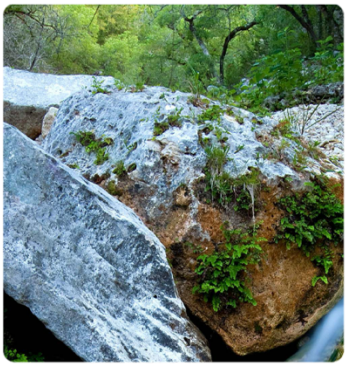
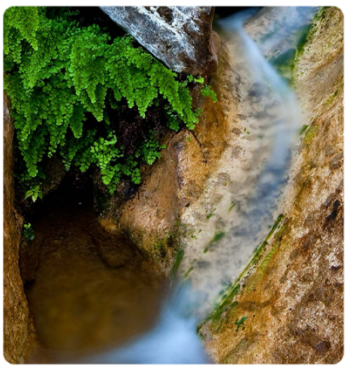


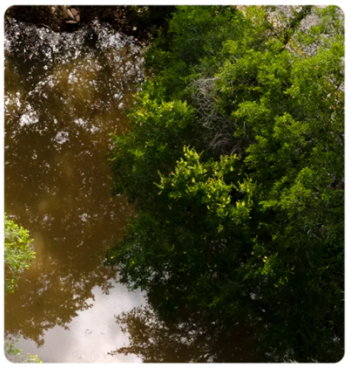


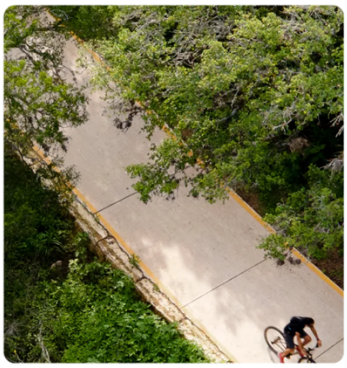
# Edwards Aquifer Protection Program

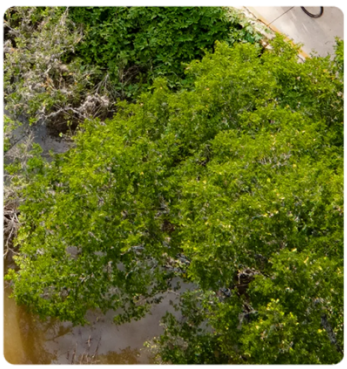
## Local options sales tax and green bonds for payment for ecosystem services

CLIMATEFIT International best practice factsheet

Case ID: 20








Varnika Srivastava

University of Antwerp

CLIMATEFIT

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

## Summary

The Edwards Aquifer Protection Program (EAPP) in San Antonio, Texas, safeguards the city's vital source of potable water, the Edwards Aquifer. Launched in 2000, the EAPP secures conservation easements to protect the aquifer, which is crucial for the region's water supply. This strategic financial initiative was strongly supported by voters, reflecting its wide acceptance and the community's commitment to sustainable water management. It has leveraged local sales tax increases and green bonds to fund ecosystem services.

Initially funded by a voter-approved 0.125% sales tax increase, the program has raised 335 million USD since its inception, enabling significant land conservation over the aquifer. These funds are used for the acquisition of land easements that restrict development, maintaining the aquifer's recharge zones and ensuring a stable water supply. In 2021, the funding strategy evolved to include green bonds, further diversifying its financial base and ensuring continued support for aquifer protection efforts.

The EAPP not only illustrates the importance of community support with repeated voter approvals but also serves as an effective model of public engagement and long-term environmental stewardship. This program conserves critical habitat, supports biodiversity, and secures a sustainable water resource for San Antonio and conserves critical habitat for biodiversity, proving that strategic financial planning and strong voter support can drive successful environmental programs.


**Keywords:** Edwards Aquifer, land easement, local options sales tax, green bond

**Actor(s) interviewed:** official working at the EAPP

**Cover images**: © Ian Shive (top photo), © Nick Wagner (middle photo), © Scott Ball (bottom photo)

**Further reading**: Edwards Aquifer Protection Program Website

**Suggested citation**: Srivastava, V. (2024). *Edwards Aquifer Protection Program. Local options sales tax and green bonds for payment for ecosystem services*. University of Antwerp for CLIMATEFIT.

