LANDSCAPE PERFORMANCE SERIES
presented by the Landscape Architecture Foundation

Waterloo Park
Methods

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This investigation was conducted as part of the Landscape Architecture Foundation's 2024 *Case Study Investigation* (CSI) program. CSI matches faculty-student research teams with design practitioners to document the benefits of exemplary high-performing landscape projects. Teams develop methods to quantify environmental, social, and economic benefits and produce Case Study Briefs for LAF's *Landscape Performance Series*.

The full case study can be found at: https://landscapeperformance.org/case-study-briefs/waterloo-park

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Research Strategy

Waterloo Park is a park and entertainment venue located over Waller Creek, near the Texas State Capitol. The design team struggled to collect enhanced data from before construction because they received a site that was already under construction from the tunnel infrastructure. As a result, much of our data comes from before 2011, supplemented by tools and personal accounts to assist in making the best estimations.

To conduct the assessment, we employed a variety of methods and tools, including i-Tree, iNaturalist, AutoCAD, Google Street View, Space Syntax's Depth Map, archival research, and on-site data records. Several of the benefits highlighted in this document stem from the ongoing monitoring and maintenance of the landscape by the Waterloo Greenway Conservancy staff.

All parties involved, from the Conservancy to the project designers, have assisted the research team in producing this thorough document. Collaboration was a crucial component of this effort, and without it, the document would not have come to fruition. Researchers acknowledge that certain results may lack rigor due to data unavailability or errors in collection.

Environmental Benefits

1. ***Reclaimed 10,414 sf of usable park area that was lost as a result of constructing the flood control inlet tunnel.***

Background:
Due to historical flooding along Waller Creek, a tunnel was built under twelve city blocks to divert water to a downstream lake. The tunnel's intake facility is located at Waterloo Park, which first broke ground in 2011. The tunnel construction process utilized and transformed much of the park area. After the tunnel was completed in 2017, the park's (re-)designers worked to conceal much of the new gray infrastructure. As a solution, they created a deck that extended parking space over the creek’s edge and inlet pond. The overhanging deck contributes a seating area for viewing the amphitheater.

Figure a. Waller Creek Tunnel construction: Allan Shearer

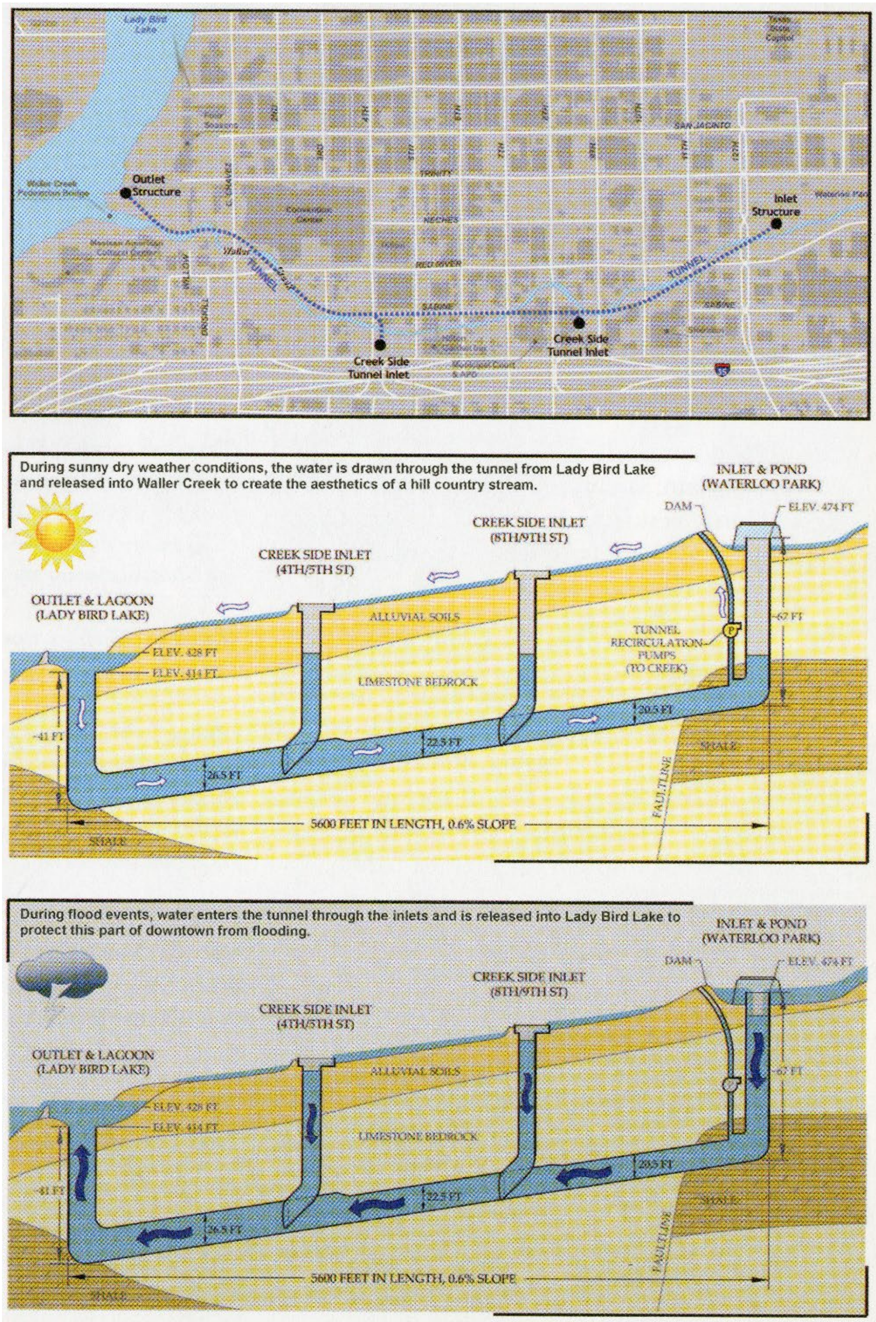

Figure b. Waller Creek Tunnel: Kellogg Brown & Root Services, Inc. and Espy Consultants, Inc.

