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EDITED BY
Qingsong He,
Huazhong University of Science and Technology, China

REVIEWED BY
Ahsan Nawaz,
NGCEF, Australia
Hamed Fazlollahtabar,
Damghan University, Iran

*CORRESPONDENCE
Yilei Wang,
hzndwyl@webmail.hzau.edu.cn

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The practice and potential of the SITES v2 rating system for the sustainable design of a landscape: A case study of Chicago's Navy Pier

Lin Jin[1,2] and Yilei Wang[3]*

[1]Interdisciplinary Program in Landscape Architecture, Seoul National University, Seoul, Republic of Korea, [2]Integrated Major in Smart City Global Convergence, Seoul National University, Seoul, Republic of Korea, [3]Department of Landscape Architecture, Huazhong Agricultural University, Wuhan, China

The landscape is a synthesis of cultural and natural processes in a place that can be designed and maintained to improve and regenerate the natural benefits and services of ecosystems. The Sustainable Sites Initiative has developed a rating system that identifies and advances best practices for landscape architecture. The SITES v2 Rating System was produced through a multi-year iterative process and incentives sustainable landscape practices by using an ecosystem services framework. Opportunities for continuing research on how SITES v2 encourages the creation of a landscape sustainability system and drives more sustainable land development will become apparent as it expands in application, scope, and impact. To illustrate the practice and potential of SITES v2 for sustainable landscape design, this research is primarily a literature review with the specific context of the SITES gold-certified project, Navy Pier in Chicago. The results show that SITES v2 is an important tool for transforming theory into the implementation of ecosystem services and guiding design decisions towards sustainable outcomes. It also promotes the entire project's accountability to a higher standard of best practices and results in a more sustainable site. In the context of contemporary landscape architecture practices, SITES v2 may lead to the transformation of sustainable landscape design. This study can promote the ongoing application of SITES v2 and the creation of a better sustainable landscape through design. It holds the potential to highlight how the methodology on which SITES has been created can be linked with the development of future cities and the management of urban landscapes.

KEYWORDS

sustainability, Chicago's Navy Pier, SITES v2 rating system, resilience (environmental), sustainable landscape design

1 Introduction

1.1 Toward a sustainable landscape

Urbanization and continuous population growth have a large impact on the environment and its ecosystem and natural functions (Forman and Wu, 2016). Cities have increasingly tough issues in developing efficient transportation systems, mitigating urban heat island effects, and meeting the ever-increasing demand for clean water and air,

open space, parks, and species habitats. Sustainable development, as an approach toward development based on the mutual coordination and co-development of society, economy, population, resources, and the environment, is widely recognized around the world to alleviate these pressures and also has influenced landscape architecture (Steiner, 2020).

The sustainable development of the landscape is gradually becoming an industry consensus. As early as 1969, Ian McHarg proposed that design should be guided by nature and developed a series of analytical methods (McHarg, 1969), while John Lyle pioneered the regenerative design ideas in the 1970s and 1980s (Lyle, 1996). Both of them argued that designed systems should replicate the ecological performance of natural systems. In terms of practical application, Germany and the USA are at the forefront. Germany began to redevelop the ecology of industrial wastelands such as mining areas in the 1980s to achieve sustainable development, with typical examples including the Internationale Bauausstellung Emscher Park in the Ruhr region. The USA has also successively incorporated stormwater management, soil remediation, and resource recycling into its landscape architecture, such as Northside Park in Denver's industrial district, and has introduced the concept of low impact development in the 1990s.

The landscape can optimally be developed in such a way that it does not prohibit natural functions and be designed and maintained to avoid, mitigate, and even reverse the frequently deleterious impacts of development. Sustainable landscapes are responsive to the environment, regenerative, and can actively contribute to the development of healthy communities. They are not only sustainable from the ecological point of view but also from the economic and social perspectives (Pieranunzi et al., 2017). Sustainable landscapes increase in value because they continue to deliver several advantages, including stormwater management, soil conservation, efficient energy usage, air and water pollution reduction, and enhancement to human health and well-being.

1.2 A sustainable site-scale landscape rating system

Drawn from the rich history of environmental design theory to create a sustainable landscape, the Sustainable SITES Initiative (SSI) began in 2006 as an interdisciplinary work to elevate the value of landscapes by developing comprehensive and rigorous guidelines and performance benchmarks for sustainable land design, construction, and maintenance. The SSI designers and scientists collaborated in groups to identify best practices of a landscape in the areas of vegetation, water, soils, materials, and human health and well-being for advancing sustainability. The outcomes of their efforts were compiled in a rating system that encompassed the site design process from analyzing the context of the site and planning through construction and maintenance (American Society of Landscape Architects et al., 2009). The initial rating system was utilized by practitioners in 175 pilot projects to analyze the performance of the system and to refine it. This work led to a multi-year iterative process that emphasized transparency and interdisciplinary collaboration, releasing a second iteration of the rating system in June 2014, called *SITES v2 Rating System: For Sustainable Land Design and Development* (SITES v2) (Lady Bird Johnson Wildflower Center et al., 2014).

SITES v2 is the first rating system accessible to the public that can be used as a foundation for attaining landscape design certification (Banerjee and Loukaitou-Sideris, 2011). As a stand-alone tool to aid and support sustainability, SITES v2 is effective by presenting a comprehensive road map for defining and enhancing sustainability in site development, measuring its performance, and ultimately assessing the environmental, economic, and social benefits of such projects. The organization of the rating system generally corresponds to the typical stages of the design and development process. It starts with the selection and assessment of a suitable site, continues through the site design and construction phases, and includes the planning of effective and appropriate operations and maintenance measures. Details about the rating system and guidance for implementation can be found in an accompanying manual, the SITES v2 Reference Guide (https://sustainablesites.org/). In other words, it includes 18 prerequisites and 48 optional credits in 10 sections. The value or number of points allocated to each credit is determined by its potential efficacy in achieving the four objectives, as stated in Table 1. The rating system itself is a 200-point system with four certification levels depending on the score of the site. Bonus points are awarded for innovative and exemplary performance outside the 200-point system. A total of 70 points are required to be certified, 85 points to receive silver, 100 points for gold, and finally, 135 for platinum certification.

