2014 LAF CSI PROGRAM LANDSCAPE PERFORMANCE SERIES: Sundance Square Plaza, Fort Worth

Research Title: The University of Texas at Arlington's Case Study Investigation 2014: Sundance Square Plaza & AT&T Performing Arts Center-Elaine and Charles Sammons Park[1]

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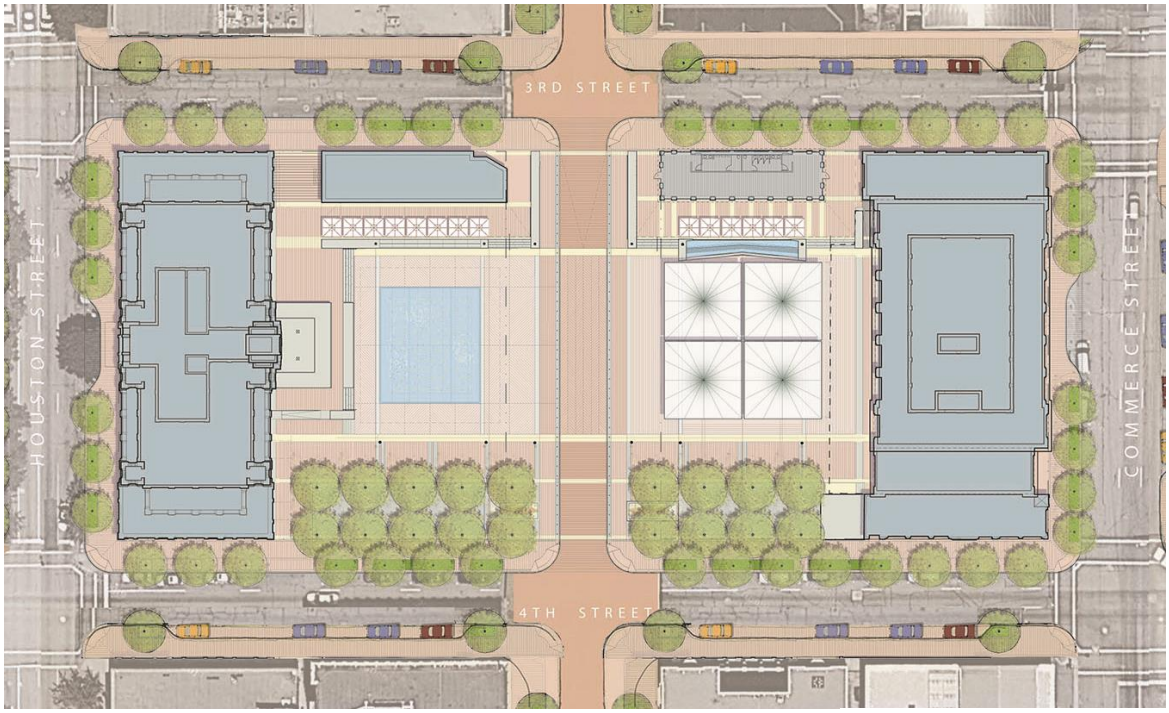

(Source: Vergason, 2014)

[1] This white paper can be cited as; Ozdil, T., & Richards, J., & Stewart, D., & Earl, J. & Brown, R. (2014). *2014 LAF's CSI Program Landscape Performance Series: Sundance Square Plaza Methodology*. The University of Texas at Arlington. Arlington, Texas.

Overview of UT Arlington's Research Strategy for Both Case Studies

Introduction:
The purpose of this research is to investigate the landscape performance of two acclaimed landscape architectural projects: 1) Sundance Square Plaza, Fort Worth, Texas; 2) AT&T Performing Arts Center: Elaine and Charles Sammons Park, Dallas, Texas. Both projects are landscape architectural centerpieces representing decades of district-level efforts in the two largest cities in North Texas. This research is initiated as part of the 2014 Case Study Investigation (CSI) program funded by the Landscape Architecture Foundation (LAF). It is conducted in collaboration with the project landscape architecture firms: 1) Michael Vergason Landscape Architects (Vergason) and 2) SmithGroupJJR (JJR).

The case study research tasks and reporting are outlined in advance by LAF to present project profile and overview, sustainable features, challenges/solutions, lessons learned, role of landscape architects, cost comparisons, and performance benefits. Within the LAF framework, the UT Arlington research team, with its professional firm partners, collected, reviewed, and analyzed/synthesized project-related data for over 21 weeks between March – August, 2014 to prepare the case studies published online at landscapeperformance.org.

The UT Arlington team developed its overall research design strategy in the 2013 cycle as one of the recipients of LAF's CSI grant/recognition (see Ozdil et. al., 2014). As a second year grant recipient in 2014, the UT Arlington team continues to follow the strategy developed last year with slight revisions based on the lessons learned in the 2013 period. The research outlines its' inquiry under the three sub-category headings: environmental, economic, and social (including cultural and aesthetic) to establish a comprehensive and systematic framework, ease the data collection and analysis process for multiple case studies, and to avoid losing sight of research goals while documenting a diverse set of findings. These sub-categories are used primarily to identify and organize the performance benefits of landscape architecture projects in this collaborative effort.

The UT Arlington research combines quantitative and qualitative methods to document both landscape architectural projects, and to assess their performance benefits (Deming et. al., 2011; Murphy, 2005; Moughtin, 1999; Ozdil et. al., 2014; Ozdil, 2008). Methodological underpinnings of the research for the case studies are primarily derived from a systematic review of performance criteria and variables from: (1) the LAF's landscape performance series *Case Study Briefs* (LAF, 2014), (2) the case study methods that are developed for designers and planners in related literature (Francis, 1999; Gehl & Svarre, 2013; Gehl, 1988; Marcus et. al. 1998; Ozdil et. al., 2013; Preiser et. al., 1988), (3) the primary data collection methods through surveys (Dilman, 1978), site observations, behavior mapping, and assessment techniques (Gehl & Svarre, 2013; Marcus et. al. 1998; Whyte, 1980 & 1990), and finally (4) project-related secondary data collected from project firms, project stakeholders, public resources and databases. The data gathered from all the research instruments are further analyzed, synthesized and summarized as the performance benefits for the two case studies under investigation. The findings are organized within the LAF framework, as it is outlined earlier in this document for online publication. The research is designed to highlight the value and significance of these two landscape architecture projects by utilizing objective measures and by documenting and evaluating their performance to inform the design of future urban landscapes.

Data Collections Methods:
The research involves collection of primary and secondary data through online surveys, site observations and systematic review of available secondary data. As a first step, the research team acquired necessary permissions from the Institutional Review Board at UT Arlington prior to primary data collection

involving human subjects. The following section briefly reviews some of the major data collection strategies adopted in this research.

Survey: A survey instrument is developed to collect social performance data for both sites. The survey measures user perception on topics such as quality of life, sense of identity, health and educational benefits, safety and security, presence of arts, and availability of informal and organized events. The survey is informed by relevant literature, as well as by other survey instruments prepared for parks and other landscape architecture projects (such as Dallas Park & Recreation Survey, New York's Central Park Survey, to name a few). The survey instrument and the variables questioned within it are kept almost identical in both cases in order to develop a more homogenous measure with which to study varying sites, and to provide LAF with replicable and generalizable instruments. The survey simply asks the visitors for their perceptions and experiences of the site.

