Landscape Architecture Foundation

George "Doc" Cavalliere Park
Scottsdale, AZ

Figure 1. Rendered site plan of George "Doc" Cavalliere Park. Image courtesy SmithGroupJJR.

Methodology for Landscape Performance Benefits
Landscape Architecture Foundation
2014 Case Study Investigation

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I. Introduction

George "Doc" Cavalliere Park (Doc Park) is a 34-acre neighborhood park nestled into the desert surroundings of Scottsdale, Arizona. The existing site boundaries included a previously established stormwater management facility, which needed to be increased in size, and undisturbed desert habitat. Doc Park responds to both conditions while providing a sustainable, community park for the nearby residents. Park amenities include a covered playground, artificial turf play areas, basketball courts, covered ramadas, and hiking trails on a site that also serves as a regional stormwater management facility. Sustainable features such as native plants, photovoltaic panels, LED lights, permeable decomposed granite (D.G.) paving, all serve to reduce long-term maintenance for an increasingly strained operations and maintenance budget. Ultimately the design was successful at preserving open space and reducing the impact of development, while providing a park that can be easily maintained by the city and enjoyed by residents for years to come. The park was truly adopted by the community after a citizen led initiative changed the park name to George "Doc" Cavalliere Park, honoring a founding member of the City of Scottsdale.

Project Goals & Research Approach

The goals of the project were to minimize the impacts of development, preserve upland Sonoran Desert habitat, minimize the impact of summer high temperatures on park visitors, reduce long term maintenance costs, improve stormwater management, and to utilize a design aesthetic that fits within the desert surroundings. These goals were already evaluated when the park was of the certified as part of the Sustainable Sites Initiative (SITES) Pilot Program. This provided the research team with a wealth of baseline information regarding the sustainable qualities of the park. However, many of the credits for SITES are written to emphasize the sustainable decision making in the design process. Where as the goal of the LAF Case Study Initiative is to evaluate the performance of design decisions. This creates an opportunity to utilize calculations and estimates from SITES as to validate or improve upon the information in the form of performance benefits. In the case of Doc Park, we used the opportunity to evaluate the effectiveness of urban heat island mitigation strategies, local habitat preservation, and visitor frequency all credits achieved by this project for SITES.

Project Context

George "Doc" Cavalliere Park is located at the northeast fringe of the greater Phoenix Metropolitan area, in north Scottsdale. The region is located within the Sonoran Desert Biome, in the more mountainous "Arizona Upland" typology. Climate within this region is typically hot and dry with over 90 days a year above 100°F. Local annual precipitation and potential evapotranspiration are about 8 and 90 inches, respectively. Rainfall patterns are bimodal and typically occur within the summer North American monsoon or winter rainy seasons. During the summer monsoon, sudden, high velocity storms are frequent in the region and flooding is a concern, especially in undisturbed desert areas. While there is significant development surrounding the park, it is largely low-density residential use. The north Scottsdale area is still significantly influenced by the indigenous Sonoran Desert landscape, and that aesthetic is maintained at many developments. The park is also located in close proximity to the McDowell Sonoran Preserve, a large protected area of desert habitat that is now mainly used for recreation and protection of native flora and fauna.

II. Performance Benefits

Environmental

PB1	Captures and infiltrates 100% of stormwater generated on-site from a 100-year, 2-hr storm event. The site also manages runoff from several upstream developments with a storage capacity of 49.5 acre-feet.

Prior to the construction of Doc Park the site was utilized as a regional stormwater management site, and this function was to remain after construction of the Park. The design team was therefore challenged with providing the required park amenities without preventing the functionality of the stormwater management systems. Additionally, early on in the project it was discovered that the original storm water retention basins were undersized. Within the park, the capacity of Basin No. 1 had to be increased to accommodate the correct volume of runoff. The following excerpt from the Drainage Report prepared by Argus Consulting outlines how drainage systems function.

