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Urban Ecosystem Analysis Phase 2: Data For Decision Making San Antonio, TX

Report Contents

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Project Overview

AMERICAN FORESTS completed Phase 2 of an Urban Ecosystem Analysis of the San Antonio Metropolitan Area in September of 2003. The study area covered approximately 500 square miles (320,000 acres), including the City of San Antonio and its Extra-Territorial Jurisdiction (ETJ) area, a five-mile buffer outside of the city limits. The cities of Balcones Heights and Leon Valley lie within this area and were also included. This study used color aerial imagery and GIS software including CITYgreen to conduct the analysis.

This report marks the second phase of a two-part analysis process and the beginning of the application phase by the community. The first phase of the analysis was completed in 2002 and provided the basis for this second comprehensive step. Phase one (see sidebar) documented the change in the San Antonio ecosystem over 16 years including significant losses in tree cover and increases in impervious surfaces costing the community hundreds of millions of dollar a year. By measuring tree canopy trends, phase one provided the public policy arguments. Phase two provides detailed documentation of the existing tree cover and calculations of the work this resource does for the community. It provides environmental benefit data for community decision-making.

In this phase of the analysis AMERICAN FORESTS used high-resolution imagery to carefully identify tree crowns and other land cover features as small as 6 feet in diameter. This land cover accounting was combined with geo-political and biological data to analyze the structure, function, and value of the ecosystem. One product of this study is a detailed digital map of the landcover, including trees, in the San Antonio ETJ. This map, called a green data layer, can be used seamlessly with existing Geographic Information Systems (GIS) planning software and data files (showing "gray infrastructure" such as roads and utility lines) already used by local agencies. The community can now use the data and findings from this study to build a better infrastructure for the future.

San Antonio is growing, with a 22.3% population increase and a 22% decrease in heavy tree canopy (areas with 50% or greater tree cover) in the last decade. Growth and development have a significant impact on green infrastructure, but this relationship can be substantially improved by engineering green infrastructure into the community. Any further decrease in tree canopy would reduce the amount of ecological services that the trees provide—natural management of air quality and stormwater runoff. This loss in natural services would mean increased infrastructure costs to compensate for the tree loss and increased health risks to the residents.

The San Antonio area has "non-attainment deferred" status with regard to federal air quality standards, jeopardizing millions of federal highway dollars. An Early Action Compact with the U.S. Environmental Protection Agency (EPA) lays out a plan for the region to improve its air quality status early and avoid the penalties of full non-attainment. Maintaining and planting trees is one voluntary measure the community can use to improve air quality. The data from this analysis and CITYgreen software provide tools to understand and quantify the role of trees in removing air pollutants.

Virtually every municipality in the country uses GIS software to make planning decisions using map layers that represent the "gray infrastructure," such as roads and sewers. The green data layer produced by this analysis is a model of the "green infrastructure" —the natural systems that manage stormwater and air quality.

This green data layer is now owned by the city and is ready for daily use. It can be used at almost any scale, providing relevant data for all land use planning projects. This study focused on smaller areas within the San Antonio ETJ, such as the Southside Initiative, 32 of San Antonio's neighborhoods, and special ecological areas such as the Edwards Aquifer Recharge Zone (EARZ). In addition, the cities of Leon Valley and Balcones Heights were included. Using existing GIS map layers such as real estate parcels and Council Districts, analyses quantified the services trees provide within these areas and modeled the effects of a changing tree canopy. These analyses used CITYgreen, a GIS program developed by AMERICAN FORESTS that is used across the country for management and planning analysis of tree cover in urban ecosystems.

Tree Canopy Trends

This Urban Ecosystem Analysis provides a complement to an earlier tree canopy trend study conducted by AMERICAN FORESTS in 2002. The previous study used Landsat satellite imagery from 1985 and 2001 to document the change in tree canopy cover over sixteen years. The analysis showed a 22% decline in heavily forested areas. As a result of this decline, stormwater runoff increased 73 million cubic feet during an average 2-year, 24-hour storm event. In addition, the canopy in 1985 absorbed 3.7 million more pounds of air pollutants per year than in 2001. The 2002 study not only showed tree canopy change over time, but also made the case for including the role of natural systems in the development process.

Major Findings

San Antonio's current tree cover provides substantial stormwater control services and air pollution removal services.

■ The City of San Antonio has 27% tree canopy, 7% open space, 64% impervious/bare urban land, and 1% water. This tree canopy includes the Edwards Aquifer Recharge Zone (EARZ), which is an important ecological zone deserving special development considerations. Without the EARZ, tree canopy in the city is 22%.

■ The tree canopy in San Antonio removes approximately 10 million pounds of air pollutants each year, a service valued at $22 million.

■ The tree canopy manages 665 million cubic feet of stormwater during an average 2-year, 24-hour storm event, a service worth a total of $1.3 billion. Calculated annually, stormwater runoff reduction is valued at approximately $115 million per year (total cost financed at 6% over 20 years).

Rapid development puts pressure on special ecological zones and threatens the city's ability to maintain canopy densities which offset the environmental impacts of development.

■ Tree cover within the in the Edwards Aquifer Recharge Zone is currently 43%.

■ In one typical Stone Oak neighborhood, a residential area within the EARZ, the tree canopy is only 2%. If the entire EARZ were developed in this way, the resulting loss of tree canopy would represent $8.5 million in lost air and water services each year not counting the important recharge function of this area.

If tree canopy were increased to AMERICAN FORESTS' recommended 35% citywide, environmental benefits would increase substantially.

■ The increased canopy would remove 2.5 million pounds more air pollutants each year, a service worth an additional $6 million annually.

■ Increased tree canopy would also reduce the amount of stormwater runoff by 103 million cubic feet during an average 2-year, 24-hour storm event. This service would be worth an additional $200 million in avoided stormwater facility construction costs.

