BORDER ENVIRONMENT COOPERATION COMMISSION

WATER SUPPLY, WASTEWATER COLLECTION AND TREATMENT PROJECT FOR

THE CITY OF NACO, SONORA

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Publication Date : 03/15/96

Last Update : 04/12/96

EXECUTIVE SUMMARY

The City of Naco, Sonora has a water supply system that marginally is able to cover the water demands for the 319 acres of urban area. The infrastructure includes a water supply source consisting of two wells that together produce 710,000 gpd; 2 storage tanks with a capacity of 26,420 gallons and 39,630 gallons, respectively; a distribution system 18.6 miles long with varying pipe diameters, predominantly 3 inches in diameter; 1,302 users, of which 1,274 are domestic, 16 commercial, and 12 industrial, and equipment for chlorine gas disinfection. Even though the distribution system is extensive enough to cover the total service area and the water source is sufficient to satisfy total water demand, the system does not effectively meet the needs of the community and often cases is not provided to all of the users, since there exist 452 households within the bounds of the system that are not connected to it.

The current wastewater collection and treatment system covers up to 85% of the urban area, and includes a lift station and pressure line that sends part of the sewage to the "Westside" oxidation pond module; a gravity system conducts the rest of the wastewater to the "Eastside" pond module, in order to treat the sewage from a total of 850 users, of which 822 are domestic, 16 commercial and 12 industrial. The wastewater treatment system is made-up of two sets of stabilization ponds; the "Eastside" module that includes 7 lagoons in series with a surface area of 9.2 acres, and the "Westside" module, with 3 lagoons in series that have an area of about 6.57 acres, for a total surface area of 15.77 acres.

The lift station that provides wastewater to the "Westside" oxidation ponds does not operate efficiently, due to wear and tear of the pumping equipment, causing overflows into the urban areas of Naco, Sonora and Naco, Arizona. With respect to the waste stabilization ponds, their removal capabilities are adequate, but because the treated effluent is not being utilized for agricultural irrigation as originally planned, they are being operated as a hydraulically closed system. This situation has generated overflows of partially treated wastewater toward and across the international boundary, which are in violation of the conditions set forth in the International Boundary and Water Commission (IBWC) Minute N° 273.

To address these issues and guarantee the well-being of the residents of the City of Naco, Sonora, this project proposes to ensure availability of a permanent water supply, eliminate foul odors resulting from mismanagement of wastewater, preserve the environment, and manage the disposal of treated wastewater, as well as solve a transboundary problem. The principle components of the project include:

1. *Upgrade the water treatment system to ensure a timely and permanent supply of drinking water for the population.*
2. *Encourage water users to hook-up to the wastewater collection system so that it can operate efficiently and at the capacity for which it was originally designed.*
3. *Expand the "Eastside" treatment pond module and operate it as one system, which will eliminate the need to use the existing lift station, which will provide additional infrastructure and allow for storage and control of the treated wastewater to be reused for crop irrigation. It will also eliminate overflows in the system and allow the City to comply with IBWC Minute N° 273.*
4. *Promote the necessary institutional capacity building in order to guarantee an efficient level of management and operation of the system.*

This environmental infrastructure project addresses transboundary issues, that fall within the objectives of the Border Environment Cooperation Commission (BECC), therefore the H. Ayuntamiento de Naco (Naco City Council), Sonora, requests BECC certification in order to seek financing from the North American Development Bank.

1 GENERAL PROJECT INFORMATION

The fundamental objective of the project is to comprehensively solve the current environmental issues of the City of Naco, Sonora, in regard to its "Water Supply, Wastewater Collection and Treatment Systems".

The project co-applicants are:

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Both are local governmental institutions in charge of operating the water supply, wastewater collection and treatment systems in the City of Naco, Sonora.

The project is located within the city limits of Naco, Sonora. The City is located in the northeastern part of the state of Sonora, Mexico, opposite the town of Naco, Arizona, on the United States-Mexico border. It is near the cities of Agua Prieta and Cananea in Sonora, and Bisbee and Douglas, in Arizona. It can be reached by Federal Highway N° 2 in Mexico and by State Highway N° 80 in Arizona.

The Naco City Council and local water utility (OOMAPAS-Naco) submitted a draft of the project for BECC evaluation and certification; however, this draft did not fully address the basic issues, especially when reviewed from the stand point of the eight categories of fundamental criteria used for certification. In order to comply with such criteria, the applicants requested aid from the BECC to be able to better develop the project in reference to said criteria, especially the technical, financial and institutional capacity building aspects. This help was granted through the Project Development Assistance Program, that provided for the services of an external consultant.

The authorities in charge of the water supply, wastewater collection and treatment systems of the City of Naco are currently facing severe hardships in order to provide these services to the community. Among which, the following aspects standout as the most important:

1. *Low efficiency of the water supply pumping equipment due to lack of adequate maintenance, which results in insufficient flow from the wells.*
2. *Since the pumps at the supply wells are also utilized to feed and maintain pressure in the distribution system, there is a lack of sufficient water pressure in the pipelines.*
3. *Again, the pumping capacity of the existing equipment is not able to meet peak demands, which in itself is normal, however, the distribution system lacks the water regulation capacity that a sufficient number of water storage tanks might provide.*
4. *Water distribution system without the capability of being isolated into sections for repair purposes, due to the lack of cut-off valves placed in the required zones.*
5. *High degree of water wastage due to the total absence of metering, both at the source as well as at the user level, which also leads to inefficiencies in the way customers are billed for their water service.*
6. *Almost 35% of the potential users (452) are not hooked-up to the wastewater collection system, although the lines have more than enough capacity for the additional flows.*
7. *Poorly maintained sewage pump station that is located very near the borderline between the two Nacos, that frequently overflows raw sewage that runs through the urban area of both cities.*

8. Hydraulically overloaded waste stabilization pond system modules, that result in frequent overflows of partially treated sewage, with the potential danger of contaminanting the water supply source for the City of Bisbee, Arizona.
9. Lack of an acceptable level of institutional capacity to provide efficient operation, conservation and maintenance of the water supply, wastewater collection and treatment systems.

This situation generates unwanted changes in the social and physical environment of the region, such as: lack of adequate water supply during periods of peak demand; soil and aquifer pollution due to the use of latrines and septic tanks, instead of being connected to the sewer system; degradation of the urban environment (foul odors) due to poor operation of the pump station; water and soil pollution due to the overflow of treated wastewater from the treatment modules; and lack of capacity to cumply with the "Recommendations for Solving the Border Sanitation Problem in Naco, Sonora - Naco, Arizona", agreed upon between Mexico and the United States on March 19, 1987, in the International Boundary and Water Commission (IBWC) Minute N° 273, which basically seeks the reuse of the pond effluent for crop irrigation in the area adjacent to the treatment modules.

Back in 1987 the border sanitation problem in the Naco, Sonora - Naco, Arizona area was the same as at the present time; that is to say that it resulted from overflows of wastewaters from the Naco, Sonora wastewater collection, treatment and disposal system into the natural drainage courses that flow northward across the international boundary and, because of the topography, the natural drainage traverses a wellfield area which provides the muncipal water supply for the City of Bisbee, Arizona. The existing wastewater disposal system, constructed in the mid 1970s and expanded in the early 1980s, does not have the capacity to retain in its oxidation lagoons all of the wastewater generated by the community. Some relief to the problem was sought by utilizing part of the effluent for irrigation of trees on 27 acres, but those facilities were insufficient to maintain the lagoons at the proper level to prevent overflows, both from the lagoons and collections lines.

