

REFLECTIONS ON DEVELOPING LANDSCAPE PERFORMANCE CASE STUDIES

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1 ABSTRACT

Increasingly landscape architects are being asked to design and evaluate high-performing, multi-functional landscapes. To grow the profession's knowledge about landscape performance, in 2010 the Landscape Architecture Foundation (LAF) launched the Landscape Performance Series (LPS). The centerpiece of the LPS are case studies, which aim to illustrate the sustainable features and subsequent benefits of high-performing built works. Though LAF has established guidelines for the content and format of its LPS case studies, a formalized procedure for identifying and quantifying a project's landscape performance benefits has yet to be developed. As foundation for a forthcoming set of performance benefit guidelines, we reflect on our experiences in identifying and quantifying landscape performance benefits as part of LAF's Case Study Investigation program (CSI). We provide an overview of the CSI program and LPS case study briefs, examples of quantified performance benefits, and conclude by identifying opportunities for strengthening and furthering ongoing work.

1.1 Keywords

landscape performance, case study, performance benefits, Landscape Architecture Foundation, methodology

2 INTRODUCTION

Increasingly landscape architects are being asked to design and evaluate high-performing, multi-functional landscapes. Such landscapes not only support a diverse array of human needs, but simultaneously provide targeted ecosystem functions as well (Nassauer and Opdam, 2008; Lovell and Johnston, 2009; Musacchio, 2009; Design Trust for Public Space, 2010). Though the concept of a multi-functional landscape is arguably not new, the concept of landscape performance is still emerging. The Landscape Architecture Foundation (LAF) defines landscape performance as the measure of efficiency with which designed landscape solutions fulfill their intended purpose and contribute to sustainability (Landscape Architecture Foundation, 2011). As an evidence-based design discipline, landscape architecture increasingly depends upon empirical evidence to inform design and guide decision-making (Brown and Corry, 2011; Francis, 2001). Thus, understanding a landscape's performance and subsequent social, environmental, and economic benefits can help justify and support sustainable design practices.

Performance assessments can be a challenging task, especially for design firms with limited physical and financial resources. Though there are formal sustainability assessment and rating systems, such as in the Leadership in Energy and Environmental Design (LEED) and the Sustainable Sites Initiative (SITES™). These systems can be cumbersome and costly to produce (U. S. Green Building Council 2009). Additionally, these systems provide little understanding of post-construction performance and subsequent benefits. To amass a knowledge base on post-construction performance, the LAF launched the Landscape Performance Series (LPS) in 2010. The LPS is not a formal rating system, but a venue for the procurement and dissemination of research pertaining to landscape performance. The center piece of the LPS are peer-reviewed case studies, which seek to illustrate the "value" of sustainable design practices to a diverse audience, including students, practitioners, developers, clients, and municipalities. Though LAF has established guidelines for the content and format of the case studies, a roadmap for identifying and quantifying landscape performance benefits has yet to be developed. In this paper we offer insight into our experiences and processes of identifying and quantifying landscape performance benefits during our participation as research fellows in the 2011 and 2012 LAF's Case Study Investigation program (CSI). We also discuss current limitations and future research opportunities for continued landscape performance research.

3 OVERVIEW OF THE LPS CASE STUDY INVESTIGATION PROGRAM AND CASE STUDY BRIEFS

In 2011, LAF launched the seminal CSI program to initiate the development of LPS case studies. The CSI program sponsors collaborations between university faculty, students, and design practitioners to advance landscape performance research. To participate in the CSI program, faculty-student teams submit proposals with research qualifications, and design firms submit proposals of high-performing built works. The selection process for CSI projects is highly competitive. After review, LAF forms collaborative teams, factoring in geographic proximity, relevant expertise, and prior working relationships. University faculty are awarded a research fellowship to support student research assistants. Faculty-student teams are assigned up to three built projects, from one or more design firms. In 2011, the inaugural CSI program ran for 10 consecutive weeks, with 10 faculty-student teams and 11 participating firms. In 2012, the CSI program lasted 20 weeks, providing more time for data collection and analyses and the solicitation of external reviews. In 2012, there were 10 faculty-student teams and 20 participating firms. To date, approximately 70 LPS case studies have been produced.

