.
- Trend toward more complicated pretreatment systems is increasing the costs of membrane systems.
- Chlorine use (versus other disinfectants) has some benefits due to its residual.
- Odor control.
- Economics - balance between **efficiency**, cost, man power, etc.
- Fouling of membranes.
- Energy costs of an RO unit.
- Developing new systems and/or new technology for future generations who may not have the water supply we have today.
- How long will we be able to treat wastewater.
- Chemicals, run-off, and pesticides removal.
- Flux rate.
- Removal of biota with ozone and other chemicals.
- Total hardness for taste.
- Longevity of the membrane operation.
- Preservation of RO membranes.
- Waste and waste water disposal.

- Plant modifications to meet increasing populations and more stringent treatment requirements.
- Reduce maintenance.
- Develop material specifications or guidelines for specific water treatment technologies.

## **4.2 Roles for the Yuma WQIC**

The second question related to Sections 3.1, 3.2, and 3.3, which was discussed and made part of the brainstorming session was, “What roles can the WQIC play in solving the problems?” The responses were gathered and the responses are summarized below. For the summary, the responses were divided into six categories and duplicate responses were eliminated. The order of listing has no significance.

### **4.2.1 Education**

- Develop centers for information and technology transfer with a national information clearing house which maintains a **website**.
- Provide **website** for students with information on processes, costs, etc.
- Publication of cost studies.
- Provide tours for public education, including school children and tourists to the Yuma area.
- Provide training programs for operators, pilot studies, and public education programs.
- Technical and process issues can be addressed using the WQIC - also training, institutional, and concentrate disposal issues.
- Develop guidelines **and/or** procedures for water treatment technician certification, membranes certification, and materials selection.

### **4.2.2 Disposal**

- Conduct research on brine management: disposal, reuse, and crystallization.
- Evaluate and test new concentrate disposal methods.
- Develop long-lasting, low-power consumption membranes that are durable and relatively insensitive to impurities such as chlorine, iron or biocides, and pesticides.

- Develop means of pretreatment of water with the use of less chemicals and more durable and easily cleaned filters.
- Implementation of alternate concentrate disposal techniques.

#### **4.2.3 Public Health**

- Health risk studies which include the medical community. Get volunteers to consume treated water.
- Research with virus seeding to determine long-term integrity of membranes.
- Research on removal or inactivation of viruses and other pathogens.

#### **4.2.4 Pretreatment**

- Surface water fouling tests to use with pretreatment, cleaning , etc.
- Evaluate MF as RO pretreatment.
- Standard method of characterizing membrane processes, including resistance to fouling in terms of performance versus time, to be able to compare different methods for evaluating performance.
- Different methods of analyzing feedwater for tendency to cause fouling, i.e., SDI, turbidity, etc.
- Relating pretreatment filtration strategies to SDI, NTU, and JTU; which technique is best able to characterize membrane performance.
- Fouling studies • pretreatment, additives, operating conditions, cleaning systems, etc.
- New pretreatment process pilot testing to verify basic research.
- Develop new and improved methods of membrane pretreatment.

#### **4.2.5 Research**

- Agriculture drainage research and development.
- Agriculture cooperative research.
- Tests on effectiveness of instrumentation.

- Develop optimal operational techniques.
- Tests on membrane performance parameters.
- Develop methods of reliability testing, testing on membrane life and fouling.
- Pilot test and optimization of new equipment or processes to define material, configuration, and instrumentation.
- Long-term equipment and instrumentation testing in actual process applications.
- Evaluation of operational reliability of data.
- Test and produce potable water from other water sources for future generations; provide important data so that some basic regulations can be set.
- Develop on-line, real-time analytical sensors and techniques.
- Pilot and make long term tests for advancements such as new RO element feed spacers and new chlorine resistant membranes.
- Tests needed or data to satisfy regulations re: Clean Water Act.
- Various testing methods for brine management, materials, pathogen removal.

#### **4.2.6 Membranes**

- Test new and better membranes.
- Long-term testing of membranes and pretreatment systems.
- Research and development on non-chlorine disinfection strategies.
- Research and development on extending membrane life of intermittently used membranes at seasonal plants (like drying membranes).
- Testing of new membranes under defined test conditions and known baseline conditions.
- Evaluate process simplification (pretreatment and membrane).
- Research and development of dynamic membranes.
- Long-term testing of selective chemical rejection membranes.

