Resilient Redevelopment for Everyone
Strategies to Overcome Risk and Unlock Potential
A Digest of Charrettes and Green-Value Engineering

Developers

Engineers

Advocates

Embrace Green Infrastructure

Unlock Overlooked Sites

Overcome Site Challenges
The Water Environment Federation (WEF) is a not-for-profit technical and educational organization of 36,000 individual members and 75 affiliated Member Associations representing water quality professionals around the world. Since 1928, WEF and its members have protected public health and the environment. As a global water sector leader, our mission is to connect water professionals; enrich the expertise of water professionals; increase the awareness of the impact and value of water; and provide a platform for water sector innovation.

Thank you to our generous funders, the U.S. Environmental Protection Agency, and the Chesapeake Bay Trust.
Executive Summary

In 2015, the Water Environment Federation (WEF) launched the Stormwater Institute to serve as a centralized hub for collaboration on the latest stormwater research, information, and field expertise. The stormwater industry has progressed significantly during these five years. The science of stormwater has improved, and clean water technology innovations have expanded. In many places, the use of Green Infrastructure is the norm for meeting water quality standards.

Yet, as stakeholders confront the task of managing stormwater in a climate of increasing "unknowns," tentative connections persist between technologies for water quality and resiliency imperatives. We convened national experts and local practitioners to explore these tensions. They were charged with advancing the inclusion of Green Infrastructure on site-level redevelopment projects and exploring opportunities and constraints through the lens of resilience. The team used a three-pronged approach, 1. Facilitating two inclusive generalist design planning charrette workshops, 2. Providing narrow site-specific Green Value Engineering design services on specific projects, and 3. Initiating a catalog of site typicals representing a range of redevelopment scenarios, conditions and green-resilient workarounds.

This digest documents their efforts. It provides a framework for considering difference between resilient and non-resilient systems, techniques for increasing resilience at the intersection of infrastructure, ecology, social structures and economy. Follow the outlined Green Value process and you too can engage developers, designers, regulators, advocates and academics in building strategies for resilience. Whether your challenge is creatively navigating regulations, unlocking overlooked sites, designing for extreme weather, incorporating green infrastructure, overcoming site challenges - or some combination thereof - this model process can be used to overcome risk and unlock redevelopment potential in your community.

The wide adoption of Green Infrastructure is critical to meeting water quality goals in the Chesapeake Bay and other watersheds throughout the nation. The tools, techniques, and processes presented here are stepping stones to broaden who is engaged in pollution control measures and where they are located. This work addresses a gap in the use of Green Infrastructure on private lands.
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Principles of Resilient Design

Designing our built environment to hedge against all risk is not possible, but we can formulate principles to follow allowing (re)development to better respond to unpredictable events.

Let’s start exploring the resiliency imperative by considering what is NOT resilient. In resilience theory, a “rational” branching structure with distributed, discrete and isolated functions is considered non-resilient (Mehaffy & Salingaros 2013). This means design and engineering approaches that maximize efficiency, centralize power, and prioritize meeting necessary functions at the lowest cost are inherently non-resilient.

By contrast, resiliency is created when systems are interconnected, diverse, and redundant. Armored embankments, concrete walls, levees, and pipe networks do not possess the resilient characteristics of green infrastructure.

The complexity and self-adaptive ability of nature-based systems can form a key pillar for engineering resiliency. Consider blended systems at the intersection of infrastructure and ecology for their diversity, complexity, redundancy, and scale.

Contrasting Risks
Resiliency increases when human systems mimic and integrate with natural systems.

**Diversity & Complexity**

Resiliency increases when system diversity and complexity increase. The interconnections of complex systems increase the ability to reorganize in response to disturbance. While combining a green roof with solar lacks the intricacy of a prairie root system, this layering improves performance under extreme heat conditions illustrating “the sum is greater than the parts”.

**Redundancy**

Resiliency increases when a system is built with redundancy. Having multiple components with similar functions reduces chances for complete disruption whether it be pollination or transportation. Does your design decentralize and repeat practices to avoid failure?

**Scale: Space & Time**

Resiliency increases when developers consider multiple aspects of scale. Planning for both large and small storms increases the likelihood of maintaining compliance through an extreme event. When designing for disturbances, consider the spaces’ adaptability for economic and social changes to ensure systems persistence over time.
Disturbance Proof

A “wild” design is built to mimic a natural system. With diversity, complexity, and redundancy, this site will be better equipped to withstand and recover from disturbances. The adoption of non-standard practices can pose “high risk” for a development plan that needs buy-in from tenants and regulators.