Method: (Land Efficiency & Preservation)

Images of the park from 2011, which mark the completion of tunnel construction but predate park construction, and an image from 2024 were used to compare usable park area. The 2011 image was used as the base for comparison. The outline from the street edge to the creek's edge was traced in AutoCAD. This outline was then overlaid on the 2024 image, and the creek's edge was re-traced to determine the difference in square footage gained by the new overhang at the park’s amphitheater. The images used and the traced lines are shown in Figure 1.

Calculations:

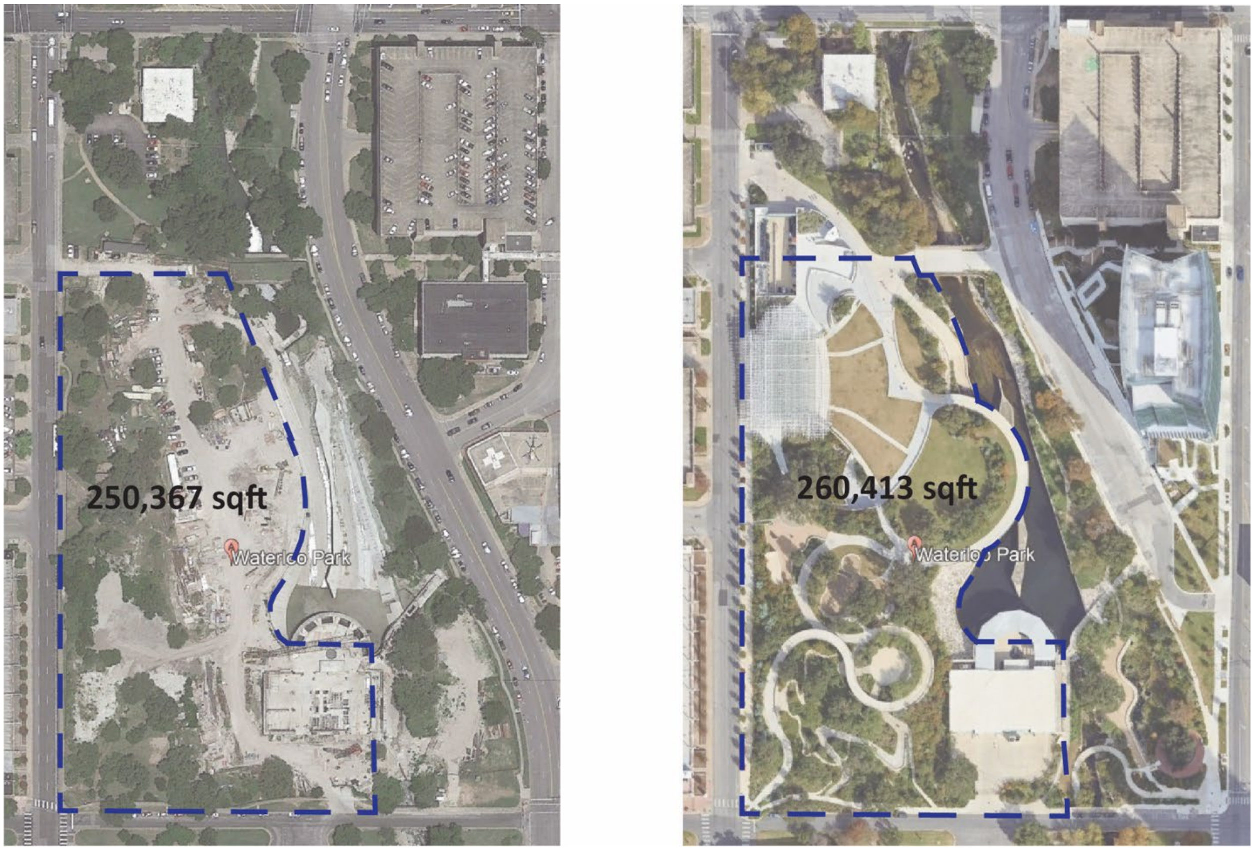

Figure 1: Aerial Images of 2011 and 2024 with the creek's edge traced.

Square footage of land after tunnel construction: 250,367

Square footage of land currently: 260,781

260,781 - 250,367= 10,414 additional square footage from new design

Sources:

Google Earth & AutoCAD software was used to attain results.

Limitations:

- The measurements are an estimation, and many calculations have errors related to imagery projection. Land survey comparisons would allow for a more accurate comparison.

2. ***Stores 80,520 gallons of stormwater with 3 rain gardens and an underground cistern. An additional estimated 4,894 gallons of runoff is intercepted annually through 61 mature trees preserved on-site.***

Background:

The flood control tunnel inlet is designed to capture high volumes of water from Waller Creek during storm events caused by runoff. The designers chose to mitigate additional stormwater in the park rather than further inundate the local creek by using an underground water cistern catchment and three rain gardens, each are shown in Figure 2.

