DESALTING AS AN ENVIRONMENTALLY FRIENDLY WATER TREATMENT PROCESS

edited by

O. K. Buros

Summary Report of a Seminar
September 1994

jointly sponsored by

U.S. Bureau of Reclamation
U.S. Department of the Army
American Desalting Association
National Water Research Institute

Water Treatment Technology Report No. 13

U.S. Department of the Interior
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This report summarizes the presentations and break-out workshop findings from a one-day seminar held September 11, 1994, as part of the American Desalting Association's 1994 biennial conference. The seminar was jointly sponsored by the American Desalting Association, the Bureau of Reclamation, the Department of the Army, and the National Water Research Institute. The purpose of the seminar was to discuss the environmental impacts of desalting. The topics addressed in the seminar included desalting as an environmentally friendly process; military issues in field water supply; residuals from desalting; potential impacts of desalting on the environment; brine disposal in oceans; current and future research directions; and research on concentrate discharge in oceans and disposal.

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EXECUTIVE SUMMARY

A one-day seminar was held on September 11, 1994, as part of the American Desalting Association (ADA) conference in Palm Beach, Florida. The seminar was jointly sponsored by the American Desalting Association, the U.S. Bureau of Reclamation, the Department of the Army and the National Water Research Institute. The purpose of the seminar was to discuss the environmental impacts of desalting.

The'major topics that were presented by various speakers were:

- Desafting as an environmentally friendly process
- Military issues in field water supply
- Residuals from desalting
- Potential impacts of desalting on the environment
- Perceptions of desalting
- Brine disposal in oceans
- Current research activities
- Future directions in research and development
- Research on concentrate discharge in oceans
- Research on concentrate discharge and disposal

In addition to the presentations, there was a breakout workshop in which seven groups individually discussed potential solutions to the problems associated with installing desalting plants in an environmentally friendly manner. The groups were divided so as to address two case studies. Each related to the installation of a desalting plant in either Florida (brackish desalting) or California (seawater desalting). The groups looked at three questions:

1. What special features should be included to keep the facility environmentally friendly and the neighbors satisfied?
2. How would the brine or concentrate be discharged and what effect would this have on the water treatment system?
3. What public relations strategy would you recommend to maintain community acceptance throughout the regulatory approval, design and construction phases?

Desalting technology originally was used only to reduce the salt content of water but it now holds promise as a treatment process that can cost-effectively reduce a wide range of constituents which are, now being targeted by the USEPA as undesired in drinking water. It can be expected that we will see a significant increase in the use of this technology in the future.

Despite the demonstrated need in the water industry, there are some problems which beset the industry and threaten to create difficulties in applying the technology. The most significant appears to be the discharge and disposal of brines and concentrates from desalting facilities. There is a **difference** of perception on the environmental impact that can be caused by this discharge and disposal.

The major methods of disposal include:

- Surface water discharge using:
  - Irrigation (Including wetlands enhancement)
  - Use for other liquid needs (Cooling or industrial water)
  - Discharge to groundwater
  - Treat in the ocean • don't bring feed onshore
  - Evaporation and then disposal of resulting solids

For the industry to move ahead, these differences in perceptions relative to environmental impact must be **resolved.** This will need to be done through a combination of technological changes, research and enhanced communications and education.

In working with any community it is important to establish the values of the community and act to serve them. While it may be possible to shape them through explanation and education there are certain inherent values that a community has which should be determined and respected. There was a discussion by several speakers that the industry needs to emphasize more research into communications than technology. Desalting technology is good and people need to hear its story.

Once a decision has been made to install and operate a facility it should be done in a way to minimize annoyance and be a friendly operation. This includes having the construction carried out as quickly and quietly as possible minimizing dust, odor and traffic. When it is operating it should also strive to minimize noise, odor, traffic and visual distraction.

Some of the key conclusions of the seminar **were:**

1. Desalting as a technology has an important future not only as a means of **using** saline water supplies, but in removal of specific unwanted constituents in today's existing water supplies.
2. Communications with the general public, planners, decision makers, and regulators is crucial to the long term viability of the industry.
3. There are certain continuing problems over the perception of regulatory agencies over the environmental impacts of the disposal of concentrates and brines. Efforts need to be placed on reaching a reasonable conclusion on these problems.
4. With some effort and sensitivity to community values on the part of the desalting **industry,** water planners, utilities, etc., there are many ways that desalting facilities can be planned, permitted, constructed and operated in an environmentally friendly fashion which would keep the immediate neighbors satisfied.

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 Technologies as an Environmentally Friendly Process” by O.J. Morin was printed as submitted by the author. The paper, “Brine Disposal in Oceans” by Jean Largier was based on a letter he wrote to the seminar organizers when he discovered that he would not be able to attend.

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 5 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 printing 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

ACKNOWLEDGEMENTS

The ADA would like to thank all presenters, chairs, receptionists, and facilitators that helped make this seminar a big success. The Association would especially like to acknowledge and thank the National Water Research Institute, the U.S. Bureau of Reclamation and the U.S. Department of the Army for its support. The joint planning committee made up of Susumu Suemoto, O.J. Morin, and ourselves all contributed many hours of time and effort to make the program and this resulting document a valuable contribution to the industry.

Additional support for the seminar came from: American Water Works Association Research Foundation, Black & Veatch, California Coastal Commission, CH2M HILL International, Electric Power Research Institute, Florida Department of Environmental Protection, General Atomics, Hutcheon Engineers, Orange County Water District, Scripps institute of Oceanography, Separations Consultants, and the University of South Florida.

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

David Futukawa and Jack Jorgensen
Seminar Co-Chairmen

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APPENDICES

ABBREVIATIONS

ADA	American Desalting Association
AF	Acre foot
AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
CCC	California Coastal Commission
EIS	Environmental impact statement
EIR	Environmental impact report
EPRI	Electric Power Research Institute
FDEP	Florida Department of Environmental Protection
IBM	International Business Machines
IDA	International Desalination Association
IRP	Integrated resource plan
LP	Low pressure
MF	Microfiltration
mg/L	Milligrams per liter
MGD	Million gallons per day
MS	Membrane softening
NF	Nanofiltration
NO_3	Nitrate
NPDES	National Pollutant Discharge Elimination System
NWRI	National Water Research Institute
NWSIA	National Water Supply Improvement Association
O&M	Operation and maintenance
OCWD	Orange County Water District
OSHA	Occupational Safety and Health Act
OSW	Office of Saline Water
PPB	Parts per billion
PPH	Pounds per hour
PPM	Parts per million
R&D	Research and development
RO	Reverse osmosis
ROWPU	Reverse osmosis water purification unit
SDWA	Safe drinking water act
SEDA	Southeast Desalting Association
SWRO	Seawater reverse osmosis
TDS	Total dissolved solids
TV	Television
UCLA	University of California at Los Angeles
USA	United States of America
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
VCR	Video Cassette Recorder

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SECTION 1

PROGRAM SCHEDULE

1.1 PROGRAMSCHEDULE

SUNDAY, SEPTEMBER 11, 1994
ADA ENVIRONMENTAL-WORKSHOP

9:30 - lo:oo	Coffee/Registration
lo:oo - 10:10	Opening remarks: Co-chairmen: Dave Furukawa, Jack Jorgensen and Stan Hightower
10:10 - 10:40	Desalting Technologies as Environmentally Friendly Processes O.J. Morin, Black & Veatch Consulting Engineers
10:40 - 11:10	Military Issues in Field Water Supply Robert Carnahan, University of South Florida
11:10 - 11:40	Residuals from Desalting John Potts, Kimley Horn Engineers
11:40 - 12:10	Potential Impacts of Desalting on the Environment Abdul Ahmadi, Florida Department of Environmental Protection, Southwest District
12:10 - 12:55	Lunch
12:55 - 1:25	Future R&D Direction to Keep Desalting Environmentally Friendly Don Owen, Don Owen & Associates
1:25 - 225	Viewpoints and comments • Jean Largier, Scripps Institute of Oceanography • Deborah Brink, AWWA Research Foundation Frank Oudkirk, General Atomics for Electric Power Research Institute • Cy Oggins, California Coastal Commission
225 - 325	Breakout sessions: Two case studies • West Coast seawater desalting project • East Coast brackish water project
325 - 3:35	Refreshments
335 - 3:55	Current research activities Ron Linsky, National Water Research Institute
3:55 - 4:00	Wrap up & Adjourn

SECTION 2

INTRODUCTION

2.1 INTRODUCTION TO THE PROGRAM

by David Furukawa and Jack Jorgensen

Welcome on behalf of the American Desalting Association **(ADA).** This is the first workshop under the label of the American Desalting Association. You are probably more familiar with the organization as the National Water Supply Improvement Association (NWSIA), but I think the new name clearly states our priority.

This particular workshop is sponsored by the U.S. Bureau of Reclamation (USBR), the U.S. Department of the Army, the National Water Research Institute (NWRI), and the ADA. The ADA has been the strong force in assembling the speakers and putting this program together.

The meeting today is a working meeting. We need you and are asking that you stick with us throughout the day because we really do need your input. We are using a well-tried technique of conferencing and a workshop with breakout sessions. As a result of that we hope to come back with some concrete new ideas on how to handle the environmental aspects of desalting. Do not be tied to what you think you know, or what you think has been done in the past. We are really interested in something new, so even if you think it's a crazy idea, put it out, and give us your help.

Our sponsors are looking for the possibility of expanding our program of R&D. We are looking for a demonstration of new techniques, new technology, as well as legislation or regulation that can help to promote the application of desalination technology in an environmentally sound manner.

We have tried to invite people to this workshop that represent disciplines other than just desalting. Although many of you are from the desalting industry, there are some faces in the audience that are new to the industry and perhaps represent some disciplines that are different. The cross fertilization of technical disciplines is one of the things that is going to help move not only desalting but other technologies forward.

Let me give you an example of productive cross-fertilization. I recently met a person from Wisconsin who was working on her Ph.D in water and had a difficult time understanding some of the basic things most of us take for granted: chemical precipitation, why do some chemical compounds precipitate more quickly than others? She was approaching it from a different direction and collaborating with her husband who happens to be a medical doctor, and they came up with a method of using nuclear magnetic resonance imaging (NMR), which is used in medicine every day but not used in the examination of water. As a result she has come up with a wonderful dissertation on using NMR imaging to examine the molecular structure of water and dissolved solids in water.

With this as an example, you might encourage others that you meet daily to talk with you and explore different avenues and problems outside their normal area of expertise. It could be very fruitful.

2.2 THE U.S. BUREAU OF RECLAMATION AND DESALTING

by Stan Hightower

The U.S. Bureau of Reclamation (USBR) is going through a major change right now, maybe some you have heard about it. We no longer will be building large dams in the western United States. The USBR has changed our overall goals and everything we do is environmentally oriented. All the way from the management of our water irrigation system and dams to all sorts of different types of projects that are aimed at environmental restoration.

Desalting is relatively large in our priorities, and hence, the USBR was interested in sponsoring a workshop like this to take a look at the environmental concerns that we have regarding desalting. USBR has a water treatment technology program, and has built a rather extensive desalting. water treatment program with a number of different interesting projects. This includes projects all the way from membrane research to the study of communities and indian tribes to try and assist them in using some of these new technologies as well as assisting with technology transfer in that area.

The USBR also has a pilot plant that we are testing near Hemet, California, where we are using the reject flow for a wetlands project to determine if that is a possible method of disposing of the concentrate in an environmentally responsible way. The USBR is also testing a number of other different types of systems. A solar pond system near El Paso, Texas, is being tested as a possible method of disposing reject flow out of a desalting system.

The USBR is also going through a number of other changes involving the reduction of staff which should make us leaner and meaner as most government agencies are suppose to become. It involves reducing a large number of our middle management, so hopefully, this will streamline our process and also make our projects more cost effective.

The USBR looks forward to a successful workshop today and we will really appreciate any feedback that you can give us in the way of suggestions to increase the value of the breakout sessions. Just brainstorm to your hearts content and give us as many ideas as you possibly can on ways we can make desalting a more environmentally friendly technology.

SECTION 3

APPLICATIONS

3.1 DESALTING AS A FRIENDLY WATER TREATMENT PROCESS

by O.J. Motin

INTRODUCTION

This presentation addresses the water quality issues of concentrated brine from the desalting process. It examines these factors in the context of the possible harm they could do to the environment. Data is presented which gives typical concentrations of the streams to be disposed of from the various desalting processes being built today. Specific data on the toxicity levels established by regulatory authorities are presented and compared-with the concentrations from these processes.

In order to evaluate possible degradation to the environment from desalting plant discharges the key issues to be examined are:

- Discharge water quality
- Heavy metal concentrates
- Temperature at discharge
- Pretreatment chemicals
- Cleaning chemicals

Each of these are discussed below.

NATURAL **POLLUTION**

The amount of minerals on the earth's surface is a fixed amount. The level will not change. Mineral concentrations in our oceans however, is continually increasing. The **increase** in **minerals** in our seas occurs from a number of areas. One such item **is the** natural dissolution of the earth's soils as rainfall percolates through the earth. These dissolved constituents end up in our fresh water and brackish water aquifers, and when pumped for use end up in our water supplies (see Figure **3.1.1).** These compounds are also formed from the dissolution of the soils in our river bottoms as they flow to our seas. Many of these minerals are not harmful substances and are not considered as pollutants because they are not harmful when ingested. However, in sufficient concentrations, they can be. There are other natural sources of pollution that flow from the Earth mostly from volcanic debris. Examples of these include mercury, arsenic, chromium, etc. These are considered pollutants because they are harmful if ingested in sufficient quantities.

Other causes of pollution come from domestic sources such as waste water (domestic wastes), the chemicals in deaning solutions used in households, etc. The total dissolved solids **(TDS)** concentration of water from households is some three to four times the concentration of the fresh water that is supplied to the home. These chemicals also add to the amount of constituents in our oceans.

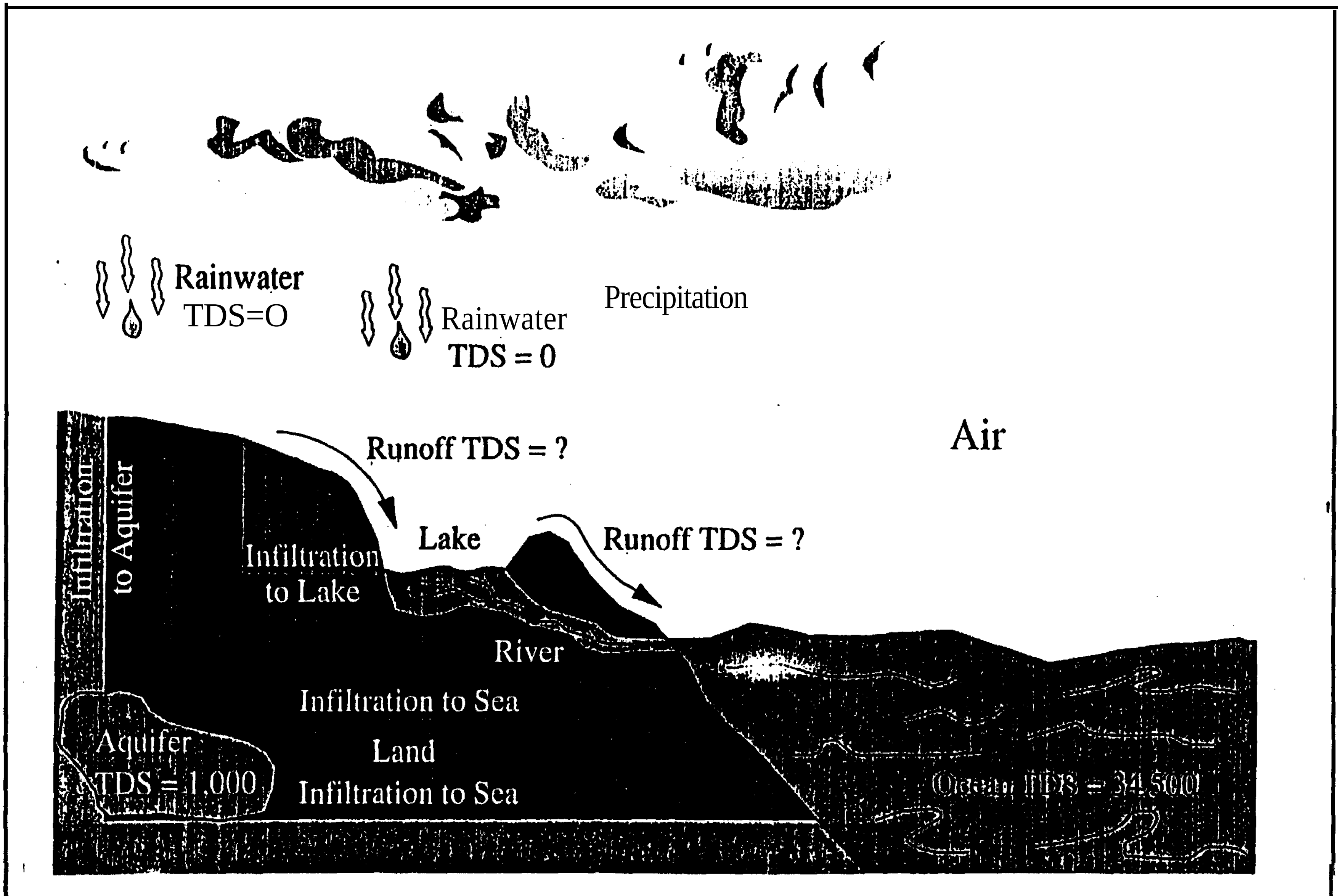

Figure 3.1.1 - Mineral dissolution

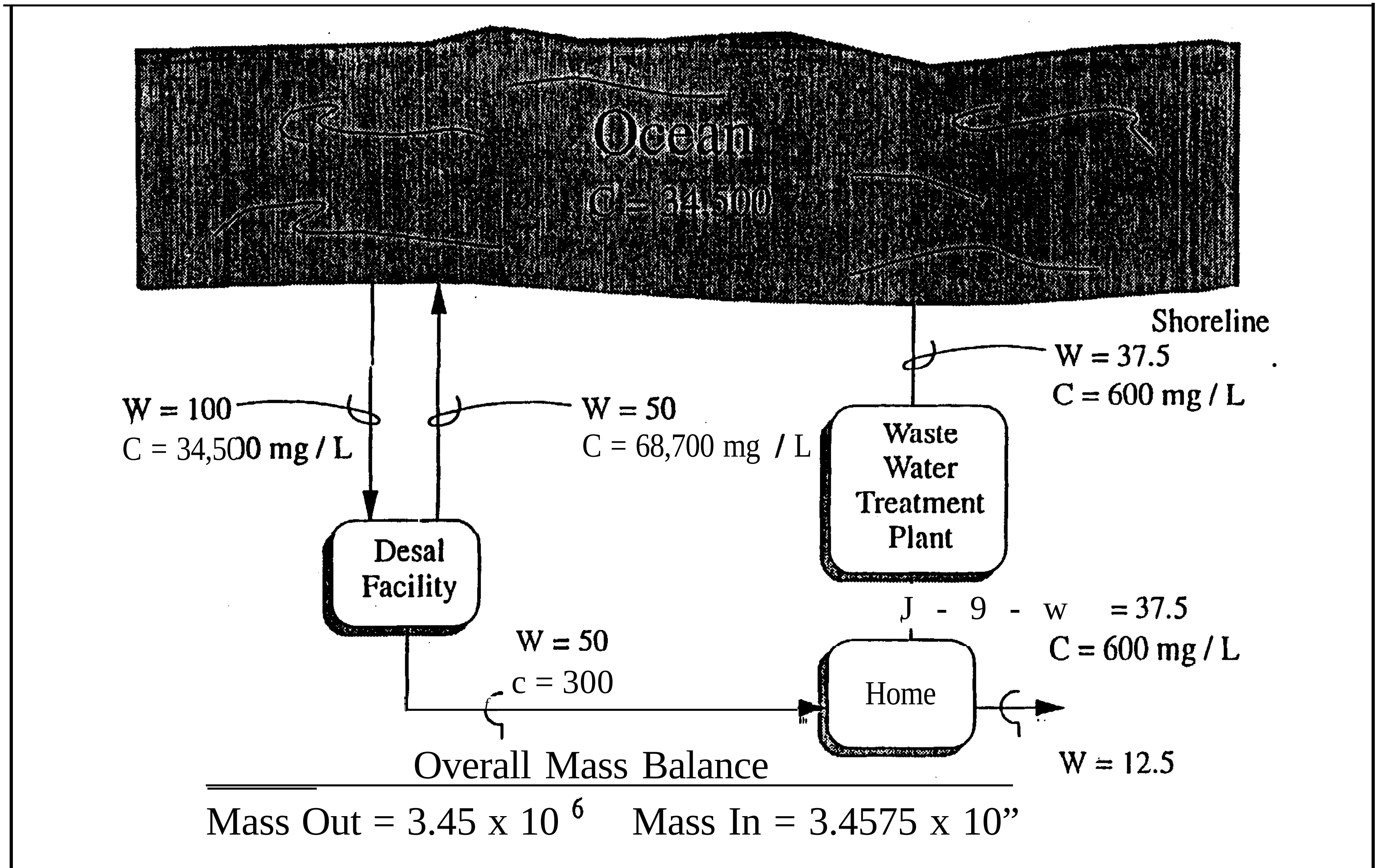

Figure 3.1.2 • Mass balance

Stormwater run-off is an additional area in which the dissolution of minerals on the earth's surface add to the amount of minerals that eventually end up in our oceans. Also, manufactured chemicals lying on the earth's surface can be washed into rivers or the sea with storm water run off.

Finally, industrial wastes, if not properly treated, can cause serious damage to the environment.