The wastewater collection and treatment system was constructed in the early 1960s to discharge into oxidation lagoons located west of the city by means of two pumping stations and a 3,300 foot force main; but, due to conditions at that time, the "Westside" lagoons were abandoned in the mid 1970s in favor of discharging the collected wastewaters by gravity into the "Eastside" lagoon system. In order to serve a projected population of 7,120 inhabitants for the year 1995, the Secretariat for Infrastructure and Urban Development of the State of Sonora Government drew-up a plan to increase the capacity of the wastewater system from 260,000 gal/day to 375,000 gal/day, by the rehabilitation and operation of the old "Westside" lagoons, with the effluent used for irrigation of crops on nearby lands, in addition to the operation of the existing "Eastside" lagoons, so that all of the wastewater generated by the City of Naco, Sonora would be contained in Mexico.

The rehabilitation consisted in deepening the old lagoons, reinforcing the levees, and replacing interconnecting pipes with 16 inch concrete pipes. The "Westside" lagoon system includes one anaerobic and two facultative lagoons with a total area of 6.52 acres which, when rehabilitated, had a total capacity volume of 32 acre-ft. The effluent from these lagoons should have been used for the irrigation of 62 acres of nearby lands that should have been developed into croplands. The rehabilitated lagoons should have utilized the total wastewater load of the City of Naco, since additional lagoon capacity would provide for effluent storage during the rainy season, when it is not needed for irrigation. The 62 acres were supposed to be prepared for crops and properly irrigated, and the "Eastside" system was supposed to be continually operated and maintained to provide irrigation to a proposed 44 acres in that area.

The plans for conveying the wastewaters into the "Westside" lagoons provided for the construction of a 12 inch gravity collector to take the sewage from the lowermost end of the collection system 1,640 ft to a new pumping station. Hence, the wastewaters would be pumped to the "Westside" lagoons by a 15 HP motor pump with a peak capacity of 870,000 gal/day, utilizing an 8 inch, PVC 2,870 ft portion of force main to the intersection of a 12 inch portion of the existing force main. The plans included the construction of control works at the confluence of the existing collector and the proposed 12 inch gravity collector to divide the flows between the "Eastside" and "Westside" systems.

Even though the "Westside" ponds were reincorporated into the treatment scheme, the same issues that existed in 1987 prevail at the present time. Three possible alternatives have been identified to address this situation, one of which was chosen for this project.

1. An upgrade and corrective maintenance of the existing pump station, as well as the expansion and maintenance of both the "Eastside" and "Westside" oxidation pond modules.
2. An upgrade and corrective maintenance of the existing pump station, as well as the expansion and maintenance of the "Westside" pond module and elimination of the "Eastside" module.
3. Construction of a new main collector sewer line, to gravity feed wastewater to the "Eastside" pond module and expand and maintain this module, as well as the elimination of the "Westside" pond module and existing sewage pump station.

The following criteria were considered in order to select the most suitable alternative: availability and ownership of the land, operation costs for conveying wastewater to the treatment plant site, potential impacts on the urban environment, requirements for reuse of the treated effluent in crop irrigation, and reliability of the system to comply with the recommendations suscribed to in IBWC Minute N° 273. According to these criteria, the third alternative, which suggests building a new main collector sewer line to gravity feed the wastewater to the expanded "Eastside" pond module and eliminate the use of the "Westside" pond module, as well as the existing pump station, is the most desirable based upon the information available for this study.

The selected project consists of an upgrade of the existing water supply wells, construction of an interceptor sewer line to cross the city and connect the west side of town to the east, eliminate the "Westside" pond module and expand the existing "Eastside" module. This will require 18.35 acres of additional land for expanding the treatment ponds; the land already belongs to the City of Naco and forms part of the area where the "Eastside" treatment module is located. Currently, this land is vacant and not in use. Finally, two new pump stations will be built, the first to connect the existing ponds with the expansion units and the second to feed treated effluent to the existing irrigation zone, that currently utilizes groundwater for irrigation purposes. The agricultural area, consisting of about 162 acres, has not previously received the pond effluent due to the fact that it is located at a higher elevation than the ponds.

To comprehensively address the water supply, wastewater collection and treatment issues of the City of Naco, the following general tasks are considered necessary:

Water Supply.- Upgrade of the currently operating wells, including replacement of well casings and new pumps; upgrade and breakup of the existing water distribution system into sections, by strategically placing cutoff valves within the network; increase storage and regulation capacity with new storage tanks, as well as upgrading the existing ones, and installation of meters at the wellheads, as well as at the individual user connections.

Sanitary Sewer System: Installation of a main collector sewer line in order to gravity feed the wastewater to the treatment system, including the sewage generated in the east part of town that is currently served by the pump station and "Eastside" pond module. Also, installation of the required appurtenances so that the whole population may be connected to the sanitary sewer system.

Wastewater Treatment: Expansion of the "Eastside" treatment system by 13.06 acres of effective pond surface and build an inter-pond lift station to transfer the partially treated effluent from the existing ponds to the new ones, and build another lift station and necessary piping to send treated effluent to the existing irrigation area, so it can be effectively reused for growing grain crops that can used as cattle feed (non-human consumption). The "Westside" pond module will be taken out of operation, as well as the existing pump station associated with it.

Institutional Capacity Building: Develop rules of procedure for the utility in order to comply with its legal obligations; develop operation manuals; update the customer database; design and establish computer operated customer control systems, to be able to easily update the administrative and commercial information systems, as well as to provide the necessary computer equipment and training for the operation of these systems. Acquisition of transportation equipment (vehicles) and other work tools that may be needed.

The total cost of these works has been estimated at 0.65 million dollars of which 0.16 million dollars correspond to water supply, 0.11 million to the collector sewer line, 0.31 million to the wastewater treatment plant and 0.08 million will be invested in strengthening OOMAPAS' billing, collection, operation and maintenance capabilities.

It is estimated that the construction of these different works will take about 11 months, as can be seen in the following table.

Construction Schedule

ITEM	MONTH										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1. Water Supply											
1.1 Pipeline Upgrade	X	X	X	X							
1.2 Installation of Sector Valves			X	X	X	X					
1.3 New Water Tank				X	X	X	X				
1.4 Upgrade of Water Tanks		X	X								
1.5 Water Well Upgrade							X	X			
1.6 Wellhead Flow Metering									X		
1.7 Individual User Flow Metering					X	X	X				
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
2. Wastewater Collection											
2.1 "Eastside Collector"	X	X	X	X							
2.2 Individual User Hook-ups				X	X	X	X				

3. Wastewater Treatment											
3.1 Expansion "East" Pond System				X	X	X	X	X			
3.2 Inter-Pond Pump Station								X	X		
3.3 Effluent Pump Station								X	X		
4. Institutional Capacity Building											
4.1 Inventory of Distribution Network			X	X	X	X	X	X			
4.2 User Census	X	X	X								
4.3 Rate Structure							X	X	X		
4.4 Computational Systems							X	X	X	X	X
4.5 Transportation Equipment											X

2 ENVIRONMENT AND HUMAN HEALTH

A volume of 66 gallons of potable water per person per day will be guaranteed for the planning horizon of the project of 15 years. This amount is the minimum recommended by the corresponding state authorities to ensure adequate protection of health and wellbeing of the population in general.