During the CSI program, university research fellows and students work directly with design firm liaisons to obtain project documents, applicable data, and to collaboratively identify all potential landscape performance benefits. Faculty-student teams are responsible for identifying methods for quantifying the project's social, environmental, and economic benefits. LAF staff offer guidance on the quality and clarity of project content, as well as conducts reviews of the case study drafts. Completed case studies go through a rigorous double blind peer-review process, first internally by the LAF Research and Education Committee, then externally by a committee comprised of academics and practitioners well versed in sustainable design. CSI teams are required to revise and resubmit per reviewers' feedback. The final accepted LPS case studies are published on the LAF website (<http://www.lafoundation.org/research/landscape-performance-series/case-studies/>).

To maintain consistency in format, all case studies contain the following content: basic project information; project overview; significant design challenges; significant design solutions; quantified performance benefits; a list and description of all sustainable features; at least one cost-comparison (between a sustainable and traditional feature/practice); a list and description of lessons learned during project design and implementation; project photos (illustrating before and after or traditional versus sustainable conditions) (Figure 1); supporting images (site plan, additional photos, diagrams, etc.); and a methodology document that includes data sources and calculations for each performance benefit.



Figure 1. (a) Example of a “traditional” design solution for a commercial landscape in southern California, as compared to (b) a “sustainable” design solution at the Frontier Project in Rancho Cucamonga, CA (2012). Photo (a) by Jessica Canfield, photo (b) by EPT Design.

4 LANDSCAPE PERFORMANCE ASSESSMENT

4.1 Identifying Landscape Performance Benefits and Data Sources

LAF’s aim is to develop case studies of built works which exhibit a full array of social, environmental, and economic benefits. To help researchers and practitioners identify these potential performance benefits, LAF developed seven landscape-performance-benefit categories, further detailed in 31 sub-benefits: (1) Carbon, Energy & Air Quality: energy use & emissions, air quality, temperature & urban heat island, carbon storage & sequestration; (2) Economic: property values, O & M savings, economic development, job creation; (3) Habitat: habitat preservation, habitat creation/restoration; (4) Land: transportation, land efficiency/preservation, soil creation/restoration; (5) Materials & Waste: reduced/recycled materials, local materials, waste reduction; (6) Social: recreational & social value, public health & safety, educational value, noise mitigation, food production, scenic quality/views; (7) Water: stormwater management, water conservation, water quality, flood protection. Though this list provides a starting point, guidelines for selecting relevant benefits and corresponding metrics have yet to be formally developed. Thus, participants in the inaugural years of the CSI program used individual strategies for identifying and quantifying performance benefits.

We experienced a significant learning curve in identifying and quantifying performance benefits. To identify a project’s potential landscape performance benefits, all sustainable practices and features needed to be identified. We found it essential to fully understand a project’s history, including original and revised design goals, the scope of design services, the construction practices employed, and any on-going maintenance regimes. Direct dialogue with a project’s design team and consultants, as well as physical site visits were ideal sources for first-hand data. However, secondary-data from project cut-sheets, award submission narratives, client presentations, photographs, and design development documents was also helpful. Staying organized and keeping track of all sources was imperative, especially in the event conflicting information was found. Close and regular communication with the design firm liaison was imperative.

Each performance benefit statement, as required by LAF, needed to include a quantified measure of a sustainable feature’s performance, as well as an indication of the significance of the performance. If a performance benefit statement did not pass a “so what?” test, in other words, if the significance or

meaning of the performance was not clear, the benefit was re-worked to better communicate its message. Note that LAF requires performance benefit statements begin with a verb (e.g., reduces, eliminates, improves, adds, etc.).