1.3 The potential of SITES v2 in future practice

Compared to the Leadership in Energy and Environmental Design (LEED) rating system for building performance, SITES v2 is still relatively new and would complement and supplement the LEED program. The US Green Building Council's highly successful LEED system has a tremendous impact on advancing green buildings. Even if LEED incorporated certain resource-related measures, such as the adoption of native plants and water-saving technologies, it became clear that more was required and might be achieved with a complementary system for landscapes that may or may not include buildings. The SITES rating system was developed as an independent tool for individual landscape projects, as well as a design approach that might influence, complement, or be included in LEED or other green development systems or initiatives. Similar to how the LEED program reflects the evolution of knowledge about building efficiency during the 1970s, SITES v2 developed from McHarg (1969)'s statement that design should be guided by nature.

More research is needed to drive the future refinements and application of SITES v2. More than 150 nations and territories presently use LEED. The certified LEED buildings constitute more than 1,254.2 square kilometers of space, and more than 201,000 professionals have been credentialed with LEED professional qualifications (Pieranunzi et al., 2017). The SITES program is supposed to have similar potential, over time, to drive more sustainable, functional, and resilient landscapes that address urgent concerns resulting from urbanization and climate change. However, such a rating system has primarily drawn attention inside the United States. Even though official figures for the number of

TABLE 1 Four goals of the SITES v2 rating system.

Goals		Description
G1	Create regenerative systems and foster resiliency	• Protect and restore natural resources such as soil, water, and vegetation. • Encourage biodiversity. • Enhance landscapes to provide multiple ecosystem services such as cleaning air and water, providing habitat, and storing carbon. • Mitigate for evolving hazards and natural disasters. • Plan for monitoring and adaptive management.
G2	Ensure future resource supply and mitigate climate change	• Minimize energy consumption and encourage use of low carbon and renewable energy sources. • Minimize or eliminate greenhouse gas emissions, heavy metals, chemicals, and other pollutants. • Reduce, reuse, recycle, and upcycle materials and resources. • Conserve water. • Increase the capacity of carbon sinks through re-vegetation.
G3	Transform the market through design, development, and maintenance practices	• Foster leadership in industry and professional practice. • Use a systems-thinking, integrative and collaborative design approach. • Use lifecycle analyses to inform the design process. • Support local economies and sustainability policies.
G4	Enhance human well-being and strengthen community	• Reconnect humans to nature. • Improve human health (physical, mental, and spiritual). • Foster stewardship by providing education that promotes the understanding of natural systems, and recognizes the value of landscapes. • Encourage cultural integrity and promote regional identity. • Provide opportunities for community involvement and advocacy.

certified SITES v2 projects show an obvious increase, from 48 in 2016 to 77 in 2022, this tool was not widely used. The research on the theory and application of SITES v2 is also lacking. Only one scientific paper reviewed SITES-certified programs and proposed their prospects for landscape governance (Steiner, 2020). There is an expectation that SITES v2 will become a broadly employed tool. Opportunities for extensive research on how SITES v2 encourages the creation of a landscape sustainability system and drives more sustainable land development will become apparent as it potentially expands in application, scope, and impact.

In this study, taking the SITES v2 gold-certified project Navy Pier in Chicago as a case study, the authors aim to illustrate the practice and potential of SITES v2 for sustainable design of the landscape. The goal of the case study is to analyze the directive role of SITES v2 for accreditation and the possibility of elevating the certification level from gold to platinum. Our analysis can promote an increased understanding of ecosystem services, the ongoing application of SITES v2, and the creation of a better sustainable landscape through design.

2 Methodology

2.1 SITES v2 gold-certified project—Chicago's Navy Pier

Chicago's Navy Pier is a 3,300-foot-long pier on the shoreline of Lake Michigan, encompassing over 50 acres (Company, 2018). It is a mixed-use destination with shopping, eating, entertainment, and cultural attractions. Designed by a nationally renowned architect Charles Sumner Frost based on Daniel Burham's "Master Plan of Chicago," Chicago's Navy Pier has been a Chicago landmark and popular attraction throughout most of its history. By 2010, it had grown to be the "number 1" tourist destination in the Midwestern United States, drawing nearly two million visitors annually (Buente, 2016).

Despite its claim as one of the world's most distinctive settings and frequented sites, Navy Pier Incorporated (NPI) chose in 2012 to perform a significant renovation at the pier since the 100-year-old site was showing signs of deterioration. The landscape architecture firm James Corner Field Operations (JCFO) led the design team selected for the project, and phase one was finished in 2016 and gained SITES gold certification, making it the first project under v2 of the grading system to obtain gold certification. The size of the SITES project reaches 6.7 acres (Figure 1) with three primary strategies: 1) making strong connections between the city and lake; 2) refreshing and decluttering the pier to allow space for new green infrastructure; and 3) rendering the pier as a place that reflects Chicago's identity (www.fieldoperations.net). JCFO emphasized the development of sustainable features in place at the project to enhance its environmental benefits on energy, water, waste, transportation, and community.