Environmental Benefits of Tree Canopy by San Antonio Council District

	Acres	Tree Canopy	Open Space	Impervious/ Bare Urban	Water	Stormwater Management Value (cu.ft.)	Stormwater Management Value ($)	Air Pollution Removal Value (lbs)	Air Pollution Annual Removal Value ($)	Carbon Stored (tons)	Carbon Sequestered Annually (tons)
Council District 1	13,879	24%	6%	70%	0%	27,873,806	$55,747,612	357,103	$851,197	145,155	1,130
Council District 2	35,416	20%	5%	75%	0%	55,404,188	$110,808,376	734,834	$1,751,564	298,695	2,325
Council District 3	59,394	19%	13%	64%	4%	102,778,244	$205,556,488	1,175,165	$2,801,146	477,681	3,719
Council District 4	41,711	18%	13%	68%	1%	69,686,848	$139,373,696	794,850	$1,894,620	323,091	2,515
Council District 5	11,997	15%	8%	76%	1%	20,906,502	$41,813,004	192,551	$458,969	78,268	609
Council District 6	36,678	42%	4%	53%	0%	88,882,486	$177,764,972	1,631,427	$3,888,703	663,143	5,163
Council District 7	19,059	31%	5%	64%	1%	37,006,056	$74,012,112	618,353	$1,473,919	251,348	1,957
Council District 8	36,585	37%	3%	59%	0%	90,997,778	$181,995,556	1,436,216	$3,423,392	583,793	4,545
Council District 9	35,343	34%	4%	63%	0%	77,713,574	$155,427,148	1,258,032	$2,998,671	511,365	3,981
Council District 10	32,582	32%	2%	65%	0%	72,301,593	$144,603,186	1,097,677	$2,616,445	446,184	3,474
City of San Antonio	319,751	27%	7%	64%	1%	661,721,773	$1,323,443,546	9,259,625	$22,071,425	3,763,855	29,303

Shrubs were included in the Tree Canopy category and grasslands were included in Open Space.

Creating a Green Data Layer

Modeling the Green Infrastructure

Adding a green data layer to the region's decision-making process introduces a new dimension to planning and development discussions, one that considers how to work with the natural environment instead of building costly infrastructure to manage air and water systems. By developing and using a green data layer, future decisions will include better information about the natural benefits of trees.

The first step in creating a green layer for use in the San Antonio metropolitan area was to classify land cover data from one-meter aerial imagery. AMERICAN FOREST's GIS analysts classified the images into different landcover types—tree cover, open space/grass, urban/bare, and water areas. This analysis produced a green data layer that can be added to gray infrastructure data already used by a variety of groups for planning. For example, using the green data layer, development can be modeled in the Southside Initiative or the EARZ to show the present and future tree cover benefits. Communities can then devise strategies to manage tree cover in these areas.

The anticipated growth in San Antonio presents the opportunity to develop new areas more sustainably. Using the green data layer in all planning decisions and cost/benefit analyses will assist in maintaining the functioning capacities of natural systems and building more livable communities.