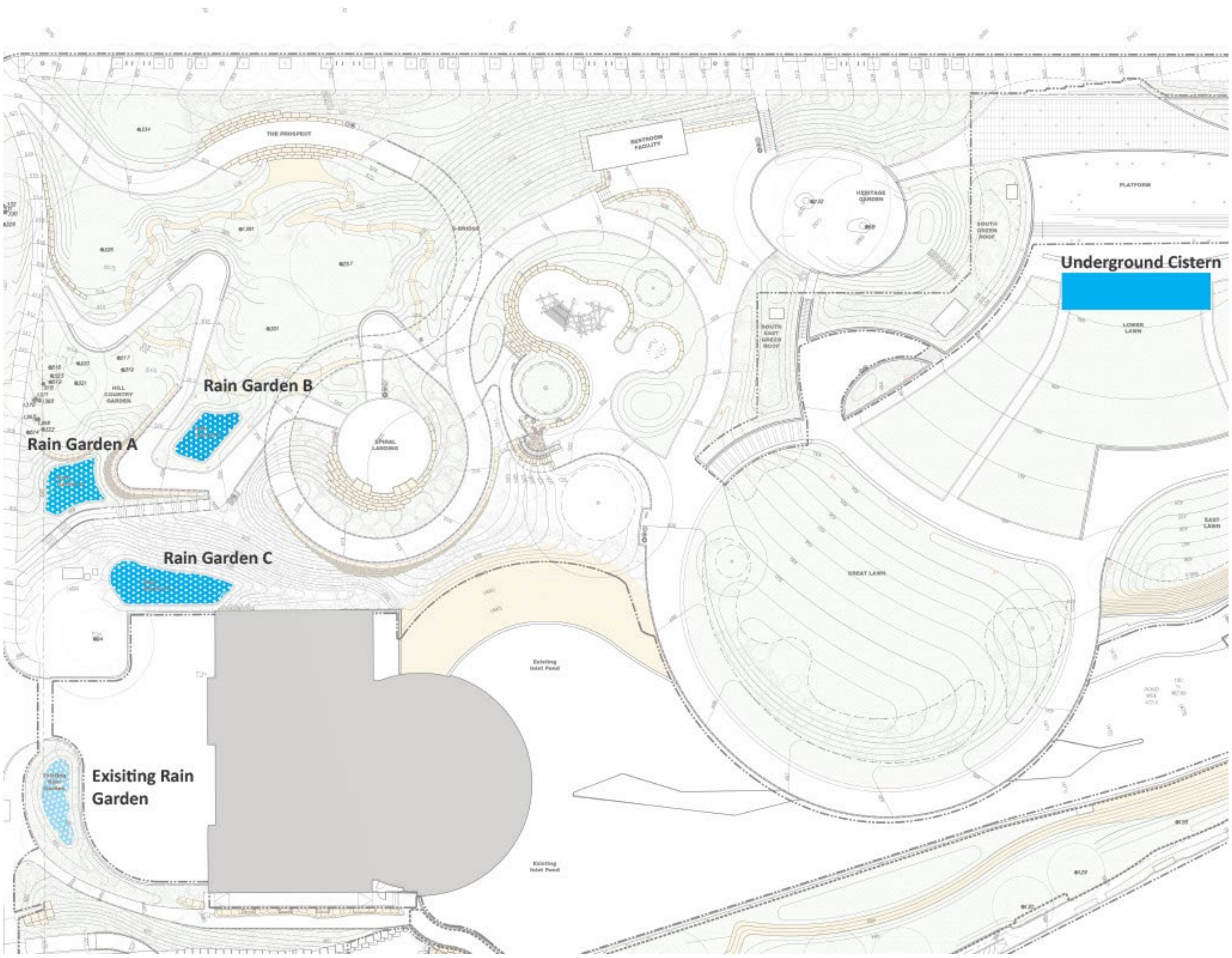

Figure 2: Stormwater holding features on site, highlighted in blue.

Method: (Stormwater Management)

Storage volumes were calculated by adding the holding capacities of each rain garden, as provided by the landscape architects, and converting cubic feet to gallons.

To find the cistern’s holding capacity, the volume of each of the seven containers was determined. The height of each container was reduced by 2 feet to account for the freeboard installed to prevent spillage. The adjusted volume was then converted to gallons.

For stormwater management by the retained trees, see findings in Appendix 2.

Calculations:

Stormwater Holding Method	*Holding Capacity*
Rain Garden A	*7,972.5 gal*
Rain Garden B	*10,200 gal*
Rain Garden C	*10,372.5 gal*
Cisterns	*51,975 gal*
Total	*80,520 gal*

Rain garden calculations:

Rain Garden A:

1,063 (Total water quantity volume) * 7.5 (convert cf to gal) = 7,972.5 gal

Rain Garden B:

1,360 (Total water quantity volume) * 7.5 (convert cf to gal) = 10,200 gal

Rain Garden C:

1,383 (Total water quantity volume) * 7.5 (convert cf to gal) = 10,372.5 gal

Cistern calculations:

6 X (7'W X 15'L X 9'H*) = 5,670 cubic feet X 7.5 (convert cf to gal) = 42,525 Gal

1 X (7'W X 15'L X 12'H*) = 1,260 cubic feet X 7.5 (convert cf to gal)= 9,450 Gal

*Due to overflow in the cistern, and the freeboard being approximately 2 ft. The height of the cistern was reduced by two feet.

Sources:

- "Going Green at Waterloo Park." Waterloo Greenway Conservancy, December 16, 2020. https://waterloogreenway.org/going-green-at-waterloo-park/.
- "The Waller Creek District and Tunnel." ULI Developing Urban Resilience, June 7, 2023. https://developingresilience.uli.org/case/the-waller-creek-district-and-tunnel/.
- Luo, Yi, Rui Hu, and Haoting Hong. "St. Pete Pier." Landscape Performance Series. Landscape Architecture Foundation, 2023. https://doi.org/10.31353/1930
- Michael Van Valkenburgh Associates. "City of Austin Rain Garden Plant Calculations." City of Austin, Texas.

Limitations:

- Not all calculations have been included. An existing rain garden constructed prior to the redesign and redevelopment of the park remains. It was not possible to obtain the calculations for it.
- The constructed mitigation wetland on site does receive some stormwater, but its main purpose is to mimic the natural habitat of a wetland.
- There is a green roof on site that can capture some stormwater, but due to the soil depth and design, it does not hold enough for rain garden consideration.
- All results were obtained using calculations, with no measurements taken in the field.
- Water captured through soil infiltration is not included in this calculation.

3. ***Saves an estimated 4.9 million gallons of water annually and eliminates the use of potable water by using reclaimed greywater for irrigation and flush fixtures.***

Background:
The City of Austin has implemented use of reclaimed wastewater infrastructure to provide treated wastewater from homes and businesses. Reclaimed water costs half as much as potable water. The City of Austin is currently expanding this infrastructure throughout the city. The park is located within the range of the new infrastructure and has benefitted with cost savings.

Method: (Water Usage)
Gallons of irrigation and flushable water usage were collected from Waterloo Greenway Conservancy. Irrigation and flushable water usage were calculated separately for each month, resulting in the total combined non-potable water usage. The water usage in gallons is listed below.

