UTILIZATION OF WASTEWATER ON THE UNITED STATES – MEXICO BORDER

Management Options for Mexican Effluent in Ambos Nogales

by

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Abstract

Along the Arizona-Sonora border, the same wastewater that was once considered only a threat to public health is now seen as a valuable commodity. In the present period, growing populations, more demand for fixed supplies of water and extended drought have made people realize effluent's true value. Wastewater is now seen as a key component of water budgets that can be treated and utilized for non-potable uses.

The cities of Ambos Nogales share surface and groundwater resources. Wastewater generated in Nogales, Sonora and Nogales, Arizona (Ambos Nogales), is jointly treated at the Nogales Wastewater Treatment Plant (NIWTP) in Rio Rico, Arizona. Seventy percent of the wastewater treated by the plant is generated in Nogales, Sonora. This paper considers some of the issues related to the management of Mexican effluent in Ambos Nogales. It describes possible mechanisms for management and how new developments may present opportunities for new ways to manage effluent between Mexico and the United States. These new developments include a proposed electrical generating plant which could utilize the effluent for cooling, a new water management authority in southern Arizona, and a scenario to cycle a portion of the effluent back to Mexico.

INTRODUCTION

Along the Arizona-Sonora border, the same wastewater that was once considered a curse and a threat to public health is now seen as a valuable commodity. In the present period, growing populations, more demand for fixed supplies of water and extended drought have made people realize effluent's true value. Like the plant that was classified as a weed until its good qualities were discovered, wastewater is now seen as a key component of water budgets that can be treated and utilized for a variety of non-potable uses. Treated water, or effluent, can be used to water golf courses and parks, to cool electrical generating plants, and in general, to stretch the amount of potable water available, using the lower-quality effluent for many uses formerly served by potable water.

Wastewater generated in Nogales, Sonora and Nogales, Arizona (Ambos Nogales), is jointly treated at the Nogales Wastewater Treatment Plant (NIWTP) in Rio Rico, Arizona. In a dry region like the Sonoran Desert, water, in almost any form, is valuable. It is easier to clean up dirty water than it is find new water. Water managers and the public in general, now realize that the only source of water that is going to increase in the future is wastewater. Population pressures have placed added demand on the shared resources (Table 1) and have caused the communities to search for more water sources to supplement traditional supplies.

The Santa Cruz River is the principal water resource in the area servicing both Nogales, Arizona and Nogales, Sonora (Map 1). With headwaters in the San Rafael Valley, Arizona, the river flows southward through Sonora, Mexico and returns to Arizona five miles east of Nogales, Arizona (ADWR 1999). Ephemeral or intermittent characterize the river, with some perennial reaches. A perennial reach of the river exists downstream of the NIWTP, caused by effluent discharged into the river from the plant. The Santa Cruz River aquifer system is generally shallow with limited storage capacity, and sensitive to drought. The aquifers also recharge quickly when rain is present.

Table 1
Number of Inhabitants in
Nogales, Arizona and Nogales, Sonora

Year	1950	1970	1990	2000	2010
Nogales, Arizona	6,153	8,946	19,489	20,878	24,282
Nogales, Sonora	26,016	53,494	107,936	206,554	275,704

(IBWC 1998; U.S. Census Bureau 2000)

Effluent represents an important, and growing, renewable water resource in Ambos Nogales (Morehouse et al. 2000; Ingram et al. 1995). Two-thirds of the effluent treated at the NIWTP is wastewater generated in Mexico. The NIWTP discharges effluent into the Santa Cruz River where it recharges water tables and supports a rich riparian habitat downstream of the plant (Scott et al. 1997). International Boundary and Water Commission (IBWC) Minute 294 established Nogales, Sonora and Nogales, Arizona treatment capacity at the NIWTP at 9.9 million gallons per day (mgd) and 7.3 mgd, respectively (IBWC 1995) (Table 2).[1] Mexican wastewater flows to