Since the "Eastside" and "Westside" wastewater treatment modules, with the exception of small amounts of effluent used for irrigation on the westside, operate as close systems, without a discharge to a receiving stream, and since the influent amount of sewage is quite frequently greater than the evaporation and infiltration losses, severe overflows of partially treated wastewater tend to occur. Due to the slope of the land, these overflows runoff toward the international border line, flooding the wellfield that serves as a water supply for the city of Bisbee, Arizona. This situation, as was summarized in the previous section of this document, has already been analyzed by both countries in 1987, and gave rise to the recommendations of IBWC Minute Nº 273; however, Mexico has been unable to comply with its commitment of avoiding any runoff of treated or partially treated wastewater towards the border line, among other things, due to the lack of an adequate pumping system able to supply the irrigation areas with pond effluent.

The proposed wastewater treatment project will ensure compliance with the aforementioned recommendations. The expansion of the ponds will provide for a larger storage capacity, which will permit better control of the wastewater. At the same time, the new pump station at the end of the pond system will guarantee the flow of treated effluent to the irrigation area, which will ensure the withdrawal of water from the ponds, a condition which at present does not exist.

Furthermore, besides solving an old transboundary issue between Naco, Sonora and Naco, Arizona, the project will help increase the level of environmental protection in the area, since no more runoff of treated sewage will occur to the area of the Bisbee, Arizona wellfield. The number of latrines and septic tanks will decrease in the urban area and a more rational use of the available water supply will be promoted, which will result in an increase in the useful life span of the existing sources.

There are three main Official Mexican Standards, which should be complied with in regard to wastewater disposal; they are as follows:

NOM-067-ECOL-1994 establishes the maximum permissible pollutant limits in treated wastewater from municipal sewers or wastewater collection systems for towns of up to 80,000 inhabitants, that may be discharged to receiving streams. According to laboratory results of the effluent from the "Eastside" and "Westside" pond modules, these comply with the permissible limits of pollutants controlled by said standards, with the exception of BOD (biochemical oxygen demand), which in the "Westside" module effuent has concentrations 1.7% greater than the 100 mg/l set forth by this regulation as the maximum permissible limit.

NOM-032-ECOL-1993 establishes the maximum permissible limits of pollutants in urban and municipal treated wastewaters that are to be reused for crop irrigation purposes. According to this standard, the effluent from both modules is considered adequate for irrigation of non-human consumption crops.

Also, the Official Standard NOM-033-ECOL-1993 establishes bacteriological conditions for urban or municipal treated wastewater or that resulting from the mixture of these with receiving streams, to be reused in the irrigation of vegetables and fruit products. The effluent from the existing ponds is classified as "Type 4"; that is to say that it is adequate for flood and ditch irrigation, as well as for spray irrigation, except in the case of vegetables and fruit products.

Based on Article 24 of the Law of Ecological Balance and Environmental Protection of the State of Sonora, a "Preventive Pollution Report" (loosely equivalent to a finding of no significant impact - FONSI) was originally submitted to the Department of Urban Infrastructure and Ecology for its authorization. However, since the project has changed substantially, a new or updated report is needed. It is expected that this new report shall be submitted before the project comes up for certification. The National Institute of Anthropology has also been requested to issue a certificate of "no significant impact" for areas of cultural interest in view of the required expansion of the wastewater treatment system. Also, the National Water Commission has under review what is available of the preliminary design of the proposed works and will have to issue an authorization letter once it receives the complete package of information, concludes the review and approves it.

The project area is located within the orographic region of the North Mountain Ranges and Plains (Sierras y Llanuras del Norte), which includes valleys surrounded by isolated hills and mountain ranges. Its soils are of the Regosol type, that is, they are shallow, light-colored soils, with low susceptibility to erosion. They are sandy-clayey soils with a lithic-gravely phase which allows the growth of vegetation typical of semi-arid areas. Natural grasslands predominate with thornless and thorny underbrush; none of the species involved are considered endangered by the authorities.

The impacts are positive for the social as well as physical environment of the project area. The population will have a permanent and potable water supply; the foul odors generated by the existing sewage pump station will be eliminated; the useful life span of the water supply source will be enhanced; the reuse of wastewater for irrigation purposes will be furthered, which will result in an increase in the amount of surface area under cultivation and greater income for the farmers; water and soil pollution caused by the use of latrines and septic tanks, as well as by the wastewater overflows from the existing sewage pump station and treatment ponds will be mitigated.

3. TECHNICAL FEASIBILITY

It is not necessary to have a treatment process for the groundwater supplied to the community since, according to the results of laboratory analyses underataken by local authorities, the water in the wells is of good quality. Therefore, it is only necessary to disinfect with chlorine at a dose sufficient to have a residual concentration of 5 milligrams per liter, which is the standard required by the National Water Commission (CNA) and the Public Health Ministry (SSA).

WATER SUPPLY SOURCE CHARACTERISTICS

ITEM	WELL No. 3	WELL No. 2
TOTAL DEPTH (ft)	*328*	*490*
STATIC LEVEL (ft)	*158*	*215*
DYNAMIC LEVEL (ft)	*213*	*251*
TRANSFORMER CAPACITY (KVA)	*30*	*75*
ELECTRIC MOTOR (HP)	*20*	*60*
WATER STORAGE TANK HEIGHT (ft)	*51*	*46*
WATER STORAGE TANK CAPACITY (gallons)	*26,417*	*39,626*
FLOWRATE (gpm)	*127*	*364*

The basic technology to be applied in treating the wastewater is the same as has been used up to now, that is, a system of waste stabilization ponds made up of an anaerobic pond, followed by a series of three facultative ponds, the last two of which will be used as storage units.

Waste stabilization ponds normally are earthen structures, with depths in excess of 8 ft for anaerobic ponds and between 5 and 8 ft for facultative ponds, where sedimentation of solids and removal of organic matter (BOD) from sewage takes place by means of natural physical and biological processes. In these ponds, the oxygen produced by algae through photosynthesis is used by bacteria in the stabilization of organic matter. At the same time, the nutrients and CO2 produced during this stabilization are utilized by the algae to generate more oxygen.

The existing Naco pond modules are operating at acceptable removal efficiency levels, mainly at the "Eastside" module, where removals of 50.5%, 67.7% and 70%, in BOD, total suspended solids (TSS) and fecal coliforms, respectively, were observed (see following table).

