American Society of Landscape Architects

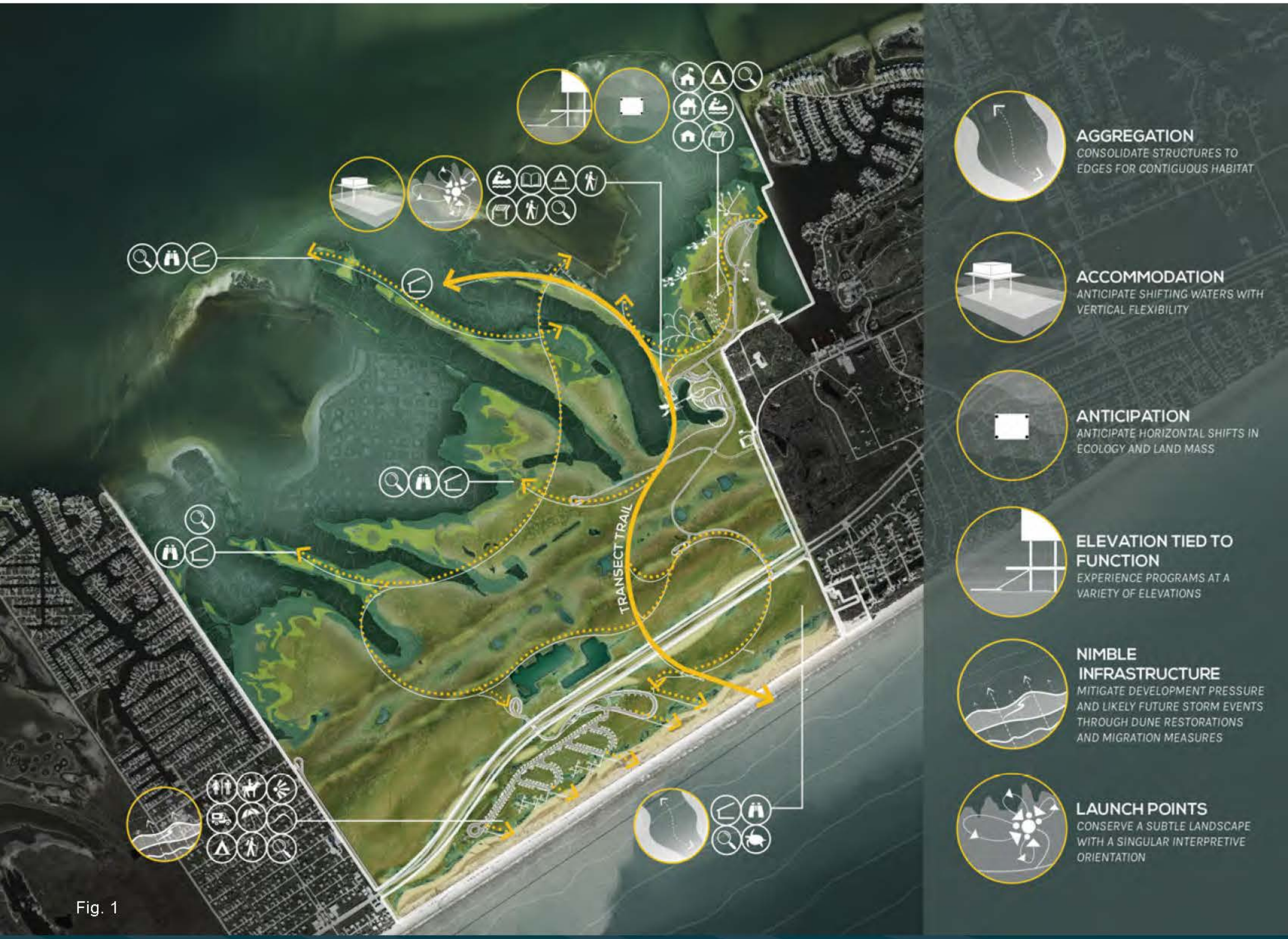


Fig. 1

# Landscape Architecture and Science, Technology, Engineering, and Mathematics (STEM): Case Studies

**2020**

ASLA Committee on Education

# Landscape Architecture and Science, Technology, Engineering, and Mathematics (STEM): Case Studies

Landscape architecture is inherently a Science, Technology, Engineering, and Mathematics (STEM) discipline. The principles of STEM constitute the foundation of the academic criteria and professional practice of landscape architecture. Through stewardship of the natural and built environments, landscape architects routinely apply their STEM education and training to plan and design vital infrastructure projects, rights-of-way, campuses and other significant private and public site developments—all places where millions of people live, work, and play.

The technical complexity of landscape architecture and its impact on public health, safety, and welfare has led all 50 states and the District of Columbia to license landscape architects. Ensuring public health, safety, and welfare in the practice of landscape architecture starts with a rigorous STEM higher education, and culminates in a nationally administered four-part examination, the Landscape Architecture Registration Exam (LARE).

Landscape architecture students are educated, trained, and tested on site design; land planning; technical and scientific areas such as grading; drainage; stormwater management; horticulture; environmental sciences; project development; erosion control; hydrology; irrigation; vehicular and pedestrian circulation; roadway alignment design; manipulation of contours and spot elevations; calculations of slopes, grades, and volumes of material; design of surface and subsurface storm drainage, including hydraulic characteristics and storm drain connections; and site planning for buildings and other structures. Clearly, the academic curriculum for landscape architecture encompasses science, technology, mathematics, and certain engineering courses of study.

Landscape architects rely on STEM knowledge areas, activities, and disciplines as fundamental components of their professional practice. The profession plans and designs all the spaces outside buildings, including community master plans, multimodal transportation networks, transit-oriented development projects, outdoor park and recreation spaces, water and stormwater management projects, and more. For these and many other landscape architecture projects, practitioners apply the science of statics, ecology, and physics for site planning, the technology of state of the art digital simulation tools like GIS, LiDAR, and others, the engineering skills and knowledge of landform manipulation and stormwater management to design and engineer roads, walkways, and drainage structures and mathematical computations for slope, grades, and structural loads—all with an eye toward public health and safety. STEM subject areas are clearly the driving forces behind both the rationale and execution of the landscape architecture projects.

STEM subject matters are intrinsically a part of both the academic discipline and practice of landscape architecture and is recognized as such by individuals, other professionals, academic institutions, and governing bodies. The Bureau of Labor Statistics Standard Occupational Classification (SOC) System has recognized landscape architecture as a science and engineering related domain.[1] This system is used by the federal government to classify workers into occupational categories, grouping together occupations with similar job duties, and in some cases, skills, education, and/or training are grouped together. Under this system, landscape architecture is grouped with civil engineers, architectural and civil drafters, environmental engineers, and surveyors. Several states formally define landscape architecture as a STEM discipline. For example, the Departments of Labor in both New York and Connecticut recognize landscape architecture as a STEM profession. The State of Florida recognizes landscape architecture as a STEM degree program through the Board of Governors' State University System's list of "Programs of Strategic Emphasis."[2]

However, there are some entities that have not formally recognized landscape architecture as a STEM discipline, including the U.S. Department of Homeland Security (DHS) Science, Technology, Engineering, and Mathematics (STEM) Designated Degree Program List. Through advocacy, communication, and research, the American Society of Landscape Architects (ASLA) is working to raise the visibility of the profession's innate STEM qualities and practice areas with federal, state, and local stakeholders, the STEM community, and the general public. To learn more about ASLA's efforts visit www.asla.org/STEM.

[1] https://www.bls.gov/soc/2018/major_groups.htm#17-0000

[2] https://www.flbog.edu/wp-content/uploads/Fall-2020-Approved-PSE-List-All-Categories-2-4-20.pdf

The following thirteen landscape architecture projects are case studies that demonstrate how STEM practice areas are comprehensively employed throughout the project and through its successful completion. Each case study also includes an evaluation of the degree to which various STEM areas are employed. The projects, which were all led by landscape architects, also demonstrate some of the breadth and scope of the profession, from urban planning, to shoreline protection, to large-scale waterfront projects, to green roofs, to university campus planning and design, to community parks, and other public spaces.