1 Decisions reached by the IBWC are published in the form of Minutes.

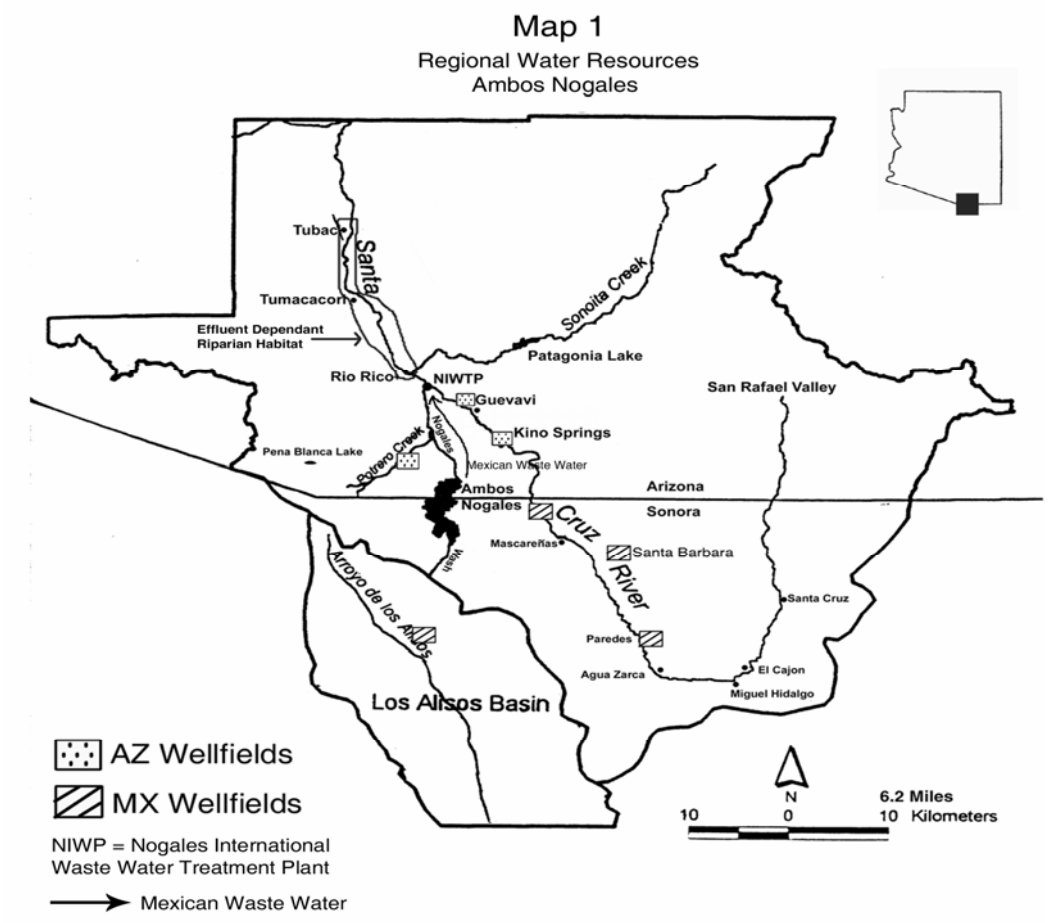


Table 2
Arizona and Sonoran Treatment Capacity and Sewage Influent
Nogales International Wastewater Treatment Plant
(million gallons per day)

City	Treatment Capacity	Sewage Influent (1994-2003)
Nogales, Arizona	7.3	4.8
Nogales, Sonora	9.9	9.6
Total	17.2	14.4

IBWC (1995); IBWC (2004a).

the NIWTP has averaged 9.6 mgd in recent years, yet Mexico exceeded its allotted capacity in 2000 and 2001 (Table 3).[2]

This next section of this paper describes the present issues that affect how the Mexican effluent is managed. Subsequent sections describe the role of the Nogales International Treatment Plant, effluent use in Sonora and Arizona, and possible mechanisms for management and how new developments may present opportunities for new ways to manage effluent between Mexico and the United States. These new developments include a proposed electrical generating plant which could utilize the Mexican effluent for cooling, a new water management authority in southern Arizona, and a scenario to cycle a portion of the effluent back to Mexico.

