



Borders and Water: Institutions, Investments, and Information

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INTRODUCTION

Water links communities, ecosystems, and economies irrespective of political borders. This is evident in North America, where the United States, Mexico, Canada, and Indigenous nations share rivers, aquifers, and coastlines. These shared water resources sustain communities and industry, but sharing brings challenges. As pressures from population growth, climate, and economic development intensify, cross-border collaboration will continue to form the foundation for managing border water resources.

This year's *Arroyo* explores the topic of water and borders, building on discussions from the 2025 WRRC Annual Conference, *Shared Borders, Shared Waters*. The

publication highlights the history of water cooperation involving Arizona, the United States, Mexico, Canada, and Indigenous Nations while examining current efforts to expand, conserve, and protect shared water resources through public and private partnerships. This *Arroyo* aims to provide readers with a clear understanding of how cross-border collaboration is shaping water management today and how partnerships can ensure equitable access to clean, reliable water.

SHARING WATER

Many of the world's politically sensitive regions also contain shared rivers and aquifers. From the Nile River to the Aral Sea, shared waters have long been viewed as areas of potential conflict. However, according to WRRC



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conference presenter Aaron Wolf, decades of research reveal that instead of igniting conflicts, shared waters have frequently encouraged dialogue and collaboration, even in places marked by historical and political tensions.

Wolf, a professor at Oregon State University, provided examples of where cooperation emerged in unlikely circumstances. In the Middle East, negotiations over a disputed strip of land between Israel and Jordan showed how reframing a conflict could open the door to resolution. While the initial dispute appeared to be about ownership of territory, deeper conversations uncovered different priorities: Israel sought to maintain agricultural production, while Jordan wanted to restore sovereignty. By acknowledging both parties' needs, the sides could devise a mutually satisfactory arrangement. In the 1994 peace treaty and lease agreement, land was returned to Jordan, while farming continued under a 25-year lease agreement to Israel. Though the peace treaty and lease agreement lapsed in 2018, it still serves to illustrate how redefining a conflict can foster diplomacy, a lesson that becomes increasingly vital as political dynamics and global climates continue to change. Wolf also pointed to efforts along the Nile River, where musicians from the 11 countries that share the basin collaborate in the Nile Project (<http://nileproject.org/>) to build cultural ties through music, remind communities of their interconnectedness, and bring attention to shared water issues.



Nile Project participants. Source: Aaron Wolf, [Wolf-Keynote-Transforming-Water-Conflicts.pdf](#)

SECTION 1: CROSS-BORDER WATER INSTITUTIONS

IBWC

The 1944 Water Treaty between the U.S. and Mexico, officially titled *Utilization of Waters of the Colorado*

and *Tijuana Rivers and of the Rio Grande*, addressed the allocation of the water in rivers bordering the U.S. and Mexico and forms the basis of cooperation between the two countries over shared waters. The International Boundary and Water Commission (IBWC) is a binational agency created to address mutual use of shared rivers between the U.S. and Mexico. It works through collaboration to address demarcation, national ownership of waters, water quality, sanitation, and flood control issues that arise during the application of treaties in the border region.

The 1944 treaty also changed the name of the IBWC's predecessor organization, the International Boundary Commission (IBC), adding water to its basic authorities. The IBC was established on March 1, 1889, following the 1848 Treaty of Guadalupe Hidalgo and Gadsden Treaty of 1853. These earlier treaties had created temporary joint commissions to document, map, and define the border landmarks between the two nations. As settlements expanded along the Rio Grande and Colorado River, disputes arose over boundaries and jurisdiction of the land along rivers. The IBC was created as a temporary, and later permanent, binational body to address these disputes and played a key role in the development of the 1944 Water Treaty.

The expanded mandate of the renamed IBWC applied to the Rio Grande, Tijuana River, Colorado River, and other shared water bodies along the border to include the operation and construction of shared water facilities and the resolution of binational water disputes.

According to Adriana Reséndez, Mexico's IBWC commissioner, and Ramon Macias III, the U.S. IBWC's principal engineer, the IBWC's mission is to provide binational solutions to challenges related to treaty implementation through transboundary, issue-focused collaboration. The commission is organized into a U.S. Section and a Mexican Section, each led by a commissioner and supported by a secretary, two principal engineers and a legal advisor. Working together, these sections oversee projects that address shared water challenges, and responsibilities, such as water deliveries, flood control projects, stream gaging and reporting, international reservoir storage, wastewater treatment plant operation, sanitation issues, and ocean and river water quality monitoring programs along a shared 1,954-mile border.

A sustaining feature of the 1944 Water Treaty, found within its articles and provided under Articles III and IV of the Convention of March 1, 1899, allows the two



IBWC structure. Source: Adriana Resendes and Ramon Macias III, [Presentacion_CONJUNTA_WRRC_2025-Final_0.pdf](#)

governments, through the commission, to address binational issues by convening experts to investigate and develop studies or reports to implement solutions consistent with the treaty and binding to both governments. The conclusion of this process is a binding agreement known as a minute. As of August 2025, 332 minutes had been signed; the first, signed October 3, 1922, in El Paso, Texas, dealt with the exchange of

this agreement, both nations committed to mutual consultation before modifying or developing projects impacting transboundary groundwater or surface water.

Shortage conditions over the past 20 years have required IBWC actions promoting cross-border cooperation, which have resulted in a series of minutes dealing with multiple related issues. Minute 323 resolved a complex



IBWC projects along the United States-Mexico border. Source: Adriana Resendes and Ramon Macias III, [Presentacion_CONJUNTA_WRRC_2025-Final_0.pdf](#)

personnel credentials, while Minute 332 concerned the construction of a project to reduce the risk of failure at Amistad International Dam, signed December 10, 2024, also in El Paso. Minute 242, the Permanent and Definitive Solution to the International Problem of the Salinity of the Colorado River, signed in 1973, which dealt with the complex problem of saline agricultural drainage water, remains the only formal agreement between the U.S. and Mexico that specifically addresses the management of transboundary groundwater. Under

set of issues relating to the Colorado River, including shortage sharing, storage of Mexican water in the U.S., salinity, the environment, and investment in projects implementing the agreements. On the Rio Grande, a similar process produced Minute 331, which dealt with a similarly diverse but related set of issues.

Transboundary Rivers: Colorado River and Rio Grande

The U.S. Southwest and northern Mexico have been experiencing a historic drought, often making headlines as both the Colorado River and the Rio Grande reach record-low levels. As of September 1, 2025,

Lake Mead was at 31% capacity and Lake Powell was at 29% capacity, while the Rio Grande's Amistad Reservoir dropped to 35.6% full as of September 10, 2025. On the Colorado River, climate models suggest a decline in flows of up to 30% from the historic record due to reduced snowpack, droughts, and increased evaporation. On the Rio Grande, New Mexico expects to have 25% less water and a 750,000-acre foot shortage within the next 50 years because of hotter, drier conditions and significant changes in precipitation patterns. This situation presents

