Green Stormwater Infrastructure for Urban Flood Resilience:

Executive Summary

The Nature Conservancy

Texas A&M AgriLife Extension

ABOVE: Dallas flooding. © Steven Luu.

OVERVIEW

Dallas-Fort Worth is the fastest growing metropolitan area in the United States (U.S. Census Bureau, 2020). With rapid and widespread conversion of natural land cover to impervious surfaces, stormwater management—for water quality and urban flooding—is an important challenge for municipalities in the region. This challenge is expected to be exacerbated by climate change. Cities across the world are increasingly utilizing green stormwater infrastructure (GSI) practices, engineered plant and soil systems that recreate natural hydrological processes, to enhance stormwater management in urbanized watersheds. In addition to improving water quality, GSI can provide an important and cost-effective tool to enhance urban flood management.

The Nature Conservancy and Texas A&M AgriLife Extension have completed a study to determine where green stormwater infrastructure (GSI) can most effectively enhance urban flood management within the City of Dallas, Texas, when considering capacity, cost,and future impacts of climate change.

The focus was on evaluating opportunities to enhance flood management where the existing drainage network may be limited. Therefore, the study was limited to areas with complete stormwater drainage system data. The U.S. Environmental Protection Agency's Storm Water Management Model (EPA SWMM v. 5.1) was used to identify and evaluate potential stormwater system "hotspots"—specific locations where the drainage network is undersized and likely to contribute to inlet overflows and areal flooding, under a variety of storm conditions. Models were run for the 2-year (50%), 10 -year (10%), and 100-year (1%) 24-hour storms, for "current conditions" and forecasted "climate change" scenarios for 2045(RCP 8.5).

The “challenged subwatersheds” draining to system hotspots were spatially evaluated in GIS for potential sites to deploy three types of green stormwater infrastructure—bioretention areas, rain gardens, and rainwater harvesting cisterns. For the selected current conditions storms, the capacity and costs were estimated for managing stormwater with the “maximum implementation scenario” for these GSI practices and compared to “gray” infrastructure for the 100-year design storm. Finally, a desktop pre- and post-GSI analysis was performed to determine the potential flood management benefits from the maximum GSI implementation scenario.

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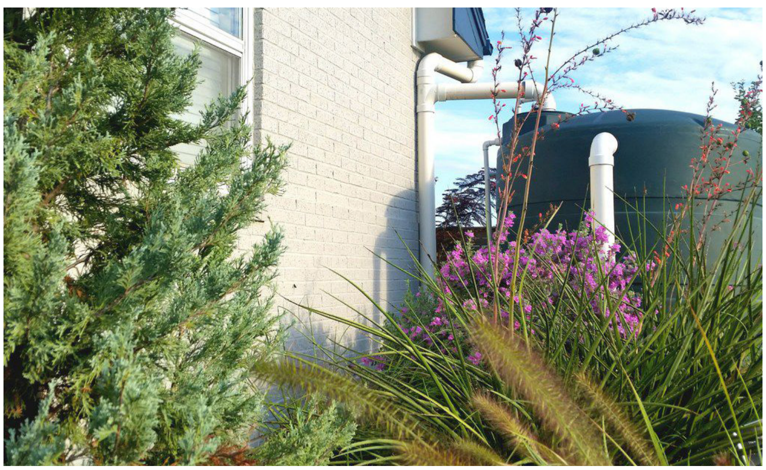
A bioretention area is essentially a sophisticated rain garden, usually involving the removal of native soil that is replaced with a high infiltration engineered soil mix.



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Rainwater harvesting cisterns are used to collect runoff from residential and commercial rooftops structures for storage and later use, or to increase infiltration for improved hydrology.