Calculations:

Date	**Irrigation (gal)**	**Flushable (gal)**
12/16/22 - 1/18/23	73,600	6,100
1/18/23 - 2/16/23	91,600	6,400
2/16/23 - 3/20/23	255,200	10,200
3/20/23 - 4/19/23	122,500	44,800
4/19/23 - 5/18/23	82,200	62,700
5/18/23 - 6/17/23	331,800	84,700
6/17/23 - 7/19/23	854,500	39,900
7/19/23 - 8/18/23	1,001,500	42,900
8/18/23 - 9/19/23	1,131,400	17,200
9/19/23 - 10/18/23	320,500	55,200
10/18/23 - 11/17/23	120,400	44,200
11/17/23 - 12/18/23	102,000	6,100
Total	4,487,200	420,400
Combined Total	**4,907,600**	

Sources:

- Reclaimed water usage for the year of 2023 provided by Waterloo Greenway Conservancy.
- Gonzalez, Homer. "Tales on the Trail Recap." Waterloo Greenway Conservancy, August 5, 2022. https://waterloogreenway.org/tales-on-the-trail-recap/.
- Gonzalez, Homer. "Going Green at Waterloo Park." Waterloo Greenway Conservancy, December 16, 2020. https://waterloogreenway.org/going-green-at-waterloo-park/.
- "Reclaimed Water System." AustinTexas.gov. Accessed July 23, 2024. https://www.austintexas.gov/department/reclaimed-water-system.

Limitations:

- The numbers were calculated by Waterloo Greenway Conservancy. The research team did not independently verify water usage on site.
- Water usage varies from year to year depending on climate conditions and the number of events held.

4. ***Increased the number of perennial plants per square meter by 600% at installation and by an additional 24% over 2 years with the growth of the "self-healing mat" and the addition of 107 new perennial species.***

Background:
For the perennial planting, the designers chose not to place each individual perennial plant but rather provide an overplanted patch to identify the area, then specify the distance each plant was placed based on the pot size. The four-inch pots were placed twelve inches apart, and the one-gallon pots were placed eighteen inches apart. This method of overplanting allowed species to adjust to microclimates and other needs. The design team calls this method the "self-healing mat." The UT team observed how plant diversity is affected through this method of planting and how effective it is for plant ecologies to naturally adapt.

Method: (Populations & Species Richness)
Before the park's redesign, there was only turf and no perennial plantings. The design called for 107 species of perennials to be planted, totaling 32,558 individual plants (perennials). To explore the success of the "self-healing mat" approach—a design decision that involves overplanting numerous species to allow plants to naturally select which ones thrive best—the UT team used test plots to assess how the plantings have changed over two years.

The number of species in three 1 meter by 1 meter test plots were counted to determine how the planting regime contributed to increased plant biodiversity.

The number of plants at the time of installation could not be determined precisely with this method. However, using the expected planting distances—twelve inches for four-inch pots and eighteen inches for one-gallon pots—it is estimated that approximately 7 plants were planted per square meter. This calculation can be found below under "At Installation Calculations."

The current calculation was obtained by counting each individual plant in the test plots. This process was repeated with three plots to achieve more accurate results using an average. Species were identified using the iNaturalist Plant Seeker app, and each result was then verified with the resident horticulturalist. The results for each test location can be found in Appendix 3.

Calculations:

	Location 1	Location 2	Location 3
Before design plants per sq meter	1	1	1
At installation plants per sq meter	7	7	7
Currently plants per sq meter	9	10	8

At installation calculations:

Planting Distance: 12" for 4" pots and 18" for 1 gal pots

Average of distance: (12 + 18) /2 = 15

15*15=225 The distance between plants

1M = 39.37 in

39.37*39.37=1,549.9969

1,550/225=**6.8889** plants per 1M X 1M at planting installation

Average of installation planting change (number of individuals):

(7-1) /1= 6 *100 =**600%** increase in plant biodiversity

Average of current planting change (number of individuals):

(9-7)/7= .2857 *100 = 28.6%

(10-7)/10 = .3 *100 = 30%

(8-7)/8 = .125 *100 = 12.5%

Average: .2857+.3+.125= .7107/3 = .2369* **23.7%**

Sources:

- iNaturalist. "Observed Species." Accessed June 4th, 2024.

Limitations:

- The planting palette of the original green space cannot be confirmed, but educated assumptions can be made since the entire park was covered in grass. It can also be assumed there were some weeds within the test locations.
- Plants are seasonal, so some may have been present, but not visible (that is, only below ground) at the time of observation.

- Due to the method used for planting, we can only estimate the maximum number of plants based on the given calculation. Therefore, the actual number of plants per square meter may vary.
- Some plants included in this calculation may be volunteer plants and not part of the original planting plan.

5. ***Sequesters an estimated 111.1 tons of atmospheric carbon in 514 trees, 90.11 tons of which can be attributed to preserving 61 existing trees on site.***

Background:
Waterloo Park was established by the City of Austin 1975. As a long-standing park, it had numerous large-diameter trees. Although the new design required extensive grading, there were strong priorities to either protect or relocate the existing trees. Through strategic placement of transplanted and donated trees, Waterloo Park quickly provided a canopy across all areas of the park. With the guidance of an on-site arborist, damage during construction was prevented. In addition to preserving the existing trees, the design team planted an additional 449 new trees.

Method: (Carbon Sequestration & Avoidance)
To determine the carbon sequestration of trees on site, iTree Eco was used to input data from both the newly planted trees and the existing trees surveyed by the design team for the tree mitigation calculation.

Two calculations were performed: one to find the total carbon sequestration by all trees on site, and another to assess the impact of the sequestered trees that were retained on site.

The calculations also provide a stormwater absorption analysis using the same parameters. These results are shown in the above stormwater benefit and result in Appendix 2.

Calculations:
To calculate carbon sequestration, data for preserved, transplanted, and newly added trees were entered into iTree Eco. Inputs included tree species and diameter at breast height (DBH), with climate settings based on data from our closest weather station. Crown health was not used in iTree Eco's mitigation computation for plant dieback because the team did not independently verify the survival of each tree during the transition. However, for the second calculation, which focused only on the retained trees, crown health was inputted using the latest survey data collected from tree mitigation efforts during construction.

See Appendix 1 for the iTree Benefits and Costs Summary for all trees, and Appendix 2 for the carbon sequestration details of the retained trees.

Sources:

- "i-Tree Eco v6." Accessed July 14, 2024. https://www.itreetools.org/tools/i-tree-eco.

- On site tree inventory conducted on June 4.
- Michael Van Valkenburgh Associates. "Tree Mitigation Survey." City of Austin, Texas.
- "History." Waterloo Greenway Conservancy, March 6, 2024. https://waterloogreenway.org/overview/history/.

