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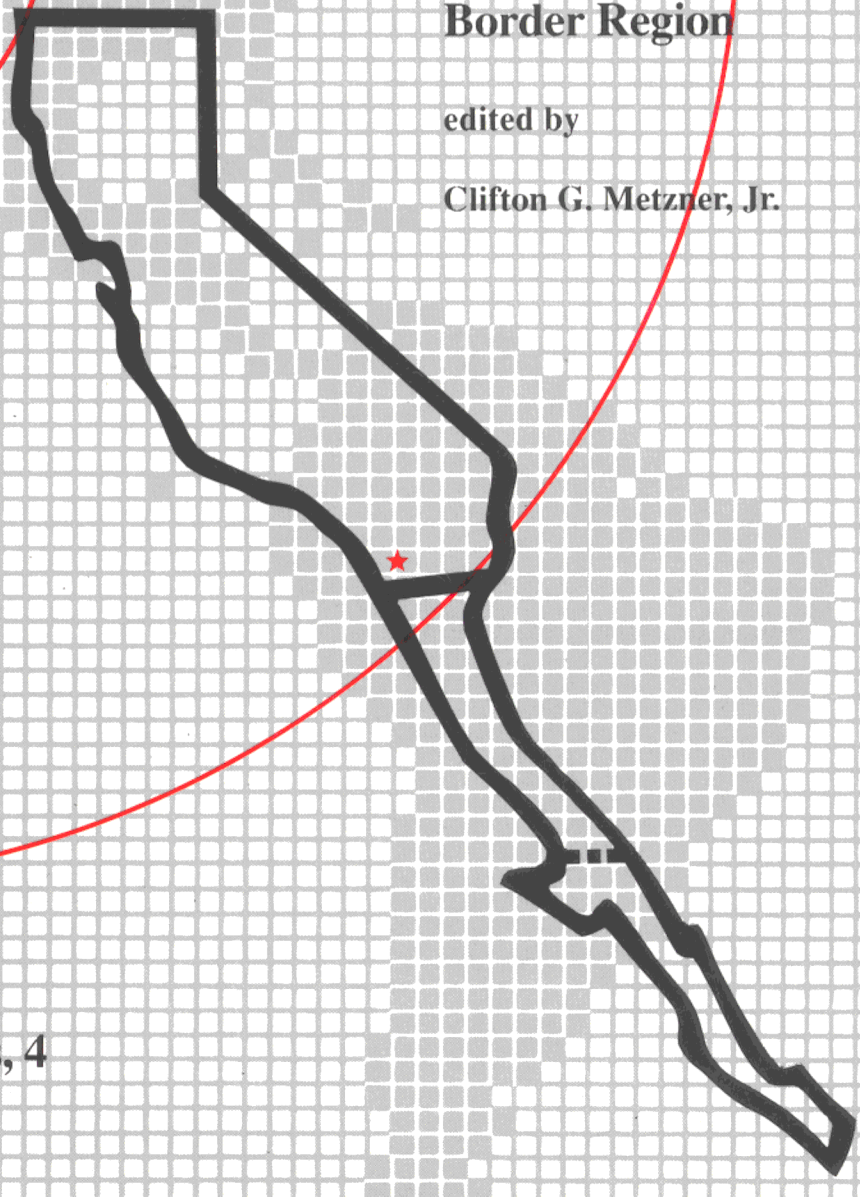
Institute for Regional Studies of the Californias

Water Quality Issues of the California-Baja California Border Region

edited by

Clifton G. Metzner, Jr.



Border Issues Series, 4

WATER QUALITY ISSUES OF THE CALIFORNIA-BAJA CALIFORNIA BORDER REGION

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Paul Ganster, General Editor

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Proceedings of a workshop held at San Diego State University
June 20-21, 1988

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Clifton G. Metzner, Jr.

Institute for Regional Studies of the Californias
San Diego State University
San Diego, CA 92182-0435
1989

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CONTENTS

Foreword

These proceedings constitute the record of a workshop on border water quality issues held at San Diego State University, June 20-21, 1988. The water quality workshop was part of a continuing effort of the Institute for Regional Studies of the Californias at San Diego State University to examine important regional issues of the California-Baja California border and of the United States-Mexico border. It is the goal of the Institute to provide information and analysis on important issues to policy makers of both countries as a contribution to the process of resolving the many transborder issues present in the region. The University, as a neutral and unofficial forum, provides an environment in which policy makers, scholars, members of the private sector, and other interested parties can intereact openly, without official constraints. Under such circumstances, new ideas can be generated and progress can be made at building a consensus on critical issues which can be transmitted to the official policy agencies and mechanisms. As well, this process serves to develop locally agreement on issues and means for their resolution.

The meetings of the June water quality workshop were recorded and a transcript of the discussions was then prepared. When necessary, translations of presentations and question and answer sessions were made. Finally, the material was lightly edited in order to enhance readibility yet preserve the flavor of presentations and discussions.

Along with the Institute, the Commission of the Californias and the Governor's Office of California-Mexico Affairs were cosponsors of the water quality workshop. Frank Marquez, Director of the Office of California-Mexico Affairs, and Valerie Gray, Chair of the Environmental Committee of the Commission, were particularly helpful in arranging the symposium, as was Jim Cornelius of the California State Water Resources Control Board. Clifton G. Metzner, Jr., Senior Research Associate at the Institute, conceptualized the program, contacted the participants, and edited the proceedings. The California Coastal Conservancy and the Office of California-Mexico Affairs provided key funding for the event. Taylor Santies provided translations of the Spanish-language presentations. Finally, the assistance of Institute staff Karen Wenzel, Jessica Rothschild, and Don Aragon in organizing and running the workshop and in preparing the proceedings is gratefully acknowledged.

Paul Ganster
Director, Institute for Regional Studies of the Californias

Introduction and Workshop Summary

Clifton G. Metzner, Jr.

Background

A workshop on water quality issues of the California-Baja California border region was held on the campus of San Diego State University on June 20-21, 1988. The workshop offered the unique opportunity to bring together U.S. and Mexican experts and authorities who deal on a daily basis with the overall problems of water quality in the border region of California and Baja California and related specific matters pertaining to wastewater treatment, disposal, and reclamation. The workshop allowed the participants, in an informal academic atmosphere of panels and audience participation, to take advantage of in-depth discussion of the ideas of these experts for possible solutions to the critical water issues that closely effect all of our lives in this region.

The subject matter was particularly appropriate at this time, with the specter of significant water shortages in the border region due to very dry years in the Sierras and in Northern California and also the Colorado basin. In general, the border region is characterized by a great aridity and, for example, San Diego depends upon imported water for approximately 90 percent of its daily needs. Given the tremendous urban expansion on both sides of the border and the fact that California will lose a portion of its Colorado River Water as the Central Arizona Project comes on line, the availability of water will increasingly become an issue in the region. Northern California sources of water above and beyond the current supply received will be difficult to expand for obvious political reasons. Plans for using surpluses of Imperial Valley agricultural waters generated by conservation projects also seem somewhat tenuous and San Diego faces stiff competition from the Metropolitan Water District in Los Angeles for those same resources.

Decreasing quantities of existing supplies, a series of dry years, and/or disruption of the long supply line through earthquakes or other natural disaster, could provoke a severe water shortage in San Diego. It is plainly evident that we must look at reclamation of wastewater as a cost efficient and reasonable way to augment current water supplies. To date, a number of interesting demonstration projects have been carried out in Southern California and northern Baja California but little has been done to use wastewater as a valuable resource in terms of reclamation and recycling.

Another factor that must be considered in overall planning for wastewater treatment in San Diego and northern Baja California is the effect of continued discharges of treated and untreated effluent into the nearshore marine environment. To befoul that environment would be an error of great magnitude. Does the ocean have the capacity to absorb any amount of effluent? Are there negative effects for the kelp beds or for marine species that have commercial or sport value? Are heavy metals and pesticides being accumulated in the tissues of marine organisms to the point where eating them would constitute a threat to human beings? What are the public health implications of recreational activities such as swimming, surfing, or skin diving in areas adjacent to ocean outfalls of effluent? What are the consequences of raw sewage, or even treated sewage, flowing into the Tijuana Estuary Reserve, one of the few salt water estuaries still remaining in California? As San Diego and Tijuana develop industrially, undoubtedly the amount of discharge of hazardous materials into the ocean will increase.

Critical water pollution problems exist also in the Mexicali-Imperial Valley area where discharges of raw sewage and industrial wastewater from Mexicali into the New River pose a potential health hazard for citizens in Calexico and the Imperial Valley in California and threaten recreation and other activities in the Salton Sea. The natural drainage in the vicinity of Mexicali is northward into the United States. Drainage water includes partially treated and raw sewage and industrial waste from a Mexican city of more than a million people. The flow crosses the border and continues through the Imperial Valley where it picks up agricultural drainage wastes for 60 miles and discharges into the Salton Sea.

Recent studies by the International Boundary and Water Commission (IBWC) have shown that the New River is contaminated by highly toxic industrial wastes and solid soil geothermal wastes as well as by the agricultural runoff that contains dangerous pesticides. In addition to Mexican government and private industrial plants, it seems many of the assembly plants, or maquiladoras, in the area are adding to the contamination of hazardous wastes in the New River.

More general but technical areas of water quality discussed at the workshop concerned various types of wastewater reclamation and groundwater issues. The use of aquatic plant systems for wastewater treatment to produce water mainly for irrigation was discussed as were problems of groundwater contaminants, public health risk factors involved in uses of reclaimed water, and the legal and political factors concerning distribution and use of groundwater from transboundary aquifers (in both the U.S.and Mexico). The bordering states are pumping up the groundwater reserves faster than they can be replenished which will ultimately result in contamination

and depleted aquifers. What are the legal aspects of the uncontrolled use of aquifers that are the property of both countries and how can arrangements be made to limit this pumping so as to conserve these valuable water resources?

The purpose of this workshop was to explore these water issues in detail and from a number of perspectives with U.S. and Mexican experts and develop ideas, suggestions, and approaches to solutions to these problems. Now is the time for creative planning and serious efforts toward a regional approach to long-term solutions that will carry us well into the 21st century. The ultimate goal of this workshop and those to be held in the future that will focus on specific subjects is not only to devise appropriate situations but to improve the ability of local, state, and federal agencies to resolve transboundary issues that have the potential of becoming major irritants in the U.S.-Mexican relationship.

The workshop consisted of seven topical sessions held over two days of meetings. Below, summaries of these sessions are provided. Following this introduction, lightly edited versions of workshop presentations and discussions are included.

Session I: Roles and Responsibilities of Agencies Regarding Border Water Quality Issues

There are several bills in the California legislature that impact on U.S.-Mexican border environmental matters. Bill 2199, by Steve Peace, focuses on creating an international border pollution contingency agency to address some of the water and environmental concerns along the border, principally the New River in Imperial County.

Another bill, No. 930, authorized by Speaker Willie Brown, would create an international border wastewater and toxic clean-up plan to be financed by a bond issue of $150 million.

The Governor's Office of California-Mexico Affairs has become increasingly involved in border environmental matters and has been successful in including water, air, and hazardous waste pollution problems between the two countries as important items on the agenda of the next meeting of the border governors. The Commission of the Californias, which was established in 1964 with three member states, California, Baja California, and Baja California Sur, has recently created an environmental committee which has a particular interest in water quality matters in the border area. A major resource of the Commission is to translate the technical recommendations of meetings such as this into political action, allocate resources, and implement plans to bring about the solutions recommended by the experts and authorities involved. The idea is for this and subsequent SDSU workshops to form a framework along with the Commission meetings for effective bilateral communication and interaction, followed by appropriate political action.

The governments of Mexico and the United States meet on a regular basis at least once a year at the Joint Coordinators' meeting arranged as an integral part of the U.S.-Mexican Border Environmental Agreement of 1983 (the La Paz Agreement). In fact, U.S. authorities and experts from the International Boundary and Water Commission, the U.S. Environmental Protection Agency (EPA), and the U.S. Department of State met with their Mexican counterparts from the Comisión Internacional de Límites y Aguas (CILA), the Secretaría de Desarrollo Urbano y Ecología (SEDUE), and the Secretaría de Relaciones Exteriores in San Diego the week prior to this workshop. The major water issues discussed concerned the development of long-term resolutions of the Tijuana-San Diego and New River-Imperial Valley problems and cooperation between the two countries to bring about these solutions.

Another meeting of the Joint Coordinators was set for September 1988 in El Paso to present a U.S. strategy to Mexico for the Tijuana-San Diego problems. The two sides will review separate project proposals. Mexico proposes a module treatment plant in the Río Alamar area of eastern Tijuana and the U.S. will present a proposal for an international plant on the U.S. side adjacent to the Mexican Pumping Station No. 1. Both project proposals will be studied. Much work has already been accomplished. For example, both the U.S. and Mexico sections of the IBWC have coordinated on the recently completed construction of a collector system that will curtail the renegade sewage flows from the canyons of western Tijuana into the U.S. This new system sends the effluent back to Pumping Station No. 1 in Tijuana. Further discussions are now underway for a moderate plan to curtail the new sewage flows from eastern Tijuana that also end up in the Tijuana River and hence flow into the U.S.

Session II: Wastewater Treatment and Reclamation in the San Diego-Tijuana Region.

The next two or three years constitute a highly critical period in the development of plans for water quality, wastewater treatment, and reclamation systems in the greater San Diego-Tijuana region that will carry us well into the 21st century. The City of San Diego, about a year ago, began a comprehensive planning process to upgrade and convert the City's sewage treatment facilities

to the secondary level. Early estimates are a cost of between one and a half billion to two billion dollars.

The City has hired the firm of James Montgomery Engineers to begin a three-year planning study for the conversion. This is a $10 million project. The City is also investigating the ways and means of financing the new treatment system which is now a political football. The City Council voted in February 1987 not to obtain a waiver from the EPA. Under the Clean Water Act, San Diego must achieve secondary treatment by July 1, 1988, or present a solid plan, including dates, as to when conversion to secondary treatment would take place. At the time of this workshop, the City Council was divided on the issue and was trying to negotiate an agreement with EPA and the U.S. Department of Justice on a more realistic date. There is also an effort being made by the mayor and some of the Southern California congressional delegation to push for substantial federal funds to construct the secondary treatment facilities. (In mid-September the City Council voted 5 to 1 to maintain the February vote not to pursue a waiver to the Clean Water Act.)

A Citizen's Sewage Task Force to aid the City staff and assist in the facility planning process was established a year ago to make sure that public participation plays a major role in the overall process. The City Council has also made it clear that any planning for treatment facilities must include reclamation as a major element in the final solutions. Planning will also consider the possibility of an international treatment plant on the border to handle both San Diego and Tijuana sewage flows.

As an initial step in the long-term approach to regional planning, the U.S. Congress appropriated $5 million to the EPA in 1984 to design a facility to correct the immediate problem of transboundary wastewater flows in the Tijuana River Valley. An additional $27 million was authorized for construction. It was hoped that the construction funds would be appropriated in the FY89 budget. Congress included $20 million in the EPA 1989 budget for the collection system now referred to as the "Big Pipe". The newly designed system was termed the Big Pipe since dimensions were increased to accommodate a land outfall if a treatment plant was eventually built in the area.

The first phase, or the Big Pipe as it is now called, would be a 140" collection pipeline across the Tijuana River Valley which would connect to a pump station in Goat Canyon and convey intercepted Mexican sewage back to the Mexican conveyance system. Designs for phase 2, the pump station, and additional lines to the Mexican side to pick up the Tijuana River flows should be complete by the end of 1988.

This is planned as part of a long-term solution that would include a U.S. treatment facility and/or an international treatment plant on the border as well as a deep ocean outfall. EPA has convened a task force that is in the process of preparing a long-range strategy. This strategy, of course, will have to be compatible with City of San Diego plans and would require extensive coordination with the Mexican government.

In the meantime, the Regional Water Quality Control Board and EPA have joined as plaintiffs in a prospective court action against the City of San Diego to seek a consent decree action for a time schedule to meet secondary treatment. Under the Clean Water Act, if agreement cannot be reached there will no doubt be penalties in the form of fines against the City of San Diego. The Regional Water Control Board's position as far as a long-term solution to the Tijuana problem is that this is a federal problem because of the impact of Mexican sewage on the U.S. and thus will require federal funds. It will also require a federal perspective to plan with Mexico. The Regional Board has recommended a deep ocean outfall with a sewage treatment plant on the U.S. side of the border with a capacity to treat at least 100 mgd of Mexican sewage.

A future San Diego plant in the South Bay region could take advantage of the big pipe element and connect to the same treatment facilities that would be treating Mexican sewage. The U.S. cannot ignore the raw sewage flows from Tijuana; they are increasing and will increase more as the population grows. Planning for future treatment and disposal facilities must be in cooperation with Mexico and must include adequate facilities to treat a substantial portion of Mexican sewage. Reclamation on both sides of the border must also be a consideration in joint planning. Although it will be impossible to reclaim 200 to 300 mgd of wastewater, adequate provision for reclamation must be included. Several options are under study by the San Diego County Water Authority.

The Metropolitan Water District of Southern California is projecting that by the year 2010 there will be a 30 percent shortfall in water services from known resources. Consequently, they are encouraging reclamation projects in all districts. The importation of water in San Diego County today is less secure that it has ever been. Today, the County Water Authority is distributing over 500 million gallons of water daily. The peak supply capabilities are around 700 mgd. Over the next 20 years, water use projections for San Diego County are considerably higher than known resources. The objective of the County Water Authority is to have 100,000 acre-feet of reclaimed water production by 2010. This would mean that about 12 percent of San Diego's water supply in 2010 would come from reclaimed water resources which would be used for landscape irrigation, agriculture, industrial supply, and ground water recharge

programs. Today 100 mgd, or 20 percent of the total fresh water supply, is used for agriculture and about 35 mgd for landscape irrigation in the County, including golf courses, freeways, parks, and so forth. These areas could be converted to reclaimed water usage. San Diego County is currently only using 5,000 acre-feet for water reuse so the stated goal is 100,000 acre feet by 2010, or 25 percent of the total wastewater discharges.

The County Water Authority has identified 26 potential projects as sources of reclaimed water. The projects are located from Fallbrook in North County to the Tijuana River Basin. The projects will be initiated over the next 20 years to reach the goal of 100,000 acre-feet of reclaimed water within the system. This is not a cure-all for our water supply problems, but will help alleviate some of the shortfalls within the demand system.

Sharing in the building, operation, and maintenance of a binational treatment plant on the border has been discussed in the past and is again under current review. Mexico, however, has always preferred a national solution to the treatment problem. Some on the U.S. side feel that Mexico should take advantage of the topography and coordinate plans with the U.S. and instead of building a separate plant in the Río Alamar, spend the funds to improve the collection system and feed the lines into a binational plant on the U.S. side simply by taking advantage of gravity. This would certainly help with the containment problem and would not require a large pumping system which would reduce the chance of malfunction and decrease the public health risks. This would especially be advantageous to both sides if San Diego makes the decision to build its new treatment plant in the South Bay and utilized the Big Pipe facilities for land outfall, perhaps extending the Big Pipe to a dual pipe system for both Tijuana and San Diego effluent.

The Mexican participants in this session outlined plans for the Tijuana sewage treatment and disposal systems as well as expanded systems for fresh water provision and collection in east Tijuana. The plans project a population of 1.3 million for Tijuana by 2000 which will require two separate systems for treatment and disposal. The first is a western system for approximately 500,000 inhabitants with a flow of about 1,100 liters per second. The eastern system will serve about 900,000 people. The western system is concentrated in Pumping Station No. 1, with a 42" pressure line and conveyance canal and treatment lagoons in San Antonio de los Buenos to handle 25 mgd of effluent for secondary treatment. This should reach capacity by 1990.

The eastern treatment system, to be located on the Río Alamar, will be in place by 1990 which will reduce the pressure on the western plant which would drop to about 700 liters per second and then would gradually increase to capacity again by 2000. The eastern system, which would begin operation in 1990 with 700 liters per second, would reach 1,500 liters per second by 2000. The eastern element can be expanded module by module as needed after 2000. A reclamation component in the eastern sector will be added at the appropriate time after the system is installed and the uses for treated wastewater are established.

Plans are also underway to coordinate the treatment systems with the collection system and the installation of connectors to an additional 40 percent of the residences in Tijuana that are not now connected to a fresh water system. The International Development Bank has provided a $90 million loan to Mexico for the collection system and reservoir for water being transported by aqueduct from the Colorado River in Mexicali. The system is about 30 percent installed at this time. The Mexican federal government is responsible for financing these treatment and disposal facilities. The strategy has been developed to balance the reservoir and fresh water network with the treatment and disposal systems.

The Mexican government has also provided $10 million for the installation of the east and west sewage collector system to halt the sewage flows from the hills and canyons into the Tijuana River, and send these flows directly to Pumping Station No. 1. The Mexican government considers that these problems must be solved jointly on a regional basis.

In addition to the plans for the eastern treatment and reclamation system, SEDUE has offered 20 acres in Tijuana for the purpose of studying alternative methods of treatment, i.e., decentralized small treatment plants of approximately 1 mgd with adjacent areas for wastewater reuse. A test plant is now being installed and hopefully will be in operation soon.

The economic problems in Mexico are, of course, severe and must be considered in any planning for facilities, whether collection, treatment disposal, or reclamation. Currently, Mexico is planning to the year 2000 and with a program called Institutional Development under SEDUE, programs are being developed with the Inter-American Development Bank, The Pan American Health Organization, and the World Bank to prepare rates for utilities and other water and electric agencies. It is proposed to set user fees for the Tijuana district for water and sewage facilities. These fees, along with IDB and World Bank funds, will help finance the building and maintenance of these new facilities. These charges and rates should be in effect by 1990 when a major portion of the fresh water in Tijuana will be pumped by aqueduct from Mexicali which is an expensive means to transport and store water.

In regard to reclamation, the Mexican government has long-term plans for an infrastructure in the Tijuana region to reuse a major portion of the sewage wastewater primarily because of the increasingly serious water shortage problem and growing population. A number of options are under review; refilling the aquifers located about 80 kilometers south of the border which would take very little pumping because of the topography; to build more parks and ecological areas in that region; and finally, to transport wastewater for use in Rosarito's thermoelectric plant and receive power for water. In the eastern part in the Río Alamar region, the treatment plant would have to be in a strategic position to serve the city, and for reuse purposes, near a reservoir. Farther to the east of Tijuana there are more possibilities for agriculture usage, but this would require more pumping and higher cost. So, there are still many planning and cost analysis studies to be completed.

The considerations of public health risks and disease from contaminated water is a serious problem for both sides of the border. Most at risk in the border areas are the children who live and play in the area. The children play in the Tijuana River flood control channel and on the U.S. side, in the Tijuana River. In the case of adults who come into contact with these waters, many could end up as food handlers on either side of the border. This could result in outbreaks of hepatitis Type A which has occurred in the past in San Diego.

Another serious area of concern for disease outbreaks is the Río Alamar vicinity which forms an international drainage basin with international water that flows both in Mexico and the U.S. This points out the complexity of the problem concerning health risks. Containment seems to be the only way to reduce health risks emanating both from the Tijuana and Alamar Rivers. With a combined San Diego and Tijuana population of about two and one-half million that is growing rapidly, it is imperative that every possible measure be taken to contain the wastewater in the region so as not to put anyone at risk.

Session III: Tijuana Estuarine Reserve

The Tijuana Estuary, a National Estuary Research Reserve, is one of about 15 in the nation but the only one with international aspects. The Tijuana Estuary contains several rare and endangered species. One, the light-footed Clapper Rail, an endangered bird, nests in this habitat. There now is a major restoration plan for the Tijuana Estuary to recreate the tidal flow regime that was present over 100 years ago. The restoration will involve a long-term sampling program, and will include experimentation at the outdoor laboratory located in the estuary. Another aspect of ongoing research involves computer experiments to determine effects of the new conditions on the estuary. It is believed if an artificial wetland is established it can help reduce the impacts of the renegade sewage flows that have reached 12 mgd in the Tijuana River, agricultural runoffs, storm runoffs, reservoir discharges, and environmental damage that can result from the construction of the Big Pipe and the new pumping station.

Sewage flows of 12-20 mgd are too much for the estuary and will cause significant changes in the ecology of the area. In fact, when 12 mgd of raw sewage flows were reached this year, distinct changes occurred in the salinity which has a disastrous impact on the fish and invertebrate populations. The invertebrate community and the fish community have both suffered declines from continuous river flow and sewage runoffs which have decreased the salinity of the salt water marsh. Unless these flows are reduced drastically, the estuary will no longer be a saltwater habitat.

The management authority for the estuary is made up of eight different agencies and municipal governments. The estuary offers the unique opportunity to carry on international cooperation which has not yet been accomplished. We need to cooperate in research, education, and environmental politics. The management authority is seeking a Mexican representative but for a variety of reasons this has not yet been accomplished. Hopefully, this will be rectified shortly. This would broaden the framework, help to ensure the environmental protection of the estuary, and enhance the possibility of international cooperation on these problems. In addition, the Southwest Wetlands Interpretive Association is beginning the construction of a Visitors Center at the north end of the estuary for education, recreation, research, and administrative use that could also be an international center of study and research. The final question is: Does this estuary deserve preservation or will it be sacrificed to solve sewage and other urban problems?

Session IV: Wastewater Treatment and Reclamation Activities in the New River: Imperial Valley-Mexicali Valley Region

The pollution of the New River dates back to the 1940s when practically the entire flow emanating from the Mexican side was raw sewage. Records back to 1950 indicated many representations by the California Regional Water Quality Control Board, principally to the IBWC, to obtain abatement of the pollution source. According to the Regional Board and IBWC monitoring records, the pollution has worsened over the years and in addition to raw sewage, industrial and toxic waste have been recorded. A fecal coliform bacteria level has been measured to 240,000,000 mpn/100 mls and the dissolved oxygen concentration was often zero.

During the past five years, according to Regional Board and IBWC, the New River quality at the boundary has fluctuated considerably but overall there has been some improvement over historic conditions. This improvement has been attributed to temporary increases in flow deliveries to Mexico from the Colorado River, thus tripling the normal flow of the New River and causing dilution of pollutants. Also, improvement of Mexicali's sewage collection and treatment facilities has been important. According to the Regional Board, however, gross contamination of the river continues causing a public health hazard. Since 1983, for example, Regional Board testing has detected some one hundred different toxics, including hexane, benzene, various pesticides, and PCBs.

The Regional Board feels that unless Mexico continues to upgrade its sewage collection and treatment system as well as point source control of toxic waste pollution and geothermal wastes, conditions will deteriorate because of the normalization of Colorado River flows and the exploding industrial and population growth of Mexicali. Finally, because of the toxic chemicals and untreated industrial and domestic wastes in the flows from Mexicali to the Salton Sea, the recreation and wildlife uses of the sea are compromised.

The California State Water Resource Control Board has evaluated over 20 pollution abatement alternatives during the past five years for implementation on the northern side of the boundary. These alternatives have been pared down to seven. The lowest priced alternative would cost from $10-$15 million and would simply convey the New River in a four meter diameter pipe from the boundary to beyond the All-American Canal. The highest priced project would pump the entire river to a nearby location for advanced wastewater treatment followed by disinfection and subsequent return to the existing New River channel. The latter alternative would cost hundreds of millions of dollars and would be prohibitive in price since the quantity of flow is twice the volume of wastewater generated by the City of San Diego. The State Board is looking at variations which would include a simple screening device at the boundary with instream wetlands treatment as an effective means of pathogen reduction. Finally, it was felt that for the least cost, the greatest water quality improvement in the New River could be achieved by investing in wastewater collection and treatment projects in Mexicali. This would accomplish the public benefit of health and welfare for citizens of Mexicali, Calexico, and the Imperial Valley but would require the agreement and cooperation of both countries.

U.S. and IBWC experts feel Mexico has accomplished considerable improvements in Mexicali. Minute Agreement No. 264 in 1980, and No. 274 in 1987, have called for improving the lagoon treatment system and expanding treatment facilities and setting water quality standards in Mexicali. In 1987, the two countries shared the expense in a $1.2 million joint project that will result in a significant improvement in water quality. A new sewage pumping plant is being built and the three existing plants will be rehabilitated. The IBWC believes strongly that the solution to the overall long-range problem is in Mexico and have formally requested Mexico to submit long-term, comprehensive plans. Again, because of the severe economic problems in Mexico, it would be prudent planning for the U.S. to assist Mexico financially in the formation, design, and construction of the necessary facilities. A jointly coordinated project would be much more practical and feasible than constructing a separate costly facility on the U.S. side of the border to treat the entire river when only a minor part from the Mexican side is pollution and the rest is agricultural runoff.

According to Mexican experts, about 95 percent of Mexicali homes have running water, but because of the tremendous growth in population, the demand for water services is exceeding the programmed budget. At present, the sewage system is capable of containing about 68 million cubic meters a year which drains to the New River. In addition, the agricultural drainage is about 200 million cubic meters. This represents about 10 percent of Mexico's quota of Colorado River water which eventually returns to the U.S. through the New River runoff. This flow also represents about 80 percent of the flow into the U.S. from Mexico. About 15-20 percent is treated sewage wastewater. Coliform counts, according to the Mexican agricultural agency, sometimes reach 2,300,000 units when the maximum allowed is around 10,000 units. Heavy metals such as chrome, magnesium, and copper have been kept at low levels. Mexico also receives more than 300 million cubic meters of agricultural runoff which contains high levels of pesticides which the Colorado River obtains in the Yuma Valley, before it flows into Mexico.

The sewage treatment system in Mexicali is made up of 13 lagoons spread over 400 acres. There are three anaerobic ponds and 10 aerated ponds. The system was designed to treat about 750 liters per second; however, now it is working about 1,200 to 1,300 liters per second. When the treatment time has elapsed this effluent is sent back to the New River and hence flows north across the border.

The Mexican Agricultural Secretariat plans to plant about 10,000 acres and use the effluent for irrigation in the area. Tests are now underway, incorporating such crops as barley, wheat, cotton, and oats using a mixture of two parts fresh and one part treated water. Although the tests have produced excellent results, (including improved yields on several crops) farmers in the area are reluctant to use these mixed waters for their crops. Since demands

for fresh water are increasing for nonagriculture uses, it is inevitable that wastewater mixed with fresh water will have to be used on a large scale by Mexicali farmers.

The Mexican Secretariat of Agriculture is moving ahead on its reclamation program, investing 920 million pesos for building two pumping stations with 40 kilometers of drainage, two structures to mix the water, and a network for capturing domestic runoff in the usage zones. The Secretariat of Agriculture would be interested in discussing these research projects with agencies in the U.S. for possible joint programs of wastewater reuse.

SEDUE, Mexico's environmental agency, identified ten main sources of pollution of toxic and hazardous waste in Mexicali including paper mills, food factories, chemical factories, and leather production factories. In April 1988, two main sources of pollution were controlled by the installation of secondary and tertiary treatment systems at the source industries. All other industrial pollution will be controlled by treatment systems by the end of 1988. In addition, several industrial plants have been fined and/or shut down for noncompliance with Mexican government standards.

During the question and answer period of this session, various abatement measures were discussed. Some of these had been reviewed by U.S. experts and could be implemented in Mexicali but no efforts have been made by the U.S. to pursue these measures with Mexico.

Another question related to whether IBWC or EPA was dealing with the maquiladoras that have been creating hazardous toxic waste pollution problems in the New River. Apparently EPA has discussed this issue with the multinational corporations in the U.S. with no results.

There was a suggestion that a follow-up workshop should address the problem of the greenhouse effect on the supply of the Colorado River which would have a potential effect on the Mexicali Valley and the Imperial Valley.

Session V: Technical Session on Wastewater Reclamation and Groundwater Issues

The aquatic plant systems for wastewater treatment have a very important role in the reclamation process. Two of the general categories of plants used for wastewater treatment are floating aquatics which are the water hyacinths and the emergent plants such as the cattail. The important element of the water hyacinth for treatment is the root, and what brings about the treatment in any plant system are the bacteria attached to the roots. By this method, treatment is obtained by absorption and biological conversion.

The general plan developed for the San Diego water treatment system was to take a portion of the municipal wastewater and send it through an aquatic treatment system for secondary treatment. The effluent would then be applied to an advanced treatment facility and then to a storage reservoir mixed with imported water. The treated water would be stored for approximately two years then would be drawn from the reservoir, treated again, and applied to the municipal water usage system. After further experimentation the aquatic treatment system for San Diego now consists of a rotary disk filter and the water hyacinth ponds. The rotary system has replaced the conventional primary settling tank which is very important from an aesthetic standpoint to provide effective screening of wastewater. One of the problems in the water hyacinth system is that the wastewater must be brought in contact with the root zone. A recycle screen allows control of this water directly to the root zones.

The wastewater that emanates from a properly operating water hyacinth system is always crystal clear. In the San Diego system this water is finally passed through a reverse osmosis unit and based on research at this unit, the water is better than the water that residents of the City of San Diego currently drink. What has to be demonstrated in these aquatic systems is performance. If this can be demonstrated, then ways will be found to reduce cost and the water hyacinth treatment system will be a practical alternative in the long-range treatment of wastewater. The San Diego water hyacinth plant in Mission Valley will be expanded to a 1 mgd facility and eventually will be moved to the San Pasqual Valley near Escondido. The water hyacinths harvested will be used in that area by nurseries as compost. This type of treatment plant will be primarily used in San Diego County in a satellite role in the 1-2 mgd size range.

NASA has been interested in the water hyacinth and other assorted plants for possible application of the technology developed for space travel. The Jet Propulsion Laboratory extended this process by growing plants for food using recycled water and nutrients in a closed system. JPL investigated a closed system as it would be on the moon or in a space system with a finite and limited source of materials for food, oxygen, and water with a finite group of people, the astronauts. The studies came to the conclusion that treated effluent consisting of recycled water, human waste, and housekeeping can be made to grow food. The effluent produced can be quite varied in its mineral content and still grow food.

In respect to transboundary groundwater aquifers, a major issue is how do the U.S. and Mexico arrange our economic and political affairs in order to come together and seek mutually beneficial solutions to the sharing of these valuable assets? The border regions of both countries are dry and arid but are the fastest growing

areas from the standpoint of population and economic development of both countries. Moreover, the four states on the U.S. side are the heaviest users of groundwater in the entire U.S. Both countries have come together mostly amicably and settled water quality problem in regard to surface waters of the Colorado and the upper Rio Grande Rivers. However, we have not been able to reach agreement in how we manage our groundwater resources in a way that would provide each country a predictable, identifiable share so both countries can plan accordingly. A good example is El Paso and Ciudad Juárez. Both cities depend mainly upon groundwater for domestic and municipal sources of water. Both cities are pumping from the same aquifer that underlies the boundary at 20 times its recharge rate. There are no restrictions and no agreements on limits of any kind.

There has been some effort over the past seven years where groups of U.S. and Mexican specialists have drafted a proposed groundwater treaty to provide some security, safety, and certainty for groundwater users on both sides of the border. The draft treaty is based on water allocation by international agreement rather than unilateral taking. The proposal has been submitted to the appropriate agencies in both countries for review.

Two interesting wastewater reclamation projects are underway in Santee, California. One, supported by EPA, employs a biological treatment process and the other, a physical chemical treatment process which uses clay as the main treatment ingredient, reclaims both water and sludge, making a valuable product out of sludge. The biological project incorporated about one acre of artificial wetlands beds of cattails and bulrushes. The quality of water in the inflow is about 60 milligrams suspended solids per liter and outflow is less than 20 milligrams per liter, reaching secondary quality. The same is true of BOD. Basically the wetlands can perform at secondary quality and at the same time demonstrate cost effectiveness and energy efficiency. These wetlands are also flexible and environmentally sound, enhancing wildlife values and providing removal of many contaminants. This is a process that could be put to valuable use on both sides of the border.

The other project is a physical chemical process called CCBA using clay as a main treatment ingredient to raw wastewater. Alum is then added which causes the clay to flocculate. The clay has the capacity to absorb many of the contaminants in wastewater, including organic matter and heavy metals. The clay sludge is used to form pellets which are fired in a kiln to about 1,000 degrees centigrade. The pellets become a lightweight aggregate which can be used to make lightweight concrete. This kind of process shows we can (1) reclaim water at secondary quality and (2) reclaim the sludge and make a valuable product.

Another wastewater treatment demonstration facility under the auspices of the Southwest Wetlands Interpretive Association was originally built in the Tijuana River basin in the United States. It consisted of a fine screen, a biological trickling filter, followed by clarification and polishing in a constructed marsh similar to an artificial wetlands area. This first phase demonstration project was built with a grant from the California Coastal Conservancy. After nine months of operation, good results were documented with 75 percent removal of suspended solids and 72 percent removal of BOD. The second phase, which included a full-size clarifier, was postponed and then eventually moved to a site in eastern Tijuana on 23 acres. This second phase, will only take about an acre and the remainder will be park land and a lake for storage of water and wildlife habitat. This treatment system will also include a full sized clarifier and the effluent would be channeled into constructed wetlands for polishing. The final concept is to create a series of small satellite treatment plants throughout Tijuana, reusing water locally for irrigation, parks, industries such as cement, roadway landscaping, and so forth.

Session VI: Technical Session on Oceanographic Factors and Marine Pollution

The state of California Ocean Plan provides standards for marine water quality protection for beneficial uses by people of this state. The Regional Water Quality Control Boards are the agencies that implement the Ocean Plan which regulates out to the three mile ocean limit. Beyond that is the jurisdiction of EPA, which use the Ocean Plan for establishing permanent limits for large sewage outfalls. The plan applies to all discharges into Californian water, contains six chapters which establish quality criteria for industry bacteria standards, protection of aquatic resources, beneficial uses, management of waste discharge, discharge prohibition, and monitoring programs. The plan which was first developed in 1972, has been reviewed and updated several times, and in 1988 the first set of amendments will be included. Changes will be made in the bioassay protocols and water quality standards and administrative clean up matters. These standards are very important to body contact sports. In addition, some of these changes in the plan will bring it more in line with the Regional Board basin plans. This is particularly true in the beneficial use area. In the case of some metals such as cadmium, copper, lead, mercury, and nickel, after about ten years of study of these metals the Ocean Plan will propose substantially lower objectives than the EPA standards.

The National Research Council has developed a nationwide study, "A System Assessment on Marine Environmental Monitoring," to assess the usefulness of monitoring programs. The study indicates that some form of regional monitoring needs to be performed.

Clearly, we need some quantitative objectives to encourage the scientific community and public involvement in this effort. Finally, the report found that costs should be shared for monitoring along the coast.

There are a number of federal programs, mostly under EPA auspices, that deal with coastal water management, including the National Estuary Program and the Water Quality Act of 1987. In addition, there is the National Pollution Discharge Elimination System Permitting Program for industrial charges and treatment plant discharges, ocean dumping, 201 H Waviers related to ocean discharges, and lastly, Superfund activities. EPA estimates that by 1990, 75 percent of the U.S. population will live within 50 miles of the coast which translates to more demand for coastal resources such as recreational uses, commercial fisheries, recreational fisheries, continental shelf development, and increasing volumes of municipal waste. EPA authorities feel that existing laws and regulations can be better applied to improve quality of near coastal waters. The EPA plan, called "Strategic Planning Initiative," focuses on several areas: (1) develop and communicate common understanding of long-term goals strategies, (2) use best available scientific technology to assess the problems, (3) use new approaches to managing coastal waters, (4) make decisions on available data, and (5) recognize and implement objectives in a rapid manner. The goals of the plan are straightforward: maintaining current national programs, maintaining present environmental quality, maintaining designated use categories for water not meeting standards, and anticipate problems and take preventive action.

At the present time, there are very serious deleterious effects on wastewater discharges on the marine environment in Southern California. However, the experts mostly agree that it is extremely difficult to quantify the effects and to show cause and effect relationships. There has been a long history of changes in the nature of discharges in Southern California and many of the chemicals discharged have extremely long lives and it is difficult to differentiate present day effects from effects of discharges as long ago as the late 1960s. However, from numerous studies made along the Southern California coast, it is fairly clear that there are large amounts of toxic substances being released by the discharges, particularly in the sediments around the outfalls. The materials being released are changing over time but high concentrations of DDT and PCBs have accumulated from 1971-83. Dramatic declines have been observed in DDT most recently.