# Best practice information card

**Table 1**. Edwards Aquifer Protection Program. Information card

| | |
|---|---|
| Location | San Antonio, Texas, USA |
| Population size | 1.473 million (2022) |
| Project area size | 1307 km² |
| Area type | Urban |
| Climate challenge | Droughts are increasingly linked to climate change as rising temperatures intensify evaporation rates, reducing rainfall. This disruption prevents underground water resources from replenishing adequately, exacerbating water scarcity in affected regions. |
| Key Community System(s) | Ecosystem and nature-based solutions, water management, health and human wellbeing |
| Objectives | The Edwards Aquifer Protection Program (EAPP) seeks to protect the underground aquifer that provides the water for San Antonio. The EAPP maintains the aquifer by protecting areas where the aquifer is replenished. The EAPP uses land easements to buy development rights for land owners to conserve open space and offers various environmental benefits. |
| Climate challenge solution | The Edwards Aquifer Protection Program combats water reuse by acquiring properties along with land easements on private land. This restricts development and protects the recharge and contributing zones, ensuring the Edwards Aquifer has a sustained water supply. |
| Key benefits | The program safeguards the Edwards Aquifer, a crucial source of clean water for the San Antonio region. This protects groundwater quality and potentially reduces future water treatment needs. Land acquisition efforts help conserve open space within the aquifer's basin, while also providing habitat for endangered species and other wildlife as a secondary benefit. By protecting the aquifer, the program contributes to public health by ensuring a reliable source of clean drinking water. The EAPP promotes water sustainability by preventing over-exploitation of the aquifer. This reduces the risk of depletion and ensures a long-term water supply for the region. |
| Implementation status | Since 2000 |
| Investment volume (€) | 335 million (2000-2024) |
| Key financing barriers | Limited public budget for buying private land |
| Financial model | The EAPP secures conservation easements to protect the aquifer, vital for the region's water supply. This strategic financial initiative was strongly supported by voters, reflecting its wide acceptance and the community's commitment to sustainable water management. It has leveraged local sales tax increases and green bonds to fund ecosystem services. |
| Financial sources | Public: Local municipalities (Local options sales tax)<br>Private: Property Owners<br>Sources for Green bond funding are not known |
| Financial instruments | Results based financing: Payment of Ecosystem Services<br>Debt based instruments: green bonds<br>Taxation |

## Overview and timeline

The city of San Antonio is the 7th largest city in the United States by population, with a rapidly expanding metropolitan area. The city is growing extensively over fragile areas like the Edwards Aquifer, which is the primary source of drinking water for San Antonio. In addition to urban expansion, climate change has increased the frequency and severity of droughts in the region. Rainfall in San Antonio can vary according to El Niño weather patterns and is often inadequate to provide a healthy and sustainable water source. Summers in San Antonio are brutal, with temperatures reaching above 40 degrees Celsius for extended periods. Rainfall can also be very erratic due to climate change, and San Antonio has experienced flooding issues in the past despite being a drought-prone area.

San Antonio has a young population with a Hispanic majority. While educational levels have traditionally been lower than in other large cities, the city is experiencing an influx of people with higher education and incomes. The major landowners primarily reside outside San Antonio in rural areas and are demographically diverse. Some are absentee owners who purchased land for investment or recreational purposes, while others are resident landowners who use their property for agriculture, personal use, or raising livestock. Rural landowners have become increasingly concerned about conservation issues. These landowners want to ensure their properties remain undeveloped after they sell or pass them on to future generations.

The Edwards Aquifer is the city of San Antonio's primary source of water. The aquifer stretches for roughly 250 kilometers and is oriented from the southwest to the northeast in central Texas (see Figure 1). Nearly all of the city's water during the 20th century came from the Edwards Aquifer.


**Figure 1**. Location of Edwards Aquifer in Texas. Source: Clark et al. (2009)

To reduce the city's dependence on the Edwards Aquifer, the San Antonio Water System (SAWS) has invested in alternative water sources over the past decade. In 2012, the city relied on the Edwards Aquifer for 90% of its potable water supply. The demand for water has increased alongside population growth, rising from 35 billion gallons in 1970 to approximately 80 billion gallons in 2012, with 72 billion gallons sourced from the Edwards Aquifer.

**The Edwards Aquifer Protection Program (EAPP) was formally launched in 2000 with the aim of protecting the depleting reserves of the aquifer.** Initially funded by a 0.125% sales tax passed by voters, Proposition 3 in 2000 authorized up to 45 million USD with 55% voter approval. An additional 90 million USD was approved by

55% of voters through Proposition 1 in May 2005. In November 2010 and 2015, another 90 million USD in financing was reauthorized with two-thirds (66%) voter approval each time. Currently, funding is supported by a green bond approved in 2021, managed through the San Antonio Municipal Facilities Corporation (SAMFC) which issues debt for the EAPP.

**The Edwards Aquifer Protection Program is a voluntary conservation initiative by landowners and is administered by San Antonio city staff.** They collaborate with private landowners across designated areas encompassing the recharge and contributing zones of the Edwards Aquifer (see Image 3). This expansive region extends westward from San Antonio and northward to include upstream streams and rivers that eventually discharge into the aquifer's recharge zone. Groundwater flows west to east towards San Antonio and then continues northwards to Austin. Therefore, land-use practices and rainfall patterns west of San Antonio directly impact the quality and availability of water extracted from the aquifer. Unlike many municipalities that rely on surface water sources like reservoirs or rivers, San Antonio depends on the freshwater underground aquifer.

The EAPP works with landowners to acquire conservation easements on their properties. These easements allow the EAPP to purchase development rights in perpetuity, enabling landowners to continue traditional uses such as agriculture or maintain personal residences. However, the land cannot be sold for future development of rental subdivisions or commercial enterprises.

