POCKET PRAIRIES
IMPLEMENTATION FRAMEWORK

Programmatic guidance and conceptual designs for transforming small-scale underutilized spaces in Houston

THE WATER INSTITUTE

SCAPE

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ACKNOWLEDGEMENTS

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The development of this guidance document and the pilot site conceptual designs would not have possible without the support and knowledge thoughtfully provided by partners at Houston Parks and Recreation Department (HPARD), Houston Parks Board (HPB), Houston Public Works (HPW), The Nature Conservancy (TNC), and Harris County Flood Control District (HCFCD), and review from Houston Advanced Research Center (HARC).

In 2020, the City of Houston developed *Resilient Houston*[1]; a resilience strategy that provides a framework for collective action for Houston's people, diverse neighborhoods, watersheds, City departments, and local, regional, and global partners to protect the city against acute shocks and chronic stressors.

The development of this guidance document and the ways in which it can support future city-led project planning and implementation is directly tied to three targets established in *Resilient Houston:*

- Target 6: Plant 4.6 million new native trees by 2030.
- Target 11: Complete 100 new green stormwater infrastructure projects by 2025.
- Target 12: Eliminate geographic disparities in life expectancy by 2050.

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Credit: Jaime Gonzalez

INTRODUCTION

BACKGROUND

Houston's rapid growth over the past century has transformed the regional landscape. Today, Houston is a city of 2.3 million residents and growing, and the Greater Houston Metropolitan Area is home to 7.5 million people. While that growth has brought with it economic opportunity, cultural diversity, and other benefits, it also creates new challenges. Over 99% of the coastal prairies that once covered much of the region have been lost[2] —and along with them, the natural sponges, air and water filters, cooling features, and wildlife habitats provided by these landscapes. Much of the area is now developed, increasing impervious surfaces like roadways, parking lots, and buildings that exacerbate stormwater runoff and create urban heat island effects. Combined with impacts from climate change, Houston is experiencing increasing and persistent threats from storms, flooding, heat, drought, and other hazards.

In response to these and other challenges, the City of Houston has focused on comprehensive approaches for increasing the city's resilience—the capacity of its residents, communities, institutions, businesses, and systems to survive, adapt, and thrive no matter what kinds of chronic stresses and acute shocks they experience. The Resilient Houston strategy, completed in 2020, created a framework for action at multiple scales—from the region to the city, to the bayous, to neighborhoods, to individual properties.[3]

At every scale, the City of Houston, regional partners, local nonprofits, and community organizations have been working to protect and expand the important functions provided by the natural landscapes. This includes efforts to conserve and restore coastal prairies as well as efforts to implement nature-based solutions into the build environment—practices that install natural features or processes into the environment to adapt to and mitigate environmental change while providing measurable co-benefits to communities.[4]

The purpose of this report is to provide programmatic guidance to City of Houston departments and partner agencies and organizations for the implementation of *small-scale* nature-based solutions on underutilized spaces within Houston's built environment, including vacant lots, parts of neighborhood parks, and along roadways or bayous. These small-scale interventions, when implemented citywide and alongside larger-scale efforts, can support the creation of a network of green spaces that restore some of the natural functions of Houston's historic landscape, help the city adapt to a changing climate, and provide multiple benefits to communities.

This guide has two parts:

- **An introduction to coastal prairies and Houston's urban habitat types, their importance to Houston, and their multiple resilience benefits; and**
- **Stepwise guidance through the entire lifecycle of implementing small-scale "pocket prairies" and other nature-based solutions—from site analysis and prioritization all the way through to maintenance, monitoring, and creating visibility.**

While much of the existing, well-established local guidance on pocket prairie implementation focuses on specific planting regimes and best practices, the focus of this guide is on programmatic considerations. Recommendations are drawn from local and regional case studies as well as lessons learned from local partners who have implemented and managed prairie restoration and nature-based solution projects.

Prairie Reconstruction at Memorial Park in Houston, TX. Credit: Jaime Gonzalez

Prairie Maintenance. Credit: Houston Parks and Recreation Department

HOUSTON'S PRAIRIE SYSTEMS

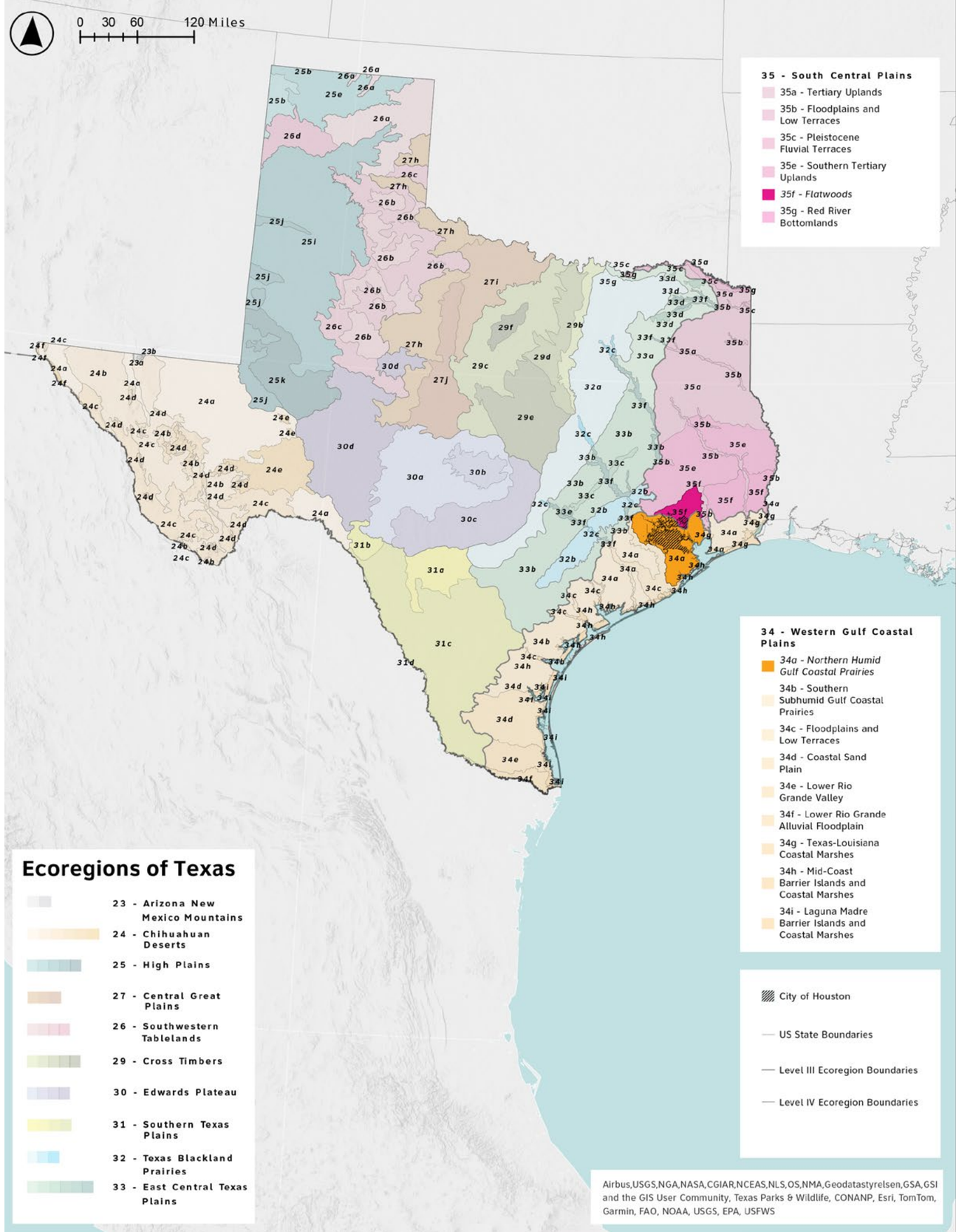
The state of Texas has 12 unique ecoregions, which each contain varying numbers of more specific sub-regions. The two ecoregions of eastern Texas—the South Central Plains and the Western Gulf Coastal Plains—include both prairie and non-prairie sub-regions.