There is also evidence that there is damage to the kelp beds from wastewater discharges as studies show in the Palos Verdes coastal area. Testing programs along the Mexican coast around Ensenada and northward, indicate that Mexico has not yet caught up with the U.S. in terms of the degree of contamination.

Few biological data are available on the effects, for example, of large spills of raw sewage into the environment or the biological effects of storm runoffs into the ocean. It does look as if the U.S. has an increasing trend toward improvement in various discharges in terms of release of toxic substances into the environment. Although Mexico is facing a critical problem in trying to deal with largely domestic sewage, they are at this time in a better position of not having to deal with large quantities of toxic substances in the marine environment.

From a public health standpoint, the increasing amounts of raw sewage flowing into the Tijuana River and hence onto U.S. beaches is creating additional problems for the U.S. The ocean water at the mouth of the Tijuana River fails to meet the recreational standards and consequently the area from the international boundary north to south Imperial Beach has been quarantined indefinitely. During the past two years, because of northward ocean flows, levels of contamination were at a high level and quarantine was in force as far north as the Naval Amphibian Base located on the Silver Strand. This has the potential of a tremendous economic loss for the beach and coast area as well as the public health danger. This was very evident in 1983 when quarantine was in force from the border north to Coronado Island. Containment of the wastewater flowing into the Tijuana River and the renegade flows from the various canyons that impact on the Tijuana River basin is important as part of a long term solution. From the public health standpoint, this is growing more serious because San Diego has housing subdivisions encroaching upon the flood plains of the Tijuana River. In addition, there is need of a failsafe system such as the proposed defensive Big Pipe system. Finally, an overall ocean monitoring program would be beneficial.

A joint program between the California Department of Fish and Game and the Autonomous University of Baja California, known as the California-Baja California Mussel Watch, monitors approximately 300 miles along the California coast south to San Diego and 300 miles along the Baja California coast to Punta Banderas. Mussel tissues are analyzed to determine accumulation of toxic materials. In addition, Mexican research includes the Sea of Cortez where 154 different components are studied such as silver, cadmium, lead, copper, and mercury. These studies are continual and comprehensive findings will be published. This program has been particularly valuable because of the scientific cooperation that has developed in both Californias, including the exchange of scientists, research techniques for contaminants, and laboratory training.

One role of the Mexican Secretariat for Urban Development and Ecology (SEDUE) is the protection of the coastal zones from contamination. Federal law and agencies are now the only source of protection for the environment, but states and cities will be given more power in this area in the future. Recently, SEDUE has included the protection of Mexico's marine environment as one of its top priorities. In regard to U.S.-Mexican cooperation on the marine environment, there have been eight binational meetings between experts in Baja California and California with the goal of prevention of hydrocarbon and toxic material spillage into the marine environment. There has been a comprehensive contingency plan worked out between the U.S. and Mexico for marine spills clean-up. Studies made by SEDUE indicate there are eight important discharge areas in Southern California and two in northern Baja California, those of Tijuana and Ensenada. In regard to management of the marine environment it is important that Mexico and the U.S. plan and work together to maintain a clean marine environment for both of the Californias.

Session VII: Workshop Wrap-up

This water quality workshop brought together scientists, professionals, scholars, and government authorities from the U.S. and Mexico to exchange information and develop ideas on how to deal with water quality, wastewater treatment, disposal, and reclamation in the border area between the two Californias and in the marine environment.

Excellent discussions were held on the wastewater treatment problem in the Tijuana-San Diego area and Mexicali-Calexico region both in terms of public health and environmental impacts. There was considerable new and interesting information presented on reclamation as a component in the broader issues of water quality and water supply issues. The workshop also brought together experts on marine environment, detailing areas of pollution impact on the coastal region and suggesting ways to work together toward a better integrated approach to monitoring. There was a definite general accord and agreement between the participants that when dealing with these transborder problems it is best to develop binational or bilateral solutions and to approach the finances on the most cost-effective basis. In addition, there was support for future workshops to be held on these issues in an academic and relatively neutral forum of the University.

The next step is to hone in on important and urgent areas that need to be considered within the next six to twelve months. There seems to be a window of opportunity pertaining to the Tijuana-San Diego sewage treatment, disposal, and reclamation problems extending over the next two years. Solutions to these problems have been suggested, including a joint or international treatment plant on the U.S. side of the border to handle a substantial portion of Tijuana sewage and dispose of a large portion of the effluent through reclamation projects both in the U.S. and Mexico. The plant would ultimately be connected to the San Diego sewage treatment system and feed into the pumping and reclamation systems in San Diego County. Decentralized treatment plants of 1 mgd capacity with adjacent reclamation projects throughout San Diego County and the Tijuana region to take the burden off of the centralized systems would ultimately be an integral part of the network. These are some of the questions and answers we will think about in order to prepare over the next six months for a the second workshop. We will be looking into the technology involved in the development of these concepts as well as where plants should be sited, types of plants for treatment and reuse, and ways and means of developing comprehensive U.S.-Mexican cooperation to solve these problems.

After the Tijuana-San Diego workshop we will have a third in the workshop series dealing with the Mexicali-Calexico New River issues which are certainly as important as the San Diego-Tijuana problem. There are a number of different plans on the U.S. and Mexican sides to deal with New River pollution and its impact on the Imperial Valley. It was also encouraging to hear of the joint effort of the U.S. and Mexican IBWC authorities to correct some of the problems related to the sewage system in Mexicali and the enforcement measures taken by SEDUE in fining and closing industries that are discharging toxic wastes in the New River.

It was proposed that at the next meeting of the Commission of the Californias Environmental Committee the participants would discuss the approval of a resolution encouraging a number of follow-up information exchanges such as this workshop. This could be implemented through the establishment of a broad regional forum for continuing education and dialogue concerning water management. These dialogues would take the form of additional workshops on specific topics of joint interest as well as making recommendations to binational authorities for action. Another resolution could address the possibility of having SEDUE assign a Mexican expert to be a member of the Tijuana Estuary Management Authority. There has been an opening for a Mexican participant for a number of years but no one has been assigned.

Finally, it was concluded that the last topic on the agenda, "Oceanographic Factors and Marine Pollution," is an extremely broad and interesting subject. Not enough time was available at this first workshop and comprehensive consideration of this topic should be the subject of a two-day workshop on its own.

Session I: Roles and Responsibilities of Agencies Regarding Border Water Quality Issues

Paul Ganster, Moderator

Paul Ganster. This meeting comes at a very good time. The specter of significant water shortages in the border region is upon us with very dry years in the Sierras and in northern California and also in the Colorado Basin. Rapid population growth and industrial development in this border region continues rapidly, expanding the demand for water. At the same time, we are unable to properly treat domestic and industrial waste water.

The purpose of this meeting is to explore these water issues from a number of perspectives and to come up with ideas and suggestions for approaches and solutions to these problems. It seems that at last we are beginning to have the full attention of many people in governments on both sides of the border. The climate is now quite positive for trying to work towards effective solutions in which both countries and different agencies are involved.

Let me emphasize that the meetings over the next two days are conducted under the auspices of San Diego State University and as such, we want to view them as being academic in nature. The University is a neutral forum where individuals from many different perspectives can get together to discuss important issues. We view all participants here as speaking as individuals rather than as officially representing an agency or other organization.

The first session is entitled Roles and Responsibilities of Agencies Regarding Border Water Quality Issues. The panelists include people who come from agencies or who are in positions where they have significant concerns about water quality issues in the border region.

The first presenter today is Frank Marquez, Director of the Governor's Office of California-Mexico Affairs, a person who has been working for many years on relations between California and Mexico.

Frank Marquez. I would like to start by saying that it gives us great pleasure to work in cooperation with the Institute for Regional Studies of the Californias here at San Diego State University and with individuals such as Cliff Metzner whom I originally met about five years ago when he was with the State Department. At that time, he was the Science Counselor at the U.S. Embassy in Mexico City, so I know that there is a great deal of dedication and commitment among the people that are involved in this conference which will hopefully make it a very productive conference.

I would like to take this opportunity to tell you about our office. It is an official unit within the Governor's office that is assigned to do the liaison with Mexico for the State of California and for the Governor. It is a unique office in that it is the only state government office specifically responsible for handling liaison activities with a foreign nation and which is set up and mandated by statute. We are now taking every opportunity to get involved in a number of new areas.

Just before the beginning of this year, our office was substantially reduced because we relocated from San Diego to Sacramento. This was principally an administrative decision that had to be made in order to better focus the activities of the office. It is not that we are not concerned with the border area; we are very much concerned. However, within the last several years, the City of San Diego created an Office of Binational Affairs, and the County of San Diego created the Office of Transborder Affairs. Along with the activity of the Institute for Regional Studies and the San Diego Economic Development Corporation, I felt there was enough activity in San Diego to complement our work in Sacramento. Moreover, most of the activity within the State of California centers around Sacramento. We have members of the Legislature to deal with as well as the administrative and budget activities in Sacramento. Also, I am trying to organize a concerted effort to educate many of these people about a number of the major issues that are confronting California and which affect us in the border area. So, with that in mind, the office principally acts as the focal point, the clearing house of information, to coordinate with all the various state agencies that are involved with Mexico. We coordinate and interface with the state agencies for business, transportation, and housing; we work with the Department of Commerce and the Department of Tourism. We also interface with the Department of Water Resources within the Resources Agency, the Department of Education, and a number of other agencies. Within our office we direct two major entities, including the Commission of the Californias, with nine standing committees, one of which is the Environmental Committee. The other major entity which we staff and participate in is the U.S.-Mexican Border Governors Conference which we have recently reactivated and given a formal structure. The most recent meeting was in December of last year in Las Cruces, New Mexico. The next meeting will be in February 1989, to be hosted by Governor Eliseo Mendoza from the state of Tamaulipas. The meeting will be hosted in California by Governor Deukmejian, in 1990, and we will continue to alternate meeting sites. There have been six Border Governors' Conferences in the past, but I do not think any were as successful as the last one that we held in Las Cruces. The governors issued a joint communique; they formulated an agenda which contains six items, one of

which focuses on environmental, agricultural, and water issues. So, this water quality workshop is very appropriate and timely.

Briefly, just to give you an indication of some of the legislative activity in Sacramento, there are several bills that would interest the participants here. One of is Senate Bill 2484 which requests the University of California and the California State University to enter into a consortium to conduct research on various California-Mexico issues, principally immigration and current border migration problems. But the environment would also be an appropriate subject for the studies that have been requested. There is an appropriation of $350,000 to fund the consortium which is to meet quarterly with a number of other agencies.

Additionally, Assembly Bill 2699 is specifically appropriate to this forum and is authored by Assemblyman Steve Peace. I do not know how successful this bill will be during this legislative session because Assemblyman Peace has participated in a couple of activities that have not been too favorable for the speaker. The bill would create an international border pollution control agency to address some of the water and environmental concerns along the border, principally the New River in Imperial County. Another bill is Assembly Bill 930 which is authored by the speaker. It would create an international border wastewater and toxics clean-up plan and would be financed by a bond issue of $150 million.

Overall, something has to be done cooperatively, not just by the state, but also with the assistance of the federal governments of Mexico and the United States. Many of these issues are sensitive in nature and must be handled diplomatically. They are going to take time, but we have been working on these issues for a number of years. There are a lot of people involved now that have great insight and sufficient years of experience that will allow them to delineate the issues so that we can come up with some creative solutions.

One of the reasons that the Commission of the Californias has been quite active in the area of environment and why we have been able to progress as far as we have is through the assistance of individuals such as Valerie Gray. I had asked her to assist us as Chairman of the Environmental Committee and she has stimulated a great deal of interest. Our last Commission of the Californias meeting was in March 1988 in Newport Beach and on prior occasions the most active committees had been the Economic Development Committee and the Tourism Committee. But, at the last meeting of the Commission, we had close to thirty individuals involved in the Environmental Committee. And that is a tribute to Valerie's efforts.

Valerie Gray. I would like, on behalf of the Environmental Committee of the Commission of the Californias, to welcome all of you to this water workshop which was in the embryonic stages of planning when we had our meeting in Newport Beach two months ago. Since then I have had the pleasure of working with both Paul Ganster and Cliff Metzner and cosponsoring this workshop. As an aside, it was my pleasure ten years ago to be serving with the Lieutenant Governor's office, where the Commission resided at that time. I was the principal staff support person to nine working committees of the Commission and was working very closely with a committee consisting of Dr. Thomas Day, the President of San Diego State University, and Dr. Julian Nava, who was later the Ambassador to Mexico, and Dr. Donald Gerth, who was at the time the President of California State University, Dominguez Hills. We were working on a proposal to encourage one or more of the universities in California to adopt and have a program such as is embodied in the Institute for Regional Studies of the Californias. And so, it is just an absolute pleasure to see something like this coming into existence.

Back in 1974, the Commission was established as a State of California Commission with three member states: the State of California and the two states of Baja California and Baja California Sur. Since then, we have evolved from an educational exchange, social, cultural, and tourism thrust into nine working committees that address issues of mutual concern to both sides of the border. Over time, the Environmental Committee grew out of the concerns for water quality. For almost a decade now, I have been involved with the Environmental Committee and with the water issues, but the concern about water has existed for far more than a decade within the Commission of the Californias. Today, I would like to talk briefly about my perspective on those water problems.

The water topics that will be under discussion today are very complex regional problems. This is complicated by the tremendous growth stemming from the magnetism that almost any border area has, particularly where there is existing development. It is really a classic human settlement problem with a twist. I see the border as a large, single settlement region with multiple players, organizations, and agencies with responsibility for the water quality and the amount of water on both sides of the international border. This makes it a very unusual and complex problem. The fact of these shared water resources and their associated problems implies that, ultimately, long-term solutions to these problems must transcend national boundaries and parochial interests.

The solutions are going to challenge us in both technical and political arenas. The first order of business, and for what we are here today, is to try to identify technologies and strategies that will be used to address conservation and cleanup. However, without another key part of the

formula, we will not be successful in translating these recommendations into actions. We must translate the technical recommendations into political action to allocate resources and implement plans to make these things happen. The Commission of the Californias becomes one resource in this process. Many of you in attendance today are instrumental in this process now and represent a significant amount of the expertise that is needed to bring about solutions to many nagging problems. There is substantial urgency in what must be done under the scenario of continued growth. In one sense, it is a race against time. In another sense, it is going to be tremendously challenging from a technical point of view. I hope that this and subsequent workshops that grow out of this meeting will provide a framework along with some Commission of the Californias meetings for effective bilateral communication, interaction, and eventual recommendations for appropriate resources and actions at the political level. Let us proceed in this work.

Paul Ganster. Our next speaker this morning is Alyse Jacobsen, from the State Coastal Conservancy. For many years she has been involved and very interested in water quality issues along the border.

Alyse Jacobson. I am very pleased to be here and pleased to see that San Diego State University's Institute for Regional Studies of the Californias has been taking the leadership to bring everybody together to continue to discuss water issues and water quality in the border region.The California State Coastal Conservancy was created in 1978 to assist in the resolution of land use problems in the coastal zone that could not be adequately resolved by regulation. Often there was nobody there to regulate because it was a historic problem or because the regulators and the developers and the land owners were at odds with each other.

Our agency receives its funding primarily through various voter passed bond acts. We have broad powers to undertake projects directly as well as make grants and provide technical assistance to local public agencies and nonprofit organizations to acquire and restore natural resources, to provide public access to the shoreline, to renovate urban waterfront areas and piers, preserve coastal agriculture, and other things. As you can see, we are a very eclectic sort of group that tries to mediate and facilitate resolutions to complex problems, primarily through assisting with technical expertise and funding.

Our resource enhancement program has been the one primarily involved in the water quality issues. It seeks to achieve a broad range of objectives through the use of Conservancy funds and staff resources and works mostly through cooperative efforts with other public agencies and nonprofit organizations. These objectives include the prevention of impacts to scenic or natural values of the coastal zone through ground resource management, the resolution of environmental impacts and issues caused by adjacent land use activities, relocation and redesign of inefficient improvements such as roads and levies, preservation of threatened habitats or unique coastal resources, and the restoration and enhancement of altered or degraded coastal resources, especially wetland areas.

Early in our history, the Conservancy staff recognized that the wetlands systems do not exist in a vacuum. No matter how much money and resources were devoted to the restoration of these habitat areas, unless attention was focused on the adjacent areas and the solution of issues on the watershed wide basis, the long-term viability of the wetlands was uncertain. Since 1981, the Conservancy has raised nearly $2 million to acquire, preserve, and enhance the Tijuana River Estuary in southern San Diego County. The quantity and the quality of fresh water flows into the estuary affects the viability of the habitat resources at the Tijuana River National Estuary Research Reserve and also raises public health concerns. Thus, the Conservancy entered into the field of wastewater treatment in an effort to both safeguard our considerable investment but also to determine whether there were treatment method alternatives that could minimize impacts to and perhaps enhance the estuary's habitat resources.

The water quality problem in the Tijuana estuary watershed is one of the most serious in California, with both natural and man-made causes. One of interest to everyone here today of course is the wastewater flows that go into the Tijuana River and downstream wetlands. When we first started looking at the issue in 1984 and 1985, solutions suggested by various United States agencies for these problems for the most part leaned toward very expensive high-tech alternatives that failed to reflect the realities of Mexico's fiscal situation, Mexico's own established policies for infrastructure development, and its ability to participate to the level needed to successfully implement any of the U.S. alternatives. Frustrated by this lack of realistic solutions, the Southwest Wetlands Interpretive Association organized a binational team of engineers and resource specialists to develop a treatment system that would preclude the necessity for an expensive conveyance infrastructure and that offered the opportunity for water reuse. This system also would not further degrade riparian or wetland resources downstream. The Conservancy was very interested in studying this type of approach further, of course, and the proposed Steward-De La Parra system consisted of several modular components that were previously used in an industrial pretreatment but they were combined in a new way. The Conservancy gave the Southwest Wetlands Interpretive Association a grant to construct and operate the demonstration advanced primary wastewater treatment facility in the Tijuana River Valley. This system was opened in April of 1985 and treated and tested approximately 80,000 gallons of sewage per day before returning the effluent to the

emergency sewage connector between Mexico and the City of San Diego's Point Loma Treatment Facility. The test results, after a few months of testing, indicated that the model project's treatment effectiveness had tremendous potential to assist in the resolution of the Tijuana River water quality problem. I am going to let Carlos de la Parra and Susan de Treville talk further on the more technical aspects of how this system works as well as discuss some of the test results, but the Conservancy continues to be interested in the plant's technology. In 1986 we awarded a second grant to the Environmental Defense Fund to take over the operation of the existing plant and to add components to test clarification and solids handling methods. Shortly after the grant award, however, we discovered that we could no longer use the property in the Tijuana River Valley where the plant was located. We then obtained permission from the state to move the facility to Tijuana which was done through collaboration of the Environmental Defense Fund and El Colegio de la Frontera Norte. The plant is still currently under construction. It has been hampered by difficult site conditions as well as some other problems encountered in the move across the border. It is hoped that in the next few months, however, construction will be completed. It is anticipated that the water quality testing will continue for six to nine months. If the system proves successful under these conditions, we feel it could have potential as one tool in the arsenal of dealing with this water quality problem, certainly in some of the unsewered areas. The Conservancy, to close, is very interested in supporting this effort and will continue to provide funding where possible and technical assistance to try to further test and develop various technologies that can help in the resolution of this big problem. And we are very hopeful that this group here will continue into the future and meet together more and share resources in order to one day finally solve this problem.

Paul Ganster. We are very pleased to have as our next presenter Commissioner Narenda Gunaji of the International Boundary and Water Commission in El Paso. Commissioner Gunaji retired from New Mexico State University after a very distinguished career there in engineering and unlike many people who retire to the golf course, he rolled up his sleeves and dived into the work of his new position with an admirable vigor. He is really stirring things up and has helped provide, at least in some quarters, a great deal of stimulus for reexamining border water problems. Commissioner Gunaji has been quite supportive to all people interested in these particular issues.

Commissioner Narenda Gunaji. Thank you, Mr. Chairman. I think you have put me in a dilemma. I cannot speak as an individual since you invited me as a Commissioner of International Boundary and Water Commission. But, I will try to do my best and at least add a few things that I think you ought to know from the Boundary Commission viewpoint. I would like to just give you some brief background on my agency and tell you what we are doing and what initiatives are underway.

The Boundary Commission has been in operation as long as the State of California has been in the Union. In fact, 1848 is the year the Boundary Commission was formulated under the Treaty of Guadalupe Hidalgo, and was also the year California came into the Union. So you can see the Boundary Commission and the State of California kind of grew up together, resolving problems at the boundary between our two nations. In fact, the interesting thing about all this history is that the first two Boundary Commissioners were the first two senators from the State of California who came from Ohio to take the job with the request of the President in 1848. So, Senator Weller and Senator Fremont from California were the first two senators and were also the first two Boundary Commissioners. And if you look at boundary marker #258, the signature of the Boundary Commissioner Weller appears on the boundary monument in the Border Fields State Park in the Tijuana River Valley.

We have gone through various treaties and organizational changes. In 1889 the two governments changed our name to the International Boundary Commission, and subsequently it was made the International Boundary and Water Commission. So next year we celebrate one hundred years of our existence under the present framework.

We have at least eleven international minute agreements with the Government of Mexico through which we implement joint sanitation projects. We have joint projects on the border in the Tijuana valley-San Diego area and near Mexicali. We are operating under international arrangements between the United States and Mexico for which both nations using their resources are solving these problems.

Ms. Jacobson earlier mentioned that we have proposed gigantic projects to solve the border sanitation problem. I would say that it is proper because the problems are of a gigantic nature. Now, if according to her proposal you are going to construct small treatment plants, as suggested, to which we have no objections, I support that. You could have gigantic numbers of those small units scattered over Tijuana and San Diego. So, in effect, when you take the sum and the substance of all those particular plants, it is also going to be a gigantic proposal or gigantic solution, but localized in various areas--and management of such a complex system could be as difficult as a gigantic proposal.

With respect to solving problems of the Tijuana River, the governments of Mexico and United States have met a

number of times. Another meeting will be scheduled in the near future to deliberate how we can resolve this problem on a long-term basis. There are some elements that are already constructed in the region that are providing some relief. I am delighted to inform you that the renegade flows from the canyons into the Tijuana Estuary are curtailed, except for a few occasional accidents due to equipment failures. I came to San Diego last week before this meeting to make an inspection of the area. Commissioner Santibañez and I inspected all this area as a mutual inspection procedure and found all the canyons were dry. However, there is a flow of sewage coming into United States from east Tijuana, and we have that problem under consideration and are planning some moderate projects.

The gigantic project that Ms. Jacobson refers to is an international plant for San Diego and Tijuana. If one were to take simply the international part--the transboundary sewage flows--it is slightly more than 25 percent of the billion dollar project. So we are not considering the joint project with Mexico as a gigantic project, although when you combine that as a regional project to give to relief to the City of San Diego and other jurisdictions in the area, then it becomes very sizable. The question before us is as follows: Either you have twenty different solutions or you consider it a regional problem by combining various project elements together so the long-term basis would fit like a jig-saw puzzle. Our objective is that any resources supplied by agencies with the federal government or City of San Diego or the Mexican government must be coordinated into a project which has been thought out ahead of time and which would provide a quantum solution. That is our goal. Now, I would consider that a noble goal and we seek participation from the State of California; in fact, the State of California is actually involved in our deliberations with Mexican officials in meetings where many agencies of the State of California were present and making inputs as to what their goals would be in this region.

As our initiative goes a little further, as elections take place in both countries, as we settle down to the new directives of our government, we will be coming forward with some sort of a long-term plan. It is my projection that if I am the Boundary Commissioner for the next twenty-five years, in 2010 I will be sitting down here reporting to you how successful we are on this project. I feel it is going to take us twenty years or twenty-five years to solve this problem. In the meantime, we are making significant efforts to reduce the impact of pollution in the area or at least try to control its impact as much as possible. I cannot say that we are actually successful on that, but we are trying our best, given the condition of our budgets and resources. We are doing, I would say, an admirable job along with the cooperation of the government of Mexico. Mexico has made significant progress in building their pumping stations, their pressure pipelines, and their 17 to 20 million gallon/day treatment plant in Tijuana. In addition, the Mexican government has required their industries to curtail their discharges into the drains of the New River in Mexicali, and they are installing on-site treatment processes before the waste water discharges feed to the drainage system.

In conclusion, what I am trying to tell you is that the United States government is not taking a nap on this problem. I talk with the Mexican Commissioner and his collaborators every week, and we have developed various initiatives. Within the resources given by our government to the Boundary Commission and the resources given by the Mexican government to my counterpart, we are doing our best. Since I came to the Commission about a year ago, I hope that I have advanced the process of devising solutions for border sanitation problems.

Paul Ganster. Our next and final presenter this morning is Ingeniero Arturo Herrera from the Comisión Internacional de Límites y Aguas from Ciudad Juárez.

Arturo Herrera. Thank you. After that wonderful presentation by the Commissioner Gunaji, I really have little left to say since we are part of the same organization. First, I would like to beg your forgiveness on behalf of Carlos Santibañez, Commissioner of the Mexican Section of the International Boundary and Water Commission, who regrets not being able to be here due to an emergency on the Río Bravo. Then, I would like at this time to describe in a little more detail how this international commission works.

The International Boundary and Water Commission is a bilateral international organization formed by the governments of Mexico and the United States in order to handle the common border water management problems and issues in both countries relating to the Colorado and Bravo rivers. The Commission is responsible for defining the land borders by identifying reference points and by marking their positions through topographic features and aerial photographs. In the zones occupied by the Bravo and Colorado, we are talking about a length of over two thousand kilometers. The Commission is responsible for maintaining these rivers as international borders, as well as resolving problems that relate to territorial jurisdiction and property when the river changes course. As far as common water management for both countries, the commission is responsible for accounting for the waters that belong to each. It is also charged with delivering these waters at appropriate times to the administrators and users on both sides of the border. Water quality is of utmost importance to the Commission as is the control of waterworks on the rivers and the joint operation of several dams.

In accordance with the water and border treaty of 1944, the Commission needs to learn border water allotment problems from both governments, in a permanent and preferential form. Both governments agree, when defining allotment problems, that when the waters cross the border they not be of unsanitary quality that could endanger the health and the well-being of any of the inhabitants of either side of the border. Nor must the waters be of a quality that might impede the beneficial use of those waters.

In order to resolve water allotment problems, the agencies of both governments supply each section of the Commission with the information and technical details needed. As Commissioner Gunaji was saying, for each border water allotment problem the Commission must create a document (minute) to be ratified by both governments. Included in the minute would be an explanation of the problem, a definition of the conditions that require solving, a specification of quality standards to be met, a definition of the course of action to be taken towards a solution, a listing of the costs, and a specific agenda towards its development. Both governments agree that the solution to any specific water allotment problem can be implemented by either of the members or jointly.

As you will see, in essence, our International Boundary and Water Commission is a technical organization that engages in diplomatic negotiations. To explain this, I will comment briefly about the Mexican section's functioning in the Commission as pertains to problems of water allotment. First, the Mexican section has a permanent workforce along the border which allows us to detect and identify, on a daily basis, sanitary problems, their causes, and their possible solutions. In case of international agreements, our field offices are responsible for ensuring their fulfillment. Because there are border water allotment problems which have not been solved by Mexico and the United States, the Mexican section carries out its policies according to the Mexican Secretariat of Foreign Relations. This institution is responsible in Mexico for setting the agenda for any matter outside Mexico. As such, the Mexican section of this commission is part of this agency with a representative who serves in the United States in an ambassadorial capacity.

In regard to its technical aspects, which are the most important, the Mexican section has only permanent personnel for solving of water allotment problems in our country. In the field, the Secretariat for Urban Development and Ecology (SEDUE) plays a very important role with responsibility for the planning and national policies for urban development and environmental matters in Mexico.

I am pleased that our governments took a great step almost a hundred years ago to create our International Boundary and Water Commission for the common benefit of both countries. The Commission allows us to keep in contact and to reach agreements in a peaceful way and in common respect. This is an agency which sets a world-wide example. It proves that problems can be solved regardless of the inherent differences between our two large countries. Finally, I think it the responsibility of each of us to use it for the benefit of both our nations.

Session II: Wastewater Treatment and Reclamation in the San Diego-Tijuana-Region

Clifton G. Metzner, Jr., Moderator

Cliff Metzner. This first water quality workshop is a unique opportunity to bring together U.S. and Mexican experts and authorities who deal on a daily basis with waste water treatment, disposal, and reclamation problems and programs as well as overall water quality in this region. This workshop will allow us the occasion, in an informal manner, to take advantage of hearing and discussing the ideas of these experts and possible solutions to these critical water issues that closely effect all of our lives in this region.

Over the years the sewage collection and disposal infrastructure in Tijuana has simply been unable to handle the exploding urban population in that city. In addition, San Diego has also begun to encounter significant difficulties with its wastewater treatment infrastructure. During the past several years both cities have experienced numerous breakdowns in pumping and collection systems. Both face the prospect of significant investment to expand treatment facilities for the future. Additionally, San Diego is required by the United States Environmental Protection Agency (EPA) to upgrade its sewage treatment and disposal system to meet higher federal standards. This crisis on both sides of the border provides a unique opportunity to view wastewater treatment and reclamation issues in a broader regional context and to examine these issues in depth.

Municipal, state, and federal entities in the United States now seem to be willing to consider specific joint projects to help resolve these problems. The Mexican federal government has also expressed interest in coordination of plans and possible collaborative projects to alleviate the present situation. Thus, there now exists a window of opportunity for using these issues as a way of increasing transborder cooperation at all levels of government on important matters of mutual concern. At the same time, mechanisms developed for cooperation and problem resolution in the San Diego-Tijuana region can serve as a model for other areas along the border that in future years will present critical, transborder water issues.

The California-Mexico border region is characterized by a great aridity and, for example, San Diego normally imports about 90 percent of the water it uses. Given the tremendous urban expansion on both sides of the border, and the fact that California will lose a portion of its Colorado River water as the Central Arizona Project comes on line and Arizona begins to use its legal entitlement, the availability of water will increasingly become a serious issue in the region. We are now, in fact, experiencing a serious drought in California as is the midwest region of the United States. To date, a number of interesting demonstration projects have been carried out in Southern California and northern Baja California, but little has been done to use wastewater as a valuable resource in terms of reclamation and recycling. Traditional policymakers and water authorities have resisted reclamation in the past, although now it appears there is a growing amount of public support for more efficient use of this vital and natural resource. The San Diego County Water Authority has developed a number of reclamation projects in San Diego County that we will hear about today. The Mexican Secretaría de Desarollo Urbano y Ecología (SEDUE) is also looking seriously into wastewater reclamation in certain areas as a government policy in the development of new sewage treatment and disposal projects.

Now is the time for creative planning and serious efforts toward a comprehensive and regional approach to long-term conservation and water reclamation projects on both sides of the border. The timing for new approaches to treatment disposal and reclamation in the region is opportune. Because of the EPA requirement to meet secondary treatment standards, the City of San Diego has embarked on a program to develop a plan for new upgraded treatment and disposal facilities with an accompanying system for reclamation of wastewater. The City has appointed a citizens' metropolitan sewage task force to review the problems and issues and to make recommendations to the city and county for long-term solutions. We will hear about the status of these studies today. We also understand that authorities of the U.S. government and the government of Mexico are conducting discussions on possibilities of coordinating development of joint projects for wastewater treatment and reclamation in these areas. We will also hear about developments of these discussions today which were held last week in San Diego.

Consequently, the next two or three years is a highly critical period in the development of plans for water quality, wastewater treatment, and reclamation systems in the greater San Diego-Tijuana region that will carry us well into the 21st century. In an attempt to contribute to this comprehensive planning, the Institute for Regional Studies of the Californias at San Diego State University is sponsoring this workshop as the first in a series of concentrated workshops to reexamine the issues in depth with both U.S. and Mexico experts. The ultimate goal of this series of workshops is not only to devise appropriate situations to critical regional issues, but also to improve the ability of local, state, and federal agencies to resolve transboundary issues that have the potential of becoming major irritants in the U.S.-Mexican relationship.

This morning we have an excellent panel. First we will have Pete Silva who is Senior Engineer in the Special Projects Division of the Water Utilities Department for the City of San Diego.

Pete Silva. Cliff has gone over a little of what I wanted to discuss; the work that the City of San Diego has embarked on to expand and upgrade its sewer system to a secondary treatment level. Before I get into that, I would like to briefly discuss the current City of San Diego treatment process and how we foresee that changing with the ongoing planning, design, and construction schedules. The current existing City of San Diego metro area sewage system is a centralized system. The City operates the main collection, transportation, treatment, and disposal system from fifteen different sewering agencies that make up the City of San Diego metro area. The sewage is collected from as far away as twenty-five miles, from as far north as Del Mar, from as far east as Alpine, and from as far south as San Ysidro adjacent to the border. All the flow is collected from the east, north, and south through pumping stations and major transmission trunk lines and then transported to the Point Loma area. There, it is pumped through the main Pump Station No. 2 where it is transported into the Point Loma wastewater treatment plant. The treatment plant operates at what is called "advanced primary treatment" level where chemicals are added to aid in removing more of the sewage solids. From there, the treated effluent is discharged into a two-mile long ocean outfall that terminates at an ocean depth of about 200 feet.

This system was constructed and in the early 1960s and began operating in 1965. Back at that time there were no EPA requirements, there was no EPA in fact, so it operated mainly under California law. From about 1965 to 1974 it continued operating under that system, wherein California delineated all the requirements for discharge into the ocean. During this time, Point Loma was meeting all the state requirements. In 1974, two years after EPA was formed, new federal regulations came into effect. The Point Loma plant then operated under both the federal permit and the state permit, although they are technically one and the same.

The intent of the federal requirements was that all treatment facilities in the United States would be at a secondary treatment level by a certain date. This date kept changing until it was finally set at July 1, 1988. In the mid 1970s, San Diego, along with other communities in the United States, went to Congress to seek what were called "ocean waiver permits." It was felt that San Diego was meeting state requirements and was not impacting the ocean environment. Ocean waiver permits that were requested in 1979 and again in 1983, basically asked the federal government for a waiver from secondary treatment. At the same time, San Diego also proposed two major facilities planning studies as part of the federal requirements, one in 1976 and one in 1981, that identified initial methods to reach secondary treatment levels.

San Diego from the 1970s through 1987 was proceeding along two tracks. It was asking Congress to grant San Diego a waiver from secondary treatment but also was proceeding with planning to go to secondary in case a waiver was rejected. Although initially the waivers were tentatively granted, in 1985 EPA issued what was called a "tentative denial." EPA effectively changed course on the city and from that time it was obvious that the City of San Diego would not receive an ocean discharge waiver. Because of this, the City of San Diego felt that it was better not to go any further in the request for a waiver and the Council so voted in February of 1987. That pretty much got the ball rolling for the City as far as converting the system to secondary system which obviously is a major, major task. There has been an initial indication that the cost could be as high as one and a half billion dollars to upgrade and convert the City of San Diego's treatment facilities to secondary treatment and water reclamation.

The initial planning process has just started and the City has hired the firm of James Montgomery Engineers to begin the three-year planning study to convert to secondary. This is a $10 million project. The City is looking at ways of financing the secondary treatment, which is obviously a very highly political issue. As Cliff Metzner mentioned, the City has formed a citizens' task force to assist the City staff and the engineering staff to make sure that public participation is a major part of the planning process. So we are proceeding on track to fulfill the requirements by the federal government. I think Mike McCann from the Regional Board will later today go into the exact details of what the law entails and how that relates to the reasons for San Diego going to secondary treatment.

Before ending, I would like to discuss the opportunity for regional planning for the area. The City Council has made it very clear that they want the staff and the engineers to take a very close look at water reclamation. They want water reclamation to be a very large part of whatever is done for the area. And in response to that, we feel that there is a good opportunity. We are working with the local sewering agencies to investigate ways we can optimize water reclamation for the San Diego area. Also, there have been planning studies in the past that have indicated the possibility of an international facility near the boundary that could treat both the City of San Diego and the City of Tijuana flows. And with this major planning effort, that window of opportunity again is open for both countries. That is one of the things that could come up in the planning stage.

In regard to the possibility of international cooperation on projects, some of you have heard about the so-called Big

Pipe project along the border which is an initial step in a long-term type approach to regional planning.

Cliff Metzner. Now we have Enrique Manzanilla from the U.S. Environmental Protection Agency, Region IX Office, in San Francisco.

Enrique Manzanilla. I want to talk to you a bit about what we are doing right now and how we are looking at this problem for the future. As many of you know, in 1984 Congress provided EPA with $5 million to design an interceptor facility to correct the immediate problem of transboundary wastewater flows in the Tijuana River Valley. An additional $27 million was authorized for the construction of the project and hopefully if things go right with the appropriations committee we will see that $27 million in fiscal year 1989. The design of Phase 1 of the project has been completed. At the outset, I should point out that in looking at alternative pipeline sizes, we considered both today's problem of pollution and contamination in the Tijuana River Valley and tomorrow's need for long-term facilities. Hence, we are looking at upsized pipeline diameters and, in fact, we are also looking at a dual pipe system which would give us some operational flexibility. In addition, given potential future needs, we recognize that construction impacts would be reduced by constructing one large pipeline at this time. As pointed out in the City's Environmental Impact Report, the consolidated project would reduce future construction costs and would use state and federal funds that may not be available in the future. It is probably safe to assume that the project would not be feasible without the joint participation of the City, the State Water Resources Control Board, and the EPA.

Basically, the upsized land outfall would replace the 66 inch line designed by the Corps of Engineers which is a standby system commonly referred to as Defensive Measure 7C. The upsized pipe would connect to a pump station in Goat Canyon and convey intercepted Mexican sewage back to the Mexican conveyance system.

Designs for Phase 2 of the project, namely the pump station and the lines to Mexico and from the Tijuana River, should be complete by the end of 1988. And at this point, I should mention that EPA will circulate an environmental assessment on Phase I for public comment sometime during the summer.

Importantly, I think that Congress, the regulatory agencies, and the public recognize that this system is just a short-term, stop-gap measure. Furthermore, in designing these interim measures, we have tried to keep one eye on the present and the other eye on the future solution of a very complex problem. Because of these considerations, the EPA convened a task force in March of 1988 to develop long-term agency strategy. We are still in the process of developing that strategy. As a matter of fact, Dick Reavis is in Washington, D.C., today meeting with different representatives within EPA in the Office of Water and the Office of International Activity to discuss a range of long-term solutions.

The task force has identified several criteria for use in evaluating the long-term options. I think many of these are somewhat obvious: First, to protect human health; secondly, to protect the estuary; and thirdly, but not least, to look at the cost effectiveness of the solution. At this point in time we continue to believe that some type of joint international facility is necessary to alleviate wastewater problems in the San Diego-Tijuana area. We are looking at ways to expedite the completion of the joint facility or of certain components of the facility. Nevertheless, the solution will have to be compatible with the City of San Diego's facility planning process. And, of course, the facility would require extensive coordination with the Mexican government to assure compatibility with their needs and facility plans.

Last week, the Bilateral Water Working Group met here in San Diego to discuss water quality problems and sanitation problems. As a follow-up action, EPA, SEDUE, and both sections of the IBWC (the International Boundary and Water Commission) agreed to meet in early September of this year to discuss a long-term solution to the Tijuana-San Diego problem. The EPA and the U.S. section of the IBWC will then present to our Mexican counterparts the U.S. government's strategy for a long-term solution.

In conclusion, taking your words from the beginning, there is "a window of opportunity" for a much closer coordination. EPA looks forward to working with the City, the IBWC, our counterparts in Mexico, and the public in arriving at a permanent solution to wastewater problems in the Tijuana River Valley.

Cliff Metzner. Now Mike McCann, Senior Engineer of the California Regional Water Quality Control Board in the San Diego Region, will speak.