**Conservation easements1 are used to protect 95% of the land currently under protection by the EAPP.** Conservation easements in the US date back to the 1950s but did not become commonplace until the 1980s. By the time the EAPP was established, conservation easements had become a well-established and successful tool used across the US for various land protection initiatives, including the safeguarding of water resources. A landowner who agrees to a conservation easement retains ownership of the land but agrees that certain types of development and land use are prohibited. Conservation easements serve as a safeguard for ecosystem services, such as maintaining the quality of nearby water supplies. **They are often a cost-effective way to achieve conservation goals because they do not involve transferring ownership outright. Landowners typically receive a one-time payment, usually ranging from 30% to 50% of the property's market value, in exchange for restricting development rights on their land.**

The EAPP was initially created to protect open spaces and sensitive properties over the Edwards Aquifer in Bexar County. It was initiated by San Antonio city leadership and community stakeholders to prevent a recurrence of the severe droughts experienced in the 1950s. Stakeholders who witnessed these historical events understood the consequences of low rainfall, which included drying springs, reduced river water levels, and diminished agricultural output across Texas. They recognized the threat to the aquifer posed by urban development during periods of low or no rainfall. The program aims to conserve sensitive recharge zones before urbanization occurs.

Prior to the EAPP, the Edwards Aquifer Authority (EAA), a groundwater management district established by the State of Texas in 1993, was created to protect spring flows, endangered species, and manage withdrawals to ensure the aquifer remains a viable source of drinking water in the future. The EAPP emerged from grassroots initiatives led by community stakeholders in the late 1990s. These efforts culminated in collaborations with San Antonio City Council members and the Mayor's office. Their discussions aimed to establish a program under municipal authority and funding. Initially, the program focused on direct land purchases, resulting in some city-owned properties. Currently, the EAPP protects approximately 38% of the city's maximum aquifer withdrawals and about 51% of what it extracts. The San Antonio Water System (SAWS) is pursuing 33 billion gallons of additional, non-Edwards Aquifer sources to meet the majority of the city's future water demands. Current regulations also empower the Edwards Aquifer Authority (EAA) to restrict withdrawals during dry conditions as part of additional conservation efforts.

The program was originally funded by a voter-approved local sales tax increase in 2000. San Antonio residents voted for a one-eighth cent sales tax levy dedicated to protecting the aquifer. This initial five-year program secured 45 million USD through local sales taxes. In total, **the program has collected 335 million USD from local sales taxes over a 23-year period. Additionally, since 2023, the program has raised an additional 10 million USD through green bonds.**

**Table 2**. EAPP. Timeline with key moments

| Date | Key moment |
|---|---|
| 1950s-1960s | • Worst drought in recorded Texas history. |

[1] A conservation easement is a voluntary, legal agreement that permanently limits uses of the land in order to protect its conservation values. Also known as a conservation restriction or conservation agreement, a conservation easement is one option to protect a property for future generations. Source: National Conservation Easement Database

| | |
|---|---|
| | • **Edwards Underground Water District (EUWD)** created with limited authority (data collection only).<br>• 1961 Texas Water Plan discourages overreliance on Edwards and proposes new reservoirs which were never built<br>• 1968 Texas Water Plan sets safe withdrawal limit at 400,000 acre-feet per year. |
| 1993 | • Sierra Club lawsuit against US Fish and Wildlife Service for inadequate protection of endangered species dependent on the aquifer.<br>• Federal court rules in favour of Sierra Club, requiring minimum spring flows and withdrawal regulations.<br>• Texas Water Commission ordered to develop a plan to ensure spring flows.<br>• Edwards Aquifer Authority (EAA) created to regulate groundwater withdrawals.<br>• Right of free capture in the Edwards region abolished.<br>• Legal framework established for assigning water ownership to historical users.<br>• Permit system implemented with a cap on total withdrawal:<br>  ○ Initial cap: 450,000 acre-feet annually.<br>  ○ Long-term cap (effective 2008): 400,000 acre-feet annually (matches 1968 plan). |
| 1998 | San Antonio Water Management Strategy developed a 50 year water supply plan focussing on:<br>• Sustainable use of existing resources within the basin.<br>• Protecting regional water environment. |
| 2000 | EAPP was created |
| 2007 | • Texas legislature increased the pumping cap to 572,000 acre-feet/year, raising concerns about the endangered species dependent on spring flows<br>• Critical period Management rules implemented |

## Governance and key stakeholders

In the United States, there is a tiered system of local government with municipalities (cities, towns, villages) at the base. Counties typically consist of multiple municipalities, and multiple counties together form regions, although regions themselves are not official government entities. In some states, municipalities like San Antonio, Texas, operate independently of counties and have their own governing bodies. In other states, municipalities may function as subdivisions of counties and have limited autonomy.

Municipalities provide local services within their defined boundaries, while counties administer broader services across both rural and urban areas. Regions, though lacking official government status, can influence regional planning and collaboration efforts. **The Edwards Aquifer Protection Program (EAPP) operates under a unique governance structure distinct from traditional programs managed by single government entities. Administered by the City of San Antonio rather than a county or regional body**, the program initially relied on voter-approved sales taxes within San Antonio and later secured funding through a Green Bond.

The primary objective of the EAPP is to acquire conservation easements on private lands situated above the recharge and contributing zones of the Edwards Aquifer. These zones may extend beyond city and county boundaries. Unlike programs with direct regulatory authority over water and land-use practices, the EAPP collaborates with landowners to promote conservation through easement acquisitions.

Separately, the **Edwards Aquifer Authority (EAA)** possesses regulatory authority over groundwater usage within a specified segment of the aquifer, distinct from the EAPP's land acquisition activities. Established as a state-mandated groundwater district, the EAA oversees the aquifer's most heavily utilized wells.