The survey is composed of three parts. The first part of the questionnaire documents user profiles as well as user perceptions and choices of activities available on the site by using multiple choice questions. The second part of the survey asks users to rate performance-related statements with Likert scale questions. The final portion of the survey asks for additional comments/concerns of visitors who want to share additional information with the research team.

The survey was voluntary and the respondents were assured that identities would be kept confidential to ease privacy concerns. The survey is kept short (15 minutes to complete) and prepared for both online and on-site platforms in order to increase its utilization by potential respondents. Due to time and resource limitations, researchers utilized the online and on-site surveys interchangeably in some case studies. Surveys for both sites were conducted over the summer months.

Site Observations: Passive observation, photography, video recording, and site inventory and analysis techniques (such as use of street furniture counts/measurements, etc.), in addition to people counts, activity mapping and tracing methods are also utilized in 2014 case studies. The research team specifically takes advantage of these methods this year since the case study sites were prone to more concentrated people activity in well-defined urban spaces. The research team primarily benefited from the site visits and observations to understand the user activity and behavior relative to how the spaces are being used. The passive observations are conducted on both weekdays and weekends in random intervals for better representation of the varying visitor activity at each site.

Observational methods utilized in this research did not involve any intrusive interaction with the subjects and necessary precautions are taken not to impede or govern the subjects' activities. Although photography or video recording is used, the identity of the subjects is blurred unless they allow researchers to use their images or the research partners provided photos with credentials. In both case studies, the research team informed the stakeholders prior to site visits, and acquired necessary permissions. Additional details of these techniques are provided in the following pages.

Archival and Secondary Data: This research benefited greatly from archival and secondary data attained from project firms, project stakeholders, public resources, and private databases. In accordance with LAF's mission, this research was a product of a partnership among the academic research team, project firm, and LAF. Where and when data were available from the secondary sources, such as the landscape architecture firm, client(s), project partners, scholarly literature, and publicly available sources, the project team systematically collected and organized the data, diligently reviewed its content, and assessed its rigor and integrity. The research team later used the relevant data to document the project, and assessed the landscape performance for both sites.

Data Analysis and Research Design:

The UT Arlington team designed its research strategy under three focused thematic areas: environmental, economic, and social (including cultural and aesthetic) for both case studies. In the beginning of the investigation, the research team benefited from this strategy for conducting a systematic research that produces replicable performance criterias and methods for both sites. After the measurable criteria were identified and the possibilies exhausted, the UT Arlington team further refined its approach by customizing performance criteria and procedures to each case study site to better document and report the varied qualities of each site independently. While achieving a comparable set of performance benefits for all sites was the goal –and this strategy produces the greater framework for the research- customising detailed performance criteria later in the process helped the research team to overcome concerns about data availability, varying project typologies, project goals and outcomes.

The findings of the investigations in both cases focused first on performance benefits related to the site itself, then its immediate adjacencies, and finally on the project block group/neigborhood/district or zip code. For example, performance benefits that are most direct and telling about the project site itself are emphasized more in comparison to indirect performance benefits and findings about the project adjacencies or neigborhoods. This strategy is also used in the reporting of the findings to clarify the document and to ease the review.

In conclusion, the data collected through these strategies were systematically reviewed and appropriate methods for analysis of specific performance criteria are highlighted in the detailed methodology below. The following section presents research design specifics for Sundance Square Plaza, a basic summary of the performance criteria under investigation, and the data sources and procedures involved in measuring that particular performance criteria.

Overview of Sundance Square Plaza & UT Arlington's Research Strategy:

Figure.1 Sundance Square Plaza, before and after (Source: Vergason, 2014)

Overview: Sundance Square Plaza, designed by Michael Vergason Landscape Architects, is Fort Worth's new "civic living room," replacing a 2-acre parking lot in the heart of downtown. The plaza celebrates the city's heritage as the "City Where the West Begins" and provides a public open space for cultural events and activities for the city's diverse population. Downtown Fort Worth's revitalization story began with Victor Gruen's 1956 plan, and most of the current urban design framework, including the concept and location of the plaza, were set in the 1981 plan by JJR. With the vision and drive of the Bass family of Fort Worth, Sundance Square experienced renewal at a block by block scale. The most recently implemented piece of this vision is its centerpiece, Sundance Square Plaza, opened in November 2013. The plaza design aligns with the overall 'modern Texas art-deco' aesthetic employed by David Schwarz's architecture. The two-block pedestrian plaza sits astride Main Street, which aligns the historic courthouse with the modern convention center to connect the city at a Baroque scale. Within the plaza, visitors are witness to monumental sculptural umbrellas that introduce critical shade, as well as aesthetic and environmental benefits. The plaza's edges are activated with seating, alfresco dining and two water features. The water provides a dance of movement, light and sound to both attract and cool people who pass by. This plaza is a regional destination and a catalyst for downtown living that supports vibrant public life and interaction.

Challenge: The project aimed to convert a downtown parking lot into a key centerpiece for Fort Worth's revitalization. Specific issues included the need to respond to Sundance Square's historical context and overall downtown revitalization. Additionally, the landscape architect needed to identify areas where environmental features could be implemented. The poor condition of the on-site soils posed a significant design challenge. The plaza's subgrade consists largely of expansive shallow limestone clay soils with no clear soil profile. Heavy loads and continuous use in the Plaza requires durability and a significant structural slab to handle the frequency and loading of large vehicles and crowds. Many of the events taking place on the plaza require large trucks or service vehicles to drive and park temporarily in pedestrian areas.

Solution: The design solution introduces an urban square that integrates with Sundance Square's historic aesthetic. Water features and shade (both from four artistic umbrellas and native street trees) enhance the overall pedestrian experience within the plaza. Concentrating planting on the southern plaza edge and the streetscape enabled continuous panels of amended soil to be used for tree growing media. The LA worked with horticulture and urban soils experts to create a soil mix to promote the growth of the Cedar Elms. The installation of structural cells throughout the soil panels prevents compaction of the soil from pedestrian and vehicular use and dedicates approximately 1,800 c.f. of soil to each tree. On the street edge, structural spanning slabs are used to increase soil volumes with a minimal budget. The LA coordinated with the structural engineer throughout the project to provide sufficient support to protect the fountain plumbing, intricate paving , and tree root systems below the surface.

Case Study Strategy: The research team followed the comprehensive investigation strategies outlined earlier in this document by concentrating on the environmental, social, and economic implications of the project. The team's approach to identifying performance benefits for Sundance Square Plaza are mainly driven by detecting contextual challenges (see above), by reviewing its spatial organization to create a people place , and by evaluating environmental elements in a complex urban setting. Its status as a destination and its social and recreational qualities as an urban plaza for downtown residents and visitors encouraged the research team to develop a deeper understanding of user perceptions. After reviewing the relevant literature, the project information, and the firm archives with Vergason, the UT Arlington research team developed detailed procedures and performance measures which can be tied to project's initial challenges, goals and objectives (see figure.2 for research design).

