Ambos Nogales

Effluent Discharges

Wastewater Treatment

Mexican Wastewater & River Flows

AMBOS NOGALES EFFLUENT

INSTITUTIONAL FRAMEWORKS FOR EFFLUENT WATER USE IN THE AMBOS NOGALES REGION

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Introduction

Perennial flows in the United States of America (US) portion of the Santa Cruz River downstream from the Nogales International Wastewater Treatment Plant (NIWTP) depend on its effluent discharges. The US portion is subject to high variability in flows, due to both wastewater overflow events resulting from heavy rainfall, and decreases in flow resulting from treatment and discharge of Mexican wastewater by Mexico.

The diversion of wastewater generated from NIWTP has the potential to have social, institutional, hydrological, and ecological effects to the Ambos Nogales region (Nogales, Arizona and Nogales, Sonora). Coupled with this change in discharge are potential stressors due to climate variability. The difference in institutions and legal frameworks north and south of the US/Mexico border further complicates water management efforts.

The following analysis focuses on the institutional setting for wastewater treatment and effluent in the Santa Cruz Aquifer Basin. The article describes the physical and legal background of the region and how those factors will impact future management decisions. The article closes by discussing future plans regarding effluent water on both sides of the border.

Information for this article was gathered from a literature review on NIWTP, the Santa Cruz River Aquifer, and policies in the US and Mexico. Five interviews were conducted with representatives from Mexican and American government agencies operating in the Ambos Nogales region.

Ambos Nogales Region Wastewater System

Since 1951, wastewater generated in Nogales, Sonora has been piped into the US through the International Outfall Interceptor pipeline (IOI) and treated at the Nogales International Wastewater Treatment Plant (NIWTP) (Varady et al. 1995). Perennial flows in the US portion of the Santa Cruz River *downstream* from the NIWTP largely depend on the effluent discharges from the plant.

NIWTP has a capability of 14.7 **m**illion **g**allons per **d**ay (MGD), of which 9.9 MGD is received from Nogales, Sonora and 4.8 MGD from Nogales, Arizona (for reference, 1 MGD is equivalent to 1120.1 acre-feet per year). About 10,000 acre-feet per year of reclaimed water discharge in the Santa Cruz River comes from Nogales, Sonora, of which approximately 7,000 acre-feet per year infiltrates into the aquifer (Fabritz-Whitney et al. 2012).

Figure 1: Wastewater overflow in Nogales, Mexico. Photo courtesy of Hans Huth.

The total amount of water reaching NIWTP can vary on an annual or seasonal basis. During the period of 2011-12, an excess of 2.1 MGD provided by Nogales, Sonora represented an environmental and economic challenge to both nations as an overload on the NIWTP — combined with heavy rainfall — resulted in wastewater overflows (Figure 1) that could discharge directly into the Santa Cruz River (Valles 2014).

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Effluent Flows

In response to the overflow, the Mexican government commissioned Los Alisos Wastewater Treatment Plant (Los Alisos WTP or Los Alisos) in 2012 to treat a portion of the wastewater generated from the city of Nogales, Sonora. The operation of Los Alisos has already changed the quantity of wastewater treated downstream at the NIWTP. The construction of Los Alisos and the subsequent reduction of wastewater flows raises questions about the future of effluent flow in the region. The effluent flow, though possibly problematic due to water quality issues, is now relied upon for ecological and recharge functions in Arizona. It is unclear how climatic changes, institutional changes, and future management plans on both sides of the border can alter the social, hydrological, and ecological regime.

Santa Cruz River

Physical Background

The headwaters of the Santa Cruz River (*see* Figure 2) are located in the San Rafael Valley in southern Arizona. From there, the river flows southward into Sonora, Mexico, recrossing the US-Mexico border near Ambos Nogales. The river is an ephemeral tributary that drains into the Gila River, which then flows into the Colorado River. The city of Nogales, Arizona has about 20,000 people, while Nogales, Sonora has been officially listed as having 200,000 residents, though this is likely an undercount — the actual population may be closer to 350,000. The undercount in population means that Nogales, Sonora may receive a smaller budget for water provisions and other infrastructure needs, as the Mexican federal government bases funding allocation on population estimates. With the increase in population, Nogales, Sonora has expanded southward up hillsides. These settlements generally lack services, including water and sewer, due to the costs and difficult logistics associated with building infrastructure on the steep hillsides (Wilder et al. 2012).

