



LANDSCAPE PERFORMANCE SERIES

Brent Elementary Schoolyard Greening: Phase 1 – Washington, D.C Methodology for Landscape Performance Benefits

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Environmental

Decreases daytime summer surface temperatures by an average of 23°F and air temperature by 9°F by replacing 1,500 sf of asphalt play surface with a rain garden.

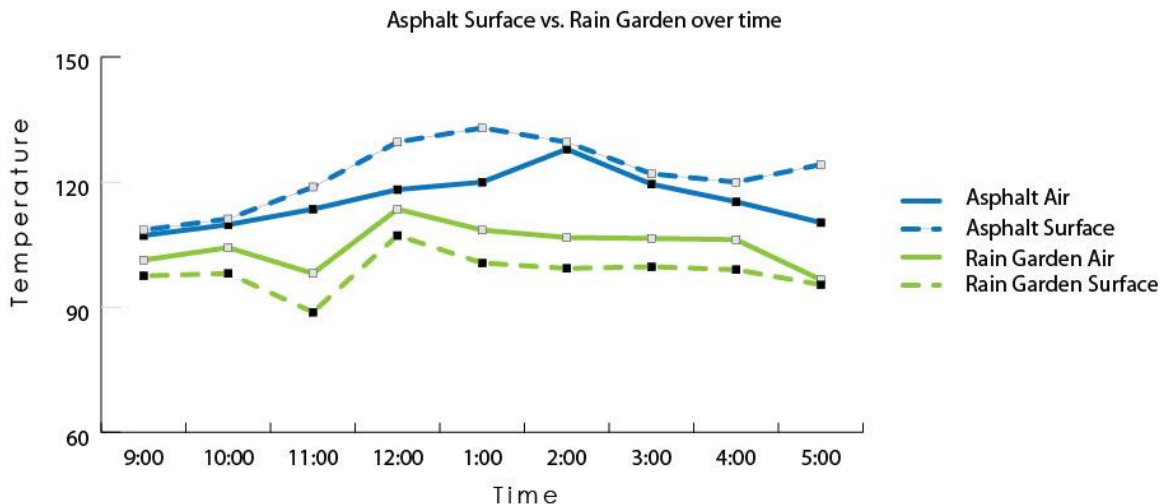
Surface and air temperatures were measured at Brent Elementary School using four Acu-Rite Wireless Thermometers #00782. These digital thermometers were set up with two thermometers at each location. The recordings of surface and air temperature began at 9am and ended at 5pm on July 1, 2012. Surface temperature was measured by placing the sensor directly on the ground while air temperature was measured by placing the sensor two-feet above the ground on a wooden post.

The following two locations were sampled:

1. Surface and air temperature in the asphalt playground
2. Surface and air temperature in the rain garden, adjacent to the play structure

Washington D.C. weather on July 1, 2012 was mostly sunny with an average temperature of 88 degrees and a high temperature of 99 degrees (weathersource.com). Temperature data was recorded throughout the day and can be seen in the graph and table below. Differences between surface and air were calculated by finding the difference in temperature each hour and averaging over the 9 time points. Rain garden surface temperatures may have been affected by wet conditions due to irrigation.

Brent Elementary School- Urban Heat Island Treatments



Holds 720 gallons of stormwater (79% of the 1-year storm) in the rain garden. The ten trees in the rain garden are estimated to intercept an additional 1,600 gallons of stormwater annually.

The volume of the rain garden was calculated using scaled construction documents provided by Sustainable Life Designs. The volume of the rain garden was calculated by multiplying the area of the section and the length of the rain garden. According to Allen Davis a professor at the University of Maryland in the Department of Civil and Environmental Engineering, the typical rain garden has approximately 20% water holding capacity (Davis, 2012).

The rain garden is an L- shape with an additional arc connecting each side. The area of the section is approximately 16.68 sf and the length of the rain-garden 202 feet.

$$16.68 \text{ sf.} \times 202 \text{ f} = 3,367.34 \text{ cubic feet of rain garden}$$

Additional volume of the arc needs to be added to this volume. The area of the arc is 74.89 sf. The depth of the area under the arch is 3.4'.

$$74.89 \text{ sf} \times 3.4 \text{ f} = 247.137 \text{ cubic feet}$$

$$\text{Total volume is } 3,614.477 \text{ cubic feet}$$

$$\text{Water holding capacity} = 3,614.477 \text{ sf} \times .20 = 722.89 \text{ cubic feet}$$

Using a scaled base plan with elevation contour lines indicated that there is a total of 8,805 sf. of catchment. Using TR-55 we calculated the volume of stormwater that would enter the rain garden for a 1 year through 100 year storm event. The results are shown in the graph below.