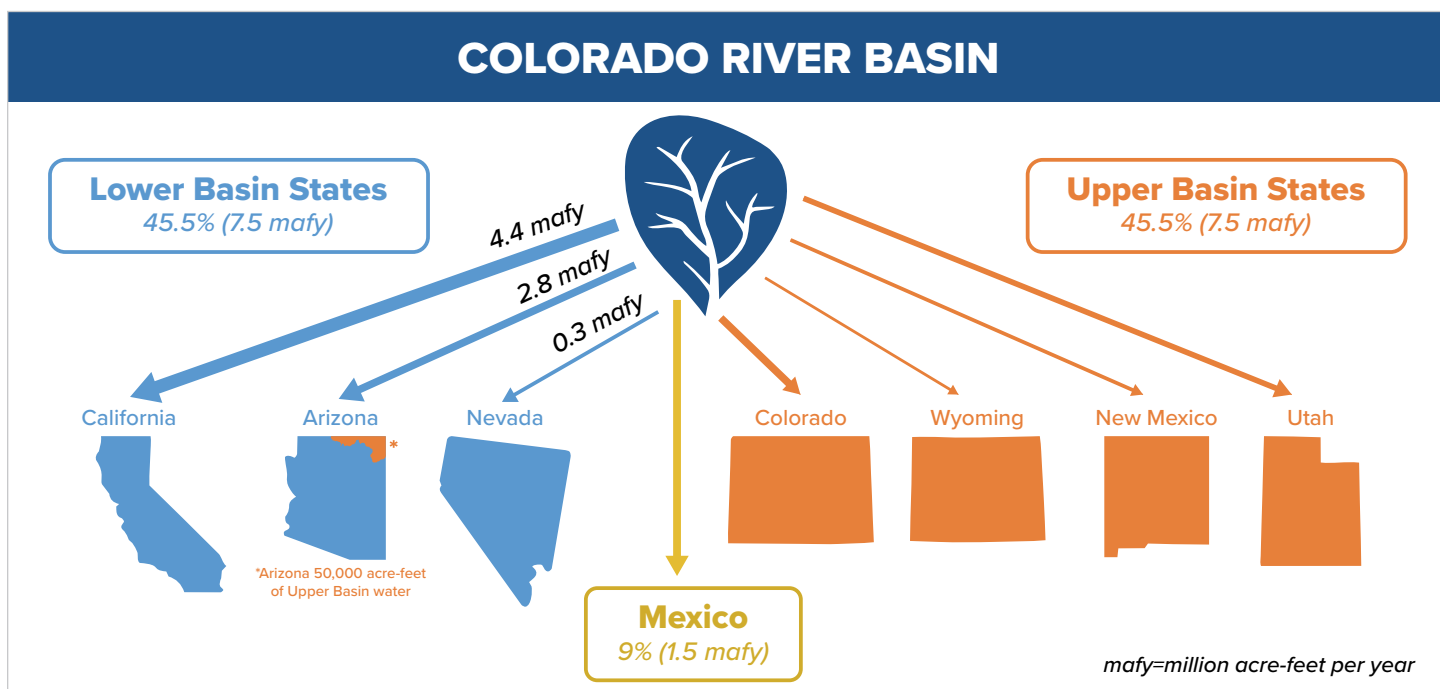
challenges for both the U.S. and Mexico with respect to their expectations and treaty obligations.

Colorado River

In the U.S., the foundation of Colorado River water governance resides in the Colorado River Compact and subsequent court cases and negotiated agreements. The compact divided the river states into an upper and a lower basin, with each basin allocated 7.5 million acre-feet of water annually. Each basin divided its allocation among its states: the upper basin states of Colorado, Utah, New Mexico and Wyoming, and the lower basin states of Arizona, Nevada, and California. Both basins are jointly responsible for delivering 1.5 million acre-feet of water per year to Mexico.

Congressional negotiations around authorization and appropriations for the Central Arizona Project (CAP), modified the priority status of Arizona's allocation vis-à-vis California. Arizona accepted a lower priority for its CAP water, which meant that in times of shortage, Arizona would take all reductions, up to its full allocation, before California would take any. This agreement has influenced California's participation in recent shortage-sharing negotiations.

While the compact outlines how water is allocated among the states under normal conditions, it does not adequately address conditions of reduced river flows lasting more than 10 years. This shortcoming, as reflected in a conference presentation by University of Arizona water policy expert Andrea Gerlak, is rooted in



Division of water among the upper and lower Colorado River Basin states in million acre-feet per year. Modified from: Andrea Gerlak, [1-Gerlak-A_0.pdf](#); Tom Buschatzke, [1-Buschatzke-T.pdf](#).

Through a series of decisions stretching from 1952 to 2006, the U.S. Supreme Court resolved the legal disputes between Arizona and California over Colorado River apportionment issues left unresolved after Arizona refused to ratify the 1922 Compact. In 1963-64, the court specified the water allocation of each of the Colorado River basin states and the reserved water rights of five Indian reservations (Fort Mojave, Fort Yuma [Quechan], Chemehuevi, Colorado River, and Cocopah). A 1979 supplemental decree specified the amounts and priority dates of high-priority Colorado River water rights in each state and described Tribal water rights. Adjustments to these Tribal water rights claims were resolved in 2000, except for Quechan claims, which took six more years.

the fact that negotiators in 1922 divided Colorado River water based on “inflated streamflow data” in a series of years when rainfall was relatively high. As a result, the negotiators allocated a total of 15 million acre-feet, when the river typically averaged closer to 13.2 million acre-feet. As a result, the compact institutionalized an imbalance that persists today—exacerbated by increasing aridity—with promised water exceeding actual supplies. Mexico and Tribal nations, which hold significant interest in the basin, were initially excluded from the compact. Mexico later received 1.5 million-acre feet through the 1944 Water Treaty. Tribal nations collectively have allocations to about 2.9 million acre-feet. Other tribal claims to Colorado River water have not yet been resolved.

The 2007 shortage-sharing agreement, Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead, was an attempt by the U.S. and basin states to address the deficit caused by over-allocation and long-term drought by linking cuts in water deliveries to declining reservoir levels. While these guidelines temporarily stabilized the system, more than two decades of drought having pushed both Lake Mead and Lake Powell to near-record low levels, each hovered at about one-third capacity. States and federal agencies negotiated agreements such as the 2019 Drought Contingency Plan, which supplemented the 2007 guidelines with additional reductions in response to falling water levels in Lake Mead. The goal of these cutbacks was to prevent the reservoir from reaching critically low levels that could threaten hydropower generation at Hoover Dam or the ability to deliver water downstream at all. Continuing negotiations aim at conserving water in the reservoirs. Despite major successes in shoring up Lake Mead levels, river conditions continue to deteriorate.

In the U.S., the U.S. Bureau of Reclamation manages the Colorado River system of reservoirs and diversions according to a set of operational guidelines that reflect the provisions of the compact and subsequent decrees and agreements. According to Amy Witherall, the binational program manager for Reclamation, the agency "...supports the implementation of Colorado River Minutes to the 1944 Water Treaty and negotiation of future minutes and facilitating trust-building, sharing of scientific and technical information, and problem solving or problem prevention...between the United States and Mexico on the Colorado River." Reclamation oversees the storage and release of water from reservoirs and the distribution of river water to rights holders. With guidelines regarding operations under shortage conditions of the major Colorado River reservoirs, Lake Powell and Lake Mead, set to expire in 2026, a post-2026 process is underway to develop new guidelines. The river is projected to remain in a shortage condition going forward, so shortage allocations are likely to reflect a new normal for the two basins. Consequently, the states have found their differences difficult to resolve, but they are committed to further negotiation, even after federal deadlines have passed and Reclamation moves forward on developing a plan that considers previously submitted input from the parties. In addition, the new guidelines must be matched by a concurrent Minute of the 1944 Water Treaty with Mexico by the time they become effective. Further, despite implementation of a separate process for Tribal consultation, participation

in these discussions remains inadequate from a Tribal perspective.