Population Impacts

In Nogales, Sonora, Organismo Operador Municipal de Agua Potable Alcantarillado Y Saneamiento de Nogales (OOMAPAS), supported by Comisión Nacional del Agua (CONAGUA, the Mexican water authority), is responsible for planning and implementing water and sanitation services (Milman and Scott 2010). Forty-seven percent of Nogales, Sonora's water comes from the Santa Cruz River Aquifer, while 34 percent of Nogales, Sonora's water is sourced from the Los Alisos watershed and 19 percent comes from the Nogales Aquifer (OOMAPAS 2017).

Water Sources

Figure 2: The Santa Cruz Aquifer, Nogales International Wastewater Treatment Plant (NIWTP), Los Alisos Wastewater Treatment Plant (LAWTP). & Santa Cruz Active Management Area (AMA)

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The Santa Cruz area is mostly rural aside from Nogales on the US side of the border. It is comprised of cattle ranching, retirement communities, and wilderness areas (Milman and Scott 2010). Around 50% of Nogales, Arizona's potable water supply comes from the Santa Cruz Aquifer (Sprouse 2005). The Potrero Creek well field, northwest of Nogales, Arizona, is the other main source of water for the city (Wilder et al. 2012).

Two Wet Seasons

The climate of the Santa Cruz River watershed is characterized as arid to semi-arid. The area experiences two wet seasons: the summer monsoon (July-September) and winter (November-March). While summer can produce intense rainfall events over a short time period and accounts for most of the annual precipitation, winter storms may last for days, with persistent rain over a more widespread area. It is predicted that there will be an increase in the frequency of dry summers and a decrease in the frequency of wet summers in future years (Shamir et al. 2015). The bimodal rainfall patterns lead to streamflow regimes that fluctuate, thereby enhancing the basin's sensitivity to variable climate conditions and increasing its vulnerability to effects of climate change (Norman et al. 2010). Future climate projections predict a decline in water reliability, decreased groundwater recharge, and an increase in the long-term water deficit (Shamir et al. 2015).

Climate Change Impacts

Riparian Vegetation

Riparian vegetation along the Santa Cruz River has increased with the construction of NIWTP. The effluent has allowed for dense vegetation areas to increase from 6,200 acres in 1954 to 8,600 acres in 1995 due to higher effluent volumes (Wilder et al. 2012). Nearly all of the Santa Cruz River's riparian vegetation is downstream of NIWTP (Varady et al. 1995).

On the Mexican side of the border, the Santa Cruz Basin had a net loss of about 7,134 acre-feet of water per year in 2011, based on an average 6.2 MGD inflow from the Los Alisos Basin and a 12.5 MGD outflow to the NIWTP (Prichard and Scott 2014).

Legal Background

Mexico' Management

In addition to the physical challenges of the region, the differences in institutions and legal frameworks north and south of the border further complicate water management efforts in the Santa Cruz Aquifer Basin. Mexico's water governance is more centralized than that of the US but is going through a process of decentralization. Mexico's national water commission, Comisión Nacional del Agua (CONAGUA), holds the authority for all activities related to use, management, and protection of "national water." The commission is also responsible for conducting studies to determine water availability and for administering permits for water abstractions, diversions, and discharge.

The Mexican section of the International Boundary and Water Commission (IBWC), known as Comisión Internacional de Límites y Agua (CILA), is charged with diplomatic negotiations. IBWC doesn't implement water management activities aside from operating and maintaining infrastructure designed specifically in foreign agreements (Milman and Scott 2010). Locally, Nogales, Sonora regulates water quality through an industrial and commercial pre-treatment program since 2003 to control on-site contamination. OOMAPAS inspects and monitors discharges and works with the binational technical committee to improve the quality of discharge.

US Governance

The US has a more decentralized system for water governance; water governance and management are primarily conducted at the state level. As in Mexico, no entity is solely responsible or mandated for addressing transboundary aspects of groundwater management. The allocation of jurisdiction across federal and state agencies leads to ambiguities over who is responsible for which aspects of water management at which scale (Milman and Scott 2010). Within the US, the federal government is responsible for establishing regulations on drinking water quality and any water discharged in the US, the standards of which are set by the US Environmental Protection Agency (EPA) (Megdal and Scott 2011).