The EAPP also engages with other stakeholders concerned with the health of the Edwards Aquifer, such as the **San Antonio Water System (SAWS)**, the primary water utility serving San Antonio. However, SAWS is not directly involved in the EAPP's land easement initiatives.

The EAPP activities are overseen by the **Conservation Advisory Board (CAB)** which consist of the following:

- City of San Antonio (COSA) Parks and Recreation Director
- COSA Parks Advisory Board
- Edwards Aquifer Authority (EAA)
- San Antonio Economic Development Foundation
- San Antonio River Authority (SARA)
- San Antonio Water System (SAWS)
- Texas Parks and Wildlife Department
- Medina County

- Uvalde County

The CAB reviews and recommends of the land easement applications that the EAPP receives,

To assist the EAPP with land identification and acquisition, two groups were established:

- **Scientific Evaluation Team (SET):** SET is a science-based advisory group responsible for determining the weighting matrix for the GIS spatial model used to rank properties. Members of SET include:
  - COSA Parks & Recreation Department
  - Edwards Aquifer Authority
  - US Department of Agriculture
  - San Antonio River Authority
  - San Antonio Water System
  - Texas Parks & Wildlife Department
  - US Fish & Wildlife Service
  - US Geological Survey
  - Southwest Research Institute
- **Land Acquisition Team (LAT):** In addition to City EAPP staff, the LAT is comprised of two non-profit conservation organizations which report to the Conservation Advisory Board (CAB) on availability of property based upon CAB and City directives
  - LAT members assist with negotiation of land purchases and easement and help coordinate due diligence necessary for each property
  - LAT members are: **Green Spaces Alliance of South Texas and The Nature Conservancy.**

The program now uses debt issuance (green bond) through the **San Antonio Municipal Facilities Corporation (SAMFC).** The SMFC is a separate legal entity established by the City of San Antonio. These bonds are not directly backed by private companies but represent a general obligation of the SMFC, with repayment guaranteed by its future revenue streams.

The geographic scope of the stakeholders involved in the EAPP is shown in the figure below (Figure 2).

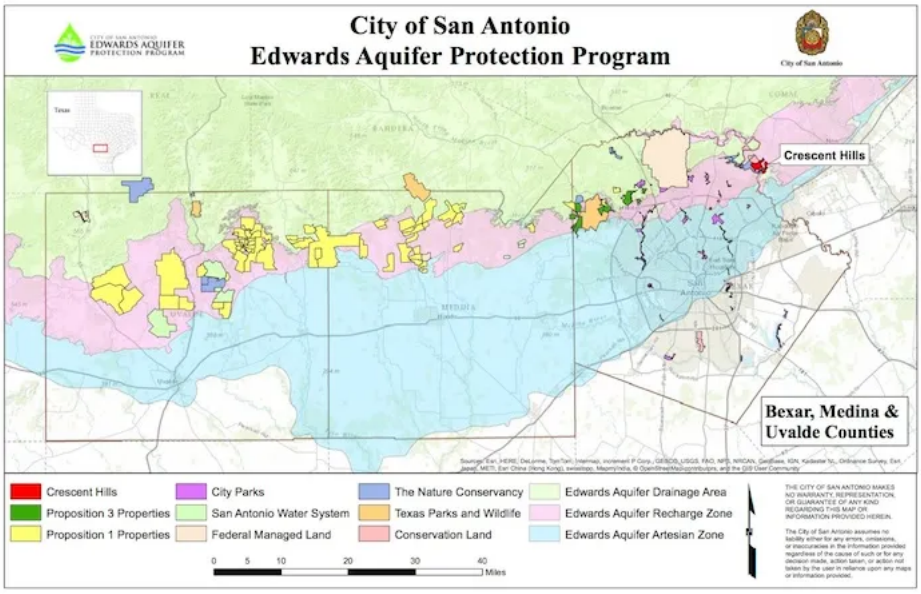



**Figure 2**. Scope of Edwards Aquifer Protection Program, source: EAPP (2023)

**Table 3**. EAPP. Key stakeholders and their responsibilities or roles

| Stakeholder | Type | Role and responsibilities |
|---|---|---|
| City of San Antonio | Public | Runs the EAPP |
| Edwards Aquifer Authority | Public | Issues permits and regulates ground water withdrawals in the Edwards Aquifer, sits on the Board of the CAB and collaborates closely with the EAPP, also provides technical support for ground staff |
| San Antonio Water System | Public | sits on the Board of the CAB and collaborates closely with the EAPP for aquifer protection |
| Conservation Advisory Board | Hybrid | Oversees the activities of the EAPP and approves easement applications |

| | | |
|---|---|---|
| Green Spaces Alliance of South Texas | Private | Provides technical assistance to the EAPP and reports to CAB |
| The Nature Conservancy | Private | Provides technical assistance to the EAPP and reports to CAB |
| San Antonio Municipal Facilities Corporation (SAMFC) | Public | Legal entity established by the City of San Antonio for green bond issuance |

# Business model & financial model

## Business model

The Edwards Aquifer Protection Program (EAPP) provides significant regional benefits beyond San Antonio, the primary metropolitan area dependent on the aquifer for its water supply. Numerous neighbouring communities also benefit, as the aquifer's eastward underground flow ensures cleaner water for municipalities located between the recharge zones and San Antonio.

