Hanhausen & Doménech Consultores, S.C.

Summary of the Seminar

Water in Mexico: Government Objectives and Opportunities for Private Investment

July 12-13, 2001

Prepared for

The Institute of the Americas

August 2001

Water In Mexico:
Government Objectives and Opportunities for Private Investment

Acknowledgements

Hanhausen & Doménech Consultores, S.C. (HDC) was invited by the Institute of the Americas to participate in the: “Water in Mexico – Government Objectives and Opportunities for Private Investment” seminar and also to produce an executive summary highlighting the key market development issues presented at the conference.

HDC is a Mexico City based consulting firm specializing in market intelligence and project development in Mexico and other Latin American countries. The firm has developed over 100 market research assignments for public and private clients and has a leading consulting practice covering Mexico’s water sector.

For more information, please visit www.hdc.com.mx or contact info@hdc.com.mx.

Executive Summary

- Mexico faces severe water quality issues as result of rampant pollution caused by municipal and industrial discharges, the vast majority of which remains untreated. A bigger problem, fast turning into a major crisis, is decreasing water availability as both superficial and underwater sources are becoming scarcer in most urban areas.

- The (Mexican) National Water Commission (CNA) is well aware of the major problems that have befallen Mexico's water sector and of their direct impact on Mexico's economy and population. Because of magnitude of these impacts, President Fox has referred to the water problem as a national security issue and is expected to take a stronger stand than previous administrations in finding a near term solution to these problems. Because of the limited government resources available for this sector, new plans will most likely involve larger private participation on infrastructure development and operation.

- Private participation in Mexico's water sector remains incipient. Only four medium sized cities in addition to Mexico City, home of 19 million people, have some form of private involvement in the operation of water systems. Private participation is expected to grow significantly in the near term as the Mexican government will try to attract private developers and operators for necessary projects in Mexico's most important cities. As a first step, a government program is underway for providing funding to those local water utilities that joint-venture with or concession their systems to the private sector. This program will be a major driver for increased private participation in this sector in the coming years.

- Mexico's largest water user is the agricultural sector with close to 83% of the total water consumed. But due to its inefficient use, between 40% and 60% of this water is lost. A top priority of the current administration is the promotion of an efficient use of water in this sector. For this, the CNA is developing programs for the construction of new and efficient irrigation infrastructure. It is developing new irrigation projects, especially in Mexico's southeast, and promoting the substitution of underground water for treated water in those crops that benefit from the use of "grey water."

- Mexico City runs a water deficit of about 10 M^3/s. Local policies to abate this problem have consisted of reducing the amount of water lost in the distribution infrastructure and on promoting water conservation through price incentives. Increased coverage of metering and collection also increases the real price of water. These programs have been successful with the assistance of four private companies operating in Mexico City, as water savings have reached 1.93 m M^3/s and are expected to reach 2.4 m M^3/s by 2004. The local government has also put into operation 120 new wells to extract water from the aquifer, but this is only a very temporary solution, as only 66% of the extracted volume can be replenished. This situation accelerates the speed at which the city is sinking and creates serious risks. The city is evaluating the feasibility to introduce water injection technologies to replenish the aquifer.

- Wastewater is another important problem not only for Mexico City but also for another 92 cities that are in noncompliance with existing wastewater treatment regulations with a deadline of 01/2000 for treating their discharges. While Mexico City authorized a Japanese loan in order to build over 40 m M^3/s of wastewater

infrastructure, political disputes between the federal, local and state governments have delayed the project. A tender is scheduled for 2002 but further delays are possible.

- The City of Guadalajara, the second largest in Mexico, is also having serious water availability problems. Lake Chapala, which traditionally supplied water to this city and its surrounding agricultural communities, is at its lowest historical level reaching less than 8 meters. Current extraction reaches 7.5 M^3/s but only 70% of this volume is replenished. The local government is interested in locating other sources of water and in developing the necessary infrastructure for the transport of this water. The project also includes the construction of a hydro-meteorological network and other related projects to promote more efficient water usage in the surrounding irrigation districts.

- Private participation in wastewater treatment in Mexico started in the early 1990s. Currently, close to 40% of the total wastewater treated in Mexico is being treated by private concessionaires but only 24% of total water discharges are being treated in Mexico. Private participation has shown to be a good alternative to providing this service, but the market has not matured fast enough because of low water rates and the inefficient revenue collection of most local water utilities.

- Several financial plans have been developed for promoting investment into Mexico's water sector and the new administration is working on developing new programs to attract increased private participation. The federal government sees no other alternative but that of private investment and operation as a means for achieving a self- sustainable water sector. This process will take years but projects involving private operators are gaining momentum.

Session I. Water Supply and Demand in Mexico: (Water Sector Overview)

Ing. César Herrera Toledo
Managing Director for Construction
National Water Commission (CNA)

Overall Assessment and Problems Faced by the Sector

- On a gross basis, yearly water availability in Mexico is 4,900 M^3 per inhabitant. This is approximately half of what is available in the U.S. and is considered as "low availability."

- Water resources are most abundant is Southeast Mexico, while demand for water is concentrated in the central highlands and Northern Mexico, where close to 77% of the population resides. In this area, water availability is 1,930 M^3 per inhabitant. Water availability in the northern region has decreased in the past years as result of prolonged drought episodes.

- Current trends show a continued decrease in water availability. In 1995, availability was 11,500 m^3 per inhabitant. It is currently 4,900 M^3 and is expected to decline to 3,500 M^3 by the year 2025.

- Mexico consumes approximately 78 billion M^3 of water per year, 83% of which is used for agriculture, 12% of which is used for urban consumption and 5% of which is used for industrial use. Of the total urban consumption, 80% is for households, 15% is for services and 5% is for industry.

- 70% of Mexico's water comes from superficial sources and the remaining 30% from underground aquifers. Underground water is of special importance in Mexico as it supplies 33% of agricultural users, 66% of the population and 50% of the industry. Underground water comes from 600 aquifers 100 of which are overexploited. Approximately 50% of the volume of underground water used in Mexico is extracted from overexploited aquifers.