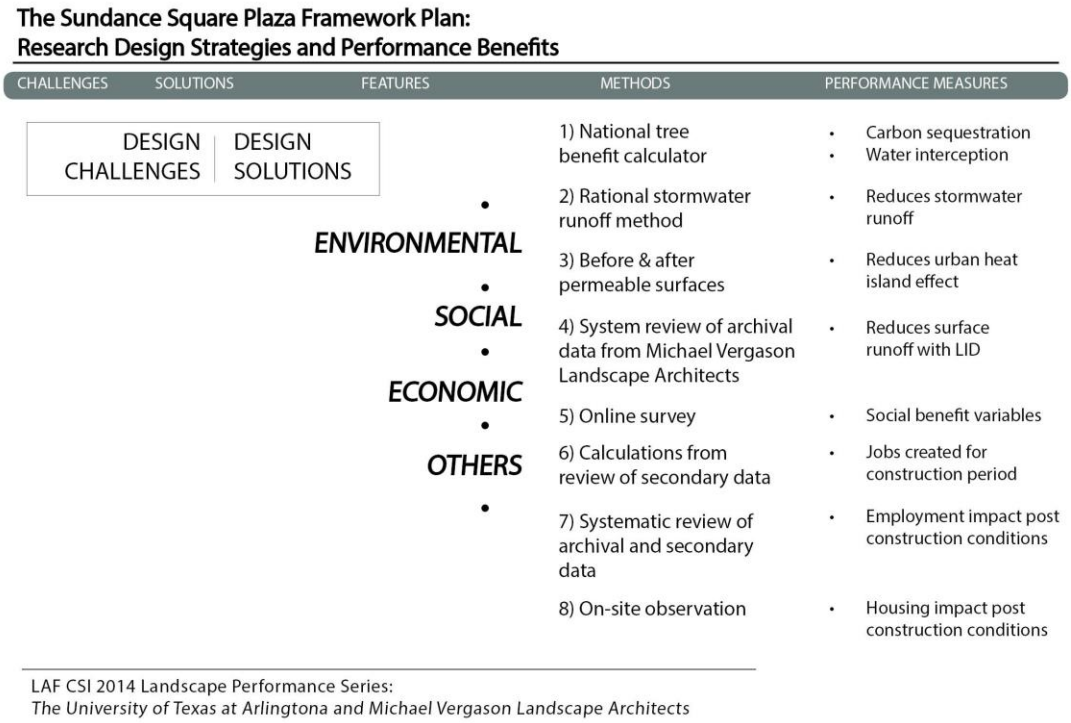

Figure.2 Research Strategy and Design

The research team followed the research design strategies outlined in the earlier portion of this document for the Sundance Square Plaza case study (see figure.2 above) by exploring all social, economic and environmental performance measures. Given the specific focus of the project, the research team emphasized performance criteria that are more telling about the perceptions of the users, programmatic elements of the plaza, and innovative construction practices, as well as its economic impact on its immediate context. The plaza's close proximity to UT Arlington allowed research team to emphasize surveys and site observations as effective data collection strategies. After acquiring Institutional Review Board permissions for human subjects from UT Arlington, the survey is distributed via e-mails, social media outlets, and/or professional network. Passive observations, specifically people count and activity mapping techniques, allowed researchers to quantitatively document the performance of the plaza.

The research procedure also involved documenting the economic performance indicators for this case study. Various secondary data sources were reviewed to determine the project's economic influence, and numerous positive indicators are found representing the larger context of the project site. However, the causality between the improvements and the economic changes were not direct and not specific enough to the project, and not as informative as the researchers desired. Therefore only a few selected economic performance measures are highlighted for the Sundance Square Plaza case study. The next section outlines the specific performance benefits documented for Sundance Square Plaza by illustrating data sources and procedures followed, as well as the limitations that are encountered measuring the particular performance criteria.

Performance Indicators:

The following bullet points explain and illustrate some of the more complex performance indicators summarized on the LAF CSI website. Performance indicators listed below are in their full form, and explained in detail to inform the reader about the calculations, procedures, limitations and/or significance of the research. These bullets are later formatted, summarized and/or further revised to comply with the online portal restrictions.

Environmental Performance Benefits

Performance Indicator 1:

- *Reduces the peak stormwater flow rate for a rain intensity of 2 inches per hour by 18.8% from 2.9 cfs to 2.4 cfs by reducing impervious surfaces by 7.3%.*

Stormwater Runoff - post-development					
Description	**Area (sq. ft)**	**i (inches/hour)**	**Area (Acres)**	**C (co-efficient number)**	**Q=CiA (cu. ft/sec)**
Brick Paving	61,706	2	1.4165	.6500	1.8415
Paving	8,467	2	0.1943	.9000	0.3497
Gravel + Planting	7,678	2	0.1762	.6500	0.2291
Total	**77,851**		**1.7871**		**2.4203**

Stormwater Runoff - pre-development					
Description	**Area (sq. ft)**	**i (inches/hour)**	**Area (Acres)**	**C (co-efficient number)**	**Q=CiA (cu. ft/sec)**
Paving	60,027	2	1.3780	.9000	2.4804
Brick Paving	15,680	2	0.3599	.6500	0.4679
Planting	2,144	2	0.0492	.3000	0.0295
Total	**77,851**		**1.7871**		**2.9778**

Table.4: Stormwater runoff; pre and post development comparison

Methods: As illustrated in the tables above the stormwater runoff is calculated with Rational Method (Q=CiA). The Co-efficient numbers for different materials are referenced from the LARE Reference Manual.

For example: A 61,706 sq. ft of brick paving surface will create a 1.8415 cu. ft per second runoff in a single rain event of 2". (Please note that the area used in the following calculation is converted into acres. The area of an acre is equivalent to 43,560 sq. ft):

CiA=Q

0.65*2 inches*1.4165 acres = 1.8415 cu. ft/sec

As seen from the tables above the total stormwater runoff post-development is 2.4203 cu. ft/sec and the total stormwater runoff pre-development is 2.9778 cu. ft/sec.

2.9778 cu. ft/sec - 2.4203 cu. ft/sec = .5575 cu. ft/sec

Thus reducing the stormwater runoff post-development by .5575 cu. ft/sec.

Considering the pre-development stormwater runoff as 100%, the post development runoff is 81.20% as a result, reducing the stormwater runoff by 18.80%.

Finally, overall there are .5575 cu. ft/sec reductions in the stormwater runoff which is 18.80% reduction for the whole site.

Limitations: All calculations were derived from aerial photos and images, which slightly hinder the accuracy of the exact sq. footage. Furthermore, the Rational Method (Q=CiA) is a mathematical formula developed to estimate stormwater runoff amount. It has mathematical limitations in terms of how accurate to round up any and all decimal outcomes.

Performance Indicator 2:

- *Sequesters 6,567 lbs of CO2 annually through 61 newly planted trees, equivalent to the CO2 emitted from driving 7,923 miles in a passenger vehicle. These trees also intercept 23,858 gallons of rainwater annually through their canopies.*

Scientific name	DBH (inches)	CO2 sequestered by one tree (lbs)	Quantity of trees	Total CO2 sequestered (lbs)
Ulmus crassifolia	6	157	18	2826
Quercus fusiformis	5	87	43	3741
Total			**61**	**6567**

Table.1: Tree's potential for carbon sequestration.

Methods: As illustrated in the table above the carbon sequestered is calculated with National Tree Benefit Calculator (http://www.treebenefits.com/calculator/).