2.2 Methods

This research is primarily a literature review based on the scorecard of SITES certification, public documents, reports, and articles with the specific context of Chicago's Navy Pier. A case study of Chicago's Navy Pier was chosen to present an example of a

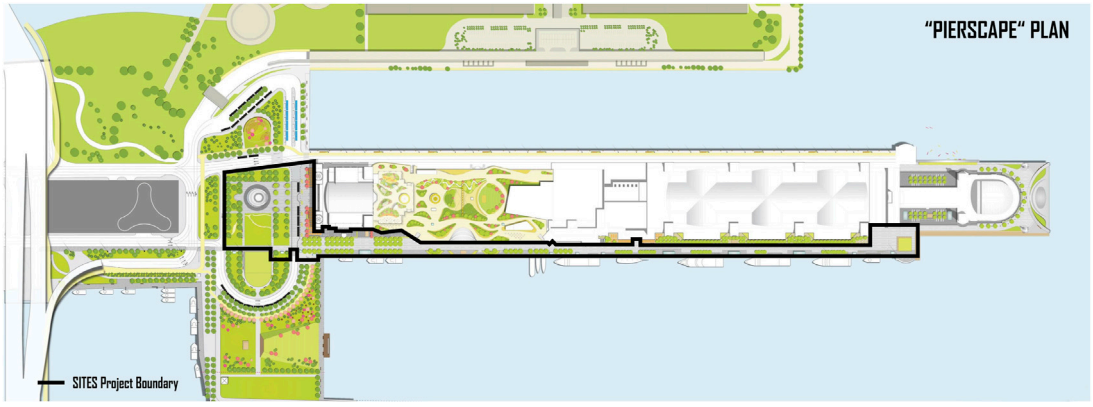

FIGURE 1
Site boundary of Chicago's Navy Pier redevelopment project (James Corner Field Operations, 2019).

Chicago Navy Pier

SITES v2 Gold (2016)

SITES v2 Scorecard Summary - Chicago Navy Pier

10	**1: SITE CONTEXT**	**Possible Points:**	**13**
Y	CONTEXT P1.1	Limit development on farmland	
Y	CONTEXT P1.2	Protect floodplain functions	
Y	CONTEXT P1.3	Conserve aquatic ecosystems	
Y	CONTEXT P1.4	Conserve habitats for threatened and endangered species	
3	CONTEXT C1.5	Redevelop degraded sites	3 to 6
4	CONTEXT C1.6	Locate projects within existing developed areas	4
3	CONTEXT C1.7	Connect to multi-modal transit networks	2 to 3
3	**2: PRE-DESIGN ASSESSMENT + PLANNING**	**Possible Points:**	**3**
Y	PRE-DESIGN P2.1	Use an integrative design process	
Y	PRE-DESIGN P2.2	Conduct a pre-design site assessment	
Y	PRE-DESIGN P2.3	Designate and communicate VSPZs	
3	PRE-DESIGN C2.4	Engage users and stakeholders	3
6	**3: SITE DESIGN – WATER**	**Possible Points:**	**23**
Y	WATER P3.1	Manage precipitation on site	
Y	WATER P3.2	Reduce water use for landscape irrigation	
6	WATER C3.3	Manage precipitation beyond baseline	4 to 6
	WATER C3.4	Reduce outdoor water use	4 to 6
	WATER C3.5	Design functional stormwater features as amenities	4 to 5
	WATER C3.6	Restore aquatic ecosystems	4 to 6
14	**4: SITE DESIGN – SOIL + VEGETATION**	**Possible Points:**	**40**
Y	SOIL+VEG P4.1	Create and communicate a soil management plan	
Y	SOIL+VEG P4.2	Control and manage invasive plants	
Y	SOIL+VEG P4.3	Use appropriate plants	
4	SOIL+VEG C4.4	Conserve healthy soils and appropriate vegetation	4 to 6
	SOIL+VEG C4.5	Conserve special status vegetation	4
3	SOIL+VEG C4.6	Conserve and use native plants	3 to 6
	SOIL+VEG C4.7	Conserve and restore native plant communities	4 to 6
3	SOIL+VEG C4.8	Optimize biomass	1 to 6
4	SOIL+VEG C4.9	Reduce urban heat island effects	4
	SOIL+VEG C4.10	Use vegetation to minimize building energy use	1 to 4
	SOIL+VEG C4.11	Reduce the risk of catastrophic wildfire	4
17	**5: SITE DESIGN – MATERIALS SELECTION**	**Possible Points:**	**41**
Y	MATERIALS P5.1	Eliminate the use of wood from threatened tree species	
4	MATERIALS C5.2	Maintain on-site structures and paving	2 to 4
3	MATERIALS C5.3	Design for adaptability and disassembly	3 to 4
	MATERIALS C5.4	Use salvaged materials and plants	3 to 4
3	MATERIALS C5.5	Use recycled content materials	3 to 4
3	MATERIALS C5.6	Use regional materials	3 to 5
1	MATERIALS C5.7	Support responsible extraction of raw materials	1 to 5
1	MATERIALS C5.8	Support transparency and safer chemistry	1 to 5
1	MATERIALS C5.9	Support sustainability in materials manufacturing	5
1	MATERIALS C5.10	Support sustainability in plant production	1 to 5
21	**6: SITE DESIGN - HUMAN HEALTH + WELL-BEING**	**Possible Points:**	**30**
2	HHWB C6.1	Protect and maintain cultural and historic places	2 to 3
2	HHWB C6.2	Provide optimum site accessibility, safety, and wayfinding	2
2	HHWB C6.3	Promote equitable site use	2
2	HHWB C6.4	Support mental restoration	2
2	HHWB C6.5	Support physical activity	2
2	HHWB C6.6	Support social connection	2
	HHWB C6.7	Provide on-site food production	3 to 4
	HHWB C6.8	Reduce light pollution	4
4	HHWB C6.9	Encourage fuel efficient and multi-modal transportation	4
2	HHWB C6.10	Minimize exposure to environmental tobacco smoke	1 to 2
3	HHWB C6.11	Support local economy	3
14	**7: CONSTRUCTION**	**Possible Points:**	**17**
Y	CONSTRUCTION P7.1	Communicate and verify sustainable construction practices	
Y	CONSTRUCTION P7.2	Control and retain construction pollutants	
Y	CONSTRUCTION P7.3	Restore soils disturbed during construction	
3	CONSTRUCTION C7.4	Restore soils disturbed by previous development	3 to 5
4	CONSTRUCTION C7.5	Divert construction and demolition materials from disposal	3 to 4
3	CONSTRUCTION C7.6	Divert reusable vegetation, rocks, and soil from disposal	3 to 4
4	CONSTRUCTION C7.7	Protect air quality during construction	2 to 4
13	**8. OPERATIONS + MAINTENANCE**	**Possible Points:**	**22**
Y	O+M P8.1	Plan for sustainable site maintenance	
Y	O+M P8.2	Provide for storage and collection of recyclables	
3	O+M C8.3	Recycle organic matter	3 to 5
4	O+M C8.4	Minimize pesticide and fertilizer use	4 to 5
	O+M C8.5	Reduce outdoor energy consumption	2 to 4
4	O+M C8.6	Use renewable sources for landscape electricity needs	3 to 4
2	O+M C8.7	Protect air quality during landscape maintenance	2 to 4
10	**9. EDUCATION + PERFORMANCE MONITORING**	**Possible Points:**	**11**
3	EDUCATION C9.1	Promote sustainability awareness and education	3 to 4
3	EDUCATION C9.2	Develop and communicate a case study	3
4	EDUCATION C9.3	Plan to monitor and report site performance	4
3	**10. INNOVATION OR EXEMPLARY PERFORMANCE**	**Bonus Points:**	**9**
3	INNOVATION C10.1	Innovation or exemplary performance	3 to 9
111	**TOTAL POINTS**	**Total Possible Points:**	**200**