# Landscape Architecture Professional Projects and STEM Criteria

## STEM Project Matrix

| | Anacostia Watershed | Shield Ranch | Living Breakwaters | Galveston Island State Park | Crosswinds Marsh | Seattle Waterfront Project | U. of Wisconsin-Madison | Baton Rouge Lakes | Gathering Place | Railroad Park | Gary Comer Youth Center | ASLA Roof Garden | Millennium Park |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Science** | | | | | | | | | | | | | |
| Ecology, Evolution, and Population Biology | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◑ | ◑ | ● |
| Physical Sciences | ● | ● | ◑ | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Physiology, Pathology, and Toxicology | ● | ○ | ● | ○ | ◑ | ○ | ◑ | ● | ○ | ○ | ○ | ○ | ● |
| Social and Cultural Sciences | ● | ● | ● | ● | ● | ● | ● | ◑ | ◑ | ● | ● | ● | ● |
| **Technology** | | | | | | | | | | | | | |
| Stormwater Infrastructure | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Multi-Modal Transportation | ● | ○ | ○ | ○ | ● | ● | ● | ○ | ◑ | ◑ | ○ | ○ | ● |
| Sustainable SITES Initiative | ○ | ○ | ● | ○ | ○ | ◑ | ○ | ● | ◑ | ◑ | ◑ | ◑ | ◑ |
| Food and Agriculture | ○ | ○ | ● | ○ | ○ | ◑ | ○ | ○ | ○ | ○ | ● | ○ | ○ |
| Interactive | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ● |
| Computer Programming and Planning | ● | ● | ◑ | ● | ● | ● | ● | ● | ◑ | ● | ○ | ◑ | ● |
| Educational/Instructional | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Planning and Inventory | ● | ● | ● | ◑ | ● | ● | ● | ● | ● | ● | ○ | ● | ● |
| **Engineering** | | | | | | | | | | | | | |
| Structure and Capacity | ◑ | ◑ | ◑ | ● | ○ | ● | ◑ | ● | ● | ● | ● | ● | ● |
| Materials and Joints | ○ | ○ | ○ | ○ | ◑ | ● | ◑ | ● | ● | ○ | ● | ◑ | ◑ |
| Codes and Regulations | ◑ | ◑ | ● | ◑ | ○ | ● | ◑ | ◑ | ● | ◑ | ● | ◑ | ● |
| Construction Documents and Specifications | ◑ | ○ | ◑ | ○ | ◑ | ● | ◑ | ◑ | ● | ◑ | ● | ◑ | ● |
| Water and Climate Performances | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| **Mathematics** | | | | | | | | | | | | | |
| Grading and Earthworks | ● | ◑ | ● | ● | ● | ● | ○ | ● | ● | ● | ◑ | ◑ | ● |
| Project Cost Estimates | ● | ○ | ◑ | ○ | ● | ◑ | ◑ | ◑ | ○ | ○ | ◑ | ◑ | ● |
| Biomathematics | ● | ● | ● | ● | ● | ◑ | ◑ | ● | ◑ | ● | ● | ● | ◑ |
| Stormwater Planning and Management | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Structural Loads | ● | ◑ | ◑ | ◑ | ○ | ● | ◑ | ● | ● | ● | ● | ● | ● |
| Urban Modeling | ● | ● | ● | ● | ◑ | ◑ | ● | ● | ◑ | ○ | ○ | ● | ◑ |

● Highly relevant
◑ Moderately relevant
○ Mildly relevant

# Project No. 1: Anacostia Watershed
## NBBJ, Landscape Architecture and Urban Planning, Boston, MA

Fig. 2 Site remediation projects identified along the Anacostia River. Image courtesy of Anacostia Waterfront Trust.

| | | | |
|---|---|---|---|
| **Site Location:** | Maryland and Washington, D.C. | | |
| **Project Type:** | River Restoration/Water Sanitation | **Prime Firm:** | NBBJ, Boston, MA |
| **Scope:** | Watershed Restoration | **Federal Departments:** | DC Office of Planning, Department of Energy & Environment, DC Water, Justice Department |
| **Size:** | 176 square miles | | |
| **Date:** | 2023 | | |
| **Cost:** | $2.7 billion | | |
| **Recognition:** | | **Engineer:** | WSP, Baltimore, MD |
| **Citations:** | Reut, Jennifer. "The River Beneath the River." *Landscape Architecture Magazine* 108 (2018) https://landscapearchitecturemagazine.org/2018/11/27/the-river-beneath-the-river/ | **Advocate Groups:** | Anacostia Waterfront Trust, Anacostia Watershed Society, Anacostia Watershed Restoration Partnership, Anacostia River Keepers |

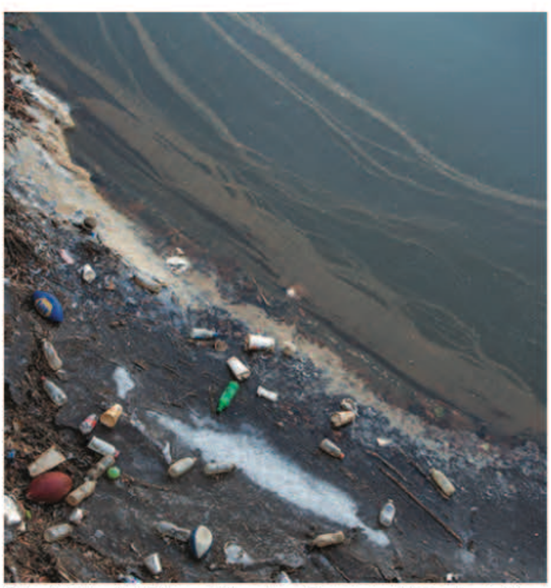

Fig. 3 The tidal flow of the river leaves pollutants on the banks. Photo by Krista Schlyer.

Fig. 4 Charismatic boring machine used to dig tunnel below Anacostia River. Image courtesy of DC Water.

## Anacostia Watershed, Continued

**Project Brief:**
This large scale project originated in Washington, D.C. as "The Anacostia Waterfront Framework Plan," which recognized the need to transform the health of the Anacostia River. Through collaboration between NBBJ, the DC Office of Planning, the Anacostia Watershed Society, the EPA, and the Justice Department, a new "Clean River Project" began with DC Water focusing on Combined Sewer Overflow (CSO) challenges. To address these issues, DC Water initially built innovative tunnels to transport water beneath the river to the Blue Plains Advanced Wastewater Treatment Plant. Once the water is processed, it is released back into the Potomac and flows towards the Chesapeake Bay. Additional green infrastructure methods were implemented by Seth Charde, the landscape architect and project manager for DC Water. The Clean River Project will reduce storm-water volume in the rivers by 96 percent, compensating for 250 years of neglect. There are still other measures to be taken, specifically cleaning up sediment pollution from legacy industries, with the aim of improving human recreation and bringing in new sources of revenue along the Anacostia waterfront.

**Science:**
Projects along the waterfront used green infrastructure and bio-retention methods to filter water along the shore of the river. These natural best-management practices use plants to trap particles from the water before flowing down stream.

Rehabilitation efforts are underway to lessen the effect of toxic mudflats, and the restored wetlands have increased biodiversity and habitat for species.

**Technology:**
The newly built wastewater treatment facility processes storm and sewage water before returning it to the natural hydrological system.

DC Water is using new trash skimming boats to remove pollution from the river. This efficient technology quickly restores the water to a healthy state through the timely extraction of trash and litter.

**Engineering:**
To stop the historic flow of untreated water entering the river, DC Water built a tunnel to separate and move the water so it does not contaminate the river. The gravity-fed tunnel transports sewage to be treated at Blue Plains Advanced Wastewater Treatment Plant. Construction of the tunnel amends for years of mismanaged water.

**Mathematics:**
The new efficient tunnel prevents 170 million gallons of stormwater and sewage from entering the Anacostia River in one storm event.

Water quality testing serves to examine the health of the river, testing for E. Coli and fecal bacteria. Additional water quality tests for dissolved oxygen, pH, chlorophyll, depth, and turbidity are done regularly to monitor and analyze the health of the river.

# Project No. 2: Shield Ranch

## Andropogon Associates, Ltd., Landscape Architecture, Philadelphia, PA

Fig. 5 Aerial view of Shield Ranch. Photo by Jonathan Jackson.

**Site Location:** Austin, TX
**Project Type:** Landscape Architecture Analysis
**Scope:** Analysis and Prevention
**Size:** 6,800 acres
**Date:** 2018
**Cost:**
**Recognition:** 2018 ASLA Professional Award
**Citations:** "From Pixels to Stewardship; Advancing Conservation through Digital Innovation". American Society of Landscape Architects. www.asla.org/2018awards/453745-From_Pixels_To_Stewardship.html

**Prime Firm:** Andropogon Associates, Ltd., Philadelphia, PA
**Consultants:** Shield Ranch Staff, Austin, TX
**Regenerative Design:** Heather Venhaus, ASLA
**Biohabitats:** Claudia Browne
Erin English, PE, LEED AP
**Consulting Geologist:** Dr. Charles Woodruff
**Mechanical Estimator:** Blair Tennant, LEED AP
**Spot Inquiry:** Alexis Sanford
**Drone Imagery:** Johnathan Jackson
**Sound Consultant:** Dr. Michael Mandel

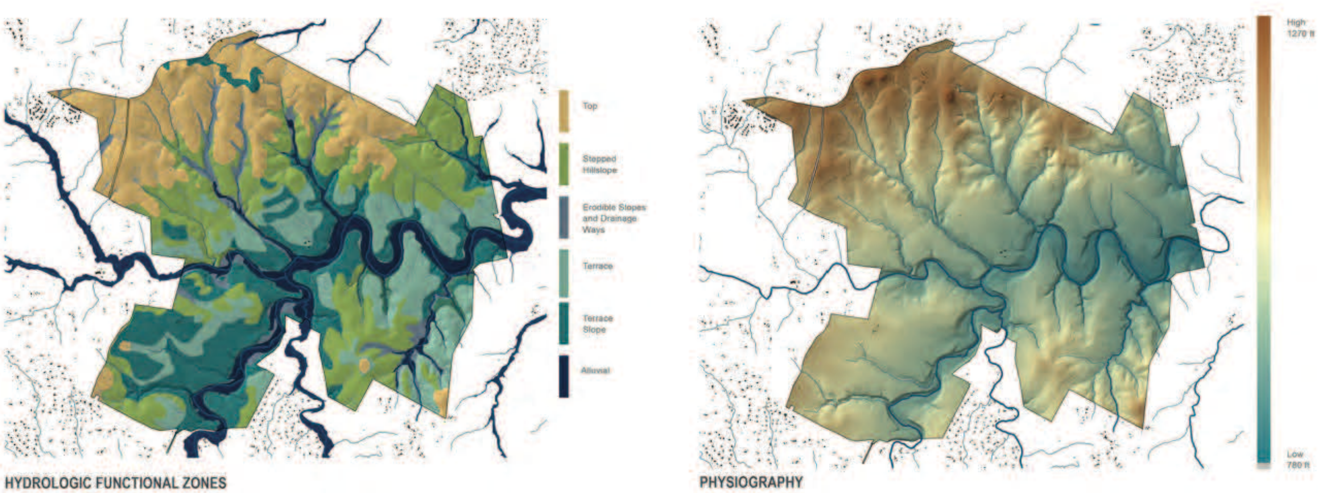


Fig. 6 Hydrologic functional zones and physiography mapped through GIS and characterized by water movement typology. Image courtesy of Andropogon Associates.