- Water pollution is another important problem that Mexico has to solve. The CNA estimates that 19% of all superficial waters are extremely polluted, 54% are polluted, 20% are of good quality while only 7% are of excellent quality.

- In Northern Mexico, water availability has become an important problem. Some of the most important cities need more water than what is available. A clear example of this is the recent tender for a desalinization plant in the State of Sonora in Northwestern Mexico, which will be built by the Spanish company Unión Fenosa.

- Global climatic change is another important factor driving Mexico's interest to protect its water resources. The "El Niño" phenomenon has become more frequent over the last decade and its impact in Mexico is less rainfall during the summer season and consequently less superficial waters and less aquifer replenishment. Hurricanes, especially in Mexico's southeast, and droughts in the north have also become more frequent and caused over US$500 million in damages per year. The frequency of "El Niño" is expected to decrease in following years.

- Mexico is 6th worldwide for irrigated agricultural areas with 6.3 million hectares, but water use in these areas is very inefficient as between 45% and 60% of the water is wasted. Insufficient investments for maintenance and modernization and low self-sufficiency in irrigation districts are the main drivers of these losses.

- Potable water coverage reaches 87% of the population while sewage reaches 73%. There are still 13 million people in Mexico without access to potable water service and 23 million without sewage. Population with access to these services complains about poor service quality.

- The operation of municipal water utilities remains inefficient as they lose between 30% and 50% of their water supply though leaks in their distribution systems. Additionally, only about 30% of the water bills are collected. Another problem with water utilities is that current water prices do not reflect the true cost of offering the service. This impedes local authorities from paying their federal water rights.

- Industry consumes 6 km^3 of water per year. From this volume, 70% comes from wells or superficial sources and 30% comes from municipal systems. The CNA estimates that 86% of all water extractions made by the industry correspond to seven industrial segments including; sugar, chemical, petrochemical, cellulose and paper, steel, textile, and food and beverage. Although Industry is not a large water user, it generates 6.3 million tons of BDO (Biological Oxygen Demand) per year. This is equivalent to three times the BDO generated by urban areas.

- According to Article 27 of the Mexican Constitution, all water in Mexico belongs to the state. (federal government). Municipalities or industries have the obligation to pay "Water Rights" to the state through the National Water Commission. An important effort has been made to restructure the CNA and bring up to date its relationship with water users. Despite this effort, the amounts collected for water rights have remained flat since 1995. The CNA will continue restructuring but now under a basin–basis to improve its fee collection. By April 2001, the CNA had established 25 basin councils responsible for developing regional water programs.

Future Outlook

- The CNA is aware of the various problems facing Mexico's water sector and their impacts on the local economy and population. It is expected that this sector will receive the strongest attention by the federal authorities, which must soon develop programs to promote strong private investment into this sector.

- The following table shows the current "water indicators" as well as scenarios for minimal and desired levels for the year 2025. At present, the Mexican water sector attracts annual investments of MX$14,000 million pesos (approximately US$1,550 million). To reach the "minimal" levels for year 2025, Mexico would need to invest MX$16,000 million (approximately US$1,750 million). To reach the desired levels, Mexico would need to invest MX$29,000 million per year (approximately US$3,190 million).

		Year 2025	
Indicator	**Current**	**Minimal**	**Desired**
Irrigation hectares modernized	0.8 million	1.1 million	5.8 million
New hectares with irrigation	N/A	490 thousand	1 million
Irrigation losses	60%	60%	46%
Losses in urban systems	44%	44%	24%
Potable water coverage	87%	87%	97%
Sewer coverage	73%	73%	97%
Wastewater treatment	24%	50%	90%
Water used (volume in thousand million m3)	78	91	81
Water Investments (in thousand million pesos)	14	16	29

- As the Mexican government lacks the necessary resources to reach the desired investment levels, the CAN, in combination with other federal agencies, will work under six "strategic guidelines" to attract private investments into the sector.

Objectives and Strategic Lines

The CNA has developed its new strategic guidelines for Mexico's water sector, which will be implemented during the 2001-2006 period. The objectives and guidelines are as follows:

1. Promote Efficient Water Use in Agriculture:

- Increase the efficiency of water use in irrigation districts by the construction of irrigation infrastructure.
- Develop new irrigated agriculture areas, especially in Southeast Mexico.
- Promote better organization among users.
- Promote water source substitution from wells to treated water for those crops that are not for human consumption.

2. Promote Coverage and Quality of Water and Sanitation Services:

- Increase water coverage especially in rural areas that still lack this service.
- Improve coverage and quality in the supply for potable water, sewer and sanitation services in urban areas.
- Promote wastewater treatment and substitution of first use water for treated water.
- Promote the efficiency of local water utilities.
- Develop alternative supply sources by the adoption of new technologies such as rainfall recovery and water re-injection.

3. Achieve Sustainable Management of Basins and Aquifers:

- Measure and inform on the available levels of water in the different basins and aquifers serving as sources of water.
- Reduce extraction volumes until balance is achieved.
- Reduce water pollution by promoting treatment and remediation.
- Redirect new investments into areas with greater water availability.

4. **Promote Technical, Managerial and Financial Development of the Water Sector:**

- Increase governmental financial support to the sector, especially for promoting efficient and self-sufficient water utilities.
- Consolidate regulatory and policy responsibilities at the federal level while transferring operational and investment responsibilities to the local authorities. This should achieve better water management.
- Develop and make available the necessary technology.

5. **Promote Water Culture:**

- Consolidate basin councils.
- Promote the National Crusade for Water and Forests.
- Make the population increasingly aware of the importance of water resources.

6. **Risk Prevention and Response to Natural Disasters and Droughts:**

- Improve meteorological warning systems.
- Develop master plans to prevent and respond to natural disasters.
- Protect inhabitants of high-risk zones.