Mike McCann. Today I would like to begin by telling you that I wear two hats with regard to the City of San Diego. One is a black hat and the other a white hat. Wearing my black hat first, I will explain briefly the enforcement action being taken by EPA and the Regional Board against the City of San Diego. And secondly, once I take the black hat off I hope to be wearing my white hat and describe our agency's effort in achieving a long-term solution to the border sewage problem.

The Regional Board and EPA have joined as plaintiffs in a prospective court action against the City of San Diego to seek a consent decree action for a time schedule to

meet secondary treatment. The City of San Diego at this time is just in the planning stages of providing secondary treatment for the entire San Diego Metropolitan Sewage Agency flow which right now is about 190 million gallons per day. The planning flow or the flows that they are going to plan for will be approximately 385 million gallons per day. That is going to take some time to build and I will make a few comments about that later.

But we are in the negotiating session right now. July 1, 1988, is the deadline for secondary treatment as far as the Clean Water Act is concerned. And the City of San Diego obviously is not going to make that. There may be some penalties involved, and most likely there will be a short time schedule. At least from the regulatory standpoint, we feel it should be. And reclamation will probably play a big role in the facilities that the City of San Diego eventually constructs.

The Metro Sewage Task Force, if you have not already heard, is a citizens' committee appointed by the Mayor and the City Council to begin the process, the public input process of the planning phase for secondary treatment. It is a monumental project and it deserves and requires a lot of public input. There are about eighteen members, and I am a non-voting member. It may seem like that is a conflict of interest, but it really is not. I am there to offer any technical advice from the Regional Board's regulatory perspective regarding the direction the City is going. The members meet every two weeks, and have been meeting since May of last year. They provide a public forum available for anyone who wishes to speak on various topics. They do have an agenda every meeting. They have committee reports on various aspects of secondary treatment. So I invite you to attend those meetings and follow how the Tijuana sewage problem and the City of San Diego's problem are going to be integrated in the planning phase.

Maybe that brief description of the status of enforcement against the city San Diego will dispense with the black hat. Now I would like to talk about the Tijuana sewage problem and put on my white hat. And I would like to begin by saying that I am a staff member with the Regional Water Quality Control Board. We are a state regulatory agency and the first line water quality regulatory agency in California. We are contracted by EPA and have the authority to administer their NPDES (National Pollution Discharge Elimination System) permit programs, and take enforcement action. On this program with Tijuana, we are working in concert with the State Water Resources Control Board, which is our administrative agency, and EPA.

Our Board has been in existence since 1950. We were part of the Health Department before that, and we have been grappling with this problem since the late 1940s. To date, you can see that the state, and I would say even the EPA and the federal government, have not been very successful in solving this problem.

One of the things I want to make clear in my remarks today is what the Regional Board's position is as far as a solution to the Tijuana problem, specifically a long-term permanent solution. Because that is what we need to be looking at right now. But before I begin I would like to put this problem in perspective. I know Mr. Gunaji has talked about the problems of the City of San Diego and the problems of Tijuana, but I think we should all look at this from a regional approach and start looking at the numbers. I would like to think that we are really talking about is the tale of two cities. Do you recall in Charles Dickens' novel, he begins it by saying "It was the best of times and it was the worst of times"? And that really fits in our border situation. It is the best of times in that we are starting to see more muscle, more commitment by both countries, and more focused attention on the problem. But it is the worst of times because the problem has gotten rapidly worse. Right now it is worse than it has ever been. And we are in a phase now where I believe if we do not act quickly and start thinking about a an adequate long-term solution, the problem may become too large, to where we will not have that luxury of being able to address adequately the entire problem.

But I want to give you some numbers, as far as the regional approach. On the U.S. side, the City of San Diego serves over a million and a half people. They do not meet water quality standards according to the EPA and the Regional Board. They are under an enforcement action to essentially replace or put in new treatment facilities. That price tag is going to be roughly a billion and a half dollars--to renovate their collection system, perhaps put in more disposal facilities, and certainly to put in a secondary treatment system.

Now, looking at the Tijuana side, there are over a million people in Tijuana. They are in need of treatment and disposal facilities. Now you can just guess how much that might be, and I should tell you our position is that we should provide at least treatment and disposal facilities on our side of the border. The total price tag for both communities could be as much as 2 billion dollars. The City of San Diego is having to face that right now. They are now under the Regional Board's Cease and Desist Order which requires that they meet secondary treatment by 1996. And there is a question whether they will actually meet that deadline. So there is a lot of work and resources required of this community over the next ten to fifteen years.

The position of the Regional Board, which we have taken since 1985 by a formal resolution that we have sent to State Board, to EPA, to the State Department, and to IBWC, is that this is a federal problem, requiring federal money, and requiring a federal commitment. Obviously,

the state and the local governments cannot fund the project that we are talking about. And that project is a long, deep ocean outfall with a sewage treatment plant on our side of the border. And we are talking well over a hundred million gallons per day treatment plant and probably more like two hundred million gallons per day.

We asked early on that in planning the defensive system for renegade flows into the Tijuana river valley from Mexico that the section of pipe be made compatible with a long deep ocean outfall. Originally, it was for a 66 inch diameter pipe to handle renegade flows from Mexico. But we have asked that in time that section of pipe be used for a long deep ocean outfall. Now the diameter pipe (in the plan) is in the neighborhood of 140-144 inches. And we feel that will be necessary in time as an integral part of the long-term solution.

The City of San Diego may now take advantage of the large diameter pipe section. There is a very good chance the City of San Diego will need to have a sewage treatment plant in the South Bay area in the Tijuana River Valley and access to an ocean outfall. With federally funded facilities, the City of San Diego may not have to build facilities just for themselves. They may be able piggy-back onto the federal joint system.

As I say that, it is easy to make that kind of a statement and certainly a scheme like that is not going to work unless cooperation comes from Mexico as far as a collection system is concerned. One of the big problems is bringing all that wastewater to one location so it can be treated on the U.S. side and discharged into an ocean outfall in the U.S. waters. And I think that is where our emphasis should be to encourage that kind of cooperation. Because the things that we have seen in Mexico and our side of the border up to now have been wholly inadequate. All you have to do is look at the figures for the Tijuana River flow. Last year in the fall, the measured flow coming down the Tijuana River was roughly six million gallons per day. That is basically wastewater coming down the Tijuana River. This spring, following the rains, that flow has been up to ten and twelve million gallons per day, or essentially double.

One of the issues that we are going to attempt to address at the state level is the issue of growth. Although we are not a land use agency, we have taken the position that growth on our side of the border and on the Tijuana side of the border just worsens the problem of wastewater into the U.S. We are intending to initiate some legislation to try to regulate in some way the industrial waste flows of U.S. owned companies that may have facilities in Tijuana, to try to make them address the water quality concerns that we have. The eastern side of Tijuana, particularly the industrial sector, is growing with leaps and bounds, and we are not clear exactly where all the domestic and industrial wastewater is going. It is on the east side of the river, and we do not believe that any of that wastewater is being sewered into the present pump station and sewage conveyance system. We believe that might be the reason for the sudden increases in flows in the Tijuana River.

Just how effective Tijuana will be in controlling growth or in requiring pretreatment standards or regulation of water quality, I am not quite sure. But there are a number of industrial firms that are in the eastern side of the city in Tijuana that need to address water quality.

Another issue that I would like to touch on is reclamation. I mentioned that reclamation will play a part in the City of San Diego's future sewerage facilities. That is also true, I think, in the solution to the Tijuana problem. But I am not as optimistic as some as to how much reclamation is possible. According to figures that we have looked at, reclamation is somewhat limited in the Tijuana River Valley and in the Otay Mesa area in that there is probably not going to be a whole lot of area in the next ten or twenty years for direct use of reclaimed water. And since we are a regulatory agency that is concerned with surface and ground water quality, we are required to regulate reclamation projects in the area. What we have seen throughout our region is that problems in reclamation revolve around quality and quantity. We are talking about quantities of two or three hundred million gallons per day of wastewater and not having the capacity or the land necessary to reclaim anywhere near that amount. In the border area, perhaps 5 to 10 percent of the wastewater could be used for direct application of reclaimed water.

One option to direct application of reclaimed water might be recharging the groundwater aquifer of the Tijuana River Valley. That basin seems somewhat amenable to that type of operation. It is quite sizable as far as basins in our region go and could have the potential of being improved. However, the quality of the water that we would want to see put in the groundwater basin would have to be the type of quality of water you could actually reuse. It has been our experience that water quality of reclaimed water has to be at least below 1,000 parts per million (ppm) of total dissolved solids. Currently, the wastewater of both cities is quite a bit higher than a 1,000 ppm. It has been our experience that a reclamation project cannot go on for a long-term basis the water that is higher than 1,000 ppm. We may be looking at some demineralization of the wastewater in order to use the wastewater for agriculture and other uses, and to recharge that basin so it can be used as a source of water for irrigation at a later date.

We also have coming our way now requests from a number of proponents, not in the Tijuana River Valley area just yet, but in other parts of the region, for discharging wastewater directly to surface waters. At this time we really do not have any domestic wastewater

producers discharging into the surface waters. And we are looking into what standards are appropriate for discharging advanced treated wastewater. We are looking at putting this type of water into streams below domestic supply water reservoirs. We are not proposing that these discharges be used for drinking water purposes, but we are looking at those basins that are below drinking water reservoirs. We also we would insist that the quality of the wastewater discharged meet all of the Title 22 unrestricted body contact criteria for coliform bacteria.

We are also looking at nutrient levels in the discharges to be in the neighborhood of our existing nutrient standards. To date, these standards have prohibited anyone from discharging to inland streams. But after reviewing some of the information from around the country, we are considering perhaps, a nutrient level for sensitive areas of approximately 0.2 mg/l total phosphorus. In some other flow regimes it might be a little bit higher, but not much more. The Tijuana River Valley, with the estuary, certainly is a sensitive area. So we are looking at holding the nutrient levels for any wastewater discharge, at least on our side of the border, into that river system at around 0.2 mg/l total phosphorus. Also, there is information to indicate that any discharge should be limited to no more than about 12 1/2 million gallons per day of treated water into the estuary.

I will conclude by saying that it is the feeling of the Regional Board that now is the time to start thinking about planning for a long-term solution of the border problem. And I repeat it is the position of the Board that we need a long deep ocean outfall and a large sewage treatment plant on our side of the border. And, until a comprehensive, long-term solution is achieved such as the one I have suggested, it is our view that the situation is going to get much worse before it gets better.

Peter MacLaggan. I am the Water Reclamation Director for the San Diego County Water Authority, and what Mr. Metzner asked me to speak to you about today is essentially why water reclamation is an absolute necessity for an area such as San Diego County and what we are doing about it to make it happen. Since some of you are not familiar with the Water Authority or the water supply situation here in Southern California, I will fill you in briefly with who we are and what our main business is in San Diego County.

The Authority service area essentially takes in the entire coastal plain of San Diego County. Our sole purpose up until recently was to purchase imported water from the State Water Project and the Colorado River from the Metropolitan Water District of Southern California and distribute it throughout San Diego County on a wholesale basis. To do this we own and operate five major pipelines that traverse the length of the county. We are one of twenty-seven member agencies of the Metropolitan Water District and we currently use approximately 30 percent of their total water supply. Annually, the Authority distributes slightly more than 500,000 acre feet. Some of you may not be familiar or comfortable with the term "acre feet" which is the equivalent of one acre, one foot deep, or 326,000 gallons. A thousand acre feet per year is in rough numbers, one million gallons per day, 365 days a year. So we are distributing well over 500 million gallons a day throughout San Diego County. Our peak supply capabilities are something on the order of 700 million gallons per day. Our engineers and staff analysts have worked out the supply and demand figures for San Diego County over the next twenty years and unfortunately they project a considerably higher demand than known resources. This is the impetus behind our reclamation program, to try and make up a portion of this shortfall. Metropolitan is projecting by the year 2010 there will be a 30 percent shortfall in their service area from known resources. So, they are out to encourage reclamation projects. They have set up a program to provide a subsidy to make sure some of these programs go forward. It is referred to as our Local Projects Program.

Our supply of importer water today in San Diego County is probably the least secure it has ever been. We all know about the Central Arizona Project which is now on line, and Phoenix and Tucson will soon be taking their full entitlement. In addition, there are Indian tribes along the Colorado River claiming prior rights to that resource. Metropolitan may use some entitlement to these Indian reservations. Then there is our other source of supply--the State Water Project. This project is only 60 percent complete. It is doubtful that it will be completed to its full 4.2 million acre feet capacity.

Lastly, we now have underway the Bay Delta Hearings. This is a program which is being conducted by the State Water Resources Control Board in which they are evaluating the amount of carriage water necessary to go through the San Joaquin-Sacramento Delta and out underneath the Golden Gate Bridge in order to maintain environmental quality for the fisheries and other considerations in the area due to salinity. The hearings are a three-year program which are approximately half complete. We do not know what the final outcome will be, but it is likely that Southern California, if anything, will lose firm yield from the State Water Project. So again, these are all reasons why water reclamation is extremely important to us and why we are moving forward with a number of programs.

The Water Authority Board of Directors last year adopted objectives for water reuse in San Diego County. These objectives are a stair-step program so that ultimately by the year 2010 we hope to have 100,000 acre feet of reclaimed water production serving beneficial uses throughout our service area. To put that number in

perspective, with our projected 2010 demand that means that 12 percent of San Diego's water supply in that year will hopefully come from reclaimed water resources. The types of uses we will be putting this supply towards will be for landscape irrigation, agriculture, industrial supply, and some groundwater recharge programs are also contemplated. Although not a water reuse in itself, the recharge does provide storage and through the recharge programs we are able to rejuvenate some of our poorer quality groundwater basins, thus actually obtaining maximum yield from both the groundwater supply as well as the reclaimed water sources.

In terms of reclamation potential, I like to consider San Diego County as somewhat of a sleeping giant. There are over 36,000 acre feet of water now going to landscape irrigation each year. We suspect that number could easily double as the area continues to grow and develop. Agricultural water requirements currently using imported water supplies amount to 110,000 acre feet per year. On an average day, 100 million gallons, or 20 percent of our total supply, is used for these purposes. Many of these areas could be converted to reclaimed water usage. However, there are two major constraints. One is the need to retrofit most of the irrigation areas to meet health department criteria for cross connection control, and so forth. The second is that many of our orchards, our avocado orchards and other large users of water are located in the northeastern part of our service area, away from the populace and away from the sources of reclaimed water. They are at the higher elevations, so it is going to be difficult to supply these resources to many of the potential users.

The last potential reuse category I mentioned was industrial supply. Here in San Diego County there are approximately 20,000 acre feet of industrial water supply currently utilized every year. Much goes to the electronics industry which requires high grade water so reclaimed water is unacceptable. So, if we look at the appropriate uses, such as cooling tower augmentation or construction type water, or maybe some processed wash water, we might be able to find 5,000 acre feet of uses for reclaimed water in the industrial sector.

Mike McCann mentioned their proposals for stream discharge. We look upon this favorably. If you want to put your reclamation plants upstream above your uses so you can serve them from gravity, you are generally away from the coast and it gets very expensive to put in an ocean outfall. Therefore, the stream serves two purposes. First, it is the point of discharge when there is no demand for the reclaimed water. You retain your high quality of treatment but the water flows to the stream for ultimate conveyance either to downstream users or disposal through to the ocean. Second, there will also be some indirect ground water recharge on a number of the reaches of these streams.

We feel that since it is extremely difficult to retrofit existing uses to take reclaimed water, the type of uses we are looking at in the short term are our larger irrigators--the golf courses, the freeways, the city parks, and so forth. However, in the long term, the future developments are where we intend the lion's share of water reuse will take place. We hope that in the future that our planned residential developments with large central green belts will install the dual piping in advance of the construction so that we will not be faced with the retrofit. It becomes much easier to convert to the reclaimed water once it is available.

I mentioned our objective of 100,000 acre feet per year of reclaimed water use. This is not an aggressive goal by any means. We currently reuse 5,000 acre feet in San Diego County for beneficial purposes, so we are looking at a 20-fold increase of what we use today. That 100,000 acre feet will represent 25 percent of the total wastewater discharges by the year 2010.

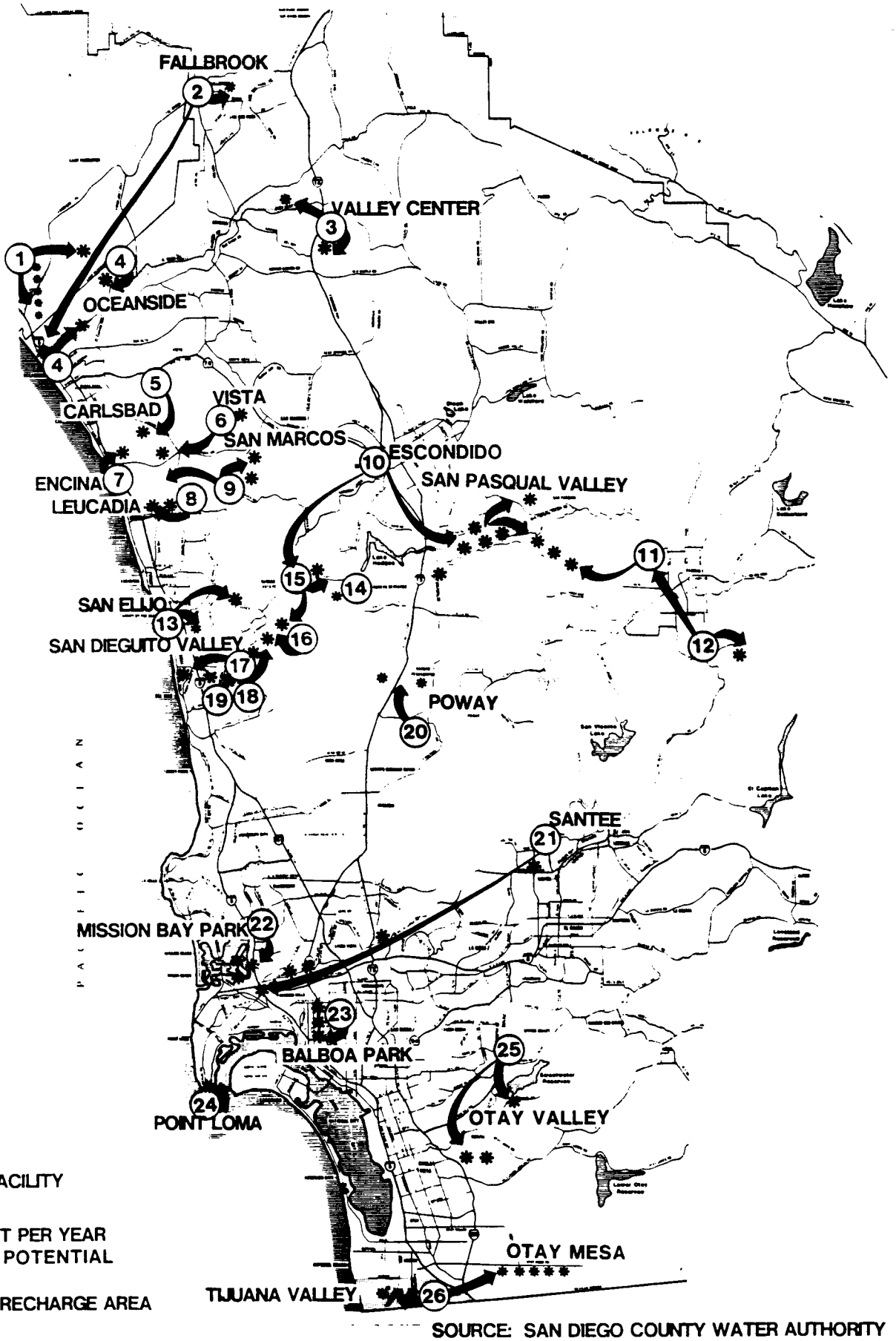
To date, the Water Authority has identified 26 potential projects as sources of reclaimed water throughout the San Diego County service area. Some of these projects will be combined to share a common distribution system. Others will combine the benefits of groundwater recharge and the reclamation program to maximize the yield for both sources.

What we are talking about here is taking existing or future treatment facilities, providing advanced wastewater treatment capabilities in terms of filtration and disinfection, and then we will be developing a distribution system to serve some of the reuse areas shown.

The Health Department, State of California, has set up reclamation criteria they refer to as Title 22 of the California Administrative Code. Title 22 goes through a whole series of levels of treatment required to put the reclaimed water out for beneficial uses and the level of treatment required fluctuates based on the degree of human contact. Each one of these 26 proposed treatment plants is more or less in an urban setting. Therefore, we are recommending that the level of treatment put forth on any given project would be to eliminate the potential risk for human health contact. We are going to go to the highest level of treatment mandated by Title 22. If we discharge to our stream courses, it may be necessary to provide some additional nutrient stripping as Mike McCann has mentioned.

Although it costs a little bit extra to provide this additional treatment level, we feel that it is justified in terms of product liability and the fact that you will not be precluding any potential uses. From the treatment plant, we will be taking the water to each of the given users

Figure l. Water Reclamation in San Diego County



SOURCE: SAN DIEGO COUNTY WATER AUTHORITY

through a separate piping system. I will start in the northern area and briefly explain what each of these projects are about.

The community of Fallbrook has a secondary treatment plant that is being retrofitted to provide filtration and disinfection. They have a connection to the ocean outfall in Oceanside. This pipeline serves as a conveyance mechanism. Fallbrook is currently supplying reclaimed water to CalTrans (California Transportation Department) along highway I-5. The Fallbrook Sanitary District, in conjunction with Oceanside, will be expanding those use areas to serve a number of golf courses and city parks within Oceanside and the Fallbrook area. Fallbrook is also looking at some agricultural use in their immediate service area.

In the Carlsbad/Vista/San Marcos area, there are four satellite reclamation plants and a major coastal treatment plant, the Encina Water Pollution Control Facility. A facility plan is now underway which will link each of these treatment plants to a common distribution system. It will be the first of what we hope to be many subregional type reclamation programs where the wastewater agencies treat the water, supply it for distribution, and the retail water purveyors take the water out of the backbone system and deliver it throughout their own service areas. This project has a potential of 7,000 acre feet.

In the center of the map on page 25, number 10 is the City of Escondido's Hale Avenue Water Pollution Control Facility. They have a connection to the San Elijo Treatment Plant, an 18-mile pipeline, which serves as a potential conveyance line for the reclaimed water. The Water Authority has also proposed a reclamation project for the San Pasqual Valley, an agricultural preserve owned by the City of San Diego. What we have proposed for this valley is to divert the treated effluent from the Hale Avenue plant, maybe as much as 10 million gallons per day, and run it down to the San Pasqual Valley and recharge the western portion of that aquifer. San Pasqual Valley has one of the larger aquifers in the San Diego region. It stores 50,000 acre feet of water and is more or less a closed basin that narrows above Lake Hodges. The western portion of this groundwater resource is a closed aquifer with a lot of agricultural activity. This groundwater has degraded for a number of years and has reached a total dissolved solids content or salinity content of 1,500 mg/l. This water resource is now marginal for some uses and not appropriate for others.

We propose to install pumps in the lower part of the basin above Lake Hodges, extract the poor quality water, take it around the north side of Lake Hodges for discharge to the San Dieguito River and substitute the existing groundwater for a higher quality reclaimed water. We have developed the hydrogeologic model for this program, and we have found that even in the worst drought conditions over a five to six year period we were able to rejuvenate that water quality back down to the 1,000 mg/l total dissolved solids which is the basin plan objective established by the Regional Board.

With the export water we take around Lake Hodges we propose a similar concept downstream, taking additional water out of the Escondido outfall, blending it with the export water and recharging the San Dieguito aquifer down near pump number 16. This aquifer has extremely poor quality; it averages approximately 2,500 mg/l tds, so we will export that water to the ocean and substitute it for the combined San Pasqual export and the additional reclaimed water from Escondido's outfall.

The San Pasqual project in the San Pasqual valley is where the San Diego Wild Animal Park is located. They would be one of the prime users of the product we would develop. Other users would be the agricultural preserve and the avocado orchards located in the Highland Valley. The Water Authority's first aqueduct passes just east of Lake Hodges through the valley. There are a number of container crops located in the valley that take imported water out of the aqueduct through an agreement with the City of San Diego. We hope to substitute their use of imported water with reclaimed water which we would develop. The ultimate amount of imported water that we hope to substitute through this project in the San Pasqual Valley is 7,500 acre feet per year or enough water to serve approximately 40,000 people. We will free this water up for a higher level of use such as domestic or industrial type applications.

The San Dieguito Valley has a number of existing small treatment plants and we talked about the potential to bring in additional effluent from Escondido. This would flow by gravity because the Escondido treatment plant sits at an elevation of 600 feet above sea level. It makes an ideal situation for distributing reclaimed water. Downstream in that valley most of the uses are landscape type irrigation. There are golf courses and some agriculture. It is a developing area where we hope to see dual piping planned into residential developments. And here we hope to develop 7,000 acre feet of nonpotable resource.

Proceeding south from the City of Del Mar to the border, is an area within the City of San Diego's Metropolitan Sewer Service area. The mayor and council more than a year ago gave up their nine-year quest for a 301H waiver, which means San Diego must upgrade its entire system and convert to secondary treatment by a specified date. Although it does pose a cost of $1.5 billion or more, it also offers an opportunity to reclaim a large portion of wastewater. Through a number of market assessment studies for the metro service area, it appears the reuse potential throughout the entire service area, possibly by

the year 2010, is 60,000 acre feet per year. Half of that reuse potential exists today and the other half would depend upon future development.

Some of the projects which we expect to emerge out of the Metropolitan sewer system upgrade and expansion include up to a 10 million gallon per day facility within the City of Poway with potential to discharge into the Peñasquitos Creek. This water could be extracted from the creek and used within the City of San Diego in the area of Torrey Pines, Carroll Canyon, and so forth.

The City of Santee has a reclamation plant which now has been on line for twenty-six years. It serves the Santee Lakes Regional Park, discharging one million gallons per day. We are underway with a program to expand that plant to its ultimate, or its original design capacity, of four million gallons per day. We hope to be on line by 1991 and plan to discharge the excess water to the San Diego River, i.e., the wastewater that cannot be used in the immediate area. There is an excellent opportunity to utilize this water again in Mission Valley, distribute it among the landscape irrigators within Mission Valley, and possibly take it as far south as Balboa Park for irrigation of the park. This is one of the many alternatives being looked at in terms of water reclamation for Balboa Park. We all feel that this is an excellent opportunity. Currently, Balboa Park uses three million gallons a day for irrigation and if the zoo is included there may be one or two million gallons per day more which could be delivered to that area to offset existing usage of potable water resources.

Mission Bay Park is another obvious target within the Metropolitan Sewer Service area. We have also looked at projects in La Mesa, throughout Center City, and North City. To the south, we have a large area of open space on Otay Mesa and the Tijuana Valley. I tend to agree with Mike McCann that this is not an area that is going to have a large reuse potential in the short term because the projections for development of that area are scattered out over the next thirty years. However, we do hope that Otay Mesa does move forward to install the proper infrastructure for dual piping. Therefore, when the industry, developers, landscapers, and others come in they have two resources to choose from. And we hope that wherever appropriate they will take the nonpotable resource.

The Tijuana Valley also provides an excellent opportunity for a groundwater recharge program which would rejuvenate that aquifer. It now has a high of 5,000 mg/l total dissolved solids. One problem we have here is that the lower portion of the aquifer is within the United States, and the upper portion is on the Mexican side of the border. I believe we each share approximately 50 percent of the storage capacity within that basin. So, if there is an intent to rejuvenate this aquifer and use it for a nonpotable storage basin, it must be a project where Mexico and the United States cooperate by working on both the northern and southern halves of the aquifer.

There is an existing treatment plant in the Otay Valley which is owned by the Otay Municipal Water District. The capacity there is 1.3 million gallons per day. They recently received approval from the Regional Board to go ahead with irrigation projects for the Eastlake development in eastern Chula Vista.

Although wastewater reclamation is not a cure-all for our water supply problems, it does help alleviate some of the shortfalls within our demand system. We feel that water reclamation is a promising alternative that the County Water Authority strongly supports and we are willing to dedicate staff and financial resources to make sure that these programs do go forward. Our effort as a regional water supply wholesaler is more or less that of a program facilitator wherein we work closely with the project proponents, the Regional Board, the State Water Resources Control Board, and all the various sources of funding in order to make sure that when the project proponent does come forward with the proposal, somebody is there to help guide them through the process and overcome some of the hurdles that are necessary to bring a project on line.

Cliff Metzner. We have a treat in store for us. Dr. Albert Utton is here from the University of New Mexico in Albuquerque. He is Professor of Law and editor of the *Natural Resources Journal* and will make a few remarks.

Albert Utton. I really came to learn more about the San Diego-Tijuana situation, the Imperial Beach, the Tijuana Estuary, and I am doing that, thanks to the speakers that you all have gathered together here.

I thought I would take just a few minutes to ask the question, "What can we learn about the experience we have had along this U.S.-Mexican border, not just the San Diego-Tijuana area? What kinds of water quality problems have we had, do we have? And what have we learned in the way of managing those problems?"

Now, in trying to think about those problems, the kinds of phrases that come to mind, would include phrases like "two-way street," the "white map problem," and perhaps "we have accomplished much, yet there is much to be accomplished." And then finally, I would include the phrase, "corriendo pero llegando tarde" (running but arriving late). Amongst those phrases we might gather some of the learning, some of the experience that we have gained regarding water quality questions along this U.S.-Mexican frontier.

First, the two-way street. I think the first lesson that we should learn is that water quality problems we share along this frontier are a two-way street. No one country, not Mexico, not the United States, has a monopoly on those water quality problems which cross the frontier, those transboundary problems. We have sent a great deal of salinity south to Mexico in the Colorado River, and are still doing so, even though we have largely worked that problem out. On Mexico's side, if we look at Tijuana-San Diego, if we look at the New River, the Santa Cruz River, and then if we look at Nuevo Laredo, we find that Mexico is sending north a lot of sewage. The water quality problems have gone both ways across the border; it is a two-way street. No one country has a monopoly on it.

And perhaps thinking of the first rule of wing walking, we might also think about the water quality problems. You remember the rule of seeking a new job, one should always bear in mind the first rule of wing walking. And that is, "never let loose of the wing you are on until you have a new wing to be on." There is a similar rule in drawing frontiers and drawing boundaries. And that rule is that you should never draw the boundary so that you are in the position of being downstream. Now someone, some surveyor, some engineer, or maybe it was some politician who negotiated a treaty who drew the boundary in the wrong place, so that Tijuana was upstream and San Diego was downstream. Poor planning. The first rule of boundary drawing was broken. The fallacy of that is that both countries are downstream. Sometimes we are downstream on one river and upstream on another river. Sometimes we are both downstream and upstream on the same river. The Rio Grande would be an example of that, perhaps. With the tributaries feeding into the lower Rio Grande coming in from Mexico then Mexico is downstream on the same river. A better example, the Santa Cruz River, which rises in Arizona, flows into Sonora, then does a U-turn, comes back up to Nogales, Sonora, and then passes Nogales, Arizona, and then flows into the Gila which then flows into the Colorado which then flows back into Mexico. The number one moral: none of us are immune from each other's problem and with population growth and economic development, both sides are vulnerable to the activities which occur on the other side and may send those flows, those residuals from those development activities to the other side. Thus we have rule number one: the two-way street.

Thought number two. In spite of this interconnectedness, we frequently act as if the other side did not exist. We carry on activities within our own little world, with little appreciation of or concern for what the impact may be on the other side of the boundary. This is the white map problem. We frequently draw the map on our side. If you look at the Mapa de la República Mexicana you will find all the states beautifully colored in, but if you come to the frontier, it is frequently just white on the other side, as if the other side did not exist. The same is true on our side--the white map as if the other side did not exist.

Three quick examples. If you look at the City of El Paso's water development plan, they have a large, voluminous plan for developing groundwater for the future growth of El Paso by installing a large groundwater pumping field in New Mexico, right on the U.S.-Mexican frontier. The map which shows where this well field will be developed has a derrick block where the well field will be and then there is a line as if Mexico did not exist. El Paso, in that plan, proposes to pump nearly a quarter of a million acre feet per year from that well field all at the same time when the Ciudad Juárez is anticipating doubling or tripling, some studies even suggest quadrupling, their water needs by about the year 2000. And where will they likely be looking for their water? Right opposite where El Paso is suggesting putting that pumping field. This is an example of the white map problem.

Example two. A few years ago Mexico put a large groundwater pumping field in the San Luis area right up against the border of Arizona and started pumping large quantities of water from that well field, without really considering the hydrology and connections with the United States or the political impact. A white map problem. We have worked that out, although it took a special agreement through the International Boundary and Water Commission.

Example three. The Welton-Mohawk project in Arizona. This agricultural reclamation project was put in place not far from Yuma to make the desert bloom and the desert did bloom with all kinds of agricultural products. The only problem was that water was placed on that soil which was salty from oceans past, from geologic past times. The water gradually built up and reached the root zone of those plants and so the question was, "How do we preserve the Welton-Mohawk? How do we lower this saline water which is creeping up from below?" The answer was quick and easy and simple. Let's simply pump that water out and pump it into the Colorado River and we will be rid of the problem of salinity. The only problem was the Colorado flows into Mexico and it was not very long before the lettuce in the Mexicali Valley was wilting, rather than in the Welton-Mohawk region.

Lesson number three is the difficulty of communication. We have problems of communication between the United States and Mexico. In so many ways, we really are very different. Mexico looks at us and they see an array of states, with a variety of different laws and legal systems and little consistency. When we look at Mexico, in contrast, we see quite a centralized decision-making system. Mexico has the new Environmental Protection Law which goes towards decentralization, but nonetheless it is quite a different administrative

jurisdictional setup. When we look at each other's cultures, we are really quite different with Hispanic values on one side, Anglo-Saxon values on the other side, that Ocatvio Paz talks about so elegantly. He kind of capsulized that, the kind of go-go attitude on one side, historic consciousness on the other side. And as we were talking this morning about the problems of financing where you have a terrific differential in wealth on one side to the other side, we were confronted with the question of how do you finance joint sewage projects in the San Diego-Tijuana area, or the Nogales area, with these differentials? Difficulties in communication would be one of the factors we can cite as affecting the ability to act jointly.

Point number four. In spite of these difficulties, in spite of the problems of communication and of understanding each other, we really have accomplished a great deal. We have amicably settled our water quantity problems in a peaceful way over the years with the 1906 treaty on the Rio Grande, the 1944 treaty on the Colorado and the Rio Grande. The International Boundary and Water Commission has made a great contribution over the years in operating major water storage and flood control projects on the Rio Grande and international sewage projects in Nogales and the Tijuana-San Diego area. And now we have the 1983 La Paz agreement between President de la Madrid and President Reagan. This is really a landmark vehicle which we have established which requires annual meetings of the national coordinators to discuss the whole series of environmental problems. This is a way of communicating in an established, regularized way. As lawyers we would look at this agreement as a framework agreement, an umbrella under which a whole series of more detailed, more specific annexes already have occurred regarding air quality questions, hazardous waste, and the Tijuana-San Diego sewage question. It is a vehicle that is allowing us to overcome some of these problems of communication. So, we have accomplished much, but yet when we heard the discussion this morning, we realized that there is much to accomplish.

Which takes me to my other key phrase, "Running but arriving late." With the population growth that we are facing along this border, we are going to run as fast as we can just to keep even. Maybe I should say catch up. So I think the final moral is we have accomplished much. But with the population and the economic growth that we face, it is going to challenge us to use every channel of communication that we have developed--the La Paz agreement, the International Boundary and Water Commission, the arrangements between states, the arrangements between communities, communications, conversations in private groups such as this. These are necessary for us to reach the consensus that negotiation is possible, for us to just to stay even in meeting water quality problems along this border.

Cliff Metzner. Thank you very much, Al, we certainly appreciate your thoughtful words. Speaking of the La Paz agreement, I participated in the drafting of it in 1983 in Mexico City, and a major feature of the agreement encourages organizations outside of the federal government to participate in the yearly coordinated meetings. This participation can be by organizations such as San Diego State University arranging meetings and seminars and making the proceedings of those seminars available to the authorities on both sides of the border in order that they can make their determinations with current information.

Arturo Herrera, Mexican Section, International Boundary and Water Commission. To begin, let's review the agreements Mexico and the United States have reached towards the solution of the international problems of Tijuana and San Diego. In April of 1985, Minute Number 270 of the International Boundary and Water Commission was signed by both countries. It represents, for the consideration of the governments, the recommendations for the first stage of the treaty for the solution of the problems between Tijuana and San Diego. Briefly, the agreement, which was proposed and ratified by the government of Mexico for its execution with the government of the United States, is as follows: The system of allocation of residual waters of the city is made up of two large stages. The first stage is one of transition, and the second, the final stage.

The first stage is planned in such a way that the system should function by concentrating all residual waters of the Tijuana River in a pumping station which we call Number 1. The integral plan of the city's allotment takes into account expansion of the reservoir and making the sub-systems feasible. This includes rehabilitation and construction of new collection pipes and their residual water collectors. This will incorporate the zones of the beaches of Tijuana which has caused us international problems.

Basically, the first stage takes into consideration the following works which are:

Number 1: concentration of residual waters from the Tijuana river to Pumping Station Number 1.

Number 2: diversion of these residual waters via a 42" diameter pressure pipe into a conveyance canal. Construction of a system of pumps and waterways in the canyon zones for transfer of the collected waters into the canal. Construction of a pump station and waterways at the Tijuana beaches channeled towards the separating canal. The separating canal would channel the residual waters nine kilometers south of the border for disposal into the ocean and finally the construction of a secondary wastewater treatment plant located 7 miles from the United States border which would treat the wastewater before it is discharged into the ocean.

Another point of this agreement establishes that Mexico will immediately begin the study of and projections for alternatives for the second stage of the integrated wastewater treatment plan and the capability criteria established for the integration of the works will not be exceeded by the collected water's volume.

In short, it is thought that by the year 2000 Tijuana will have a population nearing 1,300,000 which will require two systems of division and treatment. The first will be the western system which will collect the water for up to half a million inhabitants with an approximate flow of 1,100 liters per second. Second, another system which we have labeled the eastern system, will be the supplier for a town with approximately 900,000 inhabitants. The usage of residual waters will be handled by the second stage of the design. I'm going to ask Engineer Camarena to give us a description of these commitments with the United States government.

Alfonso Camarena, Secretariat of Urban Development and Ecology, Mexico City. I would like to thank the Secretary of Ecology for this invitation because without doubt this will allow for greater communication and of course greater results. We are sorry for each country's problems and we have a problem in common. As we know, in Mexico the agency for ecological development is in charge of the environmental ecology and of supporting technology, keeping the various agencies in charge of water for the republic informed on all of these environmental matters. Tijuana, due to its frontier character and its demographic explosion, as well as economic changes such as the maquiladoras which are creating new sources of employment, deserves the attention of the Mexican government.

However, specifically talking about the problem which brings us together, I have heard things that have caught my attention. One of the expressions that caught my attention was that things are worse now than ever, and that possibly it will get worse in the future. And there is the lack of effort on the part of the Mexican government in controlling industry in Tijuana. I am going to try to be brief and very general in order to summarize what the Mexican government has accomplished. But I also want to clarify that we are aware that there is still a lot left to be done, and that never do we assume that we have reached our goal. I am going to allow myself to explain, briefly, how the Tijuana water problem is viewed and how the problem will be resolved. Tijuana, due to its topographic characteristics, all the wastewaters reach Pumping Station No. 1 and from there are sent to the sewage treatment plant in San Antonio de los Buenos. This treatment plant can handle up to 1,100 liters per second from the city of Tijuana and in the process of division will handle 330 liters per second from the canyons and from the Tijuana beaches, reaching a total of a median of 1,430 liters per second. According to our projections, the system will have this capacity up to 1990. From that date forward, we figure that the reservoir system will be divided into two sub-systems. The western one, referred to earlier, and the eastern one which will also include a treatment plant with the capability of handling 1,500 liters per second. This dual system will be sufficient until the year 2000.