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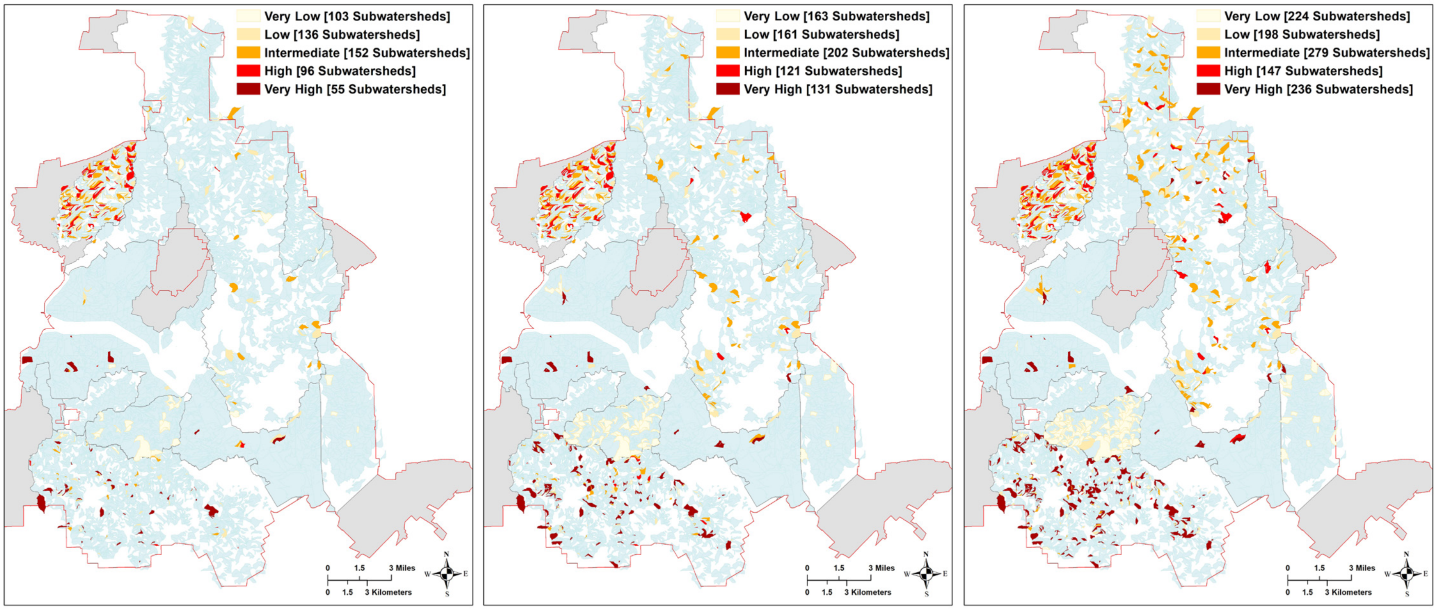
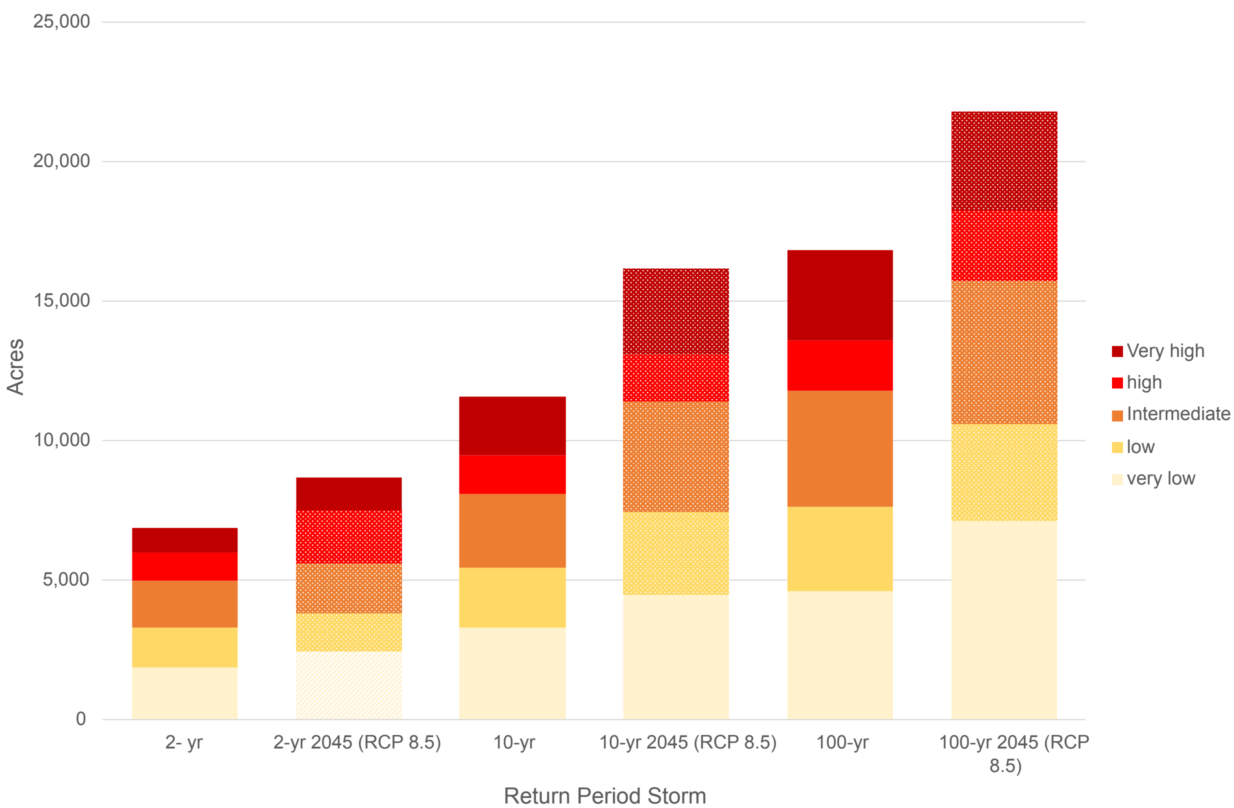
A rain garden is a mulched vegetated depression designed to capture and infiltrate a portion of surface stormwater runoff before it leaves a property. Rain garden vegetation contributes to water infiltration and water treatment