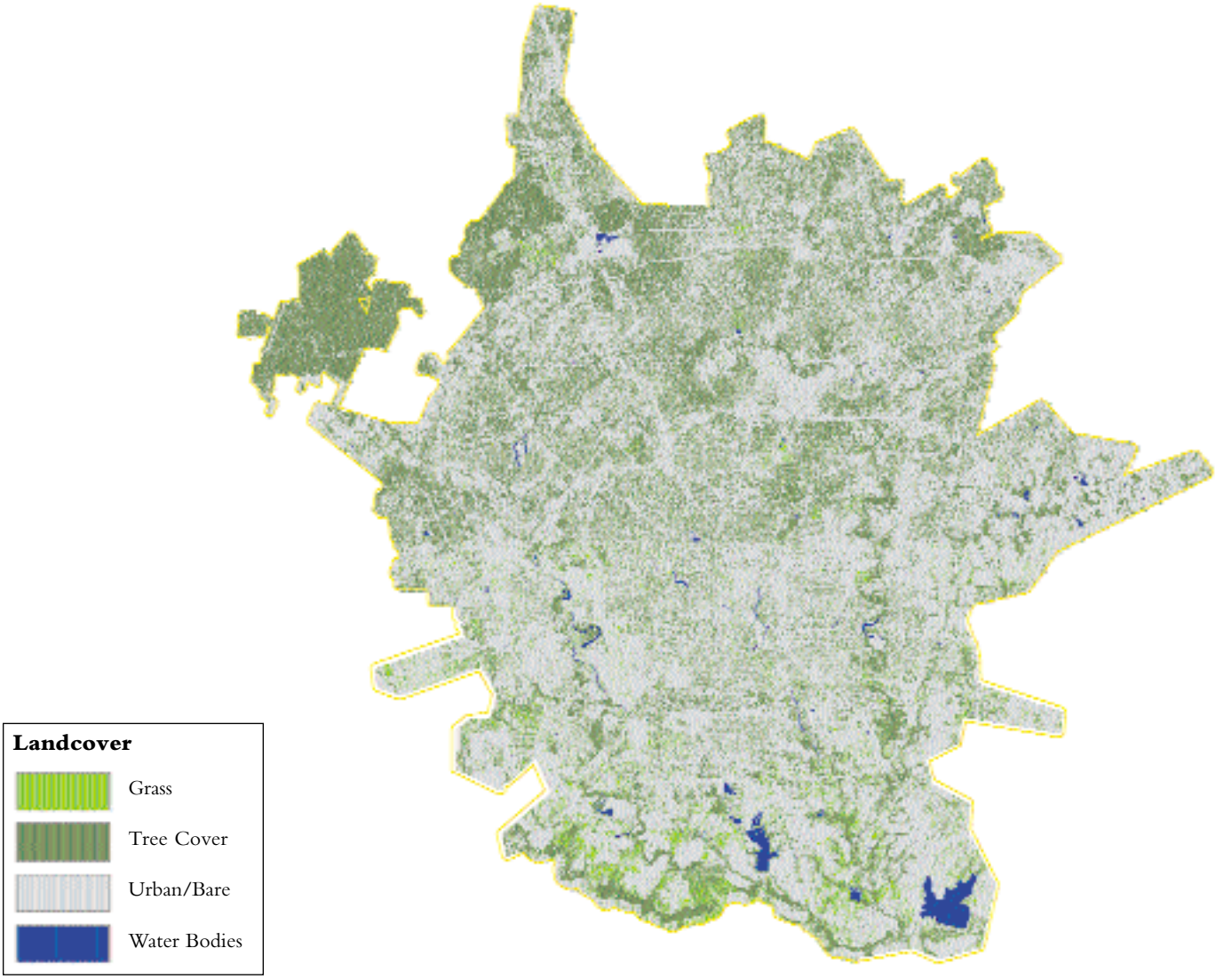
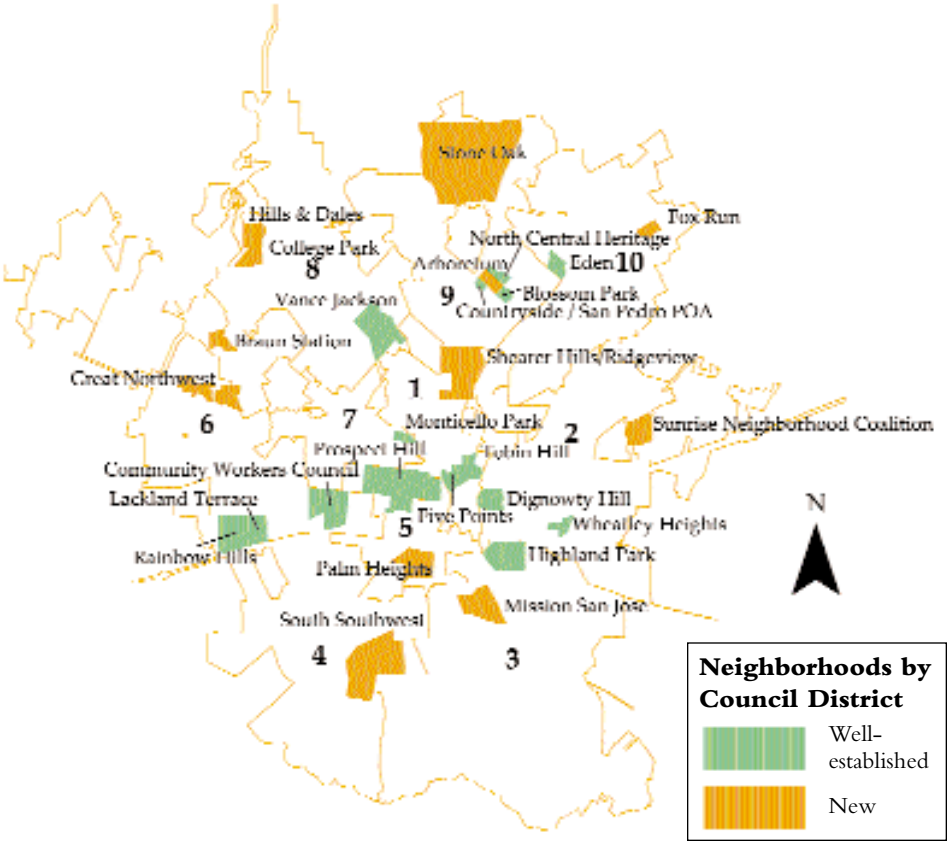


Image analysts created this green data layer from high-resolution (one-meter) color aerial imagery.

Neighborhood Analysis

While landcover data were classified for the entire metroplitan area, breaking the data into smaller analysis areas is essential to designing specific tree canopy targets for local communities. To aid in prioritizing tree-planting initiatives, two types of neighborhoods from each of San Antonio's ten council districts were selected. One type represents a well-established, heavily treed neighborhood. The second neighborhood type is a representative newer neighborhood with younger or very few trees. This targeted, neighborhood-level analysis provides one indication of where trees are needed most.