We are presently handling 950 liters per second in the western subsystem. However, when the system is divided in 1990, this will diminish to 687 liters per second. And it will gradually increase until the year 2000 as the city grows to its design maximum which is 1,100 liters per second. By the same token, the eastern system will begin its operation with 700 liters per second in 1990 and it will reach 1,500 liters per second in 2000.

As far as what has been done, I can tell you that the plant in the beach zones in Tijuana started operations in February 1986. This is a pumping station which allows us to incorporate all the waters of the coastal region into the treatment plant for the city proper. In June of 1985 Pumping Station No. 1 of the western system began operations. And in 1987 the treatment plant in San Antonio de los Buenos began operations, stopping further construction in October and restarting in February of this year. As we can see, these past three years have been a continuing struggle and in spite of the economic hardships of the country, the struggles have not been lessened in these zones.

What's more, we are considering for this year, in accordance with something John Conway said, plans for the treatment and the storage of water for Tijuana. That is, we are aware that at this time we are at a 40 percent plus deficiency in sewage collection, treatment, and so forth, and we are marking out the main lines of storage, of a reservoir and its collection system, and that it is a problem which must be grappled with. But we must keep in mind that the treatment and reservoir systems are now dealt with until 1990. Here we have an integral plan which takes into account the long term.

We talked about some numbers for this overall changeover regarding the Mexican costs of $140 million (U.S. projection). Later we must discuss the problem of integration as far as the western and eastern systems are concerned. These figures have always caught our attention, especially when we compare them to the solutions that are indicated from the United States. Possibly they are the costs for construction, labor, etc., estimated to diminish costs to Mexico. These figures have been studied by the Inter-American Development Bank. Taking into account the effort which must be made to resolve the problem in Tijuana, an agreement has been reached on all three levels between the federal, state, and municipal governments. We have also achieved new sources of financing based on credit, e.g., the

Inter-American Development Bank which, I am sure you know, has given Mexico a credit of $90 million which will provide the solution for the reservoir and for the distribution system for the drinking water only. And we also have contributions from the federal government for the treatment and disposal plants, for the Tijuana beaches, and for the ocean system. That was to clarify any doubts about the financial aspects.

Generally, from our point of view, we think a great effort has been made. But unfortunately, at this time we can't see the results clearly. Why? Because we don't have sufficient drainage of the main reservoir, which will doubtless prevent the drainage now affecting the canyons and the Tijuana River. Towards this aim, the federal government, through the ecology agency in cooperation with CILA, has established a strategy that allows us to speed up and to give preference to reservoir works. Normally, due to social problems, the establishment of drinking water is given preference. That is, people demand drinking water, but they don't care about sewage treatment. Therefore, the state and the municipality have requested that the program be balanced between the establishment of drinking water and sewage treatment.

And in the second place, a scheme is approved which will allow us to resolve, in the least amount of time, the runoff in the hills and canyons and the Tijuana River. As of this year, $10 million dollars have been allocated which is considered sufficient for the western and eastern collectors which will allow collection without contamination in this area. That is, briefly, what has been accomplished, and I would like to tell you that it is a problem to which the government has been paying particular attention because we wish to respect the existing treaties and because we are aware of the problem and that it must be solved jointly and on a long-term basis.

Carlos de la Parra, El Colegio de la Frontera Norte, Tijuana. Good afternoon. I would also like to thank the Institute for Regional Studies of the Californias for their invitation to participate in this meeting and to take advantage of the academic forum environment which the Institute has created for the study of the situation regarding the sewage in the Tijuana-San Diego zone. Therefore, I would like to adopt the attitude of an observer who without any responsibility for the outcome of the treaty between the two countries decides to evaluate the attitudes of the institutions. I will therefore address myself to the EPA (Environmental Protection Agency), to the U.S. International Boundary and Water Commission, to the Comisión Internacional de Límites y Aguas, south of the border, the Mexican section, and to the executive Mexican agency which is in charge of the urban and ecological development.

The main posture you are hearing from CILA reflects the fulfillment of the agreement of 1983 between both countries. This clearly established the overall requirements for Tijuana which started by capturing all the wastewaters and to channel the flows towards Pumping Station No. 1 to be sent to the ocean via a system of division and treatment. In Article 12, as earlier alluded to by Arturo Herrera, the study of alternatives in the second section pertains to handling the eastern section of Tijuana.

According to Mr. Gunaji, Commissioner to the U.S. section of the International Boundary and Water Commission, the problems are big in Tijuana and for big problems we request big solutions, the very words of Mr. Gunaji this morning. Within these economic conditions of years past in Mexico, SEDUE, the Secretaría de Desarrolo Urbano y Ecología, is asked to provide solutions for one city's problems which grow faster than can be handled by industrialized nations, let alone a country with problems as serious as Mexico's. In spite of this, the agency has completed the first phase of a treatment plant which was clouded by controversy. In the beginning the plant was troubled by sewage problems that were latent, however they were anticipated, and after a period of testing it was decided to close the plant in order to correct the situation. It has been handled and the plant is now working. It is working efficiently, fulfilling the first stages.

However, it seems that the problems of Tijuana, as grave as they are, have not been solved. The attempts by the Mexican government to solve the problems haven't been enough to impress the citizens of San Diego. A plant has been built to collect all the refuse waters from southern Tijuana and this is considered by the people north of the border as a section of Tijuana that is not being taken care of. It seems that the prevailing attitude is, "What good does it do to handle the northern sections if we can't handle the south?" Nor is it taken into account that the plant in San Antonio acts as a secondary treatment plant and that it has solved the problem totally, while the U.S. plant in Point Loma only does advanced primary treatment. That is, it is still in transition. There are big problems, San Diego knows them, in the water treatment plant at Point Loma. It doesn't fulfill all the requirements of the EPA and it is also in transition.

What is being done in the long run in Tijuana? That is the main theme of this conference. What is being done for water recycling in an area in which water shortage is of major importance? Everything so far has been geared to answering these questions. We are going to capture the waters, to treat the waters. What is being done about recycling of the waters? How will such a scarce resource by handled? SEDUE is considering separating Tijuana into two sections, and then to capture the waters from eastern Tijuana in the Alamar River section to further

study recycling of the waters by sending them to Matamoros. This would be a combined effort, as Alyse Jacobson from the California State Coastal Conservancy was saying this morning, together with a decentralized system. However, this decentralized treatment project had some difficulty and the project was transferred and integrated into similar project in Colegio de la Frontera Norte in Tijuana. This alternative was received with open arms and SEDUE offered 9 1/2 hectares for the purpose of studying a better way of water management. All these efforts give the impression of something in gestation, as an integral solution. The problem of collection has been resolved from the point of view of results. The problem is being resolved from the point of view of the infrastructure of the eastern section of the city. In addition, official academic studies are being done, with the federal government's sanction, in order to study up close the decentralized recycling scheme as an alternative with great possibilities.

The only thing left is to ask some questions. First why insist that there is a problem that apparently continues without solution when there doesn't exist any disagreement about the solution between San Diego and Tijuana? Second, why insist about the toxic wastes from Tijuana when the data do not document such, and the lack of evidence from San Diego? Third, what are the resources used by the United States to solve Mexico's problems? Are they solved from the point of view of solving the symptom and not the cause? That is, are we trying to collaborate towards the solution of a problem or trying to impose a solution from only one point of view? From my point of view combining the problem that is taking place in Tijuana and San Diego in the sewage water, would seem the best scheme for finding the solutions.

Jack Conway, Graduate School of Public Health, San Diego State University. This session is on treatment and reclamation on the border and south of the border. Many of you are probably wondering what somebody from the United States is doing talking about problems south of the border. The opportunity to work with colleagues at the Universidad Autónoma de Baja California in Tijuana has given me some insight into border health problems. I am going to take a more global approach in discussing health problems and the resultant risk, and I thought Al Utton's comments about the white map were especially appropriate. It is important that we look at this human health problems without limiting ourselves to either north or south of the border. Also, when the discussion is about potential health risk, the same lack of political or geographic boundaries is essential.

This forum today also presents the opportunity to make a plea for practicing the preventative aspect of public health. Hopefully, future generations will try to solve human health problems before they become major outbreaks, whether acute or communicable diseases. This should be true for citizens in both the United States and Mexico.

One area of focus will deal with acute communicable diseases. Certainly, there is the potential for many problems and one of those deals with waterborne diseases in both drinking water and domestic water systems. Chronic diseases are also a problem and should be considered by health officials on both sides of the border.

Much of this discussion will not be new, but when we talk about disease and health risk, we have to talk about the transmission of disease, and in particular, the routes of entry. The major modes or routes of entry are ingestion, inhalation, and dermal invasion. Obviously, two of them do not apply to water-borne transmission; they are inhalation and dermal invasion. This leaves us with the ingestion of polluted water and the resultant health problems.

It is important to realize that the population most at risk in this case are the children who live along the Tijuana River on both sides of the border. Unfortunately, we do not have good control over these children and what they do with their time. Youngsters are drawn to the ocean, toward the river, and toward lakes. I have been in Tijuana on numerous occasions, and when driving near the concrete flood control channel I have seen a number of children riding bicycles, walking dogs, washing their bicycles, or playing in the flood control channel. Similar situations have been observed on the United States side in the vicinity of Dairy Mart Road. Again, it illustrates that we have very little control over these children from ages six to twelve years old and what they are doing after school or during the summer. They are likely to come into contact with this water in these activities.

Another problem is the adults who have access or come into contact with this water, whether it be on the United States or the Mexican side, in the Tijuana River drainage basin or in the ocean. They cross this river, some illegally, and a few may end up as food handlers working in restaurants in both San Diego and Tijuana. If an individual who is working as a food handler has come into contact with an acute communicable disease pathogen in a polluted source of water, the potential exists for an outbreak of a disease such as hepatitis virus A. There have been hepatitis outbreaks in San Diego. The source of the pathogen may not be from polluted water in the Tijuana River, but the potential does exist.

Obviously, the containment of wastewater is a very important factor in reducing human health risk. Recent estimates state that approximately 50 percent of Tijuana does not have sanitary sewers. Others feel that this

estimate is too high, and one of my colleagues pointed out that just because there is a percentage of the people in Tijuana who do not have access to a sewage system does not mean that all their wastewater goes into the river. Some of those people have what we call on our side of the border on-site sewage disposal systems, better known

Table 1.

Tijuana Conveyance Canal (sewer) Bacteriological Sampling Results (1985-86)

Date	Time	Total Coliforms (No./100ml)	Fecal Coliforms (No./100ml)	Enterococcus (No./ml)
Dec. 6	AM	>2,400	>2,400	-
	PM	>2,400,000	>2,400,000	-
Dec. 26	AM	>2,400	>2,400	-
	PM	>2,400,000	>2,400,000	-
Jan. 14	AM	>2,400,000	>2,400,000	-
	PM	>2,400,000	>2,400,000	-
Feb. 10	AM	1,600	1,600	-
	PM	>2,400,000	>2,400,000	-
Mar. 17	AM	>2,400,000	>2,400,000	7,000
Apr. 9	AM	>2,400,000	>2,400,000	3,000
	PM	>2,400,000	>2,400,000	4,600
May 8	AM	>2,400	>2,400	2,100
	PM	>2,400	>2,400	7,500
May 28	AM	>2,400,000	>2,400,000	19,000
	PM	>2,400,000	>2,400,000	100,000
June 25	AM	>2,400,000	>2,400,000	8,000
	PM	>2,400,000	>2,400,000	51,000
MEAN	AM	1,334,000	1,334,000	7,820
	PM	2,100,000	2,100,000	40,775

as septic tanks. A year ago when I was teaching a class at the Universidad Autónoma de Baja California in Tijuana and was explaining to the class, mostly Mexican physicians, the fact an on-site sewage disposal system includes a septic tank and a disposal field and this contains the wastewater very well. As I completed this explanation, I looked at the faces of the Mexican students and could see that they were amused. They said, "Well that's a very interesting system, but let us tell you how it works in Mexico. First, land is a problem, and most people cannot afford the amount of space necessary to install what would be considered a proper on-site sewage disposal system, that is a septic tank and disposal field. What is, in fact, used for containment of sewage is a reverse well or a cesspool. And depending upon the soil condition, it can work very well." The problem with this system, and it is a problem that may occur with the proposed Alamar River Valley treatment facility, is that if you are injecting wastewater into the ground, you are recharging your aquifers with this water. Thus, depending on the geological formations and how much soil the water goes through, it can or cannot be a health problem. There exists in the Alamar River Basin several wells which are used to provide potable water for a number of the water purveyors in Tijuana. In other words, if you drive in the vicinity of the Alamar River, you will pass several well fields where the water is pumped into tank trucks and delivered to the homes in several of the colonias. The quality of this water could be severely impacted by the Alamar wastewater treatment facility.

Another health problem for youngsters in those particular colonias of Tijuana is intestinal parasites. I had the opportunity to visit a clinic in the Río Alamar vicinity and talk to a nurse and a young medical student from the University of California, San Diego, who is also a student in our School of Public Health. The question is where are those intestinal parasites picked up and the answer is, "Oh, there is no question, the children play in the river and that is where they pick them up. They come from the wastewater discharged to the Río Alamar."

That is not to say we do not have some similar problems on our side of the border. As was brought out clearly earlier, we are dumping advanced primary treated wastewater into the ocean and we have to close Mission Bay from time to time because of breaks in our sewer system. The point I really want to make is we have a major problem in the San Diego-Tijuana area with wastewater and wastewater containment. Because of this, we have a potential risk factor for human health. I am pleased to indicate that I am unaware of any major outbreak or epidemic that can be attributed to wastewater contamination, but we must not let our guard down.

Now, I would like to discuss the results of a survey that was done in December of 1985 through June of 1986 in the Tijuana River drainage basin. There is much discussion about the river, where it starts, and Figure 1 will give you a feel for the magnitude of the Tijuana River drainage basin. The basin is about 70 percent contained in Mexico, although there is a fair amount of the basin also in the United States. The Tecate Creek starts in Mexico and then actually flows across the border into the United States where it joins with the Cottonwood Creek, and the two of them join together to become the Alamar River. This river flows back across the border into Mexico where it joins with Las Palmas River and flows back across the border as the Tijuana River. This is truly an international drainage basin with international water, and you can understand the complexity of the problem in terms of talking of human health risk. The

Table 2.

Tijuana River Bacteriological Sampling Results (1985-86)

Site	Date	Total Coliforms (No./100ml)	FecalColiforms (No./100ml)	Enterococcus (No./ml)
C-1	12a	>2,400,000	>2,400,000	-
	1	>2,400,000	>2,400,000	-
	3	<2	<2	
	4	920,000	540,000	380
	5b	>2,400,000	>2,400,000	490
	6	70,000	2,000	20
	MEAN	1,365,000	1,290,000	233
C-2	12a	>2,400,000	>2,400,000	-
	1	>2,400,000	920,000	-
	3	920,000	49,000	2
	4	540,000	79,000	3.3
	5b	5,000	>2,000	11
	MEAN	1,253,000	6,900,000	5
C-3	12a	140	43	-
	1	>2,400,000	>2,400,000	-
	3	>2,400,000	>2,400,000	34
	4	350,000	49,000	<1
	6	>2,400,000	>2,400,000	240
	MEAN	1,510,000	1,450,000	92
C-4	1	>2,400,000	>2,400,000	-
	3	350,000	33,000	39
	4	40,000	20,000	7.7
	MEAN	930,000	818,000	24
C-5	3	23,000	2,000	4.4
	4	2,000	2,000	0.7
	MEAN	12,500	2,000	2.6
C-5a	1	5,000	2,000	-
	3	13	5	8.3
	4	8,000	2,000	0.9
	MEAN	4,340	1,340	4.6

discharge of wastewater into the drainage basin is truly an international problem. From a health standpoint, this problem needs to be valued by the people living in an area, regardless of whether they are Mexican or United States citizens.

The major source of water in the Tecate Creek is the brewery wastewater. Frequently, when a sample was being collected at site T1, we would find a manhole that was surcharging and it was the start of the river's flow. There is a wastewater treatment plant in Tecate designed to accomplish secondary treatment, but during the time of this study, it was never operated and wastewater from the City of Tecate was flowing directly into the river and contributing to the flow.The Cottonwood Creek is very small and drains from two reservoirs. At certain times of the year, it is almost completely dry. That would also be true for the Alamar River, except in the area just before it joins with the Las Palmas River and makes up the major flow in the Tijuana River. Some of the flow the Tijuana River comes from surface water, and it is considerably more in the spring of the year then it would be in the summer and fall.

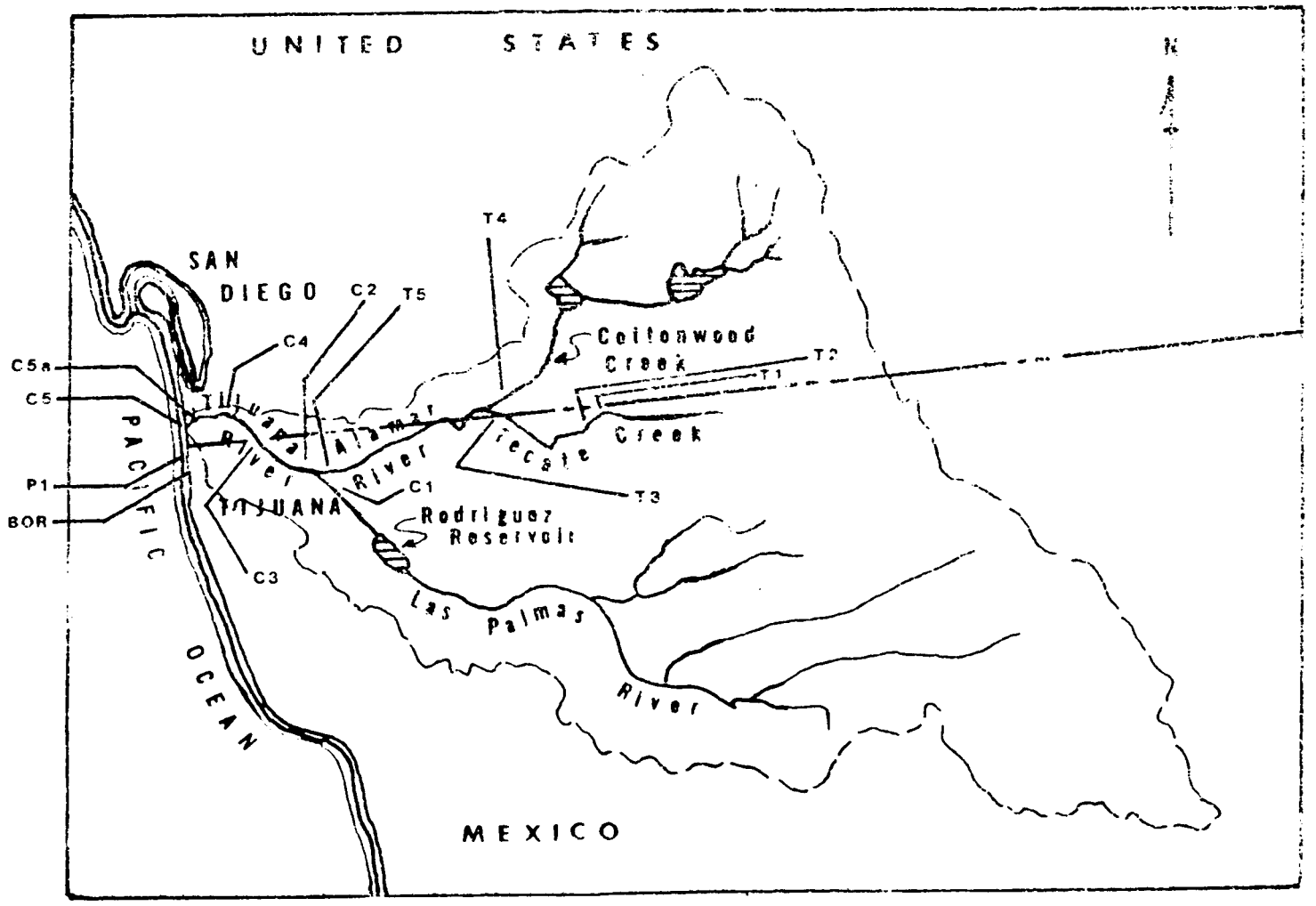
Figure 2 indicates the location of the sampling sites. Several were located on the Tecate River, running from T-1 through T-5. Additional sampling sites were located on the Tijuana River, running from C-1 which was really the Las Palmas River, all the way down to ocean outlet and the last site, C-5. Samples were also collected from the conveyance canal in 1985. This study was funded by the Regional Water Quality Control Board, San Diego Region, and it was accomplished in collaboration with the faculty at the Ciencias Químicas) and the Escuela de Economía at the Universidad Autónoma de Baja California.

Table 1 illustrates some of the sampling results, and it happens to be for the conveyance canal. This is raw sewage which has been lifted by Pumping Station No. 1, up over the hill and is running in the conveyance canal towards the new treatment facility about 4 miles south of the border.

These water samples were taken in the vicinity of La Hoya. Samples were collected in the morning and the afternoon, because we were aware of a difference in the flows in the morning and the afternoon. The number of coliforms in this wastewater was in excess of a million organisms per 100 ml. As a matter of fact, the mean morning value was 1,334,000, and the mean afternoon value was 2,000,000+. It is apparent that this is "raw sewage" and there are a lot of coliforms. These high numbers of coliforms do not necessarily mean that they are all pathogens. But when you find high numbers, in the millions, the chance of pathogens being present is very much increased.

Remember that number of 1,300,000 coliforms in the morning? Now, if we look at the results from the Tijuana River sampling, (Table 2), site C-1 is the Las Palmas River, and the mean number of total coliforms (December 1985 through June 1986) was 1,300,000. This is not much different from the raw sewage in the conveyance canal in the morning. As we go on down river, site C-2 is just below the junction of the Alamar and Las Palmas Rivers, we see the mean coliform level stayed about the same. Site C-3 was then just before the Tijuana River crosses the border into the United States and the mean coliform number is still 1,500,000. On the United States side because of dilution factors, including irrigation in the

Figure 2. Tijuana River Basin and Wastewater Sampling Sites.



valley, the mean coliform level at site C-4 drops to a million. However, before the river flows into the ocean which would be in the Tijuana Estuary, the mean number is down to 12,000 organisms. It should be obvious to everyone that because of the high coliform numbers in the river, there is a high potential health risk to anyone who comes in contact with it. Again, it must be emphasized that youngsters are probably most at risk. It is youngsters on both sides of the border who will benefit from the construction of the Mexican treatment facility which is almost in operation on the coast and the proposed treatment plant on the Río Alamar. Containment of wastewater is one way to reduce the health risk and the results of this sampling program indicate the existence of a problem, and if people are going to use the river in any great extent, I think they are putting themselves somewhat at risk.

A little over a week ago, at the U.S.-Mexico Border Health Association meeting in Chihuahua, Mexico, I had the opportunity to hear a paper titled, "The Prevalence of Intestinal Parasites in the Colonias of Chihuahua City." This reminded me of the situation in the Río Alamar and of the problems in children with intestinal parasites. Certainly, it is known that there are endemic health problems for many populations. As for water-borne disease pathogens in the border area, there are bacterial diseases, but today we do not worry much about cholera and typhoid fever. We are concerned about salmonella which causes intestinal distress and is transmitted by polluted water. We are also concerned about hepatitis and have attempted several times in San Diego to look at the incidence of hepatitis A outbreak in the southern part of the city. I am happy to report that there does not seem to be a problem at this time. The other disease concern is with protozoan parasites that are transmitted by water-borne means. Diseases such as amoebiasis *(Entamoeba histolytica)* and giardiasis *(Giardia lamblia)* are both endemic in San Diego and Tijuana area.

Next, a few comments about helminthic disease problems, especially water-borne nematodes like whipworm, hookworm, or roundworm. Water contaminated with sewage does encourage the possibility that they do exist in human populations on both sides of the border, and if we are not careful to contain our wastewater, there is always a potential for an outbreak.

In spite of the above mentioned potential health risks, we have so far not had a serious problem in San Diego and Tijuana, and I hope this continues to be the case. The point of this discussion is to raise awareness that the potential for health problems is present. We cannot let our guard down and must continue to work for containment of wastewater.

It appears that we definitely do not have a chronic disease problem on either side of the border yet, at least in terms of water-borne transmission. The sampling that we completed in the Tijuana River Basin included analyses of heavy metals and 120 EPA priority pollutants. In general, the results indicate that there is no problem in the Tijuana drainage basin at this time. Most of the trace metal levels are below detectable levels. The exceptions are slightly elevated levels of nickel in the Alamar and Los Palmas Rivers and a slightly elevated on a couple days of zinc and chromium in Tecate. In general, the drainage basin gets a clean bill of health for heavy metals, at least on the basis of the sampling that was carried out.

Again, we must be cautious about this "clean bill of health." Last week I was in Tijuana at the first graduation ceremony of the university's public health students. It had been six months since I was last on Mesa de Otay, and I was amazed by the spread of industrialization of the mesa and by the construction of a new shopping mall. San Diego is growing very fast, but Tijuana is growing more rapidly on Mesa de Otay. It would be worthwhile for someone, maybe faculty and students from the universities, to again monitor water quality in the basin. Maybe this should be done every five years; to look at the heavy metals level and some of the priority pollutants. Particularly, we should monitor the river to detect pollutants that are known to be used in the maquiladora industries.

One other thing came out in previous discussions and that is the magnitude of the health problem. How many people are at risk? In Chihuahua last week, it was brought out that in the border states in the U.S. and Mexico, there is a population of approximately 60 million people. If you include just the border counties in the ten border states, you have 8 million people; 3.5 million Mexicans and 4.5 million in the United States. In the San Diego-Tijuana area, there are more than a million people in Tijuana and somewhere between 1 to 1.5 million people in San Diego. The San Diego-Tijuana vicinity makes up a quarter of the population of the border area and it is doubtful that it will decrease. The area will continue to grow, and reach a critical mass for a disease epidemic. This makes it even more imperative that we take every measure possible to contain wastewater in the region so that no one is at risk, particularly small children.

The academic community is extremely concerned about potential health problems in the border area. Under the auspices of the U.S.-Mexico Border Health Association the universities in these ten states have met three times in the past year and are putting together a team to work on potential health problems. Our focus initially is going to be on maternal and child health problems which will include polluted water. We hope we are close to obtaining money to fund this kind of research. All the border states of Mexico, as well as many Mexican universities along the border, the Universidad Nacional

Autónoma de Mexico in Mexico City, and most of the universities in the border states on the U.S. side (Texas is well represented) are very active in this endeavor.

A final remark is to share with you a memorandum dated June 9th which came from the U.S.-Mexico Border Health Commission. It is a resolution from the people in Texas that reads as follows: "Resolution requests that Congress establish and support a permanent U.S.-Mexico border environmental health commission. Jim Hogg, County Medical Society, requests that Congress establish and support this environmental health commission and a similar resolution be introduced at the AMA House of Delegates." It goes on to say, "A permanent U.S.-Mexico Border Health Commission is being proposed, citing numerous unresolved environmental health problems such as the disproportionate high incidence of many infectious and communicable diseases along the border. This resolution proposes a federally established border environmental health commission to assist in planning, developing, financing and implementing programs designed to address these concerns." I hope this resolution will be supported by the American Medical Association and that it will obtain funding. Today, there is a large group of health professionals living along the border that are anxious to work on environmental problems and certainly water quality is one of those.

Discussion

Question: Alan Sakaris, Sierra Club. My question is for Enrique Manzanilla of EPA. One of the problems that I had noticed in reaching solutions in the international forum is that we make assumptions on this side of the border and counterparts from Mexico make other general assumptions and we sit down together to determine if the assumptions agree or disagree. It would be impossible, however, to come to solutions when the basic assumptions are in disagreement.

You mentioned that EPA is drawing up a facilities plan as part of an international solution, a solution to the border problem. Mike McCann mentioned a rather detailed joint sewage treatment plant and ocean outfall and I am familiar with that concept. Is your vision of the joint facilities approximately the same as that of the Regional Water Quality Control Board? If so, were these ideas reached in consultation with SEDUE or will you be bringing these assumptions to meetings with SEDUE? And, do they agree with you?

Enrique Manzanilla. The focus of the meeting in September is to bring these concepts to SEDUE. I should point out that the concept really is not new. The U.S. section of the IBWC presented such a concept in July of 1987. So in a way, SEDUE and the Mexican section of the IBWC have already been given this proposal. Our strategy document will merely consolidate the long-term strategy with that of the U.S. section of the IBWC.

Alan Sakaris. I guess my recommendation is to let the basic assumptions be flexible going in because you may find that SEDUE has different basic assumptions.

Enrique Manzanilla. Yes, I think we are aware of that and we are trying to be very flexible because I think there very well could be a different set of assumptions which will have to be brought together.

Question: Carl Hanson. I direct the question to Pete MacLaggan. We are speaking about reclamation and reuse of water here, but I have not heard a single word about the economics of this. How much are the different users willing to pay; how much do we pay for imported water in the first place? And also, perhaps you should put it in a broader perspective of California. We pay maybe $150 or $200 per acre foot to import water into San Diego County. The growers out in Coachella Valley, and I just talked to one gentleman from there, are screaming because their price was changed to $7 per acre foot. So what do you propose will be the cost of all this reclamation?

Pete MacLaggan. You bring up a good point, and it will take me a minute here to go through the financial situation concerning water reclamation. To start with, imported water comes into San Diego County at approximately $220 per acre foot. That is wholesale. Thereafter it is sold on a retail basis ranging from $234/acre foot to over $650/acre foot, but it probably averages something on the order of $375. A number of these reclamation projects which are currently on line or proposed, would have difficulty competing with this imported water source in terms of relative financial cost. The cost to produce and distribute reclaimed water generally averages something on the order of $350 to $450/acre foot. Projects above that are generally discounted as infeasible and below that are generally initiated and operated as soon as possible.

We have a number of tools and mechanisms at our disposal to help overcome some of the shortfalls in the costs side of the equation. One is the Metropolitan Water District's Local Project Program. Any project within San Diego County or within Metropolitan service area that develops a new water supply which alleviates demands upon potable water is potentially eligible to receive avoided pumping costs on the state project which are currently $75/acre foot. It is projected to remain at $75/acre foot through 1991 and thereafter it is estimated that it would escalate at 7 percent annually. This cost is tied to the state's surplus energy sales cost. Metropolitan would sign up the project proposer for up to 25 years as long as they have a financial need. And the County Water Authority would be a party to any agreement. We

just got the Fallbrook project on line. They will begin receiving the $75 as soon as Metropolitan's board approves it next month. This is one of the tools that we feel is an absolute necessity to make most of these programs go forward.

The second thing we have at our disposal is the fact that the State Water Resources Control Board and the Department of Water Resource offer low-interest loans for designing the construction of reclamation facilities. These are generally at a rate that is half that of the State General Obligation Bond, which is an interest rate of about 3.9 percent. So if you were to fund your entire project with monies at this rate, that is equivalent to a 30 percent subsidy, according to the State Board.

Lastly, there is the up-front planning--the preliminary engineering, the facilities planning, and the feasibility studies which must take place before any project can go forward. Previously, the project proposer was on its own for these elements and it seemed to be a stumbling block just to get the ball rolling. The County Water Authority recently initiated a program we refer to as our Technical Assistance Program wherein we will become a partner with any project proponent, sharing on a 50-50 basis up to $50,000 the cost of any preliminary engineering studies. We found that this program, although it is only a month old, has attracted a number of project proponents who seem to be moving forward with the real issues.

Question: Chuck Cooper. I am on the Board of Directors of the San Diego County Water Authority so in a sense am one of Peter's thirty-five bosses. One thing that I think Peter did not mention is that particularly now with the actions of the City of San Diego and other communities in ceasing to seek EPA waivers for secondary treatment, most agencies are now going to be required to go to secondary treatment in any case. And what is appropriate in evaluating the cost of reclaimed water is the additional cost of further treatment and distribution over and above the secondary treatment that will otherwise be required. Because very often the full cost of the total treatment is stated as the cost of the reclaimed water and this becomes utterly uncompetitive but it is also incorrect.

Pete MacLaggan. I might mention that the numbers I was quoting for the cost of reclamation do take into account the basic assumption that you are at secondary level and proceeding thereafter with your reclamation program.

Question: Augie Bareño, Department of Transborder Affairs, County of San Diego. I have a question for Mr. McCann. How would your agency propose legislation to limit the development of Otay Mesa? Wouldn't that be in conflict with the City and County's ability to regulate land use?

Mike McCann. We would run this through the state legislature and I am not quite sure how that would pan out. I know we have talked about this. Our agency, being a regulatory agency, is always asked to suggest needed legislation and we would just like that area explored. It is a concern of ours that the flows coming down the Tijuana River have toxic materials in them. Now to what degree we have some idea, but as I understand it Tijuana does not have a pretreatment program of any kind, and if we take on the commitment of treating that wastewater on our side of the border and disposing of it on our side or in our waters, that is a major concern on the part of the public. What can we do to control hazardous materials, toxic waste, and so forth?

Question: Jack Conway. I was interested this morning in hearing the figure of about half a billion dollars mentioned as the price it would cost in the city of Tijuana to include everybody into a system that would transport waste water. It has been mentioned frequently that about half of Tijuana is unsewered and obviously from a public health standpoint that presents a fairly sizable problem. I am curious about the figure. Is that figure an estimate made by American engineers for the people in Tijuana? Or is it made by Mexican engineers? And in view of the growth of Tijuana, and I am going to make some statements about that this afternoon, I wonder if that is a realistic figure?

Enrique Manzanilla. I think I mentioned the $500 million dollars and that would be our estimate of what facilities would be necessary only on our side of the border for collecting, treatment and disposal. The joint international treatment plant and outfall disposal in 1983 in the Lowery report estimated in the neighborhood of $732 million which included a number of extra things, so just as a gross estimate of what the facilities and their size would be on our side of the border for treatment and disposal, we would estimate in the neighborhood of $500 million dollars.

Question. I guess it was Mike McCann who used the term, a permanent solution, when I think of a particular project I look at a certain life-span. And we are looking at this as a 50 year project?

Mike McCann. Yes, I think it would be. The system that is initially built would be for 50 years and this system would be installed with a long deep ocean outfall where you could have some flexibility to plan out for 50 years. This is exactly what is happening with the City of San Diego. They are looking down the road to the year 2040. And we recognize that the need to essentially redesign the

whole system with this flexibility but not all that capacity is going to be built all at one time.

Question. The other factor that we look at is the ratio of your industrial waste relative to domestic waste and in addition someone also mentioned toxic problems. I am sure that the city planners and people projecting these facilities have probably taken that into consideration, but I have not heard anything directly address that aspect. Could you comment on that?

Mike McCann. Well, that is a big unknown and maybe Dr. Conway later on can speak to that. Dr. Conway did a study that we funded in Mexico on industrial waste.

Question: Valerie Gray. I work at the Jet Propulsion Laboratory at California Institute of Technology, and my question was very similar. I had not heard anybody talk about any pilot projects or studies relating to efforts to plan and build into a new system, new experimental devices, and techniques for removing toxics and heavy metals from water. Are there any studies or projects of this type underway at this time?

Peter MacLaggan. I think the question you are asking hopefully will be addressed as part of the upcoming planning work, and eventual design work for any facilities built for the Metro system. How detailed we will get into that it is hard to tell right now. Hopefully, we will look at all existing types of treatments to see what is the most cost effective method. Probably where it will be mostly addressed will be especially in outlying type reclamation projects that will be needed upstream of large facilities. But again, that is going to be addressed in the planning and design phase.

Valerie Gray. When you start a large engineering project, early on you are thinking about requirements so that you build a system to meet future needs. If the system is to last 50 years, it seems that we will probably have to be addressing the toxics issue in a big way, over time. Also, some effort to build in even yet unknown devices and technologies should be looked at.

Peter MacLaggan. Well, if you are talking about specifically toxics, again the City of San Diego has a very good existing pretreatment program and if that continues that is what probably should be investigated. Not as a treatment process for the secondary treatment level but maybe the specific industries that need to have that pretreatment system in place. So if you are talking specifically about toxics, theoretically they are not supposed to get into the sewer system. And also to present an example relating to the New River, SEDUE has been very successful in controlling industries in the Mexicali area. And hopefully this type of effort could be transferred to the Tijuana area as well. The most important aspect of the toxics problem is to control it at the source.

Question: Chuck Cooper. I would like to ask Jack Conway a question. You spoke of frequently seeing Tijuana children playing in the effluent, which does not occur nearly as often among similar age children on the U.S. side. Is it likely that the Tijuana children in effect at a very early age would get most of the diseases from that water and, hence, are not as sensitive as children or young adults on the U.S. side? In other words, are we in more jeopardy on this side of the border if sewage flows increase than they are likely to be on the Tijuana side?

Jack Conway. That is a good question although I do not know how to answer because I really do not have the information. I would guess that immunologically children on the Mexican side of the border probably do build up certain immunities because of exposure. Children on the United States side of the border are not stimulated immunologically, at least by exposure to the particular things that might be in the water. Our children are immunized against various things, certainly not bacterial waterborne diseases by any means, but your point is well taken. I do not have any evidence. Maybe somebody else on the panel might answer that better. My gut reaction is your surmise is correct. That the Mexican children are more exposed, therefore they have certain immunities and our youngsters may not be exposed so they may be more susceptible. But that is conjecture.

Question: Paul Ganster, San Diego State University. Earlier, Arturo Herrero, or perhaps it was Alfonso Camarena, talked about the Mexican agencies SEDUE and CILA taking a population base for Tijuana and running this out to the end of the century as a base for determining demand for sewage treatment capacity. What kind of a base are you starting from in terms of Tijuana's population and what kinds of growth rates are you projecting? I am somewhat puzzled as I have not been able to come to grips with where we start, and at what rate we project. Also, do you project increased per capita water consumption and sewage production because of changing socioeconomic conditions?

Alfonso Camarena. Our projections are based on figures of the Comisión Federal de Electricidad which are very exact in Mexico because each house has a meter. Within the economic program of Mexico, a great deal of importance is being given to the frontier cities due to the economic opportunities arising and because of the maquiladoras. The 1983 growth index was 3.4 percent; however, higher estimates were made for the cities in the survey and specifically Tijuana. Tijuana's growth should be 4.5 percent approximately. Also, the initial design was put at 5.6 percent to reach what was needed.

Question: Richard Davis, Resource Analyst, San Diego. First of all, I have a comment and then a few questions. It seems that as we decide upon policies and implement these policies over a long period of time, it often happens that new solutions come up that we had not counted on originally. So, I have a question for both the IBWC and SEDUE representatives, but I also would like an answer from EPA and anyone else who would like to jump in. The question is: Is your approach flexible and if so, how flexible is it? And when I say your approach, what I am referring to is the approach that you mentioned which contained the concept of two rather large sewage systems. And I am wondering how flexible this is in terms of perhaps an alternative of many, much smaller systems.

Enrique Manzanilla. Well, as you know, first of all I think we have to recognize that this is a dynamic process. I mentioned this morning that our facilities planning process has to be consistent, not only with the City of San Diego, but more importantly, I think, with the needs and the planning process that is now taking place in the city of Tijuana. I think that is first of all one hurdle we have to get over. After that, given that growth will probably continue on both sides of the border, right now it is difficult to speculate what types of needs we will have six or fifteen years from now, given the terrain, given all those different attributes that exist on both sides of the border. When we do embark on this process, we will have the normal environmental review process in place for our components which will of course be subject to public review. Hopefully, before this time we will be kept abreast or we will be keeping abreast of developments in innovative technologies. Nevertheless, at this point in time, the problems exist and we have to come to some type of strategy. We will try to keep that strategy as flexible as possible, but we cannot just hold it open forever.

Question: Cliff Metzner. Could I ask Alfonso Camarena to elaborate a bit on the financial aspects of sewer development and perhaps related water supply. How realistic are these projections for fulfillment? And are the users going to be charged for the sewers and, indeed, are there going to be charges for the water supply to the individual consumers, too?