MINERAL BALANCE OF THE DESALTING PROCESS

When the overall balance of minerals from the desalting of fresh, brackish, or seawater.- supplies is examined, there is little, if any net increase or decrease in the mineral balance if all the fresh water produced is returned to the sea. This is because only a **small** . amount of chemicals are added to the process itself (those that are added have had Food and Drug Administration approval for use in drinking water systems). However, some of the water is lost and the remainder has had minerals added from its use in households. A crude example of this can be shown by simple mass balance calculation, by using the following expressions:

$$W_o = W * C$$

Where:

W_o = Mass weight removed from the sea pounds per hour (pph)
W = Weight flow of sea water from sea, pph
C = Concentration of the sea water, mg/L

and

$$W_r = W_1 * C_1 + W_2 * C_2$$

Where:

W_r = Mass weight of sea water returned to the sea, pph
W_1 = Weight flow of brine returned to the sea, pph
C_1 = Concentration of brine, mg/L
W_2 = Weight flow of waste water returned to the sea, pph
C_2 = Concentration of waste water returned to the sea, mg/L

This calculation shows (see Figure 3.1.2) that the mass of the water returned to the sea is slightly greater than the mass removed which indicates that the mass is increasing. The increase in mineral content is not from the production of fresh water in the desalting process. It is due to the increase in solids of the wastewater returned to the sea.

Desalting, therefore, does not add to the natural amount of minerals in the sea. It does however, contribute to a temporary increase in the amount of minerals at the point nearest its discharge. Waste streams are concentrated with minerals and the disposal of this stream must address this temporary increase.

IMPACTS OF CONCENTRATE DISPOSAL

The use of a surface body of water or a sewer system are the preferred methods for concentrate disposal. These disposal systems are preferred because they are safe and offer the advantage of lowest capital and operating cost. This section discusses the impacts of using this type of disposal system.

Discharge Water Quality

The amount of minerals in the concentrate stream is a direct function of the concentration of the initial quality of the feed water. For example, for the treatment of fresh or brackish water supplies, the concentration of the waste stream can be expected to be on the order of four to five times higher than the feed water. That is, for a feed quality of 300 mg/L, the brine stream will be at a concentration of some 1,200 to 1,500 mg/L. For the treatment of sea water, the concentration of the brine stream will be approximately 60,000 mg/L, or about twice the concentration of the natural sea water. In addition to the quality of the feed water, the process used also has a direct bearing on the brine quality. For example, the use of the nanofiltration (NF) or membrane softening (MS) membranes for the treatment of fresh water will result in a much lower brine TDS than if the same supply were treated using the standard low pressure (LP) membrane. The reason for this is the rejection capability of the membranes. MS membranes typically reject at a rate of 60-70%, whereas LP membranes reject at a much higher rate of between 96-98%. The higher rejection rate results in a brine quality that is higher when compared with the MS membrane.

The treatment of fresh water by the desalting process is normally for the removal of a particular constituent(s). Examples are hardness reduction or the removal of individual ions such as fluoride or nitrate. Brackish and sea water treatment is carried out for the reduction of TDS. Mostly, all systems are used for the production of drinking water, but some are used for other purposes such as irrigation supply.

Tables 3.1.1, 3.12, and 3.1.3 give typical concentrations of feed water and concentrated waste streams from desalting plants treating supplies from fresh to sea water concentration. This information shows that the quality of the brine exiting the desalting process is a function of the type of process that is used to treat the supply.

The compliance with water quality objectives is determined from samples collected at stations representative of the area within the waste field where dilution is completed. Dilution is defined as the result of rapid and irreversible turbulent mixing of the waste water with the receiving body of water around the point of discharge. The projected desalting plant discharge qualities given in the table are those in the discharge stream from the process prior to dilution. It can be expected therefore, that the discharge from the desalting process under consideration can meet all requirements for water quality.

Table 3:1 .1 • Fresh water treatment		
Constituent	Feed Water Quality	Brine Quality
Calcium	59.2	272.9
Magnesium	6.5	30.1
Sodium	24	02.9
Iron	0.05	0.23
Bicarbonate	61.4	76.5
Chloride	80.0	276.1
Nitrate (as NO,	21.7	74.0
Sulfate	46.7	358.0
Phosphate	**0.1**	**0.5**
TDS	**300.6**	**1175.7**
pH	**7.1**	**6.54**
Dissolved Oxygen	**0**	**0**

Table 3.1.2 - Brackish water treatment		
Constituent	Feed Water Quality	Brine **Quality**
Calcium	63.6	312.9
Magnesium	16.9	83.2
Sodium	550.5	2708.6
Iron	0.05	0.25
Bicarbonate	367.1	1232.3
Chloride	505.7	2488.1
Nitrate (as NO,,	16.8	02.7
Sulfate	411.0	2379.5
Phosphate	0	0'
TDS	19962	9601.3
pH	**8.02**	**7.45**
Dissolved Oxygen	**0**	0

Table 3.1.3 - Sea water treatment		
Constituent	Feed Water Quality (mg/L)	Brine Quality (mg/L)
Calcium	400.0	666.7
Magnesium	1272.0	2120.0
Sodium '	10556.0	17592.9
Iron	0	0
Bicarbonate	140.0	6.6
Chloride	18980.0	3 1632.5
Nitrate (as NO_3)	**0**	**0**
Sulfate	**2649.0**	**4595.9**
Phosphate	**0**	**0**
TDS	**34390.0**	**57256.0**
pH	**8.2**	
Dissolved Oxygen	**6 - 8**	**6 - 8**

Heaw Metal Concentrations

It is well known that even low concentrations of heavy metals can be toxic to marine life. Thus, federal, state and local regulations limit the quantities of heavy metals discharged. Regulation of these discharges will result in protection of the ecosystems. Brine toxicity limits for these heavy metal discharges have been placed upon discharges sent to wastewater treatment plants and for discharges to brackish and sea water bodies. The limits regulated are typical of those shown in Tables 3.1.4 and 3.1.5 for wastewater and sea water respectively. The requirements for brackish water will vary dependent upon the quality of the brackish water. A comparison of these limits with the typical brine qualities given above reveals that the discharge of brine from a desalting facility will not be detrimental to the environment. The brine qualities given above for sea water are considered to be maximum concentrations since diffusion systems will be provided at each disposal point.

The qualities shown in the tables are those projected from the RO process. Brine quality from a thermal desalination plant can be different. The difference in the discharge from thermal desalters arises if corrosion is allowed to occur in the process.

Table 3.1.4 • Waste-water chemical limitations		
Constituent	Maximum Limit (mg/L)	Projected Brine Concentration (mg/L)[1]
Arsenic	2.0	0.05
Copper	2.0	0.56
Lead	2.0	0.016
Mercury	0.03	0.0014
Nickel	10.0	0
Silver	5.0	0
Zinc	10.0	0
pH	6 - 12	7.2

1). Assumes that the feed water TDS is 1,450 mg/L.

Table 3.1.5 - Water chemical limitations				
Constituent	Natural Concentration (mg/L)	Maximum Limit (mg/L)[1]	Chronic Toxicity (mg/L)	Projected Brine Quality (mg/L)
Arsenic	3.0	8.0	19.0	5.97
Copper	2.0	3.0	5.0	3.99
Lead	0	2.0	22.0	0
Mercury	0.0005	0.04	0.4	0.001
Zinc	8.0	20.0	51.0	15.9
Chlorine Residual	0’	2.0	10.0	0
Dissolved Oxygen	7 - 9	6.3		7 - 9
pH	8.2	8.0		7.0

1). Six month median.

Designers of these systems must pay particular attention to the materials chosen to avoid the possibility of introducing heavy metals into the brine stream. Thermal systems are available which operate at low temperature and do not corrode.

Temoerature of Dischatae .

The temperature of the brine discharged from thermal type desalters treating sea water is a concern. As with conventional power plants, the cooling water returned to the 'sea is at an elevated temperature when compared with the ambient sea water temperature. Marine biologists have attested that changing the temperature of life-maintaining water disturbs the natural balance of marine life. To prevent this from happening, regulations limit the maximum temperature of brine exiting the process. This temperature is typically 15 to 20°F higher than ambient temperature. All desalters furnished today are designed to operate in accordance with this regulation.

Pretreatment Chemicals

All chemicals used in the pretreatment of feed waters to all desalting processes have been approved for use in drinking water systems by the Food and Drug Administration. In addition, the quantities of chemicals used for pretreatment are extremely small, so no environmental problems are created by their use.

Cleanina Chemicals

Many types of cleaning chemicals such as acids and bases are used to clean desalination systems. These are also approved for use in drinking water treatment. Concentration strength of these chemicals is typically 1-2 %. Disposal of these chemicals requires no special provisions but are typically further diluted before disposal.

BRINE DISPOSAL SYSTEMS

Probable disposal options for brine concentrates from desalting processes are:

- Irrigation or land spreading
- Surface waters (brackish or sea water)
- Sewer systems
- Deep well injection
- Solar evaporation ponds
- Zero (liquid) discharge

The following points examine the considerations for each of these disposal options.

Irrigation

When considering the use of irrigation for the disposal of desafting brine, the **TDS** and the concentration of individual constituents must be considered. Some crops are resistant to irrigation waters of relatively high TDS concentrations. Examples are cotton, potatoes, and barley. Salinities as high as 2,000 mg/L or more, are possible for some salt resistant crops. Brine from the treatment of fresh waters are relatively low in TDS and can be used for this application. Also to be considered, are specific limits for constituents such as boron, chlorides, and others. Thus, when contemplating using brine as an irrigation water, the quality of the water (i.e., TDS and individual constituents) is an important consideration.

Surface Water

When the use of a surface body of water is to be considered, the following must be addressed:

- The mixing system should be designed to provide quick mixing (diffusion) of the brine with the receiving body
- The dissolved oxygen level of the brine must match the oxygen concentration of the receiving body
- The pH of both waters must be similar
- For sea water systems, the brine must meet the toxicity limits prescribed by regulations

Sewer Systems

The use of sewer systems has been found to be cost effective for a number of desafting installations. Considerations when using this system as a brine disposal option include the following:

- It is important that the brine concentration not cause a problem with the effluent TDS of the wastewater plant. When the brine quantities are relatively small in comparison with the total through-put of the wastewater plant, this problem is minimized
- The pH of the brine must be within acceptable levels before it enters the treatment plant
- The brine must meet the toxicity limits prescribed by the sewer system regulators

Deep Well Injection

The concern when disposing of brine by this method is the possibility of the brine leaking into an adjacent fresh water aquifer. A confining layer between the injected wastewater and the aquifer is always required to prevent this occurrence. Monitoring wells are provided to track the quality of water and determine if leakage has occurred.

Solar Evaporation Ponds

Unlike other disposal methods, the use of solar evaporation ponds presents no water quality problems at the disposal point. It is, of course, only effective where the ambient conditions promote evaporation and rainfall is minimal, such as desert areas. Because land areas are considerable, the cost of land is an important cost factor. The use of this type of disposal method must include:

- Double lining of the pond to prevent leakage of the wastewater into adjacent underground aquifers
- Provision of a leachate collection system to control wastewater formed by rainfall
- Monitoring wells to track the possible leakage of water into the ground

Zero Dfscharae

The *use* of this method although technically feasible, has not been proven for the discharge of brine from desalting facilities. It is; however, used in the power industry and has been proven as an effective method to conserve water use. Concerns to be addressed when using this method are:

- The landfill used for the disposal of the solids from the desalting facility must be designed to prevent leakage to adjacent fresh water aquifers by double lining the landfill to prevent this from occurring
- A second protection device is the provision of a leachate collection system to ensure that wastewater does not enter adjacent aquifers

DESALTING DESIGN CONSIDERATIONS

In addition to designing for the prevention of problems from the disposal of brines, the design of the treatment plant itself must be such as to keep these problems to a minimum. Design considerations include thermal desalting and membrane desalting processes.

Thermal Desaltina Processes

The brine disposal problems that can result from using these processes are the heat rejection of the brine and cooling waters to the environment, the possibility of the disposal of heavy metals (e.g., copper, nickel, etc.) due to corrosion, and the relatively high TDS of the brine exiting the plant (assumes treating sea water, see above). Plant designers can prevent the occurrence of high concentrations of heavy metals by careful selection of materials in construction such as using stainless steel and titanium materials. The thermal impact can be mitigated by the use of higher cooling water flowrates and the high TDS of the brine can be mitigated by efficient mixing with the natural sea water. Also, plants constructed at power installations can use the power plant cooling water discharge as an effective mixing water prior to entering the sea.

Membrane Desaltina Processes

Membrane processes in most instances, can be designed for operation at specific brine water qualities by manipulation of the plant **recovery.** The lower the recovery made, the lower the resulting brine concentration. Although most plants are designed for the highest plant **recoveries** in order to optimize operating costs, in some cases **due** to high brine disposal costs, it may be more cost effective to design for a lower recovery if the lower brine quality results in overall cost advantages.

CONCLUSIONS

The following conclusions can be drawn from this **evaluation:**

- The mineral content of ocean bodies is in general increasing over time
- Desalting processes do not create a net increase in mineral content of the environment
- The discharges from desalting processes can meet the requirements of wastewater and ocean regulations for heavy metals; temperature, chemical additions, and water quality
- Brine can be disposed of in a **number of** ways, including:
    - Irrigation or land spreading
    - Surface water bodies
    - Sewer system
    - Deep well injection
    - Zero discharge
- Mitigation methods are available to assist in lessening temporary environmental impacts at the point of disposal

Question & Answer Session

Question: I would like you to comment on thermal pollution related to discharge.

O.J. Morin: I did not address pollution because I did not want to have any negative aspect. However, the power industry has already regulated the core temperature in thermal desalting plants can be designed to meet these same regulations, about a 15 to 23 degree rise in temperature for brines being disposed from a power plant or a thermal desalting plant.

Question: I agree, I do not want to touch the negative aspect, but the question of large scale desalting particularly in the Arabian Gulf is that the tremendous withdrawal of water by SWCC, is that going to make the Gulf more saline in time because of desalination and all of the people have started to prove that on top of desalting it would not affect the people around the gulf. There is a continuing question that keeps coming up that we should be able to answer more scientifically than emotionally. Your point was probably well taken that desalting mainly returns the salts from the original body of water. Pollution is probably not from the steady state operation but, during peaks of cleaning and washing, and you seem to have avoided the question.

O.J. Morin: The cleaning chemicals concentrations are extremely low to begin with and in most plants that I know of they are further diluted but what they disposed of, so the concentration is very low.

Question: My question relates to we really do put more back into the ocean than what you took out in terms of all the pretreatment chemicals. I've heard some of the discussions in Santa Barbara and there is a very real concern by some of the environmental groups, unfounded or not, that there are chemicals that are added to the pretreatment. There are going to be chemicals in there, basically, that were not there before the desalination was in whatever quantity, and frankly I was kind of disappointed that you said you were just trying to present just a positive image. If there is a problem, if there is something going on, I would like to discuss it openly because this is what I am here to find out about.

O.J. Morin: Does anyone here know of any problems?

Comment (J. Potts): The **antiscalants** that are added are generally in the less than the 5 ppm range. The amount of the solids that pass through the membrane are usually in the order of magnitude of a couple of hundred ppm, so, on a solid to solid basis, much more of it has passed through the membrane and therefore, is not discharged back into the ocean then is added. In this country, all of the antiscalants if you are going to surface discharge, that antiscalant must be tested for toxicity, so that is not an uncontrolled substance that is released. The only other additives at a membrane facility are generally either an acid or a base, generally an acid to lower the pH. Those do not enter into the TDS, what they are changing is the character of the ions specifically the saturation limit of certain of the salts so, we deliberately do not add things to the feedwater.

O.J. Morin: All pretreatment chemicals are approved by the FDA (Food & Drug Administration) before it gets into the drinking water system in the United States. I believe that alot of plants use the same pretreatment chemicals

3.2 MILITARY ISSUES IN FIELD WATER SUPPLY
by Robert Carnahan

INTRODUCTION

In the area of water supply, the U.S. Army is responsible for providing safe water for the U.S. Army mobile forces. Table 3.2.1 compares the requirements between commercial and military water supply systems.

Table 3.2.1 • Military vs. Commercial Requirements for Water Purification

	Commercial	Military
Water Source	Tailored	World-Wide
Pre-Treatment	Tailored	Limited
Output Quality	EPA	Surgeon General
Transportation	Fluid	Mobile
Climate	Tailored	World-Wide
Long Term Storage Requirement	None	Yes
Required to Withstand Wet, Dry Cycling	No	Yes

Specifically, where commercial installations use selected water sources and treatment that is tailored, the U.S. Army 'must use anything that happens to be available. The treatment is limited by the size of the device that can be transported, and the water quality standards are set by the Surgeon General. The entire system must be mobile, and the applications are world wide with the need for long-term storage. It is not unusual to bring a piece of equipment back from the field and hold it in storage for six months to a year without operation, and then suddenly return it to an operating mode.

HISTORY

The U.S. Army has employed a variety of different types of water treatment equipment in the field. These tended to be media filtration type devices and often used aluminum sulfate for coagulation. Byproducts, sludges, solids, etc., were generally dumped back into the same water body which provided the supply.

At the close of World War II, the Army often treated surface water high in clay and suspended solids. At the time of the Korean conflict, a unit known as the Eurdalator was used. This was an **upflow** clarification **unit with** diatomaceous filters. This unit was designed primarily to prevent amoebic dysentery by using the diatomaceous fitters with something ahead of them to reduce the solids. It produced a lot of sludge and solids for disposal and, hence, we had a by-product disposal problem at that time.

This unit was used in Southeast Asia throughout the Vietnamese war. At that time, the Army decided that a universal system was in order. The Army needed something that could handle not only fresh water but could treat brackish water and sea water. Based on these criteria, the Army promoted the development of a reverse osmosis system.

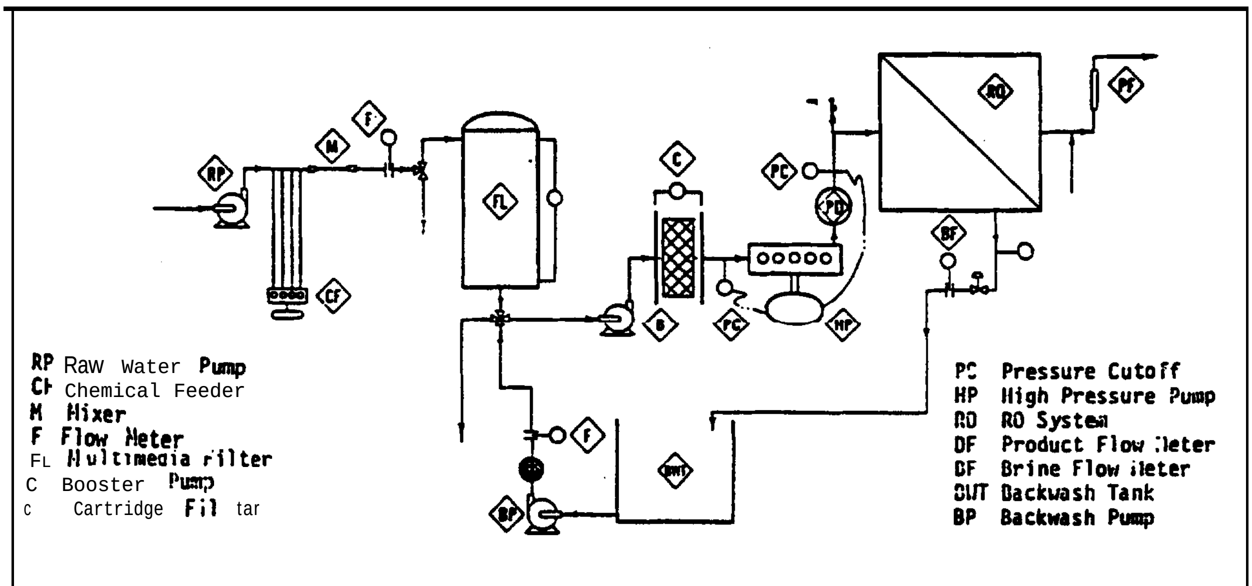

Figure 3.2.1 • Flow sheet of 600 **gal/hr.** reverse osmosis water purification unit.

The Army has many special requirements for it's water treatment units including the ability to deliver them by parachute. The basic unit, a 600 **gal/hr.** unit had to be skid mounted and could be no'higher than 166 inches in order to get out of the back end of an airplane. It **also** had to be no more than 250 inches long and 96 inches wide and weigh less than 18,000 pounds. It had to treat fresh, brackish, and sea water. The unit consists of a multimedia filter, cartridge filter, and four reverse osmosis pressure vessels loaded with a 6-inch diameter membrane. The Army now has a complete series of **units** including a 3,000 **gal/hr.** unit that is in production, a 150,000 **gal/hr.** barge mounted unit that was used in the Gulf War, and small 150 **gal/hr.** units which consist of ultrafiltration and RO membranes.

Another system is used by the Navy. One of it's units produces about 1,200 gallons per hour. And, it has the same constraints as those of the Army regarding size. The package system must fii into an 8 x 8 x 20 isocontainer and the Navy often run two of the units back to back

BY-PRODUCT DISPOSAL

Where are the problems relating to disposal? Certainly, you have disposal from the standpoint of concentrate, but you also have to deal with the sludges that are associated with the system. The Army has no particular program for disposal in a theater of operation. If they take the water out of a harbor, then concentrate is usually discharged back into the harbor. But in the United States, the Army cannot train in this manner. In other words, what constrains the Army in training are the same regulations with which engineers who design fixed facilities in the United States must comply. The Army must also comply with those regulations although on a temporary basis while in the United States. In other words, if the Army is using the units in some location such as cxFort Bragg, North Carolina, and pull water out of a lake, concentrate cannot be discharged back into the lake without ensuring that the concentrate is safe for such discharge. This restricts the Army's activities relative to the systems.