Coastal prairies, which were once the dominant ecosystem in Houston, are known for their thick, clay soils, gentle topography, and profile of native grasses and forbs. These include but are not limited to grasses like eastern gammagrass, bushy bluestem, Indiangrass and switchgrass[5], wildflowers like the Texas bluebonnet or lemon beebalm[6], as well as many other types of native plants and vines. These types of prairies can host a diversity of plant species and migratory birds, serve as carbon sinks, help mitigate the urban heat island effect, absorb and hold water during flood events, and act as filters to help prevent and remediate point and non-point water pollution.

Prairies have been an important part of Texan culture and identity even before European and Mexican colonization. The natural prairie landscape was important to indigenous groups; as it served as hunting grounds for animal species such as bison, pronghorn, deer, and elk. Around the time that Texas became part of the Mexican state, and even after Texas achieved independence from Mexico in 1836, European settlers arrived in the area that would become Houston looking for land to farm and homestead.[7] Early homesteaders saw the prairie as an endless resource, and this ecosystem paved the way for the cattle ranching industry and culture that still exists in Houston today.[8] However, in addition to establishing the cattle ranching culture, this wave of migration began to change the prairie landscape with overgrazing, agricultural activities, and other man-made disturbances that disrupted much of the prairie ecosystem.[9] Because of their multiple benefits and rich historical ties to the land throughout Texas, there have been many efforts over the past several decades to establish and re-establish prairies throughout Houston.

> ***"Prairies are the quintessential Texas landscape.*** *It forged our cowboys, built our economy, fed us, and clothed us. Heck, it even helped us win the Battle of San Jacinto. In Greater Houston,* ***it played a huge role in our development, both culturally and economically.***" - Jaime González

Credit: Texas Digital Archive



IN HOUSTON'S MODERN URBAN ENVIRONMENT, PRAIRIES FALL INTO THREE GENERAL CATEGORIES:

PRAIRIE REMNANTS

Segments of preserved native prairie habitats, minimally disturbed by urbanization, agricultural activities, and invasive species. There are many efforts to conserve remaining native prairie remnants across the Houston region, for example parts of the Katy Prairie.[10] *Credit: Jaime Gonzalez*

PRAIRIE RESTORATIONS

Rehabilitation of prairie lands that have been degraded by disturbances but still hold some relic species. A prime example is Sylvan Rodriguez Park,[11] where Houston Parks and Recreation restored 30 acres of land that had been overrun by invasive species to native coastal prairie habitat. *Credit: HPARD*

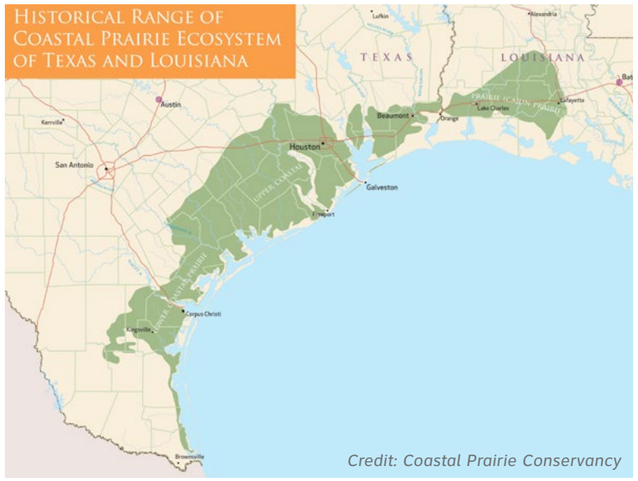
PRAIRIE RECONSTRUCTIONS

Full reestablishment of a coarse replica of a natural prairie community on land that has been converted to other uses and where prairie species no longer exist. Examples include the MD Anderson Prairie[12] and the Reed Road Urban Prairie.[13] *Credit: Jaime Gonzalez*

All these prairie communities in Houston vary in size, quality, integrity, and biodiversity—and, importantly, require different approaches to maintenance and management. However, all of them can provide valuable ecosystem services and other co-benefits. They represent important tools in the toolbox of preserving and reestablishing Houston's native coastal prairies within urban environments.

This guide is primarily concerned with reconstructions, and specifically those implemented at a small scale, which are often referred to as "pocket prairies."

This guide also considers complementary urban habitats when they are more suitable for an opportunity space. In some cases, pocket prairie plantings can even be paired with wet prairie plantings or urban canopy features on a single site. However, pocket prairies, which fall within the urban grassland category of urban habitats, are their own distinct habitat with features that distinguish themselves from other urban habitats.



Credit: Coastal Prairie Conservancy

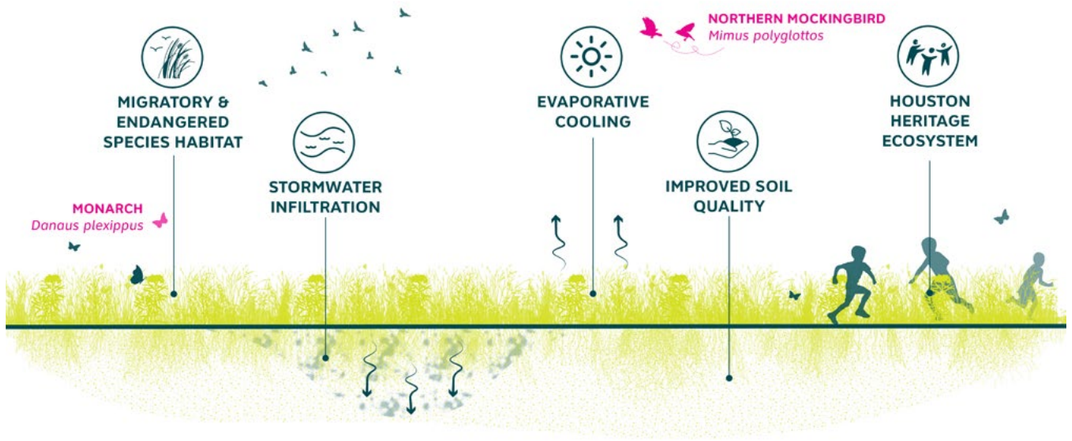
WHAT IS A POCKET PRAIRIE?

Pocket prairies, often implemented in urban or suburban environments that might otherwise lack pollinators and diverse wildlife, are reconstructed prairies generally the size of about an acre or less. Because they are smaller in scale, pocket prairies are more feasible when the individual or organization responsible for implementation and management has both the will and the resources to sustain and ensure the prolonged health of the pocket prairie.