Environmental Benefits of Tree Canopy by San Antonio Neighborhood

Council District	Neighborhood	Position	Acres	Tree Canopy	Stormwater Management Value (cu.ft.)	Stormwater Management Value ($)	Air Pollution Removal Value (lbs)	Air Pollution Annual Removal Value ($)	Carbon Stored (tons)	Carbon Sequestered Annually (tons)
1	Five Points	well-established	240	13%	324,091	$648,182	3,349	$7,983	1,361	11
1	Tobin Hill	well-established	710	17%	1,109,274	$2,218,548	13,079	$31,176	5,316	41
1	Shearer Hills/Ridgeview	newer	2,058	28%	3,899,477	$7,798,954	60,072	$143,189	24,418	190
2	Dignowty Hill	well-established	569	19%	952,358	$1,904,716	11,274	$26,872	4,582	36
2	Wheatley Heights	well-established	311	35%	600,333	$1,200,666	11,461	$27,320	4,659	36
2	Sunrise Neighborhood Coalition	newer	735	18%	1,443,215	$2,886,430	13,821	$32,943	5,618	44
3	Highland Park	well-established	1,216	15%	2,057,527	$4,115,054	19,665	$46,874	7,993	62
3	East Pyron/Symphony	newer	635	20%	1,077,478	$2,154,956	13,495	$32,167	5,485	43
3	Mission San Jose	newer	1,180	20%	1,995,314	$3,990,628	25,542	$60,883	10,382	81
4	Lackland Terrace	well-established	978	14%	1,643,048	$3,286,096	14,118	$33,652	5,739	45
4	Rainbow Hills	well-established	795	10%	1,084,228	$2,168,456	8,127	$19,371	3,303	26
4	South Southwest	newer	2,877	16%	4,733,626	$9,467,252	48,019	$114,459	19,519	152
5	Prospect Hill	well-established	2,765	16%	4,730,212	$9,460,424	48,266	$115,048	19,619	153
5	Palm Heights	newer	1,051	16%	1,775,160	$3,550,320	18,024	$42,962	7,326	57
6	Community Workers Council	well-established	1,460	13%	2,475,799	$4,951,598	19,954	$47,562	8,111	63
6	Great Northwest-West	newer	575	29%	1,123,652	$2,247,304	17,440	$41,571	7,089	55
6	Great Northwest-East	newer	579	44%	1,517,864	$3,035,728	26,780	$63,834	10,886	85
7	Monticello Park	well-established	208	29%	393,913	$787,826	6,272	$14,950	2,549	20
7	Braun Station	newer	397	48%	1,004,402	$2,008,804	20,043	$47,774	8,147	63
8	Vance Jackson	well-established	1,606	38%	3,530,836	$7,061,672	65,390	$155,864	26,580	207
8	College Park	newer	492	23%	970,704	$1,941,408	11,710	$27,913	4,760	37
8	Hills & Dales	newer	479	33%	1,303,109	$2,060,218	16,766	$39,963	6,815	53
9	Blossom Park	well-established	190	27%	413,151	$826,302	5,482	$13,066	2,228	17
9	Countryside / San Pedro POA	well-established	101	53%	269,371	$538,742	5,714	$13,620	2,323	18
9	Gardens at Brookhollow	well-established	16	31%	31,666	$63,332	522	$1,245	212	2
9	Hill Country Villas	well-established	4	37%	7,099	$14,198	148	$353	60	1
9	North Central Heritage	well-established	64	40%	147,461	$294,922	2,723	$6,491	1,107	9
9	Santa Fe Trails	well-established	128	29%	261,508	$523,016	3,932	$9,373	1,598	12
9	Arboretum	newer	316	34%	693,368	$1,386,736	11,478	$27,359	4,666	36
9	Stone Oak	newer	7,680	31%	16,531,871	$33,063,742	250,965	$598,206	102,013	794
10	Eden	well-established	364	25%	608,404	$1,216,808	9,644	$22,987	3,920	31
10	Fox Run	newer	278	35%	590,788	$1,181,576	10,171	$24,244	4,134	32

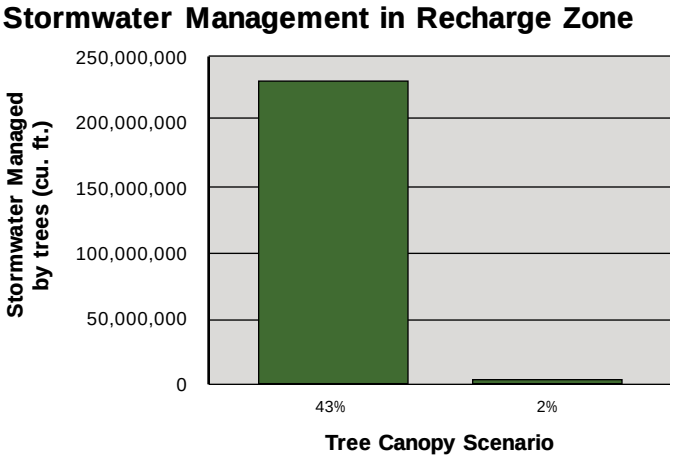
Conduct Scenario Modeling for Effective Decision-Making

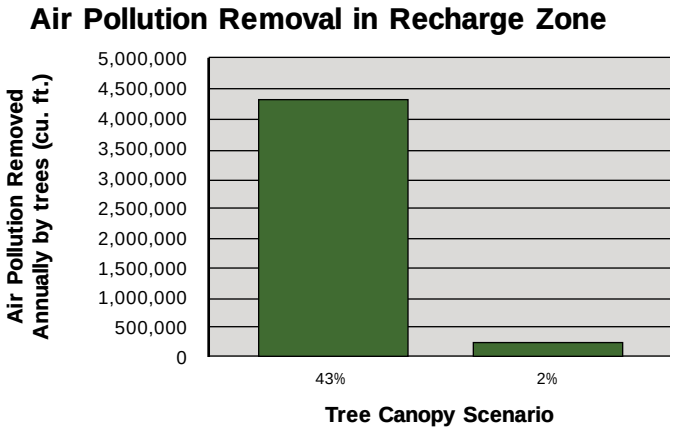
Examples:

