CHESTER ARTHUR SCHOOLYARD METHODOLOGY

SALT Design Studio
Landscape Performance Series
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Full case study available at *https://landscapeperformance.org/case-study-briefs/chester-arthur-schoolyard*

Background

The performance evaluation of Chester Arthur School in Philadelphia was carried out by SALT Design Studios after being commissioned in 2015 by the Friends of Chester Arthur to design a renovation of the Chester Arthur Schoolyard. Friends of Chester Arthur is a nonprofit organization comprised of parents and community members who support the current and future staff, teachers, students, and parents in their effort to create and maintain a successful and safe environment for all children who attend Chester Arthur. After being commissioned by the Friends of Chester Arthur, SALT Design Studios conducted a Pre-Construction Site Assessment in 2016 to obtain a baseline reading of existing conditions at the school. The initial assessment's findings were used to inform a design that focused on improving habitat, creating better conditions for children to learn and play, and managing stormwater runoff more responsibly. The Post-Construction Site Assessment, conducted in 2017, provides statistical evidence of the achievement of many of these goals as outlined in this Methods Document.

Research Strategy

The Pre-Construction Assessment was conducted in June 2016, and the Post-Construction Assessment was conducted in May, June, and July 2017. The Post-Construction Site Assessment evaluated environmental conditions and usage of the site. The assessment metrics are based on the Landscape Architecture Foundation's Landscape Performance Series as well as observation protocols System for Observing Play and Leisure Activity in Youth (SOPLAY) and System for Observing Play and Recreation in Communities (SOPARC).

Pre-construction data was gathered by two data collectors from SALT over a 4-day period on 2 school days (Wednesday June 1 and Thursday June 2) and 2 weekend days (Saturday June 11 and Sunday June 12) Post-construction, observation data was collected on 3 school days (Wednesday May 24, Tuesday May 30, and Friday June 9) and 2 weekend days (Sunday June 9 and Saturday July 8).

For purposes of evaluation, the site was divided into 9 distinct activity zones (figure 1). Zones were determined by the general layout and location of the proposed site program prior to construction. Each zone was selected to be uniform in scale and surface area.

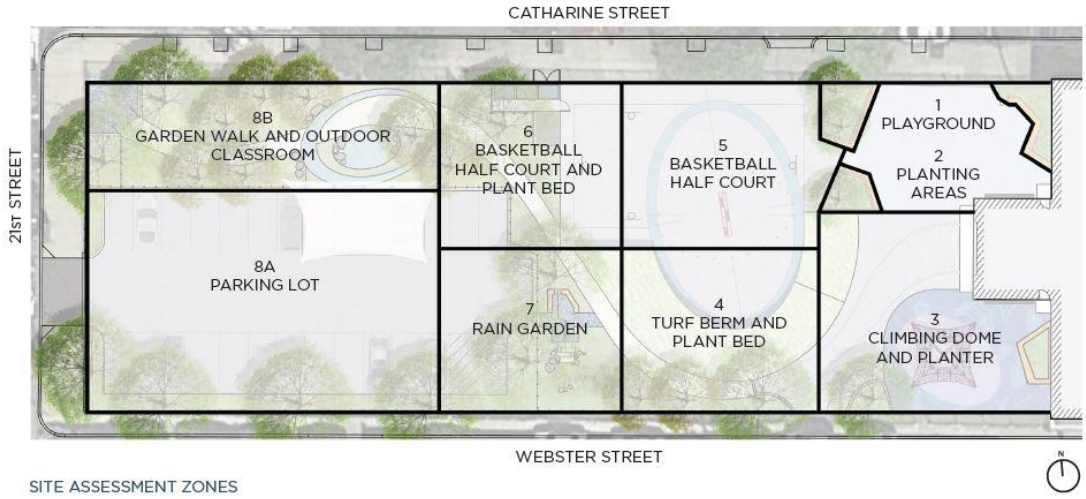


Figure 1: site assessment and activity zones

To evaluate social benefits, SOPLAY and SOPARC protocols were utilized to gather information about the location of individuals (students, teachers, staff and neighbors) on site along with their gender, ethnicity, age and physical activity level (sedentary, moderate, and vigorous). SOPLAY was selected for use during school days while SOPARC was used to evaluate community use of the site after school hours. In keeping with SOPARC and SOPLAY protocols, observations were taken from a single point in each of the 9 observation areas, with a 5-10 second visual sweep from left to right.