Removal Efficiencies of the Wastewater System Modules

	"EAST" LAGOON MODULE			"WEST" LAGOON MODULE		
POLLUTANT	**INFLOW**	**EFFLUENT**	**REMOVAL EFFICIENCY**	**INFLOW**	**EFFLUENT**	**REMOVAL EFFICIENCY**
	(mg/lt)	**(mg/lt)**	**(%)**	**(mg/lt)**	**(mg/lt)**	**(%)**
BIOCHEMICAL OXYGEN DEMAND (BOD)	*153.27*	*75.91*	*50.47*	*140.21*	*101.70*	*27.47*
TOTAL SUSPENDED SOLIDS (TSS)	*95.23*	*30.67*	*67.79*	*83.24*	*46.27*	*44.41*
FECAL COLIFORM (MNP/100 ml)	*1.04E+06*	*3.08E+05*	*70.26*	*4.51E+06*	*3.91E+05*	*91.34*

Projections for 1996, by the National Population Council, estimate a population of 4,841 for Naco, Sonora. This number differs greatly from the 7,000 estimated by the local authorities, but is more in line with the estimation of 5,733 inhabitants based on the 1,274 user connections registered at OOMAPAS-Naco, considering a population density of 4.5 inhabitants per household, which corresponds to the accumulation index determined by the XI General Population and Housing Census of 1990. According to the Official Population Census, from 1950 to 1990, the population of Naco has increased at an annual growth rate of 1.57 percent. Given this annual growth rate, the population expected for the year 2011 will be 7,242 inhabitants.

POPULATION PROJECTIONS FOR
WATER SUPPLY DEMANDS AND WASTEWATER FLOWS

		Water Supply		Wastewater	
Year	**Population**	**Consumption**	**Demand**	**Contribution**	**Daily Flow**
	(No. people)	**(gal/capita-day)**	**(gal/day)**	**(gal/capita-day)**	**(gal/day)**
1996	*5,733*	*66*	*100,023*	*53*	*80,018*
2000	*6,102*	*66*	*106,454*	*53*	*85,163*
2005	*6,596*	*66*	*115,077*	*53*	*92,061*
2010	*7,130*	*66*	*124,398*	*53*	*99,519*
2015	*7,708*	*66*	*134,475*	*53*	*107,580*

The climate in the project area is temperate and dry and the average annual temperatures are 49°F minimum, 63°F average and 46°F maximum. The average annual rainfall is 14 inches, well below the 85 inches registered for annual evaporation.

Geotechnical surveys conducted in the area for expansion of the "Eastside" side ponds detected that the soil is formed by a clayey-sandy layer, with an underlying layer of clay-packed gravel, with a permeability below 10-7 cm/s, characteristics which make the soil appropriate for the type of ponds proposed for the project.

a) Water Supply System

The water supply for the City of Naco, Sonora, is obtained from two wells, with a depth of 328 ft and 492 ft, respectively, from which a flow rate of 127 gal/min and 365 gal/min., respectively, is obtained. Both pump directly into the distribution system and the surplus goes to two storage tanks, with a capacity of 26,420 gallons and 39,630 gallons, each. The design parameters for the project are as follows:

PROJECT DATA

1996 Population	5,733 inhabitants
Water Consumption	250 l/capita.- day
Estimated Population in 2011	7,242 inhabitants
Estimated Average Flow Rate	20.95 lps
Estimated Maximum Daily Flow Rate	29.33 lps
Estimated Maximum Hourly Flow Rate	44.00 lps
Daily Variation Coefficient	1.4
Hourly Variation Coefficient	1.5
Current Regulation Capacity	Elevated 26,420 gal and 39,630 gal metal tanks
Proposed Regulation capacity	Elevated 26,420 gal and 39,630 gal metal tanks plus new 39,630 gal metal tank
Current Metering at the Source	0%
Projected Metering at the Source	100%
Current Metering at the Individual User Level	0%
Projected Metering at the Individual User Level	50%
Water Treatment Process	Chlorine Disinfection 5 mg/l.
Type of System	Pumping to System, Surplus to Storage Tanks

According to the project data, the supply sources have sufficient capacity to cover the demand in terms of the average and maximum daily flow rates, although this is not the case with the maximum hourly flow rate. However, this deficit will be covered with the proposed increase in storage tank capacity.

The main components of the water supply project are:

1. *Expansion of the distribution system, consisting in installing 9,000 feet of 4 inch diameter PVC pipeline.*
2. *Dividing the water distribution system into sections, by installing 52 cut-off valves of different diameters.*
3. *Construction of a 39,630 gallon capacity and 45.0 feet high elevated metal water storage tank.*
4. *Upgrading of the two existing water storage tanks.*
5. *Upgrading of the two existing wells. This will consist in replacing the casing, the construction of a well cross and installation of new pumping equipment.*
6. *Installation of two 3 inch diameter ultrasonic meters for measurement at the two wells.*
7. *Installation of meters at individual households, industries and commercial user connections.*

b) Wastewater Collection System

For the collection of the wastewater generated in the community, Naco has a sewer system that covers 85% of the urban area. However, only 65% of the population is connected to this system. The wastewater is conveyed by means of two pipelines, one is a pressure line which takes the sewage from the pump station near the borderline to the "Westside" treatment module and the other one carries it by gravity to the "Eastside" ponds. Both operate at low efficiency levels due to the lack of sufficient slope of the terrain, thus permanently causing wastewater backups within the sanitary sewer system. Therefore, it was deemed necessary to improve the wastewater conveyance system by building an interceptor sewer line.

The basic data used for the design of the new interceptor sewer line are as follows:

PROJECT DATA

1996 Population	5,733 Inhabitants
Estimated Population for 2011	7,242 Inhabitants
Water Supply	66 gallons/capita-day
Estimated Sewage Flow (80% Supply)	53 gallons/capita-day
Type of Collection System	Separate Gravity Sanitary Sewers
Formulas Used	Harmon and Manning
Conveyance System	Gravity
Final Disposal of Effluent	Crop Irrigation
Harmon Coefficient	3.09
Manning Coefficient	0.013
Daily Average Flow Rate	266 gal/min
Maximum Instantaneous Flow Rate	821 gal/min
Type of Treatment System	Anaerobic and Facultative Ponds

The main components of the project are:

1. *Construction of an 18" diameter, 0.7 mile long concrete interceptor sewer line, that goes from the manhole located at Ave. Libertad and Internacional to the "Eastside" pond module.*
2. *Construction of necessary appurtenances and connection of 452 homes to reach the 85% coverage capacity of the existing infrastructure.*

c) Wastewater Treatment System

Wastewater was characterized for the design of the treatment plant. According to the laboratory analyses, they have been classified as "Weak Urban Wastewaters", which means they do not have an industrial discharge load and have low concentrations of BOD, chemical oxygen demand (COD), total suspended solids (TSS), oil & grease (O&G), sulphates (SO4), phosphates (PO4), volatile organic compounds (VOC) and others.

The treatment facility will include four series-connected waste stabilization ponds. The first pond will be anaerobic, with a depth of 8 ft. and a detention time of 7.8 days. It will be followed by a facultative pond with a depth of 6 ft and a detention time of 11.8 days. The two remaining ponds will have an 8 ft depth. However, since these two latter ponds will operate as storage reservoirs for the treated effluent, before it is sent to the irrigation area, the water depth of both will be variable and, consequently, their waste reduction function will vary according to the volume of water they contain. The expected removal efficiencies for this arrangement are 54.5% for BOD, 67.1% for TSS and 94.1% for fecal coliform.