Filtration

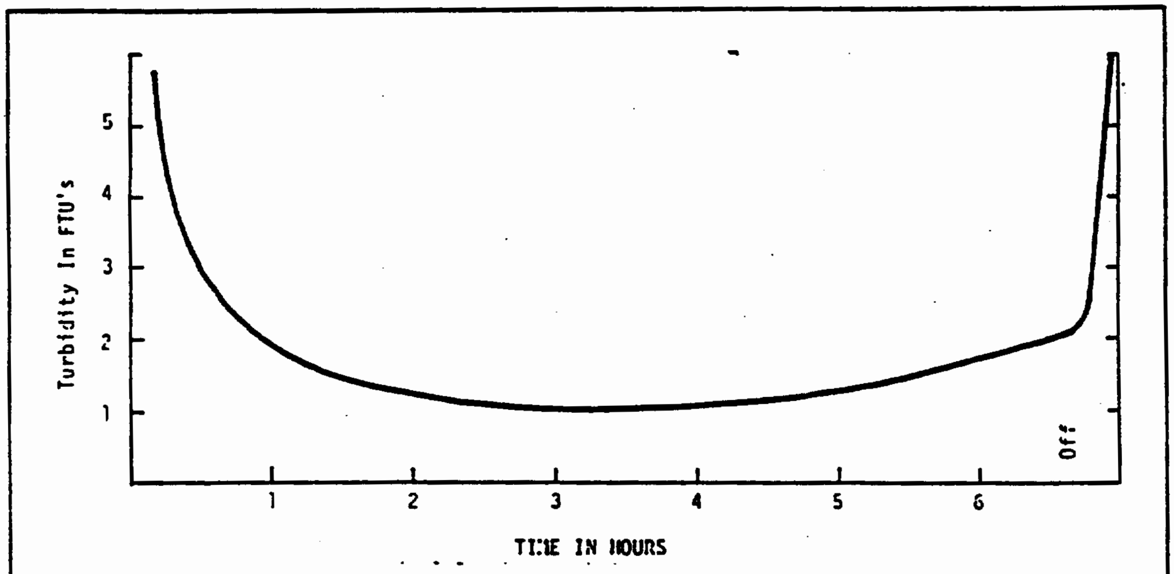

Figure 3.2.2 - Typical breakthrough curve for a multimedia filter.

Figure 3.2.2 is a typical breakthrough curve in a filtration run for the RO system. The steps are conditioning of the filter, filtration, and, finally, the breakthrough. The material from the breakthrough typically goes on to the cartridge filter. Figure 3.2.3 shows the backwash cycle. The units can discharge a significant amount of sludge, which is high in suspended solids. The system typically will remove about 98% or so of the suspended solids. Table 3.2.2 illustrates some typical values of suspended solids in the influent, the removal efficiency, and the sludge that is discharged as part of the concentrate.

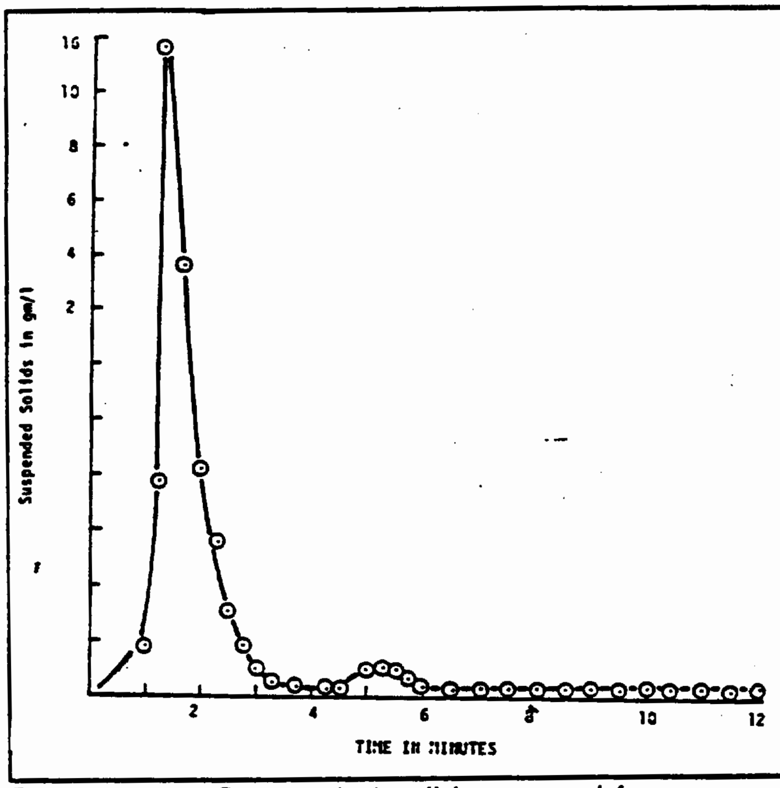

Figure 3.2.3 - Suspended solids removal from a multimedia filter during backwash.

Commercial installations do not have that problem because they can be site selective as far as the feed water is concerned. These sites are chosen based on water quality that does not require the facilities to deal with high suspended solids, or they can use wells or infiltration galleries which minimize the suspended solids. The military cannot do this in combat and, hence, they must train on waters that have high suspended solids. Otherwise, their operators are unable to cope with the problem when they are in a theater of operation.

Table 3.2.3 illustrates some test results for operation of the 600 gal/hr. reverse osmosis unit. In some cases, the product had a total dissolved solids (TDS) as high as 1,500 mg/L. In the early 1980's, the Surgeon General said the troops would be permitted to drink water that contained as much as 1,500 mg/L TDS. However, anything in a theater of operation between 500 mg/L tastes the same - it's going to be salty. The data in the table illustrates the results when the system was tested on fresh, brackish, and sea water. At times, the system was run as high as 50% recovery, which is not recommended for commercial systems.

Table 3.2.2 - Results of component test of a multi-media filter						
	Suspended Solids			Turbidity		
Cationic Polymer Dose mg/L	Influent mg/L	Effluent mg/L	Removal %	Influent (FTU)	Effluent (FTU)	Removal %
2.5	26	1.7	93	12	0.3	98
2.5	11	0.8	93	9.6	0.6	94
2.5	41	1.0	96	22	1.4	94
2.5	29	1.0	97	14	1.1	92
4.0	11	1.0	91	12	1.2	91
4.0	13	2.0	85	10	1.9	91
4.0	39	1.6	96	27	1.8	93
6.0	42	0.8	98	31	1.6	95
6.0	76	17	78	49	12	75
5.0	25.8	0.12	96	21	0.4	98
5.0	23.2	0.1	99	19	0.7	96
5.0	78.4	8.0	90	16	0.2	99

Table 3.2.3 - Performance of the 600 gal/hr. Reverse Osmosis Unit					
	Total Dissolved Solids		Flow		
	TDS		Gallons Per Hour (GPH)		
Source	Influent	Product	Influent	Brine	Product
Fresh	227	3	2040	1440	600
Fresh	229	4	2040	1440	600
Fresh	217	3	2040	1410	630
Fresh	235	5	2040	1440	600
Fresh	260	3	2040	1440	600
Fresh	270	3	2040	1440	600
Fresh	115	10	2040	1380	660
Brackish	6000	400	2040	1541	499
Brackish	5500	150	2040	488	1552
Sea Water	23560	1200	2040	1248	792
Sea Water	22036	900	2040	1012	1028
Sea Water	22100	1500	2040	1828	412
Sea Water	22500	1100	2040	1200	840
Sea Water	33050	1200	2040	1645	395

WATER QUALITY

Aside from the standard contaminants commonly found in drinking water the Army must be ready to treat for substances like arsenic, cyanide, hydrogen cyanide, lucite, mustard, and nerve agents. Not only is treatment a problem with those special chemicals, but so is concentrate disposal.

The reverse osmosis systems are capable of treating those chemical warfare agents. The organophosphate compounds and mustard are not particularly soluble, but the system can handle them. If organic compounds such as organophosphorus pesticides are in a brine concentrate at a low pH and a high dissolved solids concentration, the hydrolysis rate of those compounds is relatively fast. Thus, in an hour and a half or so the disposal concentrations are well below the permissible limits. From my viewpoint, the organophosphorus compounds or pesticides in the RO concentrate can be discharged because of the rapid hydrolysis rate. From the military standpoint, the problem of getting rid of the filtration sludges and backwash and managing the concentrate has a very limited application to the field.

It is important to note that the technology research and development team at Fort Belvoir is looking at new techniques. They recognize that the army has to comply with EPA's requirements for training, but the mission in the field is different. If a military commander at a federal facility violates any of the environmental regulations, the EPA can have them literally thrown in jail. It is a serious matter to the Army, but with mobile forces I think that you can appreciate the problems the Army is faced with.

REFERENCE

Carnahan, R.P., et.al. 1979. *Treatment of brackish, sea and chemically contaminated fresh water by reverse osmosis.*

Question and Answer Session

Question: The balloon tanks which you showed us are presumably for the storage of the brines which makes the disposal of that material pretty complicated in a field situation. Then, is one of the goals to increase the recovery to 90%, if possible, to make the volume of concentrates less? Is that one of your targets?

R. Carnahan: Right now I would have to say no, primarily because of the varied qualities of waters around the world. For example, we are always faced with problems particularly in brackish water with calcium sulfate fouling. You have to realize that the operators that are operating this equipment receive very limited training. They do not have a great deal of analytical equipment to adjust recovery. So, while it would be ideal to do this, we simply would create all sorts of problems in operating the system.

Let me give you a perspective of some of the problems that we are really faced with, not only recovery, but moving equipment in and out and storing it. For example, where typically a commercial plant may run membranes for five to ten years, we have instances where, if we can get 200 hours of operation out of a set of elements, we're lucky. So the whole perspective is different. In other words, when you think about replacing elements in a municipal plant there are thousands of them. If they had to do this, as the Army does, on a 200 hour rotational mode, I don't think that there is a bank that would be willing to support you. However, these are part of the different conditions that are part of water supply in a theater of operation. Other problems are suspended solids in fresh waters and biological activity on the membranes. With the latter, we now have no satisfactory way of controlling it.

Question: Getting back to increasing the recovery to 90%, there are technologies that could produce a more concentrated brine which would result in a smaller volume of liquid. This could minimize the disposal problem.

R. Carnahan: You are right, I think in the United States we are going to have to do that. We are going to have to take the brine and we are simply going to have to treat it.

3.3 RESIDUALS FROM DESALTING
by John E. Potts

INTRODUCTION

This paper will concentrate on what's currently available and practical rather than theoretical issues. The theme of this seminar is being friendly to the environment. What is the environment? As operators, designers, owners of membranes, whatever, one must understand that the environment is everything outside your water treatment plant. It's the air, water, ground, and the people who live outside of it, so as you consider this as an environmentally friendly process, remember who you are trying to be friendly to.

RESIDUALS

What is a residual? A residual is anything that leaves the plant, except for your product water, and goes into the environment. It can be a liquid, solid, gas, noise, light, etc. This may be getting into the real mundane issues but, they are important depending upon where you are.

There are a number of residuals associated with the membrane desalting process. The concentrate is the most important, but there are other ones that we need to pay attention to in the pretreatment process. This includes suspended solids that are removed by the pretreatment filter(micron to full sand filters). The backwash cycle removes accumulated suspended solids from the sand or multimedia filters. This backwash will contain sludge and solids. In addition, there is the raw water residue from the backwashing. Some RO plants will precipitate some of their dissolved solids, such as iron, which will also create a residual.

Most of the desalting plants are treating a brackish water which is high in total dissolved solids (TDS). In Florida, most of the plants are located on top of fresh water aquifers and this makes the disposal of even the raw feed water a problem. Therefore, the disposal of backwash or drainage from the built-in floor drains becomes a residual that could be unfriendly to the location. An example of this occurs when a train is taken out of service. The piping, pressure vessels, etc., are going to be full of salty water. You cannot put that salt water on the ground because the ground water near the surface is fresh water. This means that this residual water must be transferred to a location where it is compatible with the environment. In that example, it would probably be disposed of with the concentrate because the concentrate is salty and this would be compatible with that.

Degasification which is associated with the product end of the desalting plant can create byproducts which are very unfriendly to some environments. Among the byproducts that can be produced during degasification are hydrogen sulfide, carbon dioxide, radon, and trace volatiles.

Hydrogen sulfide is a very unfriendly byproduct due to its odor. For many years some membrane plants in Florida discharged hydrogen sulfide into the air and created an odor problem but that is not tolerated anymore. In Florida, the Health Department can shut you down if you create an odor problem. So, it is important that this residual is properly handled. An example of hydrogen sulfide removal is the use of an iron stripper which is very effective and efficient. It represents the level of technology that is necessary in order to become environmentally friendly.

Carbon dioxide discharge during degasification is common, but is not regulated. Radon is important, not as much as radon, but as the other radionuclides and trace volatiles.

Most constituents in the raw water are going to appear in the concentrate. This includes trace volatiles. The way to avoid these trace volatiles is to avoid using a water source that is contaminated with those elements.

NOISE

In the past, almost all RO plants were noisy. That is generally not tolerated anymore, especially when you are in a municipality and your neighbors are close by. The noise comes from the high pressure water pumps, concentrate control valves, blowers, and numerous other things. There are a number of ways that noise can be controlled in an RO plant. One example is a box fitted over the concentrate control valve that dissipates the noise, combined with the piping that is lagged for five or ten times its diameter down stream. That cuts out the noise, it keeps it from getting into the building and/or out of the building. Acoustical insulation blown into the ceiling will do the same thing, absorbing the noise before it gets outside.

CONCENTRATE

In my opinion, concentrate disposal is now the achilles tendon of the industry. Many people that I've talked to that are contemplating using the reverse osmosis membrane technology are afraid of it because they do not know if the money that they are going to invest can result in an operating RO plant because of the potential inability to legally discharge concentrate. Concentrate is undoubtedly the most visible, the most regulated, and the largest volume of residual coming from a desalting facility. It doesn't matter what technique we are using, whether it's RO or electrodialysis, a concentrate will be produced.

Concentrate is that portion of the raw water from which some of the dissolved solids and most of the water have been removed. Our whole principal in design desalting facilities is to produce as much product water containing as little of the dissolved solids from the raw feedwater as we can. If you've taken the ocean as your intake then the concentrate can only have what the ocean has in it. If you are using a brackish water source, then the same thing occurs. It can be nothing else significant, because of the process involved.

An important distinction must be made between brine and concentrate. Brine is water which has a higher salinity than sea water. The vast majority of the RO plants in the United States are not going to have brine discharge. They are going to have concentrate discharges - not brine. I spent several days with a regulatory agency getting them beyond the point of calling the discharge from an RO plant brine. This particular plant was going to be discharging with TDS of about 18,000 mg/L. That's not even half of sea water, but it took three days to get them to understand that it was not brine.

Table 3.3.1 - Four basic methods of discharging concentrate

	Reuse	Disposal
Discharge to a surface water body	X	X
Discharge on a land surface	X	X
Discharge with another water	X	X
Discharge in an injection well		X

Table 3.3.1 lists four practical methods of getting rid of concentrate. Each one can be categorized as having either reuse potential or are strictly for disposal. We are recognizing in Florida that our water resources are limited, therefore, we need to reuse water where it is possible. Florida has a public and a statewide policy, not mandated but highly encouraged, for the reuse of domestic wastewater. Not too many years ago domestic wastewater was something to be disposed of, now we have learned that it is a resource. This is not much different than the concrete rubble we used to consider as junk that had to be buried somewhere. Now we find that we can put it in the ocean, in the proper places, and use it to make productive reefs. I urge everyone, as you are working with the issue of concentrate discharge, to look at it under that basis, that maybe it is a resource and can be reused. If it does not pass that test, then you should dispose of it.

Discharge to Surface Water

Direct discharge to a surface water body is generally the most available and the most cost-effective method of disposal. It happens to also be probably the most regulated, at least in Florida, through the regulatory permitting process. You can discharge it on a land surface, which can be considered reuse, depending upon the character of the concentrate. You have to keep in mind that the concentrate is the raw water concentrated and it needs to be compatible with where it is going.

Concentrate can be discharged with another water, such as putting it into the sewer system, before or after the wastewater treatment plant, or blending it with irrigation quality water. Sometimes blending is a means of acquiring the discharge permit, because it will take water from the receiving body, mix it with the concentrate and then put the blend back in. The method that has no reuse potential whatsoever is a discharge to an injection well. Injection wells are highly regulated, but once you have done that the regulators really do not care what you put down the wells, so at that point they really do not regulate the concentrate. The construction of the well is regulated, but not the concentrate.

An example of a surface water discharge that is land application, is a percolation pond. One example in Florida consists of a 75 acre pond receiving about 300,000 gallons a day of concentrate. This combines blending of concentrate with surface water and land application. Land application, by percolation, is land intensive. In another example in Florida, a surface discharge had been used for 15 years. It was removed about 2 years ago because of the regulations. This was a small plant discharging about 20,000 gallons a day. It was discharging into a swamp, and it did not appear to be degrading the swamp.

Table 3.3.2 lists some guidelines for developing a plan for concentrate discharge. The most important thing you have to do is to analyze the raw water and do a projection to find out what's going to be in it. Those systems starting out without a raw water source have a problem making concentrate, but you must know what is going to be in the concentrate and you must know down to some fairly low levels. There is the potential for problems with constituents such as lead and some other heavy metals.

Table 3.3.2 - Guidelines for Developing a Plan for Concentrate discharge	
1.	Analyze the raw water and determine through projections what will be in concentrate.
2.	Try to make concentrate for analysis and testing.
3.	Be thoroughly familiar with area environment.
4.	Always first consider concentrate a resource.
5.	Identify the most compatible discharge methods and locations.

Any constituent that is rejected by the membrane can be concentrated by four, five, or six times, so looking for constituents in raw water down to 2.0 parts per billion (ppb) does not help you if the limit in the concentrate will be 2.0 ppb. If you had 1 ppb but concentrated it to be at 6, you are in violation. You should try to reproduce the expected concentrate early in a project so that you know what problem constituents might be in it. The projections do fall short in some of the elements, most of the projection software is only good for your major ions although you can make a good educated guess what some of the other larger molecules are going to do.

It is important to be familiar with the environment when planning the reuse or disposal of concentrate. You must look for an area that is compatible with your concentrate. If your concentrate is brine it has only two compatible locations, a deep well or the ocean. But if your concentrate is from a membrane softening plant or a plant treating a low-TDS or a low-chloride water you can find a lot of areas more compatible than you would think if you stop and think about it.

Always first consider your concentrate as a resource. It is something to be reused and it should be tested for that first, if it can not pass the reuse test then dispose of it. But, always consider it as a resource first.

Part of the planning process should include identifying a series of places where the concentrate can be used. Do not ever, unless you are really good, identify only one discharge location, because it will rarely be acceptable as your only one. Even injection wells are only usable in the southern part of Florida, and they are even becoming suspect as being usable down there.

Table 3.3.3 - Regulations that apply to concentrate discharges at your location	
1.	United States USEPA regulations apply through NPDES program.
2.	United States USEPA classifies concentrate as industrial waste.
3.	State agencies also usually have jurisdiction
4.	Local agencies also may have jurisdiction.
5.	Be aware of toxicity regulations.

Table 3.3.3 notes the regulations that apply to the concentrate discharge. As illustrated in the table, there are many people who regulate it. USEPA is the most important agency of them all. They have very specific regulations through the NPDES program that you must comply with. You must get an NPDES permit. A very sore point to us in this business is that the USEPA classifies concentrate as an industrial waste and that starts the process out with a whole lot of negative connotations. State

agencies almost always have a jurisdiction along with USEPA, and you must address their regulations also. Local agencies also have jurisdiction. Most state and local agencies have more stringent regulations than USEPA. That is their reason for being there. If you are in Palm Beach County, State of Florida, United States of America, then Palm Beach County can not enforce a regulation that is less stringent than USEPA. So their reason for existence is to enforce more stringent regulations, so be careful of that, don't think that if you pass USEPA's regulations that all will be good and nothing else will happen to you.

Beware of toxicity regulations. Most RO concentrates that have been tested thus far in Florida have been judged toxic. I have felt for three or four years that they have not been toxic. Through the research done by the Town of Jupiter (which they did all by themselves and spent a great deal of money), it has been demonstrated that there is another cause of mortality in that concentrate, it is called ion imbalance. It deals with the specific ratios of major salts and how that affects the osmoregulatory systems of the shrimp used in bioassay testing. This information has been accepted now by the USEPA, how they are going to deal with this they have not yet told us, but it has been accepted that all of these dead shrimp that have been popping up over the years in the bioassay tests are not necessarily due to toxic elements within the concentrate.

To put it in layman's language, it's the soup that killed the shrimp not something that is in the soup. You must be aware of that. That is one of the reasons that, as I said earlier, you need to make a sample concentrate, because you can do all the projections you want but you are not going to find out if it passes the bioassay test for toxicity until you have a jar of it, put 20 shrimp into it, and see how many of them are alive 96 hours later. That's the only way you are going to pass that test, and the utility that considers spending 10, 12, or 14 million dollars on a desalting facility are taking a risk. The banks are not very anxious to loan utilities money when a permit says that when you finish your plant and make your first concentrate, on the basis of one bioassay test, that the plant will be shut down if it fails. Believe me, there are two permits in the State of Florida than can say that. That is a tremendous gamble and people in Las Vegas do not even take that kind of gamble.

You need to treat your concentrate before you discharge it. Your treatment has to be based on the conditions of where you plan to discharge it. If you plan to discharge to a location that is high in a particular constituent then your concentrate can be high in that same constituent. If you are somewhere where it can't have something specific in it, then you need to take that specific constituent out. The routine constituent that one needs to remember is dissolved oxygen. You have got to have it in surface waters, you have to have it in any surface discharge application. You need to remove toxics, acids, and toxicants, at least reduce them to the point of no longer being toxic. To repeat, treat your concentrate to be compatible with it's use, so that it can be reused, or with the point of discharge.

A typical concentrate treatment facility in Florida might remove hydrogen sulfide, insert dissolved oxygen, and adjust the pH. Membrane cleaning solutions after they have been used can be stored in a tank and then treated to change it to a substance that the local sewer district will accept.

Blending

There is another disposal/discharge method that involves blending concentrate with other waters. You can either blend it before, or after you treat it. There are two options, one is to allow it to be used as a resource and the other is to modify it and put it in a sanitary sewer system. You put it somewhere where it blends in, dilutes it with another stream of water, which then has to be treated. I recommend that you use conservation. Quite a few of the RO plants in Florida are being built in order to meet the challenge of providing potable water when faced with a diminishing fresh water source. In other words, we are running out of water, so we are using salt water. It has been proposed by some of the regulatory agencies that you take the concentrate and blend it with some fresh water so that it will be compatible with the receiving water body. Unfortunately, this does not do much for conservation. You might as well as have taken that water you used to blend to make drinking water and be done with it.