Rio Grande

The IBWC, Reclamation, and other government agencies all have roles in the governance of the Rio Grande. The IBWC plays a central role in the enforcement and implementation of treaties along the border. Reclamation operates the Rio Grande Project, which manages the river's water resources through infrastructure such as the Elephant Butte and Caballo dams and, in coordination with basin states (Colorado, New Mexico, and Texas), delivery of flows under the Rio Grande Compact of 1938. The project provides storage for downstream Rio Grande Project irrigated lands in New Mexico and Texas and delivery of 1906 treaty flows to Mexico.



Map of Rio Grande with reservoirs. Modified from: [Presentacion_CONJUNTA_WRRRC_2025-Final_0.pdf](#)

The bases of governance are two key agreements between Mexico and the U.S.: the 1944 Water Treaty and the 1906 convention between the U.S. and Mexico. The 1906 convention obligates the U.S. to deliver 60,000 acre-feet of water from the upper Rio Grande to Mexico each year at the border in El Paso, Texas/Ciudad Juarez, Chihuahua. Under the 1944 treaty, Mexico is required to deliver an average of 350,000 acre-feet of water per year from its tributaries to the lower Rio Grande, averaged over five-year periods. Both agreements aim to ensure equitable allocation and use of water from the Rio Grande for communities in three U.S. and four Mexican states. As of April 19, 2025, more than four years into the five-year cycle that started October 25, 2020, IBWC reported that Mexico had delivered only roughly 540,000 acre-feet or, 30%, of its obligation for the cycle. In an extraordinary drought—not defined in the 1944 Water Treaty or

minutes—if Mexico fails to meet its obligations for a five-year cycle, it must make up the deficiency during the next five-year cycle. Continuing drought conditions render compliance within that time frame problematic. The impact on Texas agriculture creates regional stress and tensions, requiring diplomatic negotiations between the two countries.

Nongovernmental Organizations

When addressing the environmental and diplomatic challenges shared by the U.S. and Mexico, common priorities emerge around water storage, conservation, and ecosystem restoration. Joint efforts include storing Mexico's water in Lake Mead to reduce the risk of shortages and increase supply reliability, investing in infrastructure on both sides of the border, coordinating savings to address the region's water deficit, and advancing restoration of the Colorado River Delta.

At the 2025 WRRC conference, Carlos A. de la Parra, a founding partner of Centro Luken de Estrategias en Agua y Medio Ambiente, emphasized the need to modernize Mexico's outdated water infrastructure and conservation strategies. He also highlighted the importance of robust binational governance, calling for greater public participation and for leveraging nongovernmental organizations (NGOs) to enhance cross-border knowledge sharing and mobilize funding.

One such collaborative effort is a coalition of six Mexican and U.S. NGOs known as Raise the River (Alianza Revive el Río Colorado), which is dedicated to restoring the Colorado River Delta. The coalition's work now extends beyond field-based restoration to include partnerships with farmers who are willing to adopt innovative on-farm water-conservation strategies. These partnerships, developed in close coordination with public agencies, demonstrate the unique value of civil society organizations as trusted intermediaries between government and agricultural producers in a cross-border governance setting.

Raise the River, in collaboration with government agencies from the U.S. and Mexico under Minute 323, has achieved substantial results since 2012, according to Francisco Zamora, senior director of programs at the Sonoran Institute, one of the coalition's member organizations. These results include planting over 500,000 native trees, restoring more than 1,330 acres of riparian habitat, securing 425 million cubic meters of water for environmental use, and improving wildlife conditions. Collectively, these efforts have led to

important ecological benefits, including an 85% increase in bird populations and the return of approximately 360,000 migratory birds and ducks to the region.

Tribal Involvement

As European settlers encroached on the lands and livelihoods of Indigenous people of the U.S. Southwest, boundaries emerged between those whose water rights were acknowledged and those whose rights were disregarded. U.S. westward expansion, beginning with the Louisiana Purchase of 1803, marked years of displacement, loss of land and tradition, and confinement for Indigenous populations. In addition, the development of water infrastructure by European settlers disrupted the flow of the waterways traditionally used by Indigenous communities, further impacting their lives.

Tribal involvement in water policy negotiations is a relatively recent development. Tribal rights to water had to be established before the role of tribes in water negotiations was recognized by non-Tribal participants, and barriers to their full participation remain. The U.S. Supreme Court, in the 1908 *Winters v. United States* ruling, established the Winters Doctrine, which marked a turning point in Indigenous water rights. This doctrine explicitly stated that when the federal government creates a reservation, it reserves water rights for this tribe – rights with priority over the claims of later non-tribal users. Despite this legal foundation, disputes over the quantification and allocation of water rights have taken years to resolve through litigation or negotiated settlements. Some water rights remain unresolved.

The experience of the Gila River Indian Community (GRIC) offers an example. The Arizona Water Settlements Act of 2004 provided GRIC with 653,500 acre-feet of water annually through the Central Arizona Project, the Gila River, and groundwater. The settlement also provided GRIC with \$250 million to build and improve existing water infrastructure. Currently, the GRIC community is implementing initiatives to make the most of their allocated water resources. GRIC Governor Stephen Roe Lewis remarked at the WRRC 2025 conference, "We have built one of the most efficient irrigation delivery systems in the country." Through its focus on water conservation, renewable energy, and agricultural expansion, GRIC has advanced projects such as solar-covered canal systems and innovative aquifer recharge management. These efforts have saved more than one million acre-feet of Colorado River water while helping to shield the community from the harsher impacts of drought.

Tribal Water Rights Settlements in Arizona

Settled or Decreed	Not Yet Fully Settled or Decreed
Cocopah Indian Tribe (AZ v. CA)	*Navajo Nation (Partial) (LCR Adj.)
Colorado River Indian Tribe (AZ v. CA)	*Hopi Tribe (LCR Adj.)
Fort Mojave Indian Tribe (AZ v. CA)	*San Juan Southern Paiute Tribe (LCR Adj.)
Quechan Indian Tribe (AZ v. CA)	Pascua Yaqui Tribe (Gila Adj.)
Ak-Chin Indian Community (1978, amended 1984/1992/2000)	San Carlos Apache Tribe (Partial 1992/1994, amended 1996/1997) (Gila Adj.)
Salt River Pima-Maricopa Indian Community (1988, amended 1991)	Tohono O’odham Nation (Partial 1982, amended 1992/2004) (Gila Adj.)
Fort McDowell Yavapai Nation (1990, amended 2006)	Tonto Apache Tribe (Gila Adj.)
Yavapai-Prescott Indian Tribe (1994, amended 1996)	Yavapai-Apache Nation (Gila Adj.)
Pueblo of Zuni (2003)	Havasupai Tribe (Gila Adj.)
Gila River Indian Community (2004)	Kaibab Band of Paiute Indians (No Adj.)
White Mountain Apache Tribe (2010, amended 2018/2020/2023)	
Hualapai Tribe (2014 and 2022)	

* The Northeastern Arizona Indian Water Rights Settlement Act (NAIWRSA) pending before Congress, would settle the water rights of the Navajo Nation, the Hopi Tribe, and the San Juan Southern Paiute Tribe.

LCR Adj. = subject to the Lower Colorado River General Stream Adjudication; Gila Adj. = subject to the Gila River General Stream Adjudication

Arizona Indian Water Settlements and unresolved claims. Source: WRRRC from Robyn Interpreter, [Robyn-Interpreter-pre-conference.pdf](#), and Aminta Menjivar, [Menjivar Maldonado Aminta - WRRRC Presentation 11.12.2025](#)

During the 2025 WRRRC conference, speakers strongly emphasized the importance of recognizing water’s spiritual, cultural, and physical roles for Native people. They highlighted the importance of effective tribal consultation, which demands time and energy for relationship building and a commitment to understanding the unique challenges faced by each Tribal nation.