"Four offsite channels discharge floodwaters into Doc Park [Troon North Park] (Figure 2). All offsite channels convey floodwaters to Detention Basin No.1 where is temporarily stored, then discharged into Detention Basin No.2, and finally released onto downstream waterways."

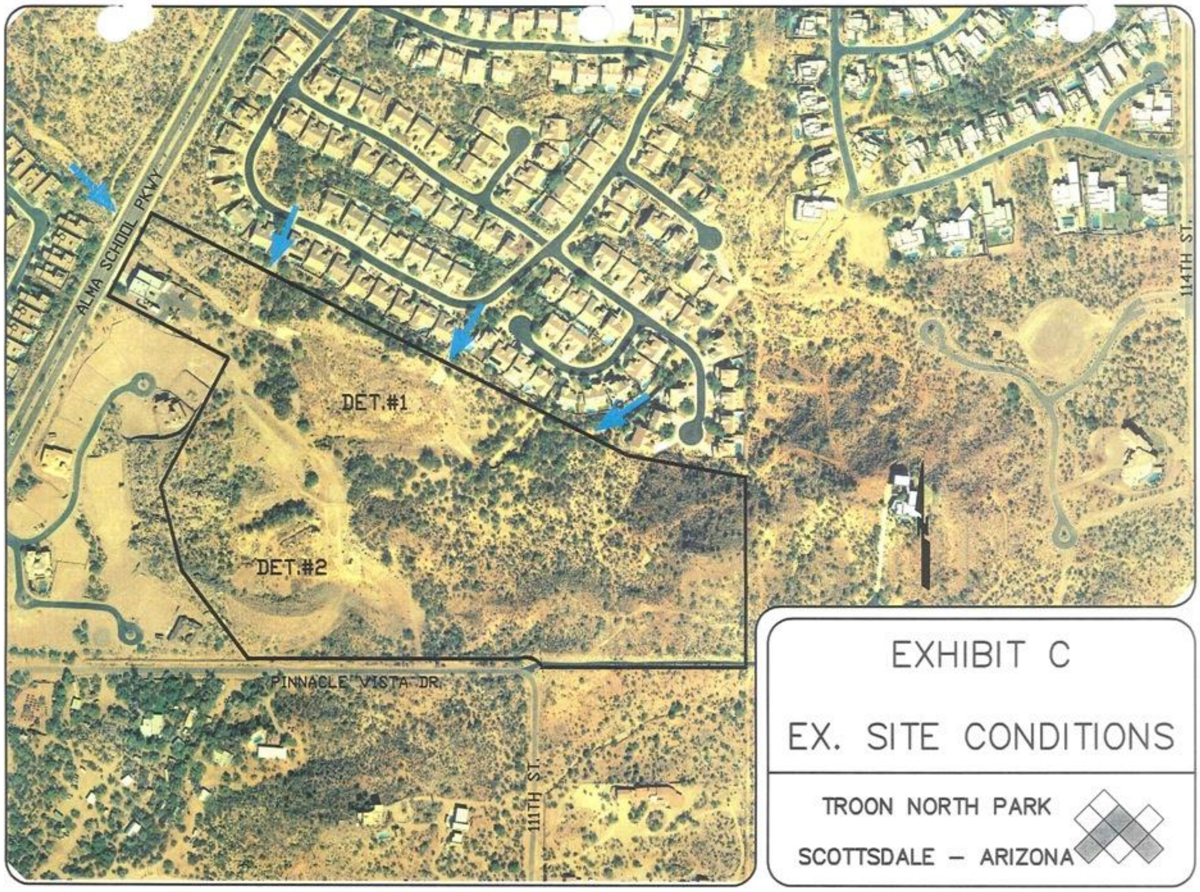

Figure 2. Existing drainage system at George "Doc" Cavalliere Park. Image from *Troon North Park Drainage Report*.