FIGURE 2
SITES v2 rating system scorecard of Chicago's Navy Pier (U. S. Green Building Council, 2022).

landscape architecture site with the profile of being sustainable and gold-certified within the SITES v2 rating system. The systematic literature review was conducted in two stages. Running concurrently with the review of the history, principles, and purposes of SITES v2, a strategic search for Chicago's Navy Pier was first launched around the question how to use SITES v2 as the guidance to operate in the real project toward sustainable outcomes. Then, we proposed a second question: Chicago Navy Pier from gold to platinum—is there a way? To figure these out, first, we were deeply involved with the components and final result of the scorecard for Chicago's Navy Pier. Specifically, according to the scores of each credit, this paper analyzed the innovation points, the strategies adopted, and how to solve the multi-objective project tasks, such as design evaluation and planning, water resources, soil and vegetation, material selection,

public education, and monitoring. Then, we singled out the scorecard criteria which can be improved at the site and made suggestions for techniques and systems to better these. The second stage provided an example of how to use SITE v2 to continue development at an already certified site by enhancing sustainability further. In the context of contemporary landscape architecture, further thinking of the potential and future evolution of SITES v2 is presented in the discussion part.

3 Results

The SITES team embraced ecosystem services and the concept of resilience as the foundation. The original definition of "Ecosystem Services" has been expanded to include the ecosystem services of designed landscapes in addition to constructed landscapes (Woodruff and BenDor, 2016). SITES v2 has a high focus on ecosystem services by employing an ecosystem services framework. These factors are highly assessed in its site-specific performance benchmarks, including reduction of greenhouse gas emissions, water conservation, waste decomposition and treatment, support for food production, and enhancement to human health and well-being. In addition, fundamental to SITES is the concept of resilience, which is described as the ability of a system to survive, adapt, and flourish in the face of turbulent change (Fiksel, 2006). The purpose of enhancing resilience is embedded throughout SITES v2; for instance, it demands the conservation of critical, functional natural features and awards ecological restoration of degraded regions. Based on the batch ideas, SITES v2 is intended for any site that is experiencing development and management, especially for degraded sites to restore their ecosystem services and be ecologically resilient places through the credit system (Lady Bird Johnson Wildflower Center et al., 2014).

SITES v2 provides an active and valuable exchange mechanism for creating sustainable landscapes and meeting long-term sustainability goals. The system encourages early engagement with the local community, which can improve the understanding of the project and its surrounding area, and helps ensure that the undertaking meets the needs of the community. SITES projects could gain up to 11 certification points based on their capacity to educate the public about the importance of sustainable landscapes. There are several cases of SITES that have demonstrated their potential to promote curiosity and education, establish a sense of community, and enhance the health of all living things (American Society of Landscape Architects et al., 2009). In addition, SITES v2 requires project teams to communicate with contractors and maintenance professionals for better coordination of design with construction and maintenance. Adaptive management and performance monitoring are highly recommended as a way to create a feedback loop for understanding how the site performs over time and collecting facts to support the case.

The prerequisites and credits cover several phases of the design and development procedure. Four parts of site design address water, soil and vegetation, materials, and human health and well-being. Figure 2 presents the final score from the evaluation of Chicago's Navy Pier in 2016 by Green Business Certification Inc. (U. S. Green Building Council, 2022). The criteria sections with high or maximum score levels are pre-design assessment + planning, construction, and education + performance monitoring. However, criteria sections with low or no scores are site design—water and site design—soil + vegetation. The upcoming sections will analyze the current design and/or planning tool, and if it currently has a low score, suggestions for improvements are provided in further sections of this paper.

3.1 Scorecard analysis

3.1.1 Site context (10/13)

The highest scores were given due to the project being located in an already existing developed area and the connectivity with close-by multi-modal transit networks such as pedestrian and bicycle paths after reconstruction. Only if the site meets the criteria of remediating a contaminated brownfield site will more points be rewarded.

3.1.2 Pre-design assessment + planning (3/3)

The section has received a high score, in fact, maximum points, particularly due to the planning team's ability to engage users and stakeholders in the pre-design and planning part of the project. A sustainability advisory working group was established to be at the forefront of decision-making, consisting of civil engineers, ecologists, botanists, soil scientists, environmental and social scientists, and non-profit groups (James Corner Field Operations, 2019). There are no possible improvements in this section.