Residential Pocket Prairie, Credit: Jaime Gonzalez

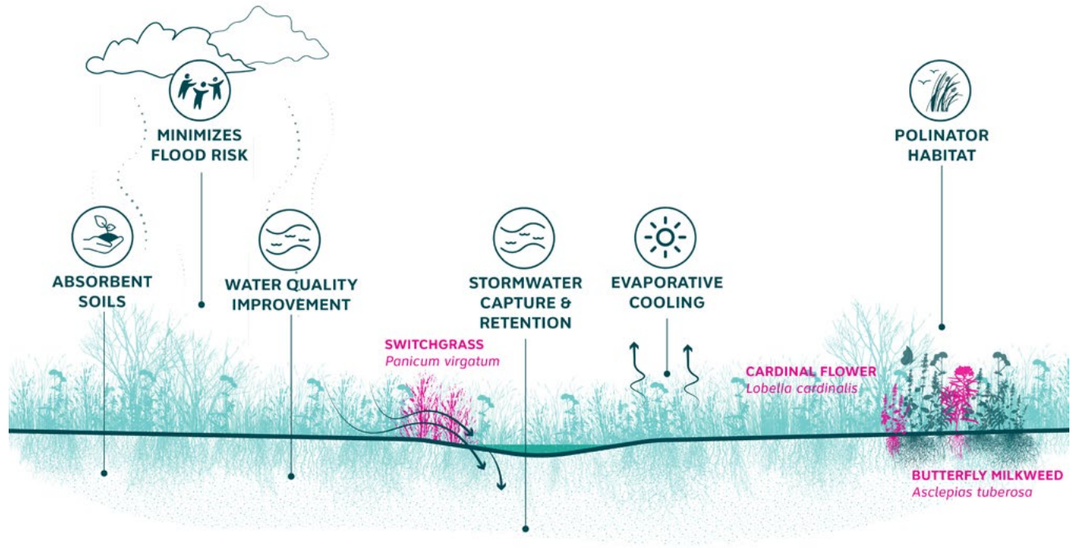
RESILIENCE BENEFITS OF HOUSTON'S URBAN HABITATS

Houston's diverse environments today can be understood in part through the following "Four Sisters" of urban habitat types that relate to the region's native landscapes. These habitat types may exist at large and small scales and include remnant, restored, and reconstructed communities. This implementation guide includes design approaches for implementing pocket prairies and nature-based solutions on small-scale sites that incorporate reconstructed elements of each of these habitat types. Reintroducing these habitats into Houston's built environment, even at a small scale, can provide multiple resilience benefits related to biodiversity, flood mitigation, and public health. It also reconnects Houstonians to landscapes that are essential to the cultural heritage of Texas.



1 *Urban Grasslands*

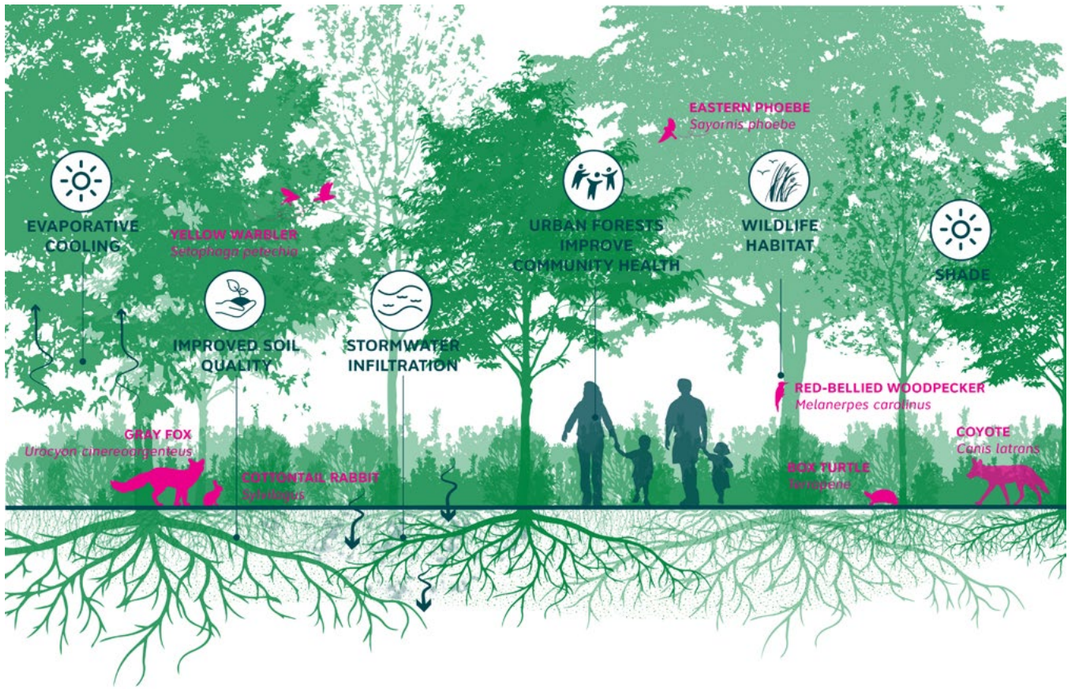
Urban grasslands are highly diverse habitats that include pocket prairies and native coastal prairie grass species such as big bluestem, little bluestem, swtichgrass, and yellow Indiangrass. The long root systems of urban grasslands can infiltrate stormwater and reduce stormwater runoff, helping to both mitigate flooding and improve soil and water quality. Urban grasslands also have the potential to provide evaporative cooling to mitigate the impacts of extreme heat, and an increase in rich plant species in urban grasslands has been shown to support faunal diversity and provide a consequential advantage for birds in cities.[14] Even with fewer number of plant species compared to rural areas, urban native grasslands support pollinators.[15] Small reconstructed grasslands have also been used for place-based education, which uses the local environment as a starting point to teach new concepts.[16] Small urban grasslands need a degree of connectivity to provide effective biodiversity and habitat support, which emphasizes the need for the construction of more high-quality sites in the most developed parts of urban areas.[17]