Year	Inches	Runoff Volume (cf)	Storage (cf)	Storage/Runoff Volume
1	1.255	921	723	0.79
2	1.658	1217	723	0.59
5	2.391	1754	723	0.41
10	3.165	2322	723	0.31
25	3.645	2675	723	0.27
50	4.208	3088	723	0.23
100	4.921	3611	723	0.20

Reference:

Davis, Allen. "Bioretention Facilities." Green Roofs and Urban Sustainability. University Of Maryland. College Park. 17,4,2012. Lecture.

The stormwater interception of the ten trees was calculated using the plant list provided by the landscape designer and the National Tree Benefit Calculator: www.itreetools.org/design.php. Three Serviceberry (*Amelanchier canadensis*) and seven Common Hackberry (*Celtis occidentalis*) were incorporated into the rain garden with a common diameter of 3 inches.

Common Name	Quantity	Stormwater Intercepted (gal./yr)
Hackberry	7	157
Serviceberry	3	179

Gallons of stormwater intercepted:

$$(7 \times 157 \text{ gal.}) + (3 \times 179 \text{ gal.}) = 1,636 \text{ gallons}$$

Reduces annual hydrocarbon emissions by 1.83 lb and carbon monoxide emissions by 69.2 lb, by replacing nearly 6,200 sf of lawn with an outdoor classroom that requires no mowing.

The maximum allowable emissions from lawn mowers are regulated by the United States Environmental Protection Agency and are listed in the table below:

Lawn Mower Emissions

	Effective Model Year	Hydrocarbons & nitrogen oxides (g/kW-hr)	Nonmethane hydrocarbons & nitrogen oxides (g/kW-hr) [1]	Carbon monoxide (g/kW-hr)
Mowers	2007	16.1	--	610

(<http://news.consumerreports.org>), Oct 2, 2008 12:01 AM, Ed Perratore. Retrieved on 7-12-2012 by Mark Storie)

The exact model of lawnmower used at Brent Elementary is unknown; therefore, emissions calculations are based on a Cub Cadet Z-Force S Commercial with a 48" deck and 23 horsepower, a mid-size commercial mower. If this model runs at 3.5 mph, it will cut 1.7 acres per hour (www.cubcadet.com). Because of the reduction of approximately 6,198 sf of lawn after construction, it is estimated that lawn mowing would take 5 minutes each time.

Assuming that the lawn is cut once per week, and the growing season is (March-October), the total horsepower hours equals 92 hp-hr:

$$5 \text{ minutes} \times 35 \text{ weekly lawn care visits} = 2 \text{ hours and } 55 \text{ minutes} \sim 3 \text{ hours}$$

$$23 \text{ horse power} \times 3 \text{ hours} = 69 \text{ hp-hr}$$

Emissions of hydrocarbons and carbon monoxide are listed in grams per kilowatt-hour (1 hp = 0.746 kW), and are calculated below:

$$69 \text{ hp-hr} \times 0.746 = 51.47 \text{ kW-hr}$$

$$\text{Hydrocarbons + nitrogen oxides: } 51.47 \text{ kW} \times 16.1 \text{ g/kW} = 828.67 \text{ g} = 1.83 \text{ pounds}$$

$$\text{Carbon Monoxide: } 51.47 \text{ kW-Hr} \times 610 \text{ g/kw-hr} = 31,397 \text{ g} = 69.22 \text{ pounds}$$

Social

Introduced 1-2 hours per week of outdoor classroom experience for grades 1-5, and 4-5 hours per week for preschool and kindergarten. Sixteen classes use the "Nature Classroom" for subjects ranging from science to art, music, and English.

Estimates of the Nature Classroom usage were gathered from Brent Elementary School's registrar, Denise Diggs. According to Diggs, students from grades 1 - 5 spend on average 1 - 2 hours a week in class activity in the Nature Classroom weather permitting. Sixteen (16) classes use the space throughout the school year. Preschool through kindergarten (ages 3-5) use the Nature Classroom an average of 4 - 5 hours per week according to Diggs.

Helped increase the demand for enrollment by 191%. The improvements to the school grounds along with other changes in the school and surrounding community contributed to this marked increase.