## Shield Ranch, Continued

**Project Brief:**
Shield Ranch, a 6,800-acre compound in Austin, Texas, has been under ownership for the past 80 years by the Shield-Ayres-Bowen Family. In 1998, the family enhanced its long-term commitment to land stewardship and advocacy by placing 95% of its land under conservation easement. Protection of water quality, water quantity, and sensitive habitats was heightened further with the completion of the Shield Ranch Master Plan in 2018. The 10-year master plan integrated a pioneering process for modeling and categorizing the iconic landscape's complex natural and cultural systems, with a consensus-building process for distilling long-term development and management priorities.

**Science:**
The location of the ranch is in an area of extremely sensitive climatic and hydrological conditions. An in-depth inventory of the geologic, hydrologic, and topographic features of the ranch; its flora and fauna; and its prehistoric and historic cultural resources, was completed in service of a vision for sustainble land management.

The nature sanctuary preserves the ecological health of complex systems, including the protection of two endangered avian species.

**Technology:**
Mapping in GIS has characterized typologies of water movement to identify hydrogeologically-sensitive landscapes. These maps depict anticipated floodplains, steep slopes, risers, boundaries between geologic formations, and soils at risk for erosion. GIS has also been integrated with smartphone technology to develop a collective knowledge of scientist's findings, site analysis, field research, and family history towards the development of a comprehensive assessment of the ranch's future integrity.

LiDAR technology was used to receive high-resolution point-cloud data to model topography and vegetation, constructing a model to analyze water movement in complex geologies, the diverse landscapes, ecological communities, viewsheds, and soundscapes.

**Engineering:**
Creating a hydrogeological model identified the dynamics and conditions of a stepped hillslope. Hydrogeology is critical for vegetation, water quality, habitat, and maintaining the health for the entire region.

Site development guidelines, per each hydrogeologic zone, focus on water management, vegetation, and land-use in order to design strategies to protect ecological systems. Storm-water best management practices are used to ensure hydrological health and proper erosion control. Practices include net-positive water building systems, bioswales, riser protection and conservation, and permeable pavements.

**Mathematics:**
The Barton Creek watershed drains into the Edwards Aquifer recharge zone, and Shield Ranch lies within the Barton Creek watershed. The Edwards Aquifer recharge zone is calculated to supply more than two million people with drinking water. The recharge zone bears the impacts of surrounding land holdings' water quality, including the property of Shield Ranch.

Through measuring quantitative data on the interconnectivity of systems, humans and species, the Shield Ranch Master Plan provides long-term intervention, minimizing environmental threats in this harsh climate.

# Project No. 3: Living Breakwaters

Scape Studio, Landscape Architecture, New York, NY

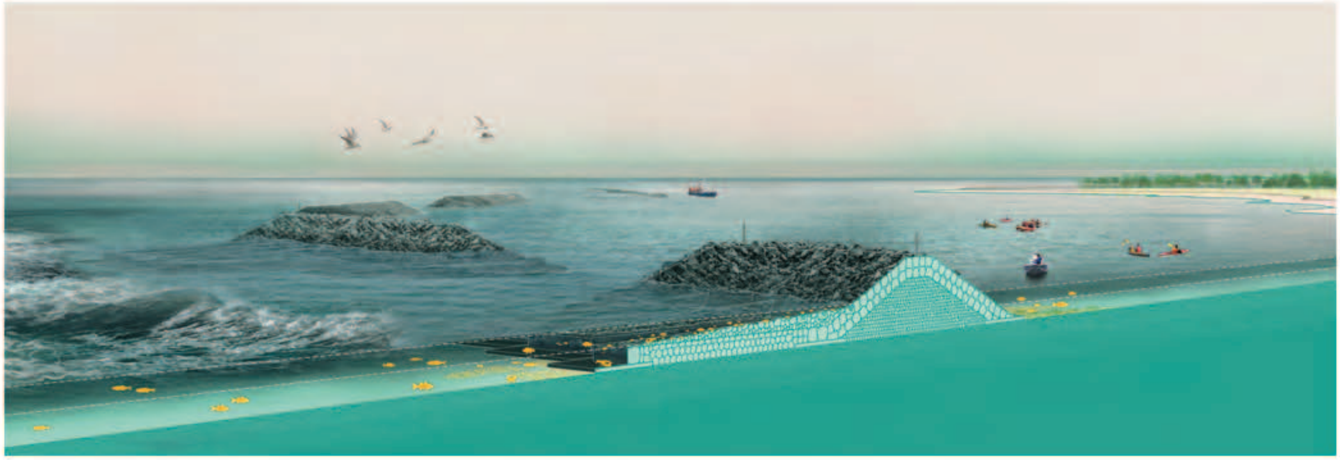

Fig. 7 Section of proposed living breakwater coastal condition. Image courtesy of Scape Studio.

**Site Location:** South Shore Staten Island & Raritan Bay, NY

**Project Type:** U.S. Department of Housing & Urban Development's Rebuild by Design Initiative

**Scope:** Professional Research Competition Proposal (Phase 1 funding $60 million)

**Date:** 2014 - Current

**Cost:** $60 million of CDBG-DR funding

**Recognition:** 2014 HUD Rebuild by Design Winner
2014 Fuller Challenge Winner
2015 National Planning Achievement Award for Environmental Planning
2015 ACEC NY Engineering Excellence Award

**Citations:** "Living Breakwaters Rebuild by Design Competition." Scape Studio. https://www.scapestudio.com/projects/living-breakwaters-competition/

**Prime Firm:** Scape Studio, Landscape Architecture, New York, NY

**Architect:** LOT-EK, New York, NY

**Engineering Consultant:** Parsons Brinckerhoff, New York, NY

**Hydrology Consultant:** Stevens Institute of Technology, Hoboken, NJ

**Engineering Consultant:** Ocean & Coastal Consultants, a COWI Co., Trumbull, CT

**Marine Consultant:** SeArc Ecological Consulting, Tel-Aviv, Israel

**Design Consultant:** MTWTF, New York, NY

**Community:** The New York Harbor School, New York, NY


Fig. 8 Building ecological resiliency through structural, ecological and water management systems. Image courtesy of Scape Studio.

# Living Breakwaters, Continued

**Project Brief:**
In response to Hurricane Sandy in 2012, as part of a global competition, Scape Studio's Living Breakwater design became one of six winning proposals submitted to the U.S. Department of Housing and Urban Development's Rebuild by Design Initiative. The project is focused on designing resilient solutions to threatening coastal conditions by establishing living infrastructure barriers. Off the coast of Staten Island, in Raritan Bay, work has begun to repair the damaged shoreline, bringing back a healthy ecosystem through nature-inspired barrier islands that protect the New York area from future coastal storms. The newly designed barriers combine built and natural solutions by merging specially-designed textured concrete blocks with living oysters; the newly built reefs slow the wave action and provide habitat for marine species to move in. Over time, the built reefs blend into the natural aquatic ecosystem while continuing to buffer a prized coastline from storm surges and erosion. The scope of the project serves as a global example of coastal management, integrating community involvement as local students participate in the oyster project.

**Science:**
The living reef infrastructure is the design of micro-pocket habitats of rocky sloped walls that provide texture for marine growth that are able to host species such as finfish, shellfish, and lobsters. The new habitats are populated by oyster communities that add structural integrity to the built reef; the oysters also act as clean water filters and provide habitat for biodiversity.

The implementation of Phase 1, the Tottenville Reach, has been used to study ecological benefits and wave-reduction impacts to establish performance before the rest of the project is fully activated.

**Technology:**
Hydrodynamic modeling provides storm surge data to prepare for wave action in storm events, allowing for accurate identification of new built breakwater locations that protect communities and support existing wetlands.

The design proposes interactive wet laboratory space, flexible gathering space for local community groups, bird-watching stations, and an area for citizen science observational input.

**Engineering:**
The proposal demonstrates how engineered living infrastructure can be constructed to reach optimal structural integrity and functional performance.

The engineered interventions propose a model that is designed to work with natural energy, while dissipating its damaging effects.

**Mathematics:**
The project proposes a mix of subtidal breakwater beds of differing forms that extend above the high water line. The design proposal was calculated to provide a four-foot reduction in wave height.

To understand how and where the proposal can most effectively protect communities, model breakwater systems were analyzed at the macro scale. This information is being used to design for and mitigate 100- and 500-year storm surge metrics.

# Project No. 4: Galveston Island State Park

Studio Outside, Landscape Architecture and Urban Design, Dallas, TX


Fig. 9 Galveston Island State Park is the only location on Galveston Island with natural bay-to-beach accessible island habitat. Image courtesy of Studio Outside.