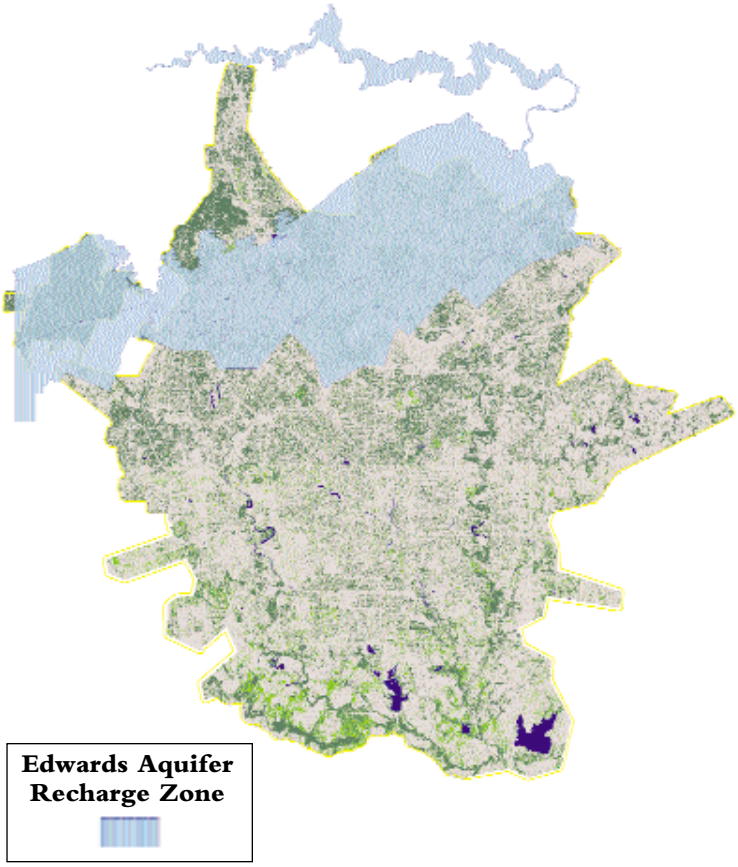
Edwards Aquifer Recharge Zone

Modeling the landcover's effect on stormwater is especially important in the Edwards Aquifer Recharge Zone (EARZ). The aquifer is San Antonio's only source of potable water, making sustainable management of the aquifer's recharge zone a necessity. Moreover, natural management of stormwater runoff in the zone helps prevent flooding. The EARZ is currently largely undeveloped, but plans are underway for major construction in this zone in the near future. With an existing 43% tree canopy, the natural system in the zone is largely intact. Any decrease in tree canopy would have costly ecological consequences, decreasing the amount of water returning to recharge the Edwards Aquifer and contributing to flooding. Managing development in a sustainable manner and selecting appropriate tree species are vital to maintaining these special ecological areas.

Using a neighborhood map provided by the City of San Antonio, a scenario was modeled examining the impact that current development practices would have on the EARZ. A newly developed two-acre residential site within the Stone Oak development served as the example: 2% tree canopy, 43% impervious surfaces, and 55% open space. If growth occurs in the entire recharge zone as it has in this Stone Oak development, the reduction in canopy would increase air pollutants by 4.2 million pounds per year, a loss in services valued at $10 million annually. The lost canopy would also require management of an additional 231 million cubic feet of stormwater during an average 2-year, 24-hour storm event, a loss in services worth $462.5 million.







The Edwards Aquifer Recharge Zone is shown in blue, overlaid on a map of the San Antonio ETJ. With 43% current tree canopy cover, the zone contains some of the densest canopy areas of the city, where the trees play a vital role in stormwater management.

Environmental Benefits of Tree Cover in Edwards Aquifer Recharge Zone

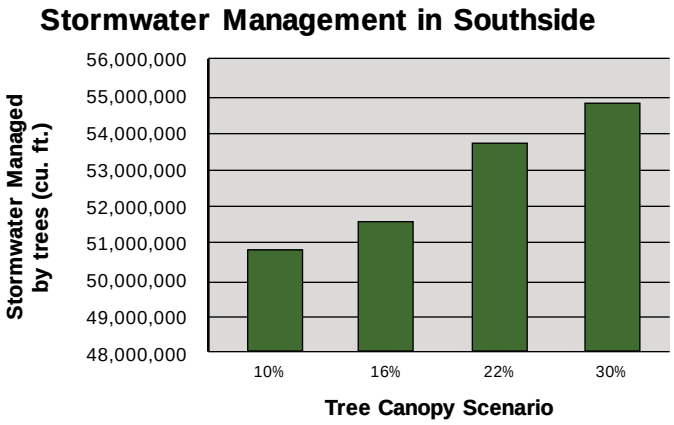
	Tree Canopy	Open Space	Impervious/ Bare Urban	Stormwater Management Value (cu.ft.)	Stormwater Management Value ($)	Air Pollution Removal Value (lbs)	Air Pollution Annual Removal Value ($)
Aquifer Recharge Zone - current	43%	3%	53%	231,231,329	$462,462,658	4,392,995	$10,471,230
Aquifer Recharge Zone - modeled	2%	55%	43%	0	$0	202,193	$481,951

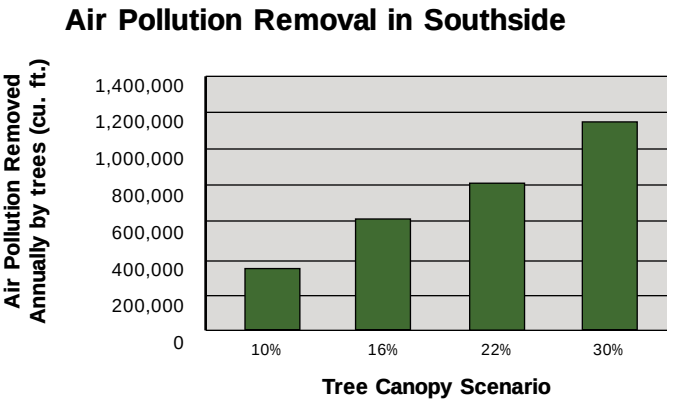
Shrubs were included in the Tree Canopy category and grasslands were included in Open Space.