- In addition to these six "strategic guidelines," the CNA is working to promote private company participation in the provision of water services. To promote this objective, the federal government has developed a "Program to Support Local Water Utilities with Private Sector Participation." (FINFRA II). This program will try to follow the success of the previous program called FINFRA, which provided partial funding for wastewater treatment projects.

Program FINFRA II

- This program was developed to support Municipal Water Utilities (*Organismos Operadores*), offering partial financing to those utilities that have incorporated private participation in their operations. The program seeks to consolidate the *Organismos Operadores* as efficient and self-sufficient entities; to support the use of state of the art technologies and to promote environmental protection though the construction of wastewater treatment and re-use facilities.

- This program is designed to assist all *Organismos Operadores* serving over 50,000 inhabitants. To be eligible for FINFRA II funding, the *Organismos Operadores* must select some of the following forms of private participation:

  Partial Service Contract: The *Organismo Operador* signs an agreement with a private company who will take partial responsibility in the operation and maintenance of the system and will make additional investments as indicated in the tender documents.

  In Mexico, there are four partial service contracts in operation in Mexico City. Each contract was awarded for a 10-year period and was divided in to the three phases outlined below.

  Phase I:

  - Conduct a census of all water users (completed).

- Install water meters (over 1,500,000 meters installed).
- Digitalize the network (completed).
- Service providers are paid a fee for each installed water meter.

Phase II: (Ongoing)
- Generate, distribute and collect invoices in conjunction with the city's treasury and banks.
- Service providers are paid a fee for each invoice generated.

Phase III: (Began in June 1998, currently ongoing)
- Operate and provide maintenance to the secondary distribution network.
- For this service, each company is paid per unit of water delivered. The local government assumes the collection risk. Companies have the incentive to reduce water losses and improve billing efficiency.
- Elimination of losses in the distribution network. (714 kilometers of pipelines have been replaced and 1,930 lps. have been recovered)
- Provide customer service.
- Assist Mexico City's treasury by collecting bills.

Since each city decides which work will be performed by private operators, partial service contracts will vary from city to city. The contracts in Mexico City serve as an example of how these contracts work and how private companies are paid.

Integrated Service Contracts: Under this plan, the *Organismo Operador* signs an agreement with a private operator who takes full responsibility for the administration, operation and maintenance of the water system. Under this plan, the private company takes the commercial risk while the Municipality is the owner of the assets and makes the decisions to set tariffs. The private company recovers its investment from the collection of water bills from users. In Mexico, there is only one city, Navojoa in the State of Sonora, who adopted this plan in the early 1990s.

Concession Title: Under this plan, the private company has full responsibility for water services including operation, maintenance, administration and the investments needed to increase coverage or expand capacity. The difference between this modality and the Integrated Service Contracts is the property of the assets in which the Concession Title is transferred to the private company for the period of concession. Under this plan, a commercial and legal relationship exists between the private company and the users since the private company is directly responsible for the service, billing and collection. In Mexico's water sector, there are two Concession Titles, one operating in the City of Aguascalientes and one in Cancun.

Joint Company (Mixta): The *Organismo Operador* and a private company invest jointly in a new water utility which will be responsible for the provision of water services under a concession title. The joint company retains public authority while achieving a more transparent operation. Private participation can be under a majority or minority stake, depending on how the new mixed company is structured. This plan is new to Mexico. The first case was just awarded and is yet to begin its operation in the City of Saltillo, Coahuila. In this case, the state will maintain a 51% control of the water utility.

- The program FINFRA II will offer partial funding to water utilities who select one of the previous plans. These funds should be used for increasing efficiency and coverage:

The Program to Increase efficiency of water utilities will include funding for:

- Supply and installation of macro-metering.
- Supply and installation of micro-metering.
- Leak detection and control.
- Develop a registry of users.
- Billing and collection systems.
- Accounting systems.
- Information systems.

The program to Increase coverage will partially fund:

- Drilling and equipment for new wells.
- Water purification plants.
- Regulation tanks.
- Aqueducts.
- Construction and rehabilitation of sewer collection systems and wastewater treatment plants.

FINFRA II will fund up to 49% of the required investment based on the efficiency level and the private participation plan selected.

FINFRA II Funding for Efficiency Investments

Current Level of Global Efficiency	Integrated Service Contracts or Mixed Company with Majority of Public Participation	Concession or Mixed Utility with Majority of Private Participation
	Funding Limit	
Lower than 30%	40%	49%
30% to 40%	30%	40%
Higher than 40%	25%	30%

FINFRA II will also provide funding for water, sewer and wastewater infrastructure. All Infrastructure projects will require a feasibility study measuring the social impact of the project and need to be approved by BANOBRAS. These funds will be considered a loan until the utility reaches a global efficiency level of 45% and, only after this, funds will be considered a grant without the need for repayment.

FINFRA II Funding for Infrastructure

Type of Work	Partial Service Contract	Integrated Service Contracts or Mixed Company with Majority of Public Participation	Integrated Concession or Mixed Public-Private Utility with Majority of Private Participation
	Funding Limit		
Water Supply	20%	25%	30%
Sanitation	30%	40%	49%

- The CNA has identified 39 Cities that are "priority" candidates for FINFRA II. Some of those cities, including Mexico City and Monterrey, declined to participate in the program. These cities are:

