

Nature-Based Solutions

Nature-based solutions (NBS) are design strategies that conserve, create, and restore natural resources to address climate hazards and other environmental stressors. NBS are engineered and constructed to complement natural processes by using or mimicking natural systems like dunes, wetlands, reefs, and vegetated buffers. Also called **green infrastructure**, NBS can work on their own or in tandem with **gray infrastructure**, which includes humanmade engineering approaches like pipes, catch basins, and concrete channels, as well as larger engineered systems like dams and seawalls. Beyond their primary function, NBS provide co-benefits that support ecosystems and people.

For example, if a low-lying area in a park lawn is frequently waterlogged, engineers might install **gray infrastructure**—perhaps a catch basin and pipes to drain the lawn. However, the pipes concentrate the stormwater runoff to an outlet, which usually discharges into a nearby water body like a stream. The pipes can carry pollutants to the water body, and the velocity of the runoff during a storm can erode its banks. **An NBS design** might instead use a swale—a shallow, gently sloped channel planted with water-tolerant vegetation—to capture, slow, and filter stormwater on-site. A small engineered swale would make the lawn usable for visitors while providing added co-benefits, such as creating habitat and a food source for wildlife, filtering pollutants, and recharging groundwater. While NBS may require more regular monitoring and maintenance, they're often cheaper to install and maintain over time.

At scale, **DCR has the power of positive impact**. NBS can reduce the impacts of localized flooding, erosion, and other impacts of extreme storms and drought. With nearly 500,000 acres under its care, DCR has a unique opportunity to enhance ecosystem function by prioritizing NBS over gray infrastructure where appropriate. While some sites may require a greater reliance on gray infrastructure, DCR prioritizes NBS when they provide clear environmental and functional benefits. Ultimately, site-specific conditions guide whether NBS are the right fit to meet project objectives.

NBS Case Studies

DCR has developed a series of case studies to highlight:

- How NBS increase resilience to climate hazards and support **DCR's Climate Adaptation Goals** (as detailed in the sidebar).
- The decision-making process for evaluating and selecting NBS, including analyzing existing conditions as well as maintenance and regulatory requirements.
- Common NBS challenges and strategies to guide future projects.

DCR's Climate Adaptation Goals

DCR's Climate Adaptation Goals are a whole-agency approach to address the growing impacts of climate change. NBS support the **Design with Resilience in Mind** goal:

DCR will update existing design and management standards and coordinate new standards for resilience to climate impacts—incorporating NBS, low-impact development principles, and sustainable methods, equipment, and materials.



Tools for Resilient Designs

Commonwealth's ResilientMass Climate Hub

- Includes climate data for precipitation, sea level rise, and other hazards to effectively size infrastructure to address increasing risks. By using the Commonwealth's ResilientMass Climate Hub together with the DCR Stormwater Handbook, managers can more effectively size infrastructure to address increasing volumes of runoff.



DCR Stormwater Design Handbook

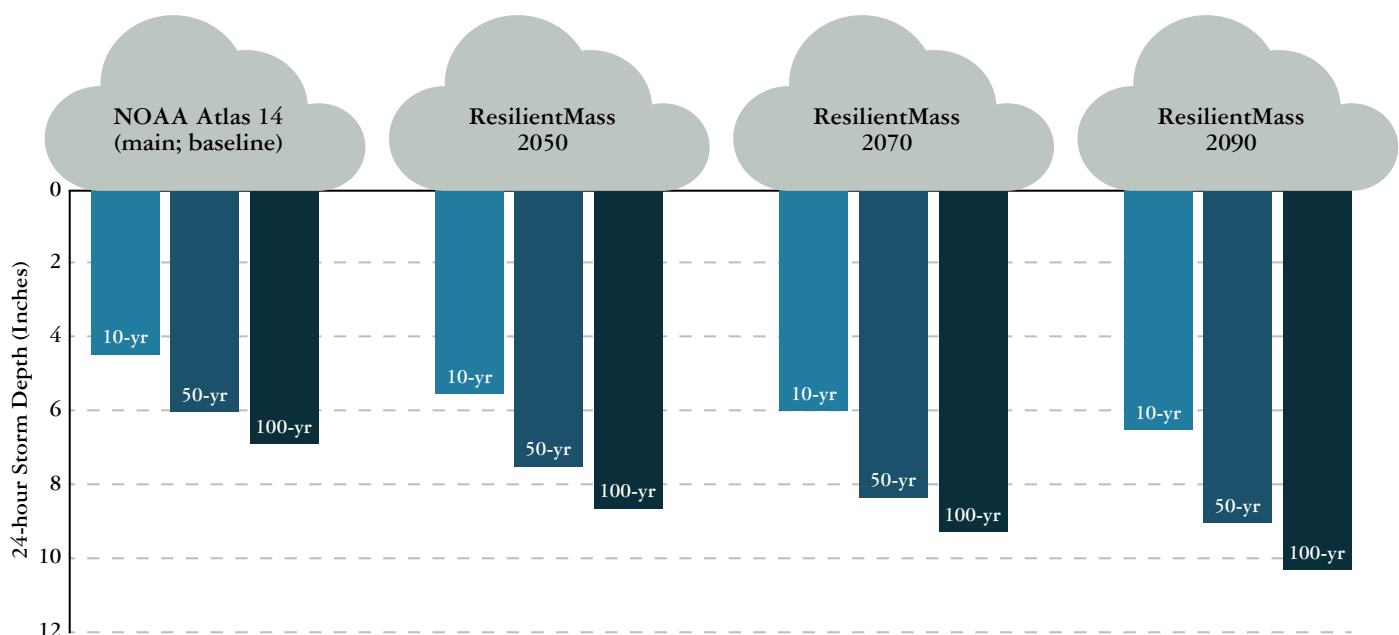
- Includes best management practices for managing stormwater to meet both state and federal water quality regulations. These regulations prioritize water quality metrics to improve the health of ecosystems; they do not contain specific requirements to handle increases in volume of runoff. As climate change increases the frequency and intensity of storms, projects must also be designed to handle larger volumes of runoff.