Drinking Water

ESA Concerns

EPA (through enforcing the federal Endangered Species Act) and the Arizona Department of Fish and Game (through the Project Evaluation Program) are responsible for ensuring that projects authorized at the federal or state level do not negatively impact critical habitat for endangered species, including the Gila topminnow and the southwestern fly catcher (Milman and Scott 2010). Internationally, the IBWC holds authority over most international water resources issues along the US-Mexico boundary, with few exceptions (Mumme et al. 2012).

Arizona Water Law (100-Year Supply)

At the state level, the Arizona Revised Statutes designate the Arizona Department of Water Resources (ADWR) to administer Arizona water law (including the implementation of groundwater management law) and ensure adequate supplies of water for the state in the long-term. The mission of the ADWR is to ensure "an adequate quantity of water of adequate quality for Arizona's future" (ADWR 2002). This is defined as "assured water supply" — 100 years of meeting current and future demands of customers. ADWR's main functions include administering and enforcing Arizona groundwater code and surface water rights laws. The agency does not have authority to address water transfers out of or into the state, nor to conduct international agreements (Milman and Scott 2010).

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Federal & State Authorities

EPA sets water quality standards across the country through mechanisms such as the Safe Drinking Water Act and the Clean Water Act's National Pollutant Discharge Elimination System (NPDES). However, as is true in most states, Arizona has had the authority to adminster water quality discharge permits delegated to it by EPA. The state can promulgate its own water quality standards so long as EPA deems them to be at least as protective as federal standards.

Water Quality Violations

NIWTP operates under an Arizona Pollutant Discharge Elimination System permit (AZPDES) granted by the Arizona Department of Environmental Quality (ADEQ). ADEQ regulates water quality discharges of NIWTP into the Santa Cruz River and has issued Groundwater Protection Permits (subsequently Aquifer Protection Permits) to NIWTP. NIWTP has been given Notices of Violation in the past for: failing to renew permits on time; not sampling biosolids in a timely manner; failing to provide lab results; and other reasons (ADEQ).

Santa Cruz AMA

The Arizona region across the international border and directly downstream of Nogales, Sonora is part of the Santa Cruz Active Management Area (SCAMA), which was created from a portion of the Tucson Active Management area in 1994 to address its own unique water management problems. These include hydrologic conditions, such as severe overdraft of water, and international issues (ADWR 1999; Shamir et al. 2015). In Arizona, Active Management Areas (AMAs) are subject to regulation pursuant to the 1980 Arizona Groundwater Act (*see* Staudenmaier, *TWR* #33). ADWR administers AMA programs in a manner consistent with meeting the state's groundwater goals. In the SCAMA, the management goal is to maintain a safe-yield condition and to prevent local water tables from experiencing long-term declines. "Safe-yield" is defined as a "groundwater management goal which attempts to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an active management area and the annual amount of natural and artificial recharge in the active management area" (A.R.S. § 45-561(12)).

"Safe-Yield"

Effluent Effects

The Santa Cruz River has received effluent water generated from the plant since the construction of NIWTP in 1972 (Figure 3). The effluent has had both positive and negative effects on the SCAMA. One area where SCAMA has seen benefits is that the state can use the amounts delivered for environmental benefits and aquifer recharge when the effluent is present. However, it should be noted that Arizona cannot rely upon delivery of effluent to meet assured water supply rules and therefore cannot use it for planning purposes (ADWR 2007; Interview conducted by Elia M. Tapia, March 20, 2019). To earn recharge credits, an entity would have to first apply for and receive an underground storage facility permit and a water storage permit. The permits would not be granted unless the applicant could prove that they have the legal right to the water that the applicant wants to use for recharge (Personal communication, email message to author, May 15, 2019). Nogales, Arizona could claim its legal right to the portion of effluent that it owns.