Example draft performance benefits and potential data sources

Social

- Benefit: *Increased community park space by xx acres or xx%, providing active recreation opportunities for xx people daily*
Data: Site plan (pre- and post-construction) and field observations or user surveys
- Benefit: *Provides xx sustainable design workshops, educating xx students annually*
Data: Visitor logs or client's tracking of educational program offerings and attendance

Environmental

- Benefit: *Reduces stormwater runoff volume by xx%, thereby increasing annual groundwater recharge by an estimated xx gallons*
Data: Calculations produced by the civil engineer for LEED documentation.
- Benefit: *Increased species richness xx% by adding xx acres of critical habitat*
Data: Habitat Assessment and Sensitive Species Survey produced by a consultant

Economic

- Benefit: *Increased adjacent property values by xx% with the addition of xx acres of new public park space*
Data: Municipal tax/property value records
- Benefit: *Saved \$xx in waste disposal and hauling fees by reusing existing pavement as sub-base*
Data: Demolition plan and cost estimates

The type of performance benefit informed the type of data needed. For example, when illustrating the social benefits of a project, data from post occupancy user surveys or data from on-site observations of user behavior was useful. Environmental benefits typically required data from water quality reports or tree surveys. Economic benefits typically required data on property values or water costs. In assessing environmental and economic performance benefits, relevant data was often extracted from project documents, such as technical reports, pre- and post-construction photographs, construction documents, and design specifications. Each performance benefit typically required data be gathered and synthesized from multiple sources.

The validity of performance benefit statements largely depends on the quality and reliability of data sources. First-hand, verified data is most desirable for performance analyses, though it was not always feasible to obtain due to geographical limitations, cost implications, and/or the short duration of the CSI program. Thus, existing, readily obtainable second-hand data was extremely useful. However, the validity of such data can be questionable, especially if the original data collection criteria and procedures were not clear. If first-hand data collection was feasible, research teams needed to carefully consider the time and cost of developing protocols for collecting and analyzing the data. Many state universities have extension programs that, for a small fee, can analyze soil and/or water samples. Depending on the type of test and laboratory availability, sample analysis can take a few days or several weeks. If collecting user survey data, sufficient time needs to be allocated for developing a survey questionnaire and obtaining formal approval from the university's Institutional Review Board (IRB). This approval process differs from institution to institution and can take 2-6 weeks to complete. All universities require IRB approval before any research involving human subjects.

4.2 Identifying Metrics and Quantifying Landscape Performance Benefits

While simultaneously drafting benefit statements, research teams also conducted a literature review to find applicable metrics, and to help identify applicable data sets. Without prior experience in conducting performance assessments, we experienced a learning curve in identifying and employing various metrics. A significant limitation for choice of metric was due to the CSI program's short time frame, which limited complex data collection and analysis. For example, to evaluate the causal relationship between property value dynamics and green space, property value data must be coded at the parcel level, which is time consuming and likely not feasible within the given time frame. Factors, such as a project's

size, age, type, context, and climate also impacted which analysis tools to use. The EPA's Rational Method, for example, is applicable for use on sites less than 200 acres. Other metrics require longitudinal studies, with data taken over a period of years. Another limiting factor in metric selection was a need for external expertise. If the data collection or quantification procedure required specific expertise, like that of an ornithologist for example, the CSI team either needed to seek external assistance or choose a different metric.

In quantifying performance benefits, a number of published LPS case studies have used basic arithmetic and data that represent pre and post-conditions. Some performance benefits have been calculated with assumptions/interpretations of similar projects' performance within the same geographic region, however this strategy tends to overlook site specific nuances. A number of LPS case studies have also employed online calculation toolkits to determine performance benefits, such as the National Tree Benefit Calculator (<https://www.arborday.org/calculator/index.cfm>) which assesses the multifaceted benefits of certain tree species (Figure 2); the Plant Stewardship Index (PSI) (<http://www.bhwp.org/psi/>) which evaluates the overall ecological quality of the site; and the Walk Score (<http://www.walkscore.com/>) which examines how walkable a site is, based on trips that run errands. However, these online toolkits are based upon scientific calculations that need to be specifically examined. Before using a third-party calculator, users must understand the required variables and how the tool is calibrated (e.g., any baseline assumptions used) to ensure results are meaningful to specific site conditions.