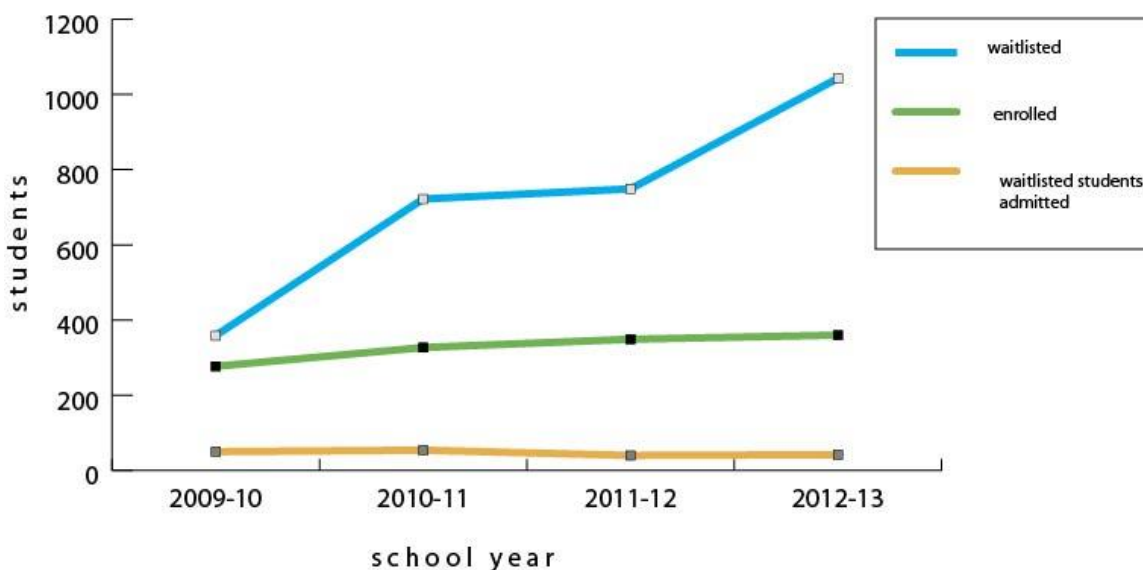
Brent Elementary School has shown a significant increase in applications for enrollment after the installment of sustainable landscape features on school grounds. Prior to construction, 359

students were waitlisted for the 2009-10 school year. The latest figures provided by D.C. Public School Office of Data and Accountability for the 2012-13 school year reveal the final waitlist has 1,043 students seeking enrollment at Brent Elementary School.

In an interview with Brent Elementary School PTA president, Jason Townsend, “seeing the improvements and greening of school grounds helped to form Brents culture.” Increasingly the school became “sought out by students outside of Brent’s School District,” says Townsend, which contributed to the increase in student population from 277 for the 2009-10 school year to 360 for the 2012-13 school year, an increase of over 29%.

Information for Brent Elementary School out of boundary lottery was provided by Research and Evaluation Coordinator Kelly Linker from the District of Columbia Public Schools Office of Data and Accountability.