The stormwater managed at Doc Park includes run-off created by the construction of the park as well as run-on originating from the surrounding neighborhoods. Standards established by the City of Scottsdale and Maricopa County requires that the site retain runoff from a 100-year/2-hour storm event. All calculations provided in the Drainage Report accommodate those standards. For calculations Argus Consulting utilized the, computer program HEC-1 and the Rational Method.

*"The required volume due to proposed park amenities **(2.4 Acre-Feet)** is included within Detention Basin No.1."*

When combined the two detention basins can store 49.5ac ft easily accommodating the 2.4ac ft generated by Doc Park.

PB2	**Saves 88% of potable water use for irrigation by limiting turf areas and utilizing a native plant palette.**

The primary strategy for reducing irrigation use at Doc Park was to supplement native vegetation with native plantings adapted to the region's low rainfall. After an establishment period, three years for trees and one year for shrubs, the plants can be weaned off irrigation until the system can be turned off completely. Documentation submitted to Sustainable Sites Initiative (SITES), which served as the basis for this methodology, was calculated assuming the temporary irrigation system. However, during the Case Study Investigation the City of Scottsdale installed a natural turf grass panel that was not installed during construction of the park. Therefore, it was necessary to update the irrigation estimates accounting for this new information. To arrive at the percentage of reduced potable water use for irrigation the research team compared an estimated Baseline Water Use with the Designed Water Use. Each was calculated using equations generated by SITES and using documentation collected by SmithGroupJJR.

The first step was to generate the Baseline Landscape Water Requirement using the following equation generated by SITES.

$$BLWR = ET_0 \times A \times C_u$$

Where:

ET_0 = average evapotranspiration for the site's peak watering month (June) in inches/month

A = area of irrigated landscape in square feet

C_u= conversion factor (0.6233 for results in gallons/month)

Table 1. Doc Park Calculated BLWR

ET_0 (inches/month)	**A (square feet)**	**C_u**	**Calculated BLWR**
10.9	427,640	0.6233	2,905,373

The second step was to generate the Designed Landscape Water Requirement using the following equation generated by SITES.

$$DLWR = RTM \times [(ET_0 \times K_L) - R_a] \times A \times C_u$$

Where:

RTM = Run time multiplier, equal to 1/low quarter distribution uniformity (D_U)

ET_0 = average evapotranspiration for the site's peak watering month (June) in inches/month

K_L = Landscape coefficient for type of plant in that hydrozone

R_A = Allowable rainfall (25% of average monthly rainfall for the peak watering month (June))

A = area of hydrozone (square feet)

C_u= conversion factor (0.6233 for results in gallons/month)

Table 2. Doc Park Calculated DLWR

Common Values; ET_0 = 10.9; R_A = 0.01; C_U= 0.6233; RTM = 1.43						
Hydrozone	**D_U**	**K_L**	**R_A**	**A**	**C_u**	**Water Req.**
Trees	0.7	0	0.01	19952	0.6233	0
Shrubs	0.7	0	0.01	53598	0.6233	0
Accents	0.7	0	0.01	10364	0.6233	0
G.C.	0.7	0	0.01	40102	0.6233	0
Reveg	0.7	0	0.01	262667	0.6233	0
Turf	0.7	0.8	0.01	40957	0.6233	357,092

					Total	**357,092**

For these calculations a KL of zero was used for the hydrozones associated with all of the plants on the temporary irrigation system. This was the most efficient way to account for the future irrigation use. Values for the distribution uniformity and turf landscape coefficient were provided by the SITES documentation. The final step was to compare the BLWR with the DLWR and generate the percent reduction.

Table 3. Doc Park Irrigation Percent Reduction

BLWR	**DLWR**	**Difference**	**Percent Reduction**
2,905,373	357,092	2,548,281	88%

Ultimately the reduction in potable water use for irrigation is dependent on the mechanical shutdown of the irrigation system. At the time of research the irrigation system was still engaged as many trees were still within the establishment time period. Managing the irrigation system to slowly wean the park's native plantings off the supplemental water source will determine if the percentage reduction is actually realized in the future.