DESIGN PARAMETERS FOR THE WASTEWATER TREATMENT PONDS

	ANAEROBIC	FACULTATIVE	REUSE WATER	REUSE WATER
CONCEPTO	POND	POND	POND	POND
	E1	E2	E3	E4
WIDTH (ft)	*178*	*249*	*430*	*423*
LENGTH (ft)	*315*	*522*	*931*	*728*
WATER DEPTH (ft)	*8*	*6*	*8*	*8*
SURFACE AREA (acres)	*0.89*	*2.37*	*7.83*	*6.15*

DETENTION TIME (days)	*7.84*	*11.88*	*54.76*	*43.03*
AVERAGE FLOW (gpm)	*266*	*266*	*266*	*266*
INFLUENT BOD5 (mg/L)	*146.74*	*114.45*	*82.40*	*74.16*
EFFLUENT BOD5 (mg/L)	*114.45*	*82.40*	*74.16*	*66.74*
BOD5 REMOVAL EFFICIENCY (%)	*22.0*	*28.0*	*10.0*	*10.0*
INFLUENT TSS(mg/L)	*89.24*	*62.47*	*36.23*	*32.60*
EFFLUENT TSS(mg/L)	*62.47*	*36.23*	*32.60*	*29.34*
TSS REMOVAL EFFICIENCY(%)	*30.0*	*42.0*	*10.0*	*10.0*
INFLUENT FECAL COLIFORM (MPN/100 mL)	*2.78E+06*	*1.86E+06*	*0.95E+06*	*0.30E+06*
EFFLUENT FECAL COLIFORM (MPN/100 mL)	*1.86E+06*	*0.95E+06*	*0.30E+06*	*0.11E+06*
FECAL COLIFORM REMOVAL EFFICIENCY(%)	*33.0*	*49.0*	*68.0*	*63.0*
ORGANIC SURFACE LOAD (lb/acre/d)	*526*	*154*	*34*	*38*
SLUDGE PRODUCTION (ton/year)	*15.61*	*14.66*	*1.89*	*1.42*

The main activities involved in the construction of the proposed wastewater treatment infrastructure include:

1. *Construction of an inter-pond pump station with a 7,926 gallon capacity wetwell and equipment consisting of 2 pumps for a 270 gal/min flow rate, each, and a total dynamic head of 56 feet, including check, air and anti-water hammer valves, as well as other accessories, to feed the effluent from the existing ponds to the new storage ponds.*
2. *Construction of 18.35 acres of ponds, with the excavation of 85,000 cubic yards of soil and 57,000 cubic yards for the formation of dikes.*
3. *Construction of a pump station for sending the treated effluent to the agricultural area, with a 7,133 gallon capacity wetwell and equipment consisting of 2 pumps for a 238 gal/min flow rate, each, and a total dynamic head of 89 feet, including check, air, anti-water hammer valves, as well as a power substation and accessories. The construction of a 6 inch diameter, 2,018 feet long PVC, Class C-7 pipeline which will carry water under pressure to an existing water distribution structure in the agricultural area.*

Additional disinfection for the treated wastewater was not considered necessary, since its final use will be crop irrigation and according to Official Mexican Standard NOM-CCA-033-ECOL-1993, treated wastewater with a bacteriological quality exceeding 100,000 NMP/100 mL in fecal coliform can be used for crop irrigation, except for vegetable and fruit crops.

At present, Naco, Sonora, does not have a program for monitoring and surveillance of industrial discharges. However, Official Mexican Standard NOM-031-ECOL-93 clearly establishes the maximum permissible concentration of pollutants for this type of discharge. Therefore, for the 12 identified industrial discharges, as well as for future ones, the water utility will establish a monitoring and surveillance program which must abide by the guidelines recommended by the Federal Attorney's Office for Environmental Protection (PROFEPA) in such cases. The same situation is true of the effluent from the wastewater treatment system, OOMAPAS-Naco will have to establish an influent/effluent water quality monitoring program, that includes sampling and analyses conducted at least twice a week.

The amount of sludge produced by the treatment system is estimated to be respectively 3,673 ft3, 3461 ft3, 459 ft3 and 353 ft3 per annum at the anaerobic (E1) and facultative (E2), first (E3) and second (E4) storage ponds. Due to the amount of sludge generated, it is estimated that it should be collected every 20 years. Given the time elapsed, it is assumed that the sludge will be stabilized and therefore, the pond can be drained so that it may be collected, deposited and disposed of at the city landfill, or it may also be used as fertilizer on agricultural land.

4 ECONOMIC AND FINANCIAL FEASIBILITY

The project budget totals $654,000, with the main items being wastewater treatment at $307,000 and water supply at $160,000, as appears in the following table.

PRELIMINARY SUMMARY OF INVESTMENT ITEMS

ITEM	AMOUNT (U.S. dollars)
Water Supply System	*160,000*
Wastewater Collection System	*107,000*
Wastewater Treatment System	*307,000*
Institutional Capacity Building	*80,000*
Total	*654,000*

The rate setting proposal, as well as the financial structure, that are presented in the following pages, are preliminary due to the fact that the City of Naco is still in the process of carrying on a discussion of these issues. Also, the authorization from the Mexican Federal Government for the required grant funds is pending. Therefore, the project may be greatly modified, in view of both of these facts.

Since the current user fees are very low, the socioeconomic impact of the investment envisioned for this project would be too onerous, unless an adequate financial scheme is developed. Naco is a small community that is unable too support a large and sudden increase in their water and sewer fees. The water supply rates have not been increased in the last three years, therefore a large deficit exists in this area. For this reason, a large amount of grant money is sought, that may amount to as much as 70% of the total capital investment. The remaining 30% may be financed through the NADBank, with an adequate repayment capacity from the community. Without the inclusion of grant funds, the alternative would be that the project be reduced in scope and total capital investment. The latter alternative would imply a reduction in the benefits of the project and the postponement of the needed infrastructure, that at this point is already urgently required.

FINANCIAL STRUCTURE

Source	Amount (U.S. $)	Percentage
Grants	*454,000*	*70%*
NADBank	*200,000*	*30%*
Totals	*654,000*	*100%*

The NADBank loan would have the following characteristics, which are the basis for the financial projections that are presented at the end of this chapter:

- *Amortization period: 20 years*
- *Amortization scheme: Equal payments of capital and interest*
- *Annual interest rate: 7%*
- *Annual payment: $19,000*

The financial analysis that establishes project feasibility, without reducing the main investment items, in order to fix a viable rate model, is based upon the following assumptions:

- *Guarantee the minimum infrastructure requirements for the adequate operation and maintenance of the system,*
- *Cover the debt service with the estimated revenues for the project,*
- *Avoid undue rate increases to the users,*
- *Equitably distribute the water supply service costs, and*
- *Not include in the rate scheme the administrative deficiencies of the operation and maintenance of the system, which derive in higher costs and thus higher customer rates.*

The projected operation and maintenance costs include $52,000 every five years for equipment replacement. The total annual O&M costs are $94,000 on the average. The rate coverage of the debt, established by the proportional amount of projected future revenues with the debt service (debt amortization) and the annual O&M costs is greater than unity for all the years of the project. The minimum projected rate coverage results in the second year (1998) and is 1.47.