How to Ensure Resilient Designs

Project managers can work with DCR's Office of Climate Resilience and the Massachusetts Executive Office of Energy and Environmental Affairs' (EEA's) Office of Climate Science to understand available data sources and select those most suitable for their project.

The figure below provides a visual overview of three design storms from different sources and under different time periods for Erving State Forest. The volumes of rainfall experienced during heavy storms today are likely to be even higher in the future because of climate change. For instance, the figure shows that by 2050, the 50-year, 24-hour storm event is projected to be about 1.5 inches higher than the design value typically used for this storm today. Similarly, the 100-year, 24-hour storm event in 2050 is projected to be about 2 inches higher than the 24-hour storm with a 1% annual chance today.

Meaning, this storm will bring almost 30% more rainfall in 2050 than the same storm event today. These projections highlight the importance of considering future climate conditions when planning NBS projects to maintain the projects' intended reliability for years to come.





Landry Park

A Nature-Based Solution Case Study



Project Background

Located in Waltham on the north side of the Charles River, Landry Park is part of the DCR Charles River Greenway and is used regularly by pedestrians, cyclists, and visitors with a variety of mobility devices. The Landry Park project began in response to a legislative request to improve lawn conditions in a heavily used area of the park.

The site holds historical significance tied to its Indigenous heritage and its industrial past as the former location of a cotton mill. Landry Park is part of the Boston Manufacturing Company Historic District. Design elements, including NBS, were selected not only to improve the park's functionality and appearance, but also to honor its Indigenous and industrial histories through interpretive signage and the sensitive preservation of key landscape features.



Project at a Glance:

- **Location:** Landry Park, Charles River Greenway, Waltham, MA
- **Project manager:** Elizabeth Walsh
- **Collaborators:** DCR (Landscape Architecture Section, Park Operations, Electrical Engineering Section, Stormwater & Environmental Section, Office of Cultural Resources, Office of Dam Safety), Waltham Conservation Commission, City of Waltham
- **Contracted services:** Hatch, Public Archaeology Lab, LEC Environmental, Precision Land Surveying
- **Challenge:** Lawn degradation due to a lack of designated bike and pedestrian paths, poor accessibility, and untreated stormwater runoff entering the Charles River
- **Impact of climate change:** Increasing frequency and intensity of storms will lead to increased runoff into Charles River and erosion of lawn areas and paths
- **Climate change considerations:** NBS elements are included as a proactive rather than reactive measure, recognizing climate hazards like increased high heat, erosion, and flooding potential
- **Implemented NBS:** Permeable pavement paths, a rain garden, a no-mow meadow, and site regrading

Image 1. The current lawn degradation (Image 1A) will be mitigated with defined permeable pavement pathways and added NBS. Image 1B (Source: Hatch Consultants) presents a conceptual rendering of the area following project completion.



Image 2. Pathway erosion to be addressed through site grading and a rain garden.



The site redesign focuses on integrating NBS for stormwater management and to improve circulation with cohesive and accessible pathways without increasing impervious surfaces, enhancing connections to surrounding historical and ecological resources, and updating site furnishings. Design elements, including NBS, were selected not only to improve the park's functionality and appearance, but also to honor its complex history through interpretive signage and the sensitive preservation of key landscape features.



Image 3. Established trees, shown here, will be preserved to provide shade and help mitigate the effects of increasing high heat events.



Image 4. Overhead view of planned Landry Park improvements. Note the improved lawn, rain garden, planted meadow, porous pavement walking paths and patio, and overall accessibility improvements. (Source: Hatch Consultants)

NBS Spotlight: Permeable Pavement

Permeable pavement allows stormwater to infiltrate through pervious materials into underlying soil and gravel layers. In addition to reducing runoff, it provides water quality benefits by filtering out pollutants. Common types of pervious pavement include pervious asphalt, pervious concrete, interlocking pavers, and plastic grid pavers.