- Studies on biofouling and the evaluation of new membrane products.
- Test high recovery systems at higher operating pressures.
- Test different types of chemicals.
- Provide prototype - set up for anti-sealant and research membrane cleaning.
- Evaluate and test additives, anti-scalants, high recovery (testing facility).
- Research on quantification of leakage, rupture in RO membranes, and means to minimize leakage and ruptures.

### **4.3 Obstacles to Research at the Yuma WQIC**

The third question related to Sections 3.1, 3.2, and 3.3, which was discussed and made part of the brainstorming session was, “What obstacles do you foresee in conducting research at the WQIC?” The responses were gathered and the responses are summarized below. For the summary, the responses were divided into six categories, and duplicate responses were eliminated. The order of listing has no significance.

#### **4.3.1 Organization**

- Excessive bureaucracy (Bureau of Reclamation, U.S. Government) and red tape.
- Government control of facility.
- Bureaucratic delays may impede research schedule.
- Confidentiality and secrecy of proprietary work.
- Marginal government facility due to undefined future funding levels.
- The Center has diverse interests, and therefore, there is a potential for conflict.
- Need to define priorities relative to use of equipment by outside researchers.
- Guarantees are needed such that data developed will be proprietary.
- Undefined cost structure, i.e., specific guidelines for cost sharing and lack of specific list of facility costs.
- Questions of indemnification and ownership.

### **4.3.2 Technical**

- Limited feed water sources.
- Hard to duplicate water characteristics prevalent in other locations.
- Possibility of lack of flexibility over the type of constituents present (or added) in a given feed stream during testing.
- Scale of project research to application.
- Where toxics or possible pollutants are employed in the research and development, there may be problems with regulators, i.e., adequacy of WQIC's discharge permits.
- Sufficient resources to accommodate everyone who may want to use the facility.
- Ability to acquire raw materials from across the nation in order to study a locale's issues.
- Space limitations.
- Feed water changes due to problems in the feed to the canal.

### **4.3.3 Costs and Funding**

- Public funding of research and development.
- Need for greater support from the water industry.
- Will large companies continue to foot the bill for research and development.
- Analytical costs related to proving technology.
- How will cost sharing work.
- Who pays - diffuse sources.
- Cost effectiveness needs to be evaluated.
- There is competition from other research and development facilities.
- Cost of testing - need published costs.
- Demonstration that the return on investment **justifies** the costs.

- Cost share requirement - what ratio of government to industry.
- Will the government and private industry provide **sufficient** financial support to demonstrate real life operating conditions, costs, etc.

#### **4.3.4 Location**

- Isolated, too far from anywhere, hot, dry, and unappealing.
- Cost of travel, etc., to Yurna.
- Need to relocate researchers to area.
- No reliable source of wastewater feed.
- Limited variety of water sources are available.
- Remote location with limited access and resources.

#### **4.3.5 Other**

- Establishing customer priorities.
- Limited availability of feedwater types.
- Multiple users using same facility coordination.
- Facilitate organized distribution of technical information to prevent duplication.
- Commitment by other agencies and industry to support this program.
- Research and development program needed to include current problems such as processing low level nuclear wastewater.
- Water sources needed for testing and developing water treatment methods from other parts of the country or the world.

### **4.4 Issues Related to Implementing Desalting in the USA**

After listening to the information summarized in Section 3.4, the workshop attendees were divided into several breakout sessions which spent time discussing and brainstorming three specific questions. The attendees were asked to provide responses to each of the questions. These responses were gathered and the responses to the question, “From a national perspective, what are the highest priority needs or issues that must be addressed in order to make desalting readily implementable in the U.S.?” are summarized below. For the summary, the responses were divided into seven categories, and duplicate responses were eliminated. The order of listing has no significance.