No.	State	Municipality or City	Total Population Year 2000
1	Aguascalientes	Aguascalientes	643,360
2	Baja California Norte	Ensenada	369,573
3	Baja California Norte	Mexicali	764,902
4	Baja California Norte	Tijuana	1,212,232
5	Baja California Sur	San José del Cabo	102,199
6	Campeche	Campeche	216,735
7	Campeche	Ciudad del Carmen	171,367
8	Coahuila	Ciudad Acuña	110,338
9	Coahuila	Piedras Negras	138,214
10	Coahuila	Saltillo	670,208
11	Coahuila	Torreón	529,093
12	Colima	Manzanillo	124,014
13	Chihuahua	Chihuahua	670,208
14	Chihuahua	Ciudad Juárez	1,217,818
15	Distrito Federal	ZM Ciudad de México	18,312,552
16	Durango	Ciudad Laredo	112,272
17	Durango	Gómez Palacio	272,806
18	Guanajuato	León	1,133,576
19	Guerrero	Acapulco	643,360
20	Guerrero	Zihuatanejo	95,448
21	Jalisco	Guadalajara	3,683,792
22	México	ZM Toluca	729,712
23	Nuevo León	ZM Monterrey	1,108,499
24	Puebla	H. Puebla de Zaragoza	1,346,176
25	Querétaro	Querétaro	639,839
26	Quintana Roo	Cancún (B. Juárez)	508,352
27	Quintana Roo	Playa del Carmen	63,478
28	San Luis Potosí	San Luis Potosí	669,353
29	Sinaloa	Culiacán de Rosales	744,859
30	Sinaloa	Mazatlán	380,265
31	Sinaloa	Los Mochis	358,663
32	Sonora	Hermosillo	608,697

33	Sonora	Nogales	159,103
34	Sonora	San Luis Río Colorado	145,276
35	Tamaulipas	Matamoros	416,428
36	Tamaulipas	Reynosa	419,776
37	Tamaulipas	Río Bravo	103,901
38	Tamaulipas	Nuevo Laredo	310,277
39	Veracruz	Coatzacoalcos	267,037
		Total	**40,173,758**

- In addition to financial support, FINFRA II will assist municipalities who include private participation in adjusting their tariff structure to cover all operational costs. FINFRA II will provide short-term subsidies during the tariff adjustment process.

- Other programs carried out by the CNA include offering incentives to large water users in the northern Mexico to relocate to the southeast where water resources are more abundant. Another program for agricultural infrastructure offers 50% subsidies from CNA for the construction of new irrigation infrastructure. Although this program is moving froward, resources from the state are limited.

Session II. Situation in Mexico City

Ing. Oscar Hernández López
General Director for Water Infrastructure
Secretariat of Urban Development and Public Works
Government of the State of Mexico

Ing. César Buenrostro Hernández
Secretary of Public Works and Services
Mexico City government

- Mexico City is home to about 20 million inhabitants and has particularly serious water problems. Greater Mexico City is formed by Mexico's Federal District and over 25 municipalities of the State of Mexico. The city has grown faster than its water supply, which has not expanded since 1995, when the Cutzamala system brought additional water to the city from superficial sources located over 130 miles away.

- At present, Mexico City consumes 64 M^3/s out of which 43 M^3/s are extracted from its overexploited aquifer and 25 M^3/s come from external superficial sources including the Cutzamala system. From this total, it is estimated that the Federal District consumes 35 M^3/s and 29 M^3/s are consumed in State of Mexico.

- Mexico City's current water shortage is estimated at 10 m3/s, 3 m3/s of which correspond to the Federal District and 7 m3/s to the State of Mexico. Mexico City has areas receiving water service through pipe-trucks. Other zones receive water only one or two hours per day and certain areas have no water service.

- The Temascaltepec Project, (also called Cutzamala II) which could offer the city an additional 5 M^3/s to the Cutzamala system, has faced opposition from farmers in the State of Mexico and has stalled since 1999. Under a best case scenario, Mexico City will be able to source only 2 M^3/s of water by the year 2005 if an agreement is reached with the farmers.

- To overcome the growing water shortage, Mexico City's government has increased water extraction from the underground aquifer, which is estimated to have overexploitation at a 1.5 to 1 ratio. This is causing the city to sink and is creating new problems such as damages to water networks and sewer systems. Since 1998; 120 wells have been taped, increasing water extraction to 3.35 M^3/s. In addition to increased extraction, the government has concentrated its efforts in minimizing water leaks and promoting an efficient use of water by increasing tariffs as well as collection.

- Mexico City is one of the five cities in Mexico that has selected some form of private participation in the operation of its water system. In 1993, The Mexico City Water Commission awarded four "Service Provision Contacts" to four major water consortia to restore and operate the water networks of the different areas in Mexico City. The bid required that each bidder had experience in the operation of potable water systems. Since Mexican firms did not have this experience, consortia were

formed between the major Mexican construction firms and water operators from France and Great Britain.

- Each contract was awarded for a 10-year period and was divided in three phases: The first included developing a user census, installing meters and detecting illegal taps. After completion of this phase, the four consortia begun metering and generating invoices. The third stage included the complete operation and maintenance of the secondary network, fixing leaks and providing service to customers.

- Given the nature of the contracts, exact dollar figures are not available. Concessionaires place the collective value of the 10-year contracts at over US$1 billion.

- Since 1998, the four consortia's have been able to recover 1,930 lps which were lost through leaks, and the government has set a goal of 2,400 lps recovered by 2003 when the contracts expire. The private companies have also been able to double the collection, which passed from US$200 million in 1997 to US$450 million in 2000.

- The Mexico City government plans to continue expanding water extraction from the underground aquifer as well as fixing leaks while a new solution is developed. Under its short-term plans, they will build five potabilization plants to clean water extracted from the aquifer. It will also incorporate valves to regulate pressures in the secondary network and is analyzing options to adopt water re-injection technologies to overcome the overexploitation of the underground water resource.

- Mexico City also has an important project to provide wastewater treatment to its effluents. This project has been under discussion since 1997. From an original capacity of 79 M^3/s, the project has been modified to 49 M^3/s, and the location of the largest plant (35 M^3/s) has changed from the old Texcoco Lake to the municipality of Tecamac. This project is expected to move forward in late 2002.

- Private Water operators should be aware that the Mexico City contracts finalize in 2003, and although the government has not yet officially announced its future strategy it is highly likely that it will continue using the services of private operators. According to Mexican laws, the new contracts would need to be tendered so they will be open to new players.