Brent Elementary School - Demand for Enrollment
student numbers over school year

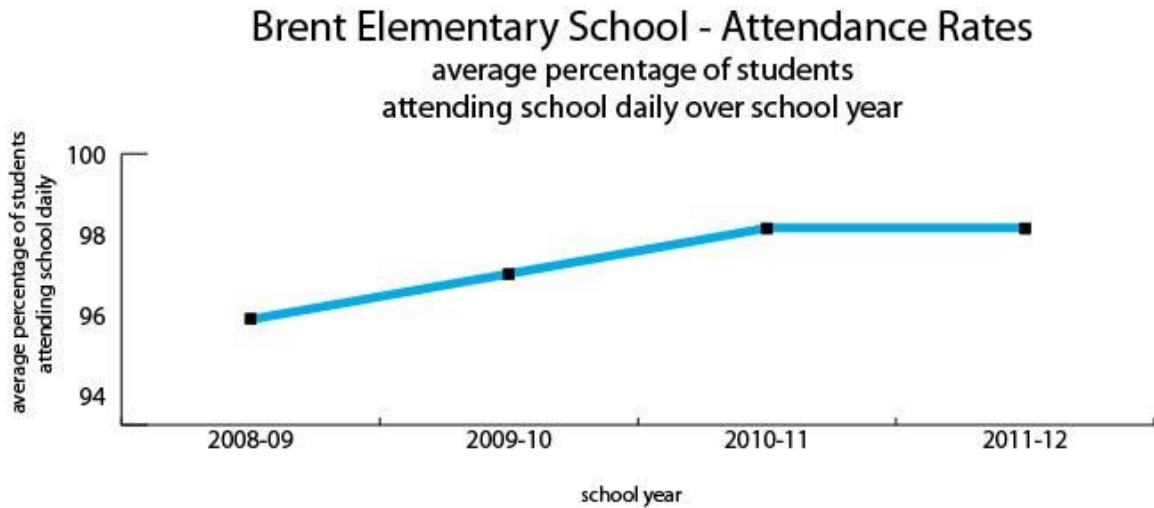


References

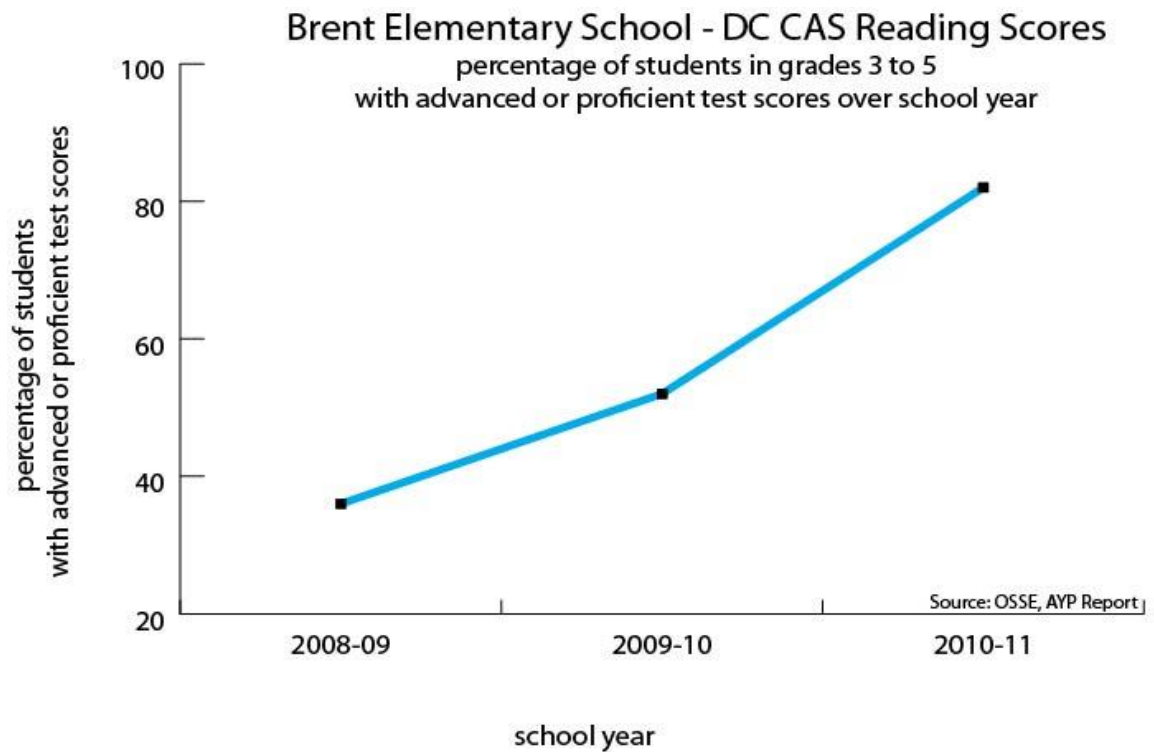
J. Townsend (personal communication, July 6, 2012)
 K. Linke (personal communication, July 11, 2012)
 D. Diggs (personal communication, July 12, 2012)
 DCPS 11-12 out of boundary lottery results. Retrieved July, 12 2012. from <http://dcps.dc.gov/DCPS/Files/downloads/Learn-About-Schools/OOB%20-%20Schools%20That%20Have%20Seats/SY-11-12-PS-PK-OOB-Lottery-results.pdf>
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 DCPS 09-10 out of boundary lottery results. Retrieved July 12, 2012. from <http://dcps.dc.gov/DCPS/Files/downloads/SCHOOLS/Enrollment/TMO-ENROLLMENT-Results-for-09-10-OOB-and-PS-PK-lottery-Dec-15-2009.pdf>

Helped increase student attendance, reading test scores, parent engagement, and parent and staff satisfaction with the school. The improvements to the school grounds along with other changes in the school and surrounding community contributed to this increase.