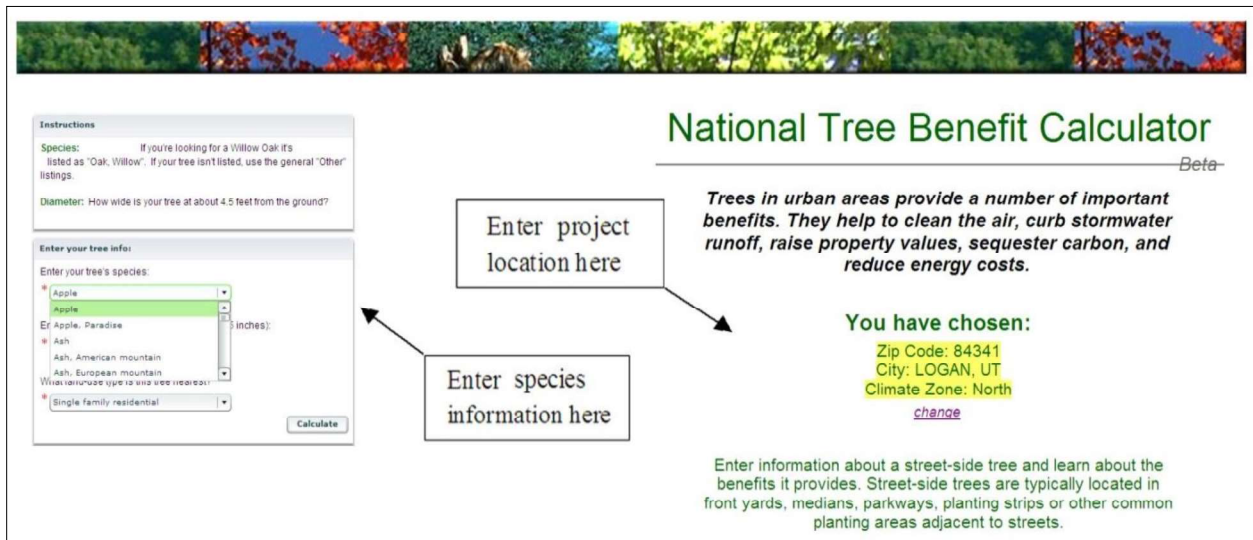


Figure 2. Example calculation from the National Tree Benefit Calculator. By entering a project's zip code, the tree species and diameter, and the land-use type that the tree is nearest to, the calculator will provide an estimate of annual benefits related to: stormwater interception, property value, energy, air quality, CO², and overall monetary value. (Image source: <https://www.arborday.org/calculator/index.cfm>)

All published LPS case studies include a standalone methodology document, which can be downloaded from the LAF website. Here we highlight two quantified benefits as examples.

Performance Benefit Example 1: High Desert Community, New Mexico

The High Desert community in Albuquerque, New Mexico honors low-impact design practices of water conservation, wildlife habitat restoration, material recycling and cultural endowment. This project changed water-conservation and landscape planting ordinances at city and state levels. Through this master plan, the design firm (Design Workshop, Inc.) strives to balance environmental sensitivity, community connections, artistic beauty and economic viability with metrics that gauge the success of outcomes (Yang and Goodwin, 2011).

A unique aspect of the project's performance lies in its water conservation success within a desert environment, where culinary water for irrigation is scarce. Because of this success we chose to demonstrate the compelling performance benefit of water conservation and we relied upon first- and second-hand data sources. Water price data were obtained from city's website (first-hand). Landscape irrigation area was calculated based upon construction documents, using AutoCAD (second-hand).

Performance Benefit:

Reduces potential annual landscape water use by 80%, by about 28.7 million gallons, with water-efficient native plants and limited areas of irrigated landscape, saving on average \$300,000/year in water costs over the traditional city-based allowance in 2010 (Yang and Goodwin, 2011).

Data:

1,660,416 sf of irrigation only area (source: area calculated from construction documents)
7,456,085 gallons water used in 2010
36,227,405 gallons water allowed in 2010
\$7.83 per unit water cost; 1 unit = 748 gallons

Calculations:

$36,227,405 - 7,456,085 = 28,771,320$ gallons saved
 $28,771,320 / 748 = 38,464$ units, $38,464 \text{ units} \times \$7.83 = \$301,175.71$ in cost savings annually
 $7,456,085 / 36,227,405 = 0.2058$, or 80% savings over allowance

Performance Benefit Example 2: Frontier Project, California

The Frontier Project is a non-profit organization and demonstration facility, created specifically to showcase the application of sustainable design practices and technologies most suitable for use in Southern California. Providing citizens with an array of educational resources and implementation tools, the project seeks to encourage visitors to incorporate energy efficient and water-wise practices in their own homes. Seamlessly integrated with the LEED Platinum building, the indigenously inspired landscape showcases a comprehensive stormwater management system, the Inland Empire's first green roof, and visually stunning, low-maintenance, water-wise plantings (Canfield and Fagan, 2012).