Where does your blended design fall on the risk scale?

Perceived Costs

A “formal” design conforms to code and is perceived of as “low risk” when development looks to minimize costs and maximize returns. Through the resilience lens this is riskier, as efficiency creates disturbance vulnerabilities. Perceptions may change when investment models consider climate trends.

Risk Reduction

Risk Reduction

Formal

Romantic

Wild

Disturbance Proof

A “wild” design is built to mimic a natural system. With diversity, complexity, and redundancy, this site will be better equipped to withstand and recover from disturbances. The adoption of non-standard practices can pose “high risk” for a development plan that needs buy-in from tenants and regulators.
Planning for Disturbance

Green Infrastructure provides a toolbox of natural and engineered technologies to meet water quality goals on (re)development projects to protect and improve downstream water resources. These technologies retain, absorb, infiltrate, reuse, and transform pollutant loads unlike Grey Infrastructure which may detain and filter but primarily deflects and conveys issues downstream.

If resilience is examined narrowly through the lens of flood management, then the role of individual Green Infrastructure tools may be devalued. Using a broader definition of resilience found at the intersection of infrastructure, ecology, social structures and economy, a network of Green Infrastructure emerges as an essential and unifying agent.

Design charrette workshops are an experiential method to design and development communities in this type of collaborative, multi-factor thinking.

An Inclusive Approach

In December 2019, the WEF Team hosted two design charrette workshops to explore resilient redevelopment at the site level with the development community. Two distinct markets within the Chesapeake Bay with differing development typologies were selected. Lancaster County in Pennsylvania represented the low density urban-inner suburban continuum while Washington DC was selected to represent the high-density large metropolitan region. Workshops were sponsored in partnership with regional leadership organizations. Participants were recruited directly or through industry stakeholder networks. The events were promoted on social media and relevant community listserves. The attendance maximized participant caps at both workshops and included a mix of engineers, landscape architects, developers, planners, government staff, officials and academics. Event seating was structured to encourage cross-discipline conversations. Resilience paradigms were introduced.

Activities were organized around current real local development opportunities. One underutilized inner suburban site of 20-acres with an adjacent transit hub was selected for each workshop. Tables were given unique development personas and each group was asked to plan the overall design including building massing and pedestrian/traffic flows while considering maximizing resilience at their site for an assigned disturbance scenario. Tools provided included large format site plans, tracing paper, marker pens, color pencils, tape, resilience pillar stickers, and activity sheets. Later activities challenged the teams to continue with the site’s development plan by considering engineering approaches or technologies to preserve the resilience in the face of a discovered design challenge. Presentations from event organizers introduced workarounds for conflicting imperatives between development and environmental goals. Each table presented their outcomes and next steps were discussed.
The charrette experience got developers and green infrastructure champions talking. The challenges helped to bridge thinking and establish shared approaches to improve resiliency.

Imposing Constraints

Development scenarios ranged from private multi-family residential to commercial shopping center to health/education campuses. Disturbances included extreme flooding, climate uncertainty, sustained drought, economic downturns, and political-regulatory upheavals. Design constraints included high water tables, inadequate grey infrastructure, contaminated soils, budget cutbacks and parking requirements.

Retaining Resilient Green

When confronted with capital costs, groups retreated from grand resilient visions formed during the initial unconstrained activity. We asked participants to consider the value of green certifications, and local incentives as motivation for going beyond regulatory compliance. We shared examples where green infrastructure saved on pipe network costs and distributing a centralized pond gained an extra lot.

Regulatory Shifts

Groups in both markets uniformly saw the value of creating strong physical and programmatic connections with transitways as a key resilient site design tool. This freed parking spaces for greening practices. A vision for a unified regulatory system was applauded by all. Additionally, participants saw rewards for innovation in timely and knowable review process as worth the extra costs.
Green Value

An inherent tension lies between the imperative to develop in a sustainable and resilient way and the need to design a site to meet the present day economic and functional needs of the client.

Expanding on the experiences and findings of the design charrette workshops the WEF Team explored how these two imperatives can be balanced in the context of (re)development. Participants from each charrette were encouraged to submit projects of their own with resilient-green infrastructure challenges.

A representative parking lot project was selected from each group to receive Resilient Redevelopment “Green Value” engineering design consulting services. The goals and challenges presented are typical to this (re)development type creating great potential for repeatable and scalable green design solutions.