PB3	**Reduces energy consumption by 97% by utilizing energy efficient fixtures instead of incandescent.**

The energy reduction achieved by the selected fixtures on site was originally calculated by SmithGroupJJR for Sustainable Sites Initiative (SITES) documentation. The results were achieved by comparing the annual energy consumption of the utilized fixtures with the annual energy consumption of the lowest cost comparable fixture. Calculations account for the quantity of each fixture, wattage of each fixture, and time of operation.

Table 4. Fixture based energy reduction. *(Reproduced from SmithGroupJJR SITES Documentation)*

Qty	**Fixture Used**	**Annual Energy Use (kWh/year)**	**Comparable Fixture**	**Annual Energy Use (kWh/year)**	**Percent Reduction**
22	**Beta LED**	**5,143**	**Incandescent**	**204,905**	**97%**
6	**Visonaire**	**4,109**	**Incandescent**	**104,781**	**96%**
3	**Visonaire**	**2,055**	**Incandescent**	**52,391**	**96%**
15	**Beta LED**	**603**	**Incandescent**	**10,478**	**94%**
27	**Bega**	**888**	**Incandescent**	**9,430**	**91%**
5	**Winscape**	**68**	**Incandescent**	**1,746**	**96%**
2	**Winscape**	**27**	**Incandescent**	**699**	**96%**
	Total	**12,892**		**384,430**	**96.6%**

PB5	**Provides habitat with 16 species of arthropods observed in addition to rabbits, quail, lizards, snakes, and birds.**

A primary goal of Doc Park was to preserve natural desert habitat and create a new park that would blend in with that habitat. Casual observations of the park indicate that there is quite a bit of wildlife activity occurring. Sightings of rabbits, quail, lizards, and birds were quite common during fieldwork. Quantifying and confirming those observations was not necessarily a straightforward task.

Figure 3. Pitfall trap locations.

To get this information the research team used pitfall traps to collect and observe arthropods through the site. This is a data collection method used frequently at ASU by the National Science Foundation sponsored Central Arizona Phoenix Long-term Ecological Research program, and the research team was able to use their experiences as a basis for the protocol. Briefly, the method utilizes 12-ounce plastic cups mounted in the ground so that the top of the cup is flush with adjacent grade. After 3 days in the field, the traps were collected and results observed and recorded by photograph. Some advantages to this method include: simplicity of installation, minimal site disturbance, limited on-site monitoring required, and streamlining the process to observe only groups of ground dwelling animals at a lower biotrophic levels. After completing the fieldwork some disadvantages to the method were discovered including: difficulty counting the number of specimens, difficulty identifying the specimens, extreme soil temperatures as high as 140^{o}F damaging portions of some plastic cups, and some specimens were lost or destroyed by predators.

Table 5. Pitfall trap results.

Pitfall Trap #	Location	Number of Species
PT1	Shade Structure	6*

PT2	**Trail Ramada**	**3**
PT3	**Trail**	**4**
PT4	**Trail**	**4**
PT5	**Trail**	**4**
PT6	**Basin**	**2**
PT7	**Basin**	**3**
PT8	**Playground**	**2**
PT9	**Parking Lot**	**2**
PT10	**Turf**	**2**
PT11	**Turf**	**2***
***Observed Lizards among species collected**		

Figure 4. Installed pitfall trap.

Figure 5. Lizard collected in trap PT11.

The highest numbers and diversity of animals were observed in PT1 and PT11, both located in close proximity to the park's large Ramada area and irrigated turf panel. Animals observed in these traps included a lizard and gecko. It is likely the higher numbers and diversity of animals captured in these traps were because of the favorable microclimate conditions of cooler temperatures from the live and structured shade and higher ground moisture conditions from the nearby irrigated turf panel. Surprisingly, many of the traps installed in the undisturbed desert areas contained few animals and portions of the cups had melted from the extreme surface temperatures. This was not the case for the traps closer to the cooler and moister developed areas of the park. These results demonstrated how developed park infrastructure within an arid undisturbed area can locally create habitats of increased structural complexity and resources that benefit an increase in the numbers and diversity of lower biotropic level organisms that in turn provide a food resource for higher level biotrophic organisms, some of which like birds are highly valued as amenities by park visitors.