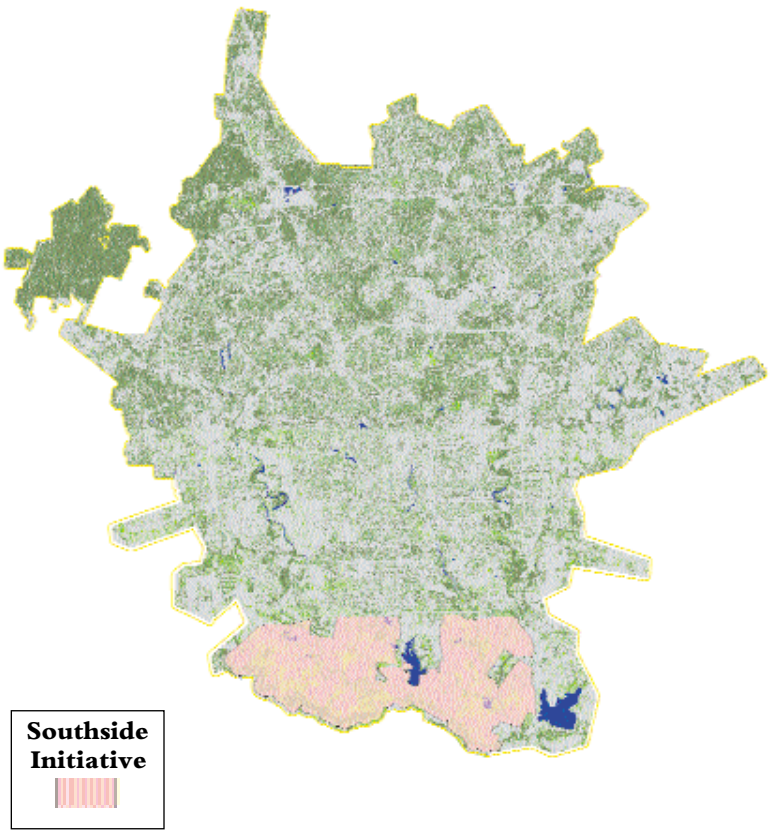
Southside Initiative

The recently annexed Southside area offers a nearly blank slate for development. With informed planning, the area can be a model example of balanced growth. If current development patterns continue instead, the results will be costly, and a unique opportunity will be lost. The current 22% canopy cover manages 53.7 million cubic feet of stormwater during an average 2-year, 24-hour storm, a service valued at $107 million. This tree canopy also removes 833,281 pounds of air pollutants each year, a service valued at $2 million. Using the current landcover data produced by this study, various scenarios were modeled showing the possible effects of the proposed land use plan on the tree canopy.

Three scenarios were modeled: an increase in canopy developed as planned with an increase in impervious surfaces, and a complete build-out scenario, based on the landcover of downtown. The first scenario showed the effects of planting trees on areas planned as vacant or parkland. This would result in a 30% canopy for the area. The second scenario modeled the effects of increasing impervious surfaces on parcels designated as commercial, industrial, or vacant. This would result in a canopy of 16% for Southside. Finally, the build-out scenario was created by matching the landcover percentages of downtown, which has 10% tree canopy. The chart below shows the exact numbers associated with these scenarios.







Modeled Environmental Benefits of Tree Canopy by Southside Initiative

	Tree Canopy	Open Space	Impervious/ Bare Urban	Stormwater Management Value (cu.ft.)	Stormwater Management Value ($)	Air Pollution Removal Value (lbs)	Air Pollution Annual Removal Value ($)	Carbon Stored (tons)	Carbon Sequestered Annually (tons)
Southside - current	22%	19%	59%	53,681,008	$107,362,016	833,281	$1,986,225	338,712	2,637
Southside with increased canopy	30%	40%	30%	54,948,589	$109,897,178	1,160,350	$2,765,833	471,659	3,672
Southside developed as planned	16%	20%	63%	51,765,682	$103,531,364	618,853	$1,475,111	251,552	1,958
Southside developed as Downtown	10%	19%	70%	50,922,053	$101,844,106	386,783	$921,944	157,220	1,224

Shrubs were included in the Tree Canopy category and grasslands were included in Open Space.

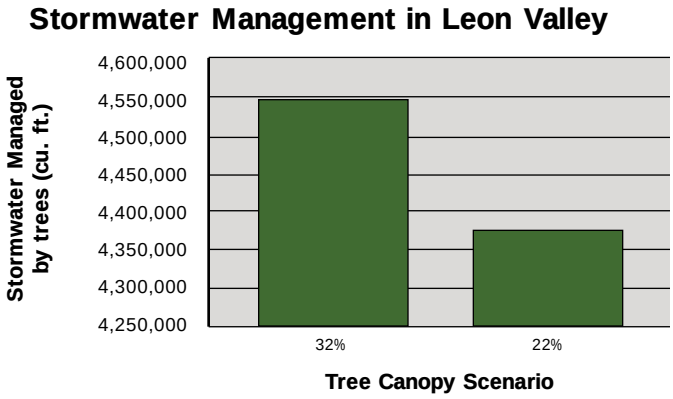
Leon Valley and Balcones Heights

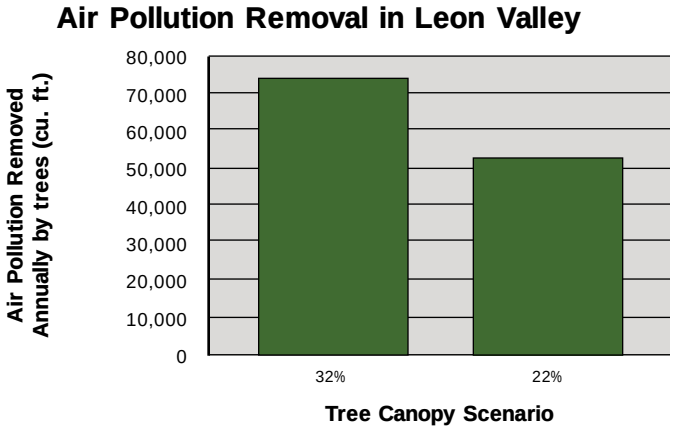
Two smaller municipalities, Leon Valley and Balcones Heights are both located in the San Antonio ETJ study area, surrounded by the City of San Antonio and feeling squeezed by its sprawling growth. In addition, both areas are faced with an aging tree population and lack of trees in their commercial areas. While the issues facing these two communities are related to the entire San Antonio metropolitan area, focusing on each individually will help local government, planners, and citizens better understand how their local decisions can impact their community as well as the surrounding areas of San Antonio.