Table 3
Annual Sewage Influent at the NIWTP: 1996-2003
(million gallons per day)

Source of Effluent	1996	1997	1998	1999	2000	2001	2002	2003
Arizona.	4.0	4.2	5.0	5.5	5.1	4.5	5.5	4.4
Mexico	8.8	8.5	9.5	9.0	10.4	11.1	9.2	9.9
Total	12.8	12.7	14.5	14.5	15.5	15.5	14.7	14.3

(IBWC 2004a)

MEXICAN EFFLUENT

Both Sonora and Arizona receive benefits from the present arrangement. Arizona receives a source of water that represents 38 percent of the renewable supplies in the Santa Cruz Active Management Area (AMA) [3] (Morehouse, et al. 2000). Sonora benefits by not having to build a treatment plant to treat wastewater on its soil and it only pays a portion of the treatment costs. Mexico pays only what it would cost to treat the water in Mexico and to the level of treatment that it would be treated in Mexico (Peña 2004). The key issues related to the present management agreement of the Mexican aquifer are summarized below.

Sonora Effluent Improves Water Resources in Arizona but Mexico Pays for the Treatment Costs

The Mexican effluent that Mexico sends to Arizona provides a vital source of water to the United States. The Mexican effluent recharges aquifers and creates 12 miles of riparian habitat downstream of the NIWTP. On the other hand, Mexico too could utilize the effluent to recharge its aquifers and to replenish its riparian habit areas.

Mexico pays approximately $200,000 a year to pay for the cost of treating its effluent in Mexico (Peña 2004). Even though they don't pay the full cost of treating the effluent, the yearly cost

2 In response to increased Mexican wastewater in the NIWTP, the Border Environment Cooperation Commission (BECC), in 2000, certified a project to increase capacity at the NIWTP and to build a small wastewater treatment plant in Mexico to treat a portion of the Mexican effluent (in excess of 9.9 mgd).

3 The Santa Cruz AMA, one of five AMAs created by the Arizona Department of Water Resources (ADWR) in areas where groundwater overdraft is most severe, is located on the border with Mexico, is distinguished by significant international, riparian and groundwater/surface water issues.

associated with treatment is a burden to pay. From Mexico's perspective, they not only lose their water but, in addition, they have to pay for the treatment costs.

From the perspective of Mexico, it has contributed wastewater for the beneficial use of residents of Arizona. Some people in Mexico ask the question, does Mexico have the right to a retroactive payment (in water or money) for its effluent; or, does Mexico have the right to more water from the Colorado River in exchange for the water it sends to the United States (Solis 2003).

Health Issues Related to the Low Quality of the Water

Health issues associated with the Mexican wastewater and effluent include concentrations exceeding standards for metals (which just pass through the plant without treatment), turbidity and ammonia (Hansel 2004). While a higher value is placed on effluent than it once was, health is still an issue. The Mexican effluent is both a burden and a benefit to Arizona.

Regional Geography Dictates that the Water Flows from Sonora to Arizona

Of all the laws in existence related to Mexican effluent and wastewater, the one law that is always in force is the "law of nature". Because of the north-to-south gradient in the area, the original treatment plant was constructed in Arizona. The gradient makes it difficult for Mexico to recapture the effluent for use in Mexico. If Mexico builds a wastewater treatment plant in Sonora (probably in Los Alisos, 10 miles to the south of Nogales, Sonora) it would require that the wastewater be pumped uphill to the plant.

Mexico Retains Legal Control of its Effluent

Under IBWC Minute 276, Mexico retains the right to return its effluent to Sonora (IBWC 1988), where it could be utilized for industrial, agricultural or aquifer recharge purposes (Cervera 1997; Sanchez and Lara 1992).. Again, because of the natural flow of water, returning the water would be an expensive project. While the effluent currently is discharged and utilized exclusively in Arizona, Arizona law (A.R.S. § 45-576) restricts its use because it belongs to Mexico, making its long-term availability uncertain. Persons proposing to offer subdivided lands for sale within an Active Management Area must demonstrate sufficient water of adequate quality will be continuously available to meet the water needs for the proposed use for at least 100 years.