Pre-construction, SOPLAY was only conducted during the 2 school days. Post-construction, SOPLAY was only conducted during the 3 school days. The SOPLAY protocol was used during school hours as follows:

- 30 minutes before school start
- 5 minutes after each recess start (5 daily recesses of 15 minutes each)
- 15, 45, and 75 minutes after school end

Pre-construction, SOPARC was conducted during all 4 observation days. On school days, SOPARC was only conducted during evening hours. Post-construction, SOPARC was conducted during all 5 observation days. On school days, it was only conducted during evening hours. The SOPARC protocol was used as follows:

- 5, 6 and 7pm on school days
- 9, 12 and 3pm on weekend days

Environmental and sound data was collected for all observation days pre- and post-construction during 4 time slots each weekday and 3 on weekend days.

Weekday:
Morning – 9:00am
Mid-day – 12:00pm – 1:10pm
Mid-afternoon – 2:30pm – 4:00pm
Late afternoon/evening – 4:30 – 6:00pm

Weekend:
Morning – 9:00am
Mid-day – 12:00pm
Mid-afternoon – 3:00pm

Environmental data collection included recording of decibel levels, observation of wildlife species, temperature readings on surfaces and objects, humidity, and general weather conditions as detailed in the sections below.

Landscape Performance Benefits

ENVIRONMENTAL

- **Reduces overall average surface temperatures by 7.2° F.**

Methodology

Surface conditions at Chester Arthur have been significantly altered from pre-construction conditions. Pre-construction, the site was 91.4% asphalt pavement. Post-construction, it was 54.3% asphalt. The renovated site contains a variety of pavement surfaces that impact the microclimate at school. Most significant is the increase in green space, which is a proven method of reducing surface and air temperatures.

Temperature readings were taken with an infrared thermometer at a single point for each surface type and selected objects within each zone. Pre- and post-construction measurements were taken at the same location within the zone, even where the zone had been altered after construction. Measurements were taken 4 times each weekday and 3 times on weekends during the times listed in 'Research Strategy' above. Daily temperatures and humidity were recorded, with data coming from Weather Underground.

The following temperatures indicate the average surface temperature per zone. The calculations are weighted by the percentage of each surface within the specific zone. The weighting method was selected to convey variations in the temperature experience of an area based on the proportion of surface types. For example, a zone that is 90% asphalt and 10% vegetated would feel different than an area that is 90% green and 10% asphalt, so zones were weighted by proportion of surface types in the zone. For example, zone 3 is 10% artificial turf, 40% asphalt, and 50% safety surface, so those were used to determine the average temperature for the zone.

Pre-construction zones	Avg. Pre-Construction Surface Temps
1. Playground	113.0°
2. Planting Areas	85.3°
3. Asphalt Adjacent to Building	97.9°
4. Asphalt with Hopscotch	106.5°
5. Asphalt with Four Square	109.3°
6. Basketball Half Court	107.4°
7. Basketball Half Court	107.1°
8. Parking Lot	101.5°
Total	828/8 = 103.5°

Zones	Avg. Post-Construction Surface Temps
1. Playground	107.0°
2. Planting Areas	75.6°
3. Climbing Dome and Planter	101.6°
4. Turf Berm and Plant Bed	102.4°
5. Basketball Half Court	102.9°
6. Basketball Half Court and Plant Bed	93.9°
7. Rain Garden	91.8°
8A. Parking Lot	104.6° (avg. with 8B = 95.15)
8B. Garden Walk and Outdoor Classroom	85.7°
Total	770.35/8 = 96.3°

Pre-construction 103.5°F – 96.3°F = 7.2°F average temperature reduction across the 8 zones (with zones 8A and 8B averaged together post-construction)

See appendix for additional temperature information.