3.1.3 Site design—Water (6/23)

According to James Corner Field Operations (2019), rainwater harvesting meets the irrigation demand by 100% through stormwater collection in subgrade systems at the site. Highly efficient drip irrigation systems are installed, and sensors measure the amount of water being collected and used. In addition, all the run-off is treated on-site prior to ending up in the lake surrounding the pier. Tests showed that the treatment removes 95% of TSS particles and more than 90% of oils in the run-off water from the pier. Hence, the requirement to manage precipitation beyond baseline was met, resulting in gaining six points.

Even though all of the stormwater passes through trench treatment filters before discharging into the lake, the stormwater management elements are not visually and physically accessible to the site users. The trenches have filter bags that need to be cleaned and maintained to sustain their quality. Biological treatment of stormwater, such as bioswales and rain gardens, is more aesthetically appealing, but they also require routine operations and maintenance. To receive a higher score in this section, a certain amount of the conventional trenches on the pier and in the connecting Polk Bros Park could be developed into bioswales or similar green infrastructure. The restoration of aquatic ecosystems can help receive points. However, this strategy is not considered an option for this project since the ecosystems in Lake Michigan are complex and a separate issue themselves.

3.1.4 Site design—Soil + vegetation (14/40)

The reconstruction of the Navy Pier induces challenges to the sustainable approach for soil and vegetation performance of the project. The site being an old pier with industries and the harbor close by has soils that are more or less contaminated with thorium. However, during the development of the new pier, the team successfully preserved healthy soils and conserved 72.8% of the vegetated area. Another successful strategy resulting in points is the exclusive use of native and appropriately adapted plants, i.e., 100% of the selected plants are suitable for the site's condition and climate. A total of 200 native trees were planted on the site, which adds biomass and reduces the heat island effect (Buente, 2016).

The remaining points are not considered for improvement due to site contexts, such as the location and condition. For example, there was no vegetation with special status on the site originally, and therefore, it is an impossibility to receive points for the conservation of special status vegetation. Due to the absence of buildings in the SITES-evaluated area of the pier, it is impossible to minimize building energy use by using vegetation.

3.1.5 Site design—Material selection (17/41)

The project team collaborated across disciplines on materials, and they experimented and innovated on them with less material waste and environmental impact. They worked with material contractors to develop contract specifications and required material suppliers to determine not to use timber from endangered species and use materials with recycled content and locally sourced materials. According to James Corner Field Operations (2019), 27.32% of materials are from recycled content, 32% of materials are extracted or manufactured regionally, and 40.35% of materials were considered designed for adaptability and reassembly. Moreover, through the use of "Unilock Pavers," site paving and surfaces exhibit a high SRI value (details in section *3.1.10*).

Even though a set of specifications that clearly described SITES v2 material credits and associated requirements to vet material suppliers was proposed, it is better to consider the higher standard and select raw material suppliers and/or manufacturers that not only disclose relevant data but also complete achievements on raw material extraction, chemical hazard assessments, and sustainable practices.

3.1.6 Site design—Human health and well-being (21/30)

Under the guidance of SITES v2, the project ensures healthy lives and promotes well-being, especially in the following aspects, resulting in a high score for this section.

1) The project links the landscape and health through the promotion of outdoor physical activity, including jogging, biking, seasonal skating, and fitness, and through social interactions and connections contributed by elements like seating, games, wireless access, picnic spaces, outdoor auditoriums, or playgrounds.
2) The reconstruction re-planned traffic streamlining, making the site easily accessible *via* fuel-efficient and multi-modal public transportation, including the CTA bus, metro, and bicycle.
3) The project tries to minimize site users' exposure to environmental tobacco smoke by creating a tobacco-free zone and dedicated smoking areas away from pedestrian traffic.
4) During construction, the hiring of local, low-wage individuals was prioritized and the workforce was provided with living wages and training.

However, there is no education about food production and nutrition by designing and managing food production on-site. Moreover, Navy Pier causes light pollution due to the exhibition of theatrical lighting, hence causing negative effects on nocturnal environments and human health and functioning. These two credits can be considered options for improvement.

3.1.7 Construction (14/17)

One prominent strategy during construction is the diversion of materials from disposal. To be specific, 100% of structural waste and 99.8% of the roadway and infrastructure waste were diverted from landfills. In addition, 100% of land-clearing materials were retained for use within 50 miles of the site (Buente, 2016). The team also used construction equipment that reduced emissions of localized air pollutants and greenhouse gases for successfully protecting air quality and reducing pollution. For example, 50% of the total run-time hours of diesel engines used on-site during construction met Tier 4 or higher engines. This section has already achieved its highest possible points, and no improvements are possible due to the context of the site related to vegetation, rocks, and soil.

3.1.8 Operation + maintenance (13/22)

Different stakeholders contribute to the maintenance and monitoring of the project. The integrated design and client team has prepared a site maintenance plan that details short- and long-term strategies. Maintenance personnel continue their education on the goals and implementation. Site visitors help perform the monitoring by filling in questionnaires which will be reported transparently and accessibly. In addition, the team has signed a 5-year renewable energy credit (Green-e certified green power) contract for 100% electrical energy usage. This action promotes the use of renewable sources for landscape electricity needs. According to a release from Navy Pier's management, an estimated 60% reduction of overall energy consumption pier-wide is through the selection of energy-efficient lighting, pumps, and aerator and transformer components (Buente, 2016). More strategies need to be considered for the protection of air quality, which is crucial during not only construction but also landscape maintenance.