#### **4.4.1 Education and Public Relations**

- Public education on desalting, its cost, and that there is a technology in desalting.
- Educate the government and industries that desalting is the prerequisite for potable water, high purity water, and so forth.
- Public acceptance.
- Encourage public/private partnership to address water supply problems.
- Desalting is a form of drought protection.
- Education, outreach.
- Curriculum development for early childhood education.
- Development of strategies for public involvement.
- Membranes are still viewed by many as impractical - a curiosity.
- Lack of operator training centers.
- Accessibility of research results • use of the Internet to update latest available information at several levels of complexity and simplicity.
- Educate the public on the true value of water that they receive and on related regulations of the area, state, country, and overseas.
- Promote desalinated water and make the public understand and, hopefully, accept this issue to make regulatory issues easier.
- Lack of public trust in research and technology communities.
- Need to educate public on cost and value of good water.
- Educate public on the importance of safe water supplies and the need for water desalination research and development.
- Utility managers and public should be educated in the perception of need.
- Define economic value of lower TDS water.



#### **4.4.2 Regulatory, Legislative, and Policy**

- Regulatory approval.
- Certification.
- Our elected officials must be prepared to fund the technology and facilities to implement the Clean Water Act and to raise public awareness so that they will accept the costs.
- Inadequate integration of water institutions: water supply, water quality, water/wastewater, water reclamation, urban runoff, etc.
- EPA drinking standards for trace **organics** and metals seem to track detection limits ▪ removal levels greatly affects treatment costs.
- Anticipate product approvals by NSF, etc.
- Regulatory action to define the best available technology which details several acceptable waste disposal or reuse options.
- Integrate research and development with overall implementation.
- Regulations - classifying membrane by-product as an “industrial waste.”
- Regulations, regulations, regulations.
- National perspective ▪ needs or issues to make desalting implementable Environmental issues where brackish water is cause of damage to wildlife.
- Water shortages are forecast where cities located along coast or rivers that are deteriorating in quality or area where the ground water supplies becoming brackish.
- Environmental & regulatory constraints on the water industry are excessive.
- Streamline the regulatory process.

#### **4.4.3 Research**

- Research should be emphasized and increased to improve the efficiencies of present processes and develop new processes.
- Pilot testing is not “on-site.”
- How to assure confidentiality during research.

- How can the WQIC become industry friendly.
- Federal funds for research and development by the public and private sector.
- Need of research on the social/political approach to permitting process for desalting projects.
- Availability to small communities.

#### **4.4.4 Cost**

- Provide grants to assist in funding seawater desalting facilities.
- Provide tax exemptions and open incentives to desalting initiatives.
- Cost of water is too low due to various subsidies.
- If true costs of other water was charged, desalination would be more competitive.
- Reduce desalting costs.
- Convince public and officials that desalination costs are not unrealistic.
- Economical management of the reject stream.
- Lower the cost of desalted water.
- Alternatives to concentrate discharge.
- Creative financing - how does a utility develop the funding base without government assistance.
- Institutional problems - there is a market for \$500/AF water.
- Need way to market water rights through a distribution system .
- Price of water will go up when you pay the real cost of water delivery.
- Have consumers pay for subsidized government water projects.
- Consider subsidy issues.

#### **4.4.5 Technology**

- Desalination plants can create environmental problems associated with energy consumption and brine or concentrate disposal.
- Use or test an anaerobic feed supply to maintain minerals in solution, such as iron.
- Cost reduction.
- High recovery plants.
- Use of improved anti-sealants.
- Reduce quantity of chemicals needed for pretreatment.
- Water with a high silica content.
- Cleaning of fouled membranes from silica.
- Membranes foul easily and are difficult to clean.
- Change spacer design.
- Change module configuration.
- Change pretreatment.
- Small system cost and reliability, need simple, cheap, small systems which requires little sophistication to operate.

#### **4.4.6 Other**

- No standardization in industry.
- Need for central location for publications (transfer of new technology).

#### **4.4.7 WQIC Management**

- Involve outside consultants, experts, etc.
- Limit the role of the government in evaluating research proposals.
- What options are most attractive to implement in the Simon Bill.

- Have government and private sector commit equal portions of funding • have private sector take lead in what projects take priority • with government review of how funds are being spent.

## **4.5 Balance Between Research and Demonstration Projects**

The second question related to Section 3.4 which was discussed and made part of the brainstorming session was, “What balance should be sought for the research versus demonstration investment?” The responses were gathered and the responses are summarized below. For the summary, the responses were divided into six categories, and duplicate responses were eliminated. The order of listing has no significance.