Discharge Outfall Configurations

The purpose of the outfall is to blend or mix the concentrate into the receiving water body. If there is a stream running perpendicular to your pipe, then you want to discharge your concentrate along the whole width of that stream so you never have a point of high concentration. If you are discharging a lighter water into a heavier water, point the discharge nozzle up so that the discharge will go up and mix better. If you are discharging concentrate that is heavier then the receiving water, point it sideways to promote good mixing.

Another issue we run into frequently is intermittent discharges. This could occur if you are discharging into a tidal water body. The tide changes four times a day, and that means four times a day there is a neap, or slack tide, during which time there is no flow. You may want to hold off the discharging of your concentrate until there is time for adequate mixing.

CONCLUSION

In conclusion, the subject of residuals is a big issue. There is a lot of it (especially concentrate) coming out of membrane plants. The rules that regulate it are byzantine, complicated, and contradictory. It is an issue you have to face before you can get a plant funded. There are very few people who are going to build one without an assurance that when it's built it will be permitted to work.

Question and Answer Session

Question: There is a seawater RO plant in Saudi Arabia that discharges about 20,000 cum/hr. into the Arabian Gulf. Do you have any comments on this?

J. Potts: As far as blending goes? This like ocean discharge, and I didn't talk much about the ocean because very few of us in the USA have access to the ocean. The Florida Department of Natural Resources has made sure of that, but ocean discharges have the ability to do spatial blending, which means, typically you go deep, project your concentrate upwards and take advantage of the fact that you have both vertical travel and currents passing laterally to achieve a good blending before that reaches its terminal blending. There are regulations that state that once you reach a certain velocity you are no longer blending, so you have the advantage that we don't have in our estuary bodies that are usually only five or six feet deep. The key issue is to spread it out, you may want to go to a multiple discharge location. You may want to consider putting the concentrate or brine in more than one outfall location in order to provide a better blending or quicker mixing for the facility.

Comment: The Electric Power Research Institute has published a report that Frank Oudkirk will be talking about later this afternoon and there are a limited amount of copies in the back of the room so, if you haven't picked one up I would recommend that you do that. Part of that program was the development of a computer program that would help you to estimate the mixing zone for the discharge, depending upon the varying ocean conditions to help you better design the discharge of the brine.

J. Potts: That is very important, as GRI is playing a big part in the toxicity problem by funding a research program which looks more specifically into ionic imbalance. The fresh water portion is done but the salt water portion is not done. The Florida Department of Environmental Protection is awaiting the results of that study before they plan to move ahead. They may not be associated with it, but they sure are doing some work that is associated with conditions in Florida.

Question: You avoided talking about zero discharge which our industry does have to do and the resultant disposal of their wastes.

J. Potts: In a large scale municipal plant to make drinking water, I believe that a zero discharge situation is currently impractical. It is certainly not impossible, I acknowledge it and I recognize it, but if you are making 12 to 15 million gallons a day, to reduce the concentrate to a powder is not going to fall within the monetary bounds with what we sell water for in this country, i.e., two to three dollars a thousand gallons. It is not going to happen.

Personally, I don't think it's worthwhile because we don't really have a zero discharge situation. Now we have a landfill issue for the powder produced. This powder must be disposed of and so, one of my favorite statements to the regulatory agencies and the public when I talk to them is, we're good, we know our job, but we can neither create nor destroy matter.

The regulators have said they do not want to have this or that constituent in the drinking water. We can remove it but we cannot destroy it, and therefore, we have to put it somewhere. It was there to begin with, you said you didn't want it in your drinking water, we took it out, now we have to put it back somewhere. That is the issue that I see being the real underlying issue. Sometimes you do a shell game when you discharge something, but it has not helped get rid of it either.

Comment: That was a good question. In fact, there are some areas where they do require a zero discharge, particularly in the Lower Colorado River Basin. All power plants have to live with a zero discharge requirement. I might point out that later this afternoon Deborah Brink will be talking on behalf of the AWWA Research Foundation. They have just published a very extensive report on concentrate disposal and in fact, Mike Mickley, who authored the report, is present today and you might have some questions for him later on. In addition to that, EPRI also did some studies on zero discharge and ways that we might get there. The AWWARF report has some very illuminating graphs on what the costs of these various processes are. It is very simple with these to add up the costs and see how much it is going to cost you to get to zero discharge. It is quite expensive.

Question: From this paper I have concluded that the discharge of concentrate to the sea is not a problem.

J. Potts: On no, in the USA, the USEPA has essentially said that there will be no discharges of anything into the Gulf of Mexico. Well, that covers a heap of our shoreline, about a third of it. A statement of that nature makes people say, okay, I can't go to the Gulf of Mexico and in a great portion of the United States you can't get to the sea. In Florida, the regulations for discharging into the ocean are not as stringent as into the surface water, however, the Department of Natural Resources has said you can not cross the shoreline with a pipe. Other than "beam me up Scotty" how are we going to get the water into the ocean? Ocean discharge is generally not practical. The other reason for this is that the ocean always comes into land in bays, estuaries, and water bodies of that nature. They are much easier to discharge into, and we would rather go to the easiest, most available location. That is going to be a bay or estuary rather than go directly out into the ocean.

Question: Outside of the United States what can one do in the area of discharge to the ocean - nothing?

J. Potts: It is possible, but as I said when I started I wanted to deal with practical concepts and it is more practical to discharge into a bay in our country then it is to go into the ocean. But there are ocean outfalls. There is one in Florida, the RO plant on Sanibel Island operated by the Island Water Association, discharges into the Gulf of Mexico. So, it has been done, it just is usually difficult because the distance from the plant to the ocean makes it further away. If you move toward the Gulf or ocean, you will find that the property values increase immensely. The closer you get to our ocean, the less likely you are going to be able to buy land and build a water plant, so our water plants are usually two or three miles inland. There is usually a bay closer than the ocean. Therefore, we usually try to discharge into the bay rather than try to go two or three miles to the ocean. We also haven't been using seawater desalting as much as you have in the Middle East.. We haven't gotten there yet. We have an existing brackish supply that we are using before we need to desalt seawater.

3.4 POTENTIAL IMPACTS OF DESALTING ON THE ENVIRONMENT
by Abdul Ahmadi

INTRODUCTION

The State of Florida Department of Environmental Protection (FDEP) is generally charged with the protection of the public health and public welfare to the extent that these are included in Florida Statutes. There is a check and a balance between those two. We may be able to protect public health using the abilities of scientists and engineers, but at what cost? That **is** where **the other** aspect of public welfare comes in.

Most of **the** RO plant facilities (and hence concentrate **discharges)** are located in the southern part of the state **on** the south, southwest, and the southeast coasts. 'In the northern part of the State, there are none as there are better sources of fresh water available. In the southern portion, which contains **more** than half of Central Florida, and almost 90% of the population living in that area, the water wars have started. In the Tampa Bay area there is not enough water now. There is talk of bringing water down from the northern **part** of the State some three to four hundred miles north of this **area.** The cost of delivery of that water and the impact that it will have on the environment **is** certainly something that needs to be considered.

SURFACE WATER DISCHARGE

The available options for concentrate disposal are rather limited. One of the main options is surface water discharge to brackish or saline waters, but one can always find one, two, or three chemicals in the concentrate that will violate the established standards for those chemicals in the receiving waters. In other words, the removal of such contaminants from one stream results in the creation of a new problem in the concentrate discharge. In addition to meeting those standards, one also has to pass a public interest test which is another regulatory hurdle to be cleared.

During the past 14 years; the South District of the FDEP has permitted only one new surface water discharge and this took about 3 years. It had to be cleared through the Cabinet and the Governor's office. It **is** the author's opinion, that as **long as the** concentrate is generally compatible with the'receiving water and is free from known **toxics** (such as chromium, lead, mercury, cadmium, etc.) that the concentrate will not have an adverse impact on the receiving waters.

One of the main **issues** that we have seen in the last few years which has impacted disposal to surface water is the toxicity exhibited by concentrates in the laboratory, primarily to one test species. We are finding that about 60 to 70% or more of the RO concentrates are failing the toxicity tests. It is possible that an ionic imbalance is causing the failure and maybe we could work with the scientific community to get an informed **judgement** on this matter. This could be used in our decisions on these facilities in the State of Florida.

About 1,000 people come to this state every day and we need, among other things, plenty of potable water for these emerging needs. Therefore, RO technology is important to the future of Florida to satisfy these growing demands. The state government is working on the development of a policy primarily to accommodate the RO technology. We have in our part of the state, probably one of the highest densities of RO plants in the world. We have to find a way to get these facilities permitted so we can get the high quality water that such technology can provide.

Florida has the most rigid standards for drinking water in the United States, and it is not surprising to find instances where one or two of these standards have been violated. When one looks at alternatives for treatment to meet these drinking water standards, then that community needs a treatment process to meet the regulatory requirements With RO as the best available technology, these unwanted constituents can be removed effectively.

INJECTION WELLS

Another alternative to surface water discharge is to use a class I injection well. That is a well which is drilled from 2,000 to 6,000 feet below the ground surface with a diameter from 10 to 48 inches. These wells are permitted in Florida but they are costly. The state requires a minimum of two of these wells for any facility. The cost could run to 5 million dollars depending on the specific location in the state. Permitting of such wells is coordinated by the state with the U.S. Environmental Protection Agency (USEPA) and the United States Geological Survey (USGS). This is accomplished through a technical advisory committee which reviews all technical and permitting issues. This can take six months or longer. It then takes a year or two for construction.

We have a number of Class V injection wills in the state that are surrounded by areas with highly saline water and they seem to be functioning well. The City of Key West is now studying the possibility of injecting its concentrate discharge into Class V injection wells.

MONITORING

The State of Florida is also reviewing the concentrate issue and is monitoring specific RO plants to collect data that can be used as a basis for some regulatory changes.

We have two kinds of permitting criteria from the state's point of view. One is a General Permit, the other is a regular permit. The General Permit is a simple permit with certain rules. If those minimum rules are met, the project qualifies for a General Permit. We are trying to come up with a General Permit for RO concentrates. The processing time for such permits is 30 days. This will help the small users to meet the state rules.

One of the missions of the FDEP is the protection of natural resources, whether they are ground or surface water resources. We find that the discharges from RO plants contain a variety of chemicals such as hydrogen sulfide, which is present in all ground waters in the State of Florida. Hydrogen sulfide concentrations range from below detectable to more than 3.5 ppm in some areas. It is necessary to remove hydrogen sulfide from RO concentrate for all surface water discharge projects. It is also important to adjust the pH and add oxygen to the concentrate for surface water discharges.

LAND DISPOSAL

Land disposal of concentrates is a lot more tricky. The State of Florida has two classifications of ground water - potable and non-potable. The distinction is by the total dissolved solids (TDS) level. If the ground water is less than 10,000 ppm TDS, it is classified as potable even though we can not drink it if it exceeds a TDS of 1,000 ppm. However, we must protect the ground water when land application takes place. The facility must meet the ground water standards at the edge of a zone of discharge which is 100 feet outside of where the concentrate is applied (provided that the property is owned by the facility). If the TDS level is 10,000 ppm or greater; the ground water is classified non-potable water.

Florida rules require that all discharges to ground waters that have a TDS of less than 10,000 ppm must meet drinking water standards outside the zone of discharge.

If you start with a concentrate that is high in TDS, it is just a matter of time before the high TDS water will get to the edge of the zone of discharge. Water flows downhill and sooner or later the higher level of TDS will hit a water of the state (surface or ground). In Florida, ground water is also considered a water of the State, even if it is under private property.

There are about 140 chemicals that are regulated by FDEP in ground water. Some of them are in concentrations of parts per billion (ppb) and in parts per quadrillion range. The analytical techniques are always getting better and therefore, you can usually find. something that shows in the concentrate that can not be permitted. This is the challenge to the industry.

BLENDING

Another option is blending concentrate with other waters. This can be considered if surface water disposal is the option. One could bring in water from the same source and mix it to minimize the toxic effects and then discharge it a little further downstream and this would probably meet the regulations.

The mixing or blending of RO concentrates can be done with other sources of water such as sewage effluent. The State of Florida, through the Water Management Districts, requires that any areas designated as a water caution areas, must have a reuse feasibility study relative to its discharges. In those cases, it is difficult to permit sewage treatment plant effluent as a surface water discharge. One must reuse the available wastewater, such as by certain forms of land application. This must involve applying it on the land for beneficial purposes. This is an area where blending can be used. If you have a ground membrane process (like RO), then you could blend the two sources back together and, if it is not injurious to the vegetation or harmful to the environment, then that could be considered an acceptable use and it helps everybody.

In the southern part of the state, land application has been permitted in one case on an area dose to a bay. This involved about one half million gallons per day of concentrate. **It** was discharged to percolation ponds and it is operational now.' From **FDEP's** perspective, we think that was a logical decision as it will not negatively impact the environment.

Another facility was permitted where they are currently using concentrate from membrane softening process to irrigate a golf course in the City of Fort Myers, and we have not found any problems. The Sanibel Island plant was permitted many years ago and that is considered on ocean discharge.

It is recommended that the consulting community together with the State and **USEPA** form a cooperative group to study and perhaps find out some of the causes and sources of toxicity in concentrate. Perhaps the universities could do some research in conjunction with the state and federal agencies to convince the regulatory agencies and the general public the RO plants are not toxic discharges. We need to know why, and how are these tests toxic. The biologists and engineers need to get together on this, as perhaps there **is some** problem with the methodology of the toxicity test.

THE WAY FORWARD

At this point, **FDEP** is studying the issue and it is trying to do what is the best from an overall environmental point of 'view for the state. We need to look at all the options for a particular facility and whether this is direct or indirect land application or ground water discharge and we need to know what the environmental impact will be through monitoring. This is something that is easily achievable and it will give some relief to.the membrane industry. In some cases it is possible that a concentrate discharge could improve a local situation rather than harm it by providing flushing.

FDEP is currently revising Chapter **62-610,** which is the land application rule applicable to domestic wastewater effluents. We are trying to make it user-friendly to accommodate the RO concentrate discharge planning concept. The draft has been changed several times and we have been working on it for almost a year, but the main thing is that **it** may be able to provide for the discharge of concentrate that will not cause any problems. If it is a beneficial application, then it is probably a proper application.

To summarize, RO technology is coming to South Florida The state and federal agencies must take a hard look at RO technology as it is probably the only technology that is available to remove the unwanted chemicals in drinking water so that it can meet the new standards. Using RO, we are now meeting the drinking water rule (removal) and we need to determine what to do with the removed material in the concentrate (disposal). Obviously, if we want to solve the drinking water quality problem by RO technology, we need to facilitate the disposal of the RO concentrate if we are to provide safe water to the public.

QUESTION AND ANSWER SESSION

Question: Are there opportunities available for the industry to work with regulatory agencies to change the labeling of the RO concentrate as an industrial waste?

A. Ahmadi: I do not know where the industrial waste classification started but it does exist in USEPA in the industrial classification codes. When it came to the creation of classes of wastes, there were only two available: domestic and industrial. Domestic is household sewage and then everything else is industrial. This was before much was known about RO. Perhaps that is another thing that the industry could work with the state to clarify. Perhaps they should suggest that the state create a separate entity or class for the RO concentrate because it does not fall into industrial - you are not manufacturing or processing anything, you are just removing what is already in water and concentrating it a little more.

The state is amiable to working with the industry and hopefully we can find an equitable solution.

Question: What else do.we as an industry need to do to demonstrate that concentrate, particularly in the State of Florida, is not detrimental to the environment? What other tests or demonstrations are required? Do you have any idea what Tallahassee is thinking about?

A. Ahmadi: We are working under the legislative mandate to acquire the NPDES delegation from the USEPA. By the end of this year, or early next year, we will be the sole agency for permitting surface water discharges. Up to now, the USEPA granted permits for surface water discharges and we do our delegation to the state, it gives us a little freedom to use some of our thoughts and ideas, and those from the industry, scientific and environmental community, to arrive at a possible compromise. One idea could be not to classify concentrate as an industrial waste. It's not associated with processing and hence this idea might be heard favorably in front of a hearing officer.

The other thing is toxicity issue as it stands right now. We are finding that 60 to 70% or more of the plants are failing the toxicity test using mysid shrimp. The concentrate has been analyzed numerous times without being able to identify the specific toxicity problem. the ionic imbalance may very well be the problem.

The regulatory agencies are willing to work with you and in some cases, it will be necessary to go to a heating officer and have them consider your case.

Question: The Southeast Desalting Association (SEDA) intends to pursue the concept of changing the classification of concentrate. This work was started several years ago and we have concluded now that concentrate is not industrial waste and it needs to be moved out of that category. If the issues related to the use of membrane plants are to be solved, they need to be viewed for what they are: water treatment plants with a by-product.

A. Ahmadi: With a change of classification the concentrate could be sent to Class I injection wells without using tubing and packer. The permit for an industrial wastewater Class I well requires tubing and packer that are not required for domestic wastewater. If it is only sewage effluent, it is permittable to discharge to Class I injection wells without using tubing and packer, The sewage effluent could contain a wide variety of unknown constituents while by contrast, what is in the RO concentrates can be known, and does not vary to any great extent. With this concept, it should be easier to try to convince the regulating community that the use of Class I wells for concentrate discharge without the tubing and packer is an appropriate application.

SECTION 4

RESEARCH

4.1 Future R&D Direction to Keep Desalting Environmentally Friendly

by Langdon Owen

INTRODUCTION

I'm going to start off by saying that I think most people are wrong in the way they describe environmental impacts. I think it is wrong to say that, "I am going to build **a** desalting plant and the environmental impact is going to be a certain concentrate or brine discharge". if you look carefully at the federal and state regulations and see what **they** describe as an environmental impact, you will see that it is not the discharge of the concentrate or **toxics,** it is rather the change that you cause by virtue of an action. Whenever you discuss, "I'm going to build a desalting plant, and it's impacts are brine discharge or **concentrate discharge", I** remind you that it's got to do with much more than that. Whether or not it has an adverse environmental impact is a measurement of the change of all those impacts, not just the one that you like to zero in on.

As I hear people say, desalting is not too environmentally friendly because **after** all, it has a concentrate discharge problem. Let's also talk about the environmental impact it has for making a large water supply available, and maybe relieving another water supply that has far worse **environmental** impact from being used. Those are all impacts that we need to talk about and we have a tendency never to talk about the full-range of impact caused by an environmental project or a desalting project. I did not know that there was a rule that you can not talk about one without the other. Somebody mentioned that, "you told us about the good parts on desalting, **I** wish you would tell me more about the bad parts". I guess I'm saying that if you are going to tell me about the bad parts, I want to hear about the good parts too.

GOAL

The next point **I** would like to make is in what direction we should be moving research towards in order to accomplish the goal that I would describe as moving desalting from the theory of textbooks and workbenches into being a major component in today's water **supply** system.

Consequently, the research goals that we need to meet may take different forms then what many start off thinking about. There are brine. discharges, concentrate discharges, power usage, air quality problems, the impact upon receiving waters, all those are things that we need to do research on to know more about. But if we did not do any more research on any one of those today, we could move ahead with the desalting program. Our desalting program is not dependent on future technical research in my mind. The basic information is there today, and things could be designed and happen today.

If we continue on the idea of only talking about the portions we want, then things are distorted. I call your attention to the fact that if we looked at the impacts of next week's Sierra Club meeting in San Francisco, we would find that they are going to cause air pollution because of their cars, they are going to cause a pulp problem to the forest industry because of their paper, etc., then they would not have that meeting.

If we looked at the impacts of having a child, Lord knows we wouldn't have any more children, because there is nothing like an adverse impact compared to that. There are impacts **for** us if we continue to exist tomorrow. The best way we can not have any negative **impacts** might well be if we all were not here tomorrow. So consequently, let's judge desalting, and let's move desalting into an area that is consistent with the net effect.

RESEARCH AREAS

To start off with, I think that there are five applied areas of research that are important. I will discuss them in the priority of which ones I think are most important to accomplishing our goal. The goal being to move desalting into the position as a major component of water supply systems today.

Communications

The first thing we need to learn more about is communications. Data transfer; the ability to take what we know in our minds and have the public understand it. **We are** lousy at that in case you don't realize it. The public conception **of the** things we deal with **is rotten,** and we have not made progress on it in the last thirty years. We've made progress in lots of other technology things, but none in that particular area.

Interdisciplinary Project Planning

The second priority for which we need some research or further development on, lies in the area of interdisciplinary acceptance and the ability to put interdisciplinary projects together. Right now, for desalting to go forward, we need some action by the water supply industry. The water supply industry doesn't understand us, doesn't want to understand us, and in fact, regards us as their enemy. So, I believe it is extremely important that we move forward in that area, and that takes some research on how to get into one's mind a better understanding of other peoples problems as well as getting into other people's minds an understanding of our problems. **We** pay little attention to their problems, as they do to ours.

Medical Impacts

The next area I think we need research on, starts to move into a technical area. **We** need research and development on a better understanding of the medical impacts of water supply upon our community. We are woefully void of having medical doctors participate shoulder-to-shoulder with us in the process of our deliberations. We tend to stay within our own technical fields. Very seldom do we promote the epidemiology and health research that is necessary to understand the impacts of the supply and use of desalted, reclaimed, or regular water on people.

When I talk about desalting here, there are three areas of desalting all of which are equally important and play equal roles. We have ocean desalting, we all understand that and that is what.most people think about when we use the word desalting. There is brackish desalting, which in Florida and California and as far as I know, most other places, has a huge future role, and one that will be explored and utilized before we turn exclusively to the ocean. The third area of desalting is also almost everywhere in the way of opportunity, and that is the desalting of reuse water, and the ability to take reuse water back to the area where we can use it for a drinking water supply. Those are three challenges, three areas, and once again I might add, one of the areas that emphasizes how limited most of us are. We don't even understand all three of those for the most part. We usually have centered or specialized in one of those three areas of desalting. Once again, in order to make the system work we have to cross the line into the other disciplines and be able to deal with the broad area that fits them. .