For example: A single *Ulmus crassifolia* of 6" DBH sequesters 157 lbs of CO2. There are total of 18 *Ulmus crassifolia* in the planting plan of The Plaza at Sundance Square. Thus, the total amount of CO2 sequestered by 18 *Ulmus crassifolia* would be:

157 lbs*18 = 2826 lbs

One metric ton comprises of 2204 lbs. Thus, the total CO2 sequestered with the help of all the trees would be:

6567/2204 ~ **2.97 metric tone**

Annual Vehicle Distance Travelled in Miles and Related Data - 2011 (1) By Highway Category and Vehicle Type March 2013						
YEAR	IITEM Motor-Vehicle Travel:(millions of vehicle-miles)	LIGHT DUTY VEHICLES SHORT WB (2)	MOTOR-CYCLES	SUBTOTALS		ALL MOTOR VEHICLES
				ALL LIGHT DUTY VEHICLES (2)	SINGLE-UNIT 2-AXLE 6-TIRE OR MORE & COMBINATION TRUCKS	
2011	Number of motor vehicle registered	192,513,278	8,330,210	233,841,422	10,270,693	253,108,389
2010		190,202,782	8,009,503	230,444,440	10,770,054	250,070,048
2011	Average miles traveled per vehicle	10,614	2,221	11,318	26,016	11,640
2010		10,650	2,311	11,493	26,604	11,866
2011	Average fuel consumption per vehicle (gallons)	460	51	530	4,126	666
2010		456	53	534	4,180	681
2011	Average miles traveled per gallon of fuel consumed	23.1	43.5	21.4	6.3	17.5
2010		23.3	43.4	21.5	6.4	17.4

Table.2: Carbon emissions comparison to annual vehicle distance travelled.

The numbers for the miles travelled in a year (11,318) and average (21.4mpg) of the passenger vehicle is set as benchmark (for comparison of the CO2 emitted) from Federal Highway Administration (FHWA) 2013 data as can be seen below:

Source: http://www.fhwa.dot.gov/policyinformation/statistics/2011/vm1.cfm

With the help of Carbon Calculator (http://www.americanforests.org/discover-forests/carbon-calculator/), a gas fuelled passenger vehicle travelling 11,318 miles in a year at 21.4 mpg average emits 9394 lbs of CO2 which is equivalent to 4.24 metric tons.

9394/2204 ~ 4.26 metric tons

The total CO2 sequestered by trees is equivalent to approximately CO2 emitted from 1 passenger vehicle in a year.

2.97/4.26 ~ .7 passenger vehicles

11,318 miles*.7 = **7,923 miles**

Finally, the 2.97 metric tons of CO2 sequestered by the trees is equivalent to 7,923 miles travelled in a year in a single passenger vehicle.

Limitations: This indicator relies on tools and estimations that are developed/provided by third parties and may be subject to errors beyond the research team's control. For example, although the Sundance Square Plaza project is recently completed in October 2013, the plants are still not fully matured. The DBH for the plants is considered as 5" and 6" as per the information sourced from Michael Vergason Landscape Architects. As another sample, the data highlighted in the table using a passenger vehicle as a benchmark is the US national average of the year 2011 (Data is retrieved in 2013 from FHWA website).

Common name	DBH (inches)	Stormwater intercepted by one tree (gallons)	Quantity of trees	Total stormwater runoff intercepted (gallons)
Ulmus crassifolia	6	604	18	10872
Quercus fusiformis	5	302	43	12986
Total			**61**	**23858**

Table.3: Trees' potential for water interception.

Methods: As illustrated in the table above the stormwater intercepted is calculated with National Tree Benefit Calculator (http://www.treebenefits.com/calculator/).

For an example: A single *Ulmus crassifolia* of 6" DBH intercepts 604 gallons of stormwater runoff. There are total 18 *Ulmus crassifolia* in the planting plan of The Plaza at Sundance Square. Thus, the total amount of stormwater intercepted by 18 *Ulmus crassifolia* would be:

604 gallons*18 = 10,872 gallons

The EPA's Water Trivia Facts states that an American resident uses 100 gallons of water in a day (http://water.epa.gov/learn/kids/drinkingwater/water_trivia_facts.cfm).

23,858 gallons/100 gallons ~ **238 American residents**

Finally, 238 American residents uses 23,858 gallons of water in a day, equivalent to the stormwater intercepted by the trees in The Plaza at Sundance Square.

Limitations: This indicator relies on tools and estimations that are developed/provided by third parties and may subject to errors beyond the research team's control. Since the project is recently completed in October 2013, the plants are still not fully matured. The DBH for the plants is considered as 5" and 6" as per the information sourced from Michael Vergason Landscape Architects.

Performance Indicator 3:

- *Reduces mid-day pavement surface temperatures by 22°F under the structural umbrellas. In the spring and summer, the umbrellas, trees, and new buildings shade 22% of the plaza, compared to only 7% shade pre-development.*

Shade Comparison - post-development				
Season	**Daily Morning Average (~sq. ft)**	**Daily Afternoon Average (~sq. ft)**	**Seasonal Average (~sq. ft)**	**Acres (Acres)**
Fall	23,600	42,480	33,040	0.7584
Winter	25,360	52,560	38,960	0.8943
Total Average (Fall + Winter)			**36,000**	**0.8264**
Spring	25,670	30,030	27,850	0.6393
Summer	24,930	26,860	25,895	0.5944
Total Average (Spring + Summer)			**26,873**	**0.6169**

Shade Comparison - pre-development				
Season	**Daily Morning Average (~sq. ft)**	**Daily Afternoon Average (~sq. ft)**	**Seasonal Average (~sq. ft)**	**Acres (Acres)**
Fall	12,530	13,150	12,840	0.2948
Winter	18,780	18,160	18,470	0.4241
Total Average (Fall + Winter)			**15,655**	**0.3593**
Spring	7,640	10,550	9,095	0.2088
Summer	5,880	8,640	7,260	0.1667
Total Average (Spring + Summer)			**8,178**	**0.1877**

Table. 5: Shade Area; pre and post development comparison

Methods: As illustrated in the tables above, the shade area is calculated by finding the square footage of shaded areas for twice a day and for one day every month of the year. A Google SketchUp model was built to replicate four different seasons of the year for both pre-development and post-development conditions, shown below (Summer season Post-Development example):