### **4.5.1 Split**

There were 14 responses with numerical splits. The percentage suggested for research was 10 percent (2 responses), 50 percent (3), 60 percent (1), 70 percent (2), 75 percent (1), 80 percent (4).

### **4.5.2 Comments**

- Demonstrations to get 90 percent with industry participation obligatory.
- Demonstrations eat up too much money.
- Research, as the dollars go farther.
- Research should be favored, demonstration plants should be small scale and limited to new and/or unproven processes.
- Research and development should have a separate pot from demonstrations.
- Research needed to develop new technology and take it to the demonstration level.
- Mostly research with researcher doing pilots for demonstration.
- Presumably those who helped to write the Simon Bill.
- Demonstrations should be the first priority, with research to piggyback on demonstrations.
- No set balance of research versus demonstration for investment • let market forces and merit determine the mix.

- Do not try to limit or define this balance because the balance should be based on evaluation of technical proposals, then fund highest value projects.
- Does not matter, research or demonstration; evaluate all and pick best.
- Let fluctuate.
- Laboratory research leads to demonstration research ▪ once something is found to work, then this process will lead the way to more laboratory research that, **hopefully**, will develop better ways and better products.
- Demonstration of existing equipment should come first; determine if a satisfactory solution or option exists, then research results or research alternatives.
- Basis of need, re: industry, urban, rural ▪ determines balance.
- Difficult to make a general statement ▪ this probably requires a case-by-case evaluation, maybe an expert panel could investigate and evaluate.

## **4.6 Implementation of the Simon Bill**

The third question related to Section 3.4 which was discussed and made part of the brainstorming session was, “From a management perspective, what options are most attractive to implement the Simon Bill?” The responses were gathered and the responses are summarized below. For the summary, the responses were divided into six categories, and duplicate responses were eliminated. The order of listing has no significance.

### **4.6.1 Management**

- Use the **NWRI** research advisory board model.
- Involve the private sector and government to determine the needs of the country and American industry.
- Have a mix of power directing the program ▪ university, industry, government and users.
- Whatever way would generate the greatest private sector participation.
- Partnership with other organizations (such as water districts) which have existing strong lobbying ties with Washington.
- Selected group of management people **from** federal government, municipal, and private industry to manage funding.

- Develop a group like AWWARF has done to manage the projects and identify experts for peer review which Reclamation could do.
- Reputable consultant.
- Joint public and private management: public, government, desalting agencies and universities, private, and industry representatives.
- Use a coalition of Reclamation, Environmental Protection Agency, members from the industry, Congress, and citizens, i.e., an ad-hoc committee to evaluate needs and recommend projects and appropriations.
- Line item appropriation for technology transfer, then apportioned out through central cooperative of the government, private industry, institutions, and the Simon Bill committee.

#### **4.6.2 Other**

- Share cost.
- Media more friendly to desalination research and technology.
- Fund desalting science fair for schools.
- Personal visits to Senators to educate them regarding need for desalting research and development.
- Have one agency determine where water quality issues are a problem and evaluate the nation overall not piece-meal.

## **APPENDIX A**

### **Registration List for the Seminar**

## Appendix A: Registration List for the Seminar

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## **APPENDIX B**

**Water Quality Improvement Center**

## **Appendix B: Water Quality Improvement Center**

The WQIC is located on the grounds of the US Bureau of Reclamation's 72-mgd reverse osmosis brackish water desalting plant in Yuma, Arizona, on the Colorado River. The WQIC offers a wide variety of facilities and services to assist the researcher, manufacturer, consultant, and end user in testing, evaluation, research, training, and understanding of water quality improvement technology.