Managed by the City of San Antonio, the EAPP operates with a small team consisting of a Manager and two staff members who oversee due diligence, technical evaluations of properties, and **annual monitoring of the program's 129 conservation easements.** Given the workload, the city has an interlocal agreement with the Edwards Aquifer Authority (EAA) to provide additional field staff and support for monitoring inspections. **The program costs approximately 575,000 USD annually,** covering staff salaries, technical resources such as vehicles and equipment, agreement costs with the EAA, and support from external organizations.

The EAPP operates with a remote workforce that convenes for collaboration during field evaluations and annual monitoring inspections. The Manager coordinates closely with the Land Acquisition Team, which includes representatives from The Nature Conservancy and the Green Spaces Alliance of South Texas. This team assists in scheduling essential tasks such as property surveys, appraisals to determine fair market value, and environmental assessments as part of the due diligence process. To facilitate land identification and acquisition, two groups were established: the Site Evaluation Team (SET) and the Land Acquisition Team (LAT) if the EAPP needs additional assistance. **The program's operational process involves landowners applying through the EAPP's online portal, followed by initial screening and field evaluation (see Figure 4).**

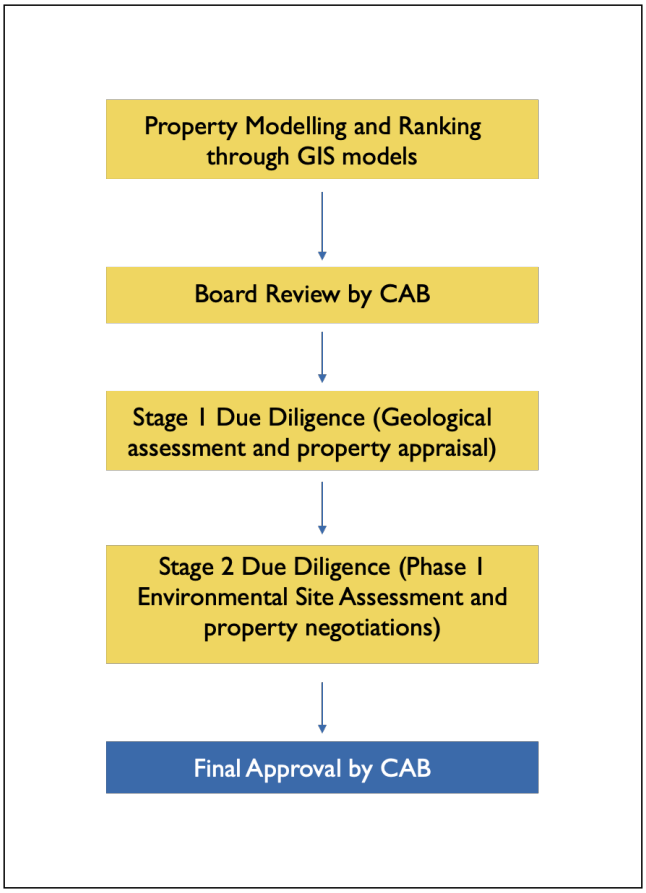



**Figure 3**. Application approval process of EAPP. Source: Author

**The application approval of the EAPP has the following steps:**

- **Step 1:** Property modelling and Ranking through a GIS model that ranks properties based on geological features such as size and locations.
- **Step 2:** Board review by CAB involves detailed review based on GIS models.
- **Step 3:** Stage 1 due diligence by the EAPP based on geological assessment of the property and appraisal
- **Step 4:** Stage 2 due diligence involves the completion of Environmental Site Assessment and property negotiations
- **Step 5:** Final approval by the CAB

SET plays a crucial role in the Edwards Aquifer Protection Program (EAPP), particularly in developing a weighting matrix for the GIS spatial model used to rank properties based on various criteria such as water resources, biology, property size, and location. During property evaluations, the EAPP assesses all geographic features, including sinkholes, caves, and fractures, to determine if there are beneficial recharge features present or if the property contributes directly to nearby rivers or streams. These features play a critical role in the aquifer's recharge process.

Each property undergoes a geological assessment to evaluate its potential for enhancing both the quality and quantity of recharge that residents of San Antonio can benefit from if the property is conserved. The evaluation also assesses the biological conditions of the property, determining whether it has been disturbed or developed in any way. These assessments are instrumental in determining whether a property qualifies for a conservation easement under the EAPP. Ultimately, the SET's work ensures that properties selected for conservation easements not only protect critical recharge areas but also enhance the overall health and sustainability of the Edwards Aquifer, benefiting both current and future residents of San Antonio.

**Conservation Easements are perpetual once acquired. 95% of property interests acquired by EAPP are conservation easements and 5% are Fee Simple acquisitions**[2]. Under conservation easements, landowners

[2] Fee simple is a legal term used in real estate that means full and irrevocable ownership of land, and any buildings on that land. Fee simple is the highest form of ownership — it means the land is owned outright, without any limitations or restrictions other than local zoning ordinances. The term fee simple applies only to real estate, which includes land, immovable property and any property directly attached, such as a building, road, pond or machinery. Source: Bankrate

retain ownership and certain land use rights but give up future development rights (which are limited to ½ of 1% of total square footage for future development). **All acquired properties are monitored on an annual basis by City and EAA staff under an Interlocal Agreement. Negotiations of conservations easements typically last between 9 months to one year. Once the conservation easement has been recorded, it is a legal binding agreement that cannot be changed and lasts into perpetuity. The landowner is compensated 30 – 50% of fair market value as established by appraisal. One-time cash payment is issued at closing.** Conservation easements are much more cost efficient than fee simple acquisitions.