2 *Wet Prairie*

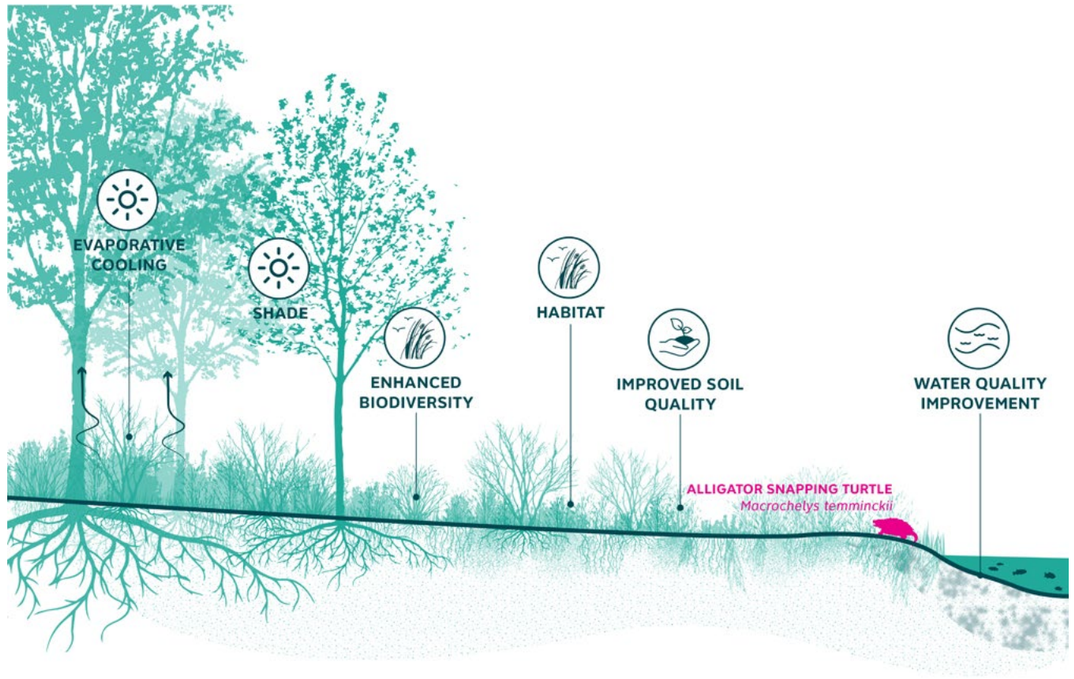
Wet prairie is characterized by low-lying prairies and wetlands with saturated soils, including plant species like switchgrass, cardinal flower, and butterfly milkweed. These habitats help to minimize flood risk and improve water quality by capturing and retaining stormwater, and can also provide evaporative cooling benefits, and support biodiversity.

Several studies have highlighted multiple benefits of constructed wet prairies (also known as urban wetlands) such as carbon sequestration, biodiversity, and cultural ecosystem services as well as water storage and peak-flow attenuation (the dissipation of energy that reduces discharge velocity to mitigate erosion and damage to ecology), nutrient cycling and burial, metal sequestration (or the removal of toxic metals), and sediment settling.[18,19] Although larger wet prairie sites have the ability to improve water quality and reduce flood risk at a larger scale,[20] smaller sites can still provide meaningful benefits.[21] It is important to also emphasize that small wet prairies are more effective in sustaining landscape functions when they are implemented with wetland connectivity in mind.[22]



3 Urban Canopy

Urban canopy habitats are areas that consist of varying levels of tree canopy. The pineywoods ecoregions in areas north of Houston were once blanketed by pine and hardwood forests with thriving undergrowth plants. Urban canopies produce many of the same benefits as urban grasslands and wet prairies like extreme heat mitigation and water quality benefits, but can also provide wildlife habitat. Urban forests also provide shade which helps to cool outdoor spaces. If carefully planned, designed, and managed, urban tree canopies can enhance human health and well-being through ecosystem services such as moderating temperatures, reducing building energy consumption and atmospheric carbon dioxide levels, improving air quality, offering an aesthetic environment and recreational opportunities, mitigating rainfall runoff and flooding, lowering noise levels, and providing additional social and environmental services.[23]



4 Riparian Buffer

Riparian buffers are habitats found along the banks of bayous and other waterways. Houston's extensive network of bayous can support riparian habitats that provide ecological benefits to entire ecosystems. Riparian areas can serve as an energy source for aquatic species, provide wildlife habitat, provide shade, stabilize water temperatures, and minimize erosion. The riparian zones throughout Houston are mainly bottomland hardwood forests—often referred to as river swamps—which are deciduous forested wetlands that support a variety of wildlife and have the ability to survive in areas that experience frequent flooding.[24]

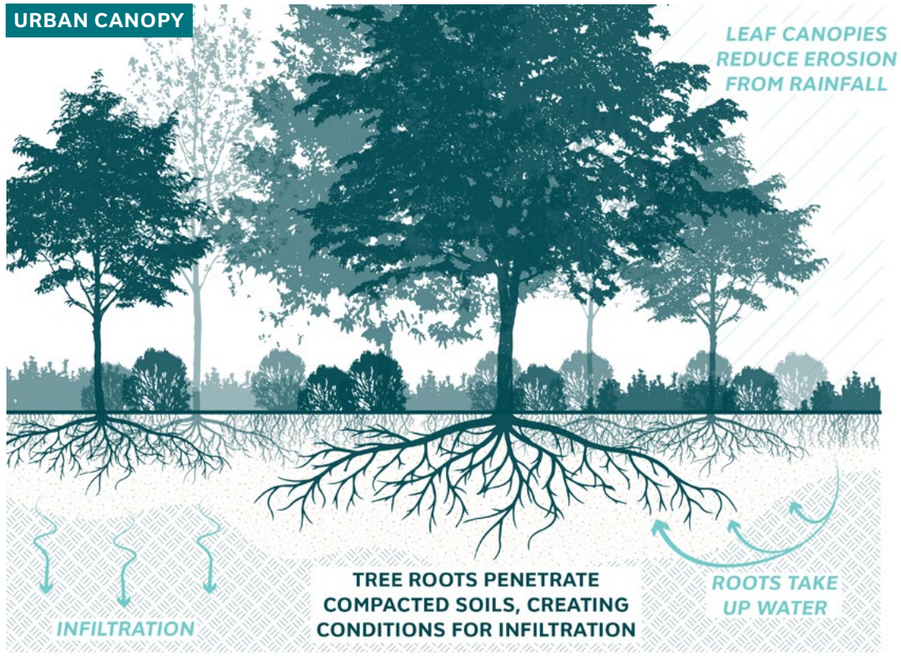
In addition, because riparian edges act as an interface between land and water, they influence "the cross-habitat food-web interactions, system functioning, and the provision of ecosystem services in heterogeneous landscapes."[25] They also intercept surface-runoff and filter pollutants.[26]

WHAT IS GREEN STORMWATER INFRASTRUCTURE?

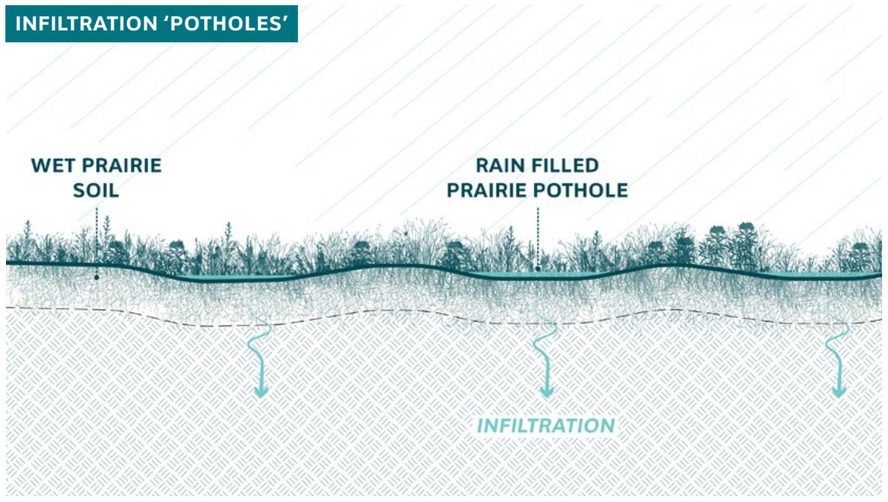
Green stormwater infrastructure (GSI) is a suite of nature-based solutions that collect, slow, and clean stormwater runoff.