**Site Location:** Galveston, TX
**Project Type:** Resiliency Planning
**Scope:** Analysis & Planning
**Size:** 2,000 acres
**Date:** 2010
**Cost:** $750,000
**Recognition:** 2017 ASLA Professional Award
**Citations:** "Storm + Sand + Sea + Strand." American Society of Landscape Architects. https://www.asla.org/2017awards/324291.html

**Prime Firm:** Studio Outside, Dallas, TX
**Lead Designer:** Michael Fraze, ASLA
**Ecological & Coastal Resiliency Planning:** Biohabitats, Inc., Baltimore, MD
**Architecture:** Overland Partners Architects, San Antonio, TX
**Interpretive Planning:** PRD Group, Chantilly, VA
**Hurricane Engineering:** Engenesis, North Sydney, Australia
**Civil Engineering & Environmental Permitting:** CP&Y, Longview, TX
**Public Engagement:** RJ Rivera Inc., San Antonio, TX
**Archaeology:** Prewitt Associates, Austin, TX
**Electrical Engineering & Sustainability:** Henderson Engineering, Dallas, TX


Fig. 10 Predictive modeling and ecological analysis depict the changes on the site by 2060. Image courtesy of Studio Outside

## Galveston Island State Park, Continued

**Project Brief:**
Galveston Island State Park covers 2,000 acres of coastline in Galveston, Texas. In response to Hurricane Ike's devastation in 2008, and the previous history of 50 hurricanes impacting the Gulf communities, the redevelopment master plan sets a new precedent for coastal resiliency. Planning with predictive models depicts site strategies for specific ecologies and elevations, anticipating what will remain in 50 or 100 years, and how ecolo-gy systems will adapt to change. With the predictive models, the master plan uses this fragile and diverse landscape to fully immerse visitors in the overall experience and understanding of Galveston Island State Park, while simultaneously mitigating the impacts of an evolving landscape.

**Science:**
Endangered species are protected through site strategies which decrease habitat fragmentation, allowing delicate systems to evolve and flourish. The fragility of the island system led to the planning strategy, and this precedent can be adapted to other coastal resiliency projects. One strategy utilized is the reduction of impermeable surfaces by 25 percent across the park.

Overnight and recreation opportunities celebrate the diversity of the island's unique environment, integrating human systems. This broad array of recreation and integration responds to an outreach process which sought to engage hurricane-displaced residents in the development of the park.

**Technology:**
Field measurements from a nearby barrier island create a framework for thriving ecologies as a case study of chemical balance and resiliency to instill success at Galveston Island State Park.

Tropical-storm dynamics were assessed through storm science technology, with the State Park's topography and storm frequency predictions were modeled to understand the level and damage of storm surges.

**Engineering:**
Predictive modeling was used to further understand the potential landloss for 2060, to inform the master plan. Topography grading was surveyed with models studying three scenarios: the impact of sea-level rise, beach erosion, and subsidence.

On-site infrastructure was proposed to withstand the impacts of sea-level rise and storm surge, and to minimize costly damage. These structures serve as both species habitats and recreational and educational zones for visitors.

**Mathematics:**
Storm surges were calculated to reproduce 11 years of damage in just one day, and measurements were taken to understand the severity of such a storm surge. A 20+ foot storm surge changes the ecosystem from freshwa-ter ponds to saltwater, and this ecological change can involve years of remediation to reverse.

Percentage calculations reveal the damage of predictive sea-level rise in order to create the master plan site strategy. Site-specific results disclose a prediction of high, medium and low calculations of land loss. Based on the results, the master plan strategizes around the mid-range scenario of a 22% landloss for 2060, turning much of the land into open water or marsh.

# Project No. 5: Crosswinds Marsh Wetland Interpretive Preserve

SmithGroup, Landscape Architecture, Detroit, MI

Fig. 11 SmithGroup's illustrative master plan. Image courtesy of SmithGroup

**Site Location:** New Boston, MI
**Project Type:** Wetland Preserve and Restoration
**Scope:** Ecological
**Size:** 1,050 acres
**Date:** 1995
**Cost:** $18.1 million
**Recognition:** 2001 The Waterfront Center Honor Award
2000 U.S. Department of Transportation Design Merit Award
1999 ASLA Presidents Award of Excellence
1999 Airports Council International Environmental Achievement Award
1998 ASLA Honor Award
**Citations:** "Crosswinds Marsh Interpretative Preserve." SmithGroup. https://www.smithgroup.com/projects/crosswinds-marsh-interpretive-preserve

**Prime Firm:** SmithGroup, Ann Arbor, MI
**Civil Engineer:** SmithGroup, Ann Arbor, MI
**Environmental Engineer:** Tucker, Young, Jackson, Tull
**Architecture:** Lincoln Poley, AIA, Ann Arbor, MI
**Contractors:** ABC Paving; W.H. Canon, Inc.; and L. Lawyer Construction

Fig. 12 Before and After images showing the transformation of the historical wetland habitat. Image courtesy of SmithGroup.

## Crosswinds Marsh, Continued

**Project Brief:**
Crosswinds Marsh is a 1,050-acre recreational park and wildlife refuge created for Detroit Metropolitan Wayne County Airport in New Boston, Michigan, one of the largest self-sustaining wetland mitigation projects in the country. When the airport expanded, the park was designed in response to environmental regulations. The new park far exceeded the necessary requirements by addressing flood protection, habitat creation, preservation, and restoration while also providing recreational, educational, and social value. Crosswinds Marsh serves as a national benchmark for ecological restoration and environmental design.

**Science:**
This landscape has restored over 1,000 acres of land that was previously drained for agricultural and residential use. The land has been returned to its historical wetland habitat.

Crosswinds Marsh now provides a diverse series of wetland habitats. The habitats include forested, wet meadow, emergent, submergent, and deep water areas. With its restored and preserved wetland systems, Crosswinds Marsh creates habitat for a variety of native flora and fauna.

**Technology:**
Monitoring data is used to identify various species on the land since restoration. Over 200 species of birds, 170 species of plants, 20 fish, 30 mammals, 21 reptiles and amphibians, and 70 species of butterflies and dragonflies have been recorded.

Scientists use the site to monitor and collect data for ongoing research and future restoration activities. They also study revegetation strategies, as well as construction and implementation methods

**Engineering:**
With careful and purposeful grading, the maintenance of natural systems is sculpted to follow site hydrology. The technical design considered pump-free hydrologic functions of the site to provide essential habitats that attract hundreds of animal species. As a result, Crosswinds Marsh requires no pumps, dykes, or artificial methods for directing water throughout the site.

The site decreased downstream and upstream flooding through grading and wetland implementation.

**Mathematics:**
In order to create self-sustaining wetland communities, quantitative data calculated over 300,000 native aquatic plants, with 10,000 seedlings and 300 acres of wetland seed added to the site.

Sensitive planning revealed the necessary area needed to protect threatened species. Limited access was given to 20 acres for the propagation and re-establishment of three rare plant species relocated from the airport. Bald eagle nesting sites are also preserved on the site.

# Project No. 6: Seattle Waterfront

## James Corner Field Operations, Landscape Architecture, New York, NY


Fig. 13 Plan of the new pedestrian-focused Central Waterfront on Alaskan Way. Image courtesy of James Corner Field Operations.

**Site Location:** Seattle, WA
**Project Type:** Landscape Architecture/Urban Design/Seawall Infrastructure
**Scope:** Ecological Waterfront and Pedestrian Promenade 1.5 miles
**Size:** 2017 - 2023
**Date:** $717 million
**Cost:** 2017 ASLA Professional Awards, General Design
**Recognition:** "Central Seawall Project." American Society of Landscape Architects.
**Citations:** https://www.asla.org/2017awards/320768.html "Seattle Central Waterfront." James Corner Field Operations. https://www.fieldopera-tions.net/project-details/project/seat-tle-central-waterfront.html

**Prime Firm:** Parsons Corporation, Pasadena, CA
**Landscape Architect:** James Corner Field Operations, New York, NY
**Lead Engineer:** Magnusson Klemencic Associates, Seattle, WA
**Civil Engineer:** Perteet, Seattle, WA
**Civil Engineer:** SvR, Seattle, WA
**Coastal Engineer:** Moffatt & Nichol, Seattle, WA
**Structural Engineer:** COWI North America
**Structural Engineer:** Exeltech Consulting, Inc., Seattle, WA
**Geo-technical Engineer:** Shannon & Wilson, Inc.
**Habitat Engineer** Hart Crowser
**Local Landscape Architect:** Harrison Design Landscape Architecture, Seattle, WA
**Artist:** Hadd/Drugan, Laura Haddad
**Construction Management:** Jacobs Engineering Group Inc., New York, NY

Fig. 14 Rendering of the new Seattle Central Waterfront after removal of the Alaskan Way Viaduct. Image courtesy of James Corner Field Operations.

# Seattle Waterfront, Continued

**Project Brief:**
With the removal of the Alaskan Way Viaduct and the reconstruction of the 75-year-old Elliot Bay Seawall, the City of Seattle is preparing to reactivate its Central Waterfront and reconnect to Elliott Bay. The comprehensive urban design framework along the 1.5 miles of waterfront has been led by the landscape architecture firm Field Operations. The multiple scale plan considers the geographic and cultural concerns of the region by prioritizing the native salmon runs and the frequency of earthquakes in Seattle. The new seawall enhances the public realm with its elevation, providing connections to downtown with new waterfront access points. The structure of the seawall is designed to withstand seismic events, with the wall also featuring a texture to encourage healthy ecological conditions, and cantilevered surfaces containing embedded light-transferring glass for aquatic life to return and flourish. The-six year infrastructure project addresses the many needs of the city and seizes the opportunity to reintroduce natural systems through the implementation of design.

**Science:**
Habitat restoration on the seawall is created through shallow habitat shelves for increased biodiversity. This improves salmon migration and near-shore conditions by providing vertical textured surfaces for biotic growth and channels for safe travel of juvenile fish.

Lower gravel surfaces of the raised seabed provide aquatic life areas to hide and forage within the varied surface. With vegetation and marine invertebrate growth, water quality continues to improve.

**Technology:**
Permeable paving materials are used on ground surfaces to allow for natural water movement to recharge groundwater and mitigate storm-water runoff.

The built cantilever infrastructure over the Puget Sound transfers daylight to the biotic life below the public pedestrian walkway.

**Engineering:**
A boring machine was used to dig the tunnel under the City of Seattle to re-route the Alaskan Way Viaduct below the city, which necessitated the revised ground level street connections that incorporate bike and pedestrian traffic.