## Financial model

The EAPP can be considered to be a form of a Payment for Ecosystem Services (PES) program, but it doesn't perfectly fit. Traditional PES[3] Programs offer direct financial incentives to landowners in exchange for adopting land management practices that benefit the environment. These payments compensate landowners for the ecosystem services their land provides, such as clean water filtration or carbon sequestration. The EAPP (in majority cases) doesn't directly pay landowners for ecosystem services. It acquires conservation easements on private land. Thus it can be said that EAPP is a variation of PES, though not a textbook example of PES program due to a lack of direct payments, However, both traditional PES programs and the EAPP incentivize land management practices that benefit the environment. The EAPP achieves this through restrictions on land use, while PES programs often offer financial rewards for specific practices. It can thus be said that the EAPP functions as a form of PES, but with a different financial structure.

The Edwards Aquifer Protection Program (EAPP) initially received funding from a voter-approved local sales tax increase in 2000. San Antonio residents voted on a one-eighth cent sales tax levy dedicated to protecting the aquifer. This initial five-year program raised 45 million USD to launch the initiative. Following the success of this funding, in 2005, the program sought and received voter approval for an additional 90 million USD to support land acquisition activities. This proposition garnered strong voter support. Similar successful renewals occurred in 2010 and 2015, each securing an additional 90 million USD for five-year funding cycles aimed at aquifer protection.

Specific voter turnout rates for EAPP-related votes are not detailed in available sources. In Texas, the process for local sales tax increases typically involves a proposal from the City Council followed by a public election. The required majority vote can vary across counties, sometimes necessitating a supermajority (over 75%) or a simple majority (over 50%) depending on local regulations. Participation rates for these votes can vary widely since voting is not mandatory, and all registered voters within the jurisdiction are eligible to participate. Detailed information on election turnout and initiation was not provided in available interview or online sources.

The financial structure of the EAPP is described in the figure below, showing the financial transactions and flow of funds within the EAPP:

[3] Payments for environmental services (also known as payments for ecosystem services or PES), are payments to farmers or landowners who have agreed to take certain actions to manage their land or watersheds to provide an ecological service. As the payments provide incentives to land owners and managers, PES is a market-based mechanism, similar to subsidies and taxes, to encourage the conservation of natural resources. Source: International Institute for Environment and Developement

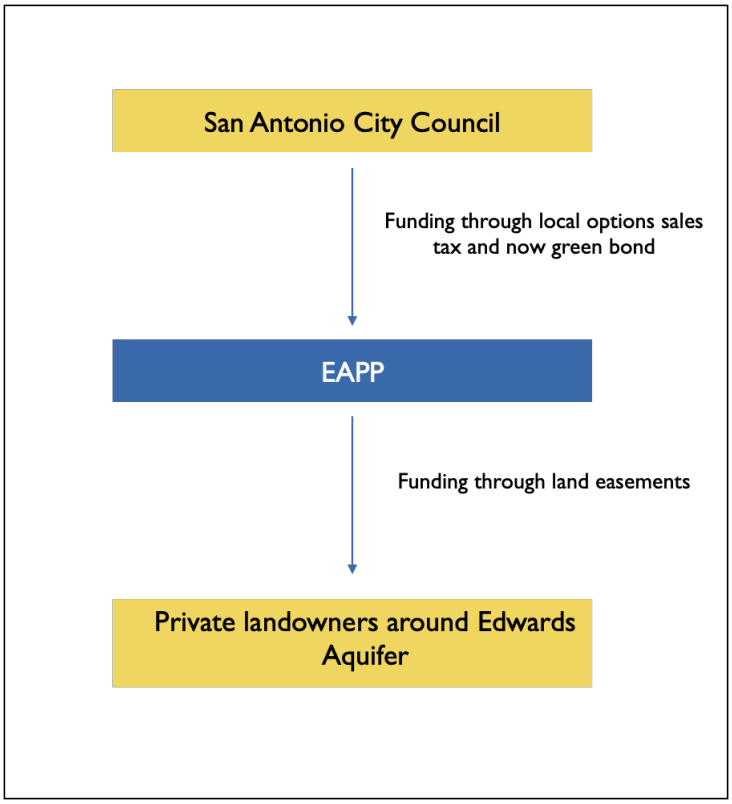



**Figure 4**. Flow of funds in EAPP, source: Author

Because of the Covid Pandemic, the city had to divert the money raised from the local sales tax for Covid relief efforts and educational investments in 2020. While City Council and voters approved the shift of sales tax funding from EAPP to Covid relief, the funds which were approved in the 2015 election were not fully collected until early 2021. EAPP did not fully expend the funds until September 2023. During this time, the EAPP transitioned to the new funding program.