### **B.1 Facilities**

- Physical facilities available include: grit sedimentation, softening, rapid mixing, flocculation, clarification, sludge removal, and dual or multi-media filtration
- Chemical processes available include: disinfection (chlorination/dechlorination and ammonia/chlorination), pH adjustment (acid/caustic), anti-scaling chemical addition, membrane rejuvenation, and other customer supplied chemical processes
- Membrane processes for testing include: reverse osmosis, microfiltration, ultrafiltration, nanofiltration, and other customer supplied processes
- One 600-gpm and two 50-gpm process trains with a 600-gpm connection to an on-line groundwater well where a range of brackish feedwater salinities can be made
- Processes are fully instrumented and feature a network Supervisory Control and Data Acquisition (SCADA) computer system with Internet access

### **8.2 Services and Other Information**

- Experienced maintenance workers and 24-hour licensed water treatment operators, engineering and technical skills in water treatment processes and instrumentation.
- Fully staffed and licensed environmental laboratory for on-site water analyses of bacteriological and inorganic constituents.
- Through the National Centers for Water Treatment Technologies, a limited number of grants are available to assist the entities without sufficient resources to conduct research at the facility.
- Fully furnished office facilities, including telephone, fax, and computer data transfer lines.

- Patent rights are retained by the researcher or developer, except in a case where the government provides direct funding to further the product development. In this case, a royalty-free right is retained for government use of the product.

### **8.3 How to Access the WQIC Facilities**

- Cooperative research and development agreements are available which can be structured to handle the individual needs of an entity taking into account such concerns as patenting rights and non-disclosure of proprietary data.
- Contact Paul **McAleese**, in **Yuma**, Arizona, at the Yuma Area Office, U.S. Bureau of Reclamation, Phone: 52013438229, Fax: 520/343-8320, E-mail: [pmcaleese-ibr3op@ibr8gw80.usbr.gov](mailto:pmcaleese-ibr3op@ibr8gw80.usbr.gov).

## **APPENDIX C**

### **Biographical Summaries**

## Appendix C: Biographical Summaries

**GARY BRYANT**, Yuma, Arizona. Mr. Bryant is Reclamation's Area Manager for the Yuma Area Office since 1994. His responsibilities involve Reclamation projects along the last 275 miles of the Colorado River as well as overseeing all salinity control projects south of Imperial Dam, including the Yuma Desalting Plant and Yuma's WQIC. He has degrees in Zoology and Biology.

**O.K. BUROS**, Denver, Colorado. Dr. Buros is a Vice President for CH2M HILL International for the Europe, Africa, and Middle East Region. He is active in the area of non-conventional water resources and is currently working on an urban water management project in Lvov, Ukraine. He was the editor of this publication.

**DAVID FURUKAWA**, Poway, California. Mr. Furukawa is the President of Separations Consultants, specializing in membrane processes. He has worked on projects throughout the world and has served as Director of the boards of ADA (President 1985-86), IDA (1 st VP 1987-88) and the NWRI (Research Advisory Board). He was on the organizing committee for this event.

**LISA HENTHORNE**, Denver, Colorado. Ms. Henthorne is Manager of Reclamation's Water Treatment Technology Program. Her current projects include working with the Middle East Desalination Research Centre in Muscat, Oman, and acting as technical adviser for Reclamation's work in Devil's Lake, North Dakota. She was on the organizing committee for this event.

**JACK JORGENSEN**, St. Leonard, Maryland. Mr. Jorgensen is a consultant on desalination and legislative strategies. He has a long career with the U.S. Government involving desalination, beginning with OSW and continuing with OWRT, until his retirement from government. He served as the executive director for NWSIA from 1985 through 1994. He was on the organizing committee for this event.

**DENNIS KASPER**, Pasadena, California. Dr. Kasper is the Vice President and Technical Director for Parsons-Engineering Science.

**RON LINSKY**, California. Mr. Linsky is the Executive Director of the National Water Research Institute (NWRI).

**ELUID MARTINEZ**, Washington, DC. Mr. Martinez is the Commissioner of the Bureau of Reclamation. He is a native of Rio Arriba County and served in the New Mexico State Engineer's Office for 23 years, working as the State Engineer and the Secretary the New Mexico Interstate Council on Water Quality. He is the first Hispanic to serve as Commissioner in Reclamation's 93 year history. He has a degree in engineering and is a licensed engineer and land surveyor. He is a noted artist and sculptor with work in the Smithsonian.

**PAUL McALEESE**, Yuma, Arizona. Mr. McAleese is the Research Coordinator at the Bureau of Reclamation's Yuma Area office. He has a degree in Civil Engineering and is a licensed engineer and land surveyor. He was on the organizing committee for this event.