Since the redesign of school grounds, Brent Elementary School has shown widespread improvements within students and school community. Gradual improvements have occurred in attendance rates, reading scores, and school satisfaction from both parents and staff. Attendance rates at Brent Elementary have risen three out of the last four years. Currently, Brent has a 98% of daily student attendance.

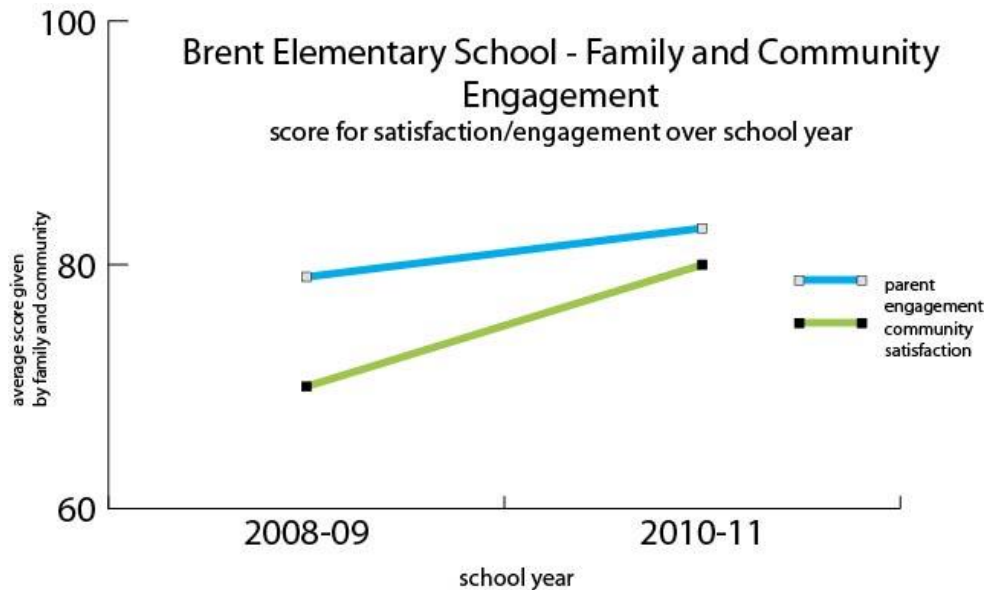


The Comprehensive Assessment System (CAS) is a standardized test given to 3rd and 5th grade students in the District of Columbia every year. The CAS results for the two years following the landscape improvements show that there was a 46% increase of students with advanced or proficient reading scores.



Community satisfaction and parent engagement were measured through D.C. Public School surveys given to parents and stakeholders every two years. According to DCPS, the community satisfaction is measured from a scale from 0 to 100 and represents overall parent and staff

satisfaction with the school. Parent engagement, measured on the same 0 to 100 scale, represents quality and frequency parents felt this school engaged and communicated with them. (DCPS 2011-12)



References

District of Columbia Public Schools (Jan. 8, 2012). 2011-12 School Scorecard: Brent Elementary. Retrieved July 13, 2012, from <http://profiles.dcps.dc.gov/pdf/brent2011.pdf>
 District of Columbia Assessment and Accountability Data Reports (2012). Retrieved July 8, 2012, from <http://www.nclb.osse.dc.gov/index.asp>

Cost Comparison Methods

Community volunteers save the school an estimated \$18,000 in grounds maintenance costs each year compared to grounds that must be maintained entirely by paid staff.

Brent Elementary holds two annual volunteer events, one in the spring and one in the fall. The approximate turnout for these events is 75 volunteers. Each volunteer contributes roughly 4 to 6 hours of work.

$$2 \text{ events} \times 75 \text{ volunteers} \times 5 \text{ hours} = 750 \text{ volunteer hours in 2011}$$

Every year from late June until the end of August, twelve parents take turns in watering and weeding school grounds one hour per day. Their efforts of watering and weeding the school grounds add up to about 67 hours of volunteer service.

$$67 \text{ days} \times 1 \text{ hour per day} = 67 \text{ hours}$$

According to Hands On Network (<http://www.handsonnetwork.org/tools/volunteercalculator>), a 2011 estimate of the cost of a volunteer hour is approximately \$21.79. By using this figure, we can estimate that 817 hours of volunteer service is equal to \$17,802.43.

$$750 \text{ hours} \times 67 \text{ hours} = 817 \text{ hours}$$

$$817 \text{ hours} \times \$21.79 = \$17,802.43$$

Reference

J. Emanuel (personal communication, July 3, 2012)