The sources of revenue for the project are seen as the following:

1. *user fees,*
2. *hook-up fees, and*
3. *sale of treated wastewater for agricultural reuse.*

a) User Fees

Currently, the water utility (OOMAPAS-Naco), charges an overall average fee of $0.263, the domestic household average fee is $0.10, the commercial average fee is $0.352 and the average industrial fee is $0.335, all in terms of per cubic meter of water delivered. As a reference point, the average domestic consumption is of 10,568 gallons per household per month (40 cubic meters), and the monthly bills average $5.62 per household (VAT not included), which is extremely low compared to other cities along the border in the same state of Sonora, such as Empalme, San Luis Río Colorado, Cajeme and others, that have an average monthly bill of $8.00.

OOMAPAS-Naco has an approved rate structure, as yet not published in the Official State Bulletin, that considers variable fees depending on the consumption range and adds a sewer surcharge of 35% to each user. It is important to mention that due to the lack of individual customer metering, the rates are based upon fixed fees estimated by the OOMAPAS-Naco.

NACO - USER FEES (1996)

DOMESTIC HOUSEHOLD USERS

RANGE (M3/MONTH)	CONSUMPTION (M3/MONTH)	USER FEE ($/M3)	TOTAL FEE (Incl.sewer)
0-15	*2,565*	*0.069*	*0.093*
16-30	*2,550*	*0.071*	*0.095*
31-50	*35,083*	*0.167*	*0.224*
51-75	*195*	*0.233*	*0.315*
76-100	*200*	*0.237*	*0.320*
	40,593		

COMMERCIAL AND INDUSTRIAL USERS

RANGE (M3/MONTH)	CONSUMPTION (M3/MONTH)	USER FEE ($/M3)	TOTAL FEE (Incl.sewer)
0-15	*120*	*0.259*	*0.348*
16-30	*125*	*0.269*	*0.363*
31-50	*340*	*0.319*	*0.429*
51-75	*65*	*0.341*	*0.460*
76-199		*0.352*	*0.475*
200-500	*900*	*0.408*	*0.551*
	1,550		

The billing and collection efficiency has been observed to be rather high. During the period from January to September of 1995, according to information provided by the OOMAPAS-Naco, the revenues were 94% of what was billed. However, by that same date a backlog of nearly $10,300 was registered, which represented 17.7% of the total income for 1994. Compared to other utilities in the state, this is a relatively small amount.

The billing and collection process consists primarily in sending out the monthly bills, that are delivered by the meter readers themselves, and receiving payment at their cashiers located at the OOMAPAS-Naco main office. The utility currently has a system to register and control the payment of receipts that allows them to maintain each customer's account updated, although it is under used and they do not generate collection efficiency indicators, nor reports that might allow them to do follow-up work on the outstanding debts.

Currently, the Badger Meter Co. is conducting a metering study that should be finished by the end of March. The objectives of the study are to establish how many meters are required, the type of meter to install, the optimum meter reading procedures and the best way to communicate with the database that contains the registered customers, so that updated readings can be incorporated into the billing process. The proposed new scheme includes the installation of meters in approximately 50% of the current users, which would target those classified as high consumption domestic households and low, medium and high consumption commercial establishments and industries. The new rate model will consider a scaled rate structure, proportional to the volume consumed, the type of water use and the economic capacity of the user.

The rates, required for O&M of the system and repayment of the capital investment debt, were calculated taking into account the expected grant funds and credit. It was also assumed that the billing and collection efficiency would be 80% on the average.

DEVELOPMENT OF NEW USER FEES FOR 1997

User Groups (m3/month)	Annual Consumption(m3)	Weight Factor	Collection Factor	Unit fee ($/m3)	Annual Billing ($)	Annual Revenue ($)	Fraction T. Rev.
DL (0-30)	*60,000*	*0.70*	*0.70*	*0.216*	*12,960*	*9,072*	*8.17*
DM(31-50)	*430,000*	*1.00*	*0.80*	*0.269*	*115,670*	*92,536*	*83.66*
DH(51-100)	*5,000*	*1.50*	*0.90*	*0.360*	*1,800*	*1,620*	*1.46*
CIL(0-30)	*3,000*	*1.00*	*0.90*	*0.240*	*720*	*648*	*0.58*
CIM(31-50)	*4,000*	*1.50*	*0.90*	*0.360*	*1,440*	*1,296*	*1.17*
CIH(51-500)	*12,000*	*2.13*	*0.90*	*0.509*	*6,108*	*5,497*	*4.96*
TOTALS	*514,000*	*1.00*	*0.80*	*0.271*	*139,294*	*111,435*	*100.*
							.

- DL, DM & DH: *Domestic households of Low, Medium and High water consumption.*

- C/IL, C/IM & C/IH: *Commercial/Industrial users of Low, Medium and High water consumption.*

The different billing factors are shown in the previous table, based on the current rates table used by the utility of low, medium and high (L, M, H) for each consumption range and user types of domestic household, commercial establishment and industry (D, C, I). In the fourth column a collection factor is considered, which assumes that revenue collection within the domestic users of low consumption (DL) is going to be less efficient (70%), and that in the other groups it will be between 80% and 90%. The basis for these collection factors lies in the fact that although the collection efficiency is currently very high (94%), this situation will not necessarily prevail when the new rates are in place.

The domestic medium consumption group (DM) stands out, as representative of 84% of the total users, and is therefore the group with the largest relative rate increase. It is worth mentioning the fact that some of the users in this group, classified as domestic households, actually have their own small businesses at the same site, which in turn translates into a substancial water consumption from the same hook-up. The Badger Meter Co. study should point-out those cases in which meters should be installed according to the type of user, and be distinguished from the purely domestic household user. The installation of metering at the household level should result in a redistribution of the consumption patterns within the community, generating a higher operational efficiency for the local water utility (OOMAPAS-Naco).

The weight factors that appear in the third column were used to calculate the unit rate, based upon total revenues, total annual consumption and the collection factor assumed for each group. These weight factors were assigned arbitrarily in order to distribute equitably the rate increase, according to the socio-economic level of the user and the consumption level, so as to produce a lesser impact on the lower income families that, although they may consume a greater volume of water and makeup a greater percentage of the total users, do not have the economic resources to support a large rate increase. That is why a factor of 1.00 was assigned to the range groups DM and C/IL and of 0.70 for de DL group. It should also be pointed out that, a lesser number of users with a relatively higher consumption, but constituting a lower percentage of the total, have been assigned significantly higher weight factors. The commercial and industrial range groups of medium and high consumption were assigned weight factors of 1.5 and 2.13, respectively. The resulting average rate is of $0.271 per cubic meter of water delivered.