Limitations:

- The plant list was not verified by the research team, so any plant dieback that occurred during the transition was determined using iTree's standard dieback calculations.
- The carbon sequestration calculations were based on the planting diameter at breast height (DBH) rather than the current size of each individual tree.

Social Benefits

1. ***Attracted 270,000 total visitors in 2023, 17% of which (48,000) were non-event visitors.***

Background:
Waterloo Park is home to Moody Amphitheater, and much of the foot traffic on site is connected to concert attendees. For this reason, non-event attendees are also important data for the park, as they help to understand the amount of natural foot traffic that occurs on site.

Method: (Recreation & Social Value)
Information about the number of event attendees was requested from the Director of Programming and Events at Waterloo Greenway Conservancy. Attendee counts vary depending on the type of event: for ticketed events, the count is automatically recorded through ticket sales; for large free events, the security team collects the count; and for smaller events, on-site park staff take the head count. Non-event visitor counts are collected and logged each hour by park employees

Calculations:

Visitor numbers were provided by the Water Greenway Conservancy through the methods listed above.

Concerts (30)	102,000 attendees
Programming (140)	115,000 attendees
Daily Visitors	48,000
Misc/maintenance/events operations	5,000

Sources:

- Donald Miller, Director of Programming and Events provided programming numbers

- “In the Community.” Waterloo Greenway. Accessed June 6, 2024. https://waterloogreenway.org/wp-content/uploads/2023/05/WG_In_The_Community_2022_PRINT.pdf.

Limitations:

- The numbers were provided by the Waterloo Greenway Conservancy, and the research team did not independently verify this data.
- Headcounts can be variable and challenging in public parks, so there is an expected margin of human error in the numbers.
- Visitors attending the park around scheduled events may be misclassified.

2. ***Hosted 119 free community programs including 75 workout classes and 10 community festivals with 115,000 program attendees in 2023.***

Background:
The redesign of Waterloo Park aimed to reconnect communities and families with Downtown Austin. This goal is being pursued by hosting a variety of free events, including workout classes, annual art exhibition (The Creek Show), and cultural events such as Dia de los Muertos.

Method: (Recreation and Social Value)
Waterloo Greenway Conservancy collects attendance information by head count for programs with fewer than 50 attendees. For larger programs and festivals, security checkpoints at the entrance record ticket counts and/or head counts of walk-up attendees. This data is then compared to the online event schedule listed on the Waterloo Greenway website.

Calculations:

Educational Programs	**21**
Workout Classes	**75**
Community Festivals	**10**
Other Events (i.e. Creek Show & Picnic Pop-Up)	**34**
Total Free Community Programs	**140**
Total program attendees	**115,000**

Sources:

- Donald Miller, Director of Programming and Events provided programming numbers.
- “In the Community.” Waterloo Greenway. Accessed June 6, 2024. https://waterloogreenway.org/wp-content/uploads/2023/05/WG_In_The_Community_2022_PRINT.pdf.

Limitations:

- The numbers were provided by the Waterloo Greenway Conservancy, and the research team did not independently verify this data.

- Headcounts can be variable and challenging in public parks, so there is an expected margin of human error in the numbers.
- Visitors attending the park around scheduled events may be misclassified.

3. ***Educated 3,400 children, youth, and community members through 21 free educational programs in 2023.***

Background:
Many of the educational programming events occur during the summer as Waterloo Park host a summer series featuring discovery classes, children's musical classes, and bioblitz events.

Method: (Educational Value)
Waterloo Greenway Conservancy collects attendance information by head count for programs with fewer than 50 attendees. For larger programs and festivals, security checkpoints at the entrance record ticket counts and/or head counts of walk-up attendees. The Director of Programming and Events assisted in providing the necessary information to the CSI team. The data is then compared to the online event schedule listed on the Waterloo Greenway website.

Calculations:

Event (number of event series)	Participants at each event
Tales on the Trail (6)	750
Morning Glories (10)	1,400
Wild Wednesdays (5)	1,250

Sources:

- The numbers were provided by the Waterloo Greenway Conservancy and the research team did not independently verify this data.

Limitations:

- The numbers were provided by the Waterloo Greenway Conservancy, and the research team did not independently verify this data.

- Headcounts can be variable and challenging in public parks, so there is an expected margin of human error in the numbers.
- Visitors attending the park around scheduled events may be misclassified.

- There are additional educational events, such as The Creek Show. However, since it is an annual art show focused on creek education, it is categorized differently.

4. ***Improves connectivity of the pedestrian network, increasing ADA-accessible sidewalks/trails from .87 to 1.37 miles within the park's boundaries. The average connectivity of the pedestrian network increased from 3.04 to 3.14 as calculated by an axial graph analysis.***

Background:
The design team took extra care to ensure that this park was accessible to all by providing interpreters upon request and inviting the Accessibility chapter to review their experience of the park. As a park with a 54-ft grade change it was important that there remained accessible paths on all sides of the park.

Method: (Access and Equity)
The axial analysis map was conducted using only streets that were ADA accessible before the park was constructed and afterwards. Figure 3 shows the findings of each map.

The role of the park in improving ADA pedestrian connectivity was assessed by comparing the integration of pedestrian networks within the park and immediate surrounding streets. Only ADA accessible paths were included in the street segments. Integration measures the number of turns one has to make from one street segment to reach all other street segments in the network using the shortest path. Connectivity is the number of routes most connected to the park and highlighted in warm colors, such as red and orange, while streets that require more turns are less integrated and highlighted in cool colors such as blue and green (Figure 3).

Connectivity was calculated by Space Syntax - a set of tools that analyze spatial configuration http://www.spacesyntax.net/. The increase in connections both within the park and directly adjacent to it was assessed by comparing the connectivity of ADA accessible pedestrian connections before and after Waterloo Park was redesigned. The research team used "depthmapX v0.8.0" released by the Space Syntax Lab in the Bartlett School of Architecture at University College London to calculate the connections. Since Space Syntax calculates shortest path, the curvilinear trails in the park were changed to straight segments, however the number of turn were kept the same to maintain the accuracy of the calculation. The sidewalks and trails in and around the park were identified using Google Earth/StreetView for the connections before the redesign, and this summer they were identified with their current status. The pedestrian networks were traced in AutoCAD and imported to depthmapX for Axial Analysis. The table below (Table 4) represents a list of the values placed on each of the colors gained by the results, the higher numbers being the routes with more connectivity.