3.1.9 Education + performance monitoring (10/11)

First, the interests of the community and public in a sustainable landscape are inspired by clearly and successfully demonstrating the summary of such a SITE v2 certified project. The team promotes sustainability awareness and eco-education to visitors through the use of electricity-generating bicycles, signage, and display systems. Information in a variety of formats, such as maps, models, brochures, and electronic kiosks, is provided on-site. The completed case study and project images are also shared online with the public. Second, besides the aforementioned monitoring from the public, the operations team maintains performance

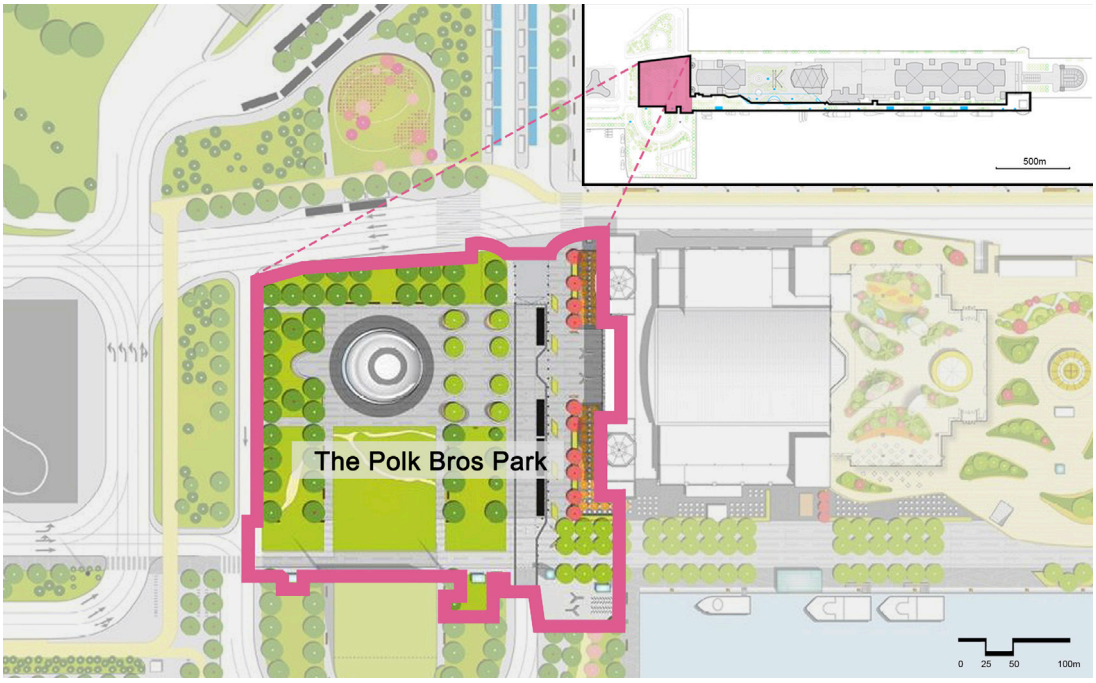

FIGURE 3
Suggestion of possible locations for bioswales in the boundaries of the SITES evaluation of the Chicago Navy Pier.

monitoring and documenting of the green infrastructure, visitors, and operational status throughout the year. For example, performance monitoring data from 2016 showed that Navy Pier diverted more than 500 tons of waste and 1.5 tons of stormwater sediment into landfills each year, saving nearly 2.46 million cubic decimeters of water each year. The body of knowledge on long-term site sustainability could be improved by evaluating their performance over time.

3.1.10 Sustainable bonus points—Innovation or exemplary performance (3/9)

The project drives innovation and transparency in the building and materials industries. The team worked with paving contractors to develop and customize new paving units named "Unilock Pavers," which are ubiquitous elements. The composition (mix) of these pavers is unique and pushed the manufacturer beyond previously established thresholds for incorporating recycled materials. Site paving and surfaces exhibited a high SRI value by using them, hence reducing the localized heat island effect. Nowadays, such pavers have been brought to the market and promote environmental protection in the materials industry.

3.2 Strategies for improvement

Some credits missing today are impossible to be received due to site contexts such as the location and condition, e.g., "Restore aquatic ecosystems" or "Conserve special status vegetation." The strategy that would impose the most effort while still only receiving a few points is on-site food production, which makes this strategy less convenient to implement. Minimizing light pollution would also require major reconstruction, and the result would be hard to assess due to the rest of the pier, outside of the project border, being dominated by light-giving structures such as Ferris wheels and outside theater structures. The final proposal is the implementation of bioswales, policies for green procurement, a switch to electric tools during maintenance, interactive elements for education on the site, and finally, tree tubs for resilience against flooding. These strategies are chosen by us due to different reasons: bioswales, because of its high points and the ecosystem services imposed with implementation; green procurement, a switch to electrical maintenance tools, and educational elements on the site are chosen because of the relatively easy processes to implement these; and finally, since climate change will increase the events of extreme weather, flooding of the pier is very probable to happen. Landscapes today should be resilient to future conditions, and therefore, measures, such as flooding control through tree tubs, should be taken. These improvements will add up to a total of 24 points which can achieve the possibility of Chicago's Navy Pier going from a gold certificate to a platinum certificate.

3.2.1 Bioswales (5 points)

Bioswales, as an addition to the already installed filter treatment and storage system, would provide the required "stormwater treatment visually and physically accessible to site users" stated by SITES v2 as a requirement for receiving points in site design—Water. Bioswales work by removing pollutants through sedimentation, plant uptake, and filtration through engineered media, as explained by Ekka et al. (2021). Compared to traditional swales, bioswales offer several advantages such as

enhanced aesthetics, ecosystem services, and reduced burden on municipal treatment systems.

In the case of Chicago's Navy Pier, the implementation of bioswales in areas closest to traffic pollution could lead to significant benefits. The infiltration of bioswales can help remove pollutants such as heavy metals, PAH compounds, and total suspended solids (TSS) generated by car traffic (Ekka et al., 2021). Among the areas evaluated by SITES, the Polk Bros Park, which is surrounded by streets and located at the west entrance of the Pier, could be the ideal site for implementing bioswales (Figure 3), as it could provide the most significant advantages in terms of pollution removal and stormwater control measures.