Limitations

It rained on one of the observation days, which resulted in significantly reduced surface temperatures; this data was omitted. We anticipated a 20°F temperature drop across site surfaces due to increased shade and evapotranspiration associated with additional trees and plants. While observed temperatures were not as low as expected, we predict that as trees and shrubs mature and grow the full benefits of shade and evapotranspiration will be realized with greater reductions in average site temperature.

- **Manages 28,000 gallons of stormwater for every 1.5 in of rainfall over a 24-hour period.**

Methodology

Stormwater management for the schoolyard was designed in accordance with the Stormwater Retrofit Guidance Manual produced by the Philadelphia Water Department (PWD) for the treatment of the 1-in, 24-hour rainfall event. The design approach was conservative due to the slow infiltration rate of the underlying soils (less than 0.5 in/hr). The completed design disconnected approximately 7,100 sf (0.16 acres) of existing impervious area to direct pervious areas with loading ratios ≤ 2:1. PWD is conducting maintenance of the green stormwater infrastructure (GSI) systems on a regular basis, including monitoring of overall function, plant health and soil retention.

The University of New Hampshire Stormwater Center (UNH) has begun to monitor the performance of the stormwater management system. A weather station will be installed on the Rain Capture Canopy to correlate rainfall to system volume capture and infiltration. In addition, UNH will be gathering data with students using the site observation wells.

Drainage areas

- Total on site Volume = 20,951 sf* 1.5"/12 * 7.48 gal/ cf = 19,589 gallons
- Total off site Volume = 8635 sf * 1.5"/12 * 7.48 gal/ cf = 8,074 gallons
- Total Runoff Managed = 19,589 gallons + 8,074 gallons = 27,663 gallons

Limitations

These are projections; stormwater monitoring equipment has not yet been installed.

Sources

http://www.phillywatersheds.org/doc/PWD-SMGM-v3_FullManual_JuneRelease_6.5.15.pdf

- **Increased number of individuals observed on site among birds, insects and mammals by approximately 266%**

Methodology

With the addition of 21 deciduous canopy and understory trees, 27 shrubs, and over 3,000 perennials, grasses, and bulbs, the planted areas have increased by 1258% based on square footage. We therefore expected the new schoolyard would expand native habitat, improve diversity and increase the number of species in the neighborhood.

Pre- and post-construction, observations were taken from a single point in each of the 9 observation areas (figure 1), with a 5-10 second visual sweep from left to right. Observations occurred 4 times each day on weekdays:

Morning – 9:00am
Mid-day – 12:00pm – 1:10pm
Mid-afternoon – 2:30pm – 4:00pm
Evening – 4:30pm – 6:00pm

And 3 times each day on weekends:

Morning – 9:00am
Mid-day – 12:00pm
Mid-afternoon – 3:00pm

Pre-construction, 67 insects, birds, and small mammals were observed on the site.

Post-construction, the following counts were made:
1. Existing playground / 10 birds (sparrows)
2. Planting areas / 13 birds (sparrows), 4 bees
3. Climbing dome and planter / 20 birds (sparrows), 1 bee, 1 butterfly
4. Turf berm and plant bed / 38 birds (sparrows, starlings)
5. Basketball half court / 14 birds (sparrows)
6. Basketball half court and plant bed / 7 birds (sparrows)
7. Rain garden / 26 birds (sparrows, starlings), 3 butterflies
8A. Parking lot / 20 birds (sparrows, finches, robin), 1 butterfly, 1 moth
8B. Garden walk and outdoor classroom / 79 birds (sparrows, finches, robin), 6 bees, 1 moth

The biggest number of and variety of wildlife species were observed in Area 8B, which was predictable as it comprises the largest area of plant beds of all the zones.

During the pre-construction assessment, 67 individuals representing 4 species of insects, birds, and small mammals were observed. Post-construction, 238 individuals representing 7 species were observed.