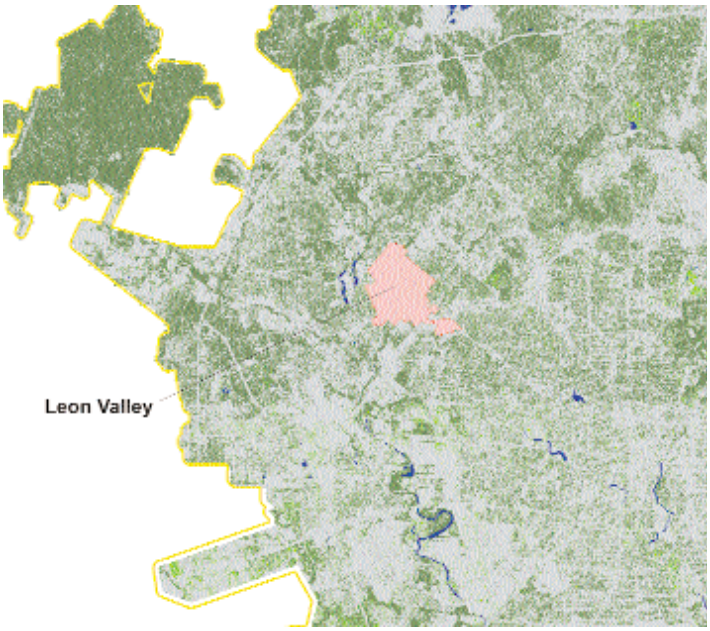
Leon Valley

Leon Valley is a 2,200 acre municipality, located at the crossroads of Interstate Highway 410 and State Highway 16. The area currently has 32% tree canopy cover, which removes 73,000 pounds of air pollutants each year. As automobile-dependent growth occurs in the region, the need for air pollutant reduction increases. The removal services provided by the trees have a value of $175,000 each year. The trees also manage 4.4 million cubic feet of stormwater, a service worth a total of $8.7 million.

As the city plans for renewing its aging tree population, maintaining tree cover will be a challenge for Leon Valley. If the area loses 10% of its tree cover, the community would have to manage an additional 200,000 cubic feet of stormwater during an average 2-year, 24-hour storm. Furthermore, the city would face an additional 22,000 pounds of air pollutants each year.







Environmental Benefits of Tree Canopy in Leon Valley

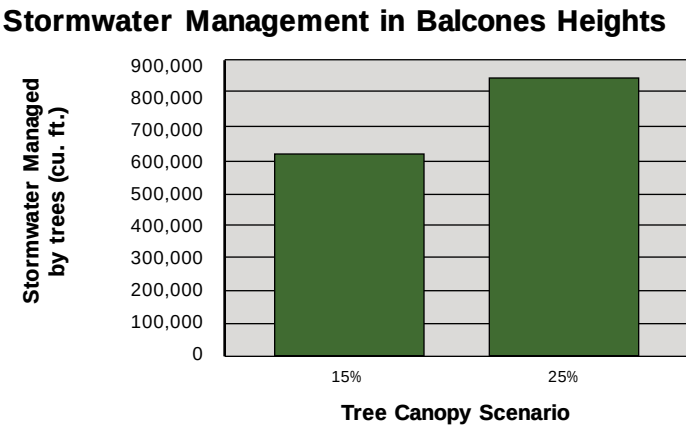
	Tree Canopy	Open Space	Impervious/ Bare Urban	Stormwater Management Value (cu.ft.)	Stormwater Management Value ($)	Air Pollution Removal Value (lbs)	Air Pollution Annual Removal Value ($)	Carbon Stored (tons)	Carbon Sequestered Annually (tons)
Leon Valley - current	32%	5%	63%	4,373,281	$8,746,562	73,484	$175,159	29,870	233
Leon Valley with 10% canopy loss	22%	10%	68%	4,551,830	$9,103,660	51,241	$122,139	20,828	162

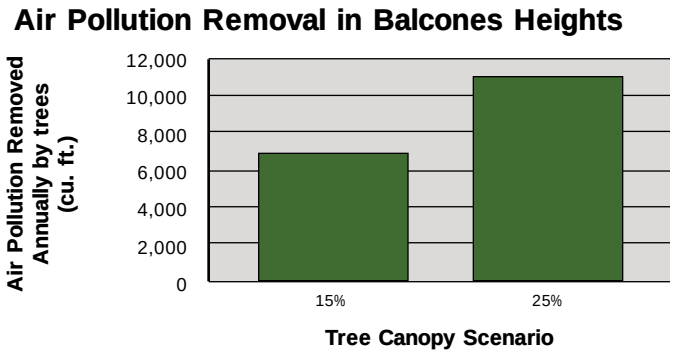
Shrubs were included in the Tree Canopy category and grasslands were included in Open Space.

Balcones Heights

Balcones Heights occupies 422 acres with 15% tree canopy. This area also faces great pressures from San Antonio's development and growing traffic congestion problem. The challenge for Balcones Heights is clearly not to lose any more tree cover and to restore age balance to an overly mature tree population. An especially low tree density in commercial zones presents an opportunity for Balcones Heights to improve both the appearance and ecological function of its commercial areas by planting trees. Using the green data layer to develop tree canopy targets for specific areas can help the community diversify its urban forest and maintain a healthy ecosystem. The city's canopy cover, while significantly below that of the entire metropolitan area, still provides valuable services, managing 616,000 cubic feet of stormwater during an average 2-year, 24-hour storm, a service valued at $1.2 million. In addition, the trees remove 6,700 pounds of air pollution each year, a service valued at $16,000 annually.

A recommended 10% increase in tree canopy would yield an additional 230,000 cubic feet in stormwater managed during an average 2-year, 24-hour storm event. The increased tree canopy would also remove an additional 4,500 pounds of air pollution per year. These services would be worth an increased $50,000 per year to the community. Not only would the immediate area benefit, the increased tree canopy would help to balance the quickly growing areas that surround this community.





Environmental Benefits of Tree Canopy in Balcones Heights

	Tree Canopy	Open Space	Impervious/ Bare Urban	Stormwater Management Value (cu.ft.)	Stormwater Management Value ($)	Air Pollution Removal Value (lbs)	Air Pollution Annual Removal Value ($)	Carbon Stored (tons)	Carbon Sequestered Annually (tons)
Balcones Heights - current	15%	4%	81%	616,063	$1,232,126	6,665	$15,887	2,709	21
Balcones Heights with 10% canopy increase	25%	10%	65%	843,061	$1,686,122	11,169	$26,623	4,540	35

Shrubs were included in the Tree Canopy category and grasslands were included in Open Space.