3.2.2 Green procurement (12 points)

To achieve the maximum of five points in credits C5.7–5.10, as shown in Figure 2, SITES v2 requires the following: 1) "Support raw material suppliers and/or manufacturers that meet or exceed standards for raw material extraction" means purchasing at least 5% of the raw materials from suppliers that have third-party verified Corporate Social Responsibility reports with descriptions of their environmental impacts, supply chain, and Life Cycle Assessment; 2) "Support transparency and safer chemistry" applies to equipment such as pipes, hoses, irrigation equipment, and wiring. According to the Green Business Certification Inc. (2014), at least 5% of the materials in this credit should be purchased from a manufacturer who conducts a chemical assessment using policies and tools such as "BizNGO's Chemical Alternatives Assessment Protocol" or "GreenScreen for Safer Chemicals"; 3) "Support sustainability in material manufacturing" relates to the business's manufacturing practices. Here, at least 25% of the materials (excluding those materials relating to other credits mentioned previously) used for the site during construction and maintenance should be purchased from companies that have made significant improvements in sustainable practices. To obtain five points in this credit, three of the following five achievements must be met: reduce emissions, reduce or offset greenhouse gas emissions, reduce energy consumption, use renewable energy sources, and reduce the use of potable water; 4) "Support sustainability in plant production" pertains to the purchase of plants for the site from businesses with sustainable methods. In this credit, 80% of the purchased plants and seeds must originate from plant producers that reduce the use of potable water, use sustainable soils, recycle organic matter, prevent the use and distribution of invasive species, and more.

One strategy to obtain more points in these credits is to incorporate green procurement as a policy in maintenance practices and future reconstruction. Green procurement, as a more widespread tool, would enable the purchase of more sustainable goods and services. However, as green product procurement is used more extensively, it creates "rings-on-water" and enhances innovation and competitive products (Dalhammar and Leire, 2017). In conclusion, to accumulate points in these four credits of the Material Selection section, time and money should be set aside to research and investigate supply options.

3.2.3 Electrical maintenance tools (2 points)

To receive a maximum of 4 points in credit 8.7 (refer to Figure 2), SITES v2 suggests the use of powered landscape maintenance equipment should be minimized. Unfortunately, the project team uses gasoline-powered landscape maintenance equipment that includes notorious polluters because they do not burn fuel efficiently (Banks and McConnell, 2015). In this context, a switch to electrical maintenance tools seems necessary. There are electric alternatives to most landscape maintenance equipment, such as electric leaf blowers and electric mowers. Another reason to be excited about the electrification of landscaping maintenance equipment is that the machines are much quieter. Pollution-free and quiet maintenance in public outdoor spaces meet the commitment to sustainability, environment, and community health.

3.2.4 Educational elements (1 point)

The team has already provided a large amount of educational and interpretive elements of on-site features and processes for increasing users' comprehension of sustainability. If they design some educational elements on-site to be interactive, this section can gain one missing point. From kids to adults, seeing equipment with lights, sounds, or other interactive elements attracts attention. This type of application can improve the visitors' experience while at the same time encouraging and expanding sustainability learning and understanding on the site.

3.2.5 Tree tubs (4 points)

The design for scaled resiliency to catastrophic natural events can help the project earn innovation credits. The team could set its goal of wanting to reduce flooding impacts in a more natural way. Applying green infrastructure techniques such as tree tubs is considered a good strategy to implement. Tree tubs are equipped with steel baskets placed in their openings, forming the underground support structure. Once planted, each tree will be covered with a steel lid made flush and surrounded by permeable pavement. Therefore, stormwater that falls on the South Dock will nourish the trees before being filtered and slowly drained into Lake Michigan. Stormwater that is not absorbed by the tree tubs will be captured by surrounding permeable pavement, passed through bio-infiltration basins, and directed to storage cisterns for reuse. The trees planted in tubs can help absorb stormwater and protect watersheds from polluted runoff and coastal non-point source pollution. In addition, such infrastructure will also reduce the heat island effect and improve the air quality and micro-climate of Navy Pier.

4 Discussion

4.1 The practice of SITES v2 for a sustainable design of a landscape

During the case study, it is made clear that the project group has indeed performed great work in producing a sustainable site from the original condition of the pier. SITES v2 is used as a means to guide the major renovation of Chicago's Navy Pier, informing various design stages, from access and circulation studies to plant and material specifications. It offers a highly effective and efficient way to compel environmental performance and project efficiencies, which held the whole team accountable to a high standard of best practices and resulted in an unprecedented project. Chicago's Navy Pier achieves successful transformation into a bolder, greener, and more contemporary destination reflective of the city's identity, bringing benefits such as increased green spaces, improved

pedestrian access, efficient resource use, and innovative construction materials.

SITES v2 guides the project team to higher levels of sustainability by demonstrating the interrelationships and synergies within the rating system and outlining the connections between credits and performance criteria. The possibility of Chicago's Navy Pier going from a gold certificate to a platinum certificate would require an increase of at least 24 points in the scorecard evaluation. The remaining missing credits could be divided into two different categories: credits to be gained from policy changes and credits to be gained from the reconstruction. Two of the strategies, which would predominantly need policy changes, are policies for green procurement (12 points) and a switch to electric tools during maintenance (2 points). The remaining strategies proposed in this research would have to include reconstruction of the site, including the implementation of bioswales (5 points), interactive elements for education on the site (1 point), and finally, tree tubs for resilience against flooding (4 points). Policy changes would not be a major effort; however, reconstruction will be needed to achieve these changes, and whether this is worth it is another issue. Preferably, the project group should have incorporated these systems and techniques already from the start of the project.