Tribal nations, including the Colorado River Indian Tribes (CRIT), which hold rights to 791,248 acre-feet of Colorado River water as specified by the U.S. Supreme Court, were excluded from both the original 1922 Colorado River Compact discussions and the operating guideline discussions taking place more than a century later. Tribal voices are calling for a place at the table during discussions at future negotiations. At the 2025 conference, CRIT Chairwoman Amelia Flores emphasized that it is time to build cooperative relationships grounded on inclusion and recognition of the unique identities of each tribe, the specific challenges impacting them, and what they can bring to the table. Verlon M. Jose, chairman of the Tohono O’odham Nation, whose members live on both sides of the U.S.-Mexico border, reinforces these ideas, adding that the Tohono O’odham Nation is about building bridges, not walls. “We don’t see any borders.

Our constitution says our responsibility goes beyond the borders of our land,” he said.

SECTION 2: INVESTMENTS IN INFRASTRUCTURE

U.S.-Mexico Border

For more than 30 years, the North American Development Bank (NADBank) has played a key role in supporting the development of water infrastructure along the U.S.-Mexico border. NADBank’s managing director, John Beckham, reported that the institution has invested approximately \$4 billion dollars in over 320 projects across the region to date. Notably, about two-thirds of these projects are dedicated to water and wastewater infrastructure.

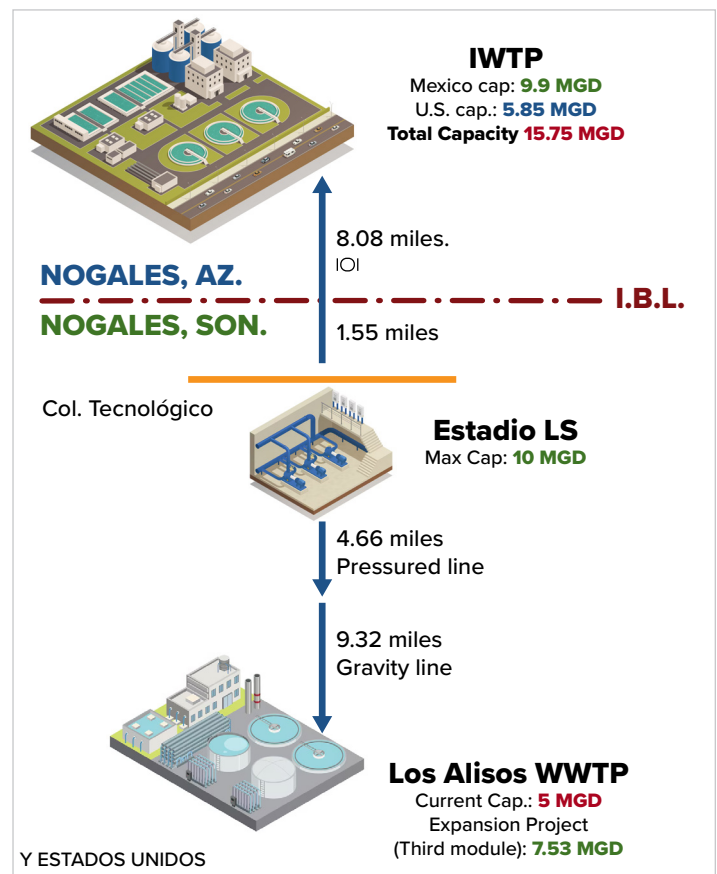
In Arizona, NADBank has financed 25 projects totaling more than \$200 million. Of these, 19 projects are directly related to water and wastewater, and two focus on water conservation. These projects span a variety of areas, including water treatment, infrastructure repairs, and the expansion of water systems. In the Mexican state of Sonora, NADBank has financed 40 projects, with an investment of over \$430 million. Eighteen of these

projects are water and wastewater-related, addressing some of the most critical water needs in the region. One of NADBank's major programs is the Water Investment Program (WIP), established in January 2025. WIP provides financial support for water, wastewater and stormwater infrastructure projects that are financed through the NADBank loan program or through grants awarded from the Community Assistance Program. The latter is funded by the U.S. Environmental Protection Agency (EPA).

Arizona State University professor Francisco Lara-Valencia, explained that concerns about water quality stem from poor sanitation and industrial pollution associated with maquiladoras, industrial facilities operating along the border. The Ambos Nogales areas refer to the two cities of Nogales on either side of the U.S.-Mexico border. Initiatives like the EPA's collaborative U.S.-Mexico Border Water Infrastructure Program are making some progress on these issues. For instance, in 2012, a joint venture under that program constructed the Los Alisos Wastewater Conveyance and Treatment project, a \$19 million project with funding partners that included Mexico's National Water Commission, the state of Sonora, and the city of Nogales, Sonora. The project diverts and treats 5 million gallons of sewage per day in Mexico. Around the same time, the program also supported upgrades to the Nogales International Wastewater Treatment Plant, owned by IBWC and the city of Nogales, Arizona, resulting in a notable reduction of ammonia levels in the water and return of native fish populations. More recently, the IBWC undertook additional upgrades because of deteriorating equipment to ensure the water quality of discharges to the Santa Cruz River.

On the U.S.-Mexico border in southern California, contamination of the Tijuana River and the region's coastal waters by sewage from Tijuana, Mexico, has threatened the marine environments, degraded water quality, and posed health risks to surrounding communities for decades. The root of this problem lies in outdated infrastructure and inadequate maintenance, which leave the region's wastewater treatment system unable to handle the wastewater volumes generated by Tijuana's growing population. The South Bay International Wastewater Treatment Plant, built in the 1990s, was constructed in the U.S. as part of the solution to treat wastewater before its release into the Pacific Ocean. However, after years of neglect and deterioration, many of the wastewater treatment plants and pipelines that feed into the South Bay system are in poor condition. For instance, the San Antonio de los Buenos treatment plant has been discharging an estimated 40 million