The weakening seawall was replaced to protect the coastal city from impending damage and stormwater events.

**Mathematics:**
The new seawall meets the seismic standards with oversight from the City of Seattle and NEHRP. The seawall was designed to maintain the vital edge of the city and last a minimum of 75 years.

# Project No. 7: University of Wisconsin-Madison Campus

SmithGroup, Architecture & Landscape Architecture, Detroit, MI

Fig. 15 The University of Wisconsin-Madison campus connects Madison to Lake Mendota. Image courtesy of SmithGroup.

**Site Location:** Madison, WI

**Project Type:** Higher Education Master Plan

**Scope:** Stormwater Management & Restoration

**Size:** 936 acres

**Date:** 2015

**Cost:**

**Recognition:** 2017 SCUP Excellence in Landscape Architecture - Open Space Planning and Design
2018 ASLA Award of Excellence - Analysis and Planning
ASLA-Michigan, Honor Award

**Citations:** "University of Wisconsin-Madison Master Plan.: SmithGroup. https://www.smithgroup.com/projects/university-of-wisconsin-madison-master-plan

**Prime Firm:** SmithGroup, Ann Arbor, MI

**Landscape Architect:** Hoerr Schaudt, Chicago, IL

**Engineering Consultants:** Kimley-Horn and Associates, Raleigh, NC

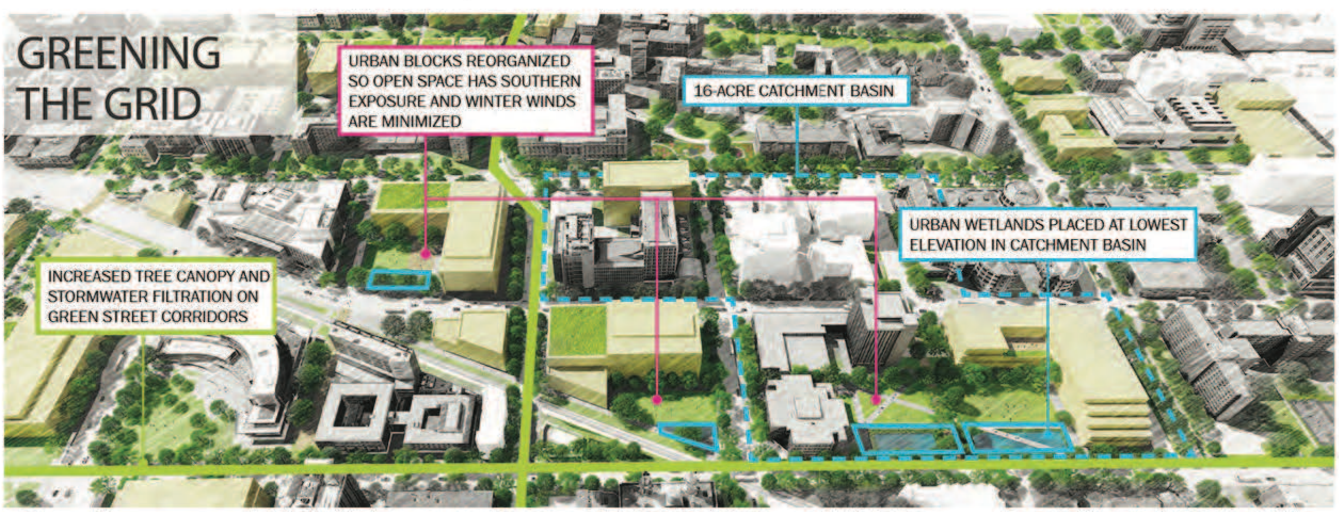


Fig. 16 Green infrastructure throughout the campus provides productive and sustainable landscapes. Image courtesy of SmithGroup.

## University of Wisconsin-Madison Campus, Continued

**Project Brief:**
The University of Wisconsin-Madison, located in Madison, Wisconsin, was founded in 1848 and is the state's oldest and largest university. The university's 936 acres and 4.5 miles of shoreline on Lake Mendota serve as a connection between the lake and the city of Madison. The university's Campus Master Plan Update recognizes the future health of the campus and the lake and is the first landscape-focused master plan in university history. Historic and culturally rich landscapes are connected through a more traditional campus plan merged with a performance-based green infrastructure approach. The university's innovative plan serves as a precedent for other institutions with its measurable improvements in stormwater management and water quality. The Campus Master Plan sets a new national standard for university planning with integrative design between public and performance landscapes.

**Science:**
New state and federal water quality regulations require significant regional reductions in Total Maximum Daily Load Regulations. Total Suspended Solids (TSS) are required to be reduced by 73 percent and Total Phosphorus is required to be reduced by 61percent. The campus planning process analyzed the interconnectivity of water systems in order to identify partnerships needed to achieve these percentages.

To protect Lake Mendota, conversions were made to Observatory Hill to protect habitat and improve water quality. The existing slope remains with the removal of a parking lot and the addition of a wetland system.

**Technology:**
Technical analysis was conducted using Geographic Information Systems (GIS) and various stormwater modeling programs to develop comprehensive watershed studies, including studies on Lake Mendota Watershed, Lake Monona Watershed, and Willow Creek Sub-watershed. The analysis reveals that 2,000 acres of upstream city stormwater flows through Willow Creek, which runs through the University of Wisconsin-Madison campus.

The existing campus green infrastructure was modeled to quantify the runoff reduction benefits in order to establish an effective baseline for plan recommendations.

**Engineering:**
The University of Wisconsin-Madison integrated landscape with stormwater management plans, making it one of the first institutions to combine landscape productivity into the larger campus master planning. Stormwater management will help the campus contribute to achieving the standards set by the state and federal water quality regulations.

To increase landscape performance while designing public space the team increased tree canopy and stormwater filtration on green street corridors, added catchment basins, reorganized urban blocks to shield winter winds, and placed urban wetlands at the lowest elevation in a catchment basin. The landscape infrastructure, green streets, and catchment basins drastically reduce the TSS conditions on campus.

**Mathematics:**
Quantified analysis reveals how the existing campus landscapes and infrastructures contribute to TSS reduction. Landscape improvements were then modeled and quantified for measurable performance, with the new campus plan estimated to capture 30,900 pounds of TSS per year, reducing the on-campus TSS by 45%.

# Project No. 8: Baton Rouge Lakes

## SWA Group, Landscape Architecture, Urban Design and Planning, Houston, TX

Fig. 17 Rendering of the Baton Rouge Lakes after restoration. Image courtesy of SWA Group.

**Site Location:** Baton Rouge, LA

**Project Type:** Restoration

**Scope:** Analysis & Planning

**Size:** 275 acres

**Date:** 2016

**Cost:** $100 million

**Recognition:** 2016 ASLA Professional Award

**Citations:** "Baton Rouge Lakes: Restoring a Louisiana Landmark from Ecological Collpase to Cultural Sanctuary." American Sociaety of Landscape Architects. https://www.as-la.org/2016awards/172896.html

**Prime Firm:** SWA Group

**Consultants:** CARBO Landscape Architecture, Baton Rouge, LA

**Outreach Plan:** Center for Planning Excellence, Baton Rouge, LA

**Restoration Team:** Biohabitats, Baltimore, MD

**Management Consultants:** Pros Consulting, Indianapolis, IN

**Engineering Services:** Stantec, Edmonton, Canada

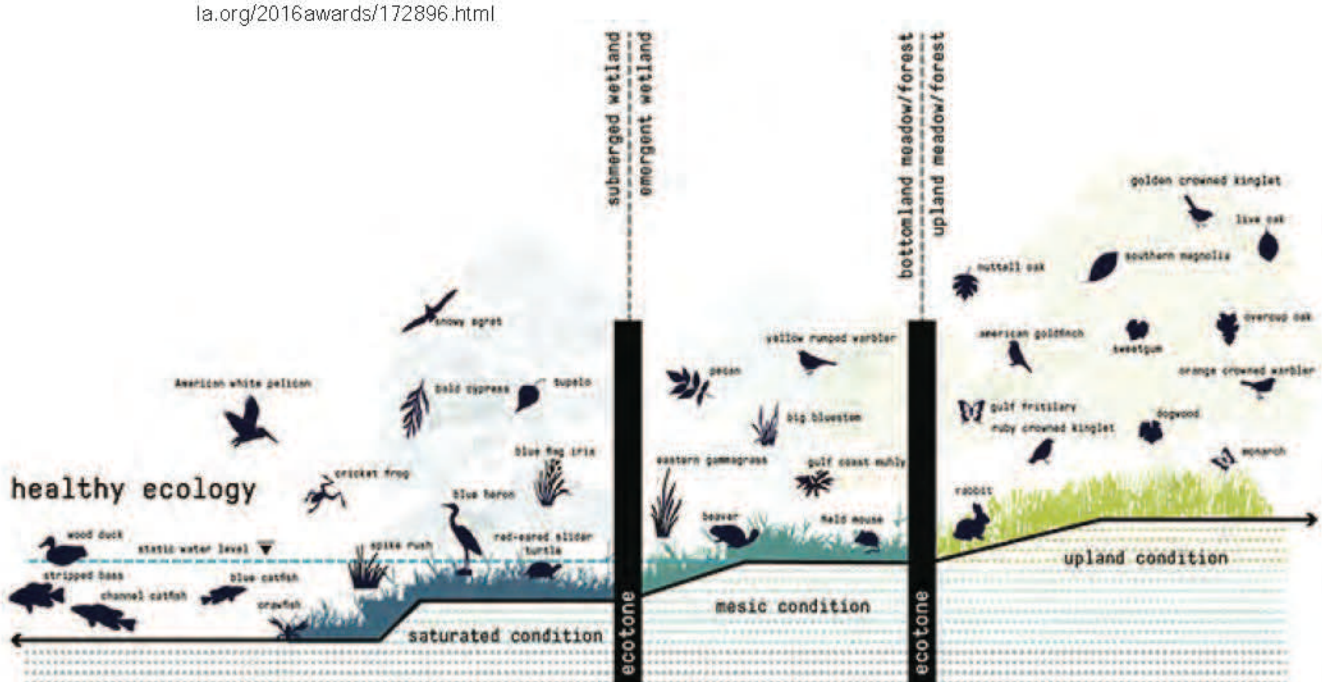


Fig. 18 Best water management practices are used to biofiltrate water, providing ecological habitats for aquatic life and healthy lifestyles for humans. Image courtesy of ASLA

## **Baton Rouge Lakes,** Continued

**Project Brief:**
Baton Rouge Lakes is composed of 275 acres, containing six lakes and three parks, in the diverse neighborhood of central Baton Rouge, close to Louisiana State University. This master plan project revitalizes a dying lake system, restoring the lakes to a previously sound ecological system while reconnecting the region with its cultural heritage. Through the use of best management practices, the Baton Rouge Lakes project provides the potential for using nature as a catalyst for healthy lifestyles, while simultaneously cleansing the lake and provid-ing habitat infrastructure for migratory birds and aquatic wildlife. With a revived lake system, life and activity is brought back to central Baton Rouge, balancing the needs of both humans and the water ecology.