Small parking lots are a ubiquitous land use type. They represent both inherent water quality challenges and unique greening opportunities. Equally common across small infill urban development are limiting site factors: stormwater from neighbors, minimal infiltration capacity, limited stormwater infrastructure and limited green space.

Green Value Engineering (GVE) begins with a zone analysis to evaluate opportunities and constraints.

Design by Zone

Our approach to GVE begins by identifying where it is possible to place green practices and what those located practices can provide for water quality. Considerations for water flows onto and off the site along with the site’s physical parameters are used to create an idealized initial concept through the “no-constraints” lens. Integrating conflicts shifts the approach. GVE seeks to balance economic viability with resilient green.

Zone 1
Rooftop Retention and Detention

- Peak Flow Control
- Retention and Detention
- Filtration and Sorption
- Biological and Chemical Transformation
- Heat Island Mitigation
- Aesthetic Benefits

Zone 2
Vertical and Elevated Storage

- Peak Flow Control
- Detention
- Retention via On-Site Use
- Filtration and Sorption
- Biological and Chemical Transformation
- Aesthetic Benefits

Zone 3
At-grade Treatment and Storage

- Retention and Detention
- Infiltration
- Filtration and Sorption
- Biological and Chemical Transformation
- Heat Island Mitigation
- Aesthetic Benefits

Zone 4
Porous Surfaces

- Retention and Detention
- Infiltration
- Filtration
- Sorption
- Biological and Chemical Transformation
- Multi-Functional Surfaces

Zone 5
Subsurface Storage and Infiltration

- Retention and Detention
- Infiltration
- Filtration
- Sorption
- Biological and Chemical Transformation
- Multi-Functional Surfaces

Expanded Vision

Our approach to GVE begins by identifying where it is possible to place green practices and what those located practices can provide for water quality. Considerations for water flows onto and off the site along with the site’s physical parameters are used to create an idealized initial concept through the “no-constraints” lens. Integrating conflicts shifts the approach. GVE seeks to balance economic viability with resilient green.
Case Study 1: Joe’s Movement Emporium

About the Site

Joe’s Movement Emporium seeks to upgrade its surface parking lot. Its current poor gravel condition makes access challenging and is an aesthetic eyesore. Joe’s is a community hub for the Arts located in Mount Rainier, Maryland. The site is nearly 100-percent impervious, with a large, one-story building and a small parking lot. The building occupies two-thirds of property spanning lot lines on three sides and abutting the adjacent parking lot on the fourth. Both the town of Mount Rainier and Joe’s Movement Emporium place a high value on environmental stewardship. They see a link between resilient design and healthy communities and are committed to improving their environmental performance.

Challenges

- Chronic nuisance flooding from off-site drainage
- Lack of stormwater management infrastructure.
- Minimal infiltration capacity
- Roof cannot support green roof
- Need to maintain existing parking capacity

Strategies

- Promote infiltration where possible
- Create treatment train to collect runoff and convey to infiltration practices
- Use modular green roof trays suspended over parking spaces to convey runoff from rainwater tower to bioretention
- Collect parking lot runoff in permeable center drive lane, which discharges to infiltration trench

Zone Considerations

1. **Rooftop Retention and Detention** - Infeasible due to structural constraints
2. **Vertical Storage and Elevated Raingardens** - Elevated conveyance, raised bioretention planters, silo rainwater cisterns
3. **At-grade treatment and storage** - Permeable landscaping
4. **Porous surfaces** - Permeable drive lane
5. **Subsurface storage and infiltration** - Infiltration trench
Zone Analysis: An Iterative Design Process

Ideal Concept

Ideally a large surface parking lot would drain to a bioretention.

Shifting Zones

The site’s high water table make anything more than shallow infiltration unlikely. Additionally, the downstream grey infrastructure is too far from the site making a below-grade connection prohibitively expensive. Consider capturing rooftop runoff instead.

Zone 1: Green roof
Complication: Roof unable to bear weight

Given the site’s large flat roof and limited ground-level space, the first constrained strategy consideration was to install a green roof on the building. Unfortunately, a structural analysis showed that the roof would not be able to bear the weight of a green roof.

Zone 2: Raised planters
Complication: Design eliminates parking spaces

The next strategy considered was to collect runoff in a cistern at the back of the building, and then convey it to bioretention at the front of the building through a raised planter running along the building’s side. This option was rejected because it would eliminate several parking spaces.