**CHARLES MOODY**, Denver, Colorado. Dr. Moody grew up on a farm a few miles from the Yuma Desalting Plant and works at Reclamation's Technical Service Center in Denver. He worked at the Yuma Desalting Test Facility as a program monitor from 1979 to 1982 and headed the effort to design and assemble the 30 gpm Pilot System 2 at the WQIC. He has degrees in Physics and Watershed Management and is a registered professional engineer.

**STAN PONCE**, Washington, DC. Dr. Ponce is Reclamation's Research Director. In that capacity, he provides leadership and coordination to the Bureau-wide R&D program covering areas of water resources, land, fisheries, wildlife, facilities operation, hydropower production, and policy. He has degrees in Forestry and Natural Resources, Forest Hydrology, and Civil and Environmental Engineering.

**RANDY TRUBY**, San Diego, California. Mr. Truby is the Vice President for Marketing for Fluid Systems. He a past president of IDA.

**IAN WATSON**, California. Mr. Watson is a principle chemical engineer with Boyle Engineering and is Director of Membrane Processes. Prior to joining Boyle Engineering, he was President of Rostek Services, which specialized in desalination plant operation and design. Ian is a founding member and President of the ADA, on the Board of the IDA, and a member of the AWWA Desalting Committee.

**APPENDIX D**

**Water Desalination Act of 1996**

## Appendix D: Water Desalination Act of 1996

The following is a copy of the Water Desalination Act of 1996, often referred to as the “Simon Bill.”

### Water Desalination Research and Development Act of 1996 (Senate • September 27, 1996)

Mr. NICIUES. Mr President, I ask the Chair lay before the Senate a message from the House of Representatives on (S. 81 1), a bill to authorize research into the desalination and reclamation of water and authorize for the States, cities, or qualifying agencies desiring to own and operate a water desalination or reclamation facility to develop such facilities, and for other purposes.

The PRESIDING OFFICER laid before the Senate the following message from the House of Representatives:

*Resolved*, That the bill from the Senate (S. 811) entitled ‘An Act to authorize research into the desalination and reclamation of water and authorize a program for States, cities, or qualifying agencies desiring to own and operate a water desalination or reclamation facility to develop such facilities, and for other purposes,’ do pass with the following amendments: Strike out all after the enacting clause, and insert:

#### SECTION 1. SHORT TITLE.

This Act may be cited as the ‘Water Desalination Act of 1996’.

#### SEC. 2. DEFINITIONS.

As used in this Act:

(1) **Desalination or desalting:** The terms ‘desalination’ or ‘desalting’ mean the use of any process or technique for the removal and, when feasible, adaptation to beneficial use, of organic and inorganic elements and compounds from saline or biologically impaired waters, by itself or in conjunction with other processes.

(2) **Saline water:** The term ‘saline water’ means sea water, brackish water, and other mineralized or chemically impaired water.

(3) **United States:** The term ‘United States’ means the States of the United States, the District of Columbia, the Commonwealth of Puerto Rico, and the territories and possessions of the United States.

(4) **Usable water:** The term ‘usable water’ means water of a high quality suitable for environmental enhancement, agricultural, industrial, municipal, and other beneficial consumptive or nonconsumptive uses.



(5) **Secretary:** The term ‘Secretary’ means the Secretary of the Interior.

### SEC. 3. AUTHORIZATION OF RESEARCH AND STUDIES.

(a) **In General:** In order to determine the most cost-effective and technologically efficient means by which usable water can be produced from saline or water otherwise impaired or contaminated, the Secretary is authorized to award grants and to enter into contracts, to the extent provided in advance in appropriation Acts, to conduct, encourage, and assist in the financing or research to develop processes for converting saline water into water suitable for beneficial uses. Award of research grants and contracts under this section shall be made on the basis of a competitive, merit-reviewed process. Research and study topics authorized by this section include--

- (1) investigating desalination processes;
- (2) ascertaining the optimum mix of investment and operating costs;
- (3) determining the best designs for different conditions of operation;
- (4) investigating methods of increasing the economic efficiency of desalination processes through dual-purpose co-facilities with other processes involving the use of water;
- (5) conducting or contracting for technical work, including the design, construction, and testing of pilot systems and test beds, to develop desalting processes and concepts;
- (6) studying methods for the recovery of byproducts resulting from desalination to offset the costs of treatment and to reduce environmental impacts from those byproducts; and
- (7) salinity modeling and toxicity analysis of brine discharges, cost reduction strategies for constructing and operating desalination facilities, and horticultural effects of desalinated water used for irrigation.