Riparian Habitat and Endangered Species are Supported by Mexican Effluent

Mexican effluent has created a healthy riparian area the supports a large array of wildlife including federally-listed endangered species. Over two hundred species of birds are estimated to use the riparian corridor and surrounding Mesquite Bosque. It serves as the primary water source for most of the area's wildlife and fish species including the Gila topminnow (*Poeciliopsis occidentalis*), a small fish listed by the U.S. Fish and Wildlife Service as "endangered" under the Endangered Species Act.

The corridor formed by the Rio Magdalena/Santa Cruz River is one of four north-south corridors that provide important habitat for migratory birds. Others include the Colorado, Rio Grande, and the San Pedro Rivers. Birds using these corridors can travel as far south as Argentina and as far north as the Arctic. This lush riparian habitat is particularly important to both nesting birds and spring migrant land birds of all types, and is considered an Important Bird Area in the state. The Tumacácori section supports some of the state's highest densities of nesting Yellow-billed

Cuckoos (*Coccyzus americanus*); the species is a candidate for Federal Threatened species designation.

THE NOGALES INTERNATIONAL WASTEWATER TREATMENT PLANT

Since its first appearance in 1951, the NIWTP has gone through two upgrades and a ten-fold increase in plant capacity. In 2000, the Border Environment Cooperation Commission (BECC) certified a plan to address wastewater problems in Ambos Nogales (BECC 2000).[4] The plan called for enhanced treatment capacity at the NIWTP, from 17.2 mgd (million gallons per day) to 22.5 mgd, and replacement of the present pipe which conveys Mexican wastewater from the border to the plant (called the International Outfall Interceptor, or IOI), with a larger pipe. Under the new plan, ammonia and nitrogen levels in the effluent would be significantly reduced. Turbidity would also be better controlled to comply with federal standards. Heavy metals, which have exceeded standards in the past, would not be treated. According to the plan, metals would have been addressed by a pre-treatment process in Mexico.

In Mexico, the plan involved construction of a new wastewater treatment plant in Sonora to be located about 11 miles south of the border, in Los Alisos basin. Present wastewater flows from Mexico to the NIWTP were expected to continue, while flows above 9.9 mgd would be pumped to the Los Alisos basin. A conveyance system would transport a portion of wastewater to the Los Alisos basin, which is not hydrologically connected to the Santa Cruz River watershed. The plan called for wastewater collection systems to be upgraded in both Nogales, Arizona and Nogales, Sonora.

Since the 2000 grant application to BECC for improvements on the U.S. side of the border, progress to implement the proposed upgrades and construction came to a halt when costs for the new plant design greatly exceeded original estimates (dos Santos 2004). There was also a dispute between NIWTP operation and maintenance costs between the City of Nogales, Arizona and the IBWC. While Nogales, Arizona is still not utilizing its total capacity in the plant, Mexico is regularly exceeding its 9.9 mgd capacity. Talks to implement the plant upgrades resumed in October 2003, with the Arizona Department of Environmental Quality (ADEQ) coordinating discussions with United States Environmental Protection Agency (EPA), BECC, NADBANK, the City of Nogales and the IBWC (Tinney 2004).

The parties involved in the plant upgrade talks were brought back to the table by two impending issues that put pressure on the group to get the process back on its feet. First, penalties could be assessed by ADEQ on the owners of the NIWTP, the City of Nogales and the IBWC. The NIWTP must comply with a deadline established by federal court order, and it must meet ADEQ's Aquifer Protection Permit program requirements. Fines could be as high as $25,000 per day. Secondly, the $60 million set aside for plant upgrades in 2000 by EPA could soon be reallocated if not used.

[4] The Border Environment Cooperation Commission is a bi-national organization created by the United States and Mexico under the side agreements to the North American Free Trade Agreement (NAFTA). The purpose of the BECC is to help conserve, protect and enhance the environment in the U.S.-Mexico border region, through the development and certification of environmental infrastructure projects that incorporate sustainability and public participation components. Once certified by the BECC, a project may qualify for funding from the North American Development Bank (NADBank) or from other sources requiring such certification. The NADB was also established under the same side agreement.