NACO - USER RATES (1997)

User Group (m3/month)	Number of Hook-ups	Average Monthtly Consumption (m3/user)	Unit Rate ($/m3)	Average Monthly Bill ($/user)
DL (0-30)	*451*	*11.09*	*0.216*	*2.39*
DM (31-50)	*838*	*42.76*	*0.269*	*11.53*
DH (51-100)	*5*	*83..33*	*0.360*	*30.00*
CIL (0-30)	*17*	*14.71*	*0.240*	*3.53*
CIM (31-50)	*8*	*41.67*	*0.360*	*15.00*
CIH (51-500)	*3*	*333.33*	*0.509*	*169.90*
TOTALS	*1322*	*32.40*	*0.271*	*8.77*

b) Water and Sewer Hook-up Fees

The water and sewer hook-up fees that will be charged to new users have been estimated at $22.67. Currently, the water distribution network covers almost all of the urban area, and 100% of the population, based on studies undertaken by the BECC for this project. The sewage collection system for domestic households, on the other hand, services only 65% of the potential users, although it also covers all of the urban area. These potential users will be required to hook-up during the initial phases of the project, bringing in much needed revenues during the first year of operation.

c) Sale of Treated Effluent for Agricultural Reuse

The project also includes the sale of treated effluent to the Ejidos, at a price of $0.01 per cubic meter, which is equal to 50% of the current price that the farmers pay for the water withdrawn from the aquifer. The sale of treated effluent will be bonus revenue for the project, although the impact of this added income will not be significant to the economic viability of the project.

If these sources of funds are considered, the project will have in 1997 and 1998 the following estimated revenues:

```
1997
user fees:                                  $110,933
hook-up fees and water sales for reuse:     $33,067
total:                                      $144,000

1998
user fees:                                  $112,933
hook-up fees and water sales for reuse:     $6,000
total:                                      $118,933
```

The revenue stream increases after 1998 at an annual average rate of 1.35%. The projected cash flows turn out positive for all of the years, except in the years that it is necessary to make expenditures for equipment replacement. The project covers in this manner the operation and financial costs, with a cash flow that permits an annual debt coverage in all of the years in excess of unity.

WATER SUPPLY, SEWAGE COLLECTION AND WASTEWATER TREATMENT FOR NACO, SONORA

PROFORMA CASH FLOW

WATER SUPPLY, SEWAGE COLLECTION AND WASTEWATER TREATMENT FOR NACO, SONORA

PROFORMA CASH FLOW

First approximation with an annual population growth rate of 1.5%

Item	Total	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016							
Revenues																													

1. User Fees	*2,567*	*0*	*111*	*113*	*114*	*116*	*118*	*119*	*121*	*123*	*125*	*127*	*129*	*131*	*133*	*135*	*137*	*139*	*141*	*143*	*145*	*147*
2. Hook-ups and sale of treated effl.	*147*	*0*	*33*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*	*6*
3. Grant Funds	*460*	*460*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
4. NadBank credit	*197*	*197*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Total Revenues	*3,371*	*657*	*144*	*119*	*120*	*122*	*124*	*125*	*127*	*129*	*131*	*133*	*135*	*137*	*139*	*141*	*143*	*145*	*147*	*149*	*151*	*153*

Expenditures																						
1. Active	*579*	*579*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Water Supply	*163*	*163*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Sanitary sewer	*104*	*104*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

Wastewater Treatment	*312*	*312*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
2. Institutional capacity building	*78*	*78*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
3. Operating costs	*1,886*	*0*	*90*	*91*	*91*	*91*	*92*	*92*	*93*	*93*	*94*	*94*	*94*	*95*	*95*	*96*	*96*	*97*	*97*	*98*	*98*	*99*
Fixed costs	*760*	*0*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*	*38*
Variable costs	*606*	*0*	*26*	*27*	*27*	*27*	*28*	*28*	*29*	*29*	*30*	*30*	*30*	*31*	*31*	*32*	*32*	*33*	*33*	*34*	*34*	*35*
Administrative expenses	*520*	*0*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*	*26*

4. Equipment Replacement	*208*	*0*	*0*	*0*	*0*	*0*	*52*	*0*	*0*	*0*	*0*	*52*	*0*	*0*	*0*	*0*	*52*	*0*	*0*	*0*	*0*	*52*
5. Credits	*380*	*0*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*	*19*
NadBank interest	*183*	*0*	*14*	*13*	*13*	*13*	*13*	*12*	*12*	*11*	*11*	*10*	*10*	*9*	*8*	*7*	*7*	*6*	*5*	*4*	*3*	*2*
Nadbank capital amortization	*197*	*0*	*5*	*6*	*6*	*6*	*6*	*7*	*7*	*8*	*8*	*9*	*9*	*10*	*11*	*12*	*12*	*13*	*14*	*15*	*16*	*17*
Total Expenditures	*3,131*	*657*	*109*	*110*	*110*	*110*	*163*	*111*	*112*	*112*	*113*	*165*	*113*	*114*	*114*	*115*	*167*	*116*	*116*	*117*	*117*	*170*

Yearly remmant		*0*	*35*	*9*	*10*	*12*	*-39*	*14*	*15*	*17*	*18*	*-32*	*22*	*23*	*25*	*26*	*-24*	*29*	*31*	*32*	*34*	*-17*							
Accumulated yearly remmant		*0*	*35*	*44*	*54*	*66*	*27*	*41*	*56*	*73*	*91*	*59*	*81*	*104*	*129*	*155*	*131*	*160*	*191*	*223*	*257*	*240*							
NadBank debt coverage			*2.84*	*1.47*	*1.53*	*1.63*	*1.68*	*1.74*	*1.79*	*1.89*	*1.95*	*2.05*	*2.16*	*2.21*	*2.32*	*2.37*	*2.47*	*2.53*	*2.63*	*2.68*	*2.79*	*2.84*							

5. SOCIAL ISSUES

Naco's economy is based on maquila industries, which are the most important source of employment. Agriculture, livestock breeding and mining rank second, third and fourth, in order of importance.

According to information provided by the Population and Housing Census, from 1950 to 1990, Naco, Sonora, increased its population from 2,495 to 4,645 inhabitants, which is equivalent to a 1.57% annual growth rate. Thus, it has been estimated that its 1996 population is 5,733 inhabitants.

The City has all of the basic public services such as: water supply with a 100% coverage; a sanitary sewer system to which 65% of the population is connected; a wastewater treatment plant system, garbage collection services and a sanitary landfill. All these services have problems in their operation, which should be addressed in order to prevent environmental negative impacts.

The proposed project should solve all water supply, sanitary sewer and wastewater treatment problems, which means it will benefit the whole population of Naco, Sonora.

The socio-economic impacts of the project are:

- *The potable water supply will be constant in regard to volume and time.*
- *The efficient use of the water resource will be furthered.*
- *Foul odors presently produced at the existing sewage pump station will be eliminated.*
- *The urban image will be improved by closing down the above mentioned pump station.*
- *Four jobs will be created within the OOMAPAS-Naco organization.*
- *Income of farmers will be enhanced, since they will be able to use treated wastewater for crop irrigation.*
- *The level of the water supply and sewage collection services will be enhanced.*
- *The project does not have any negative impacts on ecologically restricted areas, nor on historical and archeological sites of national interest.*
- *The conditions of IBWC Minute No. 273 will finally be met, thus eliminating a transboundary issue and protecting the water supply system for Bisbee, Arizona from the effects of possible contamination.*

6. COMMUNITY PARTICIPATION

In order to inform the residents of Naco, Sonora about the comprehensive water supply, wastewater collection and treatment project, a broad program was conducted that involved the entire population in the planning process, so that with the consideration of their suggestions, comments, and local experiences, convenient adjustments were made to enhance the project.