PB6	**Reduces hardscape surface temperatures under tree shade and structured shade by 30°F and 45°F, respectively, when compared to unshaded areas of the site. The steel canopy helps to maintain playground surface temperatures under 82° F.**

Temperature and how it is managed plays a large role in the success of an arid region public space. To evaluate how this was accomplished in Doc Park, the research team recorded both surface and air temperatures. Surface temperature data gave a sense of how certain materials impact temperature within the park and air temperature data gave a sense of how those materials begin to impact temperature off the ground, in the human sphere.

Live trees and structured (hard) shade reduced mid-day hardscape surface temperatures by 30.4^{o}F (Table 6) and 44.7^{o}F (Table 7), respectively, when compared to unshaded areas of the site. The average reduction was calculated by comparing the average temperature of concrete and stabilized decomposed granite (D.G.) surfaces in the open, under live shade, and under hard shade. Where possible, the research team attempted to capture data recordings for each surface type in the open, under live shade, and under hard shade. The analysis compares concrete and stabilized D.G. because these were the primary hardscape surfaces utilized at the park and the research team was able to measure these two surface types under all three conditions.

Table 6. Average surface temperature difference of hardscape materials in open and live shade conditions (^{o}F) at solar noon.

Surface Type	Open	Live Shade	Difference
Concrete	129.9	96.9	33
Stabilized D.G.	119.4	91.6	27.8
Average Reduction			**30.4**

Table 7. Average surface temperature difference of hardscape materials in open and hard shade conditions (^{o}F) at solar noon.

Surface Type	Open	Hard Shade	Difference
Concrete	129.9	78.6	51.3
Stabilized D.G.	119.4	81.3	38.1
Average Reduction			**44.7**

While Doc Park utilizes both live shade and hard shade, the large steel shade canopy at the center of the park is key to the park's microclimate heat mitigation strategy. During the day it provides consistent shade for the playground, one of the most used areas of the park. In comparison to the live shade, the hard shade of the large Ramada structure provided a very consistent and significant reduction in surface temperatures (Table 8). The highest temperature recorded under the canopy was stabilized D.G. at 81.3^{o}F, the same surface under live shade reached 96.9^{o}F (Table 9). Casual conversations with visitors also confirmed this fact as many visitors felt that this park provided a rare, comfortable playground for summer use.

Table 8. Playground surface temperature (^{o}F) at solar noon.

Play Rubber	76.6
Play Sand	74.9
Concrete	78.6
Gabion Basket	69.2
Stabilized D.G.	81.3
Concrete Bench	72.4

The research team recorded a series of temperature readings from each surface type in random locations (Table 9). These surfaces included: undisturbed native soil, vegetated surfaces, stabilized decomposed granite, natural turf, artificial turf, play sand, rubberized play surface, concrete, and asphalt. Hottest surface temperatures ranged from 119°F to 137°F and were recorded on unshaded surfaces such as impervious asphalt and concrete, bare desert soil, landscaped surfaces covered with impervious decomposing granite, or artificial turf grass. The coolest mid-day surface temperatures ranged from 69°F to 82°F and were recorded on ground surfaces covered by structured shade or unshaded live turf grass.

Surface temperature data were recorded on June 5, 2014 at solar noon (12:30 to 1:30 pm) when sunlight was most directly attenuated. Weather during this interval was normally clear and hot. Surface temperatures were recorded with a hand-held infrared thermometer at a 7° angle of view. Surface temperatures of each of the park's 12 surface types were recorded for open, sun exposed and shaded conditions. Data collection points were randomly assigned and a total of 297 data points were recorded.