**In 2021, for the continuation of the EAPP, the San Antonio City Council approved an alternative funding mechanism. The program now uses debt issuance (green bond) through the San Antonio Municipal Facilities Corporation (SAMFC).** This approach provides $100 million in funding over a ten-year period, which started in September 2023. The SMFC is a separate legal entity established by the City of San Antonio. These bonds are not directly backed by private companies but represent a general obligation of the SAMFC, with repayment guaranteed by its future revenue streams.

The specific details of the bond maturity and debt service schedule are not publicly available. However, there is a 10-year funding program set in place with a potentially longer debt service period, possibly extending to 15 or 20 years. The debt will be repaid through part of the City's property tax revenue collected from both residents and businesses. While a future sales tax increase is not currently planned, property tax revenue is a potential source for future program funding alongside other general fund resources. The decision to switch funding sources was approved by the San Antonio City Council. The EAPP has had strong voter support throughout its functioning.

## Enabling conditions

The Sierra Club lawsuit (1993) and subsequent court ruling played a critical role in providing the conditions for the establishing of the EAPP. The Sierra Club sued the US Fish and Wildlife Service in 1993 because they felt the agency wasn't adequately protecting endangered species dependent on the Edwards Aquifer. The lawsuit argued that unrestricted pumping could dry up springs, harming these species. The court victory required minimum spring flows and other regulations to limit water withdrawal, prompting the creation of the Edwards Aquifer Authority (EAA) to manage the aquifer sustainably.

The federal court decision:

- Highlighted the need for regulations to protect endangered species.
- Required minimum spring flows, necessitating withdrawal limitations.

The Texas Water Commission was mandated to develop a plan, leading to the creation of the EAA in 1993. The EAA was granted the power to:

- Issue permits and regulate groundwater withdrawals.
- Establish a permit system with a cap on total withdrawal.
- Implement critical period management plans for droughts

With the establishment of the Edwards Aquifer Authority (EAA), a dedicated entity was created to safeguard the aquifer. The EAA provided the necessary institutional framework to translate public concern for aquifer protection into a concrete program: the Edwards Aquifer Protection Program (EAPP). The creation of the EAPP was driven by both necessity and demand. Conservation easements, already widely used across the US to protect land for various purposes, provided a foundational basis for the EAPP's implementation.

The establishment of the EAPP was made possible within the framework and jurisdiction of the City of San Antonio, where the City Council had the authority to propose ballot items for voter consideration and funding. A significant development occurred in 2005 with a change in Texas state legislation, enabling the program to extend beyond city and county boundaries by acquiring conservation easements on private land contributing to Edwards Aquifer recharge. This approach effectively protects properties while avoiding ongoing operational and maintenance costs associated with direct land ownership. Landowners retain ownership with limitations on development and impervious cover.

The program has enjoyed substantial public support for protecting the aquifer, ensuring consistent funding for the EAPP over the decades. **Public support has been crucial in maintaining funding stability for the program.** A major challenge initially faced by the program was securing and coordinating participation from private landowners, especially those outside city limits who were hesitant to collaborate with a government entity due to concerns about potential restrictions on property use. The government overcame these obstacles by building trust and effectively communicating the program's benefits. They educated landowners on conservation easements, emphasizing that landowners retain ownership with clearly defined development limitations outlined in the easements, which are monitored annually by the EAPP. This transparency and focus on long-term partnership fostered positive relationships with landowners and contributed to the program's favourable reputation and popularity among voters.

## Outcomes

The Edwards Aquifer Protection Program (EAPP) aims to provide a variety of benefits centered around safeguarding the quality and quantity of water that replenishes the Edwards Aquifer. This direct benefit ensures a clean and stable supply of drinking water for San Antonio residents, which has been consistently supported through voter approvals. Beyond water quality, the program has yielded additional advantages. By acquiring land easements, it has promoted conservation and environmental protection. Restricting development reduces impervious cover, preserving scenic views and natural habitats. Moreover, the program has indirectly supported the habitat of endangered species like the Golden-cheeked Warbler by limiting development on acquired lands. Conservation efforts also protect caves and fractures within these properties, crucial for cave-dwelling invertebrate species.

When initially launched in 2000, the EAPP focused on acquiring land, effectively making it public property. This approach saw substantial success in its first decade, as land acquisition costs were relatively lower, allowing the program to secure a significant amount of protected land given the available funding. This strategy resonated with citizens because it provided tangible benefits such as protected parklands, emphasizing long-term protection of natural resources for future generations. However, this approach incurred high upfront costs, as purchasing land outright is typically more expensive than acquiring conservation easements. With a fixed budget, fewer properties could be acquired under this model.

As understanding of the Edwards Aquifer's dynamics evolved, the program's strategy shifted to purchasing conservation easements while still maintaining citizen support. This shift allowed the program to delegate some responsibility for environmental protection to landowners, who agreed to maintain land use restrictions in perpetuity. Acquiring easements in western counties proved beneficial for safeguarding critical areas essential for aquifer recharge, thereby directly benefiting San Antonio's water supply. This adjustment has enabled the EAPP to sustain operations with lower staffing and technical costs under its current business and financial model, while continuing to protect the aquifer effectively.