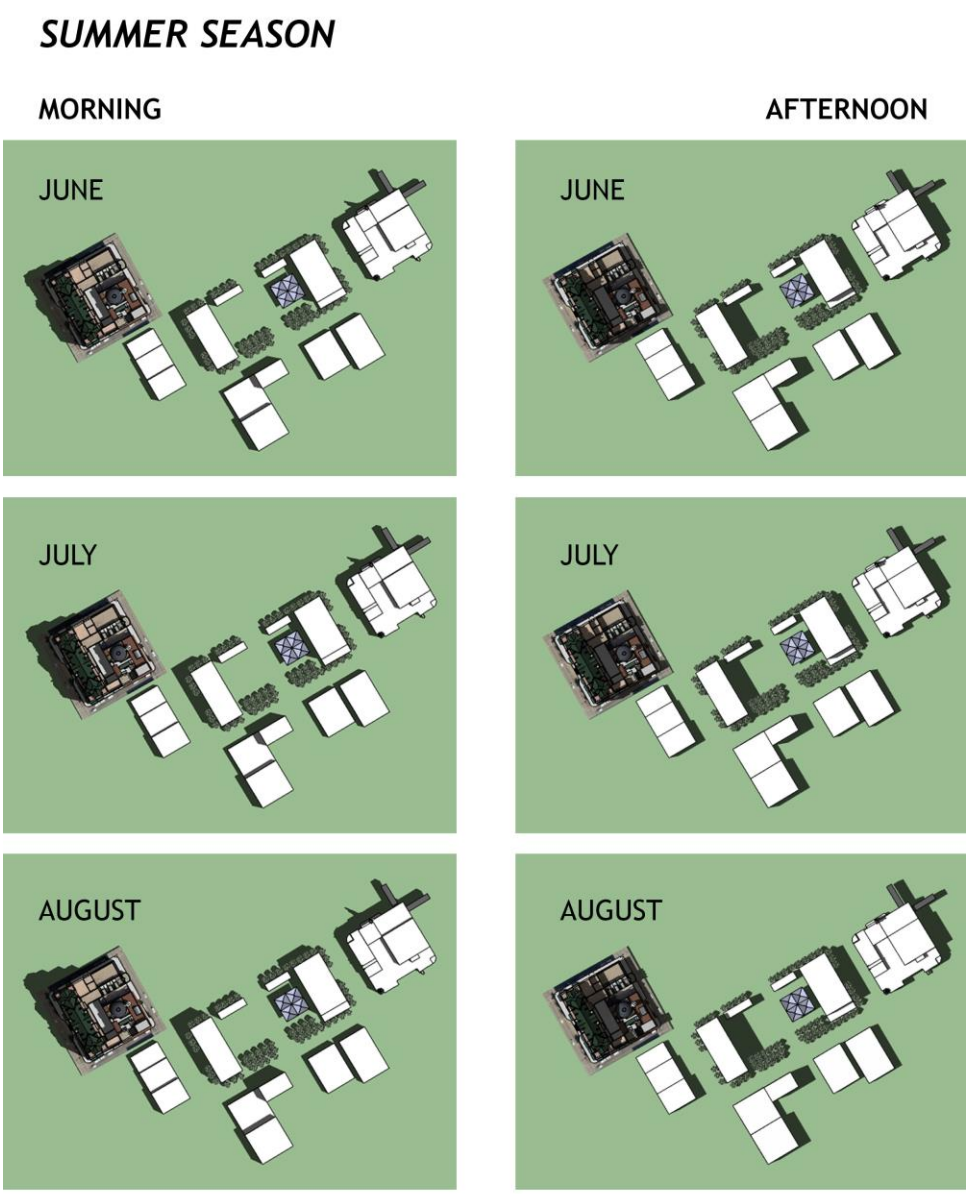

Figure.3: Post Development; Summer Season; Morning and Afternoon shade studies

For example: For each month of the year (12), an image was taken. For each month, 2 images were taken for 2 different times of the day; Morning and Afternoon. Those images were replicated for both Pre-Development and Post-Development conditions:

12 Months * 2 Images (Morning+Afternoon) = 24 images

24 images * 2 development stages (pre + post) = 48 images

For each image, the Area of the shaded zones were mapped and calculated, shown as an example for both Post and Pre-Development conditions below (Please note that each "Before Image" represents the image prior to any Area calculations and each "After Image" represents the image after the Area calculations have been complete):

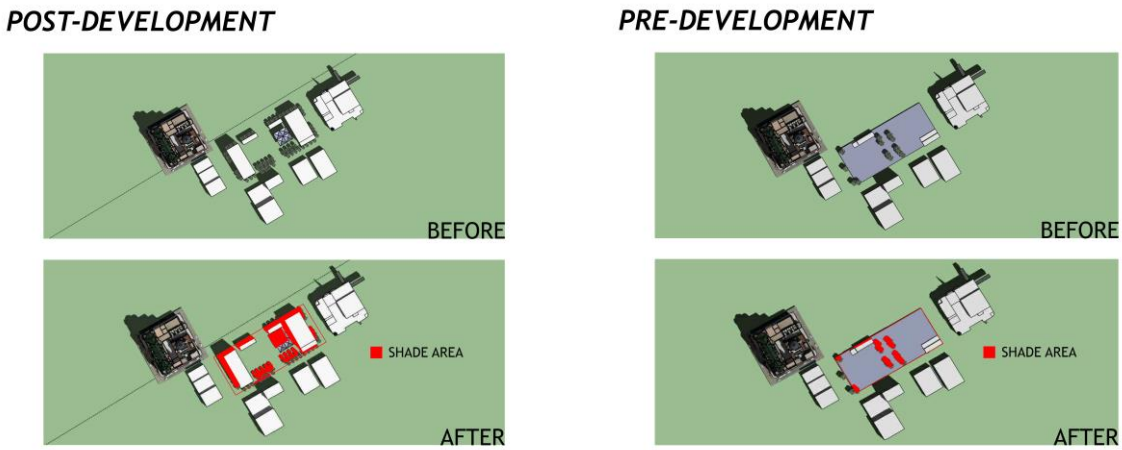

Figure.4: Shaded Area Before and After; Post and Pre Development

The seasonal calculations were taken, totaled, and averaged by the 3 images for Morning (1 image per Month) and the 3 images for Afternoon (1 image per Month). For the summer season post-development condition (example below), (Please note that the area used in the following calculation is converted into acres. The area of an acre is equivalent to 43,560 sq. ft.):

(74,791 sq. ft. (Morning) / 3 Images) = 24,930 sq. ft. (average)
(80,577 sq. ft. (Afternoon) / 3 Images) = 26,860 sq. ft. (average)
(24,930 sq ft. + 26,860 sq. ft.) / 2 = 25,895 sq. ft. (average)
25,895 sq. ft. (average) / 43,560 sq. ft. = 0.5944 Acres

After replicating the calculations above, comparing them to the summer season pre-development condition, and adding the spring season average to the summer average:

Summer season Post-Development = 25,895 sq. ft.
Summer season Pre-Development = 7,260 sq. ft.
Spring season Post-Development = 27,850 sq. ft.
Spring season Pre-Development = 9,095 sq. ft.

(25,895 + 27,850) / 2 = **26,873 sq. ft. (Summer + Spring average Post-Development)**
(7,260 + 9,095) / 2 = **8,178 sq. ft. (Summer + Spring average Pre-Development)**

Also, considering the overall sq. ft. of the studied site is approximately 2.8 acres (120,855 sq. ft.) as 100%, the approximate 26,900 sq. ft. average for the summer and spring seasons translates into 0.6169 Acres. That is approximately 25% or 1/4 of the whole site.
Summer/Spring average coverage (post-dev) = 26,873 sf/120,855 sf = 22%
Summer/Spring average coverage (pre-dev) = 8,178 sf/120,855 sf = 7%

Limitations: This study was conducted in a simulated computer environment and did not take into account every day of the year (365) individually, which would allow more sample images for more accurate calculations. The times of day taken were 11:00AM for the Morning samples and 4:00PM for the Afternoon samples in order to simulate the most impactful environments for shade. To gather more efficient results, ideally every hour would be measured, showing the constant shifting of the shaded areas. In addition, the models built for the study were not shaped exactly as the structures/buildings are in reality, hindering the potential for even more precise area measurements.

Method: Spot surface temperatures were taken hourly and various designated zones in the plaza, all with the same brick paving. The coolest surface temperatures were consistently on the shaded areas under the sculptural umbrellas. These temperatures were compared to areas about 10 feet from the umbrellas in full sun.

Limitations: With no tools to quickly measure spot air temperatures we resorted to taking area surface temperatures. While surface temperatures are telling of the benefit of the shade, air temperatures would have been more telling about the comfort of the area. Nearness to water features did not appear to affect the surface temperature of paving. Given the right tools, it would be beneficial to measure the difference in air temperature near the water features t measure their benefit in lowering plaza temperatures.