**Science:**
A living edge of wetlands and meadows was formed around the lakes to create both a biofiltration mechanism and new habitat for increasing biodiversity. The wetlands filter the first flush flows of spring from the Duplantier Bayou. This approach results in robust and diverse ecological and cultural systems with the goal of improving water quality by 80 percent.

One hundred twenty-five acres of added habitat increase the wildlife matrix by creating a complex ecological system. The included landscape typologies, based on hydric zones and local ecosystems, include upland forests, upland meadows, bottomland forests, and wetland meadows, developing a diverse flora and fauna. The biological functions of these habitats are prioritized by letting a majority of the site remain naturalized through minimal manicured areas.

**Technology:**
Lake conditions were measured to mitigate low dissolved oxygen, high water temperatures, high phosphorus, and fish kills. The prior poor water quality was caused, in part, from storm-water runoff from more than 85 unremediated storm drains and shallow depths of an approximated average of 3.5 feet.

Prior lake conditions were analyzed using the project's bathymetric survey, geotechnical report, tree assessment, lake edge stability analysis, and traffic engineering studies.

**Engineering:**
Using a series of phased coffer dams, 600,000 cubic yards of lake was excavated to a depth of 6 feet with pockets as deep as 8-10 feet. The excavated material was used to create wetland benches, to repair failing slopes, and to expand park spaces.

To mitigate noise produced from Interstate 10, a baffle system was designed on the underside of a bridge that bisects the project's northern lake. This baffle system also provides a bat habitat.

**Mathematics:**
Quantitative analysis has assessed the changes in water quality and quantity. Additionally, by making the lake 2.5-6.5 feet deeper, surrounding habitats are better able to maintain their ecological systems while filtering additional run-off.

This analysis has shown that the Baton Rouge region is an important migratory route for birds. Percentage calculations indicate that 40 percent of all migrating waterfowl and shoreline birds, as well as 50 percent of all North Ameri-can bird species use a route through these lakes. Before remediation, approximately one percent of the lake area provided a healthy habitat for migrating birds.

# Project No. 9: Gathering Place

## Michael Van Valkenburgh Associates, Inc., Landscape Architecture, Cambridge, MA

Fig. 19 MVVA's proposed master plan for the Tulsa Riverfront Gathering Place. Image courtesy of MVVA, Inc.

| | |
|---|---|
| **Site Location:** | Tulsa, OK |
| **Project Type:** | Riverfront Park/Urban Renewal |
| **Scope:** | Interactive Public Space Along the Arkansas River |
| **Size:** | 64 acres |
| **Date:** | 2011 - 2018 |
| **Cost:** | $465 million, gifted |
| **Recognition:** | |
| **Citations:** | "Gathering Place." Michael Van Valkenburgh Associates Inc. http://www.mvvainc.com/project.php?id=96 "Sustainability." Gathering Place; Tulsa's Riverfront Park. https://www.gatheringplace.org/sustainability- |

| | |
|---|---|
| **Prime Firm:** | Michael Van Valkenburgh Associates INC, Cambridge, MA |
| **Architect:** | Mack Scogin Merrill Elam Architects, Atlanta, GA |
| **Contractor:** | Crossland Construction Company, Columbus, KS |
| **City and Community:** | City of Tulsa |

Fig. 20 Children playing in one of the newly constructed interactive nodes. Image courtesy of MVVA Inc.

## Gathering Place, Continued

**Project Brief:**
The City of Tulsa, enabled by a generous gift from the George Kaiser Family Foundation, was able to transform 64 acres of a 100-acre site of fallow ground into an interactive oasis. The park is designed for the citizens of Tulsa to gather in a diverse landscape with endless activities in varied topography. The newly introduced topography provides circulation solutions and ecological benefits. The elevated areas provide layers of access, with the depressions for waterbodies creating wetland zones to reintroduce habitat for native species. The park's main purpose is to provide people with access to community spaces along the river during the hot Oklahoma summer.

**Science:**
The design focus of the world-class park focused on sustainability from the beginning. Through increasing native plants and trees on site, the design restores disrupted habitat. Site trees total 5,800 in a variety of 100 species. Local materials were used, durable stones for resilience and abundant ash and pine.

Six million gallons of water are circulated through the site's adjacent wetlands to clean and treat the water without chemicals. The parking lots have underground filtration basins to capture stormwater runoff and filter pollutants.

**Technology:**
The buildings on site have been designed for efficient heating and cooling, with the underground maintenance buildings using geothermal wells that cool in the summer and heat in the winter.

**Engineering:**
The grading of the site provides unique engineering solutions with the introduction of pedestrian tunnels and bridges. The 300-foot land-bridge provides canopy coverage for the roadway and safe crossing for animals and people.

The many play structure designs include bridges, towers, and swings which required detailed engineering for safety and program use.

**Mathematics:**
The park uses an LED lighting system with a central control panel for efficient use that conserves energy. The system is programed to only light areas while they are in use.

# Project No. 10: Railroad Park

## Tom Leader Studio, Landscape Architecture, Berkley, CA

Illustrative Plan

Fig. 21 Tom Leader Studio's proposed master plan for Railroad Park. Image courtesy of Tom Leader Studio.

| | |
|---|---|
| **Site Location:** | Birmingham, AL |
| **Project Type:** | Brownfield Redevelopment |
| **Scope:** | Former Industrial Park Revitalized through Wetland Creation and Bio-Filtration |
| **Size:** | 19 acres |
| **Date:** | 2010 |
| **Cost:** | $17.5 million |
| **Recognition:** | |
| **Citations:** | "Railroad Park." TLS Landscape Architecture. http://tlslandarch.com/portfolio_page/railroad-park/ "Railroad Park." Landscape Performance Series. https://www.landscapeperformance.org/case-study-briefs/railroad-park |

| | |
|---|---|
| **Prime Firm:** | Tom Leader Studio, Berkley, CA |
| **Landscape Architect:** | Macknally Land Design, Birmingham, AL |
| **Architect:** | Kennedy Violich Architects, Roxbury, MA |
| **Architect:** | GA Studio, Bessemer, AL |
| **Architect:** | HKW Associates, Birmingham, AL |
| **Contractor:** | Brasfield & Gorrie, |
| **Civil Engineer:** | Birmingham, AL |
| **Lake and Stream:** | Georgia Fountain Company, Tucker, GA |
| **Irrigation:** | Irrigation Consultant Services, Conyers, GA |

Fig. 22 Newly designed stream system. Image courtesy of Tom Leader Studio.

## **Railroad Park,** Continued

**Project Brief:**
Railroad Park is in the center of Birmingham, Alabama, where the steel industry previously resided. The park design celebrates the former use and features the existing rail lines that still run through the city. The site acts as a connection between the northern and southern halves of the city and provides space for diverse communities to come together. With the introduction of topography and a system of waterways, the re-design provides opportunity for biodiversity and the return of ecological systems that work to improve the water and air quality within the city. This project was developed through a public-private partnership led by the landscape architect, and implemented over a five-year span.

**Science:**
The ecological focus of the site, combined with best management practices, unites the soil with a hydrological system. Wetland creation is used for bio-filtration to manage stormwater through tree plantings that filter the water. The new tree plantings annually sequester 20,800 lbs. of carbon and intercept 92,000 gallons of stormwater runoff. With this new habitat sightings of a diverse number of bird species has increased by 250%.

**Technology:**
The unique historic value of the site provided unearthed materials that have been reused in the new design. Seating and retaining walls were created with these recycled materials to exemplify sustainable and historic preservation practices.

The newly constructed system of waterways features an irrigation scheme that reuses the existing site water to reduce stress on public utilities and simplify park maintenance.

**Engineering:**
The site engineering incorporated the historic industrial site by integrating an elevated "Rail Trail" bridge connection that allows park visitors to be eye-level with the trains.

Unique topography was introduced to the previously flat site through cut and fill earthworks, creating a chain of waterbodies and providing elevated viewing areas for a variety of park activities.

**Mathematics:**
The site grading of the topography and stormwater management systems used slope formula to design spaces that are equally technical and accessible, providing space for 600,000 annual visitors.

Metrics were used to calculate the success of the park through stormwater runoff, carbon sequestration, public perception, and private investment increases.