Although the program has not directly quantified climate-related benefits like reduced drought severity, its conservation efforts likely contribute to maintaining clean groundwater supplies. Long-term benefits, such as potentially reducing the heat island effect in western counties and influencing regional temperatures, may also result from the program's land conservation efforts. However, conclusive evidence on such effects would require dedicated long-term studies.

The program's role in protecting recharge zones may have indirectly benefited the region during recent droughts by:

- Maintaining Spring Flows: Some springs dependent on aquifer health remained flowing, potentially due in part to program efforts.

- Supplementing Water Supplies: Protected recharge zones could contribute to maintaining aquifer levels during droughts increasing the resilience of agriculture, even if the program's direct impact on drought severity is unclear. Quantifying the program's precise impact on drought resilience is challenging. Modelling potential development scenarios on unprotected lands can provide insights, but such studies haven't been conducted yet. Overall, the program likely plays a crucial role in safeguarding water quality and potentially contributes to long-term aquifer health. Further research could help quantify the program's impact on drought resilience.

The Edwards Aquifer Protection Program offers environmental benefits beyond its core focus on water quality:

- Preservation of Open Space: The program's land acquisition efforts help conserve open space, which can offer psychological benefits to residents.
- Recreational Opportunities: Some acquired properties by the city have been developed into parks, providing recreational opportunities for the community.
- Ecosystem Protection: Land conservation protects ecosystems and habitat for endangered species like the Golden-cheeked Warbler and cave invertebrates.

While landowners receive upfront compensation, the program offers broader public benefits by safeguarding water quality and potentially reducing future infrastructure needs. The avoided costs of potentially needing to import water or build new water treatment facilities in case of aquifer contamination could be significant. The EAPP specifies that it has acquired 129 conservation easements and 23 fee simple acquisitions from 2000 to present. In total, it has protected 182,066 acres (176,326 acres through easements and 7740 acres from fee simple acquisitions).

## Lessons learned

### Successes and limitations

The interviewee specifies that the main success of the program lies in the continued support that it has received through voter approved funding. Despite changes in local and federal government, the EAPP has had a funding source, since voters recognise the importance of protecting the aquifer, which still supplies most of the potable water in San Antonio. It is still difficult to say what the environmental impact of the EAPP will be, since long term studies are still ongoing or have not provided conclusive evidence.

Even though the funding of the program changed, the focus is still on tangible benefits like environmental protection and more broadly on long term sustainability. The funding for the EAPP has been voted on and approved multiple time since 2000. **Successive voter approvals for sales tax increases in 2000, 2005, 2010, and 2015 demonstrated increasing public support for the program's mission according to the EAPP website**. The city council vote of 2020 that shifted the funding from local sales tax to green bond shows that the public has shown wide support of the program.

The interview also highlights that the biggest limitation for the EAPP is that the real estate costs exceed the program's funding capacity. This limits the amount of land that can be acquired for conservation purposes, and the purchase of land easements. The EAPP is looking into partnerships with like-minded organisations to leverage funding and conservation costs. The city is also prioritising "the best of the best" properties to maximize the impact within its budgetary constraints.

### Transferability conditions and potential

The Edwards Aquifer Protection Program's core concept is of incentivising land use changes for conservation purposes. Territories looking to adopt the program should account for the following:

- **Funding Source:** San Antonio has a large tax base to enable the program's funding through voter-approved sales tax increases. In other regions, alternative funding mechanisms might be necessary**. A regional sales tax approach involving multiple municipalities with a shared water source or conservation goal can be a viable option.** The tax regime of countries and territories in the EU is different. It will have to be adapted in specific contexts, and it will depend on the territories to see whether such tax increases require legal changes and voting or not.
- **Broader Applicability:** Beyond aquifer protection, the program's core concept of dedicated funding for land conservation could be applied to various purposes, such as protecting endangered species, sensitive ecosystems etc,
- **Legal and Regulatory Environment:** Land use regulations, conservation easements, and funding mechanisms are different in each country. A legislation change in Texas enabled the EAPP to buy land easements, but similar mechanisms might not be present in each country.
- **Public Support:** Building public consensus for the program's goals and chosen funding mechanisms is crucial.

- **Long-Term Sustainability:** A sustainable funding model and clear long-term management plan for acquired lands is also essential.

The EAPP highlights the importance of public engagement and transparency for successful program implementation. This requires a proactive engagement with landowners, environmental groups and citizens throughout the whole process.

## Related Factsheets

The EAPP model shares similarities with the EcoMarkets (ID04), Groenfonds Midden-Delfland (ID06) and Wetland Mitigation Banking Program (ID17).

## References

Clark, A.R., Blome, C.D., & Faith, J.R. (2009). Map Showing Geology and Hydrostratigraphy of the Edwards Aquifer Catchment Area, Northern Bexar County, South-Central Texas.

Eckhardt, G. (2010). Case study: protection of Edwards aquifer springs, the United States. In *Groundwater hydrology of springs* (pp. 526-542). Butterworth-Heinemann.

*Edwards Aquifer Protection Program*. (n.d.). Texas Commission on Environmental Quality. URL

*Edwards Aquifer Protection & Linear Creekway Parks Program*. (n.d.). URL

*Edwards Aquifer Information*. (n.d.). URL

Reilly Jr, F. J., & Carter, K. A. (2018). Program Study and Analysis Services for the Edwards Aquifer Protection Program.