Alfonso Camarena. As far as the financial aspect is concerned, the evaluations and figures which we were talking about continue to be valid. As I was saying, in this project there exists a type on international credit in which they evaluate and analyze the project in comparison with general costs. In Mexico there is an office that knows what the market is bearing. At this point we can say that the program in Tijuana is now approximately 30 percent completed. And, also, the costs have been observed to be less than projected. This is because the BID makes its loans in dollars and the exchange rates gives us more pesos. Also, internal inflation in Mexico has helped complete more of the project per dollar. The projections are done on an engineering basis, that is, they are projections that do not deal with hiding facts but instead with resolving problems. On the other side, we insist that it be a program that will work until 2000. This is based on population density, area, etc., and the projects are planned with these characteristics.

You mentioned a very important point, especially in Mexico, the charge for services. Historically, in Mexico we have large deficiencies in that aspect, not only in Baja California, but also in most Mexican cities. The charge for services, not only for the reservoir but also for the drinking water system, on occasion does not cover the costs of these services. SEDUE, within its capacity for shoring up and creating agencies, is establishing a system in which we help the agencies. It is a program we call "Institutional Development," a program within the PAHO (Panamerican Health Organization) and in the World Bank. We have programs with the World Bank itself to institutionally develop, administratively as well technically, which will allow the agencies to determine how much to charge. There are times they don't charge because they don't know how much to charge. Then, administrative structures are set; personnel, their charging rates, etc., and what they have to do to charge and how often.

Right now in Mexico we have about 18,000 water agencies, of which 2,000 are in cities of 50,000 to 100,000 people. We are creating a system in which the agencies can be self-sufficient, as much as possible, in operation of the system, the administration, and the preventive aspects and correction of the existing works.

Tijuana is a city where water is very expensive. Because it is transported from Mexicali, it crosses La Rumorosa, and it costs a lot to store, However, the program of new charges is being implemented at the same time that the works are being created. In fact, the system takes into account the devaluation of the peso.

Question: Roberto Sánchez, El Colegio de la Frontera Norte, Tijuana. We appreciate the concern for the health of the inhabitants of this region and we share the concern that the children of the border should have the best possible living conditions. However, I believe we should not forget that the main problem is that Mexico is suffering an economic crisis. We must not forget that it is a critical time to be making investments in the public sector and that greatly limits the country. Perhaps we could come up with an alternative for the permanent solution of this problem which we are all looking for here today. We were talking about looking for other solutions that would be permanent solutions in the long run. This made me think that perhaps it may be necessary to ask

ourselves what would be the logic of having a better cooperative understanding of what is being planned. Among them are investments in San Diego like the defensive system in South Bay. Without losing track of the legitimacy of San Diego's concern with building a defensive system, which will cost $34 million, we must think how that money would yield better results than if we built a defensive system which would send the waters back to Tijuana, or perhaps we should find a permanent solution to the problem. Perhaps it would be interesting to contrast them. The defensive system in South Bay is going to cost $34 million without talking into account the ocean discharge. The construction of a treatment plant in San Antonio de los Buenos in Tijuana cost a lot less.

Then, perhaps, we have something in common to compare, using logic to find permanent solutions to the problem. We must not forget that Mexico is a country with great economic barriers that prevent or limit resolution of these problems. If we all unite and try to find permanent solutions to these problems, perhaps we'll succeed, in spite of our past record.

Jack Conway. I share with Señor Sánchez the concern about the economic situation in Mexico in trying to solve the problem. I have been listening to what has been said and it occurs to me that if we were to build on the United States side a billion and a half dollar treatment facility to handle, treat, and dispose offshore our wastewater, and Mexico, because of their financial situation cannot do anything, then we have built what I would consider one of the world's biggest white elephants. And I would be slightly annoyed as a taxpayer to have to finance that sort of thing. And I guess being somewhat idealistic from the standpoint of being a public health person, containment is the most important thing in terms of protecting the public health and reducing the risk. And that containment has to be achieved without a lot of malfunctions in the systems, that is, breaks in pumps, or breaks in lines. And if you look at the maps that have been on the board today, you know, the people that put the border where they did made a terrible mistake, obviously, because Mexico has to spend a great deal of money if they are going to handle their wastewater on their own, pumping it up over the mesa and downshore. And they have already spent a lot of money on Pumping Station No. 1 and the on the force mains. If we go ahead and build this billion and a half dollar treatment plant, I would hope that somehow the governments of Mexico and the United States could coordinate and Mexico, instead of spending the money to build the Río Alamar treatment plant, could spend that money to improve and build a collection system that would feed into the treatment plant on the United States side. I would see some advantage in that you could feed into a plant on the United States side by gravity, you would not have to install large pumps, which would reduce the chance of malfunction public health risk. This is purely idealistic, but it seems like the two countries ought to work together and determine if it is more prudent for Mexico to spend their money on building a collection system, rather than to build their own treatment system, and if it is more prudent for the U.S. to build the treatment system, the net good in terms of public health I think would be better served than for both countries to build their own systems. I realize that the political boundaries are such and the political realities are such that it will never come to pass, but it sure is a shame. Because from a gravity standpoint, Mexico must pump their sewage uphill where they could gravity feed it into a treatment plant on our side. If somehow we could work out the details of a joint international system it would certainly solve a lot of problems that would go a long way towards containment and protecting public health. That is a personal opinion.

Question: Paul Ganster. If I heard Carlos de la Parra correctly earlier, he made an allusion to data on toxic waste in the Tijuana sewage stream. I have seen a couple of papers recently that examined some of the industries in Tijuana and elsewhere in the border, generally maquiladoras. Inputs were reviewed, various chemicals going into the production, and the final products were analyzed. Something is disappearing someplace. The assumption is that what disappears is going into the wastewater stream. Jack Conway had some data from 1985, looking at various toxics and other things produced by industrial processes. I know that Roberto Sánchez has been looking at the whole problem, and I am just wondering, what kind of data do we have for the specific case of Tijuana? Are toxics in the municipal wastewater stream a problem? What changes have we seen in the last year or two? And is this something we really have to devote a lot of energy to solving right now if it is not yet a problem?

Alfonso Camarena. I don't have a lot of information now but I do know that this is handled as a major problem. Perhaps, the main problem in Tijuana is that it has terrible water, and it has toxic wastes in its wastewater. And I feel that it's a situation that, as Paul Ganster has said, really has no data to reflect this. Perhaps someone else has more information to answer this question.

Question: Richard Davis. The question for Jack Conway is if we are to use reclaimed water to help people enhance agriculture, would there indeed be a value in preventing health problems later on down the line, for instance?

Jack Conway. That is a hard question. Maybe the gentleman from EPA could take on that question because EPA is the one that keeps telling us that the viruses are the big problem in reclaimed water and how we can solve that deadlock. And I do not know how close we are to solving that deadlock in this point of time. But I know that this is the big hangup and I know that there is

reclaimed water being used in some parts of the country and how they get around the proof that there are no viruses and therefore reduced health risk. I cannot answer your question.

Question: Valerie Gray. I have several images of past history in the United States flowing through my mind, and I am reminded of the difficulty faced in financing large public work types of projects. Often I have thought, for example, we would get a Metro system built in Los Angeles only if we had another Depression, because in depressions, people need jobs and the government steps in to do something about it. Solutions to these problems are expensive, complicated by the fact that economics are different on each side of the border and there are different requirements in each context. We need to lay out all of the differences in our requirements on each side of the border and "engineer" this as a problem. I think there is real value in doing a good up-front job of saying what is required. What do we require in the U.S. out of this project, and what does Mexico require? Then, we should try to solve as many of the requirements by the design of the system.

Question: Cliff Metzner. I have a question for Sr. Camarena. What is the policy today of SEDUE in regard to reclamation, not only in this area but in all areas where you might be building new treatment plants and new sewage disposal systems? Also, what is the policy from the standpoint of reclamation, whether it be decentralized plants or centralized plants? Four or five years ago SEDUE's policy, as I remember it, at least in this area, was to take advantage of the topography and channel wastewater south into the Rosarito area, and even south of that for crop irrigation and for watering of parks. When SEDUE first planned the Río Alamar plant, they indicated that in ten years they might move ahead with a pumping system and wastewater reuse project in the area east of Tijuana for irrigation, and again for parks, and so forth. I was just wondering, what is the current reclamation policy for SEDUE?

Alfonso Camarena. You asked me three questions, one about decentralization, another about usage, another about the plans made earlier. Regarding usage, we consider that the first problem is to build the treatment plant. But we must be careful that it is managed correctly so that the municipalities and states, apart from the benefit to health, must build plants that offer other benefits beside these, so that the plants are maintained in the way required by the systems. We also have treatment plants and, unfortunately, they are not now being used properly in other parts of the Republic. Studies have been done and we have seen the causes and the main one is that the plants are not used and are forgotten.

Thinking economically, in addition to the benefits to health and welfare, and especially because right now in Mexico everything is discussed on economic terms, the plans are to use the water indefinitely. This is especially important in Tijuana, considering the droughts of the 1970s. Right now we have it planned in stages; the first is to build the plant and the second is to operate it correctly. And the third, of course, is to build the necessary infrastructure for the reuse of wastewater. As far as the plant in San Antonio de los Buenos is concerned, that is, the western system which is already in operation, several alternatives have been put into effect. One, from recharging the aquifers in the south, which are approximately 80 kilometers away, however, from our point of view, there would be little pumping needed to get the water there. It has also been considered, due to tourist traffic, to turn that area into an ecological zone with trees. It has even been suggested to transfer water to Rosarito's thermoelectric generators plant and in return get power for our water.

This last idea needs some discussion because the metric cost per second is very little for the Comisión Federal de Electricidad. However, those plans are still feasible. But I must remind you of the stages which are construction, operation, and the infrastructure for the usage of that water. Regarding the Alamar region, the problem has certain characteristics. The plant must be placed within the region it is going to serve, that it must be placed at a certain distance so that gravity can be used. Other wastewater will arrive through pumps. As we can see, the eastern plant would have to be near the reservoir. If we leave the eastern area, then we are leaving the area which is the growing section of the city. On the other hand, the further I get the more pumping I would need, that is, the higher the cost. But, I would have the advantage that by moving away I would have greater reuse of the water for irrigation, and so forth as planned. Because in Tijuana the further I move away east and south the more agricultural usage I'll have for those waters. In fact, studies were done to find out if we could build trenches that would allow us to store and save the water while it is not being used. But the turning point in the decision for the placement of the plant was the operational economic study that reached a conclusion which is very important. If the treatment facilities are too far from the collection system, the costs would increase because of the need to pump sewage a great distance.

The sewage waters are more aggressive than treated waters, which makes their pumping more difficult than for treated water. Therefore, an agreement was reached to use treated water in the industrial sections of the city. As far as Tijuana industry is concerned, a study was done with the intent of giving them treated waters and it was found that the majority of industries in operation now in Tijuana, and the ones seeking operating permits, are those industries that hardly use water in their daily operations. That is why we have little contamination from industry. And the ecological agency is being careful of which industries it issues permits to in this zone. These then are

the plans for the southern section. They are still valid and we are still running the plant. The criteria are still in effect, and also the economic aspect of the treated waters of benefit to the systems.

Cliff Metzner. Thank you so much. Are there any more questions? I think that wraps up the sessions for today. I think the window that we were discussing earlier today is closing, and we have a definite timeframe for both countries to establish what are their priorities in sewage treatment disposal and reclamation, before the plans and designs are set in the concrete. So I think that this has been extremely helpful to all of us today. What we propose to do here at the Institute for Regional Studies of the Californias is to continue on with a series of seminars or smaller workshops, where we will take each individual problem and/or issue that we have covered on a broad range today and gather together maybe 10 or 15 experts from both sides of the border and try to develop recommendations for solutions that can be fed into the overall decision process over the next couple of years. And it looks like two years, is perhaps the timeframe we have.

Session III. Tijuana Estuarine Reserve
Clifton G. Metzner, Jr., Moderator

Cliff Metzner. Now we will have a presentation by Dr. Joy Zedler, of San Diego State University, on the Tijuana River Estuary Reserve.

Joy Zedler. Today, I will address the topic, "Solving Problems That Affect the Tijuana Estuary." There are several reasons why there is concern for water that flows into Tijuana Estuary. This talk is a transition from the session about activities north of the border to one on activities south of the border because it is the Tijuana River that connects us. The watershed of Tijuana River is 75 percent south of the border and we are integrally connected with Mexico by the Tijuana River. It is a hydrologic connection.

I am an ecologist and I have worked on the Tijuana Estuary for about 15 years now, and several agencies have supported our research. They include the California Seagrant College Program, the California State Coastal Conservancy, the State Resources Agency, and our National Oceanic and Atmospheric Administration's Marine and Estuarine Management Division. Tijuana Estuary is a National Estuarine Research Reserve, one of about 15 in the nation. Other funding sources over the years have included our California Transportation Department (CALTRANS) and the California Department of Parks and Recreation. We have a book about Tijuana Estuary, *The Ecology of Tijuana Estuary, California: An Estuarine Profile*, which is available at no charge.

I want to talk about the estuary as an ecosystem and tell you that conservation of these ecosystems in the United States is very critical. We need to manage these systems very carefully in order to maintain their natural resources and to maintain regional biodiversity. That is to say, to maintain the species that occur in this region naturally. And the best model that we have of what these ecosystems ought to be like comes from Baja California, and from estuaries such as Estero de Punta Banda near Ensenada. Even in Mexico, however, the estuarine systems are threatened with development and alterations.

The natural resources of our estuaries include several rare and endangered species, and many kind of habitats. Along the coastal strand and dunes are habitats that California Least Terns use for their nesting. The terns also feed in the channels of the estuary. There are areas of salt grass near the dunes that are the sole food for the larvae of a rare butterfly, the Wandering Skipper. In the upper salt marsh, we have habitats that harbor the Salt Marsh Bird's Beak; this is an endangered plant. The mid-intertidal salt marsh has Pickleweed habitat that provides nesting areas for an endangered bird known as Belding's Savannah Sparrow. In some of our intertidal area, the lower marsh has Cordgrass that supports the Light-footed Clapper Rail, an endangered bird that nests in this habitat.

The hydrologic conditions of the estuary are what determine each of these habitat types. The characteristics of the habitat and the species they support are directly dependent on hydrology. The two main hydrologic factors are the salinity and the degree of inundation, that is, the water level that reaches each site.

We have special problems with estuarine management in the southwestern United States because we have very few remnants of this native ecosystem in this part of the country. There are some tiny remnants of wetland in Long Beach, but very, very few. Of those that remain, almost all are heavily disturbed. Often their tidal connections with the ocean have been severely modified.

The most basic modification of these estuaries is hydrologic. Either the tidal flows are constricted so that an area does not receive this natural tidal or oceanic influence, or the streamflows are modified by dams upstream or by sometimes increased flows due to discharges from reservoirs. There are also potential discharges from wastewater treatment, sewage spills, agricultural runoff, storm runoff, and irrigation runoff from urban areas.

Because disturbance is so extensive north of the border, the remaining wetlands require special care so that their values are not damaged. You cannot do large scale experiments with these disturbed remnant ecosystems, so we have sought to do smaller scale experiments under controlled conditions in order to understand these systems better. It is difficult, though, to find out "what makes an estuary tick." There is high spatial and temporal variability. Aerial photos of the mouth of Tijuana Estuary show both the spatial and temporal heterogeneity. There are many habitats in Tijuana Estuary and they are changing. High sea levels from the ocean side wash over the dunes and move the sand into the channels and change the topography of the estuary almost on a yearly basis. In addition, sea level is rising, and storms are more prone to wash over these sandy dunes than they used to be. As the estuary receives more sand from the dunes side and more sediments from the watershed side, the estuary fills with sediment and becomes more susceptible to closure of its mouth. That is, sand builds up and the inlet, the connection with the ocean, becomes more susceptible to closure.

With only disturbed and highly variable remnants of ecosystems to study, it is very difficult to characterize their structure and their function and to identify cause-effect relationships. When someone asks me, "What do the toxics do in this estuary?", it is a very difficult question to answer because there is so little left to study, and it is so variable and disturbed that the effects of toxic substances are hard to separate from other impacts.

Our research program at San Diego State University has focused on understanding functioning of estuarine ecosystems, trying to understand the effects of disturbance, and working out recommendations for restoring habitats so that we can maintain the biodiversity of this region. Because of large scale changes to our coastal wetland resources, there have been several efforts to restore degraded wetland habitat. At Tijuana Estuary there is now a major restoration plan to recreate the tidal flow regime that was present in 1852. Restoration of these systems is fraught with problems, since we do not know exactly what the estuary was like in 1852 and we would not know how to recreate it even if we could describe it exactly. Constructing the topography is not really enough. You have to introduce the right species to the areas; you have to keep out the wrong species; and you have to help the ecosystem develop the functions--the natural functions--that would have taken centuries to develop.

To date, few restoration activities have been scientific. They have been trial and error approaches. As a result, there have not been all that many successes. Because the resources are scarce and highly valued, we suggest an ecosystem-based, scientifically sound approach to wetland management and restoration. I have called this "ecotechnology," which means the careful, scientific manipulation of ecosystems to achieve desired ends. It has a parallel in "biotechnology" which is the engineering of genetic material.

An ecotechnological approach to marsh restoration at Tijuana Estuary involves several different things. It involves a long-term sampling program. For the salt marsh habitat, we have a nine-year data base, beginning in 1979, that helps us to know how this vegetation changes through time. It is not at all stable; the vegetation responds to changes in hydrology. The Cordgrass that supports the Light-footed Clapper Rail had peak growth in 1983 when we had record discharges from Rodriguez Dam. There is a definite hydrologic link between Mexico and Tijuana Estuary carried by the Tijuana River. I am not going to say that this is bad or good, but it is an effect. So, long-term systematic sampling is extremely important to understanding how altered hydrology effects Tijuana Estuary.

The second part of our ecotechnological approach is experimentation. We have a field and outdoor laboratory at Tijuana Estuary called the Pacific Estuarine Research Lab. One of our experiments includes replicate marshes in miniature where we can alter the salinity, alter the water level, and measure plant response to establish the cause-effect relationship.

The third part of our ecotechnological approach is predictive modeling and simulation. This allows computerized experiments to predict the effect of new conditions on Tijuana Estuary and other regional system.

The approach that we have applied--the long-term monitoring, the experimentation, and the simulation work--has led to many recommendations for improving restoration. Our research certainly shows that salinity and inundation are extremely important controls on Tijuana Estuary. The same ecotechnological approach is appropriate for related projects upstream of the Tijuana Estuary.

We have also been experimenting with artificial wetlands at our Pacific Estuarine Research Laboratory. With funds from the Coastal Conservancy and the State Resources Agency, we have been able to create habitat for native species. We have excavated areas of abandoned fields and lined them with plastic to create the conditions necessary to hold water. Some of the soil is put back to build a wetland with a soft substrate where plants can grow. We add water, watch the vegetation encroach (some of it with planting, some of it on its own), and then watch the wildlife come to inhabit these areas. These artificial wetlands are not replacements for natural ecosystems, but they are areas where native species can have additional habitat. We have three nesting species of birds in these ponds, even though the habitats are only a year old.

I believe that artificial wetlands can help reduce the impacts of disturbances related to many of the problems we have talked about previously--problems such as renegade sewage flows, problems with agricultural runoff, problems of storm runoff, problems with street drains conveying irrigation runoff into the estuary, problems with reservoir discharge, and problems associated with the new sewage facilities (that is, the construction of the Big Pipe which will require excavation and dewatering of the site with an excess flow of water that will be pumped out of the excavation hole). Creating the pump station will also require dewatering of the local site and a discharge of water from the dewatering location.

We have suggested constructing artificial wetlands to reduce the impacts of many of these unnatural flows. Keep in mind that for the Tijuana Estuary, changes in

salinity and inundation are both problems that are caused by abnormal hydrology. The Tijuana Estuary is a site that normally would have freshwater inflows only in winter. It is an estuary downstream of an intermittent river. All of the modifications that we have talked about this morning would change that system from an intermittent river to a permanently flowing river. Even the dewatering effluent can have a negative effect on Tijuana Estuary because the fishes and invertebrates are very sensitive to reduced salinity. Twenty million gallon renegade sewage flows are too much for the Tijuana Estuary. The invertebrate community and the fish community have both suffered declines from continuous river flows due to sewage and other runoff.

What we have suggested is the use of artificial wetlands to collect some of these flows of water. Some of the water, of course, would be evaporated by vegetation; however, one could impound the water and then discharge it on the outgoing high tides so that its contact with the native estuary is minimized in time and in area. It is a "timed-release concept" that would reduce the impacts of dry season freshwater flows. While we have not yet designed wetlands for this function, we have identified the problem and recommended consideration of the concept.

As is true for all ecosystem management, a sound scientific basis is very desirable. For a region with very high, spatial and temporal variability, we have found that the long-term data sets are crucial to understanding native ecosystems and developing recommendations that can help maintain the regional natural biodiversity.

Paul Jorgensen, Manager, Tijuana River National Estuarine Reserve, California Department of Parks and Recreation. It is really ironic when you consider that in the entire southwestern United States, the very southwestern part from say Santa Barbara south on the coast of the U.S., the Tijuana estuary is the best one remaining. So we have not done such a great job taking care of our own resources. We are also at the very end of the water pipeline and at the end of the Tijuana River. The National Estuarine Reserve established the estuary to preserve it for education, research, and as an example of the best preserved estuary left in this biophysical region. It was established in 1982. I have been the manager ever since. We have a management authority that involves unprecedented cooperation of eight different agencies and municipal governments, five of which are here today. So, the area is identified by the United States as a very important area. It is beset with major problems. It offers a unique opportunity to carry out international cooperation which we have not consummated yet. We have not been able to do this or we have not done a very good job yet in taking advantage of our international situation. Of the 17 national estuaries, we are the only one that has the international aspect to it. We need to cooperate internationally more in research, education, and perhaps environmental politics. We want very much to have a Mexican representative on our management authority. Our founding document includes the provision that we should have one, but for various reasons we have neither a voting member nor a Mexican official attending. We are trying to rectify that right now.

So, we are very concerned about the impacts of the river, but they are complicated by the other problems; that is, trying to figure out what the effects on the river are because of the sediments, turbidity, other pollutants, which are very difficult to determine. Early toxic studies were not impressive and did not show many problems, but as Jack Conway pointed out, new industrialization in Tijuana may have caused new problems. Also there was a great deal of industrialization previously, mainly military bases on the site, which may have caused toxic problems which still exist.

We are about a month away from getting results from the first comprehensive toxic study in the estuary of animal tissue and soil samples. We are very anxious to receive those. We collected birds and vertebrates, just about all forms of animals, and they were sent off to a laboratory two months ago, so we should have those results in about a month. Those samples are very expensive and have never been done here before. And even when we get the results, we will have to try to determine the origin of the toxic, whether it came from on-site uses or through the river. So it will not close the page on that chapter. We have noted declines in fish populations, endangered birds, clams, shrimp, and crabs. The populations have fluctuated but the trend in the last 8 years has been downward for all major categories of animals in the estuary. Also, because of our location, the aesthetic problem of having currently about 6.8 million gallons of raw sewage per day running through the estuary, where we are trying to conduct education, causes a lot of problems which you might imagine. We are very interested in following all the plans for treatment facilities and to ensure the environment benefits of those facilities and that they carry out the function for which they were intended. So, we will continue following the progress, as we have done for the last five years, of attempts to develop facilities. This is my first chance to be at a forum where the problems are truly looked at internationally, and I think that this is a good indication for the future. Thank you.

Discussion

Question: Richard Davis, Environmental Analyst, San Diego. Many people here today spoke about economics and the cost, and the different abilities of the different countries to bear these costs. But I have not heard any real mention of economics in terms of value. And there are two values that immediately come to mind. First

would be the public trust value in the Tijuana River Estuary, and I was hoping that Paul Jorgensen, maybe, could say a little bit about this. And the second value is if we are to reclaim vast amounts of water, then this water certainly has a value for instance in growing crops or fruit trees. And in turn these fruit trees, perhaps particularly on the Mexican side of the border, could perhaps feed a lot of children, for instance, who might otherwise be malnourished. And so, the value here may not just be the value of being able to grow crops, but also being able to prevent health problems which might develop on down the line with, say children, who have been malnourished, for instance, during their formative years. So, first I guess I would turn to Paul Jorgensen and ask if you could say something about the public trust value of the Estuary and then I will turn to Jack.

Paul Jorgensen. Well, there have been several millions of dollars spent in purchasing land, operations and now we are building a million-dollar visitor center at the north end of the estuary for our education, research, and administrative use. And I tried to allude to the value of the estuary when I said that it is the best one or example left of a coastal wetlands, south of Santa Barbara. I think that shows its value. Also, it is pressed on both sides by huge urban centers. So the reserve is 2,500 acres of open space. It has many values for recreation, passive recreation and active, and research education. And I certainly think Congress, the State of California, the various cities, and other cooperating agencies have recognized the value of it and that is why we are here, trying to help solve one of the biggest problems.

Question: Richard Davis. Can you think of a way in which the value of this tremendous resource can somehow be figured into the economic equation as we talk about the cost of dealing with the sewage?

Paul Jorgensen. You mean like $5 a bird or something?

Question: Richard Davis. Well, I do not know. It is kind of an open question. I think it needs to be figured into the economics, but I am just curious if you might have some insight into how this could be done.

Paul Jorgensen. No, I don't.

Question: Chuck Cooper. We have heard quite a bit this afternoon about toxics, about bacteria, about viruses. We have also heard about the Tijuana Estuary Reserve and its value, but I think what has not had enough emphasis, although Joy Zedler alluded to it this morning, is the importance of water flow as such in the estuary, as completely divorced from quality. In other words, flow of water regardless of the quality. Because one thing that makes the Tijuana River Estuary unique and quite different from estuaries in the eastern United States where much of the work and pressure for preservation of wetlands and estuaries has been done, different even from those in the northwest, is the fact that this and other Southern California estuaries developed at the mouth of intermittent streams, streams that flowed during the winter and spring months only, and essentially dried to a trickle during the summers and the fall. This was true according to records of the International Boundary and Water Commission which go back a long way even before construction of Rodríguez Reservoir, or Barrett Dam and Morena Reservoirs which now almost totally control the flow of the rivers even in winter, except in abnormal years. But even before those entrapping reservoirs were built, the river in almost every year dried up totally at its mouth. And this has strongly affected the nature of the organisms, the plants, the animals, the fish, the invertebrates that inhabit the area. About a year and a half ago, Joy Zedler and her associates finished an analysis of past flows in the river and the impact of increased year round flows on the ecology of the Tijuana Estuary. This report, which was published by the San Diego Association of Governments, predicted that when the flow rate reached 12 1/2 million gallons/day during the summer season, that there would be significant changes in the ecology of the estuary. The accuracy that she specified as to what some of those changes would be is incredible. The accuracy of that prediction, which was based simply on knowledge of processes not on past observations, was almost eerie. Because this last year, at the time when renegade flows in the river reached 12 million gallons/day, at that point distinct changes in salinity were noted in the estuary and as a consequence there have been very great changes in the invertebrate and fish populations. They have virtually lost the invertebrates. The plants love it, as a matter of fact. The plants are doing great, but one of the key features on which the animal life depends has been, temporarily at least, virtually lost. The point and the strong argument is that this is not due to adverse water quality, but to water quantity. And so the point I am trying to make here with this rather long statement, is the fact that simply treating sewage and discharging it into the Tijuana River will not solve the major problem of the estuary itself. And a decision, I think, must be made: Does the value of that estuary deserve preservation or is it another one of our innumerable Southern California sacrifice areas that should go the way of others in order to solve the sewage problem in the cheapest and most efficient way?

Session IV: Wastewater Treatment and reclamation Activities in the New River: New River/Imperial Valley-Mexicali Valley Region

Chuck Cooper, Moderator

Phil Gruenberg, Environmental Specialist IV, California Regional Water Quality Control Board, Colorado River Basin Region. This morning I am going to discuss the New River, which is one of California's most severe and longstanding water pollution problems. The New River is an international waterway which rises in Mexico, crosses the international boundary at Calexico, California, and flows northward some 60 miles to Salton Sea, which is one of Southern California's most popular recreation areas. Although I have been employed with the Regional Board for 13 years, I was acutely aware of the pollution problem in the New River long before my employment with the Board, having resided for many years in Calexico.

Historically, the New River channel is believed to have been formed about 1840, when flooding of the Colorado River temporarily caused the river to flow into the Salton Sea Basin instead of into the Gulf of California, its normal terminus. The Salton Sea Basin is located below sea level and is separated from the Gulf of California by a naturally occurring earthen barrier extending about 35 feet above sea level.

Following the flooding in the 1840s, the next major event affecting the course of the lower Colorado River flow occurred in 1904-1905 when the Colorado River again flowed through the New River channel into the Salton Sea Basin instead of the Gulf of California. At that time, headworks designed to divert Colorado River water for irrigation in Imperial Valley, California, were washed out during a period of above normal flow by flooding of the Gila River, a tributary of the Colorado River. It was not until 1907 that the broken headworks were repaired. Since that time the flow in the New River channel has been perennial, being sustained principally by irrigation return flows from the Mexicali and Imperial Valleys.

Initial records referring to polluted conditions in the New River date back to the 1940s, when complaints, primarily concerning the stench emanating from the Mexican flow of the river at the international boundary, were raised. In those days practically the entire flow of the river at the boundary was comprised of raw sewage, which was often described as appearing black and septic.

The California Regional Water Quality Control Boards came into existence in 1950 by action of the State Legislature and immediately one of the principal concerns of the Regional Board was the pollution (in those days principally sewage) in the New River crossing the international boundary from Mexicali (a town of about 30,000 in population). During the ensuing decades, the Regional Board made many representations, principally to the United States Commissioner of the International Boundary and Water Commission, to obtain abatement of this source of pollution.

In 1962, the Regional Board recognized the following problems in New River at the international boundary as caused by Mexicali's discharge of raw sewage and brewery wastes:

1. Coliform bacterial counts ranging to 100 million MPN/100 which was 100,000 times over the Imperial County body contact recreation standard;

2. Information from the Imperial County health officer of recorded cases of typhoid fever contracted by children playing in the New River water;

3. A threat to the health and safety of out-of-valley sportsmen who come to hunt in the vicinity of New River and are not aware that the river water is contaminated;

4. Limitation on the quality and quantity of sports fishery which could be developed in the river;

5. The presence of plainly visible sewage solids in an open stream flowing through an urban community in California; and finally

6. The creation of other general unsanitary conditions.

The above concerns were included in a legislative bill titled "Assembly Joint Resolution No. 27," memorializing Congress of critically needed emergency relief from Mexicali's pollution discharges. The bill passed the Assembly but was defeated in the Senate. We understand this was because the senator from Calexico stated concerns about possibly losing retail sales from Mexicali residents who, during those days, purchased heavily in Calexico stores.

Prior to 1966, Mexicali was not the only source of untreated sewage for the river, as several Imperial Valley communities had not yet constructed sewage treatment facilities. However, by January 1967, all of the urban centers in the Imperial Valley had sewage treatment plants in operation.

In 1968 the Regional Board forwarded complaints to the United States Commissioner of the International Boundary and Water Commission concerning conditions in New River at the international boundary including the following:

1. Presence of foam;

2. Routine discharge of wastes by Mexican septic tank pumpers right at the border; and

3. Continued discharge of untreated sewage.

In 1976 the Regional Board began routine water quality monitoring of the New River at the international boundary in order to document its allegations of raw sewage, industrial wastes, garbage, and trash discharges from Mexicali. During the initial monitoring, flows in the river were only about 1/3 of the present flow at the boundary; fecal coliform bacteria levels were measured to 240,000,000 MPN/100 MLS; dissolved oxygen concentration was often zero, and biochemical oxygen demand and chemical oxygen demand were measured to 960 and 1,204 MG/L, respectively. In addition to the analytical documentation of the problem, regional board staff recorded their visual observations as summarized from 1976 to 1978 include the following:

1. Abrupt, temporary change in the color of the river to white/gray, red/brown, yellow, or black on 58 occasions;

2. Dead fish observed on 34 occasions;

3. Black, gray, or yellow globules of greasy material observed on 29 occasions;

4. Surface oil observed on 27 occasions;

5. Dead animals (mostly dogs and cats) observed on 19 occasions;

6. Tar-like material observed on six occasions; and

7. Sewage solids and floating debris observed almost routinely; tires and vegetable refuse.

It should be noted that these observations were collected only during the short and infrequent sampling periods. Other monitoring by the Regional Board staff has documented some of the impacts of Mexicali's wastes on the downstream reach of the river. Generally, oxygen concentration in the river continue to decline downstream of the boundary for about 15 miles of river flow. Although from that point there is usually a gradual increase in oxygen, the oxygen concentration of the river remains depressed, at least at times, all the way to the Salton Sea, which is 60 miles of flow from the boundary.

During the past five years the river's water quality at the boundary has fluctuated considerably, but overall there has been some improvement over historic conditions. For example, fecal coliform levels have generally declined from the millions to the hundreds of thousands of MPN/100 MGS, and dissolved oxygen levels have increased such that anaerobic conditions are less frequent. I attribute this improvement to two things:

1. Temporary increased flow deliveries to Mexico via the Colorado River resulting in about triple the normal flow in New River at the boundary and thus causing dilution of pollutants; and

2. Improvements to Mexicali's sewage collection and treatment facilities.

Despite these improvements, gross contamination of the river continues. Practically all of the historical problems mentioned previously continue to occur to some extent, and some new problems have been identified. There remains a severe public health hazard, and the river represents a totally unfit habitat for desirable aquatic life for at least half of its flow path in California. Also, in 1983, the Regional Board began testing the river for volatile organic toxics. Since then, almost 100 different toxics have been reported as being periodically present in the river. Most of the toxics detected are solvents and include hexane, chloroform, benzene, toluene, xylene, TXA, TCE, and DCE. Additionally, various pesticides and PCBs have been detected periodically in both the river water and aquatic animal tissue.

As for the future, unless Mexico continues to upgrade its sewage collection and treatment system, and address the many other sources of pollution to the river, including industrial, animal, solid, and geothermal wastes, it is likely that water quality conditions in New River will deteriorate. I base this presumption on two factors:

1. The Colorado River flows will predictably normalize, and Mexico will then not routinely receive water in excess of its legal entitlement, thus resulting in less flow into the New River, causing less dilution of pollutants; and

2. Mexicali's population has grown dramatically, from approximately 20,000 inhabitants in 1940 to 175,000 in 1960, and close to a million at present; population growth is expected to continue, and along with it the increased production of wastes.

Finally, I want to briefly summarize the goals and water quality objectives for the New River. Because this river is comprised largely of agricultural drainage water, and because its chief purpose is to convey this drainage water to the Salton Sea in support of agriculture, it is unlikely from a realistic standpoint that this river will ever be pristine enough to support body contact recreation such as swimming or municipal use, even without Mexicali's discharges. However, there are certain basic minimal objectives which are necessary for the protection of public health and welfare, for wildlife, and for other beneficial uses of the river water as follows:

Public Health. The river must be reasonably free of pathogens, such that public health is not threatened from foam blowing from the river, from pets coming in contact with the river water, and from incidental human contact.

Aesthetics. The river must be visually free of sewage solids, oil and grease, debris, foam, scum, vegetable and slaughterhouse refuse, dead animals, abnormal changes in color, and other offensive conditions.

Odors. The river should not be a source of offensive odor.

Wildlife. The river should support desirable aquatic life. This precludes the discharge of toxic substances to the river and necessitates a minimum dissolved oxygen content of 5 MG/L.

Salton Sea. The river should support the important recreational and wildlife uses of Salton Sea. This precludes the discharge of toxic chemicals, and untreated industrial and domestic wastes. More specific water quality objectives are contained in the Regional Board's Water Quality Control Plan, and in Minute No. 264 to the 1944 treaty between the United States and Mexico.

Although to this point my discussion has left little to be optimistic about, some recent progress has occurred of a very positive nature. This progress towards resolving the New River problem has, in my opinion, been accomplished largely due to the attitude and dedication demonstrated during the past three years by the Yuma and Mexicali Regional Offices of the U.S. and Mexican sections of the International Boundary and Water Commission. Their efforts have been instrumental in the successful implementation of a joint U.S.-Mexican $1.2 million project to correct some of the most severe problems associated with Mexicali's sewage treatment system. This joint effort between the United States and Mexico hopefully represents an initial step that will lead to future cooperative efforts between Mexico and the United States to resolve the entire problem.

James Giannopoulos, Supervising Engineer, State Water Resources Control Board, Sacramento. I am Phil Gruenberg's Sacramento counterpart on the subject of the New River. In my brief presentation this morning, I will summarize alternatives which have been considered to abate New River pollution which Mr. Gruenberg described, I will describe our current recommendations and, finally, I will offer my own perspective on this subject. What I will describe are alternatives for implementation on the northern side of the boundary, assuming, unfairly perhaps, that the quality of the New River as it crosses the boundary will remain relatively unchanged for the next ten to fifteen years. Over twenty pollution abatement alternatives were evaluated in three separate engineering studies over the past five years. I will now present seven of these alternatives in ascending order of cost.

Alternative 1 would simply convey the New River in a four meter diameter pipe from the international boundary to beyond the All American Canal. This "big pipe" alternative would eliminate the possibility of public physical contact with the New River through Calexico for public health protection. Obviously, this alternative achieves no water quality improvement. The cost using recent estimates from the San Diego-Tijuana "big pipe" project, is estimated at 10 to 15 million dollars. Operating costs would be very minor as pumping would not be necessary.

Alternative 2 would divert the entire river flow through bar screens just north of the boundary. The specific design considered includes a diversion structure for flood overflows, foam suppressing sprays, and coarse and fine bar racks (the smallest bar spacing would be, perhaps, two centimeters). The flow is then returned to a regraded river channel. The capital cost of this structure is estimated at 20 million dollars. What this alternative achieves is aesthetic improvement by removing trash and suppressing foam. Screening is viewed necessary for all subsequent alternatives.

Alternative 3 would create two large instream impoundments by damming the river at and below the All American Canal. The impoundments would provide a two to five day retention time to achieve pathogen reduction through sedimentation and die-off. With screening, the cost of constructing two earthen dams is estimated at 26 million dollars. The problem with this alternative is the creation of a large treatment pond adjacent to Calexico residents. Mosquitos and odors from algal blooms may be problems. Sludge disposal could be a problem. Fencing of the impoundment, weed control, and possibly aeration would add considerably to the cost. There must be some problems I haven't mentioned.

Alternative 4 would create instream wetlands with a series of small shallow impoundments in the river channel. These impoundments would be planted with a marsh vegetation such as the type of tule or cattail that currently lines the upstream portion of the Mexicali drain. As with the previous impoundment alternative, pathogens would be reduced through sedimentation and die-off. Again, mosquitos may be a problem and fencing would be necessary. With screening, the cost of instream wetlands treatment was estimated at 27 million dollars with annual operating costs of perhaps $200,000.

Alternative 5 combines screening with disinfection using chlorine gas for pathogen reduction. Chlorine gas would be injected just downstream of the screening facility and the flow would enter an improved fenced channel. The channel would extend two miles downstream beyond the All American Canal. The existing river channel would then be regraded for conveyance of high storm flows only. The estimated cost for the screening facility followed by chlorination and a fenced, improved channel is $41 million. I should mention that the annual operating cost of $2.5 to $3 million is high because up to twenty-five tons per day of chlorine would be required. Chlorine in this quantity would have to be transported by rail tank car.

Alternative 6 would divert and pump the entire New River flow at the boundary to the Colorado River. In addition to costing well in excess of 100 million dollars with high operating costs, this alternative would create new water quality problems in the Colorado River. This and similar alternatives were quickly rejected for obvious reasons.

Alternative 7 would pump the entire river to a nearby location for advanced wastewater treatment in the form of filtration or physical and chemical treatment. Either would be followed by disinfection. The treated water would then be returned to the existing New River channel. Reuse of the treated water for irrigation is precluded because of high mineral content. The cost of this treatment alternative ranges in the hundreds of millions of dollars with very high annual operating costs. The costs of treating the entire New River flow are prohibitively high for two reasons. First, the *quantity* of flow is twice the volume of wastewater generated by the City of San Diego. Second, the quality of the New River at the boundary already resembles undisinfected effluent from a secondary treatment lagoon except coliform bacteria levels are much higher.