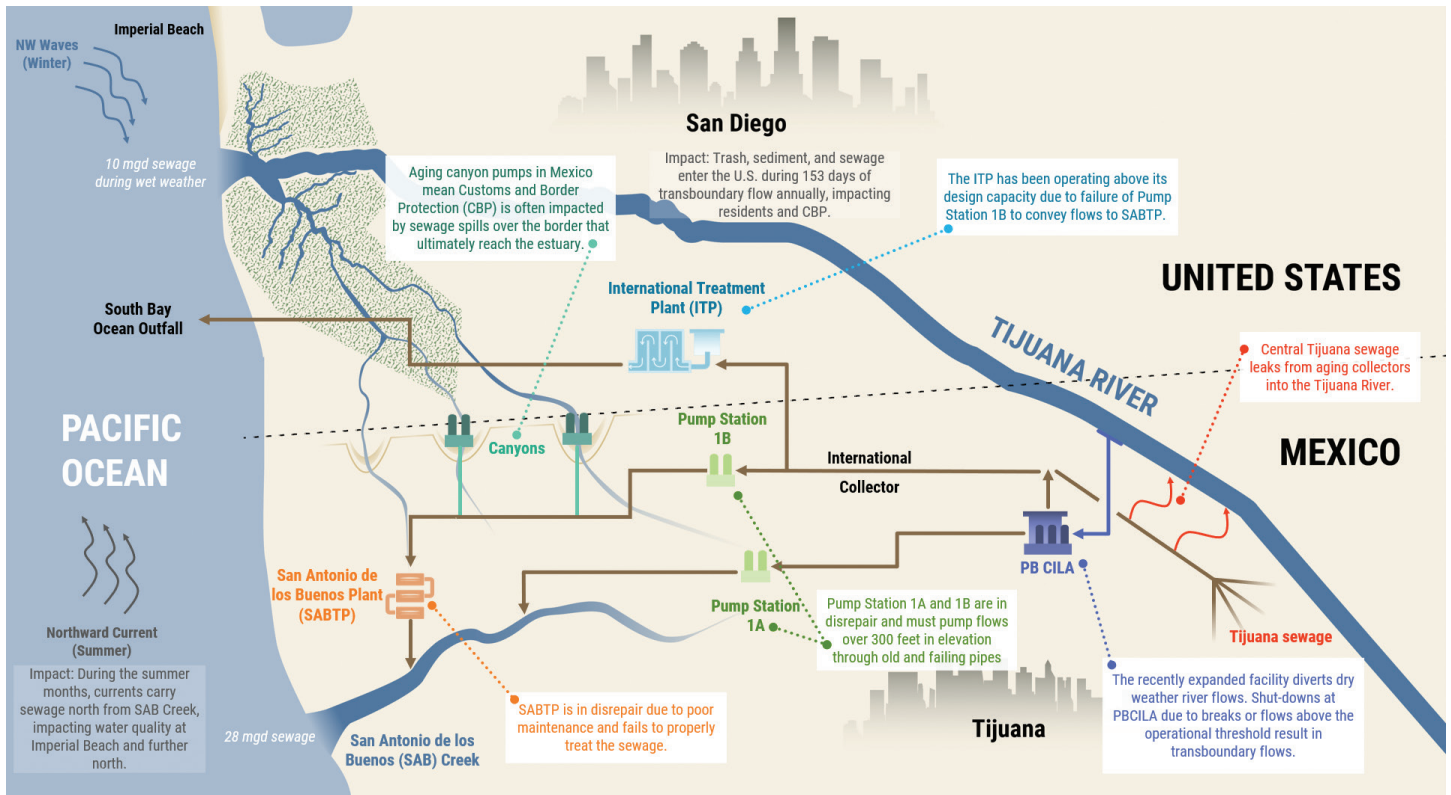
gallons of raw sewage per day into the Pacific Ocean and Tijuana beaches. In addition, the atmospheric river storms that bring heavy rainfall to the region introduce further strain, often flooding the system and forcing untreated sewage to bypass the plant entirely.



Actions taken to eliminate excess flows to the Nogales International Wastewater Treatment Plant. Source: Antonio Rascon and Ramon Macias III, [3-4-Rascon-AND-Macias_CILA_IBWC_Border_Sanitation_Nogales_Tijuana.pdf](#)

Under treaty Minute 328, signed in 2022, both Mexico and the U.S. agreed to invest \$474 million dollars in 16 infrastructure projects, \$330 million in the South Bay International Wastewater Treatment Plant Expansion (SBIWTP), and \$144 million in rehabilitation of sewer lines, pumping stations in Mexico, and a new wastewater treatment plant in San Antonio de los Buenos. Completed in May 2025, the San Antonio de los Buenos plant treats 18 million gallons per day.

The SBIWTP aims to eliminate the discharge of untreated wastewater with \$650 million in funding. Complementing the effort, California's 2024 Prop 4 climate bond designated \$50 million to improve water quality in the Tijuana River and other California/Baja California transboundary rivers, including the New River. On August 28, 2025, EPA announced the completion of an incremental 10 million-gallon-per-day expansion to the South Bay Plant in San Diego, calling it a step towards a



Sanitation infrastructures developed along the Tijuana-San Diego border. Source: Antonio Rascon and Ramon Macias III, [3-4-Rascon-AND-Macias_CILA_IBWC_Border_Sanitation_Nogales_Tijuana.pdf](#)

“100% solution to the decades-long Tijuana River sewage crisis...”

Tribal Infrastructure Investment

During the conference, Heather Whiteman-Runs-Him, director of the University of Arizona’s Tribal Justice Clinic and member of the Crow Nation in Montana, spoke about the role of Tribal water rights settlements and the importance of related water infrastructure. She emphasized that settlements are designed to secure Tribal nations’ rights to safe and reliable water resources. However, she stressed that without adequate financial backing, settlements become infeasible. Funding is crucial to the success of settlements involving infrastructure development, or else these rights may exist only on paper. Many tribes struggle to secure congressional ratification of their settlements, particularly when implementation is challenged by difficult geological conditions, which drive up infrastructure costs. In recent years, the approach to settlements has shifted from fund-based agreements to those that include specifically defined projects. This change has given tribes greater discretion over the type of infrastructure developed, allowing for more tailored and effective solutions. According to Whiteman-Runs-Him, “As of 2025, 39 Indian water rights settlements

have been federally approved, with total estimated costs in excess of \$8.5 billion.”

Two recent federal funding initiatives that support Tribal water settlements are the Reclamation Water Settlements Fund and the Indian Water Rights Settlement Completion Fund. The first initiative, established in 2009, allocates \$120 million annually through 2029 for specific projects and settlements. This fund is also dedicated to paying for significant portions of the Navajo-Gallup settlement, Montana Settlement, and the future (Navajo) Arizona Settlement. The second initiative, enacted in 2021, is the Infrastructure Investment and Jobs Act, which provides \$2.5 billion for discretionary support for completing eligible Indian water settlements. The act allows the U.S. secretary of the interior broader discretion to use these funds to “substantially complete” eligible Indian water settlements.

When describing infrastructural improvements and innovation, the Gila River Indian Community provides significant examples. Their water rights were confirmed in a 2004 settlement, which allocated 653,000 acre-feet of water annually. The community draws from a variety of sources: surface water from the Gila River, groundwater beneath the reservation, Colorado River water delivered through the CAP, and effluent supplies exchanged with neighboring cities. GRIC Governor

Stephen Roe Lewis remarked during the conference, "I'm proud of our collective efforts to date." He described the community's ongoing commitment to innovation and efficiency, highlighting practices such as solar-covered canal systems and improved water-use strategies. As a result of these efforts, the GRIC has nearly eliminated its reliance on Colorado River deliveries, instead increasing its use of alternative sources like groundwater stored through managed aquifer recharge systems.

The CRIT also has placed a strong emphasis on water conservation – not only for their own benefit but also for the broader region, especially in times of drought. To date, they have conserved over 1 million acre-feet of Colorado River water. Additionally, they have supported the expansion of system conservation and storage in Lake Mead and embraced new technologies aimed at conserving water and generating energy.