- Mexico developed a State Water Plan, in which they plan to provide treatment to 91% of the wastewater generated at the state level. To meet this goal, the Mexican government must provide wastewater treatment to the effluents of Mexico City (since the municipalities within Mexico City share sewer system with the the Federal District). Mexico estimates that in order to meet their 91% treatment goal they must invest US$384 million, US$350 of which will be destined to the Mexico City wastewater treatment plants.

Session III. Management of Existing and New Resources Development

Ing. Humberto Whaibe
Manager for Water Resources of Mexico City
National Water Commission

Dr. Michael Hanemann
Professor, Department of Agriculture and Economic Resources
University of California, Berkley

Mr. Adan Ortega
Vicepresident and Manager of Foreign Affairs Group
Metropolitan Water District of Los Angeles, California

Mr. Jesús Hinojosa Tijerina
Director
Water Utility of Monterrey, Mexico (SADM)

In this roundtable, specific water problems and solutions for large cities from the U.S. and Mexico were presented. It was interesting to compare problems and proposed solutions in Los Angeles to those for Mexico City. While the U.S. is considering the purification and reutilization of wastewater and underground storage technologies, Mexico continues to have severe problems caused by overexploitation of aquifers and water pollution.

The session also served to demonstrate that, in Mexico, efficient water operations are possible since Mr. Hinojosa presented how Monterrey has been able to adequately manage its water resources and water utility. Monterrey's water utility is the most efficient in Mexico and could serve as an example to other Mexican cities.

Mexico City

- The basin of the Valley of Mexico includes Mexico City and portions of the States of Mexico, Hidalgo and Tlaxcala. It has an extension of 9,685 Km, an average altitude of 2,240 meters over sea level and a population of 18.7 million. The basin is one of the regions with the highest elevations in Mexico and, while water resources exist in the State of Mexico, they are highly polluted. Water is scarce in the rest of the basin. Mexico City must bring water from sources located outside of the basin and pump the water to an altitude of over 2000 above sea level.

- Major water projects have historically been developed for the city. The most important include the sewage infrastructure, which is formed from three main lines: the *Emisor Poniente, Gran Canal del Desague and Emisor Central.*

- Sewer infrastructure has lost over 30% of its capacity due mainly to the sinking of Mexico City. From an original capacity of 425 M^3/s, its current capacity is 290 M^3/s. This causes flooding in certain parts of the basin during the rainy seasons and the government has had to make important investments in sewage pumping stations and water regulation infrastructure. The *Gran Canal* which as an original capacity of 75 M^3/s, can only handle 10 M^3/s at present. With current capacity of 290 M^3/s, the

system can only manage regular water outflow. It can't handle the volume during heavy rains which occurs during the summer season.

- The CAN, in combination with the local governments of the basin, need to expand water regulation capacity as well as develop some emergency projects for managing water flows. Under the CNA program, the following projects will be developed:

    - Installation of monitoring and control units in the sewer.
    - Develop operation protocols.
    - Installation of additional dams, tunnels and regulation units.
    - Build a 40 M^3/s pumping station for the *Gran Canal*.
    - Installation of a pumping station in the *Hondo R*iver.
    - Cleaning of the sewers.

- The main challenges in Mexico City's basin include the sinking of the city, unhindered urban growth, garbage thrown into the sewer and agricultural use of the untreated outflow of Mexico City.

Los Angeles, California

- The Sacramento River is an important water source for California. The northern region has ¾ of its water flow while 80% of the population in the state is located in the south.

- The state has decentralized management and water tariffs are set reflecting the costs of plumbing but not the resource. Economic regulation is not focused on public health but rather the operational costs. Consequently, water prices throughout the U.S. reflect the plumbing costs but not the real scarcity of the resource.

- The water supply industry in the U.S. is mostly public, not investor owned. Only about 14% of the U.S. population is served by investor-owned utilities. In California, this figure is closer to 5%. The public ownership of the water industry has some consequences such as 1) There is no formal economic regulation of water, 2) The main form of regulation focuses on public health requirements for urban users, and 3) There is often strong political pressure to avoid price increases for retail customers. Privatization has not yet become a significant issue for the U.S. water industry, but perhaps it may become one when cities face the need to finance major renovation or expansion of their water supply infrastructure.

- Most urban users in California are metered and the pricing structure has been moving from the fixed price structure (where large users pay less) to the block pricing structure (where large users pay higher rates). Droughts in 1977 and 1992 were the main drivers for this pricing structure change.

- Dr. Hanemann explained how prices for water are set in California and compared those to the methods of setting prices in other utilities. Current plans used follow the backward looking price strategy, which consists of evaluating the price of water service and defining prices to recover such costs. Dr. Hanemann believes that the plan should be forward looking, basing prices on future needs, capacity and future investments ties the water rates to measure the future marginal costs. This should

also include the cost of the resource itself in addition to the pumping. The problem of adopting a forward looking plan is that no customer wants to pay for a service they are not currently receiving. Rather, people want to see there is an improvement before they pay more.

- It is important to notice that the change in the water pricing structure has an important implication for making the operation systems self-sustainable in the long-term (as the fees incorporate a component to fund future expansion programs).

Monterrey, Mexico

- Monterrey's water utility, the *Servicio de Agua y Drenaje de Monterrey (SADM)* is the most efficient water utility in Mexico. SADM believes that although increased private participation in Mexico's water sector would be beneficial, public utilities could also reach financial self-sufficiency and generate enough resources for investments if those are managed correctly.

- Monterrey has 99% coverage in water supply and 98% in sewer and close to 100% in wastewater treatment. Despite high coverage and efficiency rates, the city continues investing in expanding its capacity and improving its operations.

- At present, SADM is developing a program to replace micro-meters and valves on its secondary water network. The program evisions changing 700,000 meters by April 2003, and has a progress so far of 35.45%. The program further contemplates increasing water supply to the city in 2,500 lps. by 2003. This will be done through repairing leaks, promoting water re-use in industry, extracting water from new wells, using new sources which contain sulfured water, reducing by 5% the urban consumption and using technologies to avoid evaporation in dams.