Solution: Elevated conveyance

The final solution remains in Zone 2 but raises the conveyance off the ground to avoid interference with parking. Suspended steps of green roof trays along the building’s parking lot length simulate a shallow ephemeral creek. These decorative overflows link the silo rainwater tower positioned at the existing rear rooftop redirecting large flows to the bioretention planters at the front of the building.
Case Study 2: Lancaster Reservoir Park

About the Site
Lancaster Reservoir Park is built on top of an impervious reservoir liner originally installed early in the 20th Century. Much of the park drains to the parking lot, which routinely floods due to limited and undersized drainage infrastructure. The current parking lot is in disrepair and needs to be repaved. The City of Lancaster is forward thinking about integrating resilience and sustainability into their community, and would like to leverage the needed parking lot renovation to improve water quality and flood resilience. Reservoir Park is an area that brings residents from all over the city, which makes it a great place to demonstrate repeatable resilience features.

Challenges
- High water table
- Impervious parking lot is located at base of drainage area and frequently floods
- Limited drainage features exist.
- Area is very urban in old city with undersized infrastructure and small rights of way.
- Mature trees around parking lot.

Solutions
- Capture contributing rooftop runoff using modular detention storage and infiltration
- Install permeable pavers in parking spaces
- Convert landscaping surrounding parking lot to bioretention
- Protect existing mature trees

Zone Considerations
1. Rooftop Retention and Detention - Infeasible due to structural constraints
2. Vertical Storage - Reverse siphon conveys roof runoff to elevated storage
3. At-grade treatment and storage - Permeable landscaping
4. Porous surfaces - Permeable parking bays
5. Subsurface storage and infiltration - Infiltration trenches
Expanded View: Looking Beyond the Project Footprint

Client’s Vision

The client’s immediate need is to renovate and repave the parking lot. They would like to integrate green infrastructure to improve aesthetics, water quality, and flood resilience.

Expanding Awareness

Engineering analysis shows that the parking lot receives a considerable amount of runoff from nearby roofs and relatively impervious grass surfaces. Taking an expanded approach that controls runoff generated upstream will reduce flooding within the parking lot.

Upstream Sources: Roof Runoff

Runoff from two rooftops in the drainage area could be captured with a modular, repeatable, and cost effective practice consisting of gutters and downspouts connected to modular storage containers with a controlled release into a shallow infiltration trench.

Existing Tree and Slope Protection

A sloped area adjacent to the parking lot contains established trees in good condition. The design prioritized protecting this area from disturbance and minimizing sheet flow over this slope. Captured upstream roof runoff is routed through underground pipes to modular storage containers, bypassing this vulnerable area.

Parking Designed to Infiltrate

The parking layout was redesigned with a one-way travel lane and angled parking spaces to improve flow and create space to install bioretention. The use of bioretention combined with installing permeable pavers in parking spaces maximizes infiltration and minimizes the potential for flooding during rain events.
Competing Imperatives

This effort began by framing resilient principles and creating collaborative opportunities to build common understandings through design charrette workshops. These experiences were used to formulate a green value engineering (GVE) approach and illustrate GVE through two case studies using zonal analysis, iterative design and treatment train solutions. The project’s closing bookend is a Site Catalog of redevelopment projects to place this work in the broadest context.

All stages—from concept to completion—are considered within the Site Catalog. An expansive approach to redevelopment constraints and challenges are considered. The Site Catalog is hosted on a companion website. Visit it to explore the database.

The following pages are drawn from the catalog and illustrate exploring the balance between development and environmental objectives. Use the Site Catalog to consider the impact of site conditions on optimal GVE designs.

Workaround Solutions

The workshop groups produced idealized design concepts maximizing all levels of resiliency across diverse development markets. Participants created vision plans with structural and programmatic approaches for resiliency goals. Their designs bridged the four pillars of infrastructure, ecology, social and economy. Discussions on lost goals with constraints identified three key workaround solutions.

Monetize

When the economics align (re)developing for resilience with green infrastructure is no longer a competing imperative. Several formal and informal approaches exist throughout the Chesapeake Bay and across the nation for private markets that trade an environmental benefit created at one site with low cost voluntary actions to another site with high cost obligations. Communities considering creating a market can look to a recent American Rivers (2019) publication for a review of approaches.