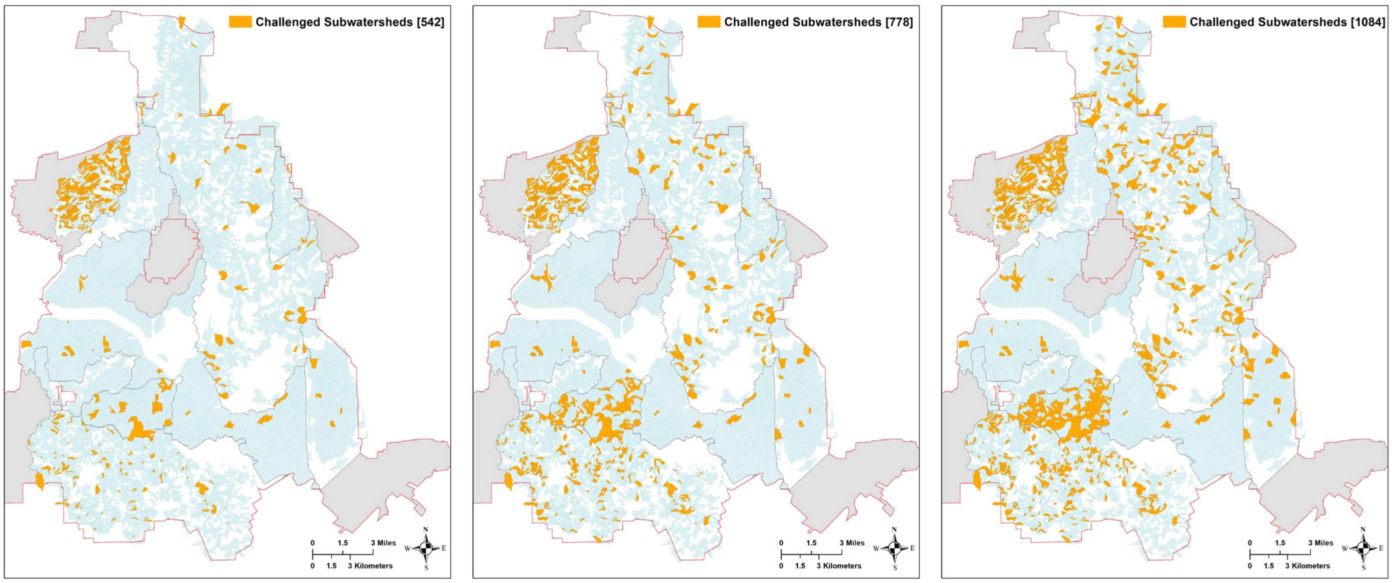


2-year (50%) **10-year (10%)** **100-year (1%)**

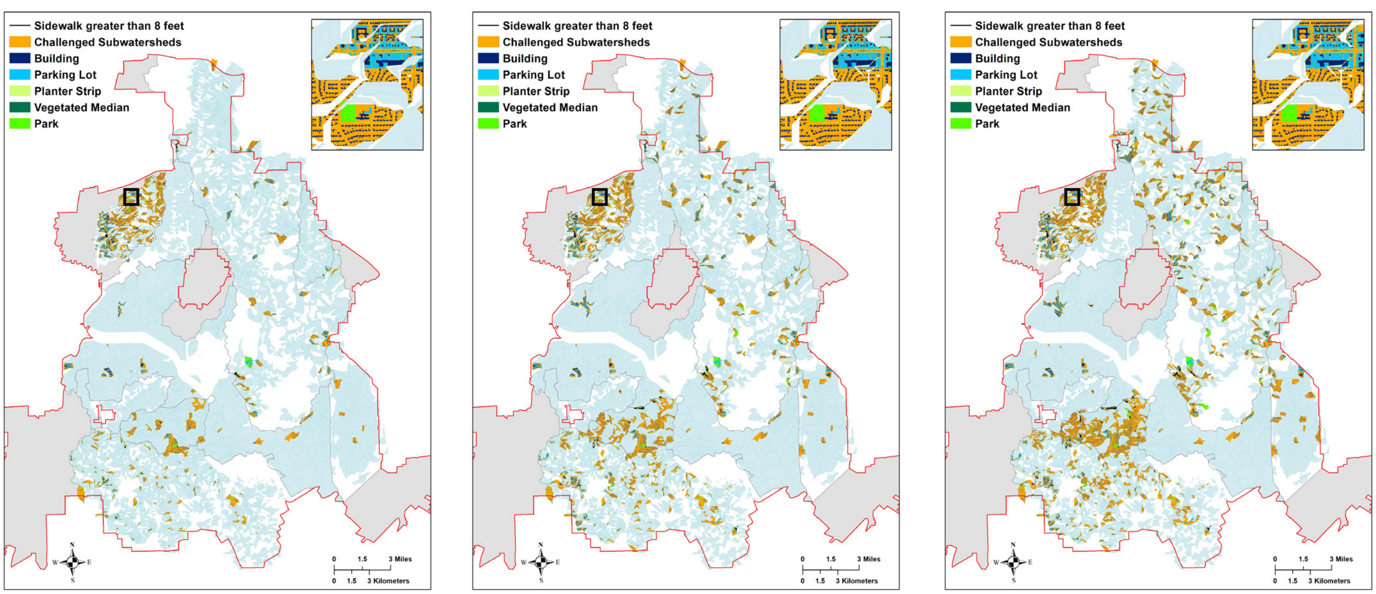
Challenged Subwatersheds, Classified by Severity of Inlet Overflows, as Modeled for Return Period Storms, Current Conditions