245-67 = 177/67 x 100 = 265.67% increase in number of individuals

Limitations
Spilled food was seen in Area 4 during one of the observation periods, which may have led to the increased number of birds observed in this area. The method used for observation was based on SOPARC, which is for observing people, but we chose to utilize the same methodology for simplicity and consistency; additionally, staff was already trained to do that type of survey. All species noted were common species (Eastern grey squirrel, house sparrow, robins, finches, cardinals, starlings, bumblebees, cabbage white butterfly, and moths)

SOCIAL

- **Reduces average noise levels from 87 decibels to 81.5 decibels, achieving a clearly noticeable change.**

Chester Arthur School is bounded on 3 sides by highly trafficked mostly residential streets and few street trees. Before the improvement, the existing materials on site were primarily hard surfaces (asphalt and brick) with very few sound attenuating attributes. The EPA recommends that urban residential noise levels range between 45-55 decibels (dB) so as not to cause long-term hearing loss, activity interference and annoyance, with a maximum 24-hour exposure of 70dB. The original hypothesis was a decrease of up to 7.5dB after construction, due to the significant change of the site surfaces and addition of plants and new site structures.

Decibel readings were taken with the SkyPaw Decibel 10th: Professional Noise Meter App on two separate iPhone 6 devices at a single point in each of the 9 zones defined on site. Measurements were taken every hour for 4 days, from 9am-7pm, on the days outlined above in the Research Strategy section. Data collectors stood at the center of each zone, with one facing inwards towards the site, and the other facing the street. Decibel levels were then averaged using their logarithmic values across observation periods and then averaged between the two devices to arrive at a single decibel average for each area.

A 3 decibel increase or decrease is the threshold of human ability to perceive it, while a 5 decibel change is clearly noticeable to an average person. A sound seems twice (or half) as loud with a change of 10 decibels.

Area	Description	Pre-construction	Post-construction
1.	Existing playground	76.4 dB	75.4 dB
2.	Planting areas	83.0 dB	86.2 dB
3.	Climbing dome and planter	81.6 dB	72.8 dB
4.	Turf berm and plant bed	82.4 dB	70.4 dB
5.	Basketball half court	81.4 dB	77.0 dB
6.	Basketball half court and plant bed	85.3 dB	73.2 dB
7.	Rain garden	86.1 dB	70.9 dB
8A.	Parking lot	85.9 dB	71.8 dB
8B.	Garden walk and outdoor classroom	85.9 dB	77.0 dB
	Average	87	81.5

- **Increases site usage by 128% during school hours and increases community use of the site after school and on weekends by 157%.**

Methods

The Chester Arthur Schoolyard has experienced a greater use by students and the community after the reconstruction, both during the school day and on evenings and weekends.

Average Pre-Construction Total Schoolyard Activity Per Observation Period

Gender	Sedentary	Moderate	Vigorous
Girls	13.17	7.47	3.23
Boys	9.07	10.73	6.47

Average Post-Construction Total Schoolyard Activity Per Observation Period

Gender	Sedentary	Moderate	Vigorous
Girls	20.77	16.59	20.50
Boys	10.59	20.45	25.55

Calculations
Average Pre-construction Schoolyard Activity: 50.14 girls and boys per observation
Average Post-construction Schoolyard Activity: 114.45 girls and boys per observation
114.45 – 50.14 = 64.31
64.31 / 50.14 = 1.28 x 100 = 128% increase

The redesigned schoolyard has experienced a surge in community use and activity during the evenings and weekends. Children, parents, teens and the occasional passerby use the schoolyard for play,

recreation, meet-ups, moments of pause or simply as a connector along the winding path from one side of the neighborhood to another.

SOPARC is an observation method that is used to evaluate and assess site use in parks and public spaces – using this protocol observers recorded users physical activity levels, race, gender, age, during weekday, non-school hours and weekends. 257 people were observed over 15 total observation periods, compared to 80 over 12 total observation periods pre-construction, a 157% increase. Eight of the nine observation areas have seen an increase in use post-construction. After-hours school users are predominantly children (52%), white (67%) and evenly split among genders. This differs from the neighborhood demographics, for which 12.5% of the neighborhood are children aged 5-15 years old and 41% are white.