Economics

The fourth area where I think we need some research on is in the ability to put together and understand the economics of the project you are talking about. Not as compared against themselves, but as comparing them against the other aspects of water resources development. I don't know of anybody who has successfully compared the cost of reclaimed water, the cost of desalting water, and the cost of dams and canal water, and makes those comparisons correctly. I'm not meaning to be critical, but in some of the papers we hear at the ADA Conference and in articles where we compare surface water diversions for about $175/acre foot for the state (California) project plus desalted water as being $1,500/acre foot forSanta Barbara. For both of those numbers you will find a lot of-backup, but they are not comparable, they are like comparing apples and oranges.

We need to develop the research that each one of the disciplines can use. Develop the same guidelines in order to compare the cost and impacts of their projects. We need to have the same guidelines on how we credit a project with health benefits, with quality benefits, and how we discredit or subtract from them where there are environmental problems. We have no yardstick in today's world of water resources supply engineering to compare those projects. It is an extremely important area where we need some research and some preparedness. And that is a much bigger area than just one or two studies. We have to take five or six or seven disciplines and try to bring them together so that they can look at things through common eyes.

Desaltina Processes

The last area that I think we need some emphasis on research is the research that most of you are talking about here in this seminar. The technical aspects of the physics of desalting. This is on the bottom of my list as far as the priorities of what I think we need in order to move desalting forward. I think that it is important, and we certainly must try to unveil additional techniques and other ways of doing things and other ways of moving forward. This is probably one of the things that holds back desalting progress more than anything else. It is almost like the computer business. I have been waiting for four years to buy a laptop, but I don't dare buy it because I know that there is something better coming out next month. We are doing the same thing with desalting. We have to find a way to get around that so that we don't let the prospect of new discoveries set back our ability to move forward on desalting programs.

THEPROJECT

The next point I would like to get to in my talk is one that I am going to try to emphasize on is a project that I think is real today, could be made real today, and yet does not stand a chance in hell of being built. Then, I would like to explore some of the reasons why it's not being built. There is today everything in place for us to do a 1 billion gallon per day desalting plant in Southern California. A billion gallons a day is what is called for and is what we need to do to economically and environmentally meet the needs of that area. That billion gallons a day is about a million acre-feet a year and'that is about the amount of water that is being contested in the Sacramento/San Joquin delta. This would represent our share of that water, that is in contest, that is otherwise environmentally damaging if we take it. It is the amount that we are arguing with large groups of environmental people about, with the federal government about, and I think that at some point we have to accept that we are going to lose that argument. We have progressively lost that argument over the years, I see no reason that we are not going to lose it further.

Prior to my life in desalting I was a project engineer on the peripheral canal for the State Department of Water Resources. I *was* probably the leading proponent of the construction of that particular project. Today, I do not think that project makes any sense because since thirty years ago when we formed the project, there has been emerging a new set of water quality requirements to meet the environmental needs of the State of California. I think this has happened every place in the United States. We are given this slow, later on emergence of legitimate environmental requirements on our water supply systems. Generally, it comes to a head in areas where there is no alternative. No alternative away from the prospect of the water supply engineers current vision, but in almost every one of those cases there is an alternative, an alternative that could be built today with current technology, and that lies in the area of one of the three areas of desalting. And yet, we don't seem to be able to put that together.

Social Aspects

What is the first reason why we can't make the project work. It is because we try to sell hardware and desalting technology. The fact is, we have to translate that into social programs. Nobody ever built a highway because of the beauty of the highway, they built it because people needed it. The Central Valley Project was built in order to accommodate small farmers. It was for the 160-acre farmer who's way of life we were trying to accommodate. So the reclamation project grew in the early 1900's, not because people liked dams, not because people liked canals, but because it was a social program trying to achieve some social goals.

After the war, the Central Valley Project got rejuvenated, so did the construction of the State Water Project. One of the driving forces of the State Water Project at that time was to meet the housing and water requirements for the veterans returning from the Second World War. That was the thrust of that project, to make the desert bloom. That project managed to succeed because it had a social aspect and planners could communicate with the public that the reason why we were building it was not because we like to build dams. So, what do we do with desalting? I have never heard of putting a desalting project into a Social context, and yet, that is what we are going to have to do if we want to have movement in major desalting projects.

In my mind, I can describe the one billion gallon a day project in Southern California as a project with the principle beneficiary as the fish and wildlife resources of the State of California. It is going to give us the ability to pull our demands for 2 million acre feet of water out of the Sacramento/San Joquin delta back to a million acre feet for Southern California. And if we can do that, we will take away the environmental conflict between the State Water Project and the environmental movement. That is a social goal that we should be tying to in our move forward in the selling and movement of a major desalting project.

I might point out that the beneficiaries of the project are not water supply people, the beneficiaries are not people who saved so much money on this particular project over what the alternative costs are, but rather it is a much broader goal that is much better understood by the public.

Institutional

The 1 billion gpd project does not have to be built tomorrow, it could be staged and in the process of doing that staging, let me tell you how you might overcome some additional problems that we have with such a project. The third constrainy that we have on projects is the institutional hangup of people who build water supply projects. Right now, one of the reasons why 'we do not move forward on projects such as this is that people want to know, "who's going to build it?" "Who's going to own it?" "Who's going to be in charge?" That is a major problem in the water supply business. The fact of the matter is, we could build my billion gallon project by letting all kinds of people in Southern California build portions of it. In that way it does not disrupt the current power struggle between local water districts and the Metropolitan Water District of Southern California. We should let it become a tool to let either one of these get an edge over the other. It takes careful planning, careful research, and more knowledge than we have today to move a project together within those institutional lines that will not present a constraint. That is something we need to spend a lot of work on trying to get done..

Another argument almost always is that the technology is not good enough. We know that is not true and that we can build a billion gallon a day desalting project today. There are companies that are now looking at several other billion gallon a day projects, so we know the technology is there and that we can do it. I don't care what technology we have, that is not the business of the person who puts this deal together. The business is to get the project off the ground and find the way of sharing the technology necessary so we don't develop a constraint upon ourselves.

Motivation

I'm going to veer just a little-bit here and talk about something that happened a long time ago. Part of what I am telling you today is the speech I gave twenty-two years ago when I was down the road in Ft. Lauderdale at the first meeting of the National Water Supply Improvement Association. When we put that group together, we had one common problem, we were trying to maintain the life of the Office of Saline Water (OSW) which was fast fading because the people who were in the desalting business were killing it. It was not the congressmen in Wisconsin, not the guys from New Jersey, but the people in the industry who killed OSW. They killed it in a very simple way. OSW would get $20 million for three research contracts to give out to 1 to 3 of the 20 companies who were in the business. The other 17 companies in the business who did not get a contract that particular year, all called up their congressmen, they, in turn, ail took on OSW to say how awful and what a rotten place this was because they did not get a contract out of it. That had the net effect of making OSW inoperable, because it generated 17 irritated congressmen for every three that were happy. And consequently, by it's own function,. we killed it. We pleaded with the desalting industry not to do that and yet they could never find their way to back off of it. That same thing could happen in my project that I am talking about. We need to have research and understanding of the motivations of the people who sell desalting hardware. We need to have enough understanding of that to be able to put together a project. That would be how we would eliminate that from being a threat to my project.

Affordable

This project is affordable today. We can pay for it within the bounds of reason. It is not a project that costs too much and it is not a project that has serious problems in getting it accomplished. Just recently, a study was accomplished by the California River Water Agency in which they surveyed various areas throughout the State of California and their conclusion was that everybody. was willing to pay, in today's world, $13 more a month in their water bill to avoid the shortages that we have been confronted with in the last few years. Let me remind you, just based on the data from that sampling alone, my project would give us a reliable financial source that wouid get around those shortages. The confidence interval of the study says that they are right, give or take $0.50 a month. The'fact is, if they are right, give or take 50% of the amount, there is enough money in that kind of a water rate increase to pay for my billion gallon a day project. Therefore, I do not think the money and cost of desalting is the major deterrent for moving forward today.

THE WAY FORWARD

So, what is the problem'with us moving forward? 'What do we lack? What do we need to know more about to make this happen? My view of what is holding back desalting from where it should be today largely falls in the area of not having a desalting planning agency, we do not have a planned water project, and the ability to articulate and communicate these projects to people in the form of solving social problems that they can understand.

You will notice that most water desalting projects are sold by people who stand to make some money, rightfully so, on that project moving forward. Very seldom do we see the formation of a state water project for a given state that articulates the need for major desalting to solve their social problems. We need that because it is there, and there is a logic for it. Yet, we have not moved to create that portion of our industry. That portion that does planning activities turns out to be the salesmen for desalting. A salesman who does not come from a position of where he needs money, rather, he comes from a public agency who determines what we need in order to move forward.

R E C A P

I just want to recap to you what I think the major priorities are. Of the five I described, the two most important ones are learning to communicate, to redescribe our projects in ways that people can understand and that people will accept. And secondly, we need to find ways for ourselves to deal with other disciplines in order to put together interdisciplinary plans to move forward.

Question & Answer Session

Question: The Metropolitan Water District has estimated that by the year 2010, there will be a shortfall of about a billion gallons per day between demand and supplies available from conventional water sources. I agree with much that you said, but I do not think you can look at this plant as the replacement for the Central Valley Project or any waters brought from Northern California. If you want that as a replacement then you would have to have a 2 or 3 billion gallon per day project.

D. Owen: The Metropolitan Water District currently plans on serving some place in excess of two million acre feet a year in 2010. They are actually bold enough to say 2.6 million acre feet. A million acre feet a year is approximately a billion gallons a day, and so consequently, they do not visualize in their current plan to develop any major desalting to make that replacement. They have such small amounts of desalting projected in their future requirements that it makes very little difference. And the conflict is about a million acre feet a year, or one billion gallons. If they need more than that, so be it, my project **is** better off than I thought. The fact of the matter is that I will start with my billion gallons/day first.

Question: John Morns, Metropolitan Water District. I want to be sure and take Don's second priority, and that is the interdisciplinary team and look for an opportunity that you and I could pursue later. That would be taking the integrated resource plan that Metropolitan is pursuing where they are working with all water agencies in Southern California The point being, we can expand their thinking in terms of resources, not only thinking of integrating monetary resources with water resources, but'also considering the environmental resources and you might get them to that direction.

D. Owen: Let me comment on the **IRP,** the Integrated Resource Plan with the Metropolitan Water District of Southern Caiifomia. It is a brilliant idea. It is a subject that is so far beyond the ability of Metropolitan to understand how good it is that I am just shocked. But the fact of the matter is they are violating the very rules I am talking about with their **IRP** by looking only from their discipline and ignoring the discipline of other agencies. I had the occasion to be critical of it about four months ago when they were going to have a public American process, I think they call it American assembly. That **is** the American way, and they specifically said, "You can not come to our meeting". "Or if you come we won't let you talk". That makes the perfect example of the problem that Metropolitan is having in executing their brilliant idea.

Question: You mentioned that the need for a state agency to plan and organize this type of project. I submit that in theory, this sort of thing could work well, but in practice the state agencies are more of an obstruction than they are help. I submit that the chaotic development by individual practitioners and agencies, public agencies included, are going to make more progress then they would under the guidance of a state agency.

D. Owen: Let me explain, I put down five priorities, and I put one priority first. The first priority I had was our ability to communicate ideas to the public, and until we have done that, until we get public acceptance to what we are doing, we have to expect our public agencies to respond *to* what they believe the public perception is. So consequently, I agree with you.' The State of California currently put together a review of the State Water Project and they do not even look at desalting, because they do not perceive that desalting is important to anybody in the State of California's mind and so consequently they leave it out of the budget. Until we have done our first priority, develop our ability to communicate with people and get across the idea that everything is here today to accomplish our goal, our goal being to move desalting into a major portion of a water resources system, until we communicate that goal to people and have our own constituency, we are not going to get anyplace with those state agencies, I agree with you on that. But as soon as we do that, having been a former state agency, or worked for a state agency, you will be amazed how 'fast they will come to the point of view we want.

Question: Louis Beck with the Department of Water Resources of California. It is not exactly part of your discussion, but it was part of your introduction. How does the Orange County Water District get a permit to discharge reclaimed water into the drinking water supply?

D. Owen: We did it by doing the research necessary. By doing the things that responded to each of the questions that was asked of us with a research program. I have to tell you, the Orange County Water District has probably spent $15 million to $20 million in research on Water Factory 21 in order to move as far along as we have. That is more money, to my knowledge, than the State of California and/or the federal government has spent on this type of research in the last twenty years.,

Question: In light of some the decisions recently, do you think it would be harder now to get that permit?

D. Owen: Absolutely not; because we are a lot smarter now. We did it in twice the time. Let me tell you about the current project we have. We are looking at a project that will divert 100,000 acre feet a year from the Orange County Sanitation District, following primary treatment, and moving that water up into the Santa Anna fore bay, taking some direct irrigation diversions as we move up. The bulk of it will be treated and spread in the spreading facility and will become part of the water supply for the Orange County's drinking water supply. We have a shellfish discharge requirement in the ocean that is 10 times, that is one order of magnitude, more restrictive that our drinking water standards. So on the list where we said we had four ways to dispose of brackish water that we could not discharge anyplace else, I suggest we add drinking it to one of them. In this particular case we can't discharge it so we drink it. That third part of the process also comes in. We have to able to put the solution in perspective. Look at the consequences, with or without our program, of how to move forward with the necessary research to get it done.

Question: My question is that since we are going to build huge projects like this, what is one of the most important things that will be used to base your estimate on and what would be the process selected? Up to now, have you found any other process alternative other than RO or thermal?

D. Owen: Your question was, with such a large project why don't we zero in on the technology early in the game and try to build one. I think we can run the study, I think we can run a relatively quick study and for the given facts of what we are going to do and we can arrive at which one of these projects we want. I think that if we select the project early, such as Metropolitan has done in their current research program, you destroy your ability to get there. I think that you should leave that out, decide to do the project, and then zero in on the technology. To do it now would be a mistake. You should not say, "Well, we've decided to build a huge RO plant, or we have decided to build a large thermal plant". The Orange County Water District (OCWD) did that with the vertical tube evaporator multi-stage flash project and all the good that did us was to bring out the critics, it didn't bring out any of the people who favored it. We can decide that after we make the decision to proceed with the program. That is an important aspect of how we go at it.

Question: I think I am all excited about the 1 billion gallon a day plant. I do not doubt that with today's technology we can build for less than a thousand dollars per acre foot or $3 per thousand gallons. However, the question is, and you brought that up, how you adjust economics. Obviously that is more expensive than drinking brackish water, and it is of a magnitude that no other project can do it. How do you bring the focus of economics on the benefits of doing large scale desalting from sea water with unlimited resources versus all other smaller projects which, on paper, look more economical?

D. Owen: I guess how you do it is you try to do it as accurately as possible and we have the data to look at what the costs of all alternatives are. We have to arrive at a way that we penalize the project that may have additional THM problems, or may have a chlorination problem on reuse with one that does not. So we put values on those kind of things. The problem is, that there are probably thirty aspects that need some pro or con monetary evaluation in order to arrive at a really comparable number. That is my fourth theory of research, I think we need some more knowledge in that area. I would be willing to try it today if I had to.

Question: Don, as a former federal agency water planner. Many of the engineering . communities at the present time are impacted by the environmental community and we are taking a back seat in this whole planning process. In fact, there are not many federal planners left. One example of that is, I was in a meeting recently when the Corps of Engineers was describing their upper Mississippi planning project. It turns out that their number one priority in that planning project is to return the upper Mississippi to it's pristine condition. If the engineers are going to be backing off and accepting that as a number. one priority, we really are not doing our job. I think the job to do is have some education in the federal community and bring it back to reality.

D. Owen: I agree. They have driven us into a defensive posture where we argue about the toxics of our discharge rather than the impacts of our project. Because of that, they have us in such a defensive posture that we can not get on the same podium and win with them. What we have to do is turn that around and start talking about the impact of our project: The degree to which a desalting project will move the Mississippi towards it's pristine condition, rather than if we do not do i. That is the way that we have to learn to couch our answers in.

Question: When you start talking about a billion gallons a day project, you are talking about a lot of energy requirement. One thing I have not heard anybody speak about today is the energy aspect of environmental issues around water supply. Can you comment on that?

D. Owen: Let's expand on that a little bit. Remember my definition of the environmental impacts with what the project causes with or without the project. Right now, the energy we are expending on importing water from Northern California, at least in the brackish area, is probably as great or greater than desalting brackish water. The advancement of energy production in what I will call environmentally benign methods, such as things like fuel cells, have prospects that we need to do some exploration in. I think in the long run we can meet this increased energy demand that my one billion gallons a day plant with little or no impact. Or if we have that impact, it is not going to be much more in terms of energy consumption that we would have had otherwise. If it is, it is still going to be mitigating an impact that we can live with. If you do scenarios with, or without, you are going to find out that it is a lot different than if you just do it looking at the energy requirements by itself.

4.2 CURRENT RESEARCH ACTIVITIES
by Ron Linsky

INTRODUCTION

The National Water Research Institute (NWRI) started its fourth year on July **1st** of this year and has made some reasonable progress during that time. We now have in excess of $8.5 million invested in research projects throughout the United States from new York at Rensselaer Polytechnic Institute all the way west to the University of Hawaii. All of our research projects are instituted as a collaborative effort with joint venture partners. One of our early partners in membrane research is the Bureau of Reclamation.

Our joint venture partnership program was developed with the purpose of building a bridge between the research laboratory and the consumer of that product whereby the product of the work is delivered to the consumer in a timely fashion. This joint venture strategy has allowed us to leverage $1.25 million in research funds to an excess of $3 million every year, an optimum opportunity for us to expand our horizons.

NWRI's Membrane Research and Development Program started a couple of years ago and has now grown into a significant program that receives a lot of attention. A spinoff from the Membrane R&D Program has been the National Centers for Separation of Critical Systems Research. That program is working, and **NWRI** is just about to complete a national survey of facilities.

Today, we find that research is taking a number of paradigm shifts from what we knew as research a decade or more ago. In water research, specifically, this shift has been occurring rather rapidly. As a consequence, **NWRI** has been encouraging **the** issue of research perspective. There needs to be a bridging or a linkage between what researchers do in the **scientific** world and what **the** operational or applied world is all about. The problem is determining how to link the two activities.

COMMUNICATIONS

It is **NWRI's** position that communications start with people, not technology; not with research, but with researchers. **NWRI** is trying to bridge that **gap** by employing a technique called the Nominal Group Technique (NGT) workshop that we have utilized successfully for the last three years. This workshop provides an environment whereby participants can focus uninterruptedly on the identification of problems, propose solutions, and reach consensus on their priorities.

This technique produces some very interesting results. We bring together 25 to 30 people representing different views that address one very tightly written question. The question, limited to 21 words • no less, no more • pinpoints a specific task. The participants are given two weeks prior to the workshop to think about the question and are asked to bring their responses with them to the workshop. During the workshop, participants have an opportunity to present their response(s). Other participants cannot challenge a response but may ask only for clarification. After all responses have been presented, the next-steps involve consolidating and prioritizing the responses. At a recent workshop, 25 participants reached consensus on an issue and contributed to a 11 4-page report.

By using the technique, we can examine all sides of an issue and benefit from the viewpoints of this diverse group who look at the question from their individual perspectives. We have been very successful using this technique to work with the USEPA and U.S. Bureau of Reclamation, and we are planning to conduct a NGT workshop in November as a pre-conference function for the Association of California Water Agencies at their conference in Monterey. We feel that bringing people together to address an issue is extremely important and by doing this, we can bridge the gap between science, technology, and the end user.

Having agreement among scientists, technologists, regulators, and the regulated is quite a challenge and is a very important goal. At a workshop that we held recently with the USEPA relative to health risk assessments in distribution systems, it was determined that fouling was one of the priorities for research in distribution systems. When NWRI did a modified NGT workshop in Muscat, Oman, we found that, on an international scale, fouling was one of the top; priorities in research. When examining different viewpoints from around the world, it turns out that technological interests were very similar. This demonstrated that fouling was a very important issue to look at and that significant attention should be directed to the processes associated with the phenomena of fouling.

Another general observation that can be made today in research is that there is a major concern about environmental issues. When one analyzes what people mean by major concerns in environmental issues, their concerns are based upon rather sketchy data or information. An example of this might be in evaluating brine impacts on coastal shore waters. If you look at a wastewater treatment plant which discharges into inshore waters (whether it be fresh water, river water, or ocean water), the greatest impact that occurs in the waste discharge to ocean water is not the suspended material; it is the fresh water itself that has the highest impact on the wastewater.

Regarding the issues of concern relative to plant siting in the coastal zone, we found that the aesthetics were more significant to the population than the technology, and so as a consequence, we must deal with some nontechnical problems and incorporate them into the process of evaluating appropriate technologies. Research programs today are highly influenced by public policy issues. Often, both good technology and good research are eroded by public policy issues and vice versa. People often lose policy perspectives in order to make technology work. Successful research has to be translated into the decision-making processes. As a consequence, NWRI has a Public Policy component within its research program. This component looks at those issues of how to *move* successful technology into the decision-making process. In fact, we have a couple of interesting projects with the National Research Council to look at the value of groundwater - not the price of groundwater, but the value of groundwater.

Fortunately for NWRI, we cohabit with the Orange county Water district and have access to Dr. Harry Ridgway and his biotechnology group who are looking at the biofouling phenomena of membranes. We are also forming linkages with Rensselaer Polytechnic Institute and UCLA. At Rensselaer, work is being undertaken on new designs for separators. We are in the process of developing with UCLA the concept of *a* smart membrane. You have heard of smart bombs, smart rockets, smart people, but you probably have never heard of a smart membrane. We hope to develop the first smart membrane which will have a brain some distance away in a computer. The work currently underway is being developed in cooperation with Dr. King Tu of the UCLA Materials Science Department.