Pocket prairies and other small-scale nature-based solutions can incorporate many types of GSI features, including:

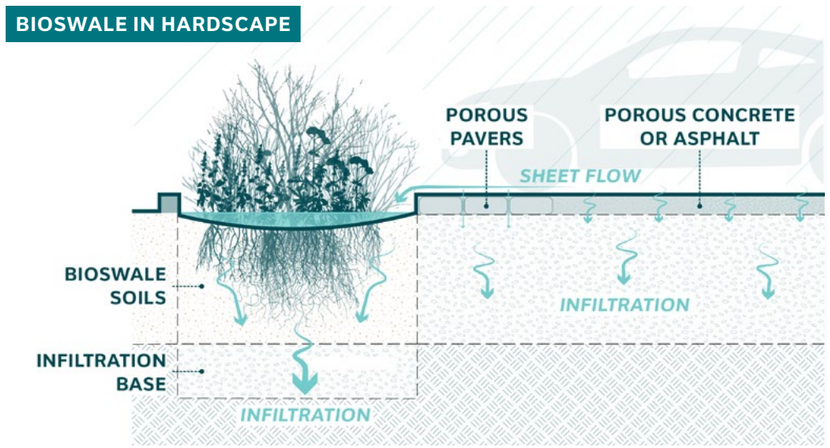
URBAN CANOPY



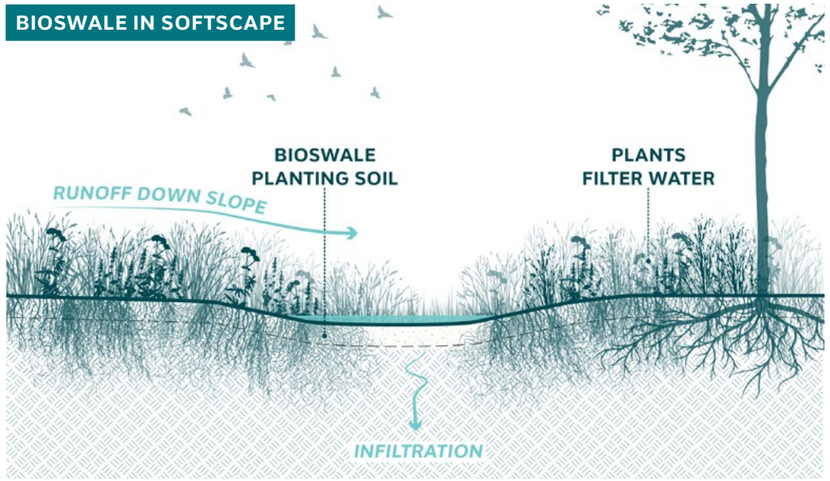
INFILTRATION 'POTHOLES'



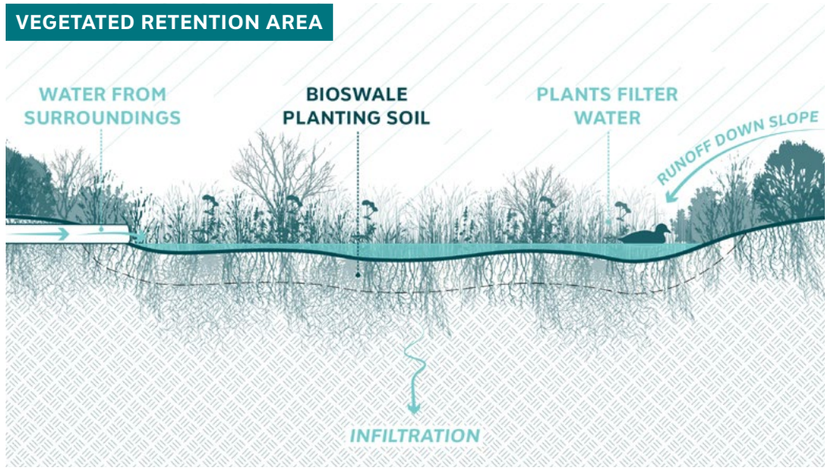
BIOSWALE IN HARDSCAPE



BIOSWALE IN SOFTSCAPE



VEGETATED RETENTION AREA



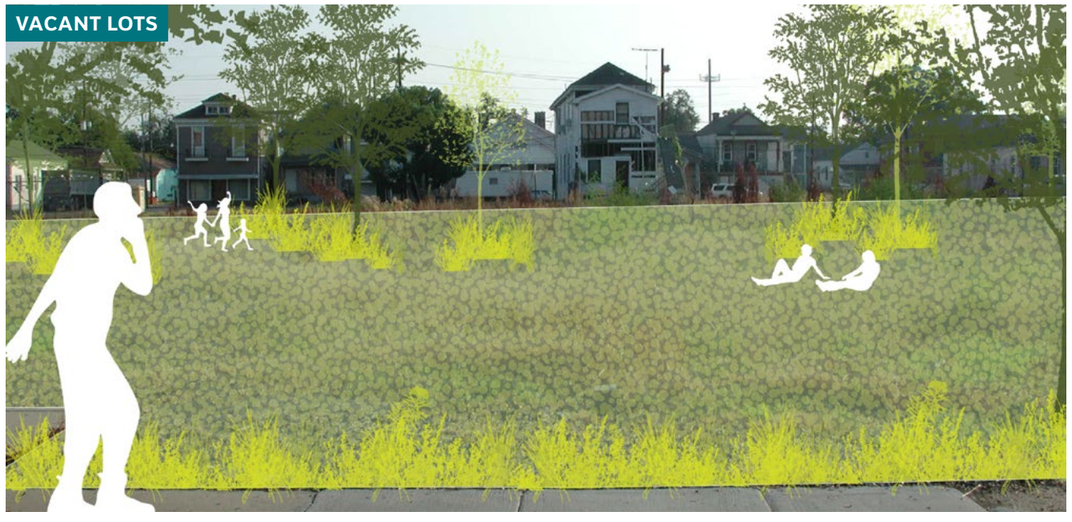
SMALL-SCALE SITES FOR INTERVENTION

The city of Houston covers 665 square miles and there are many underutilized spaces that provide an opportunity for constructing pocket prairies and small-scale nature-based solutions within Houston's built environment. **The following represent common types of sites that may be considered for intervention.**

PARK SPACES

Depending on the size, location, and maintenance regime, an existing park or part of an existing park could potentially be a good fit for a pocket prairie. For example, for a park space in which new plantings are already being considered, a pocket prairie could be a potential alternative if management capacity aligns with the pocket prairie's needs.