Table 9. Mean mid-day surface temperatures at George "Doc" Cavalliere Park, Scottsdale, Arizona, June 19, 2014. Weather conditions were seasonally hot and clear.

Surface Cover Type	Mean Surface Temperature (°F)	Std. Error
[Hard Shade]Artificial Turf	74.3	1.2
[Hard Shade]Concrete	78.6	1.5
[Hard Shade]Concrete Bench	72.4	1.3
[Hard Shade]Gabion Basket	69.2	1.1
[Hard Shade]Play Rubber	76.6	1.3
[Hard Shade]Play Sand	74.9	1.2
[Hard Shade]Stable DG	81.3	1.3
[Live Shade]Asphalt	99.6	1.9
[Live Shade]Bare Desert Soil	84.9	1.3
[Live Shade]Concrete	91.6	2.1
[Live Shade]Stable DG	96.9	1.9
[Live Shade]Vegetated Surface	78.9	1.1
[Open]Artificial Turf	137.9	0.9
[Open]Asphalt	131.1	1.6
[Open]Bare Desert Soil	125.0	1.1
[Open]Concrete	119.4	1.0
[Open]Concrete Bench	110.3	1.3
[Open]Gabion Basket	116.0	1.3
[Open]Stable DG	129.9	1.0
[Open]Steel Bridge	88.3	0.9
[Open]Turf	72.9	1.0
[Open]Vegetated Surface	79.7	1.9

PB7	**Reduces air temperatures on the natural turf field and the playground by 3.3°F and 2.3°F, respectively, when compared to air temperatures in the undisturbed desert areas.**

The portable data loggers were positioned at nine locations within the park (Figure 6) to enable an understanding of how visitors were likely to experience temperatures throughout the park.

This allowed the research team to compare air temperatures in the designed areas of the park, such as the playground and turf field, with natural desert areas indicating how design decisions are impacting microclimate mitigation. During the four days, the mean air temperature on the natural turf field was 86.1^{o}F and the mean air temperature on the playground was 87.1^{o}F. These were the two coolest locations recorded in the park. The mean air temperature on the natural desert trail was 89.4^{o}F and the mean air temperature in the parking lot was 88.2^{o}F.

Figure 6. Portable data logger locations, DP1-DP9.

Results from the portable data loggers showed some larger temperature trends throughout the park (Figure 7). The turf field was consistently one of the coolest spaces in the park during both the daytime and nighttime hours, and sharp drops in temperature caused by the latent heat of vaporization can be observed at discrete times when overhead irrigation was running. During the warmest parts of the day from about 9:00 am to 7:00 pm, spaces under the structured shade cast by the large central park Ramada were among the coolest in the park. However, during the nighttime hours, spaces under the central Ramada became the warmest in the park due to the Ramada's entrapment of long wave radiation. Although the Ramada's structured hard shade did exacerbate the impacts of extreme desert heating at night, it did provide substantial human comfort benefits during the day through shading.