GRIC solar project—solar panels over canals. Source: Northeast Valley News

Joint Investments Among Regional Partners

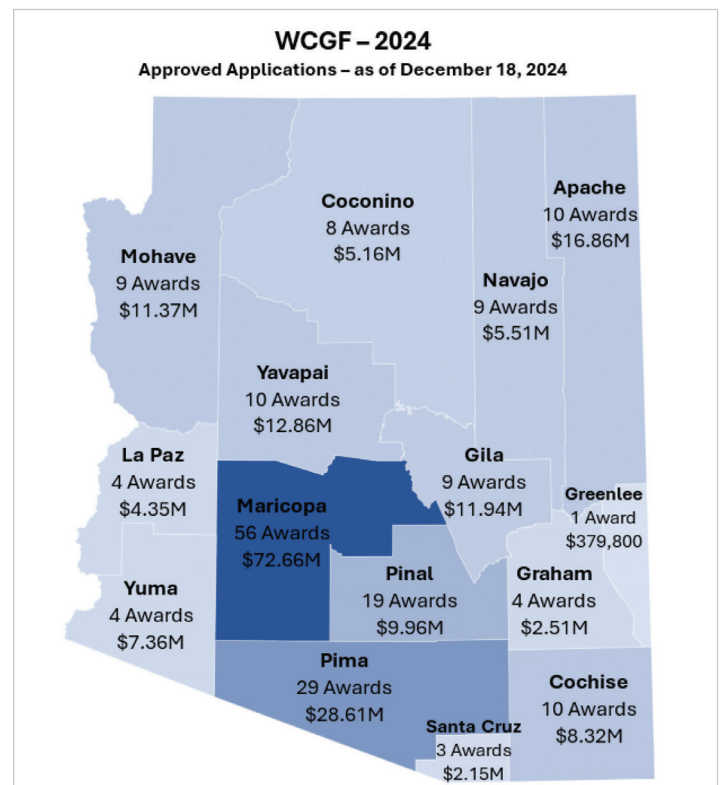
The Salt River Project (SRP)—the largest water provider in the Phoenix area, providing 800,000 acre-feet of water annually—is investing in water augmentation projects within its system. Its water augmentation initiatives include the Verde Reservoirs Sediment Mitigation Project (VRSMP) and SRP-CAP Interconnection Facility (SCIF). If approved and completed, the VRSMP will modify the Bartlett and Horseshoe dams to increase total capacity in the Verde River system by up to approximately 323,000 acre-feet of additional capacity. The project is funded through a 50% cost share between Reclamation and SRP acting for 23 non-federal cost share partners. Because of

their investments in the project, the cost share partners, even those outside the SRP service area, can receive water from expanded dam capacity. Similarly, 13 non-federal cost share partners in SCIF, which introduces two-way flexibility into the SRP-CAP connection facility, will be able to participate in the water efficiency benefits of the project.

State of Arizona Investments

Conservation

During the WRRC conference, Arizona Gov. Katie Hobbs highlighted her administration's commitment to protecting and managing the state's groundwater resources. She emphasized the urgent need to address the depletion of rural basins, which often rely on limited groundwater supplies. Hobbs outlined several key initiatives, including the 2023 Water Policy Council's framework for managing rural groundwater and the introduction of a bipartisan reform bill aimed at increasing flexibility and water savings in rural communities. She also detailed substantial financial investments, such as \$14.6 million for conservation through Water Infrastructure Finance Authority of Arizona (WIFA), \$12.3 million for infrastructure improvements in small water systems, \$5 million to combat PFAS contamination, and over \$15 million for new monitoring wells.



Map of WIFA Conservation Fund awards.

Source: Judah Waxelbaum, [5-Waxelbaum-J_0.pdf](#)

WIFA programs fund reliability and conservation efforts across the state that address resource limitation outside metropolitan areas. In 2024, the WIFA Conservation Grant Fund awarded \$200 million for projects that saved 3.2 to 5.5 million acre-feet of water.

Augmentation

Arizona municipal water suppliers have indicated that within 10 to 15 years water demand is likely to exceed their planned future projects and programs by 100,000 to 500,000 acre-feet per year, depending on the state's future allocations of Colorado River supplies, among other factors. WIFA, through the Long-Term Water Augmentation Fund (LTWAF) program, is working collaboratively with water users in Arizona and beyond to identify and pursue a project or projects for the reliable and sustainable importation of up to 500,000 acre-feet per year of additional supply in the near term. The LTWAF program issued a call for augmentation proposals and considered submissions from teams that demonstrated the necessary range of expertise and background. Ultimately, four teams proposing seven importation projects were selected to move forward and offered work orders to participate in Phase 2 of the LTWAF process.

Phase 2 is the due diligence stage, ensuring projects survive the rigor of permitting, environmental review, and community input and will deliver a lasting sustainable water supply for Arizona. All intellectual property generated during Phase 2 is owned by the state, giving WIFA maximum flexibility as the program moves forward. Of the four teams advancing to Phase 2, several may move on to Phase 3, project development. To ensure the economic viability of these projects, WIFA has convened an advisory group composed of potential water purchasers. This group will be a sounding board for WIFA and provide important considerations for the teams in Phase 2, making sure project proposals meet the needs of Arizona's water providers. All projects and details can be found at <https://ltwaf.azwifa.gov/importation>.

Several of the Phase 2 proposals under consideration by WIFA include desalination. Desalination refers to the process of extracting salt and other dissolved minerals from sources like seawater or brackish water in order to produce fresh water. There are two primary methods for desalination: thermal desalination and reverse osmosis. Thermal desalination essentially is a large-scale distillation process, in which the saltwater is heated and the vapors are collected. Reverse osmosis involves applying high pressure to push saltwater through a semi-

permeable membrane. This membrane separates the salt and minerals from the clean water. The dominant desalination method in the U.S. is reverse osmosis.

In the face of a growing water crisis, desalination offers a potential solution by supplying clean, safe water for public and agricultural use, conserving our current water resources. However, desalination faces several implementation challenges. Desalination is highly energy intensive, requiring access to reliable energy transmission and potentially the burning of fossil fuels. Additionally, the process produces a concentrated brine byproduct, and the disposal of this brine poses potential negative environmental consequences. Ocean desalination plants can discharge brine into the ocean, but this discharge can disrupt marine ecosystems. Brine from inland desalination can be injected into saline aquifers or evaporated from surface ponds where a salt residue accumulates and may pose a contamination risk to groundwater. In addition, the construction and maintenance of desalination plants are very expensive; so investments will be vital. To be a near-term solution, project initiation would have to start soon, given the 10 to 12 years required for construction.

The Canadian Connection

Speaking for the Canada Arizona Business Council (CABC) during the conference, CEO Glenn Williamson highlighted the well-established and widely respected trade partnership linking the U.S., Canada, and Mexico. Canadian investors are interested in opportunities to partner on projects that address water infrastructure issues in Arizona. In addition, Canadian investment in Mexico has been substantial, particularly in the mining sector. Canadian mining companies have invested approximately \$12 billion there, with a significant portion directed towards Sonora.

Project Hourglass is an initiative of the CABC focused on enhancing water infrastructure, advancing irrigation and agricultural systems, and supporting water augmentation efforts such as desalination. This project employs experts and engages collaborators to implement projects that address long-term scarcity issues. A project of particular interest is the potential development of a binational desalination plant. Project Hourglass has attracted the attention of Canadian investors, many of which already have invested in water and energy companies, such as Tucson Electric Power, Liberty Water, and Global Water. Williamson emphasized the urgency of moving forward on such initiatives due to current investor interest and the time required to build a desalination plant. However,

there are calls for greater public engagement, and a need for appropriate consultation with the governments of Mexico and Sonora.

Trade

Water resources travel across borders through trade in agricultural and manufactured products and mined metals, whose production consumes water. The concept of a "water footprint" has become commonplace with estimates of the water required to produce a hamburger or cotton shirt. Trade links regions and countries, establishing interdependences when products from one area become important to consumers in another. One way to measure the interdependencies and the water embodied in trade is to track virtual water.