# Project No. 11: Gary Comer Youth Center

## Hoerr Schaudt Landscape Architects, Landscape Architecture, Chicago, IL

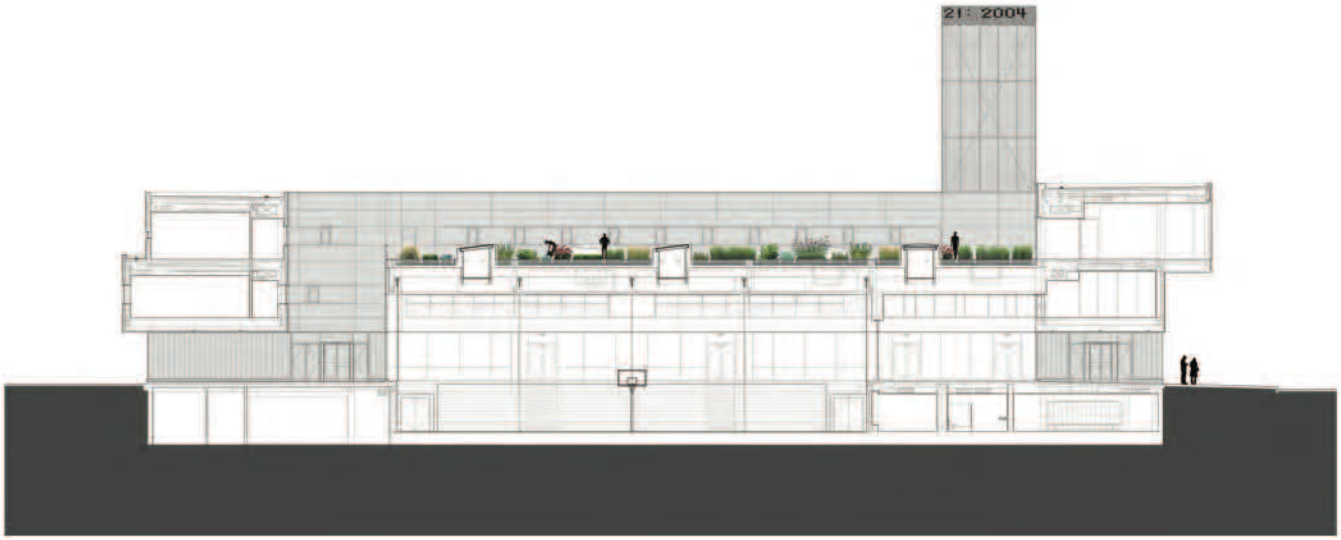


Fig. 23 North-South Section of the Gary Comer Youth Center and Rooftop Garden. Image courtesy of Hoerr Schaudt.

**Site Location:** Chicago, IL
**Project Type:** Youth & Community Center
**Scope:** Urban Agriculture
**Size:** 8,160 square feet
**Date:** 2006
**Cost:** $30 million
**Recognition:** 2010 ASLA Professional Award - Honor Award
2009 Green Roofs for Healthy Cities Awards of Excellence - Intensive Institutional Category AIA
2007 Chicago Design Excellence Awards - Special Recognition
**Resources:** "Gary Comer Youth Center." Landscape Performance Series. https://www.landscapeperformance.org/case-study-briefs/gary-comer-youth-center

**Prime Firm:** Hoerr Schaudt Landscape Architects, Chicago, IL
**Architect:** John Ronan Architects, Chicago, IL
**Structural Engineer:** ARUP, London, UK
**Greenroof System:** American Hydrotech, Midlothian, VA
**General Contractor:** W.E. O'Neil Construction Co., Chicago, IL
**Landscape Contractor:** Walsh Landscape Construction, Plainfield, Illinois

Fig. 24 Garden plots are divided by linear strips of recycled plastic. Photo by Scott Shigley.

## Gary Comer Youth Center, Continued

**Project Brief:**
Located on the second floor, the 8,160-square-foot roof on the Gary Comer Youth Center is a transformed garden for urban agriculture. It is a model for a previously underutilized space designed as a balance of an aesthetic vision with a practical use. The Gary Comer Youth Center is a safe place for community members and children to come and enjoy indoor activity, and with the extension of the roof garden a safe outdoor space has been provided. The Center's full time garden manager maintains the flower and working vegetable garden to enhance educational opportunities for the Gary Comer Youth Center.

**Science:**
A flower and working vegetable garden provides urban agriculture, promoting horticultural learning, environmental awareness, and food production for community members.

The rooftop farm's surface bed eases stormwater runoff during rain events, absorbing rainwater rather than directly diverting it to city sewers.

**Technology:**
The rooftop garden provides insulation to the inside building, reducing climate control costs for the Center, while reducing the urban heat island effect in the city.

Through utilizing building and solar heat, temperatures are maintained to create a hospitable micro-climate in the courtyard. Differences between ground temperatures and roof temperatures put the garden into a different climate zone, making it usable year round. Temperatures average between 20-30°F warmer in the winter and 10°F cooler in the summer.

**Engineering:**
Garden soils are 18-24 inches deep, making the garden viable for food production. With the soil depth, the roof is able to withstand garden tools and children enthusiastically digging root vegetables. Irrigation and weight is measured to ensure both structural support and agricultural growth.

Plastic lumber, made from recycled milk cartons, forms pathways and garden plot separation, aligning with the courtyard's window frames. Metal light wells are artistically scattered throughout the garden and provide passive solar light for the gymnasium and café below.

**Mathematics:**
The insulating rooftop garden saves $250 in annual heating and cooling costs compared to conventional roofs.

The urban agricultural garden produces over 1,000 pounds of organic food annually. This is used by students, local restaurants, and the center's café.

# Project No. 12: ASLA Headquarters Green Roof

## Michael Van Valkenburgh Associates, Inc., Landscape Architecture, Cambridge, MA

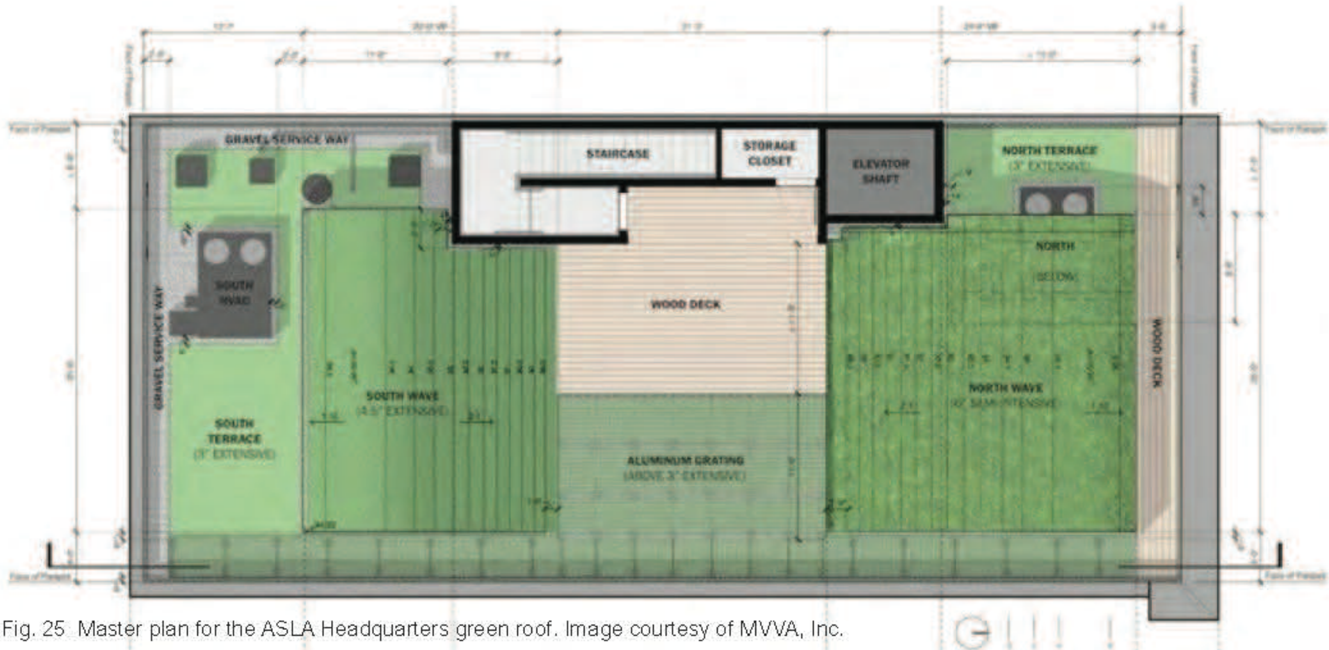


Fig. 25 Master plan for the ASLA Headquarters green roof. Image courtesy of MVVA, Inc.

**Site Location:** Washington, D.C.
**Project Type:** Office
**Scope:** Green Roof
**Size:** 3,000 square feet
**Date:** 2006
**Cost:** $350,000
**Recognition:** 2010 Green Roofs for Healthy Cities Award of Excellence
2008 Natural Resources Council of America Best Education Project
2008 Washington Business Journal Green Business Award for Education & Outreach
**Citations:** "ASLA Headquarters Green Roof." Landscape Performance Series. https://www.landscapeperformance.org/case-study-briefs/asla-headquarters-green-roof

**Prime Firm:** Michael Van Valkenburgh Associates, Inc., Cambridge, MA
**Consulting Landscape Architect:** Conservation Design Forum, Lombard, IL
**Architect:** DMJM Design, Washington D.C.
**Structural Engineer:** Robert Silman Associates, Boston, MA
**Green Roof Plants:** Emory Knoll Farms, Street, MD

Fig. 26 A variety of green roof plantings create opportunity for habitat of small migratory species. Image courtesy of American Society of Landscape Architects.