Committees have been formed to sort out the complex issues. The four committees address finance, legal, political and technical issues (Tencza 2004). One of the critical technical issues is to look for the most cost effective way to upgrade the plant. With limited money available for construction, committees must select which upgrade components are needed the most. The goal of the committees is to have some answers to the complex issues by March of 2005 (Tencza 2004). It is possible that the upgraded NIWTP could be online by 2008 (IBWC 2004b).

From Mexico's perspective, a key question that it must address is do they want to increase their capacity in the plant. If they exceed their 9.9 mgd allotment, they must pay the full cost of treatment, and not the subsidized rate they now pay. Instead of paying to build more capacity in the NIWTP, another option for Mexico is to construct a small wastewater treatment plant in Los Alisos and treat wastewater in excess of 9.9 mgd there. A third option would be to strike a deal with the United States for some arrangement to exchange effluent for payment relief (Basaldua 2003).

EFFLUENT USE

Effluent is presently being utilized in both Southern Arizona and in Sonora. There are distinct ways that the two countries utilize this resource. Sonora utilizes the effluent but there is no formal market for it, while Arizona markets effluent. In both countries the effluent serves as a low-cost replacement for potable water resources.

In Arizona

In Tucson, 40 public schools, 32 parks and 14 golf courses utilize reclaimed water. Altogether, 600 sites receive reclaimed water in Tucson. Tucson's reclaimed water is classified by the Arizona Department of Environmental Quality as Class A water. The reclaimed water has received secondary treatment at the Roger Road wastewater treatment facility in Tucson. The price per acre-foot of water for reclaimed water in Tucson, as of July 2004, is $609 per acre-foot (Tucson Water 2004). The cost of treating the water is $713 per acre-foot, with the difference between treatment costs and sales price being made up through the sales of potable water (Dotson 2004).

In Sonora

In the state of Sonora, Mexico, effluent is generally utilized for the maintainence of parks, golf courses, housing developments and hotels. In recent years it has been used as a coolant in electrical generation plants, and effluent is used for this purpose in Hermosillo and Agua Prieta. The state of Sonora pays between $270 and $379 to treat their wastewater and companies purchase wastewater from cities for the standard of $125 per acre-foot in the state of Sonora (Gobierno de Sonora 2003). Approximately 5,000 million gallons of effluent is produced each year in Sonora. Of that amount, 1,700 millon gallons is used for cooling in electrical generating plants.

There is no formal market where effluent is purchased for specified uses, as in Arizona. Usually the entity that generates the effluent also puts the effluent to use. The treatment costs are cheaper in Mexico

POSSIBLE ALTERNATIVE MANAGEMENT SCENARIOS

The increasing demand for renewable supplies of water in Ambos Nogales will probably eventually result in changes in the way Mexican effluent in managed. Constructing a power plant to meet increased demand for electricity in northern Mexico, the possible creation of a water management group in southern Arizona and creative ideas to recycle effluent, are three events that provide options to the way Mexican effluent is presently managed.

The Proposed Nogales, Arizona Power Plant

A proposal is under development to build an electrical generating plant in Nogales, Arizona, utilizing Mexican effluent for cooling (Maestros Group 2004). The Maestros Group is preparing a bid to the Mexican Electricity Commission to construct a 411 million watt (MW) gas-powered electrical generation plant in Nogales, Arizona to provide electricity to Nogales, Sonora. The benefits to Mexico would be a needed supply of electricity and liberation from the yearly payments to treat their wastewater in Arizona. An interesting feature of the plan is that Mexican effluent would be used to generate electricity for Nogales, Sonora.