Legal Right to Effluent

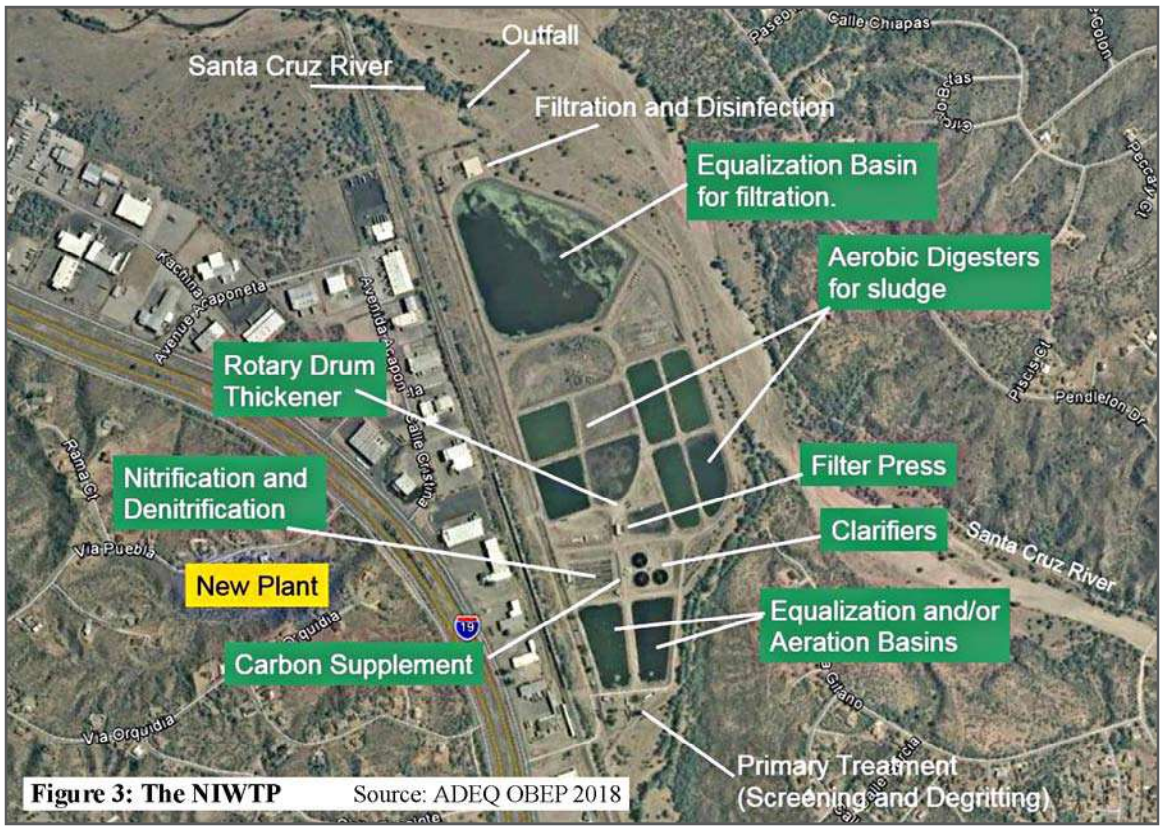

Figure 3: The NIWTP Source: ADEQ OBEP 2018

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River Flow

Binational Commission

Shared Groundwater

Technical Issues

Sanitation "Minutes"

Water levels downstream from the NIWTP have subsequently increased in part due to effluent discharge, though the levels have decreased in more recent years after Los Alisos was commissioned in 2012 (Sonoran Institute 2019). This in turn, at times aided by higher than normal precipitation and natural surface flow, has led to the expansion of riparian habitat along the Santa Cruz River (Figure 4). The effect of effluent discharge on water levels appears to diminish close to the northern Santa Cruz AMA boundary (ADWR 1999).

Binational Context

Established through the Convention of 1889 between the US and Mexico, the International Boundary and Water Commission (IBWC), or la Comisión Internacional de Límites y Aguas (CILA) in Mexico, is one binational organization with Mexican and US sections. The US section is part of the US State Department. The Mexican section is part of the Secretaría de Relaciones Exteriores. The binational organization was designed as a diplomatic outlet for Mexico and the US for developing "Minutes" — i.e., executive agreements made for implementing the 1944 Treaty — to search for solutions to water-related problems between the two countries (Mumme and Moore 1999).