(b) **Project Recommendations and Reports to the Congress:** As soon as practicable and within three years after the date of enactment of this Act, the Secretary shall recommend to Congress desalination demonstration projects or full-scale desalination projects to carry out the purposes of this Act and to further evaluate and implement the results of research and studies conducted under the authority of this section. Recommendations for projects shall be accompanied by reports on the engineering and economic feasibility of proposed projects and their environmental impacts.

(c) **Authority to Engage Others:** In carrying out research and studies authorized in this section, the Secretary may engage the necessary personnel, industrial or engineering firms, Federal laboratories water resources research and technology institutes, other facilities, and educational institutions suitable to conduct investigations and studies authorized under this section.

(d) **Alternative Technologies:** In carrying out the purposes of this Act, the Secretary shall ensure that at least three separate technologies are evaluated and demonstrated for the purposes of accomplishing desalination.

#### SEC. 4. DESALINATION DEMONSTRATION AND DEVELOPMENT.

(a) In **General:** In order to further demonstrate the feasibility of desalination processes investigated either independently or in research conducted pursuant to section 3, the Secretary shall administer and conduct a demonstration and development program for water desalination and related activities, including the following:

(1) **Desalination plants and modules:** Conduct or contract for technical work, including the design, construction, and testing of plants and modules to develop desalination processes and concepts.

(2) **Byproducts:** Study methods for the marketing of byproducts resulting from the desalting of water to offset the costs of treatment and to reduce environmental impact of those byproducts.

(3) **Economic surveys:** Conduct economic studies and surveys to determine present and prospective costs of producing water for beneficial purposes in various locations by desalination process compared to other methods.

(b) **Cooperative Agreements:** Federal participation in desalination activities may be conducted through cooperative agreements, including cost-sharing agreements, with **non-Federal** public utilities and State and local government agencies and other entities, in order to develop recommendations for Federal participation in processes and plants utilizing desalting technologies for the production of water.

#### SEC. 5. AVAILABILITY OF INFORMATION.

All information from studies sponsored or funded under authority of this Act shall be considered public information.

#### SEC. 6 TECHNICAL AND ADMINISTRATIVE ASSISTANCE.

The Secretary may--

(1) accept technical and administrative assistance from States and public or private agencies in connection with studies, surveys, location, construction, operation, and other work related to the desalting of water, and

(2) enter into contracts or agreements stating the purposes for which assistance is contributed and providing for the sharing of costs between the Secretary and any such agency.

#### SEC. 7. COST SHAPING.

The Federal share of the cost of a research, study, or demonstration project or a desalination development project or activity carried out under this Act shall not exceed 50 percent of the total cost of the project or research or study activity. A Federal contribution in excess of

25 percent for a project carried out under this Act may not be made unless the Secretary shall prescribe appropriate procedures to implement the provisions of this section. Costs of operation, repair, and rehabilitation of facilities funded under the authority of this Act shall be non-Federal responsibilities.

#### SEC. 8. AUTHORIZATION OF APPROPRIATIONS.

(a) **Section 3:** There are authorized to be appropriated to carry out section 3 of this Act \$5,000,000 per year for fiscal years 1997 through 2002. Of these amounts, up to \$1,000,000 in each fiscal year may be awarded to institutions of higher education, including United States-Mexico binational research foundations and interuniversity research programs established by the two countries, for research grants without any cost-sharing requirement.

(a) **Section 4:** There are authorized to be appropriated to carry out section 4 of this act \$25000,000 for fiscal years 1997 through 2002.

#### SEC. 9. CONSULTATION.

In carrying out the provisions of this Act, the Secretary shall consult with the heads of other Federal agencies, including the Secretary of the Army, which have experience in conducting desalination research or operating facilities. The authorization provided for in this Act shall not prohibit other agencies from carrying out separately authorized programs for desalination research or operations.

Mr. NICKLES. I ask unanimous consent that the Senate concur in the amendments of the House, and I move to reconsider and lay on the table that action.

The PRESIDING OFFICER. Without objection, it is so ordered.

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