VACANT LOTS



Vacant lots—especially ones that are flood prone or were purchased as a buyout due to repetitive flooding—can potentially be conducive to pocket prairies or other nature-based solutions. Publicly owned vacant lots in particular provide an opportunity to be repurposed for resilience benefits. With some supplemental funding and the right plans for management and maintenance, they could be converted to pocket prairie and yield ecological and other benefits that grass alone cannot. *Photo Credit: Bart Everson, Flickr*

BAYOU EASEMENTS

Because of their proximity to the Bayou Greenways trail system, bayou easements can be effective spaces for pocket prairies and other nature-based solutions. In addition to providing ecological benefits by supporting biodiversity, pocket prairies along bayou easements can directly benefit trail users—providing flood mitigation and other public and social health benefits. Bayou easements are also managed and maintained by Houston Parks Board and Harris County Flood Control District, which provides opportunities for pocket prairie implementation and maintenance that might not otherwise be feasible within other departments, agencies, or organizations.

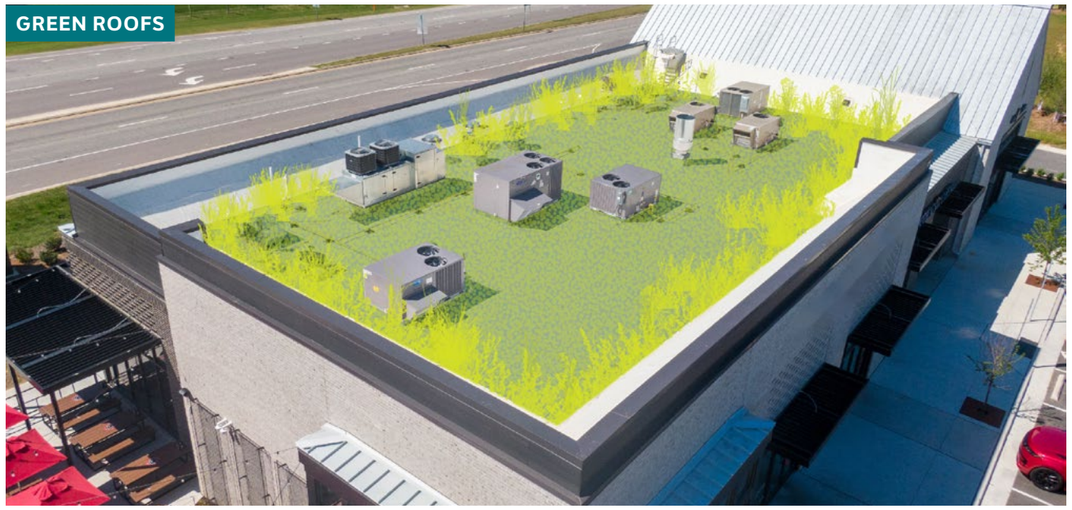
ROADWAYS & PARKING LOTS

Roadways and parking lots—which are often viewed as more challenging spaces to implement pocket prairies and other smaller, nature-based solutions because of their car-centric nature[27]—have the potential to host prairie plantings and other nature-based solutions, and thus make these spaces more pedestrian friendly through benefits related to urban heat island mitigation and mental health benefits that pocket prairies can provide. Implementing pocket prairies along roadways and near parking lots can support stormwater detention and reduce extreme heat that is exacerbated by high concentrations of asphalt and less trees. Depending on location, these types of interventions may also promote modes of transit like walking and bicycling. *Credit: Andre Um*

BUS STOP SHELTERS

There is less data surrounding the concept of green roofs for bus shelters that specifically incorporate pocket prairies, but these spaces have the potential to serve the public through heat mitigation.[28] As part of the Greener Gulfton Plan—a plan to address extreme heat and other challenges in Houston's Gulfton neighborhood—partners are working to pilot native prairie wildflowers on bus stop green roofs and pollinator-friendly vines on shade trellis structures that would both mitigate heat and increase habitat.[29] *Photo Credit: Wikimedia Commons*

GREEN ROOFS



Green roofs, which can be applied across many contexts, have, in several studies, proven to enhance stormwater capture, cooling, and biodiversity when native prairie plants are utilized. Green roofs containing native prairie plant species can also increase the energy efficiency of buildings. *Photo Credit: Adobe Stock*

CAMPUSES

Campuses—whether corporate or medical campuses, university campuses, or other—sometimes already have the budget and capacity to sustain higher-maintenance landscapes, and depending on the context can make great sites for pocket prairies. *Photo Credit: Leonard Lane*

POWERLINE & GAS EASEMENT CORRIDORS

Often located in underutilized areas, powerline and gas easements can be spaces that are conducive to native prairie plantings and contribute to biodiversity benefits by improving habitat connectivity. *Photo Credit: SCAPE*

Credit: Flo Hannah

IMPLEMENTATION CONSIDERATIONS

IMPLEMENTATION CONSIDERATIONS

To construct effective, long-lasting pocket prairies and other small-scale nature-based solutions that are based on clear goals and tied to resilience benefits and co-benefits, it can be valuable to look at the planning and implementation process from a high level view. Like many other processes that involve potentially altering a landscape, planning for pocket prairie implementation is rarely linear. Sequenced steps can help ground a planner and/or implementer in the overall process, but pocket prairie planners and implementers often need to consider multiple steps at once; or move ahead several steps only to return to an earlier step. The figure below demonstrates pathways to implementing pocket prairie and nature-based solutions, highlighting specific dependencies, important relationships, and other considerations throughout. Recommendations throughout this section were synthesized based on discussions with project partners about local best practices and lessons learned from implementation of pocket prairies in Houston.

1 Prioritize sites based on resilience benefits

- Understand which benefits are most important for the particular site and context
- Identify best available data and relevant metrics
- Conduct spatial analysis

Early site investigation (even if it's just desktop research) and site prioritization go hand in hand and are not linear. There is a need to understand at a basic level what the possibilities are for any site in question.

Sometimes sites cannot be formally prioritized without a secure funding source.

2 Investigate sites

- Understand site boundaries, location, and capacity
- Identify ownership and management

Once potential partners and/or funders are identified, additional site investigation may be required to collect more detailed information for these groups.

3 Identify partners and funding sources

- Identify ownership and management

Gather feedback from partners before and during the design process.

4 Design sites for sustainable outcomes

- Respect neighborhood context
- Consider site needs and existing conditions to guide decision

Design to levels appropriate for the site's capacity.

5 Estimate costs

Cost estimates (both initial high-level estimates and detailed budgets that come later) are most accurate when they include realistic plans for management and maintenance.

Funders will almost always require high-level cost estimates at the beginning of a proposed project. At this point, it may be too soon to build out a detailed budget, but a ballpark cost estimates can help guide the scale of a project and increase your chances for getting a project funded.

6 Prepare sites and install pocket prairies

Starting to build identity for a pocket prairie site during installation can help build buy-in, and keep the community informed about plans for the space.

7 Plan for long-term management and success

- Consider scale
- Account for early management
- Establish an adaptive management plan

8 Monitor sites and communicate benefits

- Align benefits with community needs and funding sources
- Facilitate community science

9 Develop pocket prairie identity across sites

- Build buy-in
- Provide access and education
- Create visibility
- Foster continued support for future efforts

1 PRIORITIZING SITES

Sites can be strategically prioritized by understanding a community's needs and assessing potential benefits that can help address those needs.

The benefits of the four urban habitat types discussed in the Introduction are numerous. In conversation with partners and using the best available data considering the timeline for this effort, the project team focused on three main functions for spatial analysis and site prioritization: 1) biodiversity, 2) flood mitigation, and 3) public/social health.