The benefits to Nogales, Arizona would be additional jobs, a back-up supply of electricity for Santa Cruz County, and higher air quality standards for plant emissions than if the plant were built in Mexico. The plan could also help to assure that the Mexican effluent from the NIWTP stays in Arizona. The bid process, twice postponed, is set to be announced in late 2004. The proposed plant would use an estimated 3 mgd of Mexican effluent. Sonoran effluent flows to the NIWTP presently exceed their treaty limit of 9.9 million gallons per day. This flow in excess of the treaty would be utilized for use as cooling water.

Water Management Authority

In order to more comprehensively manage water resources in southern Arizona, the prospect of establishing a “water management and importation authority” has been proposed by local water interests (State of Arizona 2002; ADWR 1999). The water management authority could be the vehicle to negotiate with Mexico about continuing wastewater flows to Arizona (ADWR 1999). The key to making an agreement work would be to assure that both Nogales, Sonora and Nogales, Arizona have their respective water needs met (Sprouse and Vaughn 2002). An equitable agreement on the effluent between the two countries could be a link that binds the two communities instead of being a point of contention.

Effluent Recycling Scenario

A water management authority, or some other entity in Southern Arizona, could choose various strategies to meet its goals. Under this scenario, some of the effluent originating in Mexico would be returned to Mexico (Barcenas 2004). The population of Nogales, Sonora continues to experience significant growth, with a substantial increase in the demand for potable water and sewerage collection facilities. This scenario makes the assumption that Mexico values its water beyond the exchange value it has for money. Mexico views its water as a part of its patrimony, as it did oil in the 1920’s, and the value placed on water may exceed the dollar amount for treating the water (Sanchez 1997). Under this scenario, Mexican effluent in excess of 9.9 mgd could be sent back to Mexico, with the remainder of the Mexican effluent used either for municipal water providers or for downstream users in Nogales, Arizona.

Returning water to Mexico could be done by transferring a portion of the effluent from the NIWTP to the Mascareñas well field on the Santa Cruz River, located just south of the U.S.-Mexican border (Map 2). This would allow the effluent to be recharged into the aquifer, taking advantage of soil filtration to remove impurities in the water, and then pumped back for use in Nogales, Sonora. This alternative has the advantage of creating an almost closed conveyance system where the water continuously cycles from Mexico to the NIWTP and back to Mexico. To help lower costs, this project could be done in conjunction with the City of Nogales, Arizona, which has proposed using its effluent (generated in Nogales, Arizona) to recharge the Guevavi well field along the Santa Cruz River (IBWC 1999). An extension added to the City's effluent pipeline could carry the water the additional five or six miles to the border. By itself, an effluent pipeline from the NIWTP to the border would be costly (Malcolm Pirnie 1997)[5].

This alternative would allow Nogales, Sonora to reduce the amount of water being pumped from the Los Alisos basin, to the south, where it must be pumped over a basin divide, to Nogales, Sonora. The water in Los Alisos could be used to support projected growth in that area while the needs of Nogales could be provided for by the effluent from the NIWTP (or by potable water pipe lines). The water authority would pay for treatment costs of Mexican wastewater at the NIWTP and would share costs for building a pipeline and pumping effluent back to Mexico.

The advantage of this scenario to Arizona is that it would receive a 100 year guarantee of flows from Mexico. Mexico would receive: 1) cancellation of a yearly debt to pay for treatment of their wastewater in Arizona, and 2) a portion of their effluent back to satisfy demands of riparian areas and growing populations. The disadvantage is the cost of building infrastructure to deliver effluent to Mexico and the yearly operation and maintenance costs associated with maintaining the infrastructure. The advantage to Arizona is that it would receive the same quantity of effluent that it presently receives. By returning effluent to Sonora and helping Mexico achieve its water needs, Arizona's water needs could be met as well. While the cost of transporting effluent back to Mexico may be expensive initially, in the long-run, the value of the effluent should increase to make it more cost effective.