Calculations:

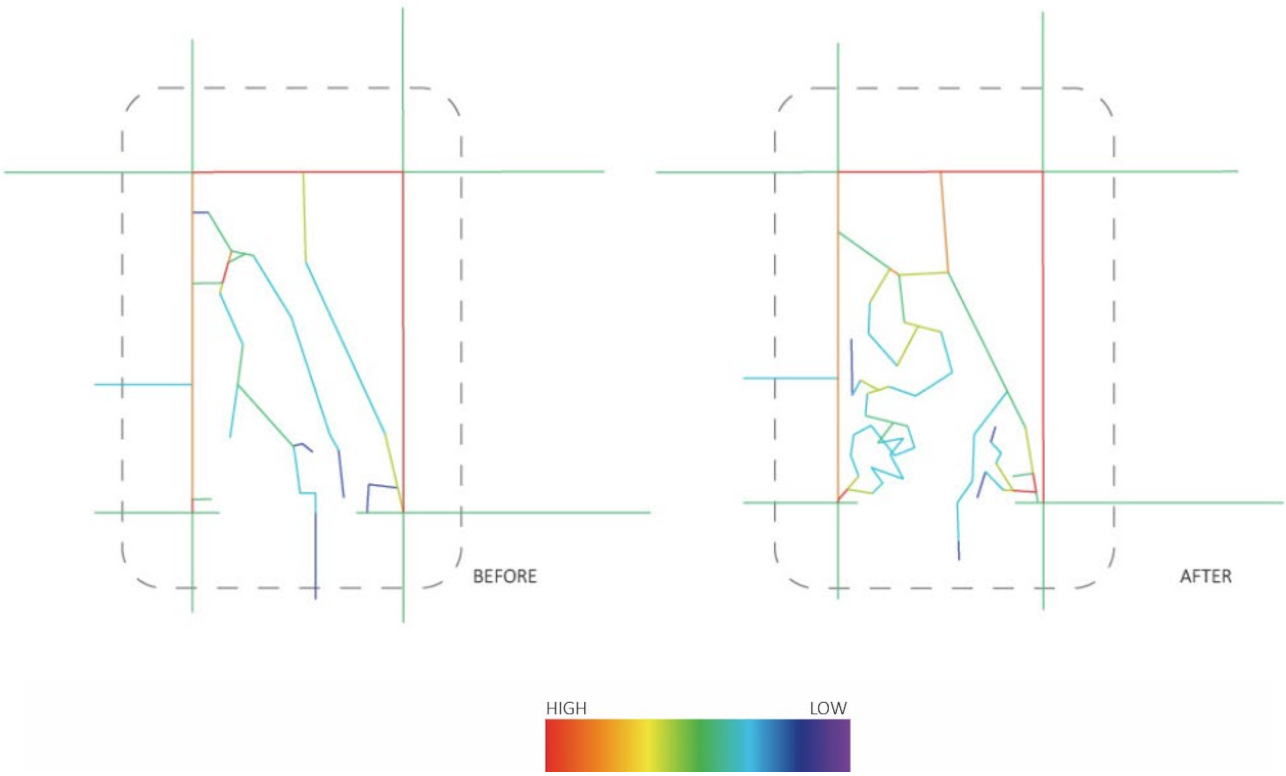

Figure 3: Before and After maps depicting ADA connectivity.

Before	After
Connectivity	Connectivity
3	3
3	6
3	5
5	5
4	3
3	3
5	6
4	6
6	3
3	3
3	6
3	6
3	3
4	3
4	6
2	3
2	3
2	3
4	2
4	3
2	3
3	3
3	3
2	3
2	3
2	3
2	4
2	2
2	4
3	6
6	3
4	1
4	1
3	1
2	3
2	3
4	2
3	2
1	2
2	1
4	3
3	2
3	4
4	6
2	5
2	1
2	2
2	2
2	2
2	2
3	3
1	2
2	1
4	1
6	3.14814815
3	
1	
2	
2	
4	
3	
2	
2	
2	
2	
2	
2	
2	
1	
3	
6	
5	
5	
3	
3	
6	
6	
3	
3	
6	
3	
3	
3	
3	
3	
2	
3.04651163	

Figure 4:Table results showing calculations for connectivity.

Sources:

- Space Syntax Lab: https://www.ucl.ac.uk/bartlett/architecture/research/space-syntax-laboratory
- Luo, Yi, Michael Volk, and Kanglin Chen. "Depot Park, Phases 1 and 2." *Landscape Performance Series*. Landscape Architecture Foundation, 2019. https://doi.org/10.31353/cs1610

Limitations:

- Using aerial images from 2003 and 2011 to track the paths that existed previously, and personal encounters but the results may be slightly off due to not having a complete ADA map from the park before construction.

Economic Benefits

1. ***Creates 5 full-time park positions including 1 full time horticulturalist for maintenance, operations, and monitoring. Combined, on-site staff work 200 hours per week and 10,400 hours each year maintaining Waterloo Park.***

Background:

At least two park employees are on the grounds every day of the week. They handle landscape maintenance, park upkeep, and provide general information and directional assistance to visitors.

Method: (Job Creation)

Collaborate with the Director of Park Operations at Waterloo Greenway Conservancy to gather data on the number of park staff roles and the number of hours each staff member works per week. Once the weekly hours are determined, multiply this figure by 52 weeks to calculate the total number of worker hours per year.

Calculations:

5 park positions * **40** hours per week = **200 hours per week**

200 hours per week * **52** weeks = **10,400 hours per year**

Sources:

- Martin Nembhard, Director of Park Operations provided employee hours.

Limitations:

- Positions are subject to change based on market conditions.
- As the park continues to expand, the number of positions will grow accordingly.

- Waterloo Greenway Conservancy has some positions not included in this calculation because their roles extend beyond park maintenance.