Recommendations

This study provides a detailed assessment of the tree cover and quantifies ecological benefits for the San Antonio ETJ. As the 2002 study using Landsat data showed, tree cover declined as impervious surfaces increased, indicative of rapid development. If this trend continues, the balance between the natural and built environment will increasingly be in jeopardy. Trees can play an integral role in restoring and maintaining this balance.

The data from this analysis are available at no cost to communities in the region who use it in conjunction with CITYgreen software for local planning and development. AMERICAN FORESTS recommends that communities establish tree canopy goals tailored to their administrative areas and then use CITYgreen to plan and manage their progress. New tree canopy percentages can be accurately determined periodically by updating the images. Armed with this green data layer and CITYgreen software, communities can better assess their urban forest as a community asset and incorporate this green infrastructure into land use planning.

1. Integrate the green data layer into municipal GIS systems.

■ Distribute to local agencies for use in management and development decisions.

2. Use the findings of this study to address public policy issues for land-use planning and growth management.

■ Add tree cover into stormwater management planning to maintain and increase tree canopy in the EARZ. High-density tree canopy is critical to capturing water from smaller rainstorms and improving water levels of the Edwards Aquifer, while managing flooding problems.

■ Integrate trees into Smart Growth planning strategies, including mixed use and areas along mass transit corridors to promote walkable routes.

3. Utilize trees as a voluntary measure for meeting the terms of the Early Action Compact with the U.S. Environmental Protection Agency (EPA).

■ The green data layer and CITYgreen provide a quantity and dollar value for the air pollutant removal value of trees.

■ Trees generally increase in value and services over time, making them a sound long-term investment.

4. Consider the dollar values associated with trees when making land-use decisions.

■ Use the green data layer and CITYgreen to measure the effectiveness of the City of San Antonio's revised Tree Preservation Ordinance and other land use ordinances.

■ Adopt this practice in strengthening tree ordinances for the metropolitan area.

■ Use CITYgreen analyses to compare development scenarios in creating a balance between development densities and providing adequate space to grow healthy trees.

5. Use CITYgreen to conduct additional local analyses.

■ Utilize CITYgreen software as a decision support tool to increase community participation.

■ Empower teachers and students to think of trees as a valuable and essential element of the urban environment. Set up workshops that train teachers to use CITYgreen software in the classroom.

■ Conduct individual project-level CITYgreen analyses to determine the energy savings from trees for residential areas.

■ Update the tree cover analysis every five years using new landcover data to track future trends in forest canopy and associated benefits.

6. Set Tree Canopy Goals

■ Local communities should set specific tree cover targets for various land use areas. Goals should be established with an understanding of current and future ecological and land use objectives. This stratification of goals is an important part of building a green infrastructure. By using available GIS zoning data for the region, targets can be set for residential, commercial, and industrial areas. Though development will continue in San Antonio, a balance can be achieved between the natural and the built landscape.

■ Update tree goals as better data become available and as new challenges arise. Using high-resolution data in this study produced more specific information about the current tree cover in San Antonio than was known from the Phase 1 UEA conducted in 2002. Using this data and considering the goals of the Early Action Compact with EPA, AMERICAN FORESTS recommends the following updated tree canopy goals for the City of San Antonio:

35% tree canopy overall
45% tree canopy in suburban residential
45% in special ecological zones such as the EARZ
35% tree canopy in urban residential
15% tree canopy in central business districts

About the Urban Ecosystem Analysis

AMERICAN FORESTS Urban Ecosystem Analysis is based on the assessment of "ecological structures"—unique combinations of land use and land cover patterns. Each combination performs ecological functions differently and is therefore assigned a different value. For example, a site with heavy tree canopy provides more stormwater reduction benefits than one with lighter tree canopy and more impervious surface.

Data Used

To create the green data layer, high-resolution (1 meter pixel) true-color aerial imagery was obtained from an archived data provider. AMERICAN FORESTS used a knowledge-based classification technique to categorize different land covers such as trees, impervious surfaces, open space, and water.

Analysis Formulas

A CITYgreen analysis was conducted for the San Antonio Metroplitan Area including: the City of San Antonio, Downtown, the Edwards Aquifer Recharge Zone, the Southside Initiative, and 32 neighborhoods within the city and Leon Valley and Balcones Heights. CITYgreen version 5.2 used the raster data land cover classification from the high-resolution imagery for the analysis. The following formulas are incorporated into CITYgreen software.

TR-55 for Stormwater Runoff: The stormwater runoff calculations incorporate formulas from the Urban Hydrology of Small Watersheds model, (TR-55) developed by the US Natural Resources Conservation Service (NRCS), formerly known as the US Soil Conservation Service. Don Woodward, P.E., a hydrologic engineer with NRCS, customized the formulas to determine the benefits of trees and other urban vegetation with respect to stormwater management.

UFORE Model for Air Pollution: CITYgreen® uses formulas from a model developed by David Nowak, PhD, of the USDA Forest Service. The model estimates how many pounds of ozone, sulfur dioxide, nitrogen dioxide, and carbon monoxide are deposited in tree canopies as well as the amount of carbon sequestered. The urban forest effects (UFORE) model is based on data collected in 50 US cities. Dollar values for air pollutants are based on averaging the externality costs set by the State Public Service Commission in each state. Externality costs, are the indirect costs to society, such as rising health care expenditures as a result of air pollutants' detrimental effects on human health.

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City of San Antonio
City of Balcones Heights
City of Leon Valley
City Public Service

For More Information

AMERICAN FORESTS , founded in 1875, is the oldest national nonprofit citizen conservation organization. Its three centers–Global ReLeaf, Urban Forestry, and Forest Policy–mobilize people to improve the environment by planting and caring for trees.

AMERICAN FORESTS ' CITYgreen® software provides individuals, organizations, and agencies with a powerful tool to evaluate development and restoration strategies and impacts on urban ecosystems. AMERICAN FORESTS offers regional training workshops and technical support for CITYgreen® and is a certified ESRI developer and reseller of ArcView products. For further information contact:

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