Innovate

Innovative pairing and optimizations of existing technology along with advances in new technology is a consistent workaround strategy. At a site level, developers and their professional design team may shy away from the technical innovation approach because it introduces regulatory uncertainty. To stimulate green infrastructure on private development communities can create innovation options in their guidance documentation. This approach relaxes documentation requirements on an initial set of installations. A safe harbor approach may be capped at a certain number of installations, it may have monitoring and reporting requirements and time limits.

Incentivize

Communities looking to advance a more holistic use of green infrastructure on private lands with resiliency goals can motivate (re)development with incentives. These might be onetime capital investments or code relaxation or expedited reviews based on going beyond the regulatory obligations.
The Site Catalog is a platform to explore balancing development and environmental objectives.

<table>
<thead>
<tr>
<th>Multi-Family Redevelopment</th>
<th>Faith-Based Retrofit</th>
<th>Transit-Oriented Redevelopment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Development</strong></td>
<td><strong>Environment</strong></td>
<td></td>
</tr>
<tr>
<td>- Maximize rental housing units</td>
<td>- Reduce cost of retrofits</td>
<td>- Maximize commercial value</td>
</tr>
<tr>
<td>- Meet parking space requirements</td>
<td>- Minimize construction disturbance</td>
<td>- Provide a comprehensive integrated design</td>
</tr>
<tr>
<td>- Attract tenants</td>
<td>- Maintain parking capacity</td>
<td>- Optimize business tenants’ visibility</td>
</tr>
<tr>
<td></td>
<td><strong>Development</strong></td>
<td></td>
</tr>
<tr>
<td>- Reduce contribution to combined sewer</td>
<td>- Design for extreme weather</td>
<td>- Prevent localized flooding</td>
</tr>
<tr>
<td>- Improve water quality in tributary streams</td>
<td>- Overcome site challenges</td>
<td>- Improve water quality</td>
</tr>
<tr>
<td>- Reduce flooding risk on-site</td>
<td>- Embrace green infrastructure</td>
<td>- Generate revenue with water quality</td>
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**OBJECTIVES**

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<td><strong>Environment</strong></td>
<td></td>
</tr>
<tr>
<td>- Offer an expedited review process to incentivize layers of Green Infrastructure for added resiliency.</td>
<td>- Use grant funding for voluntary Green Infrastructure. A trading market ensures funds for maintenance.</td>
<td>- Reducing parking codes creates Green Infrastructure space. Pass earned WQ credits value onto tenants.</td>
</tr>
<tr>
<td>- Reduce cost of retrofits</td>
<td>- Maximize open space for naturalized pedestrian access</td>
<td></td>
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<tr>
<td>- Minimize construction disturbance</td>
<td>- Pervious pavement</td>
<td></td>
</tr>
<tr>
<td>- Maintain parking capacity</td>
<td>- Below ground infiltration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Design for extreme weather</td>
<td>- Below ground parking</td>
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**OPTIONS**

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</thead>
<tbody>
<tr>
<td><strong>Development</strong></td>
<td><strong>Environment</strong></td>
<td></td>
</tr>
<tr>
<td>1. Green roofs</td>
<td>- Reduce cost of retrofits</td>
<td>- Maximize commercial value</td>
</tr>
<tr>
<td>2. Elevate building foundations</td>
<td>- Minimize construction disturbance</td>
<td>- Provide a comprehensive integrated design</td>
</tr>
<tr>
<td>3. Consider multi-story parking structure</td>
<td>- Maintain parking capacity</td>
<td>- Optimize business tenants’ visibility</td>
</tr>
<tr>
<td>4. On-site non-potable reuse of runoff</td>
<td>- Design for extreme weather</td>
<td>- Prevent localized flooding</td>
</tr>
<tr>
<td>5. Vertical cisterns</td>
<td>- Overcome site challenges</td>
<td>- Improve water quality</td>
</tr>
<tr>
<td>6. Consider regional parking planning</td>
<td>- Embrace green infrastructure</td>
<td>- Generate revenue with water quality</td>
</tr>
<tr>
<td>7. Pervious pavement</td>
<td></td>
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</tbody>
</table>

**Lancaster, PA**

- Green roofs
- Elevate building foundations
- Consider multi-story parking structure
- On-site non-potable reuse of runoff
- Vertical cisterns
- Consider regional parking planning
- Pervious pavement

**Washington, DC**

- Green or blue roof trays on flat roof sections spaced out to meet excess loading capacity
- Above ground distributed storage with reverse siphon connections to roof leaders.
- Replace parking spaces with stone bed and pervious surfaces
- Use grant funding for voluntary Green Infrastructure. A trading market ensures funds for maintenance.