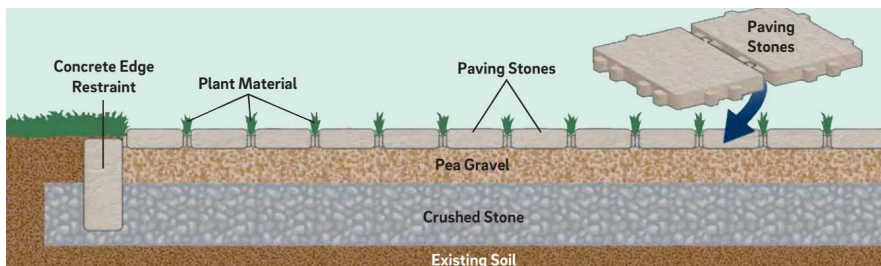


Image 5. Example schematic of permeable paving using interlocking paving stones with vegetation. (Source: Philadelphia Water Department)



Image 6. Example installation of permeable pavers, permeable pavement, and a bioswale at Silver Lake Beach in Wilmington, MA. (Source: Sara Cohen, DCR Office of Water Resources)



Project Status: Permitting



Project Design Approach

This project started with a simple goal: improve the lawn. However, DCR identified several other needs, including addressing informal bike routes that were damaging the turf, improving accessibility, and managing stormwater runoff—all without increasing impervious surfaces. These observations opened the door to a broader, more integrated design approach that aimed to reconnect the site to the natural ecosystem.

DCR’s project manager observed untreated stormwater draining to the Charles River. Drawing on past experience, they recognized DCR could reduce untreated stormwater to the river, erosion of turf areas, and localized flooding potential by implementing a rain garden. The project also incorporated permeable pavement to encourage stormwater infiltration and limit increasing impervious surface areas, all while supporting new paths and improving recreational use and accessibility. A no-mow meadow with native plantings will be implemented to increase vegetation, provide wildlife habitat, and promote ecological diversity and connectivity.

Incorporating NBS at Landry Park aligns directly with DCR’s climate adaptation goal to Design with Resilience in Mind. The project incorporates NBS while considering future maintenance needs, as discussed below.

NBS Benefits & Co-Benefits

The Landry Park project achieves the following environmental and social benefits.

Environmental

	Improved water quality
	Improved ecological health
	Reduced erosion

Social

	Recreation
	Accessibility
	Educational & Cultural Interpretation
	Aesthetics

Overcoming Project Challenges

- **Balancing design with maintenance needs.** A major challenge was ensuring the site could be effectively maintained post-construction. Operations staff needed vehicle access to the site, prompting modifications to the original path design and reinforcement of shoulders for maintenance trucks. The Waltham Conservation Commission also requested monthly vacuuming of permeable pavement paths; DCR negotiated a more realistic twice-a-year schedule based on internal capacity and standard practice.
- **Funding project maintenance.** Maintenance, such as for permeable pavement paths, may require specialized equipment DCR does not currently have. To overcome this challenge, maintenance work may be contracted out, or the equipment may be purchased through DCR’s Landscape Maintenance Contract for DCR operations staff to use.



Siting Considerations

- **Designing for on-site water management.** The rain garden was sited to reduce untreated flow into the Charles River. Site regrading promotes infiltration and minimizes erosion, aligning with DCR's prioritization of low-impact development and NBS.
- **Respecting natural and cultural resources.** The project preserved trees where possible throughout the park to maintain shade and habitat. Due to archaeological sensitivity linked to both Indigenous and industrial histories, excavating dirt was limited to two feet deep, guiding design decisions and NBS placement.

Regulatory and Policy Considerations

- **Navigating site-specific permitting requirements.** The project required a Massachusetts Department of Environmental Protection Notice of Intent and a Massachusetts Historical Commission Project Notification Form to address conservation and historical concerns, in addition to limited site excavation to preserve historic and cultural resources.

Operations and Maintenance Considerations

- **Planning for long-term maintenance.** The project design accounted for maintenance needs, including vacuuming permeable pavement paths and ensuring maintenance vehicles could access the site. A biannual vacuuming schedule was agreed upon, and site pathways were reinforced to accommodate maintenance vehicles.
- **Ensuring protection of design elements.** Fencing and signage are being considered to protect low-maintenance areas like the no-mow meadow while the project is being established. Irrigation features will be reinforced to prevent damage from maintenance vehicles.

Lessons Learned and Transferable Tips

- **Involve an interdisciplinary review team early in the process.** Early review from individuals with different perspectives and expertise, including stormwater and operations staff, can help avoid last-minute design changes. Landry Park's walking paths were designed to allow DCR vehicles to access the site and eliminate the potential for driving over newly planted areas.
- **Use signage during NBS establishment to help ensure proper maintenance.** Small signs for no-mow meadows and rain gardens can be an educational resource for the public and alert operations staff and contractors to avoid disturbing these areas during early establishment.

Additional Resources

- [EPA Porous Pavement Education Video.](#)
- [Metropolitan Area Planning Council Permeable Paving Fact Sheet.](#)
- [Massachusetts Native Plant Palette](#) provides visual assortment of appropriate plants for NBS designs.



Image 7. View of Landry Park looking east from the Moody Street Bridge.