The most recent study, conducted by Montgomery Engineers recommended what I presented as Alternative 5, screening, disinfection, aeration for odor control, and a fenced-lined channel. All this for $41 million and $3 million per year for chlorine.

My agency then recommended that the California legislature authorize money for the design of just the screening facilities. We have reservations concerning disinfection with chlorine because of the cost and we are not convinced that chlorination will achieve a high level of disinfection with the suspended solids present in the river. Instead, we are exploring instream wetlands treatment as perhaps a less costly and equally effective means of pathogen reduction.

As the final part of my discussion, I would like to give you my own perspective on the subject. Assume, as I have heard and read, that the quality of the New River presents a significant and imminent public health hazard to the residents of Calexico. And recall the axiom from Jack Conway that "containment is the only way to reduce health risk." Then I believe that what I described as the "big pipe" alternative of conveying the New River in a two-mile long pipe from the international boundary to just beyond the All American Canal, provides the greatest public health benefit by eliminating the possibility of physical contact for the residents of Calexico. At $10 to $15 million, *this is the least costly alternative* and it can be designed and constructed in a very short period of time and it preserves future treatment options. If, on the other hand, the risk is somehow tolerable in Calexico, then for the least cost, the greatest water quality improvement in the New River can be achieved by investing in wastewater collection and treatment projects in Mexicali. This, I believe, would achieve the greatest public benefit when one considers the health and welfare of the citizens of both Mexicali and Calexico. This could be good joint investment for the Californias.

George Baumli, International Boundary and Water Commission. I think in the conclusion of today's session, you will see that Mexico has done a considerable amount in the way of improvements in Mexicali. We entered into a minute agreement with Mexico in August of 1980, called Minute No. 264. That minute did call for Mexico to expand its lagoon system, to make improvements in its pumping system, to install treatment facilities at an industrial area near Mexicali and to make other improvements. That minute agreement also set forth a number of water quality standards which were developed in coordination on the United States side with EPA and State and Regional Water Quality Control Boards. The IBWC conducts a monitoring program of the New River and at the present time Mexico was in compliance with five of the seven water quality standards that are set forth in that document.

Another international agreement, Minute No. 274, was entered into in April of 1987. And that document set forth a $1.2 million joint project and the criteria for that project were that it had to result in a significant improvement in New River quality, that there had to be an equal sharing of costs, and that it had to be under the

supervision of the International Boundary and Water Commission. It took us some time to come to agreement with the Mexican agencies as to what would be the most meaningful project on their side, that would meet these criteria. A joint report of the IBWC Principal Engineers was prepared which formed the technical basis for the international agreement, Minute No. 274.

Phil Gruenberg mentioned some of these projects, such as construction of a new pumping plant to convey the collected sewage to the Mexicali lagoons. The agreement also called for the rehabilitation of three of the existing Mexicali pumping plants and for the acquisition of an aquatech sewer cleaning truck. The cleaning truck has been purchased and it is working on a daily basis helping clean Mexicali sewer lines which is an extremely important element of keeping the collected sewage flowing to the oxidation lagoons. The construction of Pumping Plant No. 1A, the new pumping plant, is underway. Rehabilitation of the other pumping plants, is probably about 50 percent completed. And all of these facilities are scheduled to be completed by the end of this year.

In regard to the long range project, the original agreement called for Mexico to submit plans to the International Boundary and Water Commission for a long-range solution to the New River problem. We believe very strongly that the most viable solution is in Mexico. Recognizing Mexico's economic problems, I think it would be most appropriate if somehow the United States would be able to financially assist Mexico in the formulation, design, construction, and operation of a project in Mexico. I think the IBWC $1.2 million project is a precedent, and if we can get the U.S. governmental agencies, the governmental agencies in Mexico, and the domestic agencies in both countries, to sit down as we did on the Tijuana project to discuss the pros and cons of various alternative long-range solutions, we will be able to put together a project which will meet the needs of both the United States and Mexico.

Charles Cooper. So far we have heard from U.S. representatives, which in that topography means that the United States is the final recipient of much of the wastewater and agricultural drainage from Mexico as well as from the Imperial Valley itself. Nevertheless, the Mexican people have a major interest and a major concern over these issues. To introduce the Mexican viewpoint from the side of the academic profession rather than the operating agencies, I would like to introduce Jesús Roman from El Colegio de la Frontera Norte in Mexicali.

Jesús Roman, El Colegio de la Frontera Norte, Mexicali. Mexicali is a city that was born at the beginning of this century. It neighbors Calexico, California. This city, like other cities on the border, has been impacted by a constant influx of immigrants which has increased the population. From 1940 to 1987, alone, it has shown an increase of 1,100%, something that today represents almost 800,000 inhabitants. During the 1940s Mexicali had only a few streets, with barely 40,000 people. Right now Mexicali encompasses an area of 100 square kilometers. The city's development is based on agriculture, commerce, services, and during the last 15 years, on the maquiladoras and agromaquiladoras. The unchecked growth of the population has created a great demand for benefits and services, mainly in sanitation, electricity, drainage, and especially in drinking water.

Mexicali's sewage waters are collected in a river bed known as Río Nuevo which started in 1905, a little after the floods, when North American engineers, with explosives, tried to get rid of the waters that inundated this region as a result of a dam breaking in the Colorado River bed. Right now, the Río Nuevo crosses and divides the city, ending in North American territory. The Río Nuevo not only collects the urban sewage, but also receives the agricultural and industrial wastes, which together create a serious international problem.

According to documents from the agency in charge of apportioning water to Mexicali, there is water service to 95 percent of the homes, which means that 85 percent of the population has running water. Although, day-by-day the city's legal power grows, through administrative changes in Mexico, the government's efforts in creating new works are minimized because as the new works budget is programmed, the demand for the service exceeds the program.

Due to the city's topography being almost 95 percent flat, almost all of the aqueducts function by gravity. Only in a few areas is there pumping. According to the need for containing sewage, the city is divided into two sections, the northern and southern. Right now the sewage collection system is comprised of almost 900 kilometers of pipes and is capable of containing a total 2.07 cubic meters per second, which translates to 68 million cubic meters per year draining towards the valley. In addition to this volume, according to reports from the agricultural agency, during 1976-1986, there was drainage from Río Nuevo on the order of 1,995 cubic meters, with an annual average of 200 million cubic meters. This volume represents 10.8 percent of Mexico's quota of Colorado River water as assigned by the international treaty with the United States.

This situation is to a certain point against history because traditionally in Mexicali there has been an emphasis on saying that the water quota is not enough to satisfy demand in the agricultural sections of Mexicali and San Luis. However, 11 percent of this hard-won quota is returned via the Río Nuevo as runoff. This percentage of water if used for agriculture would be sufficient to

irrigate approximately 14,300 hectares of agricultural, assuming an average use of 1.4 meters.

During January of 1987 to May 1988, the agricultural agency reported a larger demand on the Río Nuevo than those reported during 1976-1986, exceeding 12 cubic meters, that is, 347 million cubic meters per year. In this case, the quality of the water flowing to the Imperial Valley, the sewage is very diluted. It is fitting to emphasize that of the total volume drained through the Río Nuevo, 2.07 meters per second are sewage which were collected by the metropolitan system and the rest, approximately 8.5 meters per second, come from agricultural runoff, dairies, industry, and domestic sources which run directly into the river bed from irregular sources.

Chemical analysis can determine if international limits are being exceeded in the Río Nuevo, as is the case in the BOD which, in some cases, has reached an average of over 106,000 milligrams per litre when it should never exceed 30,000 milligrams per litre. By the same token, the coliform count sometimes reaches up to 2,300,000 units when the maximum allowed is around 10,000 units.

Regarding heavy metals, such as chrome, magnesium, copper, and others, they have been kept below stable levels. As far as chemicals, it was not possible for us to test them because the necessary equipment is not available in Mexicali. However, data show that in the agricultural runoff in the Imperial Valley agricultural there are certain chemicals present, so we presume that in the Río Nuevo there must be pesticide residue. Actually, Mexico, in its quota, receives more than 300 million cubic meters per year of agricultural water from the Yuma valley which must surely contain pesticides and other elements. The water's physical properties vary from one extreme to the other as can be seen in the dense and dark coloring, grey and reddish, in the different zones.

The sewage in Mexicali is biologically treated in treatment lagoons, built by the agricultural agency in 1982. There are over 215.6 hectares in area, which is situated 15 kilometers southeast of the city. The treatment lakes are built over clay soil and bordered with compacted dirt. The system is made of three ponds that are anaerobic and ten aerated. The anaerobic ponds measure 8.7 hectares (21.7 acres) and the aerated measure 14.7 hectares (35 acres), each according to operating capacity. The system was designed to treat 750 litres per second; however, it has been working up to 1,200-1,300 litres per second on the average per year. These lagoons were built with the aim of giving the urban drainage waters a biological treatment, taking into account the United States as well as Mexico. The drainage system collects the water and sends it, via two collectors, to the pumping stations. Once there, the sewage is sent to the treatment ponds. Once the treatment time has elapsed, the water is emptied from the ponds and sent back to the river bed, via the international drain system. The issue from the ponds is 1.1 cubic meters per second.

Even before the agriculture agency built the ponds, it was planned to use the treated urban drainage water in agriculture. A plan of planting 5,000 hectares had already been proposed to the district, since in other parts of the country they were already using sewage in agriculture. Right now, the agency continues working with the treated effluent used in agriculture in such crops as wheat, barley, cotton, sorghum, and oats. The processes studied are water direct from the source; two parts fresh water and one treated, and three parts fresh and one part treated. During the winter '87-'88, the agricultural agency coordinated the planting of 64 hectares on working farms. They had good results, but due to time constraints I won't go into details here today.

Right now the agency is in the process of putting into effect some works with the aim of mixing sewage and treated waters from the ponds. However, due to pre-existing attitudes they have not been able to find a farmer willing to definitely exchange his fresh water for treated water and they have not been able to regulate the works. This lack of acceptance and insufficient information about the use and management of water is only temporary, since the river's district is having serious problems meeting demand under normal conditions.

It is estimated that the total demand on the water, by Baja California, in the year 2000, will be 2,700 million cubic meters, about 200 million less than it has now, of which 11.8 percent or 179 million cubic meters, will be destined for urban usage. This represents an increase over present demand. This situation was anticipated in 1972 when President Echeverría ordered the creation of 67 deep wells in San Luis with the aim that that water would be sent to the city via an aqueduct. Right now the aqueduct from Mexicali to Tijuana is in operation, sending on the average 1.3 cubic meters per second. No doubt, this will not resolve the problem totally because the well system built is already being used by the Mexicali watering districts. It is estimated that by the year 2000 the present water levels from the Colorado River will not be available and that aquifer mentioned will be fully exploited and will not allow for additional extraction.

Jesús Antonio Francisco Ruiz, Secretaría de Agricultura y Recuros Hidraúlicos. I will clarify some of the experiences I have had in the use of sewage water that has been treated in the Mexicali valley. It is necessary to discuss the structural needs and availability of first usage waters in Baja California. For example, in the future, cities will use a lot of the available resources for agriculture.

As a prologue to the problem of available resources, including the recycling for agricultural use, the agricultural and resource agency, as of 1984, has instigated a master plan to prove that the use of residual waters on agriculture in Mexicali is beneficial for the production of foodstuffs and will not result in reduced growing parcels. The agency estimates that in 1988 the total investment will require 920 million pesos to build two pumping stations, 40 kilometers of agriculture drainage, two structures to mix the waters, and a network for capturing domestic runoff from sparsely populated areas centered in the usage zones.

Each year, starting in 1965, the agency has completed productivity, water quality, and also sanitary studies to determine the conditions of water, soil, and plants. The studies conclude that the northwest section of the Mexicali Valley around the oxidation lagoons is limited in cultivation potential as a result of acidity in the soil. In addition, the oxidation lagoons are subject to watering by agricultural runoff in both yearly cycles in the summer, fall, and winter.

Before starting the experiments in the section called Colonia Zaragosa, analyses called the Imperial Series were done to determine the initial conditions of the soil. They were found to be predominantly semi-permeable. Immediately afterwards, 36 experimental parcels of 64 square meters each were installed.

In order to measure the water quality, based on a statistical study of the water available from the system of lagoons in Mexicali, an optimum of mixing two parts canal water and one part treated water was decided upon. A water mixer was installed. The agricultural work was done in the same way that the farmers of the region do it. The decision as to where only canal water, mixed water, or only treated water was used was made at random to determine the effects of each type. Later, cyclical plantings of wheat, sorgum, and cotton were made during the two annual seasons. During the growing season the following measurements were made:

Water Quality. In each watering, measurements were made to determine the salinity, nutrients, and sanitary conditions of the water. Three measuring devices were installed to determine structural changes in the soil; one for the canal water, one for the mixed water, and one for the treated water.

Soil. Studies were done to determine the quantity of airborne bacteria before watering and every ten days after each watering. Also, studies were done on fertility and salinity before each planting.

After each harvest the following measurements were taken:

Products. Output in tons per hectars, sanitary quality of the same and the presence of fecal matter in the treated waters output. Also, the output of the adjoining harvest was taken into account.

Soil. Measurements of the salts retained after each harvest and of the salts in the measuring devices.

We have reached the following conclusions. The experimental parcels have shown a tendency of improved productivity, mainly in the region using treated water only. However, this tendency has not been shown to be predominant, therefore, we cannot say that it is a definite trend. The soil behavior has depended on the crop and has shown a tendency towards increased salinity. However, it is not attributable to the use of treated waters because the increase has been shown in the use of normal waters.

The well construction in the soil has shown a tendency to increase in the usage of treated and mixed waters. The usage of treated water in agriculture in the experimental soil has shown a marked tendency in the disappearance of bacterial organisms of intestinal origin on the day after watering, implying the feasible introduction of grazing animals.

Finally, the sanitary quality of the crops are similar to those obtained from the neighboring parcels. We conclude that there is no negative sanitary effect from their harvesting. We recommend to continue indefinitely the studies with the goal of determining long-term effects and to confirm the results presently achieved. The ultimate commercialization of wastewaters would avoid needless waste and improve relations between the United States and Mexico.

Jorge Escobar, Secretaría de Desarrollo Urbano y Ecología, Delegation in the State of Baja California. I am involved with contamination control. I will talk about the advances made in the infrastructural work done to control the spill of urban waters on the one side and about the control of contamination on the other side. For example, I will dicuss the importance of the work of rehabilitation, amplification, and construction of the systems of recycling, pumping, and separation and treatment of the sewage waters in Mexicali. Diverse objectives were identified to solve the contamination problem and it was considered necessary to do the following:

1. Rehabilitate Pumping Stations No. 1 and No. 2, because due to their failure new spillages occurred into Río Nuevo.

2. Construct additional Pumping Station No. 1A.

3. Construct two sub-collectors to serve as backup for the pumping station being built and connect them to the collection lagoons located east and west of the city. Failure of the subcollectors, due primarily to absorption, made conduction difficult and resulted in the subsequent spill of their waters into the Río Nuevo.

4. Amplify the treatment capacity of the lagoons for stabilization in González Ortega.

In relation to the contaminated waters discharge, prior to the identification of the diverse control measures, there had to be an exact and detailed diagnosis about each of the separate problems constituted in each source. There is no way we could come up with a global solution by thinking of it as only one problem. Each one of the industrial contamination sources was in itself a complex problem and needed an adequate and exact description for a solution. In the preliminary stage of identification, ten main sources of contamination were identified including paper mills, food factories, and chemical factories, especially those specializing in agricultural products. These contamination sources were given time to construct treatment systems in compliance with particular conditions given to each plant. As a consequence of this first step, we are dedicated to verifying the advances in the control of contamination.

We have found to this date, the following advances in three areas:

1. As of December of 1987, the main source of contamination into Rio Nuevo was controlled. However, there are other industrial contaminants that do not discharge directly into the river but instead into its subsidiaries. I refer specifically to the municipal treatment system that was built last December to be later connected to the aqueduct and to direct the waters to the treatment plants.

2. Last April, the two principal sources of contamination per discharge volume and quality of the same were controlled by the construction of secondary and tertiary treatment systems. Right now they are in a period of stability for the treatment systems. One of these sources is the Química-Orgánica plant. The status of the remaining seven sources of contamination are as follows: five of them will be controlled by treatment systems within the next two months, and the other two should be done before the end of this year.

To conclude, independent of verifications made to certify compliance, as well as the advances made in the installation of works to better the systems of aqueducts, monitoring was used in different places in the Río Nuevo and its tributaries to verify the water quality in regards to the systems we have talked about.

The water quality monitoring has bacteriological and sanitary reference points. That is, measurements were made as to the total number of bacteria and fecal bacteria on the one side and the quantity and quality of oxygen on the other side because a large portion of the affected areas conserve the same qualities. The quality of the water found in the Río Nuevo will reflect on the measures imposed once all the sources are controlled. Even after seeing important advances in quality of wastewater of the aqueduct, we are sure that the effects on the Río Nuevo will be significant only when they have been concluded. There is a series of additional measurements in this formal picture which creates a series of dependencies but, due to time constraints, it is more convenient to leave them for later.

Discussion

Question: Paul Ganster, San Diego State University. James Giannopoulous and George Baumli both pointed out advantages and indeed recommended point source control in Mexicali as one major step in dealing with the New River problem. And, of course, this approach has been recommended by some individuals for many years. We also saw in the presentations specific suggestions of projects that could be done on the U.S. side. If the conclusion is that most of the corrective work should be done on the Mexican side, have any of the California agencies involved in these studies undertaken specific designs or estimated costs for what precisely needs to be done on the Mexican side? Have you tried to sketch out ways to collaborate actively with counterparts in Mexicali to get some of these things moving along for really effective joint efforts on dealing with the New River? I am not sure who I am addressing this to, so I suppose anyone who feels like responding should.

James Giannopoulous. One of the engineering studies that I mentioned was an EPA joint task force back in 1983; they turned out a report. The members of that task force included IBWC, the Regional Board, and the State Board and they examined various abatement measures that could be implemented in Mexicali. Since that time I do not think any efforts have been undertaken on our side to pursue those. I think now would be a good time to revisit those alternatives and pursue discussions with Mexican officials.

Question: Mike McCoy, Tijuana Estuary and Management Authority. You may have answered this question before I got here. I just wanted to see if you have. With respect to multinational corporate interests in Mexicali and those corporations that are headquartered in the United States and identified as point source producers of pollution problems, are the IBWC and the EPA dealing with these corporations or do they have a framework to deal with these corporations that are creating severe

problems with respect to the New River? Or the Tijuana River?

George Baumli. The IBWC does not have a framework to deal with that particular problem. EPA has addressed it on a number of occasions and I do not think their efforts have borne much fruit.

Question: Mike McCoy. What do you suggest that a conference like this might do to bear fruit on something like that, because I think it is a serious problem.

George Baumli. Based on the reports that we heard today from the SEDUE officials, it seems to me that Mexico is taking significant action on its own and I think that they are probably capable of handling the problem, without interference.

Charles Cooper. I would like to make one final comment. What we have been discussing for the last two hours primarily is industrial and, to a lesser extent, domestic and agricultural pollution problems in the New River. This is one of only a host of water related problems that jointly face the Mexicali Valley and the Imperial Valley. One of these which I referred to is the increasing salinity and toxicity of the Salton Sea. There are problems with flooding in the Salton Sea which are currently being addressed. There are critical questions of salinity in the water supply from the Colorado River, particularly to the Mexicali Valley. There are questions of availability of water supply, particularly, and this happens to be my own specific field of interest and concern and research at the present time, if the greenhouse effect from trace gases in the atmosphere is increasing global temperatures. We now have, for the first time within the last few months, fairly conclusive evidence this is actually occurring. If this adversely affects the supply of water in the Colorado, it will affect both the Mexicali Valley and the Imperial Valley. There are enough questions to occupy a full workshop of this type simply on these international questions and I would urge Paul Ganster and Cliff Metzner to think about, in the future, another workshop devoted to this whole diversity of problems in this international geographic area bisected by a purely artificial boundary.

Session V: Technical Session on Wastewater Reclamation and Groundwater Issues
James Cornelius, Moderator

James Cornelius. I am with the California State Water Resources Control Board in Sacramento, and it is my pleasure to be here with you and to continue the program. We have a very interesting panel to represent some different viewpoints to follow up on the reclamation concept and to some degree to tie the reclamation concept into the groundwater aspects. Along that line I wanted to take a moment and say a bit about the State Water Resources Control Board and the roles and the responsibilities of the Board. The State Water Resources Control Board has five full-time board members appointed by the governor, confirmed by the senate. These members are very active in setting the policy and program directions of our agency. The State Water Resources Control Board has a number of activities related to water rights and water quality.

I am with the Division of Loans and Grants which is operated by the State Board out of Sacramento. We have, in the last fifteen years, administered state and federal grants for over $5 billion worth of construction for new sewage treatment plants or modification of plants in the state of California. With that introduction, I would like to move on to the program, and the first speaker, Professor George Tchobanoglous from the University of California, Davis.

In the state of California system, the University of California serves as a major research arm for many state programs. An example of the types of activities is presented in the publication *Irrigation with Reclaimed Municipal Wastewater: A Guidance Manual.* This book represents an effort funded by the State Water Resources Control Board and prepared by the Department of Land, Air, and Water Resources of the University of California, Davis. It happens that one of the persons who edited this book is a co-worker of mine at the State Water Resources Control Board, Dr. Takashi Asano. You would find this an extremely interesting book because it goes through, chapter by chapter, the many different aspects that need to be considered in irrigation with reclaimed wastewater.

With that, I would like to introduce to you George Tchobanoglous, professor of civil engineering at the University of California, Davis, who teaches primarily in the environmental engineering field. Dr. Tchobanoglous has been very involved in wastewater reclamation, particularly related to the water hyacinth project, and has been an advisor on the water hyacinth project that was developed here in San Diego.

George Tchobanoglous. This morning, what I would like to do is take a few minutes and try to explore with you the role of plants in wastewater treatment. Even though we have looked at these for some time, our understanding is still really in its infancy.

There are general categories of plants that are used for wastewater treatment. There are floating aquatics, represented by the water hyacinth and there are emergent plants, represented by cattail. These are the two types of plant systems that are commonly used although there are many, many varieties and there are variants of the kinds of systems.

Most of the aquatic systems are what we call uncontrolled. Essentially, they are large ponds in which we threw plants in and expect a treatment process. Unfortunately, the performance of these systems has not lived up to expectations. What has happened, then, is that an evolution has occurred in which we made the channels long and narrow. Unfortunately, that also proved to be a bit of a disaster. When we did that, we got odors in the front end of these systems basically because they were overloaded. We then said there must be some way of controlling that. We then went to a system where we recycle a portion of the flow. Now the recycle is very important because it lends to the treatment, which I will talk about in a second. Beyond that, then, we have developed a system in which we distribute the flow along the length of the channel, with recycle, and we have now gone to another system in which we, again, distribute the flow and now we bring the recycle in at the front end. This last system has rather dramatic characteristics with respect to the performance of these plants. But in any of these flow configurations, we can either use floating or emergent plants. In some of them, we can also use rooted plants. A typical example of a rooted bed system has gravel of about a foot to a foot and a half deep. Tuberous-type plants, cattails, are planted in the layer immediately above it. And the idea is that the roots penetrate down into the medium and provide oxygen for the treatment of the wastewater. Again, we have a whole series of different configurations that we can use and Rich Gersberg will be talking about this a bit later so I will not dwell on those. What I would like to do now is give you some comparisons.

Water hyacinths under winter conditions are characterized by the small size of the leaves and they also develop floats, the wide spots in the leaves, so that the plant will not sink into the bottom of the tank. When the plants are growing rather lushly, as in southeast Asia, the plants do not have floats because they grow so closely together.

Now, the important part of a water hyacinth and all of the plant systems that we are going to be talking about is the root. What brings about the treatment in a water hyacinth or any plant system are bacteria attached to the roots. Bacteria colonize the root system and as we pass wastewater by the root system, we enhance and we get treatment by absorption and biological conversion. But, now, the most interesting feature of these plants is that they transport oxygen down to the root system from the atmosphere and methane up from the root system out to the atmosphere. All of these plants transport oxygen down to the root system, and it is a critical feature because it allows plants to survive in environments that would otherwise be extremely hostile.

For example, we grew a series of cattail in a tank with muds that were anaerobic, that is, in the absence of oxygen. The plants flourished and when we pulled them out the mud was black and the black color is caused by the precipitation of hydrogen sulfide with the metals that are present in the anaerobic mud. Now the interesting thing is that even though the environment is totally anaerobic, the plants, the tubers themselves are aerobic. And one of the ways you can tell this is if you pull out a cattail system out of an anaerobic environment and if you break open the tuber, it is white. You can see the black color of the mud surrounding it, but the tuber internally is white. And if you press it you can actually release the oxygen in very, very fine bubbles from the tuber mass itself.

These plants can survive an environment where the liquid above the plant surface has a pH of 2. They are now used extensively for the treatment of acid mine drainage. They are planted in a shallow bed, and once they are rooted they cause a whole series of reactions. There are biologically mediated reactions, there is sedimentation, but the most interesting aspect of this is that even though the bottom layers are anaerobic, the plants survive because they are always pumping oxygen down to the root system. That is really one of the important features of these particular types of plants.

After this brief introduction to the two types of plants, I would like to focus on the San Diego water treatment system and give you a kind of a considered review of this system and how it is performing. The general plan called for by the City of San Diego was to take a portion of municipal wastewater and to give that portion secondary treatment, using an aquatic treatment system. The effluent was to be applied to an advanced treatment facility and from there to a storage reservoir mixed with imported water, stored roughly for a period of two years and then water would be drawn from the storage reservoir, would be treated, would again go to municipal usage, and the cycle would repeat. Today, I will discuss the secondary treatment and I am going to mention the advanced treatment, show you some of the facilities, and mention some of the recent results.

After much experimentation, the flowsheet for the City of San Diego consists of a rotary disk filter and the water hyacinth pond. Now, what is unusual about this is that the rotary disk filter has replaced the conventional primary settling tank that you see in more mechanized plants. Increasingly, these days, it is very, very important from an aesthetic standpoint to provide very effective screening of wastewater. The filter employs openings of about 250 micrometers. So it is a very, very fine screen.

Before continuing, I would like to present the characteristics of wastewater and there is not much to talk about with respect to biochemical oxygen demand or chemical oxygen demand, total organic carbon suspended solids, but I come down to the last item, sulfate SO_4. And the reason that is important is that if you look at the average value for the San Diego wastewater, it as 164.5. And the problem that causes are, as someone mentioned in the earlier panel, odors. When you have a wastewater that has a very high sulfate content, you always have the possibility of odors developing in a treatment facility, especially if it is overloaded biologically. Hydrogen is a carbon source, the sulfate is reduced to hydrogen sulfide, and if there are not enough metals in the wastewater to precipitate that out, you release it as a gas.

As an aside, we have now established in the United States a very effective industrial pretreatment program in which we typically remove the heavy metals that were normally discharged. Well, one of the things that has happened in a number of the Southwest cities is that the hydrogen sulfide production has become so intense that corrosion of concrete pipes has accelerated dramatically that the repair and replacement cost is going to be immense. Now, what caused this? Heavy metals that were discharged by industrial sources were normally precipitated as sulfides, ferrous sulfide, a whole series of sulfides, and when this does not occur accelerated corrosion occurs in sewers along with accelerated odor problems at the point of release, whether at a pumping station or at where waste is brought into a treatment facility. Down the road, it is not unusual to expect that almost all the headworks of treatment facilities will be covered. So, what I would like to do is call your attention to the fact that it is very important to characterize your waste effectively if you want to achieve positive treatment.

In the initial experiments at San Diego, the filter was compared to a conventional settling tank. The rotodisk filter and sedimentation tank were housed in a building to control the immense odors that were produced. In the process, material removed as a first cut by the rotodrum screen and includes cigarette butts, plastic goods, rubber goods, and so forth. It is extremely important to remove this material from a wastewater if you are going to apply

it to open treatment systems. When this material gets out into a treatment system, it is very difficult to control by hand, or any other way. And so, in my judgment, screening becomes an absolutely crucial issue in all of these facilities.

The rotodisk filter is a series of disks. The wastewater flows between a series of two disks, and out through the screens on the face of the two disks. And as the disks rotate, the material starts to build up on them. But as it builds up, as it makes a complete turn, it falls and is captured in the drum in front as the water passes through the screened area. Now, the reason that this is important is that it represents a new option for pretreatment as opposed to conventional primary sedimentation. And as we start to think about these aquatic systems, we need to think about new kinds of pretreatment options. The screens, for example, occupy a very small space compared to a conventional primary settling tank. So, what we are beginning to look at are a series of different kinds of options that might be suitable.

Now, to give you some idea of the performance with respect to BOD, the removal over a 13-month period was about 23.5 percent. And you can compare that to about 35 percent in a primary settling tank. With respect to suspended solids we are at about 45 percent and you can compare that to about 55 to 60 for a primary settling tank. But again, the thing that is remarkable about this is that we have a very consistent performance with this particular unit and there is no floating surface debris, which is very important from an aesthetic standpoint.

One of the problems in a water hyacinth system is that wastewater must be brought in contact with the root zone in the plugflow ponds. A recycle screen allows control the hydraulics in order to transport the waste up to the root zone. Another very important, but often misunderstood, element of these systems is that root mass must be open. In many locations, I am sure that many of you have seen these plants, where you pull the plant out and the entire root mass is covered with sediment. Under those conditions no benefit is obtained from the mass of bacteria that are present because the surface area exposed to the wastewater is significantly reduced. So the idea then, is to bring in the recycle, dilute the flow, and then transport it up to the root zone. And that is the key to success with all of these plant systems. And one of the things that we are finding across the country is that most of our systems that are designed as long plugflow systems are inappropriately designed.

Now, to give you some idea of long-term performance over a 13-month period with respect to the effect of water temperature. We varied the water temperature in pond 3 from about 26 or 27 degrees down to about 11.5 with very little effect on the performance. We found that the effluent from this particular system is more stable than the effluent from most activated sludge plants in the state of California. And the way you do that is by plotting the monthly data on the probability plot, and looking at the slope of that particular line.

The long-term performance of these systems for BOD removal has been excellent, effluent has averaged 9.5 and suspended solids have averaged 10.2. And that is over a 13-month period with extremely stable performance. I have worked with a number of treatment plants, and it always amazes me to go out and take a look at that particular effluent because it is always crystal clear.

One of the questions that comes up--what about harvesting? Well, the technique that is used in San Diego is to use a truck with an articulated arm setup. The operator sits on top, reaches over, pulls out a portion of the water hyacinth plant, and deposits it directly into the truck body. Then a worker uses a stick to manually redistribute the remaining water hyacinth plants.

The advanced wastewater treatment facility consists of a water filtration plant. The effluent from this particular plant is then passed through a reverse osmosis unit. Based on the preliminary results of research funded by the state of California, the effluent from the reverse osmosis unit was compared to the water that the residents of the City of San Diego currently drink. By every objective measure, the effluent from the reverse osmosis unit is better than the water that is currently drawn from the City of San Diego. An interesting question is why would you want to take this high quality water and then put it back into a reservoir for two years and degrade its quality. But that is not a question that, fortunately, I have to answer, but nevertheless it poses an interesting question that as we start to look at this technology, we are in fact producing an effluent that is better than the drinking water we are currently using.

I feel that what we have to first demonstrate in all of these aquatic systems is performance. If we can demonstrate performance, we will then find ways to reduce the cost. But one of the things that has plagued this particular field has been the inappropriate use of plants for aquatic treatment. Case in point--in Texas, they had hundreds of these ponds, but what they did is they made them 8 feet deep. The problem with an 8-foot deep pond is that you would never get the water to the root zone, which extends 6 inches into the water. And, if we continue along that tack, we are probably never going to optimize the utilization of these plants.

I just came back from a wetlands conference that was held in Chattanooga, Tennessee. Originally, the organizers thought that 200 participants might show up; preregistration was 400, and the final total was 700 people. So there is a lot of interest in these things. If you

system, the original water flow has now been supplemented by an aqueduct to supply the needs of the increased population and industries. This additional water is being added to the river system. Here is a system which has evolved and stabilized over periods of thousands of years. Today, by human intervention, more water has been added, causing an imbalance. I ask the participants here to at least think about what has been done to this natural system. And the question might be, do we then dump the accumulated wastewater into the river and increase the flow or do we divert the excess through an aqueduct emptying directly into the ocean near a site where the excess water would have originally entered? As I understand the situation as it is now, the water flow, instead of being a trickle during the summer, is something on the order of 12.5 million gallons per day. To receive this high flow during the summer months is not a natural condition for this system and its estuaries.

Likewise, let's now look at some of the organic and mineral increase that has occurred in this river basin. Specifically, I am now talking about the increased number of people, the food is being brought in as well as other materials required for the sustenance of the population living on the river ecosystem. We can see that a large increase of materials has been added to this system. Automobiles have also been introduced into the area so fuel and lubricants are being imported and added to the river system as petroleum waste. In all there is now an increase of materials in this ecosystem. And finally, one of the concerns of the planners and leaders of this area is that with the expanded industry and increase in commerce, exotic organic materials and some of the heavy metals are imported, portions of which contributed as wastes to the river flow.

Another factor to consider here is the growing infrastructure within the drainage system. I refer to the necessary increase in housing facilities, road system, utilities, and so forth. But I will not discuss such topics as I would like to keep this discussion short. Basically, what I am trying to say is that we have an ecosystem that is now completely overwhelmed and under stress. As a consequence the ecosystem responds. The response is not to our liking. I think the problem we are looking at here is trying to figure out what kind of modifications can we now apply to this ecosystem so that the whole system will function as it should. The problem facing us, I am afraid, is that a major decision must be made "in a vacuum," i.e., without adequate information. We might find with an explosive population growth a situation where, because of finite resources, a decision must be made such that some entity will be sacrificed. As an example, in Los Angeles, one of the larger estuary systems, Ballona Creek, has been virtually eliminated to accommodate the increase in population.

Permit me now to move from a systems evaluation to one of a more philosophical aspect. Let us again stand further back and look at the problem before us. Instead of just looking at the Tijuana River system, let us look at the earth as a whole and understand how it nurtures us and all human beings. Unless we are careful as we plan for the future, and unless we turn from exploiting the earth to nurturing the earth, I see in the not too distant future some real problems for the human race. And I think that here within this group we are at least now addressing this particular problem. So I will end on this point.

Jim Cornelius. Thank you, Tak. That should generate a few questions for you all to be thinking about for later discussions. We will now continue with Professor Albert Utton from the University of New Mexico, School of Law. Professor Utton is going to be discussing some groundwater issues that he has been involved in for a number of years.

Albert Utton. Last Friday, I was at my mechanic's place of business getting my air conditioner serviced, appropriate for this time of year, and I noticed that he had, as most mechanics do, amongst the calendars with scantily clad girls and so forth, various bits of wisdom on the wall. One of these sayings was "May my words always be sweet and soft, because tomorrow I may have to eat them." And I think that is maybe appropriate for at least my initial remarks. It seems to me we have had a marvelous example the last two days of the difficulties and the challenges in trying to reach solutions to international or at least binational problems. How do we get together? How do we work together? How do we plan together? How do we reach mutually beneficial solutions with these different countries? You know, you draw this thing called the political boundary somehow, with someone with a stick in the sand for whatever historical reasons, that divides us one from another, one political system from another, one society from another, one fiscal budgeting system from another. How do we work together? That is what we are about, it seems to me, these two days, with the help of Cliff and Paul, we are trying to think through and talk about these things and to discuss them with each other at an unofficial level, where we are less constrained by political considerations than the official diplomatic types are. For example, yesterday, to me it was interesting, that we were hearing some of the American speakers, saying in the case of the Tijuana-San Diego sewage problem, given that San Diego is downhill, that we ought to follow the laws of nature, not the laws of men and women. Let the sewage flow naturally by the laws of gravity down to an international joint sewage treatment and collection system. Let us work together and do it the most efficient, economical, and easiest way. Let us follow the laws of nature.

On the other hand, it seemed to me that I was hearing from the Mexican representatives, "Hey, we want to have a separate system. We want to maintain our independence and we also don't want to lose that resource, that water, which we can reclaim and use productively, independently on our side." We also had the kind of internationalist, law of nature advocate saying, "Let's do it in the South Bay." And then also we apparently hear from others on the U.S. side in south San Diego, "No, not in my backyard. I don't want my part of the county, of San Diego County, being a sewage disposal site." Then we also heard that Dick Reavis (of EPA) is off in D.C., the national capital, seeking that elixir that dissolves and solves all problems, money, in large amounts. And I did not actually read it or hear it, but I think I could hear it somewhere in that the great capital on the Potomac saying, "No, that is your problem. You won't get the money in my backyard." Perhaps, that is Washington speaking.

And then, I think I also heard from that other great capital there on the great plateau, Mexico City, saying, "Hey, that is your problem up north, or maybe it is their problem, because they are downstream, they are downhill and besides we have severe money crunch problems here." I think of all those elements in trying to reason together and agree on what solution may be the best one and then how to finance it.

The suggestion is really that we ought to have an international plant, with gravity flow downhill. We ought to do it together, we should not be spending X amount of money there independently, separately and then duplicating or doing it separately and so much money downstream. Then this morning we talked about the New River problem. And it seemed there again we were treated with variations, but with differences. The challenge is again, how do we work together? How do we get together? How do we plan together? And we had suggestions with seven, eight, nine alternatives for throwing large amounts of money at the problem downstream on the United States side, which did not seem to get to the root of the problem of trying to intercept and deal with the problem at the sources on the Mexican side. And again, perhaps, there were some physical, hydrological differences there. But again, perhaps, with some signs of progress, we should be pushing harder for more international solutions, in both of these situations. I think we all agree with that. But in both cases we see the difficulty and the agonizingly slow progress that is required in reaching international solutions. In both cases we have the same difficult challenge of how do we work together to achieve joint solutions which would be difficult enough, even without that artificial thing, a political boundary. But the truth is, that boundary is there, so how do we get around it? How do we get over it, under it? How do we dissolve it? How do we establish the mechanism?

With that, if I could just switch from the water quality problems of the New River and the water problems of Tijuana to groundwater problems along the border and ask that same question of how do we arrange our affairs so as to manage them beneficially, mutually? If we look at that border region, various things could be observed. To the north in the U.S. Sunbelt area, we have one of the fastest, if not the fastest, growing areas from a population and economic development point of view in the United States. If we look south of that political line, we see one of the fastest, if not the fastest, growing areas in Mexico. So that is point number one.

Point number two: Much of that border is one of the driest parts of both countries.

Point number three: The largest, the heaviest, users of groundwater in the United States, understandably because of the aridity, are those four states which happen to be contiguous to Mexico.

Point four: I want to put in some good news in this panorama. In regard to water quantity, we, Mexico and the United States, have together largely and amicably settled our water quality problems in regard to surface water. Through the treaties of 1906 and 1944 we have largely and amicably said, "You the United States, you get so much of the pie, you Mexico get so much." We have done this on the Colorado and we have done the same thing in regard to the upper Rio Grande in the 1906 treaty. By that treaty of 1906, Mexico got 60,000 acre feet. On the lower Rio Grande, in the Treaty of 1944, the U.S. got 50 percent and Mexico received 50 percent. Each country received an allocated quantified share that they can depend upon in the future. There might be better ways for water resource planning, but nonetheless it provides a certainty within which each country can organize itself.

However, we have not yet been able to reach agreement in regard to how we manage our groundwater resources in a way that will provide each country a predictable, identifiable share so that it can act accordingly. Instead we have a situation in which we have no ground rules to provide either side with the security of knowing how much water it does or does not have.

Let me give you examples of kinds of problems that we are facing. First, I will give you an example of a large urban area. Next I will give you an example of a small urban area. And third, I will give you an example of agricultural use, for example, which could lead to conflict between our two countries. And then I will give you a couple of water quality examples.