2. ***Contributed to the catalyzation of $65 million in investment into subsequent phases of construction of Waterloo Greenway through events held in Waterloo Park.***

Background:

This project was designed with the goal of using Waterloo Park to contribute to funding opportunities for the construction of additional parks along Waller Creek that would be managed by Waterloo Greenway. Events contributing to this funding include the annual Glow in the Park fundraiser, the Pop-Up Picnic, and a benefit concert and dinner. While personal donations can also be made at any time through their website, these annual events significantly boost the conservancy's contributions.

Below is a summary of some publicly listed contributions, which account for a portion of the $65 million mentioned above, provided for reference only.

Event	**Amount**
Benefit and Dinner (8th) Before opening of park	462,000
Benefit and Dinner (7th) Before opening of park	Not listed Publicly
Glow in the Park Fundraiser (2021)	1,700,000
Pop-up Picnic (2022)	200,000
Glow in the Park Fundraiser (2022)	1,900,000
Pop-up Picnic (2023)	Not Listed Publicly
Glow in the Park Fundraiser (2023)	Not listed Publicly

Method: (Economic Development):

This number was provided by the Waterloo Park Conservancy and reflects contributions from Waterloo Greenway charity events since its development.

Calculations:

This amount was calculated by the Waterloo Greenway Conservancy.

Sources:

“Fundraisers.” Waterloo Greenway Conservancy. Accessed July 29, 2024. https://waterloogreenway.org/category/support/fundraisers/.

"Glow in the Park 2024." Waterloo Greenway Conservancy, July 16, 2024. https://waterloogreenway.org/sponsorship-events/glow-in-the-park-2024/.

"Pop-up Picnic." Waterloo Greenway Conservancy, March 31, 2023. https://waterloogreenway.org/events/pop-up-picnic-2023/.

"Support." Waterloo Greenway Conservancy, May 14, 2024. https://waterloogreenway.org/support/.

Limitations:

- The collection of information utilizes data collection through the Waterloo Greenway Conservancy. The accuracy of the material obtained has not been independently verified.

Appendix 1: iTree Results for all trees by species

Location: Austin, Travis, Texas, United States of America
Project: Waterloo Park 2024, Series: All Trees, Year: 2024
Generated: 7/21/2024

Species	Trees	Carbon Storage		Gross Carbon Sequestration		Avoided Runoff		Pollution Removal		Replacement Value
	Number	(ton)	($)	(ton/yr)	($/yr)	(gal/yr)	($/yr)	(ton/yr)	($/yr)	($)
Sweet acacia	6	0.14	23.88	0.01	0.89	50.37	0.45	0.00	0.00	3,971.07
Red buckeye	13	0.05	9.34	0.02	3.53	30.38	0.27	0.00	0.00	839.59
Texasplume	2	0.01	1.74	0.00	0.60	1.40	0.01	0.00	0.00	129.17
Pecan	11	11.76	2,005.39	0.27	46.83	535.81	4.79	0.00	0.00	63,447.77
Eastern redbud	29	0.11	18.09	0.04	6.55	35.21	0.31	0.00	0.00	1,872.94
Desertwillow	23	0.15	25.04	0.05	8.09	33.68	0.30	0.00	0.00	1,485.43
Texas persimmon	30	0.09	14.96	0.02	3.83	37.95	0.34	0.00	0.00	2,236.10
Texas kidneywood	3	0.02	3.71	0.01	1.27	3.83	0.03	0.00	0.00	193.75
Texas ash	2	1.90	323.55	0.00	0.41	177.71	1.59	0.00	0.00	11,358.44
Possum haw	11	0.04	6.95	0.01	2.07	10.17	0.09	0.00	0.00	710.43
Yaupon	30	0.17	29.35	0.04	6.68	38.19	0.34	0.00	0.00	1,937.52
Eastern red cedar	32	0.42	71.09	0.06	9.67	71.04	0.63	0.00	0.00	4,698.75
Littleleaf leadtree	5	0.01	2.32	0.01	1.24	4.41	0.04	0.00	0.00	322.92
Japanese privet	2	0.24	41.33	0.03	4.61	48.59	0.43	0.00	0.00	1,881.34
Chinaberry	2	1.03	175.56	0.05	8.44	62.87	0.56	0.00	0.00	5,334.95
Southern bayberry	40	0.25	43.10	0.07	11.94	61.23	0.55	0.00	0.00	2,583.36
Jerusalem thorn	31	0.14	23.18	0.06	10.61	35.79	0.32	0.00	0.00	2,002.11
Mexican sycamore	7	0.08	13.35	0.01	2.53	47.13	0.42	0.00	0.00	1,566.25
Honey mesquite	12	0.04	6.65	0.02	2.77	5.34	0.05	0.00	0.00	775.01
Mexican plum	13	0.05	8.21	0.02	2.62	14.62	0.13	0.00	0.00	827.04
Buckley oak	17	0.79	134.40	0.11	19.59	92.38	0.83	0.00	0.00	5,238.08
Plateau oak	1	0.05	8.33	0.01	1.15	7.13	0.06	0.00	0.00	308.12
Lacey oak	12	0.64	108.42	0.09	15.81	65.21	0.58	0.00	0.00	3,697.47
Bur oak	8	0.10	17.83	0.01	2.54	34.87	0.31	0.00	0.00	2,141.26
Chinkapin oak	9	0.34	58.44	0.05	8.98	35.35	0.32	0.00	0.00	2,385.24
Monterrey oak	16	0.77	131.68	0.07	12.71	86.94	0.78	0.00	0.00	4,929.96
Shumard oak	18	0.73	125.03	0.11	18.23	100.04	0.89	0.00	0.00	6,041.25
Live oak	54	86.01	14,668.78	1.50	254.99	4,199.38	37.53	0.00	0.00	420,081.98

Benefits Summary of Trees by Species

Location: Austin, Travis, Texas, United States of America
Project: Waterloo Park 2024, Series: All Trees, Year: 2024
Generated: 7/21/2024