Post-construction	Child	Teen	Adult	Senior
TOTAL	133	26	97	1
AVG	9.5	1.857143	6.928571	0.071429

Pre-construction	Child	Teen	Adult	Senior
TOTAL	39	16	23	2
AVG	3.25	1.333333	1.916667	0.166667

Calculations
17.13 – 6.67 = 10.46
10.46 / 6.67 = 1.568 x 100 = 157% increase

- **Doubles physical activity levels in students for both boys and girls. Increases vigorous activity for girls by 160% and boys by 80%.**

Methods
The physical transformation of the schoolyard has had a profound impact on the overall use of the site during school, after school, and on the weekends. Students are more active during recess and after school, there is more integrated play between boys and girls, the distribution of activity across the schoolyard is greater; and there is substantial increase in community use after school and on the weekends. The SOPLAY protocol was used to evaluate use of the site. 1,260 children/caregivers were observed over 3 days during 33 observation periods as outlined in the Research Strategy section above. The protocol allowed information to be gathered about the location of individuals (students, teachers, staff and neighbors) on site and their gender, ethnicity, age, and physical activity (sedentary, moderate and vigorous).

Physical activity levels have doubled during school hours for both boys and girls. Pre-construction, the most common activity level was sedentary with an average of 45% of students participating in sedentary activities and only 19% in vigorous activities. The least common activity level was vigorous pre-construction; this essentially flipped post-construction with 38% of student activity being sedentary and 40% being vigorous. Moderate activity levels remained relatively consistent.

While vigorous activity levels for both genders increased significantly, girls' vigorous activity levels increased more than boys – by 160% for girls versus 80% for boys. Girls' vigorous activity went from 14% of the total physical activity pre-construction to 36% post-construction. Pre-construction, 25% of boys' physical activity was vigorous, and post-construction 45% of activity was vigorous.

The distribution of play and use across the schoolyard is much greater. Prior to construction, almost half of all play/use on site occurred on only 9% of the entire schoolyard area (existing playground and seating, areas A1+ A2). Post-construction, Area 1 experienced the greatest decrease in use, while Area 4 experienced the greatest increase. Area 1 is the existing playground and Area 4 has the berm, path, and planters. Pre-construction, only 24% of use occurred in areas 4-8. Post-construction, 48% of use occurred in areas 4-8. There were more girls than boys observed in every area of the site other than Areas 5 and 6 (basketball courts).

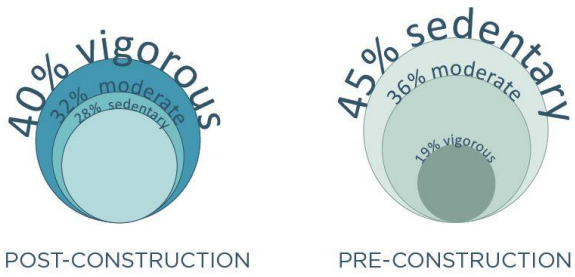


Figure 3: changes in activity levels for both boys and girls

Figure 4: site use demonstrating general post-construction usage frequency

Limitations

SOPARC and SOPLAY are protocols that have their own inherent limitations including: bias of the observer, human error, or other factors beyond the researchers' control. The researchers did their best to ensure that the observed days were 'typical' days and that no major or disruptive events were occurring.

Sources

McKenzie, Thomas L. et al. "System for Observing Play and Recreation in Communities (SOPARC): Reliability and Feasibility Measures." *Journal of physical activity & health* 3 Suppl 1 (2006): S208–S222.

McKenzie, Thomas L., Marshall, S.J., Sallis, J.F., and Conway, T.L. "Leisure-time physical activity in school environments: An observational study using SOPLAY." *Preventive Medicine* 30 (2000):,70-77.

United States Census Bureau. “American Fact Finder.” <https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>.