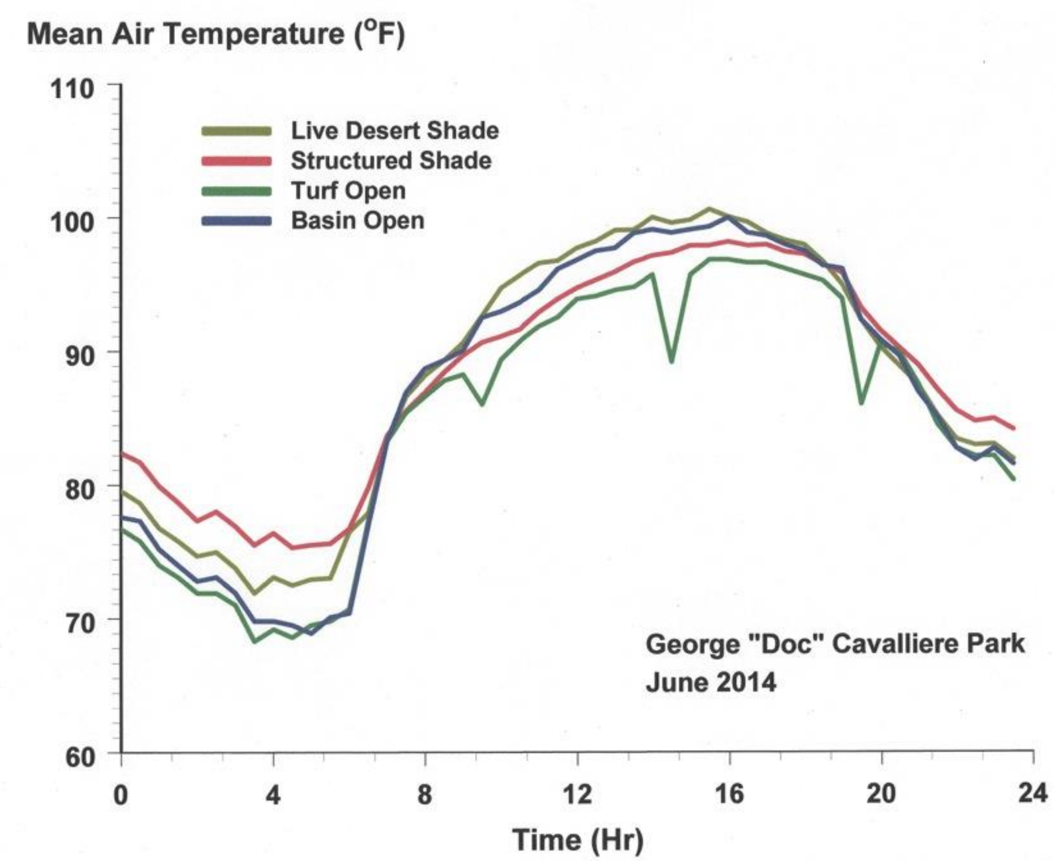

Figure 7. Mean patterns of daily air temperatures from June 19-22, 2014, under live desert tree shade, structured hard shade, over turf grass or bare soil in an open basin.

Air temperature data were recorded by portable data loggers every 30 minutes for 4 days from June 19-22, 2014. Weather during this interval was seasonally hot and clear. The portable data loggers were WatchDog B series 2K button loggers from Spectrum Technologies, Inc. (http://www.specmeters.com/). Nine data loggers were installed at approximate heights of 4 to 8 feet above ground throughout the site. The data loggers were installed in orientations removed from exposure to direct insolation, either protected by tree canopy shade, structured hard shade, or placed inside a white-louvered plastic micro-meteorological shelter. Locations were selected to optimize the variety of park conditions. Data loggers were located in the natural turf field, parking lot, restroom, playground, hiking Ramada and in several trees located in the basins and trails (Figure 6). The data loggers located in the turf and basin bottom, where they could not be hung on a nearby tree or structure, were placed in the white-louvered shelters. Air temperature data were directly downloaded to the computer for analysis using JMP8 statistical software (http://www.jmp.com/software/jmp8/).

Social

PB8	**Attracts an average of 32 visitors per morning on a weekend in the low season of summer. Of these, 92% were engaged in optional activities, and 70% of these were also engaged in social activities.**

The methodology for observing site visitors to the park were derived from Jan Gehl's observations on public spaces as well as methodologies developed in previous LAF Case Studies. The basis of these types of observations is that visitors to the park will engage in three general types of activities: necessary, optional, and social. A successful public space has a greater percentage of both optional and social activities. Doc Park is a rather suburban park that tends to be more active on the weekends when visitors have more leisure time. For this reason we planned our observations for three days over a weekend (Friday, Saturday, and Sunday) from 8:30 am – 12:30 pm. Each visitor was recorded, identifying their location in the park, activity, and classifying their activity as necessary, optional, or social.