Challenged Subwatershed Area (acres), Classified by Severity of Inlet Overflows, as Modeled for Return Period Storms, Current and Forecasted Conditions



2-year (50%) **10-year (10%)** **100-year (1%)**



Total Challenged Subwatersheds, All Classes (top) and Spatial Opportunity for Select GSI (bottom), as Modeled for Return Period Storms, Current Conditions

Key Findings

- Larger amounts of precipitation will lead to more, and more severe, system hotspots and contributing subwatersheds—for larger return period storms, and with the increased precipitation forecasted for 2045 (RCP 8.5).
- Climate change will result in an average increase in the number of system hotspots (+26%) and area of challenged watersheds (+30%), compared to current conditions for the three return period storms studied.
- Precipitation amounts and the resulting hotspots for the 10-year storm forecasted for 2045 resemble those for today’s 100-year storm.
- Substantial cost-effective opportunities have been identified to deploy GSI for improved stormwater management in Dallas—particularly within the Joes’ Creek, Cedar Creek, and Five Mile Creek Watersheds, and portions of the White Rock Watershed.
- GSI was found to reduce modeled overflows for all storms (17-31% reduction) and to delay peak flows which can reduce areal flooding as well as creek flows and overbank flooding.
- GSI was found to be 77% less costly than upgrading gray infrastructure alone, to meet modeled overflows, and a combination of green and gray provides the maximum cost-effective benefits.
- Of the systems studied, bioretention areas—particularly in parking lots—represent the “biggest bang for the buck,” with the most widely available siting opportunities.
- Rain gardens and cisterns, as well as bioretention areas in parks and planting strips, also offer substantial opportunities for distributed benefits.
- GSI practices—together with additional “greening” interventions—can support community health and resilience within the City of Dallas, by enhancing urban flood management, improving water quality, reducing urban heat island impacts, and improving ecological function of city landscapes.

ABOVE: Sidewalk bioretention areas in Deep Ellum. © Katy Evans/ City of Dallas

TRANSFORMING FINDINGS INTO ACTION

While this study focused on GSI systems likely to achieve the greatest volumetric capture for the cost, it is important to consider the stormwater management benefits of additional GSI practices and urban “greening” interventions— along with the co-benefits— when planning in the urban landscape. When combined with additional data and planning objectives, the findings may help to prioritize interventions to achieve multiple goals, including community health and resilience,improved water quality, urban heat island mitigation, and ecological function.

The results of this analysis will be shared with the City of Dallas and integrated into The Trust for Public Land (TPL)’s Smart Growth for Dallas (SGD) Decision Support Tool for consideration with additional data, such as: City data on channel flooding, customer service calls, and upcoming streets and parks projects; Federal Emergency Management Agency (FEMA) flood plain maps;and data on water quality, equity, and land use types, available within TPL’s SGD tool. It is our hope that these results will support planners, policymakers, and investors in Dallas to consider GSI as an important—and cost effective—tool for enhancing urban flood management.

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For additional information or to request the full technical report, visit nature.org/DallasGSI or contact:

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This study was accomplished through a partnership between The Nature Conservancy in Texas and Texas A&M Agrilife Extension & Research Services (Agrilife), in collaboration with Dallas Water Utilities (DWU), the City of Dallas Office of Environmental Quality & Sustainability (OEQS), and The Trust for Public Land (TPL). The analysis was supported by Lyda Hill Philanthropies.