- SADM's program for 2003 will bring the losses through leaks to under 10% and overall unaccounted water to 15% which is considered as the optimal level. For wastewater treatment, the utility will continue expanding capacity of existent wastewater treatment plants as well as building new small plants in remote localities using its own activated sludge technology and equipment currently supplied by U.S. filter. SADM has plans for three new wastewater treatment plants to be built by 2003. These plants will have capacities of between 0.20 and 0.50 m3/s each.

- The utility is also planning to incorporate tertiary treatment systems for part of the water treated on its 5 M^3/s plant *Dulcesnombres*. The Tertiary treatment system will have an initial capacity of 25 lps..

- SADM is also seeking alternatives for treating sulfured waters and converting them into potable water. Most additional water available near Monterrey contains sulfur. SADM believes this could represent an additional source if they can find a cost-effective technology for its treatment.

Special Presentation on Lake Chapala

Ing. Enrique Dau
Director
Jalisco State Water Commission

Dr. Art Douglas
Profesor, Environmental and Atmospheric Sciences
University of Creighton, Nebraska

- Lake Chapala is an important source of water for the City of Guadalajara but also an important environmental resource of the region. The lake has a surface of 1,112 Km^2, and a maximum storage capacity of 8,000 Mm^3 with an average depth of 8 m. In 1936, the lake was reduced in approximately 30% of its extension through the construction of a dam, with the purpose of opening 20,000 hectares for agriculture and increasing the depth of the lake.

- The lake has lost depth over the past two decades, a process that continues to this date as it reaches its lowest historical levels. This phenomenon is caused by various factors including evaporation (1,440 million m^3), extraction for potable water supply (240 million M^3) and agriculture (90 million M^3). The lake receives a supply of approximately 1,500 million m M^3 per year, so with current extraction, the lake has a net loss of 270 million M^3.

- To “save the lake,” the CAN, in combination with authorities of Jalisco and Michoacán, developed a program for the efficient use of water resources in the Lerma-Chapala basin. This program is divided in three basic components.

- The first component aims to promote a more efficient use of water in the agricultural sector by providing 50% subsidies to new irrigation investments in the zone (cost estimated at US$100 million). The second component includes the installation of a network of 36 hydro-meteorology stations. (US$6 million). Each station will measure air temperature, humidity, pressure, wind speed and direction, water precipitation and solar radiation. The third component contemplate building the necessary infrastructure for developing alternative potable water sources for the city in substitution of what is currently being extracted from Lake Chapala. This project is expected to have a very high cost and current options include the Verde River, which could provide 9.6 M^3/s and replace the 7.5 M^3/s currently extracted from Chapala.

- Art Douglas provided valuable information on Lake Chapala and for all of Mexico in general. His presentation showed how weather forecasting works for Mexico and he showed the patterns affecting rainfall in Mexico and how climatic change is impacting rainfall in Mexico. Of particular interest is the Pacific Decadal Oscillation. This large-scale shift in temperature patterns across the Pacific appears to modulate local mechanisms of rainfall in Mexico. From 1976 to 1997, the Pacific Decadal Oscillation was in a phase that favored frequent and strong El Niños. El Niño events in this period favored dry summers throughout much of Mexico, while winters tended to be wetter than normal. Recently, the Pacific Decadal Oscillation shifted into a cold phase for the West Coast of North America.

- For the next decade or two, Mexican climate is more likely to resemble that of the period from the late 1940s to the early 1970s. Judging from historical records, the potential impact of this shift on Mexican rainfall will be to favor drier winters across much of Mexico. Summers may average slightly wetter than normal due to a decrease in frequency and intensity of El Niño events.

Session IV: Use of Technologies to Solve Water Problems

Dr. Francisco Javier Aparicio Mijares
Coordinator for Hydrologic Technologies
Mexican Institute of Water Technologies

Luis Redondo Pimentel
Manager for Irrigation Zones
National Water Commission

Mr. William Mills
General Manager
Water District of Orange County

Management of Underground Water in Mexico

- Of 647 aquifers identified in Mexico, more than 100 are being overexploited and several others have water quality problems. Underground water is very important in Mexico as 28.2 km^3 of the 79.4 km^3 consumed in Mexico come from underground sources. In the case of water for urban consumption; 69% of this water comes from underground sources.

- Overexploitation of aquifers represents between 5 and 6 km^3 per year of excess extraction. Some aquifers have reached critical levels and must be replaced by other sources or need to be artificially recharged in order to continue as viable water sources.

- With assistance from the World Bank, the federal government has invested over US$ 109 million under a program for the modernization and management of Mexico's water resources (PROMMA). From these funds, over US$ 6 million have been invested in underground water monitoring stations, hydro-geological studies and models to measure underground water flows.

- The government has made an initial characterization of underground waters in Mexico and has defined some protected areas where no additional concessions for water extraction will be granted. Current users will be invited to substitute their water extraction titles for other alternatives. Under this first characterization of underground water, approximately 33% of the Mexican territory will have underground water protection.

- The policies to increase management of underground water in Mexico will include:
    - Decentralization of regulatory and enforcement activities to the basin level.
    - Continue with investments under the PROMMA program.
    - Develop hydraulic plans, covering a 25-year horizon.
    - Increase the technical capacity of the CNA.
    - Promote the stabilization of overexploited aquifers.
    - Expand the underground water-monitoring network.

Technologies for an Efficient Use of Water for Irrigation in the Valley of Mexico

- Agriculture with irrigation in the Valley of Mexico covers only 2,500 hectares while the neighboring districts of Tula, Alfajayucan and Chiconautla represent 80,500 hectares. The water consumed in these districts is wastewater-mostly untreated and originating in Mexico City. Because of the nature of this water, it can only be used for low value crops such as sorghum, beans and wheat. Rainfall in the region occurs only four months of the year, and agriculture is dependant upon irrigation

- These irrigation districts have very low efficiency in their use of water, as crops have low values and there are no resources to invest on treatment or the expansion of the systems.