A Comprehensive Community Participation Program was prepared in which the Municipal Coordination Council for Public Works of Naco, Sonora (Consejo Municipal de Concertación para la Obra Pública de Naco, Sonora), Enlace Ecologico, A.C. and the North American Investigation and Development Center of the University of California in Los Angeles (NAID CENTER UCLA) participated.

Specific goals defined for this community participation program were:

- *To prepare an evaluation showing positive or negative opinions regarding the project, a week before the general public consultation meeting.*
- *To prepare press releases.*
- *To hold weekly meetings in different neighborhoods within Naco, Sonora.*
- *To hold meetings with organizations, whether governmental or non-governmental, from Mexico as well as from the United States, interested in environmental sanitation.*
- *To hold weekly meetings with the OOMAPAS-Naco Advisory Council to evaluate the progress and results of the project and the community participation program.*
- *To prepare and broadcast a radio program of regional scope.*
- *To hold information meetings in Naco and Bisbee, Arizona, with the participation of the environmental sanitation staff of Cochise County.*
- *To hold a General Public Meeting at the latest on March 15, 1996, informing thereof in the terms set forth by BECC.*
- *To submit to BECC a written report of the results obtained with the Community Participation Program.*
- *To maintain the population informed and to prepare a post-certification community participation program.*

The General Public Meeting was held on March 15, 1996 and the residents of Naco, Sonora were informed of the likely rate increases expected to come in effect once the project got underway. The project was accepted by the population as necessity, not only to solve potential transboundary issues, but to address the inadequacies of the present level of service to the community.

7. OPERATION AND MAINTENANCE

OOMAPAS-Naco has a three-member team for the operation, conservation and maintenance of the water supply, wastewater collection and treatment systems. This staff is considered insufficient because of the high work load required to perform the tasks with a high level of efficiency. Due to this situation and considering the limited financial resources available, it is very difficult for OOMAPAS-Naco to maintain a systematic conservation and maintenance program. Therefore, as part of this project, a conservation and maintenance program that would include safety and other measures to be implemented in case of contingencies should be prepared.

The works considered in the project are programmed to begin operation according to the following schedule:

- *Water supply, immediately after completion of works.*
- *Home hook-ups, as soon as connections are completed.*
- *The collector sewer, the expansion of the ponds and the two pump stations should begin operation simultaneously.*

The necessary recommendations, for start-up and testing of the pumping equipment, as well as for hydrostatic pipeline tests, will be made at the beginning of the project. The main operation, conservation and maintenance tasks for the proposed project are:

- *Pumping equipment operation.*
- *Valve operation and water supply distribution system sectorialization.*
- *Monitoring of storage tanks.*
- *Monitoring of flow meters at headworks and individual users.*
- *Stabilization pond operation.*
- *Water quality monitoring at least twice weekly.*
- *Preventive maintenance of pumping equipment.*
- *Preventive maintenance of valves, meters and accesories.*
- *Storage tank maintenance.*
- *Conservation of pond dikes.*
- *Conservation of pump station structures.*
- *Safety and hygiene measures.*
- *Tasks and measures in case of contingencies.*

The necessary recommendations for training of the operation and maintenance personnel will be provided in order to support the application of these programs. Four new employees will be hired to take-on these duties at OOMAPAS-Naco. The new employees must have a technical level such that they are able to undertake said tasks.

The average annual O&M costs for the project are $94,000, of which $28,200 are for the water supply system and $65,800 are for the wastewater collection and treatment system.

8. SUSTAINABLE DEVELOPMENT

The project will make several contributions to the sustainable development of the area.

- *Soil and aquifer pollution due to the inadequate management of raw as well as treated wastewater will be reduced.*
- *Recycling water will be furthered, by using treated effluent for crop irrigation purposes.*
- *The useful life span of the local aquifer, which happens to be the only water supply source available, will be increased by reducing losses due to leaks and by promoting a more efficient use of water.*
- *Electrical power consumption levels will be reduced by an estimated 20%, by operating appropriate and more efficient equipment.*
- *Official Mexican Ecological Standards for the discharge of wastewater will be complied with.*
- *Four full time jobs will be created.*
- *Farmers using treated wastewater for irrigation will enhance their income, by gradually increasing crop area, as the volume of effluente grows along with the population. It is estimated that inicially 40 acres will be added and by the year 2015 another 50 acres can be incorporated.*
- *Water service levels will be increased and there will be a sufficient and constant supply.*

Institutional Capacity Building

The water utility, OOMAPAS-Naco, will be strengthened so that it may increase its level of efficiency in the performance of its assigned tasks. Among these tasks, the following can be identified: up-dating the register of users and technical inventory of the systems, development of a new rate structure, organization and procedure manuals, managerial information systems, billing, collection and supervision, acquisition of computer and transportation equipment.

ANNEX

PROJECT STATISTICS OF THE WATER SUPPLY, WASTEWATER COLLECTION AND TREATMENT SYSTEM FOR THE CITY OF NACO, SONORA

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1. **Population** *(Inhabitants)*

    - *1990 Census 4,645*
    - *1995 Estimate (CONAPO) 4,841*
    - *1996 Estimate (this project) 5,733*

1. **Water Service Coverage** *(%)*

    - *Domestic Household 100*
    - *Commercial Establishments 100*
    - *Industries 100*

1. **Number of Hook-ups** *(January 1996) (%)*

    - *Domestic Household 1,274 97.85*
    - *Commercial Est. 16 1.23*
    - *Industries 12 0.92*
    - *Total 1,302 100*

1. **Consumption** *(GPD)*

    - *Domestic Demand 357,242*
    - *Commercial and Industrial Demand 13,696*
    - *Total Demand 370,938*

1. *(The domestic demand was estimated at 62.4 gal/capita/day)*
   (The commercial and industrial demand was estimated at an average of 489 gpd per establishment)
2. **Water Withdrawal** *(GPD)*

    - *Well No. 2 525,020*
    - *Well No. 3 182,615*
    - *Total 707,635*

1. **Coverage of the Sewer Collection System** *(%)*

    - *Domestic Households 85*
    - *Commercial Establishments 100*
    - *Industries 100*

1. *(The theoretical coverage of the system is of 85%, although only 65% of the households are actually hooked-up. The wastewaters are conveyed to the treatment modules by means of two main collector lines, one pressurized and the other by gravity)*
2. **Number of Wastewater Discharges** *(January 1996) (%)*

    - *Domestic Households 822 96.71*
    - *Commercial Establishments 16 1.88*
    - *Industries 12 1.41*
    - *Total 850 100*

1. **Wastewater Treatment System**

    - *There are currently two treatment systems with a combined capacity of 114,000 gpd, that is able to handle only 41% of the present wastewater flow.*
    - **Naco Water Utility (OOMAPAS)**
    - *Is capable of covering the total population of 5,733.*
    - *Presently has a staff of 3 and an annual budget of $22,847 for personnel. The personnel expenditures represented 30.1% of the total operation and maintenance costs.*
    - *The total O&M costs for 1995 were of $75,967.*