While detailed site-level characterizations are essential for small-scale design, the project team employed citywide datasets and applied an analysis framework that examines the specific site candidates across multiple functions. The approach can be replicated to support the city's ongoing and future pocket prairies and small-scale nature-based solutions initiatives. In this framework, the project team gathered and analyzed data to highlight the areas with high need for interventions that support each function mentioned.

Examples of selected relevant metrics in available data that the team included to represent the need for each function in different locations in the city are the following. For *biodiversity*, the project team looked at areas of wetlands in a 300 ft radius of the sites, urban ecosystem types, and urban canopy coverage. The highly developed areas with high impervious surface and low tree coverage close to wetlands and/or bayous were considered as high-need areas for habitat support and biodiversity-focused interventions.

For *flood mitigation*, the team looked at Special Flood Hazard Areas (SFHA), estimated inundation based on future sea level rise (SLR), impervious surface percentage, and ponding average in a 300 ft radius of the sites. The areas in SFHA, high impervious percentage, and estimated SLR inundation or ponding were considered high-need areas for flood mitigation interventions. These metrics were chosen based on the most accessible data during the time of the analysis, as well as limitations related to the analysis timeline. City/regional modeling of stormwater is crucial to not only highlight the issue areas but also the high-impact areas for providing flood mitigation benefits upstream.

For *public/social health*, the project team looked at the social vulnerability index, young and old population, income, redlining legacy, and environmental justice metrics such as toxins released into the air, wastewater discharge, and proximity to hazardous waste, as well as heat-related metrics such as heat anomaly and energy burden. Areas of more vulnerable populations, with redlining legacy, high heat anomalies, and other environmental justice issues, were considered as high-need public/social health areas.[30]

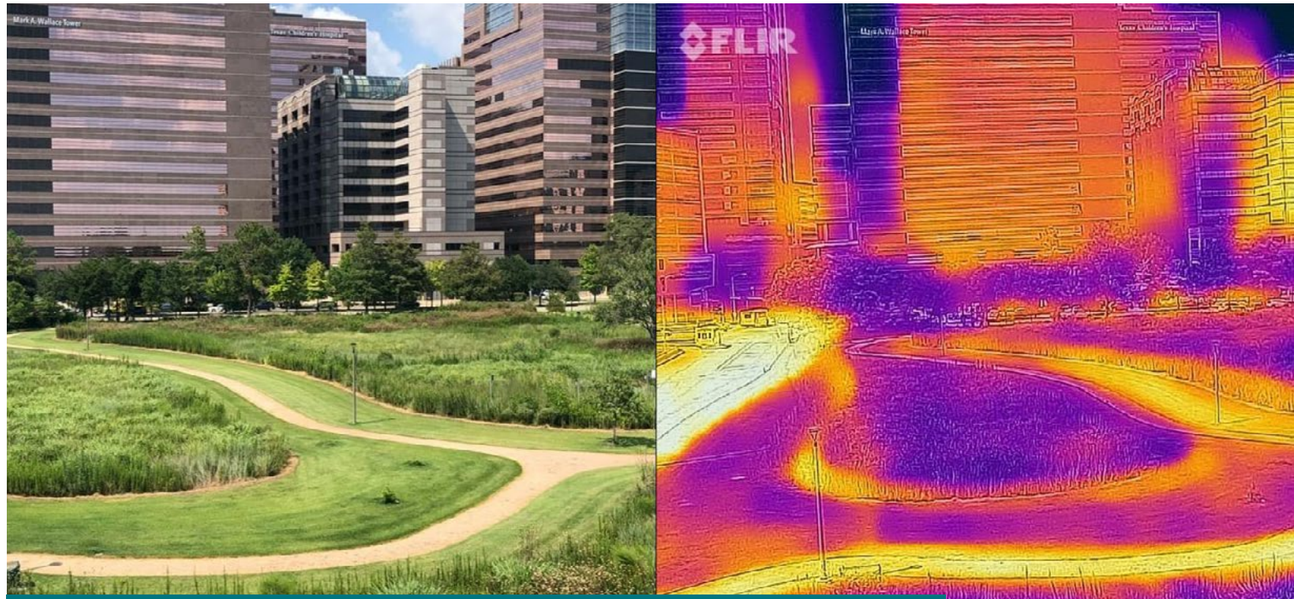
After defining the metrics for the three main functions, the team performed two types of analysis[a] to facilitate prioritization: *clustering* and *scoring*.

Clustering analysis: Being able to categorize and group similar types of spaces is a critical first step in being able to assess potential benefits and eventually prioritize sites. Clearly defined categories help facilitate understanding of unique problems and systematic approaches to their solutions. This is particularly important for researching and designing pilot planning projects, as they aim to be representative and support future project selection efforts. Although expert and local judgment plays a vital role in the development of these defined categories, quantitative and data-driven approaches are replicable and can enhance expert knowledge and illuminate potential blind spots. Once categories are developed, a planner can conduct spatial analyses to better understand the needs of specific sites and think strategically about what the goals and potential benefits might be for sites. Clustering analysis employs unsupervised machine learning methods to cluster candidate sites into different types of need areas across all functions.

Scoring analysis: This analysis establishes a scoring system based on each data input, with values normalized to allow comparable scoring across different data inputs and functions. This can be helpful in conjunction with clustering analysis to find sites that might consistently score high across many need metrics. However, while often performed as the sole approach for suitability analysis, the scoring across all metrics has several limitations as it is constrained by what is included, overlap between metrics, and pre-weighting that can potentially inflate the priority score and distort the results. This framework suggests the use of this analysis for answering selected questions and not the sole analysis to prioritize pilot sites.

To learn more about the clustering and scoring analyses utilized to prioritize pilot sites for this study to maximize resilience benefits, see *Houston Pocket Prairies: Site and Benefit Evaluation.*

a For more information on the methodology used for each of these analyses, and the results produced for the sites in this particular effort, see *Houston Pocket Prairies: Site and Benefit Evaluation*



Pocket Prairie at MD Anderson Campus
Houston, TX

The MD Anderson Pocket Prairie has demonstrated how pocket prairies can provide heat mitigation benefits. To capture this benefit, partners involved in monitoring for the site measured the temperature of the lawn surface, the middle of the prairie, and the adjacent road surface all at the same time. The lawn surface was 99 degrees Fahrenheit, the middle of the prairie was 87 degrees, and the road surface was over 120 degrees. *Credit: Jaime Gonzalez*

2 INVESTIGATING POTENTIAL SITES

Understanding all variables associated with a single site—including boundaries, capacity, neighborhood context, ownership, and management—can minimize potential obstacles later in the planning process.