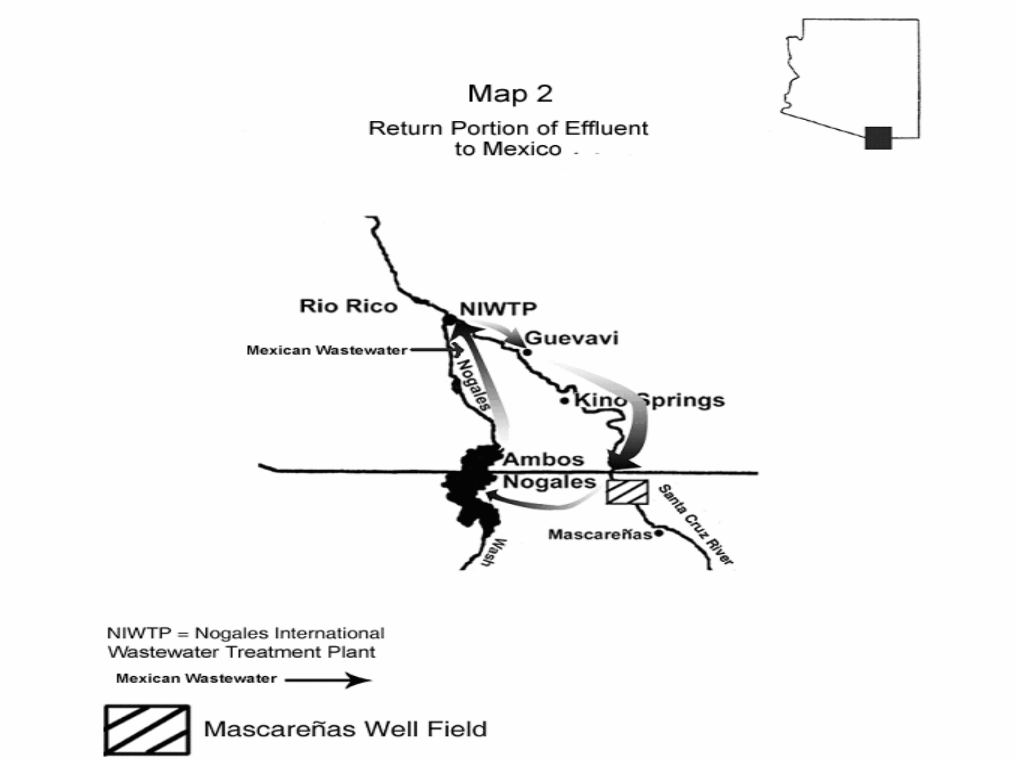
Value of Water

The value of water, particularly effluent, is not something that is easy to put a monetary value on. In an economic sense, the value of water is the amount that the user would be willing to pay for the use of that resource. The Mexican effluent provides many benefits to Arizona; it recharges aquifers in Arizona and supports a lush stretch of riparian vegetation and habitat. There are esthetic values associated with a flowing river to the county, to present residents and to future residents.

New housing developments require a long-term source of water, and flowing water near houses means higher property values. A study of private property values in Tucson indicated that areas within a one to five mile radius of riparian area proposed for protection received a property value premium of three to six percent (Colby 2002). The premium is even higher for undeveloped land near riparian corridors. The increased property value of vacant land located closer to riparian corridor ranges from 10 to 27 percent (Colby 2002).

[5] Cost to re-capture and pump effluent from the NIWTP outfall to Nogales, Sonora are estimated to be about $184 per acre-feet, or $1,030,000 to pump eight acre-feet of effluent to the border. Sixty-four percent of the cost is associated with capital equipment repayment.

A river draws tourism, including birders, to the area. Studies in southern and central Arizona riparian areas found that each visitor to the Hasayampa National Conservation Area contributed $65 to $102 to help maintain the quality of the area (Colby 1996). In the San Pedro Riparian National and the Nature Conservancy's Ramsey Canyon Preserve Conservation Area persons contributed $65 to $97 to protect riparian ecosystems (Colby 1996).



CONCLUSION

The Mexican effluent can serve as a way to unite the communities of Nogales, Arizona and Nogales, Sonora. The geography and proximity of the two areas has created the necessity that they work together to address regional water issues. While it would require extensive negotiations on both sides, and the need to overcome many political obstacles, the changes that may be in store for the future could well affect the way that Mexican effluent is managed.

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