The first example that I will point to will be the large urban situation of El Paso and Ciudad Juárez. We have a

large urban area there, we think that Ciudad Juárez is in excess of a million people and the City of El Paso has more than a half million for a total of a million and a half, not unlike Tijuana-San Diego in population. But it is a very arid area without maritime breezes. Do both of those cities, El Paso and Ciudad Juárez, depend almost completely for their water resources on imported water from the Colorado? No. On reclamation return flows? No. On the surface flows of the Rio Grande? No. They depend almost completely upon groundwater resources for their domestic, municipal sources of water. And they happen to be pumping an aquifer which underlies the boundary and which is divided by the boundary. So we have Ciudad Juárez pumping on its side, El Paso pumping on its side, and they are pumping the aquifer down at a rate of 20 times its recharge rate. For every barrel of recharge, they are withdrawing 20 barrels. There is no regulation, no assurance as to how much water each has. The only, maybe ultimate restriction is that of the law of he who pumps fastest: "I will race you to the bottom of the aquifer." There does seem to be a "we are pumping it down together," kind of gentleman's agreement, an agreement between engineers, maybe, as opposed to lawyers. We know that engineers are always gentlemen and reliable. We lawyers take a more cynical view and feel it would be safer to have some kind of regulation, an agreement, so each side would know. Now, it just happens that since both of those cities are growing so rapidly--population growth for Ciudad Juárez since 1940 has been about 2,000 percent. So the City of El Paso has decided to move west and put in the large well field that I was talking about yesterday in New Mexico right up against the international boundary, and there is lots of water over there in New Mexico. But again with the white map disease, they did not really consult the city fathers and mothers of Ciudad Juárez because Ciudad Juárez is deciding that they may have to increase their water supply availability from 200 to 400 percent by the year 2000. Where are they going to get that water? Ah, brilliant idea, they are going to put in their well field just to the south of the border in the same aquifer as El Paso, again with no agreement, no security. We think that the aquifer flows from north to south and we can see how the affects of what El Paso does on the north could directly affect what Ciudad Juárez does on the south, or vice versa.

Now, if we move further west on that same boundary to the twin cities, Los Ambos Nogales: Nogales, Sonora, and Nogales, Arizona. They happen to be situated on the Santa Cruz River which rises in Arizona, flows into the Sonora, and changes its mind goes back northwards into Arizona, eventually flowing into the Colorado River. Again, both of these Nogales are growing quite rapidly. The Santa Cruz River is not a large stream and we find that both cities rely upon pumping from the groundwater the river for their municipal water needs. And Nogales, Arizona, is quite fearful for two reasons: one, the water quality question, and number two, they find that when there is heavy water pumping in Nogales, Sonora, south of the border, within a matter of hours they can see the lowering of the water table on their side of the boundary. This is a second example of potential conflict. For a third example, we will go to California to the All America Canal that flows along the border there through the sands of southeastern California. With San Diego and Los Angeles facing water shortages because of Arizona claiming their share of Colorado River water through the Central Arizona Project and thereby reducing the availability of water supply for Southern California. Los Angeles, especially, thinks, "Oh, well, we could line that canal and we could claim that water that is otherwise lost. We could create water out of the sand and that same water that is lost then by some magic of alchemy, we could divert it farther upstream through the established distribution works and make water from the desert, like magic." The only problem might be that we find that water seeps into the sand and without knowing really where the map is above it, happens to percolate south to where significant quantities are then pumped up and used to irrigate 10 to 12 thousand hectares or 20 to 25 thousand acres of farmland, dependent upon that stream of underground water. Again, an ungoverned, unknown, uncertain situation.

So I am now getting into problems and what do we do about it, what should we do about it? Over the last seven years, a group of Mexicans and Americans, specialists in the field, have taken on the task, unasked for, of drafting a proposed groundwater treaty which would provide some security, provide some safety, some certainty for groundwater users on both sides of that international frontier. This draft treaty would be based upon the principle of water allocation by mutual agreement, rather than unilateral taking. This is not the rule of "I will meet you at the bottom of the aquifer," but that of mutual agreement.

We have severe problems, I would suggest, looming on the border. There are established ways of dealing with them. It would be better if we could reach an agreement so that we could anticipate the problems and resolve them jointly. We have seen the same message in the case of Tijuana and in the case of the New River.

Jim Cornelius. Thank you for that very interesting presentation. I am sure that will generate a few questions also. I do have a transition item that could go from your presentation to the next. This is a joint report of the State Water Resources Control Board, the Department of Water Resources, and the Department of Health Services entitled, "Report of the Scientific Advisory Panel on Groundwater Recharge with Reclaimed Wastewater." This report was released in November of 1987 and can be ordered from the California Department of Water Resources.

This report addresses the potential health affects of recharging of groundwater basins with reclaimed wastewater and what impact this may have on the quality of the drinking water. It is particularly addressed to the Los Angeles-Orange County area, but I am sure the concepts could be applied in other locations, in the San Diego area or in areas of Mexico. The report was prepared by a national panel set up by the State of California to advise on this particular issue. Essentially, the panel was satisfied with what has been done so far in the Los Angeles-Orange County area, that there was no reason why they should take efforts to stop the recharging of the groundwater basin with reclaimed wastewater, at least at this time.

As this relates to the groundwater quality issue and also introduces some of the health aspects, I would like to move to the next speaker, Richard Gersberg, who is an Assistant Professor in the Graduate School of Public Health at San Diego State University.

Richard Gersberg. Today I will be talking about the reclamation of municipal wastewater. I will briefly talk about the health risks involved, although I could spend quite a bit more time on that, and will also discuss two innovative water reclamation projects that have been carried out here in San Diego.

In order to do a risk assessment of reuse of municipal wastewaters one has to know the type and amount of contaminants in the water, and then the degree of exposure of the receptor or human population to that wastewater. And, of course, the latter changes depending upon the beneficial use situation of those waters. And we have a whole range of different uses. We have already heard about the reuse of those waters for irrigation. But in the San Diego region, for instance, we have a series of recreational lakes at Santee, where people go fishing and boating, and the water is also used for irrigation of park land. So there are many types of uses, short of industrial use which is another one. And usually when one is looking at human health risk, the bottom line comes down to the microbial purity of the water. There are three major groups of contaminants which can adversely affect human health. First are bacteria, second are viruses, and third are parasites. I will in this talk focus mostly on the first two, bacteria and the viruses.

In the case of bacteria, we have already seen that water can have very high levels of indicator bacteria which are usually total coliform or fecal coliform bacteria, and these do indicate that pathogens might be present because of fecal contamination. However, luckily for us, the minimum infective dose, also known as the MID, that is the number of bacteria it takes to cause disease, is fairly high for most of the known bacterial pathogens. For instance, it takes about 10,000 bacteria, that is an ingestion of 10,000 *Shigella* cells to cause dysentery, and that is a fairly low value, but for the other bacterial pathogens, particularly toxic forms of *E. coli* and *Salmonella*, and *Vibrio cholera*, which causes cholera, it takes between 1 million and 100 million bacteria to cause disease. And so, when we look at some form of treatment of raw wastewaters, usually what that high minimum infective dose means is that the risk to human health if you give the water any kind of treatment, (even short of disinfection) and also do not use that water for drinking, it is usually very low. And so, for this reason I will focus more on the viruses in wastewater than the bacteria, because it is fairly easy to bring the bacterial count below that which causes disease, assuming that people do not drink large volumes of that treated wastewater.

With regard to viruses, however, it is now known that the minimum infective dose for several viral diseases, such as hepatitis, polio, and some of the gastroenteritis diseases caused by viruses, can be as low as one viral particle. Considering that raw wastewater can have as many as 10,000 virus particle per liter, then to get down to one virus particle is very difficult. And for this reason, the California Department of Health, in particular, has developed very stringent regulations for the treatment of municipal water before reuse. And I will not go into detail on them, just to say briefly that the California Department of Health requires primary treatment, secondary treatment, chemical coagulation, clarification, filtration, and then disinfection. So it is this whole treatment train which is fairly costly.

In recent years, other countries, particularly Israel, South Africa, and some of the other countries that practice wastewater reclamation, have suggested that the California regulations are too strict. And there have been a few studies, which I will briefly talk about, which are now beginning to support that claim. That is, the California treatment sequence is really overkill. A study done jointly by the U.S. EPA and Israel, where they widely practice the reuse of municipal wastewater, included an epidemiological study of people downwind of an area where aerosols of wastewater were produced by crop irrigation. They found no increased rate of disease in that downwind population.

Another study done in Colorado Springs also supports the claim that water does not have to be treated to very high levels in order to reduce the risk of disease due to viruses. And another study done in Monterey, California, shows that you can just take secondary effluent, filter it and disinfect it without going through that very costly treatment train, and there are no more viruses and bacteria on crops than if you went through the strict California regulations. And so, basically, what I am saying is that though California requires very strict standards, evidence is now accruing that you could probably treat wastewater a lot less and not increase the incidence of disease in the receptor population.

The first project I will discuss is the artificial wetlands which was constructed in 1980 with funding from the EPA employing biological treatment in much the same manner as Dr. Tchobanoglous has talked about. And the project after that is a physical chemical treatment process which uses clay as its main treatment ingredient, and reclaims both the water and the sludge, making a valuable product out of the sludge.

About one acre of artificial wetland test beds were constructed at Santee, California. We used cattails and bulrushes, emergent aquatic plants. The excavations were plastic-lined so that we could do a water budget and so that groundwater did not interfere. Then they were filled with gravel, they are about 2 1/2 to 3 feet deep, filled with regular washed, crushed rock and then filled with the wastewater that we wanted to treat. We planted natural stands of bulrush and cattail, about 1 per square meter. After several weeks, we could see the new shoots coming up and we repropagate very easily with about better than 90 percent propagation efficiency. After about six months the bulrushes were in seed and the cattails were well developed. So they grow very well, of course, in the San Diego environment. We harvest them about once a year and we have to cut them because they get very tall, about three or four meters, and we cut them to prevent them from falling over.

The quality of water in the inflow is about 60 milligrams suspended solids per liter and in the outflow less than 20 milligrams per liter, meaning secondary quality. The same is true with BOD; the inflow is about 140-150 milligrams per liter, and in the outflow is less than 30 milligrams per liter. There were several times when the 30 milligrams level was exceeded, but for the most part, the mean was well below 30 milligrams per liter.

Basically, these wetlands can perform secondary treatment of wastewaters. The main feature of this treatment is the ability of the aquatic plant, as George Tchobanoglous has said, to translocate oxygen into the substrate; the wastewater then flows through the root zone and the oxygen that is translocated by the plant stimulates bacteria to breakdown the contaminants.

These constructed wetlands are cost effective and energy efficient. They are very flexible and environmentally sound. They enhance the wildlife value and provide removal of a variety of contaminants. And they have aesthetic value. They can be used to form greenbelts. I think it is an excellent approach for both sides of the border: wastewater treatment plus enhancement of the environment and wildlife value.

The reduction of total coliform bacteria (from about 10^8 per 100 ml, to about 5 x 104) it is better than 99.9 percent. And the same is true for removal of viruses by these wetlands. These are a particular kinds of bacterial viruses, but again we have reduced them from about 5 x 103 to about 101, better than 99 percent removal of these viruses. The residence time in these wetlands is about 4 to 6 days, so the water does stay in there for a number of days.

The other project is a departure from the biological treatment that wetlands afford. This is strictly a physical, chemical process called CCBA. As raw wastewater is coming in, we are adding several ingredients. The main treatment ingredient is clay. After we add clay to about 600 mg/l we then add alum. That causes the clay to flocculate. The clay has the capacity to absorb many of the contaminants in wastewater including organic matter, such as BOD, and also heavy metals. The clay, once it absorbs all of these contaminants in the wastewater, then gets caught up in the alum floc and settles out very quickly. The water coming off, we have shown, can meet secondary treatment requirements, less than 30 mg per liter BOD and suspended solids. However, importantly, what then happens is that clay sludge so formed is made into pellets and fired in a kiln to about 1,000 degrees centigrade. After it is fired, it becomes a lightweight aggregate which can be used to make lightweight concrete. The organics that were present in the sewage sludge turn into carbon monoxide and carbon dioxide, but as the gases try to escape, the clay forms a glass-like material and the pellets puff up to become very lightweight lava-like pellets. We then incorporate those pellets instead of gravel into lightweight concrete. It is 35 percent lighter than normal concrete, and we have shown it is just as strong. So this kind of process shows that you can (1) reclaim the water to secondary quality which with subsequent filtration and disinfection, can be used for all applications short of drinking, and (2) we can also reclaim the sludge and make a valuable building product. With that I will stop.

Jim Cornelius. Thank you, Richard. We have one final speaker this morning, Susan de Treville, who is the Project Manager for the Environmental Defense Funds' demonstration project for an innovative low-tech approach to water reuse.

Susan de Treville. In 1983, I was hired by the Southwest Wetlands Interpretive Association through a grant from the State Coastal Conservancy to evaluate some proposals that were on the table to correct the Tijuana sewage problem. At that time, three proposals were being considered and the Conservancy, having invested a significant amount of money for acquisition of the estuarine sanctuary, was interested in coming up with the quickest and most effective way of dealing with the periodic inundation of parts of the reserve by raw Tijuana sewage.

Two of the proposals were from the City of San Diego; one was by Lowry and Associates, Engineers, which would cost approximately $739 million for an advanced primary plant. This is assuming that a 301(h) waiver was available, and would have an ocean outfall that would extend about 5 miles into the ocean. This project would probably have had a significant negative impact on the estuary while being built.

The second plan was by Council Member Uvaldo Martinez which would take effluent from Tijuana and carry it by an expanded "emergency connection" all the way to the Point Loma treatment plant. The problem with that was three-fold: (1) projected flows would soon exceed the hydraulic capacity of the Point Loma treatment plant, (2) we would have no source control over Mexico which is a requirement of the Clean Water Act, and (3) it precluded water reuse.

The third was a proposal by Mexico which included the construction of aerated lagoons at Punta Bandera with a 4 1/2 mile conveyance south of the border. The second phase, which was addressed yesterday by Alfonso Camarena, is the Alamar River plant, which proposes the discharge of effluent into the Tijuana River which we felt would create problems with decreased salinity by freshwater inundation of the very delicate estuarine ecosystem.

After evaluating each of these proposals, I found they were all flawed, mainly because none addressed water reuse in a serious way. The next step, since I did not find any of the proposals acceptable, was to put together a team of both Mexican and U.S. planners, engineers, and policymakers that could brainstorm and determine what would be a good alternative for Mexico that would protect the estuary and yet make use of the valuable resource, water. The State Coastal Conservancy awarded a grant to this team. We came up with a group of criteria with reuse being the cornerstone for building a plant. First of all, we all agreed that the solution was in Mexico, not on the U.S. side of the border. It should be modular, expandable, produce high quality effluent suitable for a variety of reuses, low in capital costs, low in operation and maintenance costs, quick and easy to build. Initially, we received $100,000 from the State Coastal Conservancy to build a pilot project on the U.S. side of the border. At first, we had received so much skepticism from agencies such as EPA about the proposed treatment train, which consisted of a fine screen, a biological trickling filter, followed by clarification, and, for polishing a constructed marsh like that described by Dr. Rick Gersberg, we decided that the only way to convert the skeptics was to build a demonstration plant.

For Phase I, we built a plant sited on International Boundary and Water Commission land in the Tijuana River Valley on the U.S. side of the border. We drew our sewage from the San Diego-Tijuana emergency connection. Our influent BOD was about 400 mg/l as were the suspended solids. We operated for nine months and had very good results with 75 percent removal of suspended solids and about 72 percent removal of BOD. This is with simulated clarification using an Imhoff cone. These results were so promising that we decided to initiate Phase II which would include a full-size clarifier, constructed wetlands, solids composting, and disinfection for reuse. We received an addition $239,000 from the Coastal Conservancy. However, due to a couple of factors, including Mexico starting to operate Pumping Station No. 1 which took away our supply of sewage, we had to move to Mexico, and that required about a year of negotiations, really paving new ground, because this was the first project that had ever gone across the border that was funded by the State of California.

The Environmental Defense Fund collaborated with El Colegio de la Frontera Norte and found a suitable site between Mesa de Otay and Colonia Buena Vista, which has a good supply of sewage. The site is on a steep slope which was deliberate in order to take as much advantage of gravity as possible. In fact, we have no power to the site. It is a completely passive treatment plant. We were given 23 acres, and the treatment plant itself will only occupy an acre or less and the rest will be park land which will be planted with a variety of trees. We will have a lake for storage at the bottom, which will include an island for wildlife habitat.

The first part of the process is bar screens, followed by the fine hydrasieve screen. This screen can remove not only most of the solids which usually come out as floatables, but also grit. This is followed by a two-stage trickling filter, using plastic media, and then a clarifier. After that it goes into constructed wetlands for polishing. It is our feeling that constructed wetlands would not be incorporated in a series of plants like this unless the water was to be either discharged directly into the Tijuana River, or recharged into the aquifer either by injection or percolation, due to the fact that these marshes require quite a large amount of land and this is not generally available in Tijuana.

The concept is to create a series of small satellite treatment plants throughout Tijuana, 15 or 20 of them, reusing the water locally for irrigation for slope stabilization or parks, for wildlife habitat, for industry such as cement, for dust control, and for roadway landscaping.

As an aside, I recently returned from a trip to Northern California where I spoke with wastewater specialists from a variety of cities, including Santa Rosa, and was appalled to learn that San Diego was widely considered to be in the stone age of wastewater treatment, and no one could really understand why we, being at the "end of the

pipes," should be so recalcitrant in both water conservation and wastewater reuse. This is also the case for Tijuana which has to import water from distant sources.

Discussion

Jim Cornelius. Thank you, Susan. I would like to thank all the speakers. We will go ahead and take some questions at this time.

Question. What are different technologies used for wastewater treatment and what are some of the uses for the harvested plants?

George Tchobanoglous. With respect to water hyacinth, perhaps the best use is as a compost which will ultimately be used as a planting mix. I personally do not anticipate that you would fill the entire state with water hyacinth plants, but I think that there are enough uses that could be made of the material and if composted properly produces a very high quality mix. Now there are other plants, for example, *lymnaea* (a duckweed) which is an interesting subset. There is a company that markets *lymnaea*. What they have developed are a series of floating baffles, and these baffles are made so that a harvester can run right over the top of them and they just sink into the water. The nice thing about that is that they prevent the lymnaea from piling up on the banks and becoming anaerobic. So there are a whole series of technologies out there that are available and can be used. Perhaps Rich Gersberg can comment on the use of the cattails.

Richard Gersberg. Well, they do not have to be harvested. We harvested some of the beds once a year. They do not necessarily have to be harvested to get treatment, because as we have mentioned most of the treatment is not due to the plant's uptake, in which case you would have to harvest, but is in fact due to the bacteria growing on the root. And we did not harvest some of ours for four years with no adverse affects. So that is the first point. The other point is there is a project, I believe, in Minnesota and Michigan area, by the gas research institute, and I believe that the hyacinth plant also looked at converting biomass to methane gas, so that is a possibility.

Question: Chuck Cooper. This is addressed to Al Utton, because of your international groundwater treaty. Here in the United States, we have not been able to negotiate enforceable groundwater treaties between states. Even within the state we have not been able to negotiate enforceable groundwater treaties between counties. And even within a county, we have not been able to get enforceable groundwater treaties between adjacent landowners. My question really is both political and legal: would the controversies over groundwater within the United States be a barrier to negotiation of an acceptable international treaty and/or would the existence and ratification of an international treaty affect groundwater policies or precedents within the United States?

Al Utton. Chuck, if I could just respond in the following way. You are partly correct and partly incorrect. But overall, the main thrust of your question is correct. Yes, it is an added difficulty to find that the legal regimes regarding groundwater are different in each one of the four states that front on Mexico. We look at Texas, they still have the law of capture which a friend of mine said must have been written by that great jurisprudential thinker, Attila the Hun, in that anyone can do whatever he or she wants to damn well do on his land, or her land. You can pump and capture all of the water that you can pump even though you are stealing that water from your neighbor. That neighbor might be Mexico, it might be New Mexico. That is a rather difficult-at-best nineteenth-century approach borrowed from England, at least a century ago. Then you come to the case of New Mexico, which is where you are partly wrong. Many western states, including New Mexico, now have groundwater regimes which give the state water administrator the authority to declare groundwater basins and control withdrawals through spacing of wells, size of wells, and so forth, with the ultimate goal of reaching a balancing of the water budget in that aquifer. New Mexico has such a regime. Water all belongs to the public, no individual owns it, much as is the situation in Mexico. Arizona has a different regime, but after "heroic leadership" on the part of Governor Babbitt, they enacted a new groundwater law about 1982, which declares critical zones within Arizona where recharge does not meet the withdrawals. It is designed to bring those critical zones into balance. New Mexico, luckily, has had our law in effect for more than half a century, so we have kept ourselves in balance. Arizona is trying to shrink back to balance by about 2020, a more difficult task. But they, within critical zones, are able to assert administrative control over withdrawals, spacing of wells, size of wells, and so forth, and also control over recharge areas. Then you come to California where the law was not written by Attila the Hun, but must have been written by a committee. There must be a better way of saying it, a more powerful way to say it, but the California groundwater law is chaotic. It is a mess. Californians do not have the ability to adequately control their groundwater future. That is kind of a panorama. If we look on the Mexico side, they do have a unified legal regime. Water belongs to the public, you have to get a permit to exploit it, it can be controlled. That is the good news. The actual enforcement is difficult. But they have a unified legal regime. Many western states within the United States have the approach of Arizona and New Mexico and that is of exercising administrative control over withdrawal in groundwater areas in so-called critical zones. We do not have the administrative ability nor the

budget to exercise control everywhere, so we will pick those areas that need the most control, those critical zones, and administer them more intensively. So with those examples, following that example, the proposal that we make is that the International Boundary and Water Commission first of all establish the ability to develop the information, the research projects to determine what the groundwater situation is, identify the aquifers, what the recharge is, what the water quality problem is, and then after doing that, to declare critical zones, conservation areas we call them, and then exercise control over those areas. As there are additional critical zones developing, they could do that. That is not a novel approach. That is done in Utah, Colorado, New Mexico, Idaho, Wyoming, and Arizona. So, part of what you say is the bad news, but there is also some good news to look at.

Question: Tom Dean, Coastal Resources Associates. A number of terrestrial plants sequester selenium, primarily as a defense against grazing pressure. I was curious to know if any aquatic plants do this. If so, is it possible to use them as a possible solution to the problems in the Salton Sea area?

George Tchobanoglous. We did a study looking at the role of plants in selenium uptake and the sad news is that the area required for plant uptake is almost double the area required for evaporation. I wish I could be more optimistic. I am a keen believer in plants, but it is just unfortunate that, again, it is a transport phenomenon, giving it to the zones and then for the concentrations we are looking at, evaporation was more effective.

Question: Carl Hansen. A question for Professor Tchobanoglous, about the San Diego aquaculture. Where do we go with this? It was expanded in Mission Valley, is there a future or are there problems?

George Tchobanoglous. The answer to the question is that currently the plans are to expand the facility in Mission Valley to one million gallons per day and build a one million gallon per day facility in the San Pasqual Valley. And the EIR has just been completed and to the best of my knowledge, it was a negative declaration so that plant will continue. The idea then is to use the water hyacinths at that particular location, the nurseries have expressed an interest in accepting all the water that could be produced. I see the role of these systems really as satellite treatment systems, as Susan de Treville suggested, and that the logistics of these plants as they get very much larger are not well understood. We have made some significant modifications, for example, in wrapping the channels around so we can control the hydraulics at a very low cost. But, again, I see them primarily because there are not large reuse applications in San Diego for sizable quantities, I see them more in a satellite role, in the one mgd, two mgd, and below size range.

Question. A question for Professor Utton. You are familiar with the fact that over the last 100 years or so in this country, the laws regarding contracts and torts that have been restated because of the hodgepodge of laws within the states. Do you see any kind of groundswell in the legal community to try to do that, you know, perhaps using space technology to take pictures of the ground, using that type of technology to restate the law of water throughout the dry western states.

Albert Utton. Certainly the science of remote sensing, satellite sensing, is useful and could be extremely useful in the administration of water resources in general and groundwater in particular in identifying where those aquifers are and determining quantities, amounts, locations of groundwater sources. And a second example along that line, many states in the west require that you put the water to use, to beneficial use and if you do not put the water to beneficial use, then you forfeit your water rights to someone else who will put it to beneficial use. The enforcement of that through satellite technology could easily tell where the water is being put to beneficial use and where it is not being put to beneficial use. Politically, however, many state water administrators do not really want to know that, and so, probably satellite technology, even aerial surveillance, which is available, would make it possible for them better to enforce the laws of forfeiture regarding water rights. So there is a political dimension which is in conflict with the information that can be generated by the technology that is advanced. Technology does, however, make possible the administration of laws, and therefore the change of laws to reflect that better availability of knowledge within the limits of what people want to know, of the politics.

Now, if I could squeeze back to the question of how about a water quality example in the groundwater area along the border, it seems to me what we were talking about yesterday about American industrial plants located in Tijuana or in Mexicali and what kinds of environmental impacts are they generating and what kind of controls might be exercised by the EPA on this side over American companies operating abroad. You have another example in the El Paso-Ciudad Juárez area where you have large numbers of maquiladoras now located. You have something of a Silicon Valley there in the microchip manufacturing operations by numerous large American and Japanese companies generating microchips. One has to ask the question, and it is only a question: What effects are there on the groundwater quality given the solvents and other chemicals which we know are to be used there, the kind of problems we have seen in Silicon Valley in California, Love Canal, and so forth, combined with the fact of the aridity of the region, and when you contaminate groundwater sources, it is almost impossible financially and physically to clean them adequately. So, that contaminated water means loss of water for most uses. So the question that has been raised with no answers is what might be the impact of

those offshore American operations which are subject to Mexican environmental laws?

Question: Craig Wilson, State Water Resources Control Board. I am very encouraged to hear that these types of treatment plants that you are talking about, Dr. Gersberg, are becoming more popular for use in greenbelts and so forth. One thing you did not address is control of mosquitos in those types of plants. What is your experience with that?

Richard Gersberg. That is a good question, Craig. In the systems that I was showing, the rock or the substrate was not a clay soil which is not permeable where you get overland flow and of course, pooling and mosquitos. But it was, on the other hand, a permeable gravel, where the water could actually be run as an underflow so there was no surface water. If we allowed the water to pool on the surface, we would get mosquitos, but we would then just drop the water, let it run in the root zone underneath the rock and the mosquitos would eventually go away. So the best alternative is to use either a natural soil which is permeable like a sandy or gravel soil, or else to import a soil which has permeability and then you do not need water on the surface. But it is a problem if you do have water on the surface.

Question: John Melbourne, County Department of Health Services for the County of San Diego. It was mentioned by two of the participants here that the health requirements were setting reclamation efforts back. I do not really believe that. I also would like to point out that it was incorrectly portrayed to you that Title 22 entailed complete advanced wastewater treatment. There is a variety of different steps that you go through, and Jim you are in a better position probably to portray that than I am, but it goes all the way from primary treatment to highly treated wastewater.

Jim Cornelius. I would just like to take a minute and follow up with the comments that were made yesterday by some of our friends from Mexico relative to treatment plants in Mexico. They have many plants, evidently, that are not being operated effectively, and this would apply also to certain types of reclamation plants. Regardless of how much planning you do, and how much money you spend on construction of treatment facilities, you must have properly trained operators. You must have people who know how to operate and maintain the facilities. In the Clean Water Grants Program in California, we have set up what we call an Operations Section. The speaker earlier in the program from the State Water Resources Control Board, James Giannopoulos, is the Chief of that section. The section staff reviews operations and maintenance manuals and conducts final project inspections where we check the operations of grant-funded treatment facilities. In addition, the section includes an operator certification program in the State of California and an operator training program. Dr. Don Proctor, the Director of Water Quality Control Institute which is located here in San Diego, is here with us today. Dr. Proctor has been a professor of Sanitary Engineering and has been in private practice as a troubleshooter and operator under contract for wastewater treatment facilities.

Session VI: Technical Session-Oceanographic Factors and Marine Pollution
James Cornelius, Moderator

James Cornelius. The panel is a technical session on oceanographic factors and marine pollution. One of the many projects that the State of California is involved in is preliminary work on oceanographic studies leading to the potential predesigned work, and, ultimately, the design of a new ocean outfall in the San Diego area immediately north of the Mexican border. If you were here yesterday, you heard from the Regional Water Quality Control Board which had gone on record a number of years ago indicating that any ultimate solution for sewage treatment and disposal in the Tijuana-San Diego area needs to be tied into the design and construction of an ocean outfall. However, in the decision-making process, many alternatives need to be evaluated, including the preparation of environmental impact reports. But that does not mean that preliminary work cannot be done. If we had the go-ahead to do the additional studies today, it would take at least another year to complete the redesigned studies, an additional year to design the outfall, and probably two years to construct it. So, we would still be four to five years away from an operational new ocean outfall.

One of the concerns that affects these studies is the state's ocean plan which is now in the process of being revised. I won't get into that because our first speaker this afternoon is Craig J. Wilson, the program manager for the Ocean Standards and the Policy Unit of the Division of Water Quality of the State Water Resources Control Board.

Craig Wilson. State and federal law require the review of the Water Quality Control Plan for Oceans Waters of California (Ocean Plan) every three years. The State Water Resources Control Board (SWRCB or State Board) began the review of the California Ocean Plan with two public hearings held in October 1986. The SWRCB adopted the Triennial Review and Workplan in March 1987. On June 20, 1988, the SWRCB held a public hearing on the first set of proposed amendments to the Plan. In this presentation, I will present an overview of the Ocean Plan, the results of the 1987 triennial review, discuss the amendments proposed in 1988, and then conclude with a brief description of the National Academy of Sciences study on the systems assessment of marine environmental monitoring.

The Ocean Plan is the Water Quality Control Pan for Ocean Water of California (SWRCB 1983a) that established the water quality standards for California's ocean waters and, along with federally-mandated technology-based standards, established the basis for regulation of wastes discharged into the coastal waters of California. It is applicable to point and nonpoint discharges. The State Board establishes the Plan and both the State Board and the six coastal Regional Boards implement and interpret the Plan (Figure 3).

The Ocean Plan contains sections on beneficial use designations, water quality objectives, requirements for management of wastes, effluent and receiving water requirements, discharge prohibitions, and general provisions for exceptions and monitoring programs. The State Board identified several uses of marine waters that should be protected. These uses include protection and enhancement of marine life, recreation, industrial water supply, aesthetics, and navigation. To protect beneficial uses the Board has established a set of narrative and numeric water quality objectives. The objectives include bacteriological standards for the protection of body contact recreation as well as objectives for the adequate preservation of marine biological communities and their habitat.

The third portion of the Ocean Plan gives guidance for the development of new discharges into marine waters. The Plan provides a listing of the considerations a discharger must address before a new discharge will be permitted. The fourth part of the plan is the effluent and receiving water quality objectives for the protection of marine waters. The effluent limits (Table A of the Plan) apply to all public-owned treatment works (sewage treatment agencies) and to industries that do not have established effluent limitation guidelines established by EPA regulation.

The water quality objectives contained in Table B of the Plan are derived from data of the scientific literature that measure the toxicity of various substances on marine organisms. These scientific data, along with information on attainability and site specific considerations, are considered by the State Board which adopts the water quality objectives. The water quality objectives for receiving water are converted into effluent limitations that apply to all discharges into state ocean water. These effluent limitations are established on a discharge specific basis, depending on the initial dilution calculated for each outfall. The Table B objectives in the Plan must be met after initial dilution is complete. In all, there are twenty-one numerical objectives for specific substances or groups of related substances as well as objectives for toxicity and radioactivity.

The last two sections of the Ocean Plan contain sections on discharge prohibitions (e.g., municipal or industrial sludge, bypassing, discharge into areas of special biological significance, and others) and general provisions. These provisions mandate Regional Boards

Figure 3

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARDS

to require dischargers to monitor their discharges and provide the State Board a mechanism for allowing exceptions to the Ocean Plan under special circumstances, provided beneficial uses are protected and the public interest is served.

Triennial Review of the California Ocean Plan

The Ocean Plan was adopted in 1972 (SWRCB 1972) and was first reviewed and revised in 1978. During that review (SWRCB 1978), the concept of initial dilution as used currently and the Table B limitations based on the toxicological literature were incorporated into the Plan. These receiving water limitations are established on a discharge specific basis, depending on the initial dilution calculated for each outfall. The Table B (with the exception of limits on radioactivity) limits must be met after initial dilution is complete.

Another revision was completed in 1983 (SWRCB 1983b). The major changes to the Plan were the addition of several compounds to Table B, modification of the bacteriological standards, and the incorporation of portions of the 1972 and 1978 guideline documents into the Ocean Plan.

The most recent review was begun in 1986. The SWRCB held two public hearings, one each in Northern and Southern California, to solicit input on which parts of the California Ocean Plan needed improvement. The testimony and comments were summarized and presented the Triennial Review and Workplan to the SWRCB at the March 1987 Workshop and Board Meeting. The SWRCB adopted the Ocean Plan Triennial Review and Workplan on March 19, 1987.

Forty-two issues were raised by the public in the hearing process. The State Board identified seven high priority issue categories (see Table 1).

The first was suspended solids which included issues related to level of treatment, sediment objectives, bioaccumulation standards, additional protection in environmentally stressed areas, and mass emission limitation of toxic substances. These issues will be addressed concurrently and the SWRCB will address some of these issues for possible Ocean Plan amendment by FY 1989-90.

The SWRCB is mandated in the Water Code (Section 13170.2) to adopt marine bioassay protocols by January 1, 1990, and then to implement the protocols for some dischargers by January 1, 1991.

The other high priority issue groups are the use of enterococcus as a better indicator of pathogen-caused illness, the policy for the regulation of nonprofit pollution sources, water quality standards (e.g., update and add to Table B--receiving water objectives), revise initial dilution concept, expand beneficial uses, and others), and establish guidelines for the consistent implementation of monitoring programs. The Administrative-Cleanup group covers simplification of the exception process, clarification of terms, and sludge disposal policy.

Proposed Amendments to the Ocean Plan

In accordance with the 1987 Triennial Review and Workplan, the State Board circulated a draft functional equivalent document (equivalent to a negative declaration as described in the California Environmental Quality Act) that contained seven proposed amendments to the Plan. A hearing was held on June 20, 1988, to receive comment on the proposed changes.

The proposed amendments cover some of the issues under water quality standards and the administrative matters mentioned above. Amendments are proposed affecting the designation of beneficial uses, turbidity measurement, water quality used by marine laboratories, and revision of the water quality objectives for nine metals in Table B objectives.

Table 1.

Schedule for completion of the high priority issues identified in the California Ocean Plan Triennial Review and Workplan (SWRCB1987).

	Fiscal Years 1987-88	1988-89	1989-90
1. Suspended solids			x?[a]
2. Bioassay Protocols and Implementation			x[b]
3. Enterococcus		x	
4. Nonpoint Sources			?[c]
5. Water Quality Standards	x	x	x
6. Administrative Clean-up	x	x	
7. Monitoring Methods			x

[a] x? = Part of the issue analysis completed, decision point for for the remainder

[b] x = Issue analysis completed.

[c] ? = Decision point (Recommendation to SWRCB).

The recommendation for the Ocean Plan's beneficial uses is to make them consistent with the State Board's

standard list of beneficial uses that was used to establish the beneficial uses in each of the Regional Boards' Basin Plans. The second recommendation is to change the use of Jackson Turbidity Units (an outdated measure of water clarity) to Nephelometric Turbidity Units (a measure more commonly used). The third recommendation is to specifically state in the Ocean Plan's Chapter III that the preservation of water quality around existing marine laboratories should be considered in the design of new outfalls.

Amendments are proposed for the receiving water objectives for several metals. Of the nine metals considered, the objectives for three metals remained the same (arsenic, chromium, and zinc), five were decreased (cadmium, copper, lead, mercury, and nickel), and one was increased (silver) (see Table 2). For comparison, the Environmental Protection Agency (EPA) criteria for each metal are presented in Figure 2. For the most part, the proposed objectives are lower than the EPA criteria (except for mercury and copper).

Table 2.

Comparison of the Current and Proposed Water Quality Objectives with the Environmental Protection Agency Water Quality Criteria.

Substance	Current (ug/l)		Proposed (ug/l)	EPA Criterion (ug/l)
Arsenic	8	=	8	13
Cadmium	3	>	1	9.3
Chromium	2	=	2	50
Copper	5	>	3	2.9
Lead	8	>	2	5.6
Mercury	0.14	<	0.04	0.025
Nickel	20	<	5	8.3
Silver	0.4	<	50.7	2.3
Zinc	20	=	20	86

The remaining recommendations are to include recent changes in the California Water Code (state law) that affects the Ocean Plan, simplify the exception procedures in the Plan, and to propose new definitions for "degrade" and "kelp beds." The proposed definition of "degrade" will permit clearer and more consistent interpretation of marine environmental data and the definition of "kelp beds" would be expanded to include the dominant Northern California species, bull kelp.

National Academy of Sciences Study on Marine Monitoring

One of the high priority issues being addressed by the State Board is monitoring used to determine compliance with the Ocean Plan. The Marine Board of the National Academy of Sciences has undertaken a study entitled "A System Assessment of Environmental Monitoring" to assess the use and usefulness of monitoring programs in making environmental management decisions. Specifically, the project intends to identify: (1) the role of monitoring in environmental management, (2) the interaction of monitoring research, (3) improvements necessary in monitoring technology, (4) the effective use of monitoring in environmental management, and (5) improvements needed in implementation and decision making.

The study has been conducted nationwide; the Marine Board panel has convened case studies on monitoring in Chesapeake Bay, the North Sea, and the Southern California Bight. In the Southern California case study, the panel has made some preliminary observations including monitoring should be performed on a regional basis, monitoring objectives should be less vague, and monitoring procedures should be standardized.

The California Ocean Plan sets environmental objectives for the protection of California ocean waters and the disposal of waste in the state's coastal waters. The triennial review of the California Ocean Plan was completed in March 1987. Seven high priority issue groups were identified. Proposed amendments were heard by the State Board in June 1988; the comments received will be summarized and the Ocean Plan will be brought before the Board for their consideration in September 1988.

Jim Cornelius. The next speaker is Enrique Manzanilla from EPA Region IX. You heard Enrique speak earlier on a number of topics. Enrique will be discussing EPA's efforts to protect coastal waters.

Enrique Manzanilla. I feel like I have a split personality, doing the presentation yesterday and now doing this one. But this in many ways is my true hat. What I want to do is go over the approaches that are being developed in EPA for looking at near coastal water problems. I first want to review what we have been doing so far and what we are trying to do now, and hopefully what this means for the future.

In looking at the management of coastal waters, to say that it is fragmented is an understatement. There are some acronyms for agencies that have responsibilities for coastal waters that are a mystery to me. This gives you an idea of one of the problems that we are faced with in the management of coastal waters.

Focusing on EPA's current approach, it does not seem like the picture gets too much better. We have different programs in different parts of the agency that all impact the management of coastal waters. When we talk about the estuary management program, that basically refers to the national estuary program which was recently put in place by Congress and the Water Quality Act of 1987. In addition, there are other programs, the National Pollution Discharge Elimination System Permitting Program for both industrial chargers and treatment plant dischargers. As well, there is ocean dumping, 201(h) waivers, again related to ocean dischargers, water quality monitoring. Dredge and fill activities that are regulated under Section 4 of the Clean Water Act and the EIS's by other federal agencies for activities in coastal areas, super fund activities, and, of course, marine research.

Even with this approach the agency found that environmental quality was still a problem in many coastal areas. Consequently, there was a certain amount of urgency in the agency in trying to develop a new approach, given certain future trends that we were seeing. First, coastal county populations are expected to continue increasing. We estimated that by 1990, 75 percent of the U.S. population will live within 50 miles of the coast. This translates, of course, to more demand on these coastal resources for recreational uses, commercial fisheries, recreational fisheries, out of continental shelf development, and, of course, increasing volumes of municipal waste and also increasing volumes of nonpoint source dischargers.