## ASLA Headquarters Green Roof, Continued

**Project Brief:**
ASLA implemented a green roof design strategy at their headquarters to demonstrate the sustainability commitment of landscape architects. They received a grant from the Chesapeake Bay Commission as green roofs have a significant role to play in collecting and filtering water before it enters the natural hydrological system. The roof features a variety of plantings that incorporate six distinct green roof conditions with soil depths ranging from three inches to twenty-one inches in elevated locations. The roof acts as a test and model for future green roofs; the plants and performance metrics are constantly being monitored to assess the roof's capacity for mitigating climate-related stresses on the environment.

**Science:**
The green roof reduces the amount of nitrogen entering the watershed, according to results from water quality testing. By addressing the water quality issues at the source, the roof improves the overall health of the water and the ecological communities that rely on it.

The plant palette intentionally includes "experimental" plants along with those that have been green-roof tested and are in common use on green roof installations in the northeastern seaboard of the USA. The key species utilized are varieties of drought-resistant sedums adapted to the extreme climatic conditions common on urban roofs.

**Technology:**
A seamless waterproofing/roofing membrane protects the integrity of the structure by separating the green roof systems from the human uses of the building.

The insulation that the green roof provides acts as a cooling agent, with the surface temperature, during the hottest days of summer, recorded at 43.5 degrees cooler than the conventional black roofs of the buildings next to the headquarters. Two 25-foot-wide elevated "waves" form a structural skeleton filled with rigid insulation and covered with a green roof system. The waves' innovative design and placement protect the roof's usable space from noise generated by nearby HVAC units.

Flow meters and rain gauges are in place on the ASLA green roof to collect data on stormwater retention.

**Engineering:**
Engineering of the roof garden considered the load bearing capacity of the roof system, utilizing constructed Styrofoam to create mound conditions. The soil is also engineered with ribbons of non-biodegradable plastic to prevent erosion and reduce the structural load.

**Mathematics:**
The 3,000-square-foot green roof has monitors that track stormwater runoff, water quality, and air temperature to compare with data from the conventional roof on the building next door. In eleven months the roof prevented 27,500 gallons of stormwater (77 percent of all precipitation hitting the roof) from entering the sewer system in Washington, D.C.

# Project No. 13: Millennium Park

Terry Guen Design Associates, Landscape Architecture, Chicago, IL

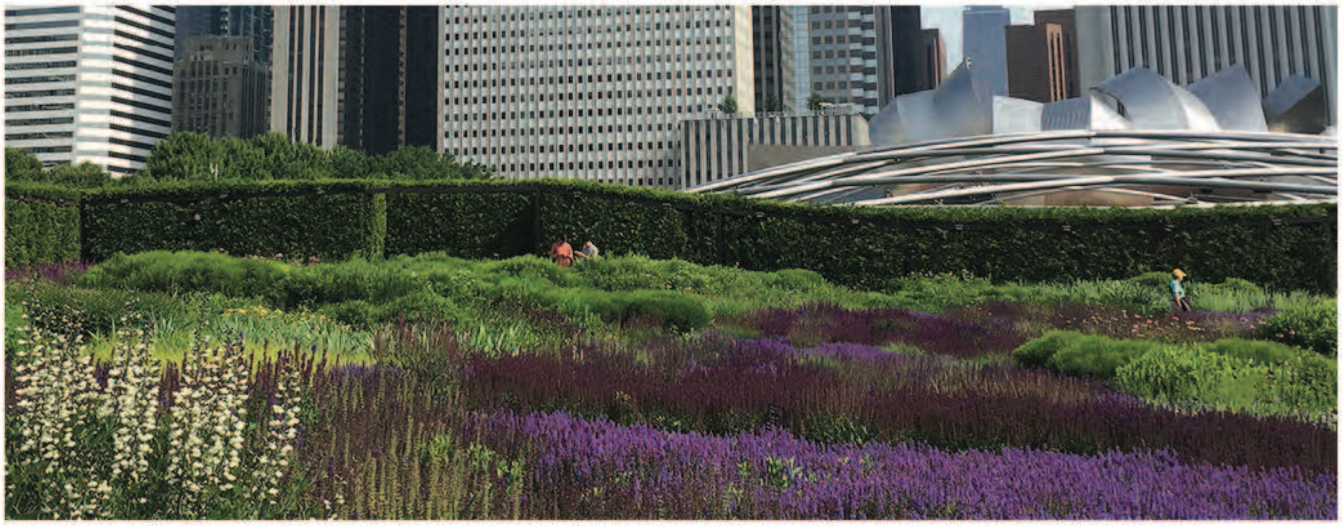

Fig. 27 The Lurie Garden at Millennium Park features 35,000 different perennial plant species. Image courtesy of Lurie Garden.

**Site Location:** Chicago, IL
**Project Type:** Park/Open Space
**Size:** 24.5 acres
**Date:** 2004
**Cost:** $482.4 million
**Recognition:** 2017 Best Continued Use, Lurie Garden
2009 Rudy Bruner Award for Urban Excellence, Silver
2008 Professional Award of Excellence, ASLA
2006 Excellence in Urban Design, AIA
**Citations:** "Millennium Park." Landscape Performance Series. https://www.landscapeperformance.org/case-study-briefs/millennium-park#/project-team

**Prime Firm:** Terry Guen Design Associates, Chicago, IL
**Consulting Landscape Architect:** Gustafson Guthrie Nichol, Ltd. Seattle, WA
**Planting Designer:** Piet Oudolf
**Architects:** Frank Gehry, Hammond Beeby Rupert Ainge, OWP&P, Kreuck Sexton, Jaume Plensa
**Engineers:** Skidmore Owings & Merrill, McDonough Assoc.
**Developer:** Public Building Commission of Chicago
**Artist:** Anish Kapoor

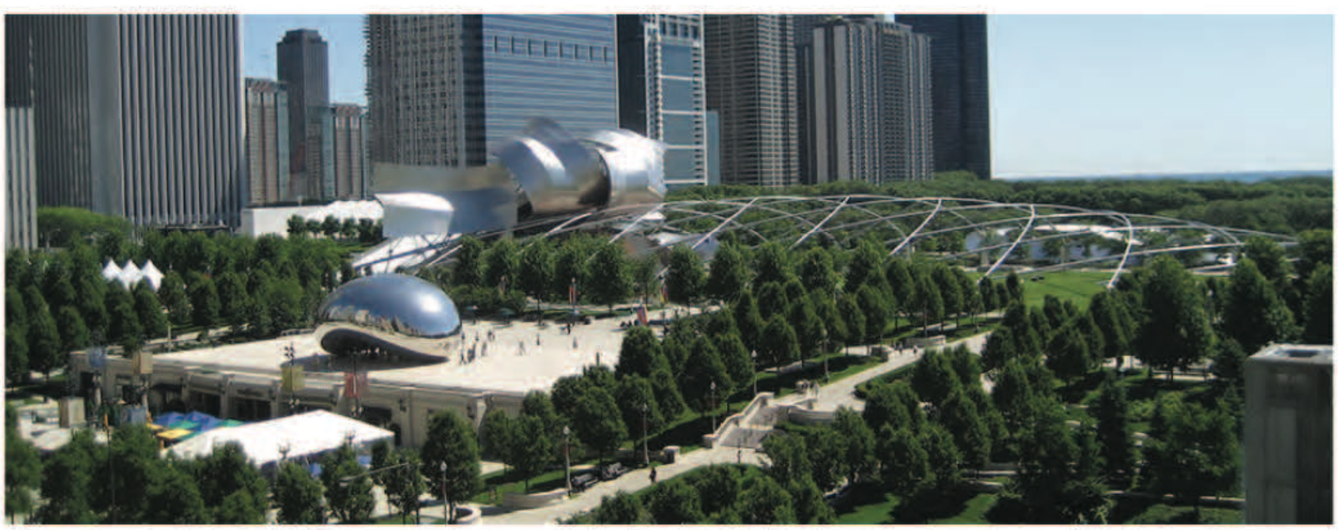

Fig. 28 Millenium Park is situated in downtown Chicago, offering an urban public park and plaza for city residents and 3 million yearly visitors. Image courtesy of Terry Guen Design Associates.

## **Millennium Park,** Continued

**Project Brief:**
Millennium Park, in Chicago's East Loop District, transformed a former parking lot and rail yard into one of the world's largest green roofs. The park has become an icon in Chicago and an example of dynamic placemaking that has the capacity to spawn increasing tourism and development in an underutilized part of the city. With the addition of the Park, Chicago's green space increased by 62 percent.

**Science:**
The intensive green roof provides 12.24 acres of permeable surface, making up almost half the park's total surface area. Large areas of this permeable surface are planted zones, with 35,000 perennials, 5,800 woody plants, and 450 trees, 60 percent of which are native to the Midwest. These plantings have been designed as ecologically sensitive and low-maintenance to increase biodiversity and lower costs.

Within the park there are over 15 environmental education programs for both children and adults.

**Technology:**
The Park offers multi-model transportation with a focus on sustainable methods, including I-GO car-sharing cars, 250 rental bikes provided through the McDonald's Cycle Center, and light rail and bus stops within a five-minute walk.

As a former rail yard, the site soils were highly contaminated and required remediation efforts, utilizing the parking garage's bottom floor as the cap for contaminated soils.

**Engineering:**
As a park built over an existing parking garage, repairs to the garage were necessary to reinforce its load-bearing capacity, specifically addressing existing columns which had developed cracks from additional loads that had exceeded original specifications.

**Mathematics:**
In order to determine the load-bearing capacity of the parking garage, and remediation of soils for new plantings, load calculations had to take into account the weights of trees 100 years into the future.

The iconic park has contributed to a $1 billion increase in real estate values in downtown Chicago, and an additional $1.2 billion in tourism revenue yearly for the city.

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American Society of
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