While the US and Mexico have an extensive history of formal cooperation over their shared surface waters, they have not signed a formal agreement regarding shared groundwater, aside from one agreement to limit groundwater pumping near the Yuma, Arizona/San Luis Rio Colorado, Sonora border region with the signing of Minute 242 (IBWC 1973).

ADWR participates in the Environment & Water Committee of the Arizona Mexico Commission, a forum where Arizona and Sonora can discuss current and future water management plans. ADWR "is attempting to use this forum to gain additional insight into Sonora's plans" for its wastewater sent to NIWTP (Fabritz-Whitney et al. 2012, p. 18). NIWTP's pretreatment program also has a binational technical committee, made up of: the US and Mexican sections of the IBWC/CILA; EPA; ADEQ; ADWR; City of Nogales, Arizona; CONAGUA; and OOMAPAS. The committee reviews data and exchanges technical information every two to three months. The primary purpose of the committee is to identify sources of contamination and to prevent contaminating discharges into the collection system (IBWC 2005).

Sanitation issues such as NIWTP's have already been recognized within a binational context. A few binationally agreed-upon minutes have specifically addressed sanitation issues, including Minutes 206, 227, 261 and 276. Minute 206 established joint operation and maintenance of the Nogales International Sanitation Project in 1958 (IBWC 1958). Minute 227 established that Mexico has no responsibility for operation and maintenance costs of a section of sewer line that would extend from the original wastewater treatment plant to its new location of Rio Rico, Arizona (IBWC 1967). The minute also states that Mexico may dispose "a part or of all" the sewage emanating from Nogales, Sonora (IBWC 1967). Minute 261 of 1979 states: "That in each case where the approved course of action provides that a border sanitation problem be jointly corrected by the two Governments, the Commission develop the plans and designs for the works necessary therefor, as well as the division of work and cost between the two countries, submit them for approval of the two Governments, and upon such approval, each Government through its Section of the Commission proceed to carry out the construction, operation and maintenance, with the greatest speed and timeliness possible" (IBWC 1979).

Figure 4: The Santa Cruz River in Southern Arizona Source: ADEQ OBEP 2018

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Aquifers Assessment

Treatment Plant History

Shared Costs

Improper Disposals

Excess Volumes

Conveyance Pipeline

Stormwater Overflows

Infrastructure Proposals

In 1988, Minute 276 reiterated that Mexico "reserves the right to dispose of part or of all of the Nogales, Sonora sewage, in its own territory or return for reuse, in its own territory, the effluent from the international plant that is part of the sewage inflows corresponding to Nogales, Sonora" (IBWC 1988). The Minute also restates that Article No. 3 of the 1944 Treaty stipulates that the two Governments "agree to give preferential attention to the solution of all border sanitation problems" (IBWC 1988). Minute 276 established the total capacity of NIWTP allotted for Nogales, Sonora (9.9 MGD; 0.045 MCM).

The US and Mexico have also cooperated scientifically through the Transboundary Aquifer Assessment Program (TAAP). TAAP is guided by the Joint Report of the Principal Engineers Regarding the Joint Cooperative Process United States-Mexico for the Transboundary Aquifer Assessment Program (IBWC 2009). The Joint Report guides the binational study of four transboundary aquifers: the Santa Cruz and San Pedro (shared between Arizona and Sonora), and the Mesilla and Hueco Bolson (shared between New Mexico, Texas, and Chihuahua). This cooperation, as the Joint Report states, is "solely for the purpose of expanding knowledge of the aquifers and should not be used by one country to require that the other country modify its water management and use" (IBWC 2009, p.3).

Infrastructure, Economic and Environmental Concerns

International watersheds such as the Santa Cruz often encounter difficulties in managing shared infrastructure and environmental concerns. Wastewater difficulties in the Ambos Nogales region have been formally recognized by both countries for over 80 years. The first international wastewater treatment plant constructed in the Nogales, Arizona area was authorized by the US Congress in 1935 and completed by the IBWC in 1951 with federal funds from both the US and Mexico. It was built in Arizona because engineers did not find an area near the border on the Mexican side that was suitable for a treatment plant solely dedicated to treating wastewater from Mexico (Varady et al. 1995). A new, larger facility was completed in 1972 but soon became overburdened by an increasing population. The US and Mexico signed an agreement in July 1988 for the construction of a new plant in Rio Rico, Arizona (Varady et al. 1995). Mexico pays its proportional share of operational and maintenance costs of the plant (IBWC 2008).