NWRI focuses upon applied research and continues the further implementation of its joint venture partnership programs and is moving ahead on a number of fronts including NWRI's Membrane R&D Program and the further evolution of the National Centers Program.

4.3 BRINE DISPOSAL IN OCEANS

by John Largier[1]

This discussion is based on my experience in studying dense estuary flows, in working on the Electric Power Research Institute (EPRI) project "Modeling of Brine Disposal in Oceans" during 1992-93 and in consulting with local authorities in California that are becoming involved with the desalination of seawater. My concern in this work is not with the more obvious impacts associated with the desalting plant itself (e.g. use of land and energy), but with the discharge of large quantities of warm brine from the plant. In contrast to wastewater power plant discharges, desalination brine is denser than ocean water and tends to sink If the brine reaches the bottom before complete mixing occurs, the rate of mixing and dilution is severely reduced. The greatest danger is found where desalination brine is released into a sheltered bay or harbor which is separated from the open ocean by a region of shallow water. This was the case with a small pilot plant constructed at Key West, Florida during the 1960's. In retrospect, the damage to that ecosystem in Florida was not directly due to elevated salinity, but a result of copper accumulation in the dense brine that covered the base of the harbor.

Looking for generalities in the study of potential marine environmental impacts of brine discharge, rapid mixing and dilution is the key. For typical desalination discharges, it is the salt concentration that presents the greatest challenge. If adequate dilution is obtained, the whole desalination process is no more than the natural hydrological cycle. Adequate dilution is obtained most readily through the discharge of small volumes (i.e., small productions units) into open ocean water (i.e., not bays and harbors). Larger desalination plants are not precluded by their potential impact on the environment, but they will typically require offshore outfall structures that can enhance mixing and dilution as is done in the discharge of wastewater. The definition of a "small" or "large" plant is determined by the physical nature of the ocean into which the brine is discharged (i.e., the assimilative capacity of the local environment). For example, in the presence of large waves and strong currents, larger discharges will be diluted more rapidly.

Little work has been done on the tolerance of organisms to elevated salinities. It is important to conduct site-specific studies of the tolerance of organisms and ecosystems to salinity perturbations because both organisms and ecosystems are adapted to the local conditions prior to perturbation. Unfortunately, it is difficult to fully resolve this tolerance by pre-construction studies and discharges should be designed conservatively. In our report on modeling brine disposal, we used salinity perturbation of 1 ppt as a conservative estimate of typical ecosystem tolerances, but we have no

[1] John Largier was not able to attend the seminar to make a presentation. This paper was derived from a letter to ADA which discussed the points he intended to present.

in-field evidence that this is appropriate. Rigorous monitoring programs should be put in place after the plant comes on stream. These monitoring programs would map out the salinity perturbation field and determine any affects on the ecosystem. It is my intention to become involved in such studies of existing plants. At this stage, however, California does not offer the opportunity to study a desalination discharge of significant size and it appears that this work would be best done in the Middle East where large plants are presently operating.

It is my belief that, while desalination does carry some threats to the marine environment, if designed and practiced judiciously, it has the potential to produce significant quantities of potable water without any significant impact due to the brine discharge. As compared with the further extraction of water from river systems, this water source appears to be the way of the future in an environmentally aware world.

4.4 AWWARF RESEARCH ON CONCENTRATE DISCHARGE
by Deborah Brink

This paper focuses on a project funded by the American Water Works Association Research Foundation (AWWARF) that was undertaken by Mickley & Associates of Boulder, Colorado, on the subject of membrane concentrate disposal. The report for this project was recently published by the foundation and AWWA. In addition to this report, the AWWARF also has a number of other membrane projects being completed or under way. These other projects cover areas such as biofouling, particulate removal by membranes and so on.

This project included an exhaustive research effort and resulted in a report of about 400 pages which focused specifically on membrane concentrate disposal. The conclusions and recommendations are very representative of the state of science in this area.

There appear to be **no** basic fatal flaws in the use of membrane technology to provide drinking water. The challenge in the design is in the permitting of the facilities. This challenge **must** be met for this technology to reach it's full potential. Because of the rapid growth of the industry, the timing **of all** these actions are critical at this time. It is clear that more and larger membrane facilities need to be built. But also, at the same time, we will probably be having more stringent concentrate discharge requirements. Both of these things have to be factored into the recommendations on where we go from here.

The disposal of the concentrate from a membrane plant will have a major financial and design impact on the facility. Concentrate disposal should therefore be an integral part of the design and evaluation process for any membrane facility. In many cases the disposal issue will' probably be one of the deciding factors on the future of a specific project.

All those involved in the design, permitting, operation and ownership of membrane drinking water plants must be educated. Despite the rapid growth of the technology, there is still a need for education for all those that are directly involved in the process. This must be interdisciplinary and cross educational backgrounds. People who are involved **in** the permitting process should understand what is happening in design and vice versa. Also, there is a need for community education and improved public relations. Often times, membrane technology is really the only viable means for providing a potable water source for the community. It also provides a chance for getting a better quality water to communities in an economical way. There still remains the issue of educating the public on the benefiis of using desalting technology. Often times, they do not get into the loop until the end when they hear about the permitting and at that point it is very difficult to overcome any misconceptions about the process.

Another thing that has really fed into this public misconception are some of the labels that are applied by the permitting agencies. Such as, when federal and state agencies describe the characteristics of the discharge from a membrane drinking water plant, using the term "industrial waste" and talk about "toxic" and "hazardous". These words are understood in the technical sense by professionals, but when these terms are heard by the public at large, they become more emotionally charged terms. Related to this, one of the big recommendations from this project is that the membrane concentrate be reclassified to avoid the misleading "industrial waste" label.

Another definite conclusion of the project is that the success rate of operating plants is excellent and public satisfaction with the product water is high. This information needs to be publicized. Another conclusion is that discharge regulations are constantly changing. Federal, state, and local regulations appear to be in a constant state of revision. This makes it very difficult to plan a new installation and even existing facilities may be at risk Facilities may find that they meet one set of regulations and then, under revised regulations, their discharge methodology is inadequate.

Another conclusion is that we expect the number of water treatment plants to be increasing in the future. At the same time the discharge regulations are expected to become more restrictive. Many communities will need to develop lower quality waters (brackish and saline) as the demands increase. However, at the same time, as we are treating lower quality sources, the water membrane concentrate waste disposal issue will also become more difficult.

A cooperative effort is needed. Currently many of the groups that are involved in membrane drinking water plant processes seem to act fairly independently; legislators, regulators, utilities, engineers, the public and so forth. This ADA seminar is a good example of trying to overcome this barrier and getting all those groups to work towards getting the technology implemented and the environmental issues clarified.

A final conclusion is that further research and development is needed and should focus specifically on the issue of membrane concentrate disposal. The membrane equipment industry has focused its efforts on optimizing performance to-date, and not much on the concentrate issue until now. The regulatory agencies have applied evaluation techniques and discharge regulations to membrane waste, which were originally developed for discharges from other industries. So, in a way, the membrane concentrate issue has gone into a technical and regulatory gap. A cooperative effort is the first step in developing tools and information beyond what is available right now in order to support the technical and regulatory requirements in future years.

Based on this report, a series of recommendations can be made. First of all, the membrane concentrate drinking water industry should select an organization to take the lead in the concentrate disposal issue. It appears that ADA has clearly decided to assume this role. The purpose of this group should be to make information available to others and to endorse and support research. There also needs to be an effort to inform and educate the different stake holders, related to the use of membrane treatment for drinking water. These include legislators, city councils and other decision makers, regulatory agencies, the public utilities, and consulting firms.

Each of these groups have different information needs, and the outreach efforts that are needed in the area of communication must be tailored to their specific needs. ADA should encourage various planning organizations to sponsor research to provide regulatory agencies with better tools and other technical information related to concentrate disposal. One of the chapters in the report deals with specific research needs that have been identified in this particular study. AWWARF is one vehicle for funding research and ADA could make a submittal as a group defining what the organization feels is most important in regards to critical research needs that could be conducted during the upcoming year.

The industry should support the regulatory agencies in ways that will help them develop and apply more meaningful regulations to be implemented.

One of the highest priority efforts recommended in this project was to change the classification of drinking water derived from membrane concentrate from industrial waste to something like "drinking water plant membrane concentrate". The "industrial waste" label has a lot of negative connotations and therefore causes problems.

The second priority is to directly study the fundamental issue of surface water discharge as it relates to the toxicity of membrane concentrate. This report recommended that the toxicity of groundwater, which is the source of membrane concentrate, be the immediate focus.

Permit applicants, which in broad terms includes utilities and engineering consultants, need to work together to support the industry and to address the issues that have been discussed. They also need to actively participate in educational and other efforts and specifically address concentrate disposal issues eariy in the considerations of a membrane water plant facility. In the report there are a lot of recommendations on what utilities shouid be considering if they decide to implement a membrane plant for their system.

In summary, the report is about 400 pages and has a lot of information on disposal options, cost, estimating, etc. If you are a subscriber to the AWWARF, you may order the report directly from AWWARD at no cost. Please contact P. Hampton at 303/347-6121. The report number is 90637. If you are not, and you are interested in getting a copy of the report please call 8001926-7337. The **cost is** about $72 for AWWA members and $91 for non-members.

4.5 EPRI - RESEARCH ON CONCENTRATE AND BRINE DISCHARGES

by Frank Oudkirk

INTRODUCTION

This is a discussion about some research work that the Electric Power Research Institute (EPRI) carried out on the discharge of concentrate and brines from desalination plants. Why is EPRI interested in desalination? There are some demographic similarities in that when people use water, they use electricity. Both water utilities and electric utilities are somewhat similar, one has a pipe and the other has a wire at the point of sale. Beyond that, there are some other similarities between the industries. In 1991 EPRI studied what might be the advantages of co-locating desalination plants along with existing power plants.

The study came up with several conclusions. The major conclusions are listed in Table 4.51. The first is that for a

Table 4.5.1 - Conclusions from 1991 EPRI/FPL Desalination Research Study	
1.	RO is least expensive and most suitable technology for backfit of existing power plants to dual purpose plants.
2.	Large scale seawater RO is 4 - 6 times and large scale brackish RO is 3 - 4 times cost .of existing supplies.
3.	Environmental and cost benefits to co-location with power plants.
4.	Manufactured water can adapt a cost structure similar to that used by utilities for electric power.
5.	Brine disposal is serious problem for both brackish and seawater desalination.

plant that is already built, seawater reverse osmosis seems to be the most desirable technology. There are some cost problems involved here as manufactured water is more expensive than water from most existing supplies. There are some environmental and cost benefits to co-locating a plant. Then, brine disposal is a serious problem.

BUOYANCY EFFECT ON DISCHARGE'

If you have a positive but buoyant discharge like sewage water into the ocean, which is mainly fresh water, it tends to rise to the top. Figure 4.5.1 shows that if it is neutral it would tend to disperse in the mid stream or mid level,- and then with negative discharge, pure brine, roughly twice the salinity of seawater, would tend to roll over on the bottom.

What we have identified as the result of this study is that every field needs further investigation. There needs to be one tool developed that will be recognized by the regulators and the industry as being a reliable device for predicting how these plumes behave. We narrow it down to two codes. One is the plume code which EPA uses mainly for positively buoyant plumes, that is those that tend to rise to the surface, like wastewater or brackish water. The other is called CORMIX. CORMIX is also primarily for handling positive or buoyant plumes, but CORMIX has some features to it that we deemed advantageous to modifying it to handle negatively buoyant plumes.

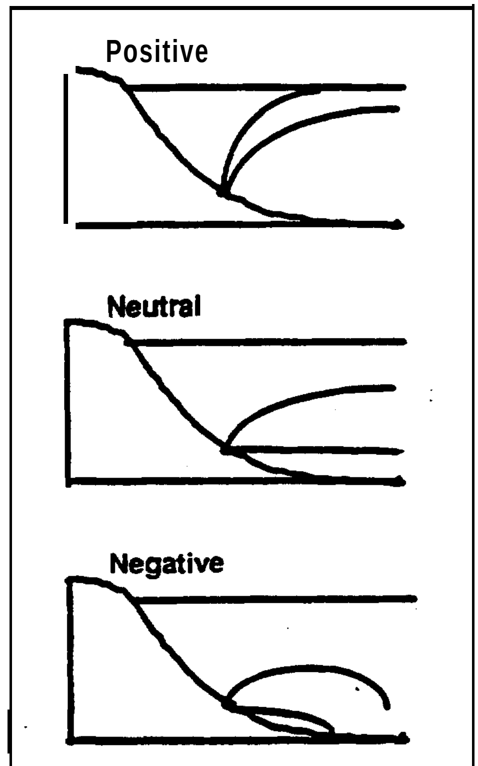

Figure 4.51 • Buoyancy effect on discharge.

Mixing wastewater and other discharges with desalting plant brines changes how the resultant plume will act once discharged and how they would be diluted in the ocean. One modeling effort. looked at various discharge options from a point about 3 ft off the ocean bottom. In this instance a pure brine discharge almost immediately hits the ocean floor and when it touches the bottom there has a dilution of about 40. Then, if you mix it with some wastewater (dilution about 280) it would still be slightly negative and move further from shore before touching the bottom. If the brine was mixed with lots of wastewater (such as a dilution of 1310) it would be slightly positive and moves to the surface as it moved away from the shore.

Salinity can have an effect on some ocean plant life. This was examined by EPRI to try to quantify how brine discharges might affect the biota. One thing that was examined was the change of observed photosynthesis on some plants that grow on the bottom of the ocean at different salinity levels. There appeared to be some salinity band (from the normal) where you can vary the salinity from the background and not harm the specific species studied.

The CORMIX code looks at all the factors that might be involved in designing of a discharge point. It gives you these kinds of outputs including the plume trajectory (as you are looking down on the plume), the side view of the trajectory and the expected dilution. This work used a dilution of 1 ppt (parts per thousand) above ambient which was something that EPRI would like to achieve but this standard may be too severe.

In California we know of a case where they are using 10 ppt above ambient and obtained a permit.

A model of how a discharge on the west coast of Florida would look was made according to the CORMIX codes. For this model a simulation was made assuming that the brine was discharged in 18 feet of water (the worst case), with a 50 million gallon a day plant discharge and no current. What would have to be done to achieve a result keeping the water within 1 ppt above ambient is to use a nozzle configuration which would be 300 feet long with 72 nozzles. This is quite an expensive device and that is why co-locating a desalination facility with a power plant would appear to offer some advantages.

The work that we have done so far on the B-CORMIX is to develop a computer model that can be used as a tool for many things, including convincing permitting agencies that the discharge from one of these plants would be environmentally acceptable. That work is basically done and the code is finished. Table 4.52 lists some of the features of the B-CORMIX.

Table 4.5.2 - Features of the Ocean Brine Disposal B-CORMIX Model	
1 .	Modification of EPA sponsored cormix.
2.	Well suited for use by water agencies.
3.	PC based.
4.	Easy to use.
5.	Self-training.
6.	Desirable hydrodynamic features.

We are verifying it now primarily using the data that was collected from pumping out salt dunes along the coast of Texas where the petroleum reserve is located. Quite a bii of data was taken by Texas A&M at that time, and we are verifying the code against that. The next step we have in the project will be to run co-disposal studies, one in Hawaii with sewage water, and one somewhere in the Tampa Bay area, either in the Gulf or in the Bay with power plant discharge. As was mentioned earlier, power plants have a thermal discharge. Since the brine is heavier, co-mixing of that, might actually benefit both the brine and the power plant discharge.

The third step is to investigate whether a plant could be located on Tampa Bay and predicting what would be the long term effects would be on that body of water of a brine discharge from a plant in the range of 5 and 50 million gallons a day . The

EPRI committee feels that Tampa Bay seems to be an area where there is a lot of interest in desalination plants and that it would be valuable to model this.' The Committee is working now to develop a work scope with the National Estuary Program and some of the people they have worked with on a computer analysis that would take into account all of the factors that might be involved, like tides, currents, fresh water inflow, rainfall, and seasonal variations in those. These data and analysis would be combined with data on a potential point discharge of brine from a desalination plant mixed with power plant coolant water to see what the long term effects would be on the bay.

Information on this project is discussed further in the EPRI report entitled, *Modeling of Brine Disposal in Oceans,* published in June, 1994.

4.6 CALIFORNIA COASTAL COMMISSIONS' PERCEPTION OF DESALINATION

by Cy Oggins

This paper discusses the California Coastal Commissions' role in desalination, some of the coastal act issues applicable to desalination plants with a focus on the issue of brine concentrate, update you on some recent Coastal Commission actions with desalination which are not specifically related to brine discharge, and then finally, suggest some conclusions and recommendations.

ROLE IN DESALINATION

There is a perception today that the permitting process in California is confusing and perhaps **byzantine** and contradictory. For example, the permits needed to build and operate a desalination plant in a coastal zone include the following: Building permits with local governments; air emissions permits from the local air pollution control district: a lease from the State Lands Commission; a **NPDES** permit from the Regional Water Quality Control Board; you may require Section 10 and Section 404 permits from the U.S. Army Corps of Engineers. If there are any sensitive species or habitats in the area, you will need to get approval from the California Department of Fish and Game; you may also need approvals from the National Fishery Service and the U.S. Fish and Wildlife Service. Finally, the last permit that you will need is a coastal development permit from the California Coastal Commission or the local government which has jurisdiction.

The Coastal Commission permit process is not that hard to understand. The Coastal Commission has refused proposed desalination plants, but this has happened with other **coastal** development projects in the coastal zone. Projects are considered on a case-by-case basis. The review of desalination facilities is conducted not because the Commission has predetermined that desalination plants are environmentally unfriendly, rather, that we want to analyze the full impacts of any specific project on the coastal zone. There are two standards of review. The first is the resource protection policies that are contained in Chapter 3 of the Coastal Act. There are also land use plans, zoning ordinances, and water management plans that are part of the coastal plan for local government.

One of the issues that the Coastal Commission looks at is **conformance** with a local coastal plan. Most of these plans specify the land uses for the area, establish and develop standards and contain policies to allocate limited water resources. Similarly, the Coastal Commission will look at the energy impacts. Most desalination plants require significant amounts of energy. The Coastal Act specifies that new development shall minimize energy consumption, so one of the things the Coastal

Commission will most likely do is show preference to those projects that minimize energy consumption. This for example, would favor RO plants or desalination facilities that use co-generation.

The Commission also looks at the impacts on marine resources and environmentally sensitive habitat areas. This is of particular importance to concentrate discharge. Specifically, the Coastal Commission will examine the effects on marine resources of both the discharge and the intake for a desalination facility. Coastal Act policies that the analysts will review are that marine resources shall be maintained, enhanced and restored. The same with biological productivity and water quality as specifically mentioned in Chapter 3 policies. Other issues that the Coastal Commission will look at include the effect of the desalination plant on public access, recreation, commercial fishing, and navigation. It will also look at things like visual quality that could be affected by the intake structure.

The issue of brine or concentrate discharge is rather new. As recently as May, 1991, the policy of one of the State's Regional Water Quality Control Boards was, "to exempt discharges of desalination brine permit requirements on the basis that properly managed discharges of concentrated seawater has insignificant water quality effects". The major concern for brine discharge today is the potential adverse impact on aquatic life and on beneficial uses of the receiving water. At this time, neither the State Water Resources Control Board or the Regional Water Quality Control Boards (types of state agencies in California that influence the NPDES program) are planning to classify desalination brine as anything more than that type of general waste discharge that requires'an NPDES permit. However, additional studies are continuing. Right now it is left up to the discretion of the Regional Water Quality Control Boards whether or not to issue the NPDES permits.

The Coastal Commission will review the issue of desalination concentrate. First of all, we will require an NPDES permit from the State Regional Water Quality Control Board. Both the Regional Water Quality Control Board and the Coastal Commission are interested in modeling, and B-CORMIX is the one model that the State Water Resources Control Board is looking at. We are also interested in the discharge location and whether it is to the open ocean or to an enclosed bay. One of the ways that the Regional Water Quality Control Board is approving desalination discharges in California is where blending or co-mingling of the discharge with existing facilities occurs. For example, at Chevron Gaviota, desalination discharges are mixed with treated produced water. In Morro Bay, it is mixed with power plant cooling water. In Santa Barbara, it is mixed with treated effluent from a waste water treatment plant. In the Monterey Bay, the aquarium tends to mix it's concentrate discharge with a significantly large discharge of seawater that is used in the aquariums. Lastly; the Coastal Commission and the Regional Board will be requiring monitoring.

Two years ago, at the meeting at Newport Beach it was stated that desalination is a new issue to California and one which is undergoing significant change. In the past two years not much has changed. In the last two years the Coastal Commission has not received any new permit requests for desalination projects. In Morro Bay, the city actually voted to take water from the State Water Project rather than extend the use of its desalination plant on a permanent basis. That management plan will be reviewed by the Coastal Commission. The City of Morro Bay also intends to come before the Commission to extend the emergency use of its desalting plant until the State Water Project connection is made.

The City of Santa Barbara is intending to come to the Coastal Commission to extend the life of their desalination plant and to change it from temporary to permanent. Lastly, the Coastal Commission did review a number of amendments to the local coastal plan which affect desalination. These are not related to brine discharge but are related to the use of public versus private desalination. Specifically, the policy that the Commission approves, states that Santa Barbara County may grant discretionary permits for development of projects using desalination water only if the source of desalination water is from an established water purveyor. Desalination water from private sources designed to serve a single project in a geographic area within surface boundaries that establish public water purveyors shall not be a source of water for applicable developing projects.

Finally, some overall recommendations to people in the desalination community. One, read the Coastal Commission report entitled, Seawater Desalination in California. This report outlines a lot of things that would be helpful to go through before you come to the Coastal Commission, and two, communicate with the Coastal Commission **early,** as that is the way to streamline the process.