One of the project's most significant sustainable features is its rainwater cistern and adjacent infiltration basin. To express an environmental benefit of this feature, we chose to calculate how much runoff was being prevented, and thereby eliminated from the local storm sewer. Since the site was less than an acre we chose the Rational Method. We worked closely with the design firm liaison to obtain applicable data, which was found in a small area unit hydrograph that was produced by a project consultant.

Performance Benefit:

Collects 100% of stormwater runoff on site from storm events up to a 5-year event, preventing an estimated 48,900 gallons from entering the municipal storm sewer for each 5-year event (Table 1) (Canfield and Fagan, 2012).

Table 1. Frontier Project Small Area Unit Hydrograph (2012). Reproduced with permission from the Landscape Architecture Foundation

Condition	A = Drainage Area (ac)	5-year event			
		T _c = Time of Concentration (min)	Q = Peak Discharge (cfs)	Volume per T _c (ac-ft)	Volume (gal)
Pre-Development	0.79	7.81	1.36	0.0146	4,758
Developed (w/o BMP mitigation)	0.86	6.28	1.9	0.1561	50,868
Developed with BMPs	0.86	7.95	1.21	0.15	48,878

Source: Area from EPT Design 16029-BSCN.dwg (2008); All other figures from RFB Consulting, Frontier Project Small Area Unit Hydrograph

Data:

Figures for time of concentration, peak discharge, and volume were obtained from a small area unit hydrograph prepared by the stormwater consultant. Drainage area figures were obtained from project construction documents.

Calculations:

The Rational Method was used to calculate peak discharge. $Q = C \cdot i \cdot A$, where Q is peak discharge, C is the runoff coefficient of the land cover material, i is the average intensity of rainfall on site at the time of concentration (T_c), and A is the drainage area.

In its pre-development condition, the site was estimated as producing 4,758 gallons of runoff during a 5-year, 24-hour storm event. Once developed, the site was estimated to produce 50,868 of runoff during a 5-year, 24-hour storm event (without inclusion of stormwater Best Management Practices). If developed with stormwater Best Management Practices (thus increasing the time of concentration and decreasing the amount of runoff), the site was estimated to produce 48,878 gallons of runoff. These figures helped the design team size the stormwater infiltration system, which included a 2,000 gal. subgrade cistern, and a 50,000-gallon overflow infiltration basin. Thus, during a 5-year, 24-hour storm event, 100% of on-site runoff is either captured and stored in the site's underground cistern (for future irrigation use) or recharged in the overflow infiltration basin.

5 MOVING FORWARD

The landscape architecture profession cannot rely solely on other disciplines to generate empirical knowledge about landscape performance. The LPS and CSI research initiatives are making big strides in promoting landscape architecture research. Though, for the LPS case studies to be of greatest value, results must be generalizable, enabling case studies to be compared. With an array of methods/metrics currently in use, this is not yet feasible. However, LAF has recently initiated a new research program that aims at strengthening the validity of the CSI program's methodology. As this program takes shape, and as the production of LPS case studies continues, we offer the following suggestions for further research:

- (1) Assess the extent to which existing metrics in the published case studies are a valid representation of the claimed performance benefits.
- (2) Determine to what extent the methods used in these case studies are appropriate for the targeted performance metrics.
- (3) Evaluate the strengths and weaknesses of the methods for their applicability of use in design practice and/or in the classroom.
- (4) Conduct a literature review of each type of metric used. This will help to identify any potential limitations or known problems, as well as the level of difficulty to use it.
- (5) Solicit design practitioners' input for improvements in case study preparation, evaluation, and dissemination.

(6) Determine the impact of the LPS case studies. Find out which agencies or advocacy organizations have made use of specific benefits. Also provide examples of how specific benefits can be used for design decision making or for policy improvements/revisions.

(7) Develop a set of landscape performance benefit guidelines or a roadmap that provides recommendations on which performance benefits to measure, which metrics to use, the best type of data to collect, and any potential limitations of the metrics and methods.

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