NIWTP was upgraded in 2009 to mitigate excess ammonia, nitrates, and biological oxygen demand discharged to the river (IBWC). However, wastewater discharges from Nogales, Sonora have exceeded the allotted 9.9 MGD on occasion, at times by more than 3 MGD. NIWTP is currently designed to treat 14.74 MGD, with a peak operational capacity of 17.2 MGD (Norman et al. 2013). Occasionally, NIWTP experiences issues stemming from the maquiladora industry and other businesses not properly disposing waste, dumping chemicals into the sewage system. The IBWC has engaged in efforts to help OOMAPAS evaluate and educate the businesses and industry, but occasionally improper disposals happen (Interview, January 23, 2019). The IBWC was sued in 2012 for State of Arizona permit and Clean Water Act violations for failing to implement a program designed to stop industrial waste entering domestic sewage (ADI News Service 2012). The IBWC then filed a third-party suit against the City of Nogales, Arizona claiming that the city was liable if violations were established (Woodhouse 2016).

As the population of Nogales, Sonora has grown over the years, NIWTP has been treating, on average, an excess volume of Mexican wastewater — 126% over the binationally authorized volume of 9.9 MGD (Prichard and Scott 2014). During 2005, 69% of the wastewater influent originated from Nogales, Sonora, with the remainder originating from Nogales, Arizona. The average volume was 14.8 million gallons (IBWC 2005). The treatment plant consists of preliminary treatment to remove debris such as sand and trash from wastewater, then the wastewater is delivered to manmade lagoons where it is aerated for secondary treatment. The wastewater then enters other lagoons for settling of other materials and microorganisms (IBWC 2005).

Maintenance Issues

NIWTP receives water from Nogales, Arizona through a conveyance known as the International Outfall Interceptor (IOI). Operating since 1972, the concrete structure of the pipeline has developed cracks, substantial erosion, and deterioration. The Santa Cruz basin experiences severe flood events during the North American monsoon, during which stormwater may build up sediment and trash, causing more damage by scouring the IOI. Sometimes, these high rainfall events have included infrastructure leaks where a small percentage of wastewater leaks out of the IOI, or, in more rare cases, complete failures where wastewater has flooded residential streets and the Nogales Wash; repairs have been costly to fix these leaks (LaBrie 2016). These sanitary sewer overflows also impact water quality, resulting in repeated detections levels of E. coli, copper, cadmium, chromium, lead, zinc, and chlorine in the Nogales Wash (ADEQ OBEP 2016). The metals were also detected in the blood and feathers of song sparrows along the Nogales Watch and Santa Cruz River (Lester and van Riper 2014).

ADEQ's Office of Border Environmental Protection listed several recommendations to help prevent spillages and other issues associated with international wastewater infrastructure. The recommendations include: recommending that municipalities should be required to develop operation and maintenance plans; develop municipal pretreatment requirements for oversight and monitoring; and require immediate binational notification for failures of international wastewater infrastructure (ADEQ OBEP 2015).

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International Spillage

The Binational Technical Committee has also implemented strategies for reacting to international wastewater spillage. The Committee agreed to a protocol in December 2018 to formalize an agreement that would identify which people will be available at all times on each side of the border for monitoring and advising when spillages occur. The agreement, however, has not been formalized as of this writing. There is also a notification protocol for events that might cause flooding (Interview January 23, 2019). According to interviews, most of the city of Nogales, Sonora's sanitary structure is damaged, old, or working over its capacity. This causes sewage overflows during the rainy seasons.