Social Performance Benefits:

Performance Indicator 4 and 5:

- *Attracts an average of 133 people at a time on Saturdays and 39 people at a time on weekdays in summer, excluding times during special events.*

- *Encourages people to linger in the plaza. Of the 629 groups (1,991 people total) observed staying in the park longer than one minute, 43% stayed for more than 15 minutes, with a 21 minute average length of stay. The average stay for families with children playing in the fountain was 49 minutes.*

Methods: Onsite observations are conducted on four days during a one week period – one weekday morning, July 7, 2014 (8:00 a.m. – 1:00 p.m.), one weekday afternoon, July 9, 2014 (12:00 p.m. – 5:00 p.m.), one, weekday evening, July 10, 2014 (5:00 p.m. – 10:00 p.m.) and one full Saturday, July, 12, 2014 (8:00 a.m. – 10:00 p.m.). A total of approximately 50 hours of time was collectively spent on site by UTA Arlington research team members. For the observation methods the UTA research team followed the Jan Gehl site counting method described in *How to Study Public Life* (Gehl et.al, 2013) as well as the activity mapping method described in *People Places* (Marcus et.al, 1998). Three researchers are present onsite for all days of study and are assigned zones for which they are responsible. Every hour, on the hour, researchers conduct a head count for their assigned zones that must be completed within 10 minutes. The busiest time observed was a Saturday evening at 9:00 p.m. when 367 people were counted in the plaza. For the remainder of the hour, researchers observe randomly selected individuals or groups and track their activities as well as time spent in the plaza. Of the groups of people observed visiting the plaza 73% sat down.

Limitations: The limited number of days studied in one week is a relatively small sample size and only presents a snapshot of the site for that one week. The performance of the site recorded during the observation week does not take into account special daily conditions, such as special events and weather conditions impacting the district and the city. Ideally, a sampling of days throughout the year would give a more representative count of the number of people on the site at different times of the day and the activities they engage in. The advantage of conducting the observation studies in the hot summer months, as the UTA team have, is that researcher can study site usage during the unpleasant

climactic conditions that many features of the site were designed to mitigate. . The following images (figure.4) are recording instruments developed by the research team based on samples from the relevant literature.

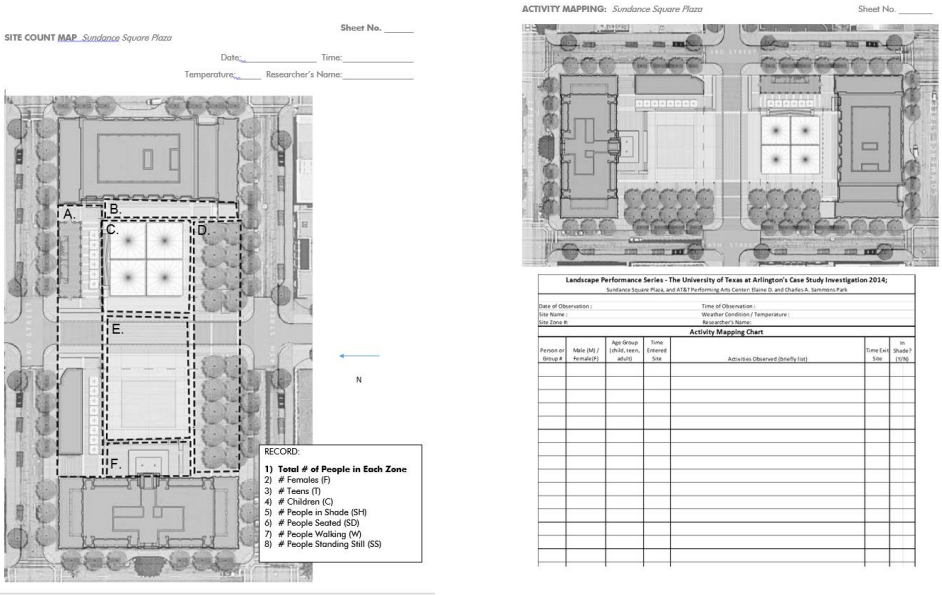

Figure.4: Site Count Map and Site Activity Mapping Chart Used for Site Observations

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Sundance Square Plaza, Fort Worth, Texas

Activity Mapping Chart

Sheet No.	Researcher's Name	Date	Time	Temp.	Weather Conditions	Zone A. Total No. People	Zone A1 Total No. People	Zone B Total No. People	Zone C Total No. People	Zone D Total No. People	Zone D1 Total No. People	Zone E Total No. People	Zone F Total No. People	Zone H Total No. People	Hourly TOTALS Per Researcher	Site Hourly TOTALS
SS7N	Natalia	7/7/2014	1:00 PM	99F	39%, p.sunny	3	4	4	10	0	6				27	27
SS1J	JJE	7/7/2014	2:00 PM	97F	SUNNY		8				0	0	9	3	20	35
SS8N	Natalia	7/7/2014	2:00 PM	97F	34%, p.sunny	0		2	11	2					15	
SS2J	JJE	7/7/2014	3:00 PM	97F	SUNNY		3				0	0	8	0	11	17
SS9N	Natalia	7/7/2014	3:00 PM	100f	33%, p.sunny	0		1	4	1					6	
SS3J	JJE	7/7/2014	4:00 PM	99F	SUNNY		7				0	0	2	1	10	13
SS10N	Natalia	7/7/2014	4:00 PM	99F	31%, p.sunny	0		0	0	3					3	
SS4J	JJE	7/7/2014	5:00PM	100F	SUNNY		0				0	5	1	0	6	15
SS11N	Natalia	7/7/2014	5:00 PM	104F	28%, p.sunny	9		0	0	0					9	
SS5JJ	JJE	7/9/2014	5:00 PM	99F	SUNNY		14				6	44	0	2	66	71
	Ryan	7/9/2014	5:00PM	95F	clear, sunny	0		2	2	1					5	
SS6J	JJE	7/9/2014	6:00 PM	99F	SUNNY		5				9	13	0		27	42
2	Ryan	7/9/2014	6:00PM	95F	clear, sunny	1		11	1	2					15	
SS7J	JJE	7/9/2014	7:00 PM	97F	SUNNY		13				2	61	0	9	85	112
3	Ryan	7/9/2014	7:00PM	95F	clear, sunny	2		21	3	1					27	
SS8J	JJE	7/9/2014	20:00	93F	SUNNY		60	191			57		0	86	394	483
4	Ryan	7/9/2014	8:00PM	95F	clear, sunny	3		27	54	5					89	
SS9J	JR	7/9/2014	9:00 PM	93F	DUSK							769			769	1680
SS10J	JJE	7/9/2014	9:00 PM	93F	DUSK		54					326			380	
5	Ryan	7/9/2014	9:00PM	95F	clear, sunny	27		47	379	78					531	
SS11J	JJE	7/10/2014	9:00 AM	81F	SUNNY		1				0	1		0	2	5
SS18N	Natalia	7/10/2014	9:00 AM	80F	55%, sunny	0		0	2	1					3	
SS12J	JJE	7/10/2014	10:00 AM	84F	SUNNY		2				1			5	8	9
SS19N	Natalia	7/10/2014	10:00 AM	86F	52%, sunny	0		0	1	0					1	
SS13J	JJE	7/10/2014	11:00 AM	88F	SUNNY		6				2	2	0	0	10	13
SS20N	Natalia	7/10/2014	11:00 AM	90f	46%, sunny	0		0	3	0					3	
SS14J	JJE	7/10/2014	12:00 PM	89F	SUNNY		4				0	6	0	13	23	57
SS21N	Natalia	7/10/2014	12:00 PM	95F	38%, sunny	2		9	19	4					34	
SS2N	Natalia	7/10/2014	1:00 PM	96F	36%, sunny	0	6	6	17	3	0	0	4	0	36	36
SS35N	Natalia	7/12/2014	9:00 AM	84F	44%, sunny	2	5	0	2	8	3	62	2	3	87	87
SS15J	JJE	7/12/2014	10:00 AM	81F	SUNNY		4				3	30	0	6	43	57
SS36N	Natalia	7/12/2014	10:00 AM	90F	43%, sunny	2		0	9	3					14	
SS16J	JJE	7/12/2014	11:00 AM	86F	SUNNY		4				6	1	0	5	16	36
SS37N	Natalia	7/12/2014	11:00 AM	90f	36%, sunny	8		0	11	1					20	
SS17J	JJE	7/12/2014	12:00 PM	91F	SUNNY		4				5	0	0	2	11	76
SS38N	Natalia	7/12/2014	12:00 PM	88F	34%, sunny	1		46	17	1					65	
SS18J	JJE	7/12/2014	1:00 PM	93F	SUNNY		7				1	4	0	4	16	47
SS39N	Natalia	7/12/2014	1:00 PM	91F	34%, sunny	0		21	10	0					31	
SS19J	JJE	7/12/2014	2:00 PM	97F	SUNNY		30				6	33	0	0	69	116
SS40N	Natalia	7/12/2014	2:00 PM	94F	33%, sunny	1		11	35	0					47	
SS20J	JJE	7/12/2014	3:00 PM	97F	SUNNY		10				10	58	12	0	90	107
SS41N	Natalia	7/12/2014	3:00 PM	100F	26%, sunny	0		2	14	1					17	
SS21J	JJE	7/12/2014	4:00 PM	99F	SUNNY		14				9	60	22	0	105	108
SS42N	Natalia	7/12/2014	4:00 PM	99f	28%, sunny	0		0	3	0					3	
SS22J	JJE	7/12/2014	5:00 PM	99F	SUNNY							64		11	75	147
1	Ryan	7/12/2014	17:00	99F	clear, sunny		27				23		12		62	
SS43N	Natalia	7/12/2014	5:00 PM	99F	27%, sunny	4		6	0	0					10	
SS23J	JJE	7/12/2014	6:00 PM	99F	SUNNY							58		5	63	129
2	Ryan	7/12/2014	18:00	99F	clear, sunny		18				17		13		48	
SS44N	Natalia	7/12/2014	6:00 PM	99F	28%, sunny	0		11	5	2					18	
SS24J	JJE	7/12/2014	7:00 PM	97F	SUNNY							56			56	176
3	Ryan	7/12/2014	19:00	99F	clear, sunny		19				27		17		63	
SS45N	Natalia	7/12/2014	7:00 PM	96F	28%, sunny	3		41	4	9					57	
SS25J	JJE	7/12/2014	8:00 PM	97F	CLEAR							62			62	281
4	Ryan	7/12/2014	20:00	99F	clear, sunny		32				52		7		91	
SS46N	Natalia	7/12/2014	8:00 PM	95F	30%, sunny	8		52	51	17					128	
SS26J	JJE	7/12/2014	9:00 PM	93F	DUSK							105			105	367
5	Ryan	7/12/2014	21:00	99F	clear, sunny		33				59		18		110	
SS47N	Natalia	7/12/2014	9:00 PM	93f	30%, sunny	13		58	61	20					152	