- For surfaces shorter than one hectare, hydroponics and greenhouses are good options to increase profitability through intensive cultivation. Crops such as green-hydroponics cradle feedstock have proved to be of great value in Europe. For larger areas in the irrigation districts of Tula, Alfajayucan y Chiconautla which reuse wastewater generated in Mexico City; adequate wastewater treatment systems and technologies for irrigation using wastewater are needed to avoid potential transmission of diseases to humans.

- The needs of agricultural activities in the Valley of Mexico and in the districts of Tula, Alfajayucan and Chiconautla are various. Farmers do not have the resources to incorporate new technologies into the operation of their lands and for producing higher value crops. Also, the CNA offers a 50% subsidy for irrigation programs, but local farmers lack the matching funds. New financial plans are necessary for supporting the farmers in the adoption of hydroponics and the construction of greenhouses and additional irrigation infrastructure. Only by receiving support to generate higher value crops would they be in a position to finance the necessary investments for irrigation expansion.

Replenishing Potable Aquifers with Purified Sewage Waters

- Orange County in California sources most of its potable water from its underground aquifer. This aquifer is threatened by the sea, which could pollute the aquifer with salted water. The Water District of Orange County has built an injection barrier that injects fresh water to form a pressure ridge to repel salt water.

- Water for injection to the aquifer is treated by a plant called Water Factory 21. This is a 60 mld advanced wastewater reclamation facility, which uses reverse osmosis and activated carbon. Water Factory 21 must be updated and expanded since the needs of water replenishing are now 160 mld and reverse osmosis technologies have advances very much in the last two decades.

- The Groundwater Replenishment (GWR) System will replace Water Factory 21. The system, though the use of microfiltration, reverse osmosis and ultraviolet disinfection, will produce 100% pure water from wastewater generated in the city. The new plant will have lower operational costs than Water Factory 21 and will serve over 200,000 families in addition to preventing sea water from invading the aquifer.

- Microfiltration costs have decreased dramatically due to technological progress, costing 50% less than in 1997. The investments for the GWR System will reach US$352, with an average OM cost of US$22 million. Final design is expected by May 2002, and the plant is planned to be operational in 2005. Construction will involve twelve contracts.

- The GWR System has faced some social opposition due to the “sewage to tap” phenomenon. Some misinformed people refuse to pay for potable water which originates in the sewer. The Water District of Orange County is continuing successfully with a public information program.

Session V: Priority Projects, Challenges and Opportunities

Lic. Alberto Helguera
General Director
OSMONICS – Mexico

Ing. Patrice Keime
General Director
ONDEO-Degremont Mexico

Ing. Mateo García Vázquez
Sales Director
IONICS – Mexico

This session of the seminar allowed three private companies to present their experience and recent technical advances on water purification and wastewater treatment. These companies are the technological leaders in Mexico's water sector or have state of the art technologies which could represent cost-efficient solutions.

- IONICS is a world leader in water desalination and disinfection through membranes and ozonization systems, as well as the leading supplier of ultra-pure water for the electronics industry. In Mexico, the company developed a project for the Mexico City Government in which they are purifying 30 lps of water extracted from the Iztapalapa aquifer and which is polluted with minerals. IONICS uses reverse electro-dialisis, a cost-effective method (US$0.093 per m^3), for treating this water.

- ONDEO-Degremont is the leading private company treating municipal wastewater discharges in Mexico. The company also holds one of the top positions serving the industrial market. At present, ONDEO-Degremont is operating the municipal wastewater treatment plants in Ciudad Juárez, Culiacán, Puebla, San Luis Potosí among others. Additionally, it operates Industrial wastewater systems in Pemex's petrochemical complexes, Smurfit, DuPont, Temex, Basf and Danone among other companies. Part of ONDEO-Degremont's success in Mexico has resulted from its capacity to offer cost effective solutions for both municipalities and industries. Most of ONDEO's wastewater systems consider water reuse as a component of the project. This additional revenue source allows the municipalities to pay only a fraction of the investment. ONDEO-Degremont mentioned that Mexico could be an attractive market for water operators, but political disputes and lack of definition from the different levels of government have stalled investments. Mr. Keime mentioned that they have high hopes on the Fox administration and on the FINFRA II program to increase private participation in the operation of municipal water systems.

- OSMONICS is another private company active in Mexico's water sector. It offers water purification using activated sludge and Ozone technologies. OSMONICS technology eliminates most metals, organic materials, carbon, color, smell and leaves no residues. OSMONICS presentation focused on why this technology is more cost efficient than traditional chloride purification technologies.

Session VI: How Private and Public Sectors can Participate

Alberto Usobiaga
Representative for Mexico
Agbar

Mr. Juan Payeras
International Financial Corporation

Ing. Francisco Tello
General Manager
National Association of Water Utilities

Private Participation Plan Selection

- Aguas de Barcelona (Agbar) is one of the leading companies operating water systems in Latin America, but has no experience in the Mexican market as it considers the market is only beginning to mature. Mr. Usobiaga presented the various plans for private participation.

- The selection of the most feasible plan for private participation depends on several factors such as system and population size, regulatory framework and the political will to accept private operators. In Mexico, privatization of water systems is not allowed but all other plans are now present. Aguas de Barcelona just entered Mexico and they participated in the tender for the creation of a mixed company in Saltillo to operate the water system. This is the first time in Mexico this plan appears, but it has proved to work for Agbar in Colombia.

- Agbar mentioned that all plans for private participation need to have a transparent bidding processes. If they do not, future administrations might question the process, something that has already happened in Mexico.