Conveyance Repair Issues

Economic Arrangements

In 1953, the IBWC and the City of Nogales, Arizona (City) created an arrangement where the maintenance of the sewer line is a shared responsibility. In 1965, the City requested that the IBWC negotiate an agreement with Mexico to move the plant from Nogales to Rio Rico. The Rio Rico plant was completed in 1972 (IBWC). The IBWC took over the plant's operation in 1996 (Pineda 2017). However, the IBWC and the City have argued over who owns the IOI and is therefore responsible for paying to repair it. Perhaps in part due to its binational nature and controversy over who is responsible for funding its maintenance, the IOI has a reputation of lacking proper maintenance and upkeep. In 2004, a US district court settlement ruled that Nogales, Arizona would pay 23% of the operation costs of the treatment plant, despite producing only 14% of the sewage treated by the plant. The court also ruled that the City must pay to replace the IOI. Estimates for the costs of repair range from $30 to $100 million (Kapoor 2017). The US House of Representatives passed an amendment in June 2019 to the IBWC budget to redirect $4 million to cover the maintenance and operation of the IOI. This will add to the $2.6 million allocated by the 2019 Arizona state budget for repairs, and $21 million that the IBWC already has to fix the line (Nogales International 2019).

Mexico Annual Payments

The current arrangement allows Mexico to send its wastewater to the US in exchange for annual payments (IBWC 1988). Mexico pays a penalty fee for wastewater in excess of 9.9 MGD (Fabritz-Whitney et al. 2012). While that may be more economically efficient with both countries benefiting from the current arrangement (Sprouse and Villalba Atonodo 2004), treating wastewater in Mexico and conducting aquifer recharge could also be positive for both countries, as it would reduce the effects of Mexico's groundwater use (Milman and Scott 2010).

Penalty Costs & Mexican Treatment Plant

The Mexican government built Los Alisos Wastewater Treatment Plant (Los Alisos) partly as a response to wastewater overflows, and has created plans for its expansion. If this expansion of Los Alisos is to go forward, it will come at a significant cost, as lift stations are needed to deliver sewage to Los Alisos. Treating wastewater at Los Alisos is less expensive than paying the penalty costs that accrue when exceeding the 9.9 MGD (0.045 **m**illion **c**ubic **m**eters (MCM)) threshold ($0.16 USD/MCM to treat at Los Alisos, compared to $0.206 USD/MCM after exceeding the threshold) (Valles 2014). Estimates suggest that the cost of treating the sewage at Los Alisos will be greater than the cost of treatment of the base volume of effluent at NIWTP (Fabritz-Whitney et al. 2012) ($0.16 USD/MCM compared to $0.047 USD/MCM; which is what Mexico pays for the sewage sent below the threshold quantity) (Valles 2014).

Effluent Recharge v. Guaranteed Flow

Options for Conducting Recharge in the Santa Cruz Aquifer

Both countries have options for conducting aquifer recharge of the Santa Cruz Aquifer. In the past, Mexican officials have expressed the desire to retain control of the effluent generated on their side of the border and treated at NIWTP for their potential use, as demonstrated in previous Minutes. This has created a barrier to making progress towards negotiating a guaranteed flow of influent from Mexico to the US (Brown et al. 2003). In addition to negotiating guaranteed flow, another issue is that the US could consider the possibility of increasing treatment costs to fund: maintenance and operation of the wastewater treatment plants; delivery infrastructure; and potential environmental remediation due to environmental degradation caused by the effluent (Norman et al. 2013). In other words, Mexico could pay more to send its wastewater downstream to NIWTP. Alternatively, one option for the US is that it could pay Mexico to guarantee future releases. Norman et al. (2013) estimated that 12 MGD of effluent water is valued at $2.12 million/year when considering domestic water and recharge.

Mexican Treatment Impacts

Mexico commissioned the Los Alisos Wastewater Treatment Plant in August 2012 with $8 million in grant support from EPA's US-Mexico Border Environment Infrastructure Fund and the North American Development Bank to treat part of the wastewater generated in Nogales, Sonora (NADB 2010; Norman et al. 2013). According to Prichard and Scott (2014), the plan — once Los Alisos became operational — was for Mexico to deliver 9.9 MGD of municipal wastewater (the limit specified in the binational agreement) to NIWTP, with the remainder to Los Alisos. The plant wwould then discharge the entirety of its effluent into the Los Alisos River. The two phases of Los Alisos were expected to be completed in 2015, with a capacity of 7.5 MGD (8,437 acre-feet/year) but have not been completed as of this writing. If Mexico revises their stated intentions, thereby reducing the volume of reclaimed water in the Santa Cruz, less water will consequentially be available for downstream recharge, demands of near-stream well users, and possibly the Tucson AMA (Fabritz-Whitney et al. 2012). As of 2019, Los Alisos is receiving around 2.3-2.7 MGD, partly due to some problems with the engines that pump water to Los Alisos Wastewater Treatment Plant.