SECTION 5

WORKSHOP

5.1 WORKSHOP INSTRUCTIONS
by Sus Sumoto

INTRODUCTION

During this seminar we have heard from the experts, a lot of experts, now we want participation from you, and we firmly believe that there is no ridiculous or bad idea in this workshop session. We want any and all comments relative to the questions associated with each of the case studies. Each of you were given a case study, either a yellow or blue one with a number on it. The number corresponds to a group. Each one of these groups will have a facilitator, we want to have these groups meet for 45 minutes or so. During this workshop session, you will be presented with one of two different case studies to determine how *to* resolve particular problems related to a West Coast seawater desalting plant and an East Coast brackish water project.

INSTRUCTIONS TO FACILITATORS

The facilitators are: Ed Backstrom, Sus Suemoto, Lisa Henthome, Laura Herbranson, Fred **Balling, Kevin Price,** and Tom **Bagwell.**

The **45-minute** breakout workshop session should be divided in time as **follows:**

1. Introduction - 5 minutes
   - Explain purpose of breakout session (To read the case study and answer three questions) - Hand out case study
   - Explain process (Brainstorm/sorting technique using yellow **stickies)**
   - Any Questions?

2. Read Case Study - 5 minutes

3. Question **#1**
   - Individual brainstorm - 5 minutes
   - Sorting - 10 minutes

East Coast Case Study
- Options for discharging concentrate?
- Affect of options on water treatment system?

West Coast Case Study
- Brine disposal options?
- Advantages and disadvantages?

Note: For these questions, you will want to have the group answer the two questions together. That is, they should list an option for discharging concentrate and then **also** say what affect that option would have on the water treatment system. The information for both should be on the same yellow **stickie.** For the West Coast case study you might want to recommend identifying one advantage and disadvantage for each brine disposal option listed.

4. Question **#2**
   - Individual brainstorm - 5 minutes
   - Sorting - 10 minutes

East and West Coast case studies

Special Plant Features
- Facility environmentally friendly
- Immediate neighbors satisfied

Note: For this question, you will want to have them answer each part of the question separately. That is, you would have them answer, "What special plant features might you identify to keep the facility environmentally friendly", and then, "What special plant features might you implement to keep immediate neighbors satisfied". You will want to collect the information for each part of the question separately.

5. Question **#3**
   - Individual brainstorm - 5 minutes
   - Sorting - 10 minutes

East and West Coast case studies

Public relations strategy to maintain community acceptance
- Planning/regulatory/approval phase
- Design/construction phase

Note: Same as for Question **#2**

5.2 EASTCOASTCASESTUDY

THE SITUATION

A mid-sized coastal south **Florida** city has a lime softening water treatment plant treating fresh, shallow ground water. Current population is 30,000 people and that population will reach 50,000 *in* the next 15 years. The area agency which issues permits for withdrawal of ground water has informed the City that their existing supply of **groundwater** will be reduced and no future withdrawals will be allowed. This action is taken in order to protect wetlands in the area. Wastewater effluent is already being used to irrigate golf courses and parks.

After reviewing their options of obtaining raw water from 1) the ocean, 2) inland waterways, or 3) the deep aquifer, the City decides to utilize water from the deep aquifer since it is much less salty than the ocean or inland waterways. The existing water plant site has adequate vacant land for expansion of the water treatment system and is totally surrounded by residential and commercial development.

THE QUESTIONS

1. Assume that either electrodialysis (reversal) or reverse osmosis treatment will be used; therefore, a concentrate stream will be generated. How should the concentrate be discharged and what effect will each of the available discharge options have on the water treatment system?

2. What special plant features would you include to keep the facility environmentally friendly and keep your immediate neighbors satisfied?

3. What public relations strategy do you recommend to maintain community acceptance throughout the planning, regulatory approval, design and construction phases?

5.3 RESPONSES TO THE EAST COAST STUDY GROUP 3 & 5 - EAST COAST

1 • OPTIONS FOR DISCHARGING CONCENTRATE

DEEP WELL **INJECTION**
- Utilize RO concentrate residual pressure for **reinjection**
- Monitor for radionuclides
- Monitor for pretreatment chemicals
- Adjust **pH**
- Will increase the cost of the water treatment system

PIPE TO OCEAN
- Monitor for radionuclides
- Monitor for pretreatment chemicals
- Adjust **pH**

SURFACE DISCHARGE (FRESH WATER)
- Permit
- Possible lime softening
- Sludge disposal in landfills
- Compatibility with receiving water
- Toxicity, recycle effluent

DEEP WELL INJECTION
- Effect is little (none)
- Permit
- ♍□⬩♦

SURFACE DISCHARGE (COASTAL MARINE)
- Permit
- Compatibility with receiving water
- Toxicity
- ♍□⬩♦

DISCHARGE TO INLAND WATERWAYS
- May need to be treated first to meet regulations
- Depends on TDS of concentrate and recovery

BLEND **WITH** WASTEWATER TREATMENT PLANT EFFLUENT
- Use waste dilution
- Can help with future irrigation requirements
- Blending with wastewater and discharge into wetlands
- **Solar** evaporation barges
- Truck concentrate to permitted ocean outfall disposal facility

- Deep well injection with blended wastewater
- Deep well injection (will affect water quality directly
- Might severely impact quality of irrigation water
- Park and golf course irrigation
- More grey water available for golf courses and parks
- If concentrate TDS is low enough
- Need piping
- Combine discharge with a sewage treatment facility's waste
- Probably simplifies disposal problems of both entities
- Dilute with waste water effluent and add to water available for golf courses and parks
- Reduce quality of irrigation water, but increase quantity
- No need to treat plant effluent beyond current needs (excepting increase in volume)

DISCHARGE TO OCEAN

- May need to be treated first
- Temperature of effluent
- Amount of concentration permitted (i.e., percent of product waste extraction allowed)

2A • ENVIRONMENTALLY FRIENDLY FEATURES

GENERAL

- Wind direction if degas used
- Wet gas scrubber if no good wind direction
- Sound proofing buildings
- Earth walls with plants (noise and sight)
- Control of iron
- Control of hydrogen sulfide
- Noise control
- Structure environmentally acceptable
- Keep accurate data on water (concentrate and permeate) this could possibly prevent future problems
- Plant offshore, small control room
- Very environmentally friendly leases
- No chemicals in ocean

NEIGHBORS DO NOT KNOW IT IS THERE

- Good building design, aesthetically pleasing and architecturally Similar to general style of surrounding buildings
- Biodegradable treatment chemicals
- Attractive building and landscaping

LOCATED SO AS NOT TO INTERFERE WITH BEACH RECREATIONAL **ACTIVITIES**

- Amount of land devoted to facility
- Proximity to usable beach area
- Visibility from beach areas (appearance of structure and height)
- Location of pipeline with reference to beaches

28 • IMMEDIATE NEIGHBORS SATISFIED

GENERAL

- Delivery (unloading) of supply chemicals should not be visible
- Tours of plant
- Viewing area
- RO • must be quiet
- No odors
- Architecturally compatible with surroundings
- Minimize weekend, after hours site activity
- Keep dean, grass cut, painted
- Use the **facility** grounds as an educational native garden, e.g., learning center for school kids
- **Low** profile, attractive design
- **Include** community recreational facility on grounds
- Employ residents as operators
- Use product water for swimming pool for locals
- Use product water landscaping to fit locals desires

GOOD TECHNICAL DESIGN

- Consider noise avoidance benefit of ERT versus throttling the concentrate for RO
- Assuming low permeate TDS **from** RO and less than 2 **mg/L** feed sulfide concentration, **oxidize** sulfide to sulfate by chlorine • this avoids odor complaints from neighbors
- Control blower and other noise sources, and secondary odor from sulfide
- No noise, smell, or light pollution
- Avoid high frequency of hazardous chemical deliveries by minimizing chemical requirements in desig, and providing adequate on-site chemical storage
- Containment for any kind of process accident

3 • PUBLIC RELATIONS STRATEGY TO MAINTAIN COMMUNITY ACCEPTANCE?

GENERAL.

- **Radio/TV** public **service** announcements
- **VDR** tape for civic associations, **public** meetings
- Stress environmental benefits
- Plant tours

- Brochure describing project benefits; financing, environmental aspects, schedule, staffing, Water costs, etc.
- Form local community awareness groups/committees that can eventually understand the problem and then pass on to. the locals the shys and whereofs
- Consider enclosing site with peripheral tree plantings, then maintaining all Sit8 structures below Sit8 line.
- Town meetings strategy to solicit and address community concerns regarding with impacts on environment
- Hire locals to assist during the construction
- Bring locals to meetings with regulatory agencies
- Have scheduled tours during construction
- Only work 8 • 5, and only on weekdays
- Ensure dust control is maintained at all times
- Pursue multiple permits early
- Stress safety as a priority

EDUCATE THE PUBLIC ON THE WATER TREATMENT METHOD

- Newspaper
- Local meetings
- Open hearings in local community near plant
- Public hearings
- News coverage: positive
- Political support
- Do not leave the publics' questions unanswered
- Give tours
- Provide product water samples from pilot unit, then keep pilot unit for this ongoing purpose
- Cost less to build now vs. later (lowest monthly bill increase)
- Land us8 now before Sit8 might lose some area
- Early interaction with regulatory groups

COMMUNITY INVOLVED EARLY

- Open and early discussion of the regulatory process with the public
- Solicit public input and respond to their input
- Continuing public involvement throughout entire design and construction phases
- Design sized to need and modularized for future growth
- Constructed anywhere then installed offshore
- Show how plant will look and let public offer appearance suggestions
- Involve through employment
- Open and early interaction with public on the decision making process that results in choosing membranes

- Assuming that the deep aquifer to be used is brackish, stress in a PR campaign how the treatment process proposed will have a minimal impact on fish and wildlife, as opposed to using the inland waterways as a source.
- Work with community leaders and other interested parties to identify problems early
- Develop multiple options
- Develop process for choosing an option
- Find a couple of the best critics and solicit their input
- Need to identify way to motivate critics to participate

OFFSHORE PLANT WILL NOT USE LAND

- No plant
- No noise
- Will not spoil view
- Ties into existing water system
- Product water could be used to dilute brackish groundwater to potable standards

GROUP 4 - EAST COAST

1 • **OPTIONS FOR BRINE/CONCENTRATE AND EFFECTS** ON SYSTEM

COASTAL **OUTFALL/DISCHARGE** TO OCEAN

- Treatment of concentrate required
- No possible reuse
- Extended permitting process

SURFACE WATER (DISCHARGE TO)

- Treatment required to meet NPDES regulations
- May be more costly

DISCHARGE TO BRACKISH CANAL

- Least expensive and may be beneficial to receiving body.

BLEND CONCENTRATE

- with irrigation quality water
- with industrial discharge
- with wastewater plant effluent
- cooling, tower supply
- Allows possible reuse
- Cheaper than deep well injection
- Need to manage effluent quality (e.g., **pH**)
- Could be inexpensive if near wastewater treatment plant

DEEP WELL INJECTION

- Low cost
- High cost
- No possible reuse

2A • **ENVIRONMENTALLY FRIENDLY**

PLANT FEATURES

- Reduce Noise
- Control odor
- Reuse concentrate for irrigation
- Design for low energy use
- Attractive, appropriate plant architecture
- High perimeter fence
- Find use for concentrate that has favorable impact on surrounding environment
- Enhance surrounding area of recreated wetlands or xeriscape demo sites
- Keep concentrate TDS low (operate at low recovery)
- Name the plant after an environmental activist or group
- Entertain local press at the Breakers with free golf lessons

- Promote the positive aspects of the project and point out the environmental damage if not accepted

2B • IMMEDIATE NEIGHBORS SATISFIED?

GENERAL

- Point out that they will have plentiful, safe water to drink
- Control odor
- Minimize Noise
- Use architecture and landscaping to make facility unobtrusive and blend into the community
- Communicate with, and educate the neighbors through questionnaires; open houses, and public meetings

3A • PR DURING PLANNING AND PERMITTING STAGES?

GENERAL

- Communicate, communicate, communicate
- Educate, educate, educate
- Hold town meetings on a regular basis
- Set up booths with brochures and/or videotapes at city hall, libraries, and other public buildings
- Plant tours
- Show steps being taken to minimize environmental impact
- Advertise improved drinking water quality
- Compare new plant to alternatives
- Enlist support of educators, community leaders, and local civic groups
- Meet all regulatory criteria with an overkill of safety margin

3B • PR DURING DESIGN AND CONSTRUCTION PHASE?

GENERAL

- Hold public town meetings
- Shelter neighbors from construction activities, i.e., noise, dust, etc.
- Stay on schedule
- Offer plant tours
- Use recycled materials
- Be aesthetic
- Post an attractive sign out from "Coming Soon! • Safe and Plentiful Drinking Water for your Town!"

GROUP 7 - EAST COAST

1 • OPTIONS FOR DISCHARGING CONCENTRATE

INJECTION WELLS

- Water chemistry (mix of ground water an concentrate may limit recovery)
- Use concentrate pressure for reinjection but loose energy recovery
- Plant may require high pressure pumps
- May need a higher voltage feeder
- Increased cost

DISCHARGE TO SANITARY SEWER

- Limits to water treatment plant may limit recovery

DISCHARGE TO WETLANDS

- Recovery may be limited depending on concentrate TDS or specific ions

DISCHARGE TO INLAND SALT WATER ESTUARY

- Concentrate must meet higher quality standards

DISCHARGE TO OCEAN

- Allow highest recovery
- Cost of line to sea
- Location of plant near sea
- Must achieve dilution at discharge

SOLAR BRINE POND

- Need additional evaporato

EVAPORATE TO DRYNESS

- Added expense

COMMENT: Before any'desalting plant is built, ensure users pay full cost of water including scarcity value, to ensure efficiency in water use

2A. • SPECIAL PLANT FEATURES

FACILITY ENVIRONMENTALLY FRIENDLY?

- Keep chemical addition to a minimum
- Minimize power use
- Perform EIS and mitigate input as much as possible
- Reduce noise
- Dust control
- Look for EMF problems
- Low profile buildings
- Use concentrate to recover an existing polluted canal

- Remove odors
- Extensive vegetation
- Consider periodic payments to neighbors to compensate
- Eliminate glare from lighting
- Minimize truck transfer by having adequate chemical storage

2B. IMMEDIATE NEIGHBORS SATISFIED?
GENERAL

- Many of Item A were included
- Setup **citizen** advisory panels early on, meet regularly to discuss issues, continue when plant operates
- Visit local schools and provide teaching material and allow schools to become involved
- Setup office in the town to answer questions before design is frozen
- Produce newsletter
- Relocate the neighbors
- Construct park on plant site (below ground buildings or reservoirs)

3A - PUBLIC RELATIONS STRATEGY TO **MAINTAIN** COMMUNITY ACCEPTANCE?

PLANNING - REGULATORY - APPROVAL PHASE

- **Early** contact and involvement of regulatory agencies
- 'Ad-hoc' citizen advisory committee
- Involve media
- Educational programs
- Open public meetings with scientists to explain impact
- Respond to all criticism rapidly
- Aggressive publication of positive aspects of facility
- Public information meetings under someone with news background
- Brief editorial local board and local politicians
- If jobs created, tell the community
- Let the. options be known, what if you do not proceed

3B DESIGN - **CONSTRUCTION** PHASE
GENERAL

- There were many of the same comments as in A
- Noise and visual impact
- Mitigation, e.g., vegetation barriers
- Offer "bribes" of cash or community improvements
- Progress tours
- Accelerate construction
- Advance notice of operations which affect the public
- **24-hour** hotline
- Frequent newsletters

- Do not try to hide problems when they occur, face the problem and provide solutions
- Minimize noise and nuisance during construction

5.4 WESTCOASTCASESTUDY

THE SITUATION

A mid-sized coastal California city has relied exclusively on groundwater wells for its water supply. In recent years, seawater intrusion has rendered certain nearshore wells unproductive and the water quality of the City's upland wells is deteriorating. As a result of a feasibility study to identify a reliable future water supply, the City is considering a desalting plant that will treat groundwater as well as seawater.

The City owns and operates a wastewater treatment facility near the coastline that utilizes a mile-long subsea ocean outfall pipe for treated effluent disposal. Before the City's treatment facility was built in its current location, it operated an older facility one-half mile downcoast. The older onshore facility has been removed, but its subsea outfall pipe was abandoned in-place.

Assume that the operating wastewater treatment plant is surrounded by light industry and agricultural land uses, and is adjacent to a small river mouth. There is vacant space within the treatment plant site, but it is slated for treatment plant expansion in the future. There are other vacant parcels in the City, but they are all zoned for visitor-serving recreation uses or residential.

THE QUESTIONS

1. What brine disposal options might exist for the City? What are the advantages and disadvantages of each?

2. What special plant features do you suggest to keep the facility environmentally friendly and keep your immediate neighbors satisfied?

3. What public relations strategy do you recommend to maintain community acceptance throughout the planning, regulatory approval, design and construction phases?

5.5 RESPONSES TO THE WEST COAST STUDY GROUP 1 - WEST COAST

1 - **BRINE** DISPOSAL **OPTIONS**

SEAWATER DISCHARGE .

Advantage	-	Mix with wastewater plant discharge
Disadvantage	-	Site space limitation

INDUSTRIAL SUPPLY

Advantage	-	Use for cooling
Disadvantage	-	Treatment costs

PERCOLATION PONDS

Advantage	-	May be least expensive
Disadvantage	-	May not be geologically possible

ZERO DISCHARGE BRINE CONCENTRATE

Advantage	-	Most accepted by environmentalists
Disadvantage	-	Very expensive .

DEEP WELL INJECTION AT OLD TREATMENT **FACILITY**

Advantage	-	Reduction in land requirements
Disadvantage	-	Well construction post, ground water quality control, providing water supply/treatment facilities

DILUTE BRINE AND USE FOR AGRICULTURAL IRRIGATION

Advantage	-	Help relieve need for additional irrigation water
Disadvantage	-	TDS may be too high

DEEP WELL INJECTION

Disadvantage	-	Leakage from disposal to fresh water aquifer
Advantage	-	Solves problem
Disadvantage	-	Too costly, precipitation problems
Advantage	-	Convenient
Disadvantage	-	Potentially unacceptable to regulators

IRRIGATION

Disadvantage	-	Possible adverse effect on the environment

IRRIGATION REUSE

Advantage	-	Irrigation replacement
Disadvantage	-	May be more costly as requires lower RO recovery to provide dilute reject

SOLAR EVAPORATION PONDS

Disadvantage • Concentrated waste over time

Advantage • Inexpensive if one liner is required

Disadvantage • Probably requires double liner with leachate drams, . takes large acreage in area where land is expensive, not a final solution

SOLAR PONDS

Advantage • Can be used for power generation and MSF desalting in combination with RO and pay for later **brine** disposal once project costs **are amortized**

Disadvantage • **Need large** flat **area** of land • may be expensive

USE OUTFALL AT NEW TREATMENT **PLANT** AND CONSTRUCT PLANT AT OLD SITE

Advantage • Use of available space and outfall

Disadvantage • Pipe construction costs

LOCATE DESALTING PLANT ON ABANDONED SITE OF OLD SEWAGE **PLANT**

'Advantage • Cheap, near old outfall

MIX CONCENTRATE WITH SEWAGE DISPOSAL TO INCREASE SEWAGE **SALINITY** CLOSER TO SEAWATER

Advantage • **Less adverse** impact from salinity

PUT BRINE IN **WITH** EFFLUENT DISPOSAL

Advantage • **Dilute** with effluent

Disadvantage • Takes away from capacity of effluent

USE OLDER OUTFALL PIPE

Advantage • More **capacity** left for existing **effluent discharge**

Disadvantage • Cost for piping

BLEND WITH EXISTING WASTEWATER TREATMENT OUTFALL

Advantage • Much of the existing system can be used

Disadvantage • **Existing system** may not **be** large **enough to** accommodate additional flow

OFFSHORE DISPOSAL THROUGH EXISTING PIPELINES

Advantage • Convenient and in-place

Disadvantage • Pipeline may be **deteriorating**

DISCHARGE INTO NEARSHORE. WELLS

Advantage • Existing facilities available

SEAWATER DISCHARGE

Advantage • Use old waste treatment plant site

Disadvantage • Environmental restrictions

DISCHARGE CONCENTRATE INTO RIVER WHEN THERE IS FLOW AT RATE TO PRODUCE ABOUT SEAWATER SALINITY

Advantage • Zero impact on ocean

SURFACE WATER DISPOSAL

Advantage • Discharge to river for mixing

Disadvantage • River impact

2 • SPECIAL PLANT FEATURES

GENERAL

- Construct building that is relatively sound proof
- Put strippers in system to remove H_2S or other objectionable gases
- Keep concentrations of each constituent below acceptable levels in concentrate
- Put insulation around pumps and valves to keep noise levels acceptable
- Use seawater source rather than wells to reduce influx of seawater to aquifer
- Keep facility aesthetically beautiful with landscaping, and noise muffled
- Make facility visually pleasing, landscaping, architecture
- Advise or communicate that no additional pollutants are added
- **Locate** in industrial area
- Explain the process
- Stress creation of jobs
- Get-public to suggest alternatives
- Publicize as the *Best" alternative.
- Use highly skilled plant operators
- Combine with thermal power and mix effluents (hot and salty) to make a buoyantly neutral effluent
- Plant wetlands, make area a wetlands, park, dispose of brine to **salt-**tolerant marsh
- Keep the costs down
- Put the facility underground
- Do not force the solution on the users
- Design with noise control
- Hold meetings early on with neighbors to get their feedback and concerns into design
- Keep noise down
- Make sure it works
- Have open house and educate neighbors

- Keep facility neat and pleasing
- Construct building that is consistent with the other structures in the immediate area.
- Emphasize a public relations program
- Make it earthquake proof
- Minimize service impacts

3 - PUBLIC RELATIONS STRATEGY
REGULATORY

- Emphasize quality control methods
- Note environmental improvements over previous method used
- Hire consultant that has good ties to regulators
- Prepare applications early
- Have regulatory people attend planning meetings
- Do a good job of explaining how the plant works
- Tell regulators the environmental impacts if no plant versus plant
- Compare costs and environmental impacts of other conventional alternatives On same basis

PLANNING

- Emphasize need for new supply methods
- Emphasize quality improvements
- Get buy-in from public
- Conduct research to fully understand brine discharge effects on ocean, provide feedback to regulators and public
- Bring a representative of the opposition into the planning process to reduce their ability to criticize later
- Get public directly involved, by appointing a public representative chosen by the public to sit in on planning meetings and decisions
- Have public and regulatory people attend meetings
- Hold community meetings to educate the public on need and procedures
- Plan open houses and encourage community visits
- TV and radio progress reports
- Plan a grand opening party
- Keep alternative approaches alive quite far into design and keep them before the public - reminder that there are pros and cons
- Stress positive effect to the public
- Use establish technology

DESIGN & CONSTRUCTION

- Aesthetically consistent with surroundings
- Use established practices and equipment
- Use local contractors where possible
- Limit traffic disruptions

- Reasonable work hours
- Publicly provide model/drawings to obtain public reactions and comments
- Totally enclose construction site
- Periodically have news media press conferences to tell progress of construction
- Give tours of construction site with tour guides for schools and other groups
- Make color brochures
- Incorporate environmental concerns into designs
- Use local contractors as much as possible
- Have a Chamber ground breaking, include prominent community leaders

GROUP 2 - WEST COAST CASE STUDY

1 - WHAT BRINE DISPOSAL OPTIONS MIGHT EXIST FOR THE CITY? WHAT ARE THE ADVANTAGES AND DISADVANTAGES OF EACH?