**Capital Heights, MD**

- Green roof
- Above ground bio-planters
- Maximize open space for naturalized pedestrian access
- Pervious pavement
- Below ground infiltration
- Below ground parking
Selecting the optimum design depends on site conditions and objectives. What would you do?

<table>
<thead>
<tr>
<th>Light Industrial Retrofit</th>
<th>Shopping Center Redevelopment</th>
<th>Mixed-Use Redevelopment</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Maintain parking spaces</td>
<td>- Maximize build-able area</td>
<td>- Maximize high value rental space</td>
</tr>
<tr>
<td>- Minimize piping costs</td>
<td>- Increase on-site parking &amp; vehicle access</td>
<td>- Create real estate value</td>
</tr>
<tr>
<td>- Create noticeable entrance</td>
<td>- Reduce cost for development</td>
<td>- Increase resilience to extreme events</td>
</tr>
<tr>
<td></td>
<td>- Minimize water quality impacts</td>
<td>- Reduce localized &amp; downstream flooding</td>
</tr>
<tr>
<td></td>
<td>- Decrease runoff post-development</td>
<td>- Improve water quality in tributary streams</td>
</tr>
<tr>
<td></td>
<td>- Create retail and mass transit connectivity</td>
<td>- Decrease stormwater runoff</td>
</tr>
</tbody>
</table>

**Mount Rainier, MD**

- Stepped tray conveyance alongside of the building
- On-site storage for non-potable reuse
- Bioretention
- Pervious pavement
- Below ground infiltration

**Manheim Township, PA**

- Vertical storage for non-potable reuse
- Pervious pavement

**Manheim Township, PA**

- Reduce size of centralized stormwater features
- Bioretention
- Locate parking close to connectivity to Amtrak station
- Minimize aisle widths in parking areas
- Consider community parking planning
- Pervious pavement

- Leverage the high transit location for an innovation lab to showcase resiliency with Green Infrastructure.

Use an innovative technology “safe harbor” program to quickly approve a non-standard approach.

Stack incentives for rooftop controls that integrate Green Infrastructure with energy or food production.
Glossary

**Resilience** - The ability to withstand or recover from a disturbance

**Green Infrastructure** - An approach to stormwater management that uses soils, plants and permeable surfaces to restore the natural water cycle

**“Formal” Design** - meets code, conforms to established construction standards

**“Romantic” Design** - exceeds code, incorporates some innovative green approaches

**“Wild” Design** - mimics and integrates with natural systems

Selected References


Carey J. 2011. Calculating the True Cost Of Global Climate Change. Yale Environment 360, published online January 6, 2011. [https://e360.yale.edu/features/calculating_the_true_cost_of_global_climate_change](https://e360.yale.edu/features/calculating_the_true_cost_of_global_climate_change)


Contributors

Rebecca Stack is the founder and principal of Designgreen, LLC, a woman-owned engineering firm offering consulting and technical support services to local government, for-profit, non-profit, and community groups. Designgreen’s mission is to integrate ecological principles into the urban landscape shaping resilient, environmentally aware communities.

Marcus Quigley, DWRE, PE, is the founder and principal of EcoLucid. He works at the intersection of technology and practice to leverage novel approaches to complex engineering problems. They are passionate about finding better solutions that are fiscally responsible and sustainable that help enterprises and communities thrive and grow.

Mary Gattis works to improve communities through engagement, education, planning, project implementation and policy. She is recognized throughout the Chesapeake Bay watershed for her expertise in local government and her ability to affect change through the translation of technical information into actionable programs and policies.

Adriana Caldarelli is the Director of the Water Environment Federation’s Stormwater Institute (SWI) and the Director of National Green Infrastructure Certification Program (NGICP). Prior to joining WEF, Adriana spent 17 years with the New Jersey Department of Environmental Protection working in various water quality-related programs, including wastewater management planning, stormwater management policy and combined sewer outfall permitting.

Rebecca Arvin-Colón is a senior programs manager in WEF’s Stormwater Institute. Her work focuses on managing WEF’s stormwater initiatives, including the National Municipal Stormwater and Green Infrastructure Awards Program and the National MS4 Needs Assessment Survey. She is also the liaison to two technical committees: Stormwater and Watershed Management.
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[Logo images of sponsors]

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