Table 10. Summary of visitor observations from June 20, 2014 – June 22, 2014. Weather was seasonally hot and dry.

Date	Total Visitors	Percent Optional	Percent Social
06/20/14	31	87%	67%
06/21/14	31	87%	89%
06/22/14	35	100%	60%
Average	32	91%	72%

Visitors to the park were overwhelmingly there for optional activities. The park is not connected to other urban activities; therefore, a majority of visitors drive to the park, treating it as a destination. The summer temperatures may have influenced this trend. In cooler times of the year pedestrian (or cyclist) visitors may be more numerous. Visitors who did make it to the park often engaged in unplanned social activities. This was most frequently observed with children playing together in the playground and their parents who would talk while watching them play. There were also several visitors who utilized the trails for hiking and walking dogs.

A significant limitation of this investigation was that our observations had to occur within the summer. The number of visitors observed during this study was probably not representative of park use throughout the year. The heat also presented a challenge to the research team, and is in part why observations were limited to the morning hours. It is also possible that the timing effected when the park was most used, due to children being out of school for the summer. When the research team was completing other environmental measurements during the week, the park was busier than expected. This may be due to the fact that parents may have been trying to occupy their children's time during the week that would have otherwise been spent at school. To get a more complete picture of the social benefits provided by this park, observations should be extended to other, busier times of the year.

It is also important to note that the plan for site observations required review and approval by the ASU IRB Board. The data collected about visitors during observations was more limited than some previous case studies; however, the research team found that streamlining the data collected allowed for a prompt review and approval process.

Economic

PB4	**Generates an estimated 25,000 kWh of solar power annually, which has a value of $2,993 per year.**

The contractor selected to design and install the photovoltaic system provided informative calculations as part of their submittal. Data provided by the solar panel engineer estimates the system to provide 24,945 kilowatt-hour (kWh) of power each year. Using an estimate of $0.12 per kWh, also provided by the engineer, the estimated value of the annual power generated can be calculated.

24,945 kWh (power generated) x $0.12 (power cost per kWh) = $2,993.40

These data are based on estimates generated by the engineer and would vary depending on actual conditions throughout the year. At the time of research a method for tracking the actual performance of the system was not available.

III. Cost Comparison

Wherever it was practical, the design team elected to use permeable stabilized decomposed granite (D.G.) paving in lieu of more traditional materials. The parking lot, most of the entry drive, and pathways are constructed from stabilized D.G. harvested from the site. **The cost of paving these areas in stabilized decomposed granite totals approximately $87,317. The cost of paving these same areas in with standard impermeable surfaces such as asphalt and concrete would be approximately $206,571.** In this application the more rugged material does not present maintenance concerns and is a cost effective option for a permeable paving material.

The research team was provided with a cost estimate of Doc Park generated by JJR|Floor. This estimate was the last one prepared prior to contractor selection and represents a fairly accurate idea of costs at the time of construction. The organization of the estimate also allowed the research team to compare costs quite easily. Total quantities of each paved surface type and unit costs were provided allowing an easy comparison between the materials.

Table 12. Material Costs As Designed

Material	Area	Unit Cost	Total Cost
Stabilized D.G. Path (2” Depth)	23,991 s.f.	$2.23/s.f.	$53,499.93
Stabilized D.G. Drive (4” Depth & 4” ABC)	2,505 s.y.	$13.5/s.y.	$33,817.50
		Total Cost	**$87,797.25**

Table 13. Material Costs Traditional

Material	Area	Unit Cost	Total Cost
Natural Grey Concrete Path	23,991 s.f.	$6.00/s.f.	$143,946.00
Asphalt Paving	2,505 s.y.	$25.00/s.y.	$62,625.00
		Total Cost	**$206,571.00**

The difference in cost between the designed solution and a more traditional solution comes out to $119,254.

IV. References and Resources

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