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Los Alisos Aquifer

Aquifer Proposals

Reuse?

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Four of the five pumps used to transport wastewater over a hill and to the plant have been malfunctioning since mid-January 2019 (Jones 2019). At this point, however, Mexico does not have a plan to reclaim its share of inflow from NIWTP but does want to send more waste to Los Alisos, which would decrease the exceedance of allotted volumes sent to NIWTP (and subsequent penalties).

Nogales, Sonora also draws some of its drinking water from the Los Alisos Basin. With the Los Alisos WTP, Nogales, Sonora is now taking freshwater and then releasing its wastewater back into the Los Alisos River near Cíbuta, Sonora. The use of the Los Alisos aquifer by OOMAPAS has resulted in a decrease in the water table (Prichard and Scott 2014).

Currently, the effluent water generated from NIWTP is discharged entirely within Arizona. However, as noted above, Arizona state law (A.R.S. § 45-576) restricts relying on effluent in state water planning due to Mexico's ownership (Sprouse and Villalba Atondo 2004; ADWR 2007). There have been ideas proposed for recharging the Santa Cruz Aquifer using NIWTP's effluent via the Mascareñas well field just south of the international border. This would allow the effluent to recharge the aquifer and then groundwater would be pumped back for use in Sonora (Sprouse and Villalba Atondo 2004).

The addition of the Los Alisos WTP, recharging effluent into the Los Alisos Basin, would allow for reuse of some of the effluent by Mexico. There are no current plans to fund the expansion of Los Alisos WTP according to Mexican officials. It has been observed that there are now drier portions in the Santa Cruz River in the US downstream of NIWTP due to the decrease of effluent discharge being sent down the river because of the Los Alisos WTP (Sonoran Institute 2019).

The IBWC does not monitor recharge; it only monitors static groundwater levels at groundwater monitoring stations (Interview, February 11, 2019). The City of Nogales, Arizona could use effluent generated from its wastewater for long-term storage credits (Personal communication, email message to the author, July 12, 2019). As of March 2019, no entities have set up long-term storage accounts in the Santa Cruz AMA (ADWR 2019).

The effluent discharged from NIWTP now supports around 17 miles of flow and 460 acres of forest along the river, starting in southern Rio Rico and flowing past Tubac (Weber et al. 2016). The wastewater treatment was upgraded to tertiary-level standards in 2009; odor has been reduced and the river now supports small fish (Weber et al. 2006). The treatment plant now has three bioreactors with "anoxic zones and aeration zones, new secondary clarifiers, existing sand filters, a new UV disinfection system with chlorination/dichlorination as backup, aerobic digester, a sludge belt filter press, and waste activated sludge storage pond" (AZPDES Fact Sheet, 2013). Any dramatic increase of Mexico recapturing its effluent, however, could result in negative consequences for the riparian area in Arizona, including damaging habitat for the Gila topminnow and the southwestern willow flycatcher, both of which are federally ESA-listed endangered species in the US (Sprouse 2003).

Conclusions

Every drop of water is important in the semi-arid Santa Cruz River Aquifer Basin. The increases in population and withdrawals on the Mexican side of the border may lead to future expansion of wastewater treatment plants in Nogales, Sonora. Mexico has the legal entitlement to the effluent water resulting from treatment of wastewater that originates within its territory or boundaries, as reaffirmed in several Minutes between the US and Mexico. As the aquifer levels in the Los Alisos, Nogales, and Santa Cruz basins continue to drop at increasing rates, the option to recharge aquifers with treated wastewater will undoubtedly become more attractive to Mexico. At this point, Mexico has no plans to expand Los Alisos WTP beyond 5.0 MGD (0.023 MCM), or to build new wastewater treatment plants. In the meantime, determining who is responsible for funding maintenance on infrastructure continues to create difficulties. The City of Nogales has asked Congress to address the issue through a congressional act, which has not been introduced as of this writing (Jones 2019). Though it appears that nothing will alter the status quo in the short term, wastewater and treated effluent in the dynamic Santa Cruz River Aquifer will continue to bring both challenges and opportunities for cooperation for both countries.

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