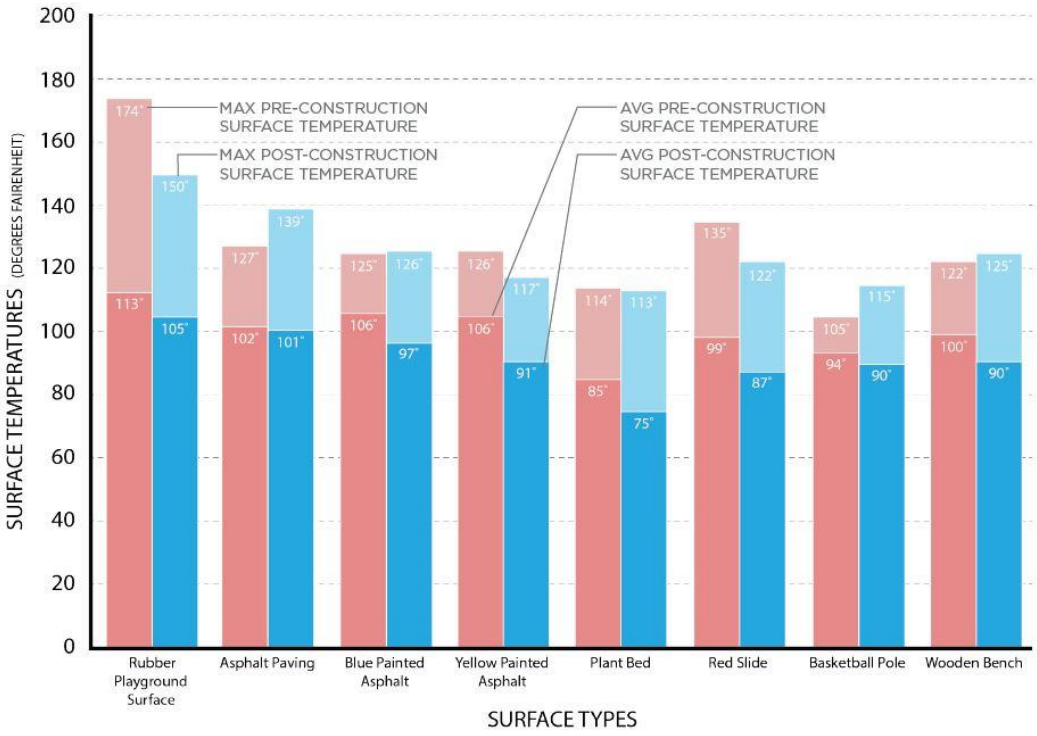
Appendix

The below surface temperatures were taken post-construction (according to protocols outlined above) in order to demonstrate the impact of various surfaces in the urban environment and to understand urban heat island effect. Vegetation and pavements with a higher albedo have lower surface temperatures on average than those with lower albedo.

Surfaces	Low - High / Avg.
1. Porous Asphalt	93.6 - 129.1° / 110.9°
2. Rubber Safety Surface	64.8 - 135.1° / 106.8°
3. Artificial Turf	86.2 - 129.9° / 106.4°
4. Asphalt	84.6 - 120.2° / 103.5°
5. Blue Painted Asphalt	78.7 - 111.2° / 96.6°
6. Colored Concrete	80.1 - 108.9° / 95.2°
7. Pavers	74.6 - 110.7° / 94.1°
8. Yellow Painted Asphalt	76.5 - 102.5° / 90.7°
9. Exposed Agg. Concrete	78.4 - 104.5° / 91.7°
10. Plant Beds	71.1 - 87.5° / 76.7°

Objects	
1. Red Plastic Slide	65.0 - 107.5° / 87.5°
2. Planter Bench	77.8 - 108.2° / 91.4°
3. Green Wall	63.6 - 81.0° / 72.0°
4. Light Fixtures	95.8 - 118.8° / 104.8°
5. Steel Basketball Pole	78.7 - 104.3° / 91.6°
6. Art Panels	69.7 - 92.1° / 81.2°
7. Shed	82.4 - 93.0° / 84.6°
8. Water Pump	82.1 - 102.7° / 87.5°
9. Bench	85.1 - 113.5° / 97.1°
10. Fence	86.5 - 97.1° / 89.1°
11. Boulders	75.9 - 100.9° / 87.4°

The below chart illustrations surface tempearture changes among materials that stayed the same pre- and-post construction, illustrating how the transformation of the site resulted in reduced temperatures even for similar materials that were present on site pre- and post-construction.



Summary of temperature changes across surface types