- The International Financial Corporation (IFC) considers that successful private participation needs, in addition to financing and improved management, a clear definition of the government's needs and an effort from both the private sector and authority. The IFC considers that at the time of selecting the most appropriate plan of private participation, all alternatives should be analyzed to select the most appropriate. The IFC considers that attracting private investment requires clear rules and the development of a dispute resolution mechanism as they consider that contracts don't anticipate situations.

- Other important aspects to be considered when selecting private participation include defining a clear project scope and a detailed cost of construction and operations to guarantee that the tariff structure will assure full cost recovery. Pricing structure analysis must include the political will to implement tariff structures as well as social acceptance.

- The IFC considers that since most local governments in Mexico lack the necessary expertise in private participation on their water systems, adequate technical, legal

and financial advisory is needed. Bringing external advisors to these contracts also provides transparency and increases the confidence of private players.

Mexican Water Utilities

- The National Association of Water Utilities (ANEAS) groups 354 water utilities in Mexico. This association presented the CNA with an assessment of their current situation and on what they perceive as their needs for further developing the sector.

- Mexican Water Utilities, in general, work with obsolete infrastructure, which hinders service quality. Their operations are inadequate due to a lack of financial resources. Water tariffs do not reflect the full cost of operations and any tariff increase faces political and social opposition. Local government authorities are changed every three years so there is no long-term view for solving their challenges (directors of the water utility are replaced on average every 1.8 years). Municipal wastewater utilities have unpayable debts with the federal government for water rights. All these combined factors explain the precarious level of service and inefficiencies of over 50% in many cities and the cause of very low (33%) compliance with wastewater regulations.

- ANEAS considers that the federal government should write-off their debts and should review the water rights set by the CNA in order to allow utilities to invest in new infrastructure. They consider that the government's deadline for compliance with environmental regulations was unrealistic and they proposed a five-year grace period so municipalities could comply. Their other proposals, which had political implications, included that laws be changed and municipal officials be allowed to be re-elected. This they say, will help them in developing long-term plans for their utilities.

- Regarding private participation in water systems, the ANEAS took a neutral position. The Association believes that while private participation could facilitate resources for badly needed investments, public operators could also turn water utilities into profitable companies or at least break even. Mr. Tello mentioned Monterrey as an example. On the other hand, Mr Keime from Ondeo mentioned that new investments in water, especially in wastewater treatment, can not wait and, because of this, private participation represent the best short- and medium-term alternative. He considers that lack of wastewater treatment in Mexico and the bad financial condition of many local water utilities is not a question of money, but a question of political will.

- Mr. Henemman made a series of recommendations to ANEAS. Those included promoting water tariffs based on the cost of the resource and not on political disputes; working with federal authorities to create a clear regulatory framework for the whole country, with consistency between federal and local regulations; and also working on developing regulations which set realistic time frames and parameters for wastewater.

Session VII: Financing Sources for Improving Water Services in Mexico

Dr. Mariano Gamboa
Expert Officer of the Directorate of Government Organisms and Industrial Services
Nacional Financiera (NAFINSA)

Lic. Ismael Díaz Aguilera}
Manager for Multilateral Financing
BANOBRAS

Ing. Rafael Forseck Rodríguez
Commercial Director
Atlatec-Earth Tech

- NAFIN is a government development bank whose purpose is the development of Mexico's industrial sector and support to the small and medium industry. Because of the link between industry and environmental issues, NAFIN has tried, with some success, to play a role in the financing of industrial related environmental projects like industrial wastewater treatment. NAFIN offers diverse financial services that range from direct credits, to provide funding to other private banking institutions for ear marked credits. It also offers warrantee programs where NAFIN takes up to 70% of the credit risk in front of private banks.

- NAFIN manages a program sponsored by the Japan Bank for International Cooperation (JBIC) where companies inspected by federal authorities and companies participating in the volunteer audit program and which structure an investment plan are eligible for low interest credits from the Japanese bank. NAFIN manages the monies of the North America Environmental Fund (NAEF), whose objective is to invest in companies whose core business is environmental protection. Eligible companies include manufacturers of alternative power equipment, wastewater treatment plants, and recycling facilities. Under this program, NAEF can invest up to US$3 million for up to five years.

- NAFIN also provides technical assistance and funds for feasibility studies, pilot projects, and manufacturing prototypes of environmental equipment through the European Community Investment Partners (ECIP). This program has the objective of supporting co-investment of Mexican and European investors of small- and medium-sized companies. The program provides:

    - Financing for feasibility studies, pilot plants and prototype manufacturing.
    - Capital investment for joint companies.
    - Financing for training technical and managerial personnel.

- NAFIN has provided US$20 million to eleven companies under this program. Beneficiaries include companies in the areas of wastewater construction and operation, plastics recycling, hospital waste treatment, energy savings, chemical residue treatment and air conditioning systems for vehicles.

- BANOBRAS is another major financial player for Mexico's water sector. It is the principal conduit for infrastructure-related loans from the World Bank, the

Interamerican Development Bank and the Japan International Cooperation Agency (JICA). Banobras, in addition to disbursing those loans, established a series of financial instruments to provide financing to municipal water projects. The most important is called the Infrastructure Investment Fund (FINFRA).

- FINFRA fund has been an important support for infrastructure project development, especially in water. FINFRA offers equity for Build-Operate-Transfer (BOT) or concession projects, reducing the investment risk to the concessionaire. FINFRA provides subordinated capital for up to 40% of the total investment cost of the project, and venture capital for up to 35%. FINFRA can also combine subordinated and risk capital and finance up to 49% of the total investment. FINFRA can also combine both instruments with other BANOBRAS credits for up to 66.6% of the total project cost.

- FINFRA also provides technical assistance and advisory to municipalities to structure feasible water projects with correct size and structure. Therefore, projects with FINFRA participation have lower risk than other municipal BOT projects. After five years in operation, FINFRA has become a detonator for private investment in wastewater treatment plants. For each dollar invested by FINFRA, private companies have invested two, and over 10% of all wastewater treated in Mexico is through plants built with FINFRA's financial support.