USE OF OUTFALL PIPE

Advantage
- Existing structure, lowest cost
- In an existing industrial area
- Could be used as the intake

Disadvantage
- May be difficult to permit
- Not designed for the purpose so more impact
- Diffuser designed for the low density freshwater, concentrate may be heavier or lighter than seawater but heavier than the fresh water used in the design

DILUTE WITH SEA WATER OR WASTEWATER, POSSIBLE USING THE NEW WASTEWATER OUTFALL PIPE

Advantage
- **Dilution of** concentrate
- cost
- Reduced salinity gradients between effluent and **seawater**
- **Existing** outfall permitted

Disadvantage
- Requires structures to implement
- May adversely affect wastewater discharge permit
- Space and capacity limitations
- Reduce wastewater capacity
  Location vis a vis wastewater plant

GROUNDWATER INJECTION

Advantage
- Infrastructure in place maybe lowest cost

Disadvantage
- Possible deterioration of **groundwater** quality

USE VERTICAL OFFSHORE **TURBULATOR** WITH DEPTH DEPENDENT ON CONCENTRATE DENSITY

Advantage
- Injecting concentrate into seawater of **same** concentration

Disadvantage
- High maintenance

BUILD A **"RANNEY"** COLLECTOR FOR BRINE DISPERSAL

Advantage
- Clean brine

Disadvantage
- cost

BUILD A HIGH PRESSURE LINE, USE SPRAY OR ATOMIZING NOZZLES FOR DISPERSION

Advantage • Better and quicker mixing
Disadvantage • Higher power consumption

BUILD **FACILITY** TO USE BOTH PIPELINES FOR DISPOSAL OF BRINE

Advantage • Better dilution, less concentrate in one location
Disadvantage • Cost of two systems

2A - SPECIAL PLANT FEATURES
TO KEEP THE PLANT ENWRONMENTALLY FRIENDLY
GENERAL

- Structures to control nuisance factors (noise, odor)
- Locate plant as the old wastewater treatment site as this location is more compatible than most for a plant
- **Build new** plant outside of the city
- Build plant on new wastewater treatment site
- Design to be architecturally pleasing and compatible with neighboring structures
- Design for high recovery to minimize brine quantity
- Add public reception area with "hands-on" exhibits
- Perform study of preexisting conditions and bioassay brine or concentrate **disposal** area and evaluate the impacts/risks of the plan to be used

2B -TO KEEP IMMEDIATE NEIGHBORS SATISFIED
GENERAL

- Educate neighbors as to safeness: benefits of good water: how plants work and operates; environmental safeguards, benefits, risks; newsletter: economic benefits
- Use as a community asset, i.e., meeting rooms, teaching facility
- Build plant to city them (Santa Barbara is Spanish)
- Build oversize to reduce operating time
- Hire a public relations firm to establish ties between political, public, and bureaucratic factions
- Disguise as a public building like city hall
- Review Denver's experience and actions in building DIA - do not duplicate
- Design for nuisance control such as odor, noise, traffic
- Make architecturally pleasing, landscape
- Involve and keep involved planning and permitting agencies, community groups, individuals. Do it early and substantively

3 • PUBLIC RELATIONS STRATEGY TO MAINTAIN COMMUNITY ACCEPTANCE

PLANNING • REGULATORY • APPROVAL PHASE

- Publicize planning schedule in public areas
- Create and, maintain citizens advisory group
- Involve stakeholders **early,** including environmentalists, regulatory, permitting, beneficiaries of the project
- Meet early with permitting agencies
- Publicize impacts, concept, benefits, and costs of project

DESIGN • CONSTRUCTION PHASE

- Implement and maintain nuisance control, dust, noise, etc.
- Do what you said you were going to do, tell people quickly about significant changes (no surprises)
- News releases, tours, photo opportunities as construction proceeds, promotes ownership
- Meet with neighbors to develop acceptance, disadvantage more cost

GROUP 4 - WEST COAST

1 - BRINE DISPOSAL OPTIONS

DISPOSE **INTO SEA** THROUGH EXISTING OUTFALL PIPE (EITHER OLD FACILITY OR PRESENT)

Advantage
- existing lines therefore low cost
- mixing effect with presently used line

Disadvantage
- may be unacceptable to regulators
- could have capacity problems
- old line could have maintenance problems

SOLAR EVAPORATOR **PONS/SOLAR** PONDS

Advantage
- Inexpensive if using only one line
- Inexpensive

Disadvantage
- Take large area - expensive where land is of high value
- Environmentally unacceptable

DEEP WELL INJECTION

Advantage
- Solves problem

Disadvantage
- Costly, geological problems

IRRIGATION REUSE

Advantage
- Irrigation replacement

Disadvantage
- May be too costly to lower recover

2 - SPECIAL PLANT FEATURES TO KEEP FACILITY ENVIRONMENTALLY FRIENDLY

GENERAL
- Minimize chemicals utilized
- Use skilled operators - prevent plant upsets
- Plant wetlands around facility, make it a wetlands park for community, dispose of brine here using salt tolerant plants
- Sound proof facility
- Combine with thermal power facility, mix effluents
- Make facility aesthetically pleasing with landscaping and eye-pleasing architecture
- Make it earthquake proof, have a public relations program
- Keep costs down

3 - PUBLIC RELATIONS STRATEGY DURING:

PLANNING & REGULATORY PHASE

- Emphasize need for new supply methods
- Get public directly involved, appointed or volunteer to assist in planning
- Use all media - TV, radio, Newspaper for campaign
- Be honest about environmental impacts - discuss "do nothing" option
- Use established technology

DESIGN AND CONSTRUCTION PHASE

- Use Local contractors
- Enclose construction site
- Incorporate environmental concerns into design
- Limit traffic disruptions
- Have grand opening party for community

GROUP 6 - WEST COAST

1 • Brine Disposal Options.

BLEND WITH TREATED WASTEWATER AND USE FOR LANDSCAPE AND RECREATIONAL IRRIGATION PURPOSES

Advantage • **Conserve** limited water resources

Disadvantage • Costly treatment for wastewater reuse

BLEND **WITH** WASTEWATER TREATMENT PLANT EFFLUENT FOR **AGRICULTURAL** IRRIGATION

Advantage • Conservation/reuse

Disadvantage • Salinity may be bad for crops

USE **EXISTING** WASTEWATER TREATMENT OUTFALL

Advantage
- Low cost
- Land available to build new plant
- Proximity of plant to **outfill**

Disadvantage
- Cost to connect it to existing line
- Discharge may conflict with NPDES Permit
- Brine will be displeased by slow diffusion

DISPOSAL WITH SEWAGE

Advantage
- Mixing/dilution by sewage
- **low cost**

Disadvantage • wastes discharge water

LIMIT RECOVERY

Advantage • Decreased concentration

Disadvantage • Higher cost of water

CONCENTRATE AND DISPOSE AS **SOLID** DISPOSAL

Advantage
- **Use** as road salt for the winter months
- If stream is clean, separate it and reuse it. Find use **for** the industry

Disadvantage
- Not cost effective
- Research about unwanted compounds
- Toxicity study

BUILD A NEW OUTFALL

Advantage • Modem design with latest developments

Disadvantage
- Costly
- Significant adverse impact to marine environment during construction

2A - SPECIAL PLANT FEATURES

GENERAL

- Environmentally Friendly
- Low energy/energy recovery
- Acceptable brine discharge, no discharge into sensitive areas (i.e., river mouth)
- Treat concentrate before discharge
- Use existing outfalls if feasible
- Make facility as self contained as possible
- Educate the neighbors; determine and exploit any mutually beneficial goals/objectives/needs
- Design facility to fit in with existing environment
- Detect all discharges from the plant, i.e., noise, light, and mitigate them as much as possible
- Use RO rather than thermal process, more acceptable and causes no atmospheric pollution

2B - IMMEDIATE NEIGHBORS SATISFIED

GENERAL

- Give community members tours of the facility
- Enclosed all facilities
- Impose strict acoustical limit on noise, noise suppression
- Design aesthetic facilities that blend in with the community
- Control odor, use degasification if necessary
- Include neighbors in planning process
- Low traffic

3A - PUBLIC RELATIONS

PLANNING - REGULATORY - APPROVAL PHASE

- Involve public/community in planning stage and regulatory agencies. Hold public meetings as needed. Establish a community advisory board
- Research positive impacts to community, include a sense of pride in the community of having futuristic technology in their community
- Develop an educational program - desalting does not damage the environment
- Pro-actively provide information
- Deal honestly with all inputs
- Solicit endorsements from involved and concerned parties
- Finish environmental documents early, provide adequate time for public review. Provide plenty of copies of EIR for public review

DESIGN/CONSTRUCTION PHASE

- Include community input in project design
- No significant traffic impacts

- Design to'blend into community (plant trees, landscape, reduce noise)
- Good dust control
- Include mitigation measures during construction, address issues with affected parties and explain efforts made to minimize hum.

SECTION 6

SUMMARY

6.1 A SUMMARY OF DESALTING ACTIVITIES AS AN ENVIRONMENTALLY FRIENDLY PROCESS[1]

by O.K. Buros

INTRODUCTION

A one day seminar was held on September 11, 1994 as part of the American Desalting Association (ADA) conference in Palm Beach, Florida. The seminar was sponsored by the American Desalting Association, the U.S. Bureau of Reclamation (USBR), the Department of the Army and the National Water Research Institute (BWRI). The theme of the seminar was desalting as an environmentally friendly process. This paper is a summary of that seminar along with some comments on the content.

Table 6.1 .1 lists the major topics that were presented by **various** speakers. In addition to the presentations there was a breakout workshop which discussed potential solutions to the problems associated with installing desalting plants in an environmentally friendly manner.

Table 6.1 .1 - Major presentations at the seminar
Desalting as an environmentally friendly process
Military issues in field water supply
Residuals from desalting
Potential impacts of desalting on the environment
Perceptions of desalting
Brine disposal in oceans
Current research activities
Future R&D directions
Research on concentrate discharge in oceans
Research in concentrate discharge and disposal

Desalting technology has moved from the exotic to the common place in many parts of the USA. Originally used only to reduce the salt content of water it now holds **promise as** a treatment process that can cost-effectively reduce a wide range of constituents which are now being targeted by the USEPA as undesired in drinking water. It can be expected that we will see a significant increase in the use of thii technology in the future.

[1]This summary of the seminar was presented on Tuesday, September 13, 1994 to a technical session at the ADA Conference in Palm Beach

Despite the demonstrated need in the water industry, there are some problems which beset the industry and threaten to create difficulties in applying the technology. This seminar spent considerable time addressing the environmentally friendly aspects of desalting while mentioning the one area that seems to be universally recognized as the main problem area for the industry. This area is the discharge and disposal of brines and concentrates from desalting facilities.

UNFRIENDLY ASPECTS OF DESALTING

There are a number of other areas which could be considered as making the use of desalting an environmentally unfriendly being. Many of these problems are associated with any major utility capital improvements project but they need to be faced anyway. Some of these are listed in Table 6.1.2.

Table 6.1.2 - Potentially unfriendly aspects of desalting
• Makes more fresh water available • Visual - buildings, tanks, towers, paving & power lines • Discharges - liquid and air • Noise & odor • Runoff • Generates traffic (staff and deliveries) • Potential for hazards (spills, accidents & explosions) • Represents new technology

Of these, most can be overcome with technology, education and community relations. One area which can created difficulties is the fact that a desalting process can help to increase the available fresh water in an area by treating here-to-fore unuseable saline water sources. In any area there am some people who do not want additional fresh water made available as this water could be used for growth and if you are opposed to growth then you are then often opposed to those factors, water included, that help to encourage or support growth.

This is a subject area that most engineers and other people involved in the water industry are not at their best In discussions. With this subject it is crucial that it be recognized for what it is and addressed on the basis of community values rather than technology. Otherwise meaningful communications will not even begin. The water industry is there to supply technology to help people and communities who want water. It is not there to try to argue that some area must have water.

However, as pointed out during the seminar by Don Owen, engineers, planners and others involved in the water industry do not necessarily do a good job in communicating the overall concept and benefits of major, or probably even minor, water improvement projects. There are many very positive aspects of these projects that are not directly related to the technology or the installation specifically. His recommendation was that the industry needs to emphasize more research into communications than technology. Thii theme was carried further by Ronald Linsky who described some of the communication related research that is being funded and encouraged by the NWRI.

DISPOSAL OF DESALTING CONCENTRATES AND BRINES

The disposal of concentrate was the major topic of discussion by the seminar participants. The most significant problem with the disposal of concentrates and brines is the perception of the environmental damage that can be caused by the disposal. Environmental regulations, which for the most part; were made for discharges not related to desalting are applied to the disposal of concentrate and brines. This creates some conflicts such as in the classification of concentrate as an "industrial waste' and the difficulty with which concentrate discharges have in passing a standard bioassay toxicity test

For the industry to move ahead, these differences in perceptions must be resolved. This will need to be done through a combination of technological changes, research and enhanced communications and education.

The major methods for the disposal of concentrates and brines are listed in Table 6.1.3.

Table 6.1.3 • Major methods for used for the disposal of desalting concentrate and **brine**

Surface water discharge using:
New outfalls
Old outfalls
Multiple outfalls
Special static turbulence devices
High pressure dispersion
Designed mix to achieve desired specific gravity
Irrigation (Including wetlands enhancement)
Use for other liquid needs (Cooling or industrial water)
Discharge to groundwater
Percolation ponds
Reverse Rainey wells
Injection wells
Treat in the ocean - don't bring feed onshore
Evaporation and then disposal of resulting solids

DESALTING AS A FRIENDLY TECHNOLOGY

It is my opinion that the commercialization of desalination technology is one of the most significant advances in water treatment in the past century. It ranks with the us8 and understanding of disinfection of water supplies. There are many ways that desalting technologies can be implemented in a community in a friendly fashion. Some of these are listed in Table 6.1.4.

For any major change in a community it is important to establish the values of the community and act to serve them. While it may be possible to shape them through explanation and education there are certain inherent values that a community has which should be determined and respected.

Table 6.1.4. Implementing desalting as a friendly technology

Establish community values
Consider the five B's when siting the facifii
Bearing with it • just put it there
Blocking • landscape
Burying • out of sight
Blending • to fit the community
Bribery • some tradeoff or compensation
Be sensitive • minimize annoyance

Site location has always been a delicate issue. Just planning a normal type facility, installing it and bearing with the consequences and community objections was long a standard practice in the utility business. This is changing as utilities, consultants, politicians are bcoming more sensitive and aware of public concerns.

However with some thought there are ways to at least minimize the visual impact and reminder of the facility by blocking the view of it using imaginative landscaping including earthen berms along with a low structural profile. Some utilities have literally buried their facilities so that it isn't visible from the outside. Using appropriate architecture to make the facility blend into the existing look of the community is a way to have it there but not so noticeable. Realizing that a facility in a neighborhood can be an imposition on a segment of the community there may be ways to compensate them by providing parks, a community center, etc as part of a package deal

Finally once a decision has been mad8 to install and operate a facility it should be done in a way to minimize annoyance and be a friendly operation. This inciudes having the construction carried out as quickly and quietly as possible, and minimizing dust, odor and traffic. Once it is operating it should also strive to minimize noise, odor, traffic and visual distraction.

SUMMARY

The key concepts in making desalting activities as an environmentally friendly process include:

1. Recognizing that desalting is a technology which has an important future not only as a means of treating saline water supplies but in removal of specific unwanted constituents in existing water supplies.

2. Communications with the general public, planners, decision makers, regulators is crucial to the long term viability of the industry.

3. There are certain continuing problems over the perception of regulatory agencies and environmentalists over the environmental impacts of the disposal of concentrates and brines. Efforts need to be placed on reaching a reasonable conclusion on these problems.

4. With some effort on the part of the desalting industry and water planners, there are many ways that desalting facilities can be planned, permitted, constructed and operated in an environmentally friendly fashion.

APPENDICES

APPENDIX A
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APPENDIX B
BIOGRAPHICAL SUMMARIES

ABDUL AHMADI, West Palm Beach, Florida. Dr. Ahmadi is the water facilities administrator for the Southwest District of the Florida Department of Environmental Protection (FDEP). He has been with the FDEP since 1981. He has been instrumental in developing some of the department's permitting guidance documents. He is a graduate engineer (BS & Ph.D) from the University of Florida and the University of Cincinnati (MS).

DEBORAH BRINK, Denver, Colorado. **Ms.** Brink is the director of research management for the American Water Works Association Research Foundation (AWWARF). She has been with AWWARF since 1986. She is a graduate engineer (BS & MS) from Colorado State University.

O.K. BUROS, Denver, Colorado. Dr. Buros is the manager of water and wastewater technology for CH2M HILL International Ltd. He is the editor of this report. He specializes in the area of non-conventional water resource planning and has worked on projects throughout the world. He is currently working on a variety of environmental and water resource projects in the former Soviet Union. He has edited a number of publications for ADA and IDA.

ROBERT CARNAHAN - Tampa, Florida. Dr. Carnahan is Associate Dean of Engineers at the University of South Florida. He is responsible for R&D there. Dr. Carnahan spent over 20 years in the U.S. Army working on various areas of water. treatment. He directed the Army's program to develop the 600 gph reverse osmosis water purification unit (ROWPU) which is the standard mobile water treatment unit used now by the Army.

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

STAN HIGHTOWER, Denver, Colorado. Mr. Hightower is the manager of the water treatment engineering research group based at the U.S. Bureau of Reclamation (USBR) Engineering Center in Denver.

JACK JORGENSEN, St. Leonard, Maryland. Mr. Jorgensen is a consultant on desalination and legislative strategies. He had a long career with the US Government involving desalination beginning with the Office of Saline Water (OSW) and continuing on through Research and Technology until he retired from the government in 1985. He served as the executive director for NWSIA from 1985 through 1994, and serves as a member of the National Water Research Institute (NWRI) advisory board. He served as the co-chairman of this seminar.

JOHN L. LARGIER, La Jolla, California. Dr. Largier is a physical oceanographer and coastal ecologist with the Scripps Institute of Oceanography (University of California). He conducts research on coastal hydrodynamics and the role of water circulation in coastal ecosystems. In particular, he works on dense inflows to estuaries. He has over 10 years experience, having obtained his Ph.0 from the University of Cape Town.

RONALD LINSKY, Fountain Valley, California. Mr. Linsky is the Executive Director of the National Water Research Institute (NWRI). NWRI was a cosponsor of this seminar. NWRI is responsible for co-funding of research projects related to water. In conjuction with the USBR, he is the developing the National Centers for Separation of Critical Systems Research and has been active using workshops based on the nominal group technique for the resolution of disputes and problem areas.

O.J. MORIN, Orlando, Florida. Mr. Morin is a senior engineer at Black & Veatch. He has over 30 years experience in the desalination field in consulting and the manufacturing of desalination equipment. He is a member of the Water Desalting and Membrane Processes Committee of AWWA, an advisory board member for the International Federation for Water Science and Technology, and past president of ADA. He obtained his BS in engineering from the University of Connecticut.

CY OGGINS, San Francisco, California. Mr. Oggins is an environmental analyst and water quality specialist with the California Coastal Commission since 1990. He was formerly an oceanographer with the National Oceanic and Atmospheric Administration in Miami, Florida. He has a MS in water resources administration from the University of Arizona.

LANGDON OWEN, Fountain Valley, California. Mr. Owen is a director of the Orange County Water District. He is a founder of the National Water Supply Improvement Association (NWSIA), and has a long history of involvement in water resource development in the western United States especially in California. He is (was) the president of the consulting firm of Don Owen & Associates. One of his earliest job was as the project manager for the Department of Water Resources on the peripheral canal.

FRANK OUDKIRK, San Diego, California. Mr. Oudkirk is the director of water programs for General Atomics. He serves as co-chair of EPRI's Community Environmental Center Desalination and Water Reuse Committee. He has 30 years experience in the electric utility industry, primarily in operations,.maintenance, design, and planning of power generation systems. He is a graduate engineer from the University of Texas.

JOHN E. POTTS, West Palm Beach, Florida. Mr. Potts is an engineer with the consulting firm of Hutcheon Engineers. He has been actively involved in the membrane treatment industry since 1985 and worked on eight membrane projects during that period. He was the project manager during the construction phase of two large municipal RO plants in Florida. He is a graduate engineer from the University of South Alabama.

SUSUMU (SUS) SUEMOTO, Yuma, Arizona. Mr. Suemoto is a consultant in the field of desalination processes and operation. He has recently retired from the position of Chief of the Research Division at the USBR's Yuma Project's Office where he administered the R&D program for the Yuma Desalting Plant. He is a mechanical engineer with 36 years of experience in a wide variety of water resource projects.