We felt that near coastal water problems are important and they are also manageable. There is an ecological value that is inherent in coastal waters, a commercial value, and an integrative value, i.e., recognizing that coastal waters really serve as a repository of an entire watershed. We also recognize that we have many mechanisms in place already that we have not really fully utilized in an integrative approach. And that is why we feel that existing laws and regulations can be better applied to improve the quality of near coastal waters. And, of course, I think the management of near coastal waters represents an opportunity to take a multimedia approach to environmental problem solving.

Our approach builds upon something that was developed within the agency in 1985. It is called the Strategic Planning Initiative and it basically focuses on a number of areas. The first area, "develop and communicate a common understanding of long-term goals and strategies," tries to address perceptions and realities that are faced by the public and also breakdowns in communication that occur between the regulatory agencies and the public.

The second area refers to using the best available scientific technology to assess these problems and also organizing the data that are already available in a fashion that is usable by managers of coastal waters.

The third area is self-explanatory. We want to develop new approaches to managing coastal waters.

The fourth area is also very important in that we do not want to study the problem ad infinitum. If the data are available and we can make decisions on managing coastal waters, we want to implement those decisions. Next, we have to recognize the intermediate nature of pollution problems in near coastal waters and all these objectives are meaningless, basically, if we do not implement them.

The near coastal waters strategic goals are fairly straightforward. They call for the restoration and maintenance of ecological integrity and for a coastal environmental management related to human health, public welfare, and economic potential.

There are several specific objectives in the near coastal water strategic plan: maintain the current national programs; maintain present environmental quality; maintain designated use categories for water that is not meeting standards; and anticipate problems and take preventive actions. The EPA convened a panel of experts to define the major problems facing near coastal waters when formulating a strategic plan. We came up with basically five problem areas: toxics contamination; eutrophication; pathogens contamination; habitat loss and alteration; and changes in living resources.

As you can see, this is a somewhat ambitious program and you might at this point be asking, "How are we going to accomplish all these wonderful things and how are we going to implement them?" There are about seven implementation themes that EPA headquarters has espoused. I want to talk about three of these in detail.

The first theme relates to the use of near coastal water assessments. Early on, the agency realized that the detailed understanding of near coastal waters, near coastal water quality, lagged behind that for inland waters. Even though large amounts of near coastal water data existed, they were not organized in a way to support regulatory or management decisions. Consequently, the agency has embarked on trying to integrate or provide a framework for integrating data on near coastal waters. Our goal is simply to direct regional and state attention to those near coastal waters which are threatened with degradation. We are trying to do this by institutionalizing assessment activities, establishing a baseline for monitoring programs, and maintaining state and regional attention on management action in near coastal waters.

As a first step, EPA headquarters has conducted a case study to identify and compile existing data on near coastal waters in a format that could be used by water quality managers. A first draft of this case study has basically been completed. In essence, what they want to do is use this as a model for other coastal areas to use in organizing the data and making them available not only to EPA out in the regions, but also to state and local authorities for managing coastal problems.

The second area in the near coastal waters planning initiative is the use of innovative cost-effective management tools. We see these as joint federal/state efforts to explore innovative management action for improving and protecting near coastal waters and to demonstrate approaches for possible application in other near coastal waters. Management action includes demonstration of innovative point source and nonpoint source controls and habitat restoration techniques. Last month, the San Francisco office of the EPA sent out a request for concept papers for projects of this type and we received about 15 or 20, including one from Joy Zedler dealing with the Tijuana Estuary.

The third and final area that I want to talk about is the National Estuary Program. As some of you may know, Section 320 of the Water Quality Act in 1987 institutionalized a management approach for estuaries. It is basically a geographic approach to managing estuaries and it utilizes a three-phase approach: (1) characterize the problems of an estuary; (2) develop a management plan; and (3) develop implementation mechanisms for this management plan.

In implementing this program, we are trying to target basin-wide assessments of the problems in estuaries. We are trying to integrate all the available regulatory tools and we are trying to establish a collaborative problem-solving organization. I think one important aspect of the estuary program is not only the process it sets in place for assessing the problems, but it also establishes a framework for implementing solutions to those problems. And that framework depends on collaboration among federal, state, and local entities, as well as the public.

I would just like to conclude by emphasizing that this approach is very comprehensive. There is more information that we need to develop on technology transfer, regulatory tools, the use of regulatory tools, and public involvement. This is a 15-year process so it will take a long time to get from Point A to Point B, but we are trying to at least take that first step on a very long journey.

Jim Cornelius. Our next presenter is Thomas Dean from the Coastal Resources Associates

Thomas Dean. I would like to discuss what effects wastewater discharges have on nearshore biological communities. I will break my talk into several parts. First, I will briefly discuss the effects on the physical chemical environment and then I will talk a little bit about what affects we might expect on the biological communities. Then I would like to take a few moments and talk about monitoring and, as Craig Wilson has mentioned, some of the new monitoring tools that are being proposed. Finally, I will make a few comments about wastewater treatment, both in the United States and Mexico.

First of all, I think I am going to convince you that there are in fact, deleterious effects of wastewater discharges on the marine environment in Southern California. However, it is extremely difficult to quantify those effects and to show cause and effect relationships. By and large we rely on correlation analysis to indicate that there are effects and, in most cases, there are not clear cause and effect relationships between discharges and observed effects. There are several other problems in trying to assign cause and effect relationships. First of all, there has been a long history of changes in the nature of discharges in Southern California. Second, a lot of the things that are discharged, especially some of the organic materials, have extremely long lives, particularly in sediments. Therefore, it is very difficult to differentiate present day effects from historical effects of discharges.

There is also a great deal of temporal and spatial variability in the biological communities. Even in so-called control situations where we have no effect of discharges, we see changes in communities over time and spatial scales, due to purely random biological processes or possibly to some environmental influences other than those induced by man.

Finally, there are also historical components in biological systems. We see, for example, that a particularly good recruitment year, a good year for the birth of a particular polychete worm, for example, might have effects that are realized within the biological system for many years to come. Therefore, it is very difficult to look at a biological system at any one point in time and predict its future.

By the way, most of the data I will use are from the Southern California Coastal Water Research Project's Reports, and I would like to give credit to people there. The Southern California discharges for which we have the most data are in the Los Angeles area, and I will especially be concentrating on the White's Point discharge that is operated by the County of Los Angeles.

I want to give a brief overview of some of the physical affects of discharges. Based on a plot of secchi dix

readings which indicate transparency of waters, there is a trend of decreasing transparency as you get closer to the discharge at White's Point. This is in agreement with what we see in the sediments. Fine sediments accumulate around the outfall, especially at depths of 30 meters and greater.

It is also clear that there are large amounts of toxic substances being released by these discharges, and that quality and quantity of materials being released are changing over time. DDT and PCB concentrations that have been discharged by Southern California dischargers have been plotted for the period 1971-1983. I especially wanted to point out that there have been dramatic declines in the discharge of some substances, especially in DDT.

These are some of the biological affects. Classically what we see around discharges are increases in the number of individuals, an increase in the biomass, a decrease in the number of species, and a change in the species composition. Ampheodia, a brittle star, was found in much higher in abundance at control sites than at contaminated sites. A classical sewage tolerant polychete species, the worm *Capitella*, was much more abundant around contaminated sites than control sites.

A recent paper by Stull, et al., in the journal *Marine Biology*, is important because it points out the complexity of the system, based on data from 1972 to 1982. There are several things that I want to point out. First of all, the discharge site always had different communities than the control sites. Perhaps more importantly, there were dramatic changes in the community around the discharge over a ten-year period. Up until 1975 or 1976, the communities around the discharge were dominated by a small polychete worm. In the years around 1975 there was a massive recruitment of another polychete, *Listriolobus*, around the discharge, and because of this one massive recruitment event, *Listriolobus* was able to dominate for a period of about 3 to 4 years. Eventually, *Listriolobus* died out and were replaced by *Capitella*.

Just a few words about algal communities around discharges. Through a plot of percent cover of algae at sites going from sites near the discharge to sites some 20 kilometers away, we can see that there is higher percent cover of algae at the sites distant from the discharge.

There also seems to be some evidence suggesting that there may be effects of discharges on kelp bed communities, especially around the Palos Verdes peninsula. There is a negative correlation between kelp abundance and the temporal trends in emission of suspended solids at White's Point. The peak in emissions in the late 1950s coincided with an historical low in kelp abundance. However, the die-off of kelp in the late 1950s was widespread, occurring over most of Southern California, and it is not clear that the die-off of kelp at White's Point was caused by the discharge. However, there is at least a suggestion that there may be some effects of wastewater discharges on kelp beds.

One last point I would like to mention refers to data on concentrations of chlorinated hydrocarbons in scorpion fish that have been collected along the Southern California bight. Surprisingly, we see rather high concentrations of toxics, especially of DDT, even at places like Cortez Bank, which are far removed from discharges. The least contaminated site was along the coast of Ensenada, Mexico. It looks, at least in terms of these toxic substances, that Mexico has not caught up, if you will, to the United States in the degree of contamination.

Just a word or two about monitoring. These large-scale programs of sampling that I have described, that demonstrate biological effects, are extremely costly because of the temporal and spatial variability we see. They are extremely difficult to use in terms of setting discharge standards. Historically, regulatory agencies have used chemical standards as opposed to biological ones for setting discharge limits. This has met with some success, although we have to make a rather large leap of faith from chemical standards to coming to grips with changes in biological systems, the ultimate goal of the monitoring program.

More recently, the State of California has come up with programs to evaluate wastewaters based on bioassay procedures using sensitive life-stages (smallest larval stages). I think this is a big advancement and gives regulatory agencies a viable tool that will enable them to reasonably manage the discharge of waste on a real time basis using biological systems. As Craig Wilson mentioned, these new bioassays are much more sensitive than the old ones.

Summing up, I would just like to make a few comments. I have not really touched on what I think are some of the deficiencies in our knowledge of the effects of discharges. What I described to you are effects of normal operations of discharges. We really do not have a good feeling for the effects of so-called catastrophic events. For example, what happens when we have large spills of raw sewage into the environment? We have very little biological data that suggest what impacts of these catastrophic events may be. We also have very little indication of what storm water runoff and other nonpoint discharges of pollution into the ocean may have on biological communities.

It looks as though in the Southwestern United States we have an increasing trend toward improvement of the environment with regard to effects of marine discharges. Our discharges are improving, especially in terms of the release of toxic substances into the environment. Although Mexico is currently facing a nontrivial problem in trying to deal with largely domestic sewage, in some ways they are in the rather enviable position of not having yet to deal with large quantities of toxic substances. I hope that they can learn from our mistakes, avoid the release of toxic substances in the environment, and avoid the necessity for a Mexican superfund.

Jim Cornelius. Our next speaker is John Melbourne, who is a public health engineer with the San Diego County Health Department. For a number of years John has been the person evaluating the public health impacts of the discharges along the coastal waters.

John Melbourne. I appreciate the opportunity to be with you here today and I certainly give thanks to those who assembled the program, because this has given me a much broader view of the border problems and the border relationships between the United States and Mexico, instead of just looking or focusing on the southwest corner of the United States. It appears to me that growth, however, is a major issue and I am not going to address that today. But if anybody has any quick ways of controlling growth I am sure there are a number of people here that would listen to you.

I have had a multitude of experiences along the coastline of San Diego County, and have monitored water conditions for approximately twenty years. I recall one chart of bacteriological data was developed for the EPA approximately five years ago that was four feet long. In that chart I noticed that the bacteriological count at the international boundary tended to increase a little bit each year. And then suddenly in 1978 it dropped to virtually zero. That sudden drop in bacteriological count in 1978 was when all of Tijuana's sewage was connected to the San Diego metro system via the emergency connection. In 1980, when the sewer line was reconstructed after being washed out by floodwaters, we found that it would no longer contain the wastewaters that were generated in Tijuana. In other words, there were approximately 13 million gallons/day capacity in the metro connection, but that volume was now being exceeded and there were continual discharges into the United States.

Last Wednesday, I made a tour of all of the arroyos along the border and I am pleased to report that all were dry. I had not seen that in a long time. However, I stopped at the Monument Road-Dairy Mart Road bridge and I noticed that the discharge in the Tijuana River Flood Channel itself was substantially increased from the volume that I previously had witnessed. I had asked for some answers as to what had happened and I think what I was seeing was a peak flow about 4 o'clock in the afternoon versus the daily flow that was reported as being the normal 8 million gallons per day. But I can tell you that the volume of wastewater coming across in the Tijuana River is increasing and that creates additional problems for us.

First of all, our responsibilities have to do with public health. In terms of the responsibilities, one of those basic responsibilities is in recreational health. When a public beach used for public water contact sports fails to meet the standards, the health officer or the State Department of Public Health has the authority to close that area in the United States. Obviously, we have no authority beyond the international boundary. In the United States, as soon as there is a discharge of wastewater into recreational waters, an orange sign is posted that says, "Contaminated Water, Keep Out."

Our scope, as I indicated, covers all of San Diego County, however, for our purposes here today that scope is reduced to approximately five miles of the Tijuana River Valley and approximately five miles of coastline starting at the international boundary and going northward. The conditions that we are dealing with in that small area have a number of constants and a number of unknowns. We know that there is a constant flow of sewage into the United States. What we do not know is how much will reach the ocean and what direction it will travel. At times the current will run southward and then it will reverse and run northward at 1 to 5 kilometers per hour, which is very fast. Contamination induced by sewage discharges can travel a long way in a relatively short period of time, particularly if the plume remains intact. Sometimes that occurs. It appears as though the specific gravity, the temperature, or some other condition of that flow is such that it remains intact several miles northward from the discharge point. We have shifting winds and other meteorologic conditions that affect the movement of the plume.

We also have malfunction of wastewater systems both in the United States and in Mexico that impact that area. We have, as I stated earlier, renegade or fugitive flows coming down the Tijuana River in an increasing quantity. There are times when the pump station at the Playas de Tijuana community is not operating and we experience extremely high bacteriological counts at the international boundary. Then there are times also that the count increases at the Tijuana River mouth and decreases as it goes southward, indicating that currents are moving southward and that the contamination results from the river. The discharge point makes a lot of difference. Our bacteriological sampling can readily track the contamination and pinpoint the source.

One of the conditions that we deal with on an every day basis is a demanding public. They demand a high quality

of water, whether it is groundwater, surface water, ocean water, whatever it might be, and they also demand continual use of recreational waters. So that creates some problems when areas are quarantined due to poor recreational water quality.

Under public health considerations, as I mentioned earlier, we have recreational water contact standards. This bacteriological standard is being challenged as to whether or not the coliform dies off more rapidly than the pathogens that may be present with the contamination. But, the current standard will be in effect until a better standard is demonstrated. The current standard requires that the coliform organisms be less than 1,000 per 100 ml of specimen and that level not be exceeded more than 20% of the time. We also use a fecal coliform analysis but use the results as an interpretative tool rather than as a standard.

In addition to the recreational water contact, there is food, fish, and shellfish harvesting in the Tijuana Valley area. Remembering back to the early 1970s, I used to take littleneck clams out of the Tijuana River mouth area. After the storms, I believe it was in 1978 or 1979, many of the cobble areas that the littleneck clam is partial to, were washed out or buried so deeply that they were inaccessible. Starting in 1980, there was a continual flow of poor quality water coming down the Tijuana River, so I have given up clamming.

We have perpetual problems in San Diego County with mosquito breeding. Both encephalitis and malaria are spread by mosquitoes. You may have heard about a malaria outbreak in the Carlsbad area north of San Diego last year. Encephalitis or "sleeping sickness" is also endemic. We have had some serious mosquito problems in the Tijuana River Valley. Late last fall, mosquito control staff was finding approximately one larval form in every milliliter of water dipped from the river. And in a day's time, with this continual density passing into the United States, we had a tremendous mosquito population.

Drinking water is also an issue in the Tijuana River Valley. There is one home on Tia Juana Street, fairly high up in the valley, that uses groundwater for drinking. Other valley residents use it for varying purposes such as flushing toilets and washing dishes, but seldom for drinking.

There is also incidental body contact. In the daytime you will see children playing in surface streams. They are attracted to water as we were as children. They do not seem to pay much attention as to what the quality of that water is. In addition, there is a tremendous flow of undocumented alien traffic coming across the border and I have witnessed people wading in the Tijuana River or putting their clothes on top of their heads and walking across when the water is deep. I have also seen the Immigration Service chasing them back across the river. Incidental contact can be very significant, especially with the poor quality of water that is in the Tijuana River.

In terms of sampling, we were sampling the groundwater on a quarterly basis. That, however, has been dropped to approximately once per year, because the groundwater changes very slowly. We ran chemical, physical, and bacteriological constituents on the groundwater from five different wells in the Tijuana River Valley. Also, in cooperation with the City of San Diego, we run monthly analyses on the sewage when it is being discharged to the Tijuana Emergency Connection when there is a flow in the pipe. We also have run tests for pathogens, finding a wide variety of pathogens as you would expect in highly contaminated river water.

Surface streams are analyzed for coliform organisms by the International Boundary and Water Commission, U.S. Section, and the California Regional Water Quality Control Board on a weekly basis. In addition, in conjunction with IBWC and the Regional Water Quality Control Board, we run weekly samples on the ocean waters, starting at the international boundary and ending up at the City of Coronado beaches.

In terms of results, the groundwater tends to be highly mineralized and has a poor taste and odor and is probably a result of intensive agriculture and overproduction of wells in the valley. The sewage tends to have a higher Biomedical Oxygen Demand (BOD) and a slightly higher, but not significant, concentration of industrial waste than found in the City of San Diego. I would suspect that if there were industrial waste control programs in Tijuana, as there are in the City of San Diego, that waste would be very similar to that from the City of San Diego.

Stream waters are generally high in bacteriological count and there is physical evidence of sewage at the international boundary. The ocean water fails to meet the recreational standards at the mouth of the river, and at the international boundary itself.

Some of the bacteriological sampling programs overlap. As an example, the City of San Diego monitors the ocean on a weekly basis. In Figure 2 you will note the shore stations, starting with D-1 almost at the border; going northward you will note D-2, D-3. These stations meet the bacteriological standards for recreational waters. At the present time, we have a quarantine of approximately two miles that extends from the International Boundary the south end of Seacoast Drive, which is one of the southernmost streets in Imperial Beach. It is not the city limits, because the city limits of Imperial Beach go to the International Boundary. That quarantine is constantly

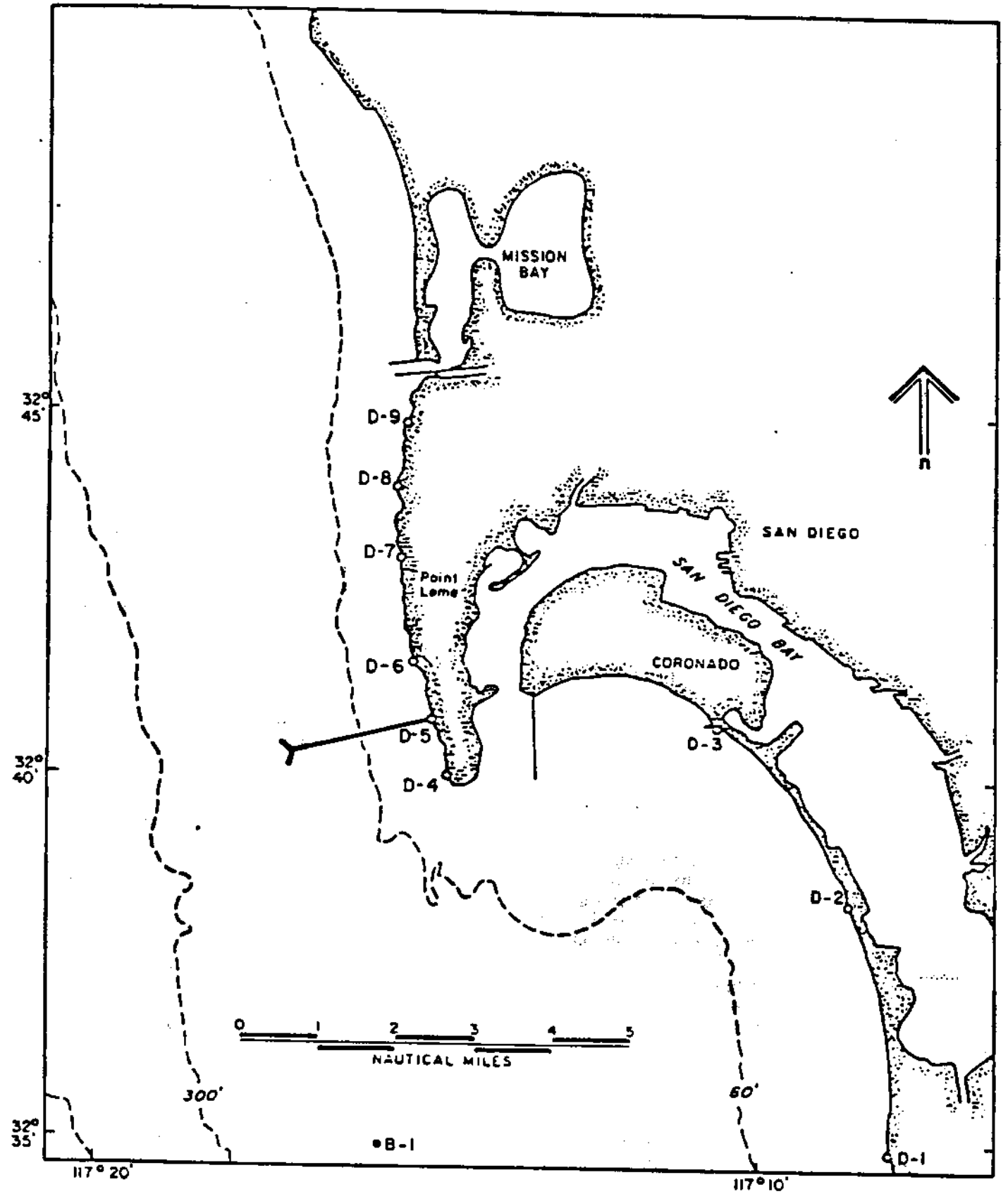


Figure 4

SAMPLE LOCATION SHORE STATIONS

CITY OF SAN DIEGO

OCEAN PROGRAM

monitored. There are times when currents move rapidly northward and our bacteriological samples indicate a high level of contamination. We then extend that quarantine northward. Within the last two years, the quarantine has been extended as far north as the Naval Amphibious Base area for a short period of time.

In terms of long-term solutions as we see it, our primary concern is containment of the waste flow coming down the Tijuana River. We see that as being a continually growing problem and one which is of significance to both countries because the populace of Tijuana is also exposed to those wastewaters. Our county is gradually becoming more and more densely populated in that area also.

Due to the topography, we also feel there is a great need for a failsafe system in the event that the Tijuana sewage system fails. Craig Wilson suggested an overall ocean monitoring program and I think that would be beneficial to all of us and probably save a few dollars, especially to us as a health agency which has no means of being reimbursed for the cost of our recreational water sampling. So it might be beneficial to utilize a program like that as a unified approach to sampling the entire coastline.

I would like to conclude my remarks at this particular time. I appreciate the opportunity to be here.

Jim Cornelius. Our next speaker is from the Instituto de Investigaciones Oceanológnas at the Universidad Autónoma de Baja California in Ensenada, Dr. Efraín Gutiérrez Galindo.

Efraín Gutiérrez Galindo. I am going to deal with hydrocarbons and trace metals. The border strip and the Sea of Cortez are considered prime study zones.

Following the lines of action set down by this program, keeping in mind the political climate of Mexico and lack of funds for our programs, we instituted an institutional program which proved demonstrable hydrocarbon and trace metal coastal contamination in the Baja California peninsula.

This was started in 1983 in accordance with the La Paz agreement signed by presidents from both countries. We were generally concerned with the coastal region of the Pacific, the drainage and canal waters from the agricultural valley in Mexicali (which can be contrasted to the Imperial Valley), and with the extreme north/south sections of the Sea of Cortez. This study suggests some evidence of damage to the marine flora and fauna and to the population. It also indicates the concentration and possible direct sources of environmental contamination.

It is important to mention that these programs are the first to be done in the peninsula. The principal objectives were to generate general information for research on the frontier area between the two states. This is very important because there is a lot of information from the American side and very little from the Mexican side.

In the Pacific we needed to evaluate organisms of importance, such as the mussel, oysters, and carp. In the Sea of Cortez, we used the California oyster.

Since I am from a university organization, there is great importance placed on the social service thesis and the famous phrase that is discussed when national meetings occur, and that is the creation of a conscience in the public, which has great impact on science.

The main goal was to provide the Baja California region with a reference point to watch for coastal contamination by toxic substances. In the Pacific area, we have started a program from Carson City to San Diego, and we continue it in the 300-350 miles in Baja California from Punta Banderas south. In the Mexican region they have the same organisms as in the Mussel Watch here in California and two additional mussel and oyster species. Those two species are exploited by the cooperative association of San Quintín. They have approached us, indicating that they will export some of their production to the United States.

In the Mexicali Valley, we concentrate on drains and canals similar to the ones in the Imperial Valley. We studied twenty stations in August of 1985 and February and June of 1986, collecting the shells and other items. We also studied the Río Hardy, technically the Río Prieto, and touched upon Mexicali.

In the Sea of Cortez we were studying areas such as the Gulf of Santa Clara which borders on the state of Sonora, to the port of San Felipe to San Lucas. We were looking for 154 different components. In trace metals, they range from silver to zinc. This includes elements such as silver, cadmium, lead, copper, and mercury. We have published our findings in the United States, France, England, and other European nations. We have an international committee to decide what research to follow at the Institute. We have a bulletin that details all the problems we have discussed.

Whenever we are invited to conferences, we try to present scientific works that are all-inclusive, from beginning to results, which is not the case at this time. We have gone to different areas in Mexico and the United States. Also,

we have gone to sanitation conferences in Mexico, the Fiesta Viva Exposition in Ensenada, and also to Rotary Clubs. There is international interest in the Institute.

As far as financial workings are concerned, it is under the Consejo Nacional de Ciencias y Technología, the Secretaría de Educación Pública, the University, and international organizations. We are grateful to the Department of Fish and Game in California, to Scripps Institute of Oceanography, and AID, the U.S. Agency for International Development. The purpose of this conference was to develop scientific cooperation between both Californias, to scientifically investigate contamination in both Californias, to exchange scientists and techniques in the investigation of contaminants, and to develop and exchange information as well as training and use of laboratories.

Jim Cornelius. Thank you, Dr. Gutiérrez. Now our final presentation of the day will be Jorge Escobar of SEDUE.

Jorge Escobar. The main topic of my presentation is work done by the agency regarding the quality of discharge from the Tijuana sewage and the effects on the marine environment in the Punta Banderas area. The infrastructure of trash collecting, toxic waste control, and the protection of coastal zones and marine contamination were also considered.

The activities of the agency (SEDUE) are varied and it is in charge of many functions. Currently, ecological protection is centered in the federal government although this will be modified in the future to give the states and the municipalities more power.

I will now comment on contamination control and environmental protection in the area. The environmental zones between the ocean and land constitute a very important area and the agency has an important task in developing controls for coastal activities. It so happens that in our country's development plans, as is usual, the needs of the coastal region and its resources and exploitation of coastal zones are often overlooked. Due to this fact, there has been an additional charge added to the ecological elements in the coastal region management.

As far as urban development and the administration of coastal regions are concerned, there is also a need for environmental controls to protect the marine environment which, in many cases, is the final receptacle for all garbage. It is important to point out that the protection of the marine environment is an important function of the agency's marine department. The national program for the protection of the marine environment is an inter-departmental program that includes the civil defense, which has federal and state representation, and the fisheries commission. In this program, there have been eight binational meetings between California and Baja California held with the goal of prevention of hydrocarbon and dangerous material spillage into the marine environment.

The main coastal protection role is on the American side. Through this commission, we have been able to employ contingency and prevention plans as required in case of emergency.

The agency's activities are fundamental. In the area of contamination control, a study was done in Baja California of the characteristics of contamination on the Pacific side and on the Gulf. This is where the wide differences are evident in the marine resource management between California and Baja California. In an earlier study we found that there are eight important discharge sources from urban areas on the coast of California.

In Baja California, we can talk about two important discharge sources: Punta Banderas, in Tijuana, and Ensenada, approximately 125 miles south of the border. Besides these, there are less important discharge sources. Their contributions are relatively small and do not go directly into the ocean, but instead are treated along the way.

The strategy followed is to suggest the course of development according to environmental impact, which, in the beginning, makes the use compatible as regards to the zone and, in particular, in relation to the urban development plans in the coastal regions. This way we are able to generate a series of protective measures for the coastal zone that takes into account the resources as well as the specific control measures according to the discharge sources, keeping in mind compatibility of the different coastal environments. Those are the functions of the agency in regards to the coastal environment.

We are particularly interested in continuing the monitoring of the water quality in the coastal region. The state program to monitor water quality has thirty stations to monitor continental waters, drinking water, is also part of the monitoring system that maintains eight monitoring stations in the coastal region. Six of them are in Tijuana; two are in Ensenada. The monitoring is done every fifteen days and has provided data that are combined with information about resources as well as potential resources in the coastal region so that they can be handled in the evaluation of these zones.

Session VII: Workshop Wrap-UP

Paul Ganster. I would like to make some general comments and then turn the podium over to Cliff Metzner. This workshop has brought together scientists, professionals, scholars, and others from Mexico and the U.S. to exchange information and develop some ideas on how to deal with some of the issues that have surfaced over the past two days. We have covered a wide range of water issues in the California-Baja California region and to me this has been one of the strengths of the symposium. The range of issues that we have dealt with has helped me personally in terms of filling in some gaps where my knowledge was weak. The diversity of the group assembled here has been excellent.

The very good discussion of wastewater treatment problems in the San Diego-Tijuana region and also in the Mexicali-Calexico region, in terms of public health effects as well as in terms of impacts on the environment and particular ecosystems, was a significant effort. We received very good information about some of the progress that has been made in our region in dealing with wastewater treatment and with pollution problems. Particularly pleasing to me was to learn about some of the major progress that has been made on the New River in addressing the very serious water pollution problems there. Also, we received very good information regarding efforts to include reclamation as a component in the broader programs and schemes to deal with water quality and water quantity issues in the region. We were briefed about a number of specific demonstration projects including the reclamation project at Santee, the efforts in the Tijuana Estuary, and some others. This workshop also brought experts on the marine environment and suggested what impacts pollution is having along our coastal areas. Two of the speakers raised the concept of working towards a better integrated approach to monitoring, joining of forces and not only saving money but providing better data over the long run.

Overall there was fairly clear agreement among participants from different agencies, in both Mexico and the United States, on what the problems are. Also, in what I feel is a very important development, I sensed that there was some sort of general accord and agreement that when dealing with these transborder problems, it is best to develop bilateral or binational solutions. The group seemed to be rejecting the white map syndrome that Al Utton and others have spoken about. There was general enthusiasm for the concept that we should pursue the most cost effective solutions and if this means spending U.S. money entirely in Mexico on point source control or even vice versa, that is fine, but let us approach these problems in a cost effective way and deal with the issues on a regional basis. We do have very good examples of binational cooperation in this general area. Efraín Gutiérrez talked in some detail about the California-Baja California Mussel Watch, which is a model of long-term effective cooperation at the monitoring level. Other examples of good U.S.-Mexican cooperation on specific problems in the border region have been mentioned.

There also seemed to be some sort of an agreement, or acquiescence at least, that meetings that bring together people from different areas and from both countries in the relatively neutral forum of the university are useful. Moreover, it is clear that we should think about extending these meetings in the future to focus on specific subsets of the problems that we have discussed here at San Diego State University.

Our task now is to summarize some of the important material that we have treated in the last two days and to discuss an agenda for a future series of workshops or future approaches to some of these problems.

Cliff Metzner. The next question, of course, is where do we go from here? We have meetings and seminars and workshops and people leave and it was pleasant and we gain information, but what happens next? Sometimes, material from the workshop is published, sometimes it is not. We plan to do a report on this meeting, both from the tapes that we have and also from notes and papers that were given to us by the presenters. So that is the first step.

The second step is trying to hone in on the areas that we feel are most important, at least for this particular time or within the next six months or so. I believe we were talking yesterday about a window of opportunity. This window pertains to the timeframe to come up with solutions to the Tijuana-San Diego sewage treatment, disposal, and reclamation problems. I think this window is open for a while. We just heard some discouraging news today that the U.S. Senate Appropriation Committee has voted against earmarking the $27 million appropriation for the "big collection pipe," or what used to be referred to as the 7C defensive system, i.e., the sewage collection system that was proposed for south San Diego along the border to intercept renegade flows of Mexican sewage. As you probably remember, the U.S. government originally authorized $32 million three years ago for the system and $5 million was appropriated to California and to the City of San Diego to design the system and the Corps of Engineers did develop a design of the collection system. It was decided to move ahead to obtain the remaining $27 million and the State of California and City of San Diego would contribute additional funds for the Big Pipe and the pumping station, so I do not know really what the next move will be if the decision is not turned around. (In August the U.S. Congress appropriated $20 million for the Big Pipe in the EPA budget.)

But in any event, from the standpoint of what do we do next, I think there are certain areas that we are going to concentrate on. One is the idea of an international or binational treatment plant, located in the South Bay area, that would also handle a substantial portion of Tijuana sewage. As you probably know, James Montgomery Engineers have proposed 21 different solutions to the City of San Diego Sewage Task Force. These are only options at this point, and they go all the way from expanding the Point Loma plant to the construction of a $1.5 billion plant which would handle all of San Diego and a major portion of Tijuana sewage plus an accompanying reclamation project. Having been involved in these planning efforts for probably six or seven years, it seems to me that the only plan to carry us into the 21st century would be an international or binational plant that would provide treatment for a large part of San Diego sewage and for a major portion of Tijuana sewage which would be in conjunction with a useful reclamation system that could serve both cities as well and the County of San Diego. It seems only feasible to take advantage of the gravity flow from Tijuana to the U.S. side of the border rather than using extensive pumping systems in Mexico. There could also be an added plan for decentralized treatment plants in Tijuana and for northeast San Diego County that would take some of the burden off of the Point Loma plant which could be upgraded to secondary treatment. These decentralized plants would include adjacent reclamation projects throughout the county. So, I think these are some of the ideas that we have to think about in order to prepare over the next six months.

What I am going to do is bring together another smaller group of experts here at San Diego State University, probably within the next four or five months. The questions that we will deal with will include the technology involved in development of these concepts and the issues concerning where plants should be sited, the type of plants for optimal treatment and reuse, and a comprehensive government of Mexico analysis of the issues and ideas relating to coordinated international regional plan.

We were told yesterday by Commissioner Gunaji that in September there will be another meeting of the U.S.-Mexican Border Environmental Group, the water working group, and at that point the EPA and the State Department (IBWC) will present the U.S. strategy for an international plant to the Mexican authorities on an official basis. So, I think by that time, at least we will know more about the U.S. strategy to solve this problem and I think we can provide some input to that.

Secondly, we would like to deal with the Mexicali-New River issue, which I believe is certainly as important as the Tijuana one. And again, this would involve a separate group workshop. The U.S. has, as we were told this morning, six or seven different plans that they could deal with on the U.S. side of the New River. The most reasonable plan, however, seems to be the development of some sort of a wetlands area that would drain off much of the New River water.

These are some of the items we have to review. Certainly we are encouraged, I was anyway, by what the government of Mexico is doing in Mexicali and the number of corrections they are making in conjunction with the International Boundary and Water Commission and the EPA of the entire sewage system in Mexicali. These include corrections to the sewage pipe system that leads into the main sewage system, and in more extensive control of some of the industrial companies in Mexicali that have discharged toxic waste into the tributaries that run to the New River. To my knowledge, there are two Mexicali industries that have been fined on a number of occasions, and even closed.

These events are very encouraging and certainly, I think that they should be investigated more closely before we move ahead in the State of California with any large operation on the New River. Next, I would like to call on Valerie Gray who is with the Commission of the Californias. She would like to discuss what could be proposed as resolutions for the Commission of the Californias to consider at their next meeting.

Valerie Gray. It has been heart warming to see the different disciplines represented here and that represents to me the exact nature of the problem which is multidisciplinary. This is an educational process but it has been just a beginning. I see the last two days as a kind of "survey" course, and that what we need now is "level 2" information where we delve into the different topical areas to open them up for people who are interested in just one aspect of the problem.

Let me explain a little about the Commission of the Californias. The process that is provided in the Commission is that meetings are held on different subjects and topics such this. However, we do not get down to this level of detail at the general sessions of the Commission. We try to involve people with awareness of the real issues; then, if it is appropriate, we usually develop one or more resolutions for each general session, held twice a year, or make recommendations for some follow-up work or suggestions to state government agencies, or whatever action seems appropriate. It occurred to me that there were a couple of possible resolutions for our next Commission meeting. One has to do with binational cooperation and getting somebody to participate from Mexico on the Tijuana River Estuary Management Authority. But since Paul Jorgensen is not here now, that is something we can talk about later.

The other is a draft that I have just developed. This is a sample of a resolution that I will present to the Environmental Committee. Then, as a committee, we would vote on it and then we take it to the Intergovernmental Committee, where they decide whether or not it is something that we, the two states of Baja California and our State of California, would like to approve. Bear in mind that this is just tentative language, but it could state: "Whereas substantial regional growth has contributed to potential water shortfalls and deteriorating water quality, making long-term supply and treatment solutions imperative; and whereas there are significant differences in the United States and Mexican economic, political and organizational contexts, making joint solutions very difficult to plan and implement, yet nevertheless critical; and whereas the quality of water treatment approaches and facilities is an important investment (like future capacity planning); and whereas, resolving the many regional water problems along the California-Baja California border and coastal waters will require increasing cooperation between the two states and countries; and whereas, a substantial amount of additional information will be needed to facilitate both shared perspectives and bilateral actions directed towards long-term solutions, especially in the absence of a widely perceived disaster or other highly visible or imminent crisis; therefore, let it be resolved that more detailed follow-on information exchanges be encouraged and implemented through the establishment of a broad regional forum for continuing education and dialogue concerning water management." This would take the form of additional workshops on specific topical areas under discussion, to increase user visibility and participation and to identify, document, and communicate issues, concerns, techniques, and recommendations to the binational authorities that are responsible for the resolving and managing of these problems.

That draft resolution was constructed from a lot of the issue areas I had identified from my notes. It will be discussed and we will probably change the wording, but I think, in spirit, the message is that this dialogue is needed because we are all participants and users of this water, even the people who are managing it and responsible for distributing it.

Chuck Cooper. Even though Paul Jorgensen is not here, both Mike McCoy and I are members of the Management Authority of the Tijuana River Estuary, and both of us would very strongly encourage you to frame the resolution asking for a representative from Mexico on the Management Authority, because, I think, the Commission of the California is probably as good a vehicle to get that accomplished as any.

Valerie Gray. Yes, and in fact, maybe we could talk about it afterwards in terms of wording a resolution. I have a possible draft resolution that could request a person from SEDUE to participate with the Estuary people. Perhaps a person has already been identified to participate with them.

Jim Cornelius. I appreciate being able to participate in these two days of meetings. I just had some thoughts about a couple of concepts.

There are a number of topics such as the Tijuana-San Diego South Bay land outfall project where there has been a great deal of recent activity. It is unfortunate that the Senate Appropriations Subcommittee did not include funding for the federal share of the project in EPA's budget. However, since the House of Representatives Appropriation Committee did include funding, the issue will be resolved by the U.S. Congress Appropriation Conference Committee.

A topic that should be given further consideration is the last topic today, Oceanographic Factors and Marine Pollution. We had a large number of speakers who each had information to share. We did not have enough time to really address all the questions. I feel a great deal has been accomplished in these two days.

Cliff Metzner. I would like to thank you all very much and I appreciate your attending and sharing your ideas with us. I hope to see many of you again in a few months for the second water workshop.