4.2 The potential of SITES v2 for a sustainable design of the landscape

In the context of practices of contemporary landscape architecture, the SITES v2 rating system may be transformational in three ways. It can encourage rigorous and measurable practices for sustainable landscapes, facilitate the successful application of sustainable design intent, and stimulate innovation in sustainable practices *via* project work. The case of the Navy Pier presents such capacity and potential.

To begin with, SITES v2 adopts a rigorous and practical approach to creating performance-based benchmarks which will encourage sustainable landscape practices. The system emphasizes quantifiable performance results and the maintenance and promotion of ecological services and natural processes rather than just awarding projects for compliance with particular prescriptive measures or for adopting a list of desired properties. In the case of Chicago's Navy Pier, the team considered SITES v2 as a tool to guide the reconstruction of projects and add a level of rigor and measure to the sustainable principles. They made their efforts to earn points in sections including water, soil and vegetation, material selection, human health, construction, maintenance, and innovative design, and finally realized significant performance benefits in the environment, society, and economy. SITES v2 creates learning chances for all the designers and contractors involved, making the team think through clear and practical benchmarks for landscape performance throughout the whole process of a project. All the challenges that come out of this process are all chances for producing growth and, ultimately, value targeted to sustainable landscape practices. By applying sustainable design and development principles, teams planning and designing landscape projects for which SITES v2 certification is not attainable or suitable can still refer to such benchmarks to solve specific problems and elevate the performance and resilience of the landscape.

Next, SITES v2 holds the potential of facilitating the successful implementation of a sustainable landscape by connecting design with ecology and people to place. A key part of the Navy Pier project is enhancing physical, mental, and social well-being as a result of human connection with nature. The team transformed the outdoor landscape into a more vibrant setting for recreation and social life, such as the fountain and plaza in Gateway Park, the garden room at South Dock Pocket Parks, and pavilions along the lake. Even seating, seat types, and seat groupings are offered with various configurations to enable a range of social interactions, from the individual to the group, and connection with nature. Moreover, one credit aims to increase the site users' ability to understand, access, and feel safe in outdoor spaces. The design team provides educational opportunities that promote the understanding of natural systems. Reconnecting people with nature not only offers human health and well-being benefits but also promotes environmental stewardship among current and future generations. In this context, sustainability will be achieved in the true sense. Not only does SITES v2 ensure a healthier, safer, and happier future but also SITES v2 projects appreciate in value over time.

Lastly, projects that use innovative and exemplary performance strategies can receive bonus points. SITES v2 can be a tool to drive innovation in sustainable practices, and the Navy Pier case study demonstrates this capacity in the aspect of the materials industry. Due to the extensive use of unit pavers throughout the site, the design team set very high standards for pavers in terms of material makeup (recycled content), provenance (regionally sourced), color (high SRI value), and applications (different scenarios support) in order to achieve SITES v2 certification (Banerjee and Loukaitou-Sideris, 2011). However, with no available product that met such high standards within the range of regional suppliers, the team chose to collaborate with paving manufacturers and design by themselves. Finally, they produced a custom paver named "Unilock Pavers" that has subsequently been added to its standard product line (Kafka, 2017). With the aim of SITES v2 certification, the team created a scenario of competition between manufacturers that resulted in a novel product and material use, therefore advancing their sustainability intent, encouraging collaboration, and driving innovation. SITES v2 supports the unique status of each landscape by offering performance measures rather than prescribing practices. It drives project teams to be adaptable and creative as they create and build landscapes appropriate for their context and intended use.

4.3 Future evolution of the SITES v2 rating system

The continued evolution of the landscape rating system will need ongoing study and refinements of SITES v2. Future research will most likely focus on the following two areas. First, the SITES v2 rating system is a climate solution. SITES v2 encourages practices that conserve, restore, and improve the carbon storage capacity of landscapes, minimizing the release of

carbon. For example, it promotes project teams to minimize energy consumption and use low-carbon and renewable energy sources in landscape architecture. SITES v2 also inspires teams to reduce, reuse, and recycle materials and resources; conserve water; and increase the capacity of carbon sinks through re-vegetation. This helps in mitigating the effects of climate change. We can imagine the Sustainable SITES Initiative and SITES v2 could be one more way to safeguard the climatic and ecological systems. Second, SITES v2 will provide COVID-19 guidance for parks and other outdoor landscapes. Equitable site use and support for mental restoration, physical activity, and social connection are already central to SITES v2. In response to the current pandemic, health and safety become an even stronger priority for a smart, equitable, and sustainable recovery, and SITES v2 can develop ways to achieve this goal. As "the recovery will happen in public space" (Phil, 2020), we expect to expand and refine the best recommendations from SITES v2 for precautionary measures in managing and visiting parks and other outdoor landscapes during the COVID-19 pandemic.

5 Conclusion

With increased urbanization and climate change, landscape architects, planners, urban designers, engineers, and builders are looking for tools to help ensure that their work is sustainable and linked to resilience, and SITES v2 presents such a useful system grounded in ecosystem services. In this study, a brief review of the rating system displays its utility, and one project in Chicago illustrates the usefulness and potential of the system. These practical applications and potential of SITES v2 help inform socio-ecological practice and theory. The results show that as an important tool for transformation from theory to the implementation of ecosystem services, SITES v2 is being used to support design decisions toward sustainable outcomes. It can also make the entire project accountable to a higher standard of best practices and result in a more sustainable site. Its great strengths are that it is more accessible and easier to use for assessing and monitoring performance. Those planning and designing projects for which SITES v2 certification is not attainable or suitable can still refer to the general SITES principles to solve specific problems and enhance the performance and resilience of their endeavors. Our study can promote the ongoing application of SITES v2 and the creation of a better sustainable landscape through design. It holds the potential to highlight how the methodology on which SITES has been created can be linked with future city development and urban landscape management.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material; further inquiries can be directed to the corresponding authors.

Author contributions

LJ and YW designed research, performed research, analyzed data, and wrote the paper. All authors discussed the results and revised the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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