Table.6: Simplified Hourly Site Count Talley. The Full Talley also Includes Data on Other Factors such as No. of people Sitting, Standing as well as Sex and Age Group in Each Zone.

Performance Indicator 6:

- *Functions as the "civic living room" for downtown Fort Worth, hosting an average of 10 free public events per month, including weekly yoga classes and weekly movie nights which draw over 1,600 attendees.*

Methods: Data sourced from a systematic review of websites, archival data, and literature from the Sundance Square from June to August 2014.

Limitations: The research team did not have access to a complete list from site management on the total events since opening and an estimated number of attendees. Numbers provided above illustrate systematic review of publicly available sources.

Performance Indicator 7 and 8:

- *Improves the quality of life for 88% of the 120 survey respondents and promotes healthy living for 75% primarily through relaxing, leisurely strolls, and fountain play*

- *Improves perception of the city for 88% of the 120 survey respondents and creates a sense of identity for 87%.*

*According to the Sundance Square Plaza Survey conducted by the UT Arlington research team, respondents **agree or strongly agree with the statement** that Sundance Square Plaza (N: **120**):*

- ***Is perceived favorably by 91%** of the respondents (61% strongly agree).*
- ***Promotes a safe & secure environment for 91%** of the survey respondents primarily through the visibility, lighting design, and security personnel.*
- ***Improves perception of the city for 88%** of the survey respondents (58% strongly agree).*
- ***Improves the quality of life for 88%** of the survey respondents primarily through a place to be outdoors, a place to bring visitors, and a place for community.*
- ***Creates a sense of identity for 87%** of the survey respondents.*
- ***Promotes scheduled/organized events for 81%** of the survey respondents through festivals, music concerts, and cultural events*
- ***Accessible for all (American Disability Act-ADA) for 80%** of the survey respondents.*
- ***Promotes art and artistic activities for 77%** of the survey respondents primarily through water features, performing arts, painting and garden design.*
- ***Promotes healthy living for 75%** of the survey respondents primarily through relaxing, leisurely strolls, and fountain play.*
- ***Increases participation in outdoor events for 63%** of the survey respondents (20% neutral).*
- ***Improves understanding of landscape architectural practice for 61%** of the survey respondents.*
- ***Promotes educational activities for 49%** of the survey respondents (39% neutral).*
- ***Promotes a better understanding of sustainability for 41%** of the survey respondents through walkability, climate control, and urban greenery, (39% feels neutral about this question).*
- ***Encourages them to live within walking distance for 32%** of the survey respondents (while 28% neutral and 28% disagree with this statement).*

Survey notes: **120** Sundance Square Plaza users were surveyed between late June and early August, 2014 by UT Arlington research team. **52%** of the plaza users surveyed noted themselves as '**resident'** while **32%** as '**visitor'** and only **15%** as **'employee'.** Survey findings also illustrated that only **7%** of the users were visiting the park **first time** while **80%** visits the park **at least one time per month**. Additionally, nearly **70%** of the respondents arrives Plaza by using a **personal vehicle** while **25%** arrives Plaza **on foot.** Median respondents' travel **10** miles (11.8 miles average respondent) to get to Sundance Square Plaza**.**

Method: Please see the data collection methods in the beginning of the paper.

Limitations: This survey is conducted only on online platform due to resource, time, and permissions limitations. Online survey recruitment letter is circulated among various e-mail lists and social media groups throughout Fort Worth and North Texas. It is realized that online survey may produce more targeted results depending on where the survey can be circulated in a short amount of time. However, it may not always assure high response rate. Another potential limitation is that the recruitment strategies used in this instance do not assure randomized sampling which may have influenced the results.