Virtual Water

The concept of virtual water trade captures the economic interconnectivity of the U.S., Mexico, and Canada. Virtual water refers to the water consumed in the production of goods that flow virtually across borders through trade in those products. At the WRRRC conference, Northern Arizona professor Ben Ruddell described his model of global flows of virtual water. He illustrated how water resources from the Colorado River and Sierra Nevada sustain not only the southwestern U.S. but also Canada and the Great Lakes through agricultural exports. Ruddell discussed the economic appeal of reallocating water from agriculture to industry, suggesting that such a shift could yield higher profits for Arizona. However, his model demonstrates that while it may seem reasonable to reconsider how water is used in the southwestern U.S. – particularly the percentage dedicated to irrigated agriculture – it is important to recognize the broader consequences. Reducing water allocated to irrigated agriculture in this region would lead to a decline in crop production, ultimately impacting regional economies and disrupting international trade. The extensive dependence on the U.S. Southwest's agricultural output underlines the importance of a comprehensive, transboundary view of water resource use.

Agriculture

The economic interdependence of North America is illustrated by trade in agricultural products. Arizona's top agricultural markets are Canada (33%) and Mexico (22%). Rob Sim, a senior vice president for Stantec, reported at the WRRRC conference that in 2023, Mexico was a net exporter of agricultural food and beverage products with a trade surplus equivalent to \$7.8 billion. As Mexico's

second-largest market for these products, Canada imported the equivalent of \$1.3 billion from Mexico, or approximately 20% of Canada's annual net produce consumption. In the same year, Canada imported 56.8% of its \$48.2 billion in total agricultural imports from the U.S. Looking at Arizona, Canada imported \$556 million of agricultural food products, including vegetables, fresh or dried grapes, lettuce, melons, and fresh or chilled tomatoes.

At the conference, Allison Moore, the executive vice president of the Fresh Produce Association, a non-profit trade association representing North American produce companies, emphasized the importance of U.S.-Mexico agricultural ties, noting that "Mexico represents 39% of all imported fruits and vegetables consumed in North America annually." Given the economic interdependence of North America in terms of agricultural trade, it is important to foster cooperation across borders on a host of issues, including water resources.

Mining

Mining is a multinational industry with a long history of international operations. The Southwest U.S. plays a critical role in mining, particularly in copper production. As Sandy Fabritz, director of water strategy at Freeport-McMoRan, explained at the WRRRC conference, the U.S. is the world's fifth-largest copper producer, and "74% of the...copper produced in the United States comes out of the Colorado River Basin."

Historically, mining operations have been among the region's largest water users, consuming large quantities of water, and it has a checkered past as it relates to water quality. However, mining enterprises in the modern era are exploring processes and technologies to substantially reduce their water consumption and eliminate off-site contamination. Mining now accounts for less than 2% of the state's total water use, as companies in the region advance water reuse, reduction, and augmentation efforts. A strong example comes from Freeport-McMoRan's operations, which collectively reuse 89% of the water in their operations. To reduce water consumption of local freshwater sources, they are investing in wastewater reuse and desalination projects such as the construction of the ocean desalination project for the recently constructed smelter in Indonesia.

SECTION 3 - INFORMATION

When addressing water scarcity and quality issues, one of the greatest challenges institutions face is

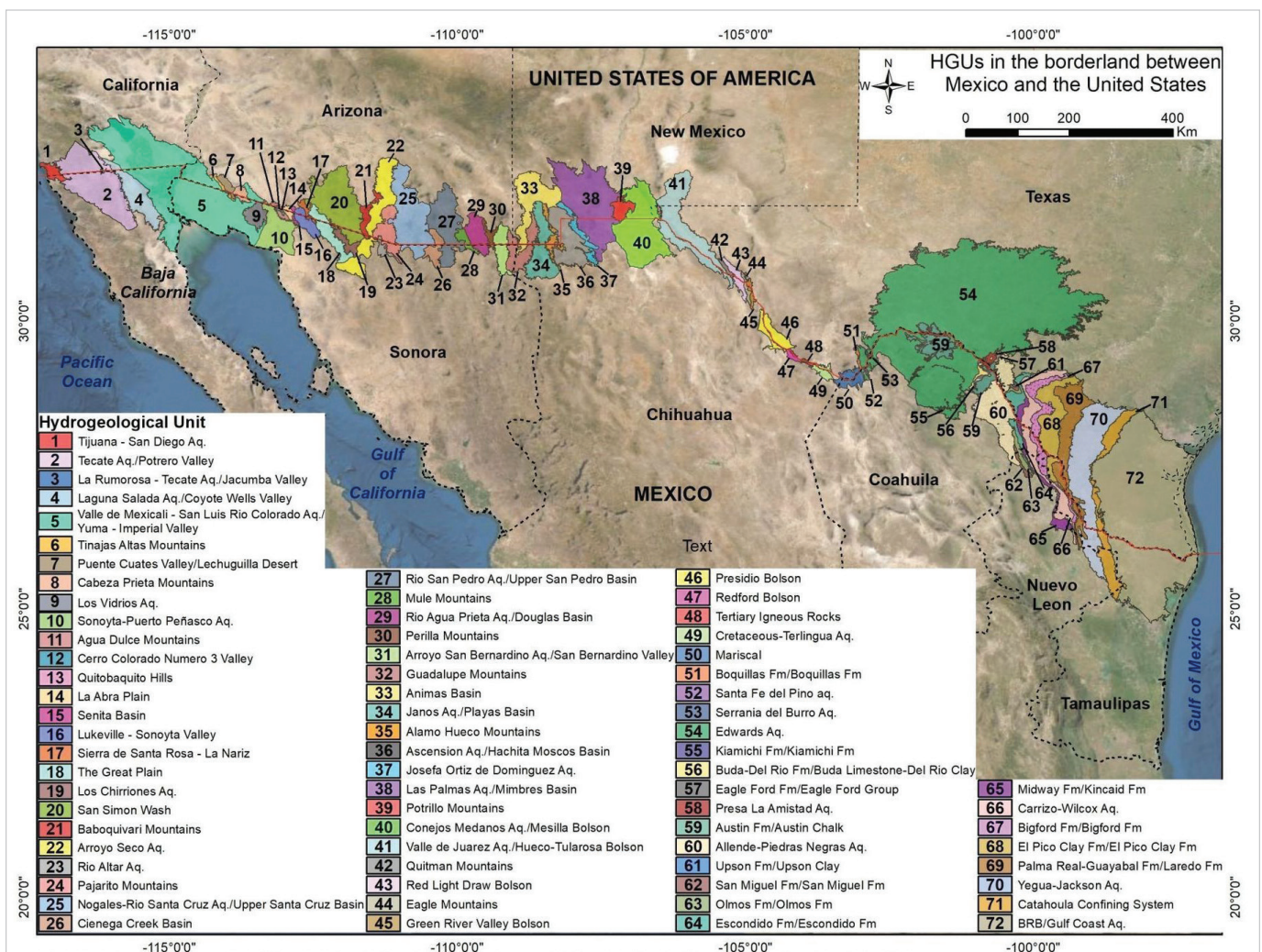
communication, whether due to literal language barriers or other barriers to understanding. Overcoming communication barriers will be essential in binational negotiations. During the conference, Rosario Sanchez, senior research scientist of the Texas Water Resources Institute, and Elia Tapia, professor of the Universidad de Sonora, noted that scientific language must be translated not only linguistically but also contextually. Technical knowledge must be presented with local relevance, bridging science and policy to avoid creating a divide between the scientific community and the communities they aim to serve.