Species	Trees	Carbon Storage		Gross Carbon Sequestration		Avoided Runoff		Pollution Removal		Replacement Value
	Number	(ton)	($)	(ton/yr)	($/yr)	(gal/yr)	($/yr)	(ton/yr)	($/yr)	($)
Texas sophora	13	0.05	8.88	0.02	3.22	19.08	0.17	0.00	0.00	839.59
Mescalbean	29	0.70	119.64	0.07	11.25	132.37	1.18	0.00	0.00	6,936.55
Montezuma cypress	4	0.07	11.31	0.01	1.82	11.79	0.11	0.00	0.00	1,193.33
American elm	1	1.06	180.37	0.04	7.45	83.79	0.75	0.00	0.00	7,370.44
Cedar elm	6	2.95	502.81	0.19	31.79	387.77	3.47	0.00	0.00	20,879.48
Mexican buckeye	22	0.15	25.92	0.06	10.88	39.88	0.36	0.00	0.00	1,420.85
Total	**514**	**111.10**	**18,948.64**	**3.14**	**535.60**	**6,601.70**	**58.99**	**0.00**	**0.00**	**591,637.57**

Carbon storage and gross carbon sequestration value is calculated based on the price of $170.55 per ton.
Due to limits of available models, i-Tree Eco will limit carbon storage to a maximum of 7,500 kg (16,534.7 lbs) and not estimate additional storage for any tree beyond a diameter of 254 cm (100 in). Whichever limit results in lower carbon storage is used.
Avoided runoff value is calculated by the price $0.009/gal. The user-designated weather station reported 2.7 inches of total annual precipitation. Eco will always use the hourly measurements that have the greatest total rainfall or user-submitted rainfall if provided.
Pollution removal value is calculated based on the prices of $0.00 per ton (CO), $0.00 per ton (O3), $0.00 per ton (NO2), $0.00 per ton (SO2), $0.00 per ton (PM2.5), $0.00 per ton (PM10*).
Replacement value is the estimated local cost of having to replace a tree with a similar tree.
A value of zero may indicate that ancillary data (pollution, weather, energy, etc.) is not available for this location or that the reported amounts are too small to be shown.

Appendix 2: iTree Results for Preserved Trees by species

Location: Austin, Travis, Texas, United States of America
Project: Waterloo Park 2024, Series: Retained Trees, Year: 2024
Generated: 7/21/2024

Species	Trees	Carbon Storage		Gross Carbon Sequestration		Avoided Runoff		Pollution Removal		Replacement Value
	Number	(ton)	($)	(ton/yr)	($/yr)	(gal/yr)	($/yr)	(ton/yr)	($/yr)	($)
Sweet acacia	2	0.13	22.86	0.00	0.70	50.57	0.45	0.00	0.00	3,976.39
Pecan	8	11.71	1,997.39	0.30	50.37	500.88	4.48	0.00	0.00	69,157.57
Texas persimmon	2	0.02	4.15	0.00	0.68	7.56	0.07	0.00	0.00	476.91
Texas ash	2	1.90	323.55	0.00	0.44	182.03	1.63	0.00	0.00	12,424.45
Japanese privet	2	0.24	41.75	0.03	5.16	55.35	0.49	0.00	0.00	2,097.58
Chinaberry	2	1.03	175.56	0.05	8.94	61.74	0.55	0.00	0.00	5,645.26
Live oak	28	70.61	12,043.43	0.98	167.65	3,470.53	31.01	0.00	0.00	365,894.35
Mescalbean	8	0.45	77.31	0.03	5.40	79.15	0.71	0.00	0.00	4,451.81
American elm	1	1.06	180.37	0.05	8.32	92.00	0.82	0.00	0.00	8,217.62
Cedar elm	6	2.95	502.81	0.20	33.29	394.74	3.53	0.00	0.00	21,832.59
Total	**61**	**90.11**	**15,369.18**	**1.65**	**280.94**	**4,894.55**	**43.74**	**0.00**	**0.00**	**494,174.54**

Carbon storage and gross carbon sequestration value is calculated based on the price of $170.55 per ton.
Due to limits of available models, i-Tree Eco will limit carbon storage to a maximum of 7,500 kg (16,534.7 lbs) and not estimate additional storage for any tree beyond a diameter of 254 cm (100 in). Whichever limit results in lower carbon storage is used.
Avoided runoff value is calculated by the price $0.009/gal. The user-designated weather station reported 2.7 inches of total annual precipitation. Eco will always use the hourly measurements that have the greatest total rainfall or user-submitted rainfall if provided.
Pollution removal value is calculated based on the prices of $0.00 per ton (CO), $0.00 per ton (O3), $0.00 per ton (NO2), $0.00 per ton (SO2), $0.00 per ton (PM2.5), $0.00 per ton (PM10*).
Replacement value is the estimated local cost of having to replace a tree with a similar tree.
A value of zero may indicate that ancillary data (pollution, weather, energy, etc.) is not available for this location or that the reported amounts are too small to be shown.

Appendix 3: Plant Inventory (1M x 1M)

Location #1

June 4th 2024

Scientific Name	Common Name	Quanity
Dichondra argentea	Silver Ponyfoot	
Erigeron canadensis	Horseweed	
Melothria pendula	Creeping Cucumber	
Phyla nodiflora	Frogfruit	
Solanum elaeagnifolium	Silverleaf Nightshade	
Callirhoe involucrata	Winecup Mallow	
Vernonia lindheimeri	Wooly Ironweed	
Nassella Leucotricha	Texas Wintergrass	
Heuchera richardsonii	Prairie Alumroot	

Plant Inventory (1M x 1M)

Location #2

June 4th 2024

Scientific Name	Common Name	Quanity
Salvia coccinea	Tropical Sage	
Solanum elaeagnifolium	Silverleaf Nightshade	
Dichondra argentea	Silver Ponyfoot	
Phyla nodiflora	Frogfruit	
Vitis cinerea	Graybark Grape	
Symphyotrichum oblongifolium	Aromatic Aster	
Melothria pendula	Creeping Cucumber	
Acalypha ostryifolia	Hophornbeam Copperleaf	
Desmanthus illinoensis	Illinois Bundleflower	
Erigeron canadensis	Horseweed	

Plant Inventory (1M x 1M)

Location #3

June 4th 2024

Scientific Name	Common Name	Quanity
Yucca pallida	Pale Yucca	
Carex texensis	Texas Sedge	
Salvia greggi	Autum Sage	
Scutellaria ovata	Heartleaf Skullcap	
Dichondra argentea	Silver Ponyfoot	
Symphyotrichum oblongifolium	Aromatic Aster	
Merremia dissecta	Alamo Vine	
Calyptocarpus vialis	Horseherb	