**Not all of the survey results/findings are reported in their entirety due to LAF's online formatting restrictions for their website, therefore the list only includes a sample of the survey findings. For further information, contact the UTA research team for this case study: Dr. Taner R. Ozdil, ASLA, tozdil@uta.edu.*

Economic Performance Benefits:

Performance Indicator 9:

- *Helps stimulate economic activity and revitalization. In its first six months, the plaza activated over 90% occupancy in two new buildings adjacent to the site. Over 275,000 sf of mixed use development surrounding the plaza has occurred since its completion.*

Limitations: The Westbrook and The Commerce Buildings are completed while The Cassidy (made up of two buildings) is under construction and scheduled to be completed in July 2014. Although the details of these developments are collected and confirmed from multiple reliable sources such as local newspapers, real estate reviews, and/or development websites there found to be slight variations. The numbers above represents minimum totals from the references. Occupancy rates may also vary depending on the market dynamics. Also, the reader should be aware that developing an understanding of the economic impact of a project like Sundance Square Plaza in an urban environment is a complex task. Although this bullet takes into account very promising real estate activity within the adjacent properties and within walking distance to the plaza, it cannot fully take into account some of the larger complex economic trends within the greater district and city. Therefore, the impact of the plaza on economic revitalization must be viewed as indirect.

Performance Indicator 10:

- *Contributed to a 5% increase in per square foot sales prices of residential units in Downtown Fort Worth during the plaza's first six months of existence.*

Methods: Data sourced from a systematic review of archival data and literature from the Downtown Fort Worth, Inc., 2014. The price per square foot is actually lower than in 2012 but does represent an increasing trend since the plaza's opening.

Limitations: Data was collected from secondary sources; there may be errors and/or omissions inherent to such data beyond the researchers' control. Data is for the entire Downtown block group and not just the Sundance Square district. Also, the reader should be aware that developing an understanding of the economic impact of a project like Sundance Square Plaza in an urban environment is a complex task. Although this bullet takes into account promising real estate activity within the adjacent properties and within walking distance to the plaza it cannot fully take into account some of the larger complex economic trends within the greater district and city. Thus, it must be viewed as indirect.

Economic Indicators	Source	2Q 2012	3Q 2012	4Q 2012	1Q 2013	2Q 2013	3Q 2013	4Q 2013	1Q 2014	2Q 2014	Change from Q4 2013 to Q2 2014
Median Residential Sales Price ($/SF)	MLS	$276	$202	$175	$161	$184	$202	$185	$196	$194	**4.9% increase**

Table.7: Median Residential Sales Price ($/SF) 2Q 2012 – 2Q 2014

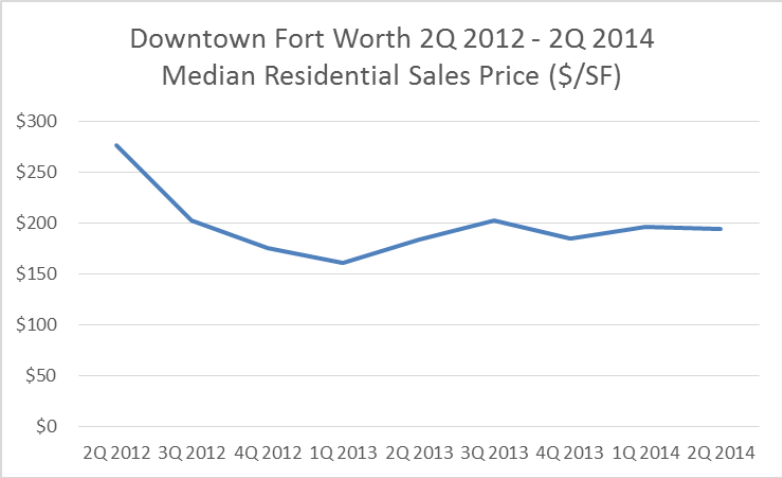

Figure.4: Median Residential Sales Price ($/SF) 2Q 2012 – 2Q 2014 (MLS, Downtown Fort Worth, Inc.)

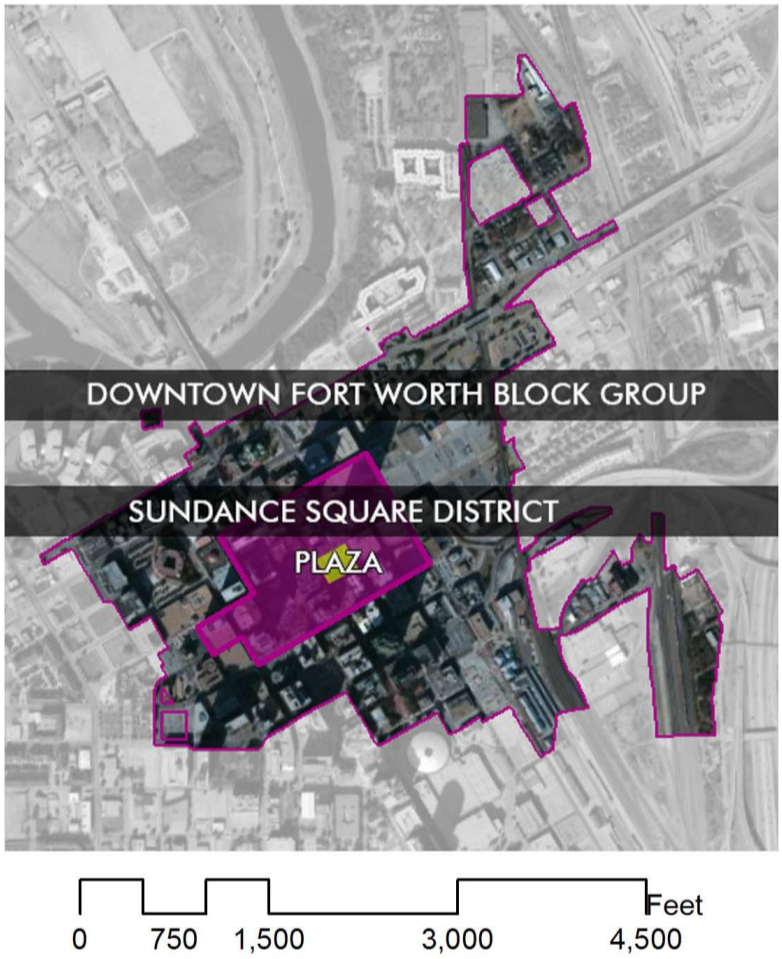

Figure.5: Sundance Square district within Downtown Fort Worth Block Group

Cost Comparison Calculation:

- *The site was formerly a parking lot with spaces for 196 cars. With a daily parking price of $13, if all spaces were occupied on a weekday the gross daily revenue would total about $2,548. Currently the plaza provides space for 190 outdoor chairs at 72 table for three sit-down restaurants on the plaza. The potential gross daily revenue for these tables just for lunch and dinner times is $16,294, figuring that all seats are occupied during those and that only average priced entrees are ordered. That is a 604% increase in potential gross revenue from the outdoor space.*

Methods: Calculations completed based on the assumption that customers stay at the restaurants for 75 minutes each during the dinner time hours of 6:00 p.m. until 9:00 p.m. and for one hour during lunch time. The price of the entrée was established by taking the average price for an entrée at each restaurant. For the three different restaurants these averages were $26, $23, and $11.

Limitations: Due to newness of the project most publicly recorded data was not published before the completion of this research. Therefore, the cost comparisons relied on estimated meal value as well as estimated average daily parking price for the Sundance Square district rather than publicly available data such as retail sales and taxes. These calculations did not take into account the costs associated with overhead, maintenance, etc. and resulting profit margins that might impact net revenue. These calculations also did not take in to account other retail activity taking place within the district. For example, due to limited availability of data, alcoholic drink sales after the completion of the project, or occupancy rates for parking lot before the start of the project were not taken into consideration for the calculations. Such precision in numbers may have significant impact on the potential revenue generated as a result of the project. Therefore above number should be taken as references to potential impacts and implications rather than a complete and accurate reading of net revenue.

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