Transboundary Aquifer Assessment Program

In transboundary regions, such as the Arizona-Sonora area, shared challenges have different impacts on either side of the border due to different governance structures. Programs like the Transboundary Aquifer Assessment Program (TAAP), a congressionally authorized program that works to evaluate and characterize aquifers lying

across the U.S.-Mexico border, play a vital role in this process. Among other activities, they produce public, bilingual assessments using coordinated data, maps, and measurements that align across both countries. As explained by Blanca Cabello, deputy director of water quality and sanitation of the Mexican Section, and Gilbert Anaya, chief of the environmental management division of the U.S. Section of the IBWC, the implementation of TAAP through the IBWC framework established the cooperative process for the exchange and generation of groundwater-related information.

TAAP works to foster the development of binational efforts with a jointly defined scope of work that could include the exchange of hydrogeological information; the development of binational databases, including land use, well data, groundwater levels, groundwater quality, and pumping records; and the development of mathematical flow models, all of which must be in a repository hosted by the IBWC and documented in a bilingual final report. Two efforts have been developed in the Arizona-Sonora area: the Binational Study of the



Map of U.S.-Mexico transboundary aquifers. Source: Blanca Cabello, 2-Anaya-Cabello.pdf

Transboundary San Pedro River Aquifer, published in 2016, and the Binational Study of the Transboundary Santa Cruz River Aquifer, with the binational report expected in 2026. Also, through the TAAP framework, a binational Geo Web Portal will be created and will include the information generated in the above-mentioned studies. The portal, which will provide access to an interactive web mapping application to support the understanding of transboundary aquifers by decision makers, natural resource managers, and private citizens, is a truly collaborative enterprise, whose participants include IBWC/CILA, Mexico's water agency, CONAGUA, EPA, and USGS.

Lessons learned from years of collaboration programs highlight the importance of aligning methods, terminology and outcomes across institutions and nations, as well as co-developing frameworks for effectively communicating relevant information on both sides of the border. Beyond data sharing, these partnerships require trust, transparency, and consistent communication to overcome differences in governance and resource priorities. Programs like TAAP demonstrate how coordinated, bilingual efforts can bridge administrative divides, improve decision-making and strengthen long-term water sustainability across the U.S.-Mexico border. Cooperation not only advances scientific understanding but also fosters resilience and mutual accountability between neighboring countries.

Verde Model

Agreement on basic facts can be impeded by distrust, and trust in basic information is essential to resolving contentious water issues. The Verde Basin Multi-Scale MIKE SHE Integrated Model is a tool developed by the Yavapai-Apache Nation and The Nature Conservancy for generating a common understanding of the science around the Verde River. MIKE SHE is a suite of integrated modeling tools developed over 40 years ago to simulate the entire hydrologic cycle. A refined Verde Valley-Oak Creek MIKE SHE model was nested within the multi-scale model. It incorporates a wide variety of scientific inputs to help users better understand how groundwater pumping, surface diversions, and climate change can impact flows in the Verde River. The model was developed with direct input from communities in the Verde Valley who were involved at the earliest opportunity. Asking for early input on the model, its objectives, and goals created shared objectives and buy in, making it clear that the model is a tool that can help everyone in the valley to make better decisions about water management. The

Yavapai-Apache Nation and The Nature Conservancy were careful to specify that the model will not be used to litigate water rights or prove anyone wrong. The MIKE SHE modeling process also was used by the Yavapai-Apache Nation during its negotiations on the Yavapai-Apache Nation Indian Water Rights Settlement, which was completed in 2024 and now awaits formal approval in Congress.

Water Science Diplomacy Forum

Science diplomacy, the use of scientific collaboration to build relationships and solve problems between countries, encompasses both formal and informal exchanges among technical experts, researchers, and academics. These collaborations operate within the broader context of international relations to help nations work together to solve shared national and global challenges. Scientists are encouraged to learn to communicate persuasively to different audiences and become science "diplomats." An example of water science diplomacy in action is the Permanent Forum of Binational Waters, a multidisciplinary nonprofit institution of more than 270 water scientists and experts dedicated to fostering water resilience in the Mexico-U.S. border region. The forum's members collaborate to promote the sustainability of water resources across the region. Rather than following strict protocols, they rely on flexible processes and principles that build shared vision, honor commitments, foster trust, respect differences, and support effective communication.

CONCLUSION

Shared rivers, aquifers, and coastlines both connect us and present challenges that require cooperation to address effectively. Historical governance frameworks such as the 1944 Water Treaty, the Colorado River Compact, and Tribal water settlements provide the foundation for evolving governance to manage shared waters. The ability of these frameworks to adapt to emerging crises and expand inclusivity provides a valuable model for future work. They also provide an institutional context for national, state, and local problem solving involving borders.

The work of these institutions is supplemented and expanded through less formal collaborations and the involvement of NGOs representing various aspects of civil society. Transboundary work by NGOs on multiple scales champion concerns for environmental values, equity, and understanding.

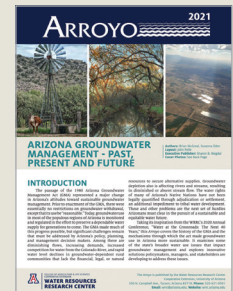
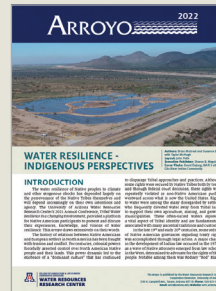
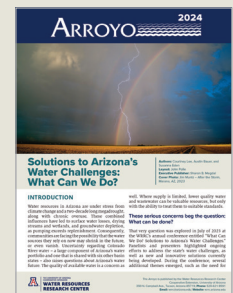
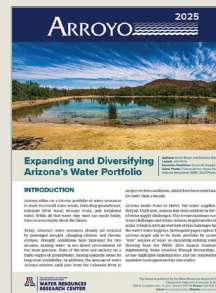
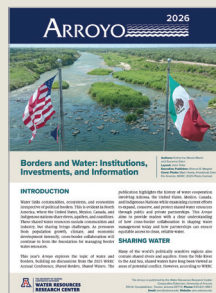
Governance alone, however, is insufficient without investment to translate policy into infrastructure and action. Institutions such as NADBank, the EPA, and IBWC in collaboration with cities, municipalities, and counties are addressing aging systems, rapid urbanization, and pollution. At the same time, initiatives by public and private entities, including SRP, CABC, and WIFA, provide investments needed to realize water augmentation and long-term reliability.

Governmental and private institutions rely on accurate information and transparent dialogue to guide decisions and foster public trust. This exchange of information, in addition to the purely technical, should also reflect human factors. Water can foster cooperation even in regions shaped by conflict when reliable and relevant information builds a foundation for understanding and collaboration. As climate change, drought, and population growth intensify, shared information will be fundamental to our ability to adapt to new challenges.

ABOUT THE ARROYO SERIES

The WRRC's *Arroyo* is produced each year to look in depth at a single water topic of timely importance to Arizona. Intended for the lay public, it reaches educators, water managers, decision makers, students, and other interested individuals and has been used to inform policy discussions. Published regularly since 2007, topics have ranged widely. In recent years, the *Arroyo* has been linked with the WRRC Annual Conference topic to capture and expand on the themes and lessons of the conference. Prepublication reviews by experts ensure accuracy and comprehensibility. Copies of the *Arroyo*, from its earliest issue to the present, are available online:

<https://wrrc.arizona.edu/arroyo>.





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Katherine N. Marsh is a student majoring in biosystems engineering with a minor in mechanical engineering and environmental science at the University of Arizona. She is a coauthor of the upcoming book, *The Air We Breathe: A Patient's Guide to Environmental Allergy, Intolerance, and Toxicity*, with Dr. Julie Wendt, and is dedicated to advancing environmentally responsible solutions to issues of air, water, food, and energy.

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