Understanding Site Boundaries, Location & Capacity

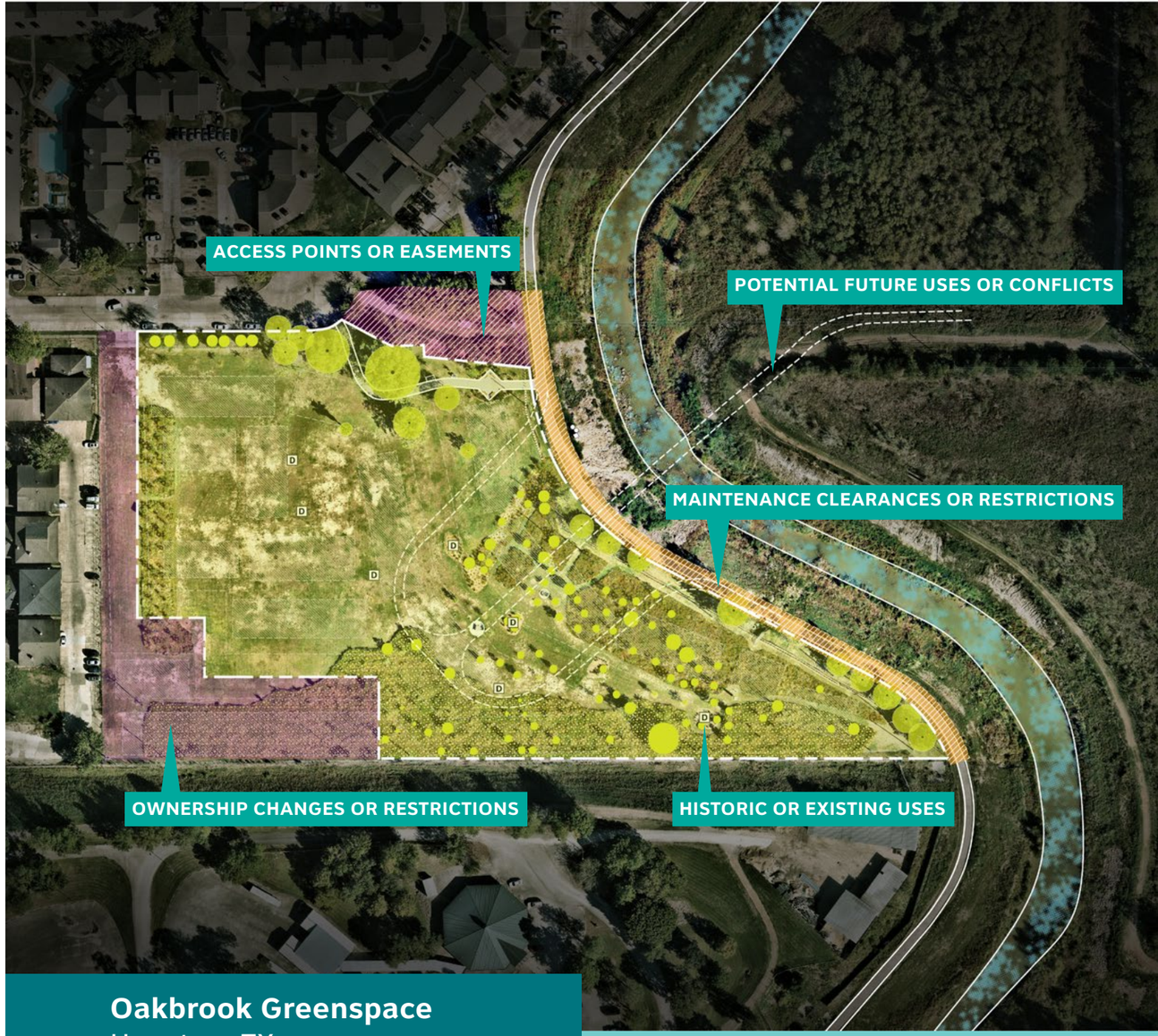
Once a site is prioritized for resilience benefits, it is important to understand which parts of the site are available for interventions and where exact property boundaries or access easements exist. Sites may appear to belong to one single entity when viewing them through aerial imagery or even on foot, but it is possible for there to be separately owned properties adjacent to a site that appear to be part of the site itself, or for there to be an access or maintenance easement that needs to be maintained.

Additional investigation that can be done on the ground at a site includes soil testing. Soil testing before any other plans are made at a particular site is an important step—a site with poor soil quality or soil that is not conducive to pocket prairie plantings may require soil remediation or soil amendments before it is selected for pocket prairie implementation. Because a lot of the land within the city of Houston can have thick, clay soils, testing is critical to ensure that layers are not holding water and thus retaining excessive levels of harmful material like soluble salts or chlorides. Soil testing can help eliminate sites early in the planning process and save a large portion of the budget that can be required to treat soil in order to establish vegetation that will support a healthy pocket prairie.

Before proceeding with planning and implementation for a site, it is also critical to observe, understand, and engage with the surrounding neighborhood. Neighborhood context—specifically proximity to residences—will help inform the appropriate design, maintenance regime, and programming of the pocket prairie. This information is then used by the project team to assess whether the managing and/or maintaining entity has the resources necessary to cover maintenance of the site. Engaging communities early and often will minimize skepticism and potential pushback during later planning phases and leading up to implementation.

Identifying Ownership & Management

Land management and maintenance is not always straightforward. Sometimes, the owner/manager and the maintainer of a parcel can be two separate agencies or organizations. Other times, parcels may contain easements that are publicly accessible, but not available for any type of land alteration. Additionally, agencies often employ contractors for more specialized or intensive maintenance regimes. When the owner and the maintainer are different, it is valuable for both entities to have input into the feasibility of a proposed pocket prairie, and it is critical that both are highly engaged in planning, design, and implementation.



Oakbrook Greenspace
Houston, TX

Oakbrook Greenspace is an example of a site that required a significant amount of site investigation before drafting a conceptual design. Ownership status of different parts of the site, access points and easements, as well as maintenance clearances, historic or existing uses, and potential future uses were all pieces that needed to be understood and considered before proposing a final conceptual design. *Credit: SCAPE*

3 IDENTIFYING PARTNERS & FUNDING SOURCES

Strategic identification of partners and funding sources for a pocket prairie project can expand the pocket prairie's reach and effectiveness.

Credit: Jaime Gonzalez

When planning for and implementing pocket prairies and other nature-based solutions, partnerships are critical for cost sharing, division of labor, and leveraging and maximizing potential co-benefits that can result from collaborative work between different departments, agencies, and organizations. Additionally, public and private land ownership each present their own unique set of advantages and opportunities related to pocket prairie implementation. While this guidance document is heavily focused on publicly owned land, many pocket prairies have been implemented on private land in partnership with nonprofits and other community organizations that provide programming and other modes of support to ensure the success of a pocket prairie.

Projects may be funded through a combination of city and county general funds, state and federal grant programs, and philanthropic funds. Public financing methods like municipal bonds, and private financing opportunities and public-private partnerships (P3s) can also be considered options for funding GSI projects.[31] The multiple resilience benefits and co-benefits that pocket prairies and other nature-based solutions provide can help to unlock additional sources of funding and combine multiple sources of funding. For example, a project might be implemented with funding targeted for flood mitigation, public health, habitat restoration, and neighborhood revitalization, respectively. Partnerships across departments, agencies, and organizations can support creative project funding strategies.

NORA Pilot Rain Gardens
New Orleans, LA

The New Orleans Redevelopment Authority (NORA) works to comprehensively revitalize neighborhoods in New Orleans by partnering in affordable housing and commercial developments and supporting land stewardship and GSI projects. NORA's Pilot Rain Garden program, which transformed vacant properties into neighborhood amenities that capture stormwater, provides an example of how projects designed for multiple benefits can be funded through a range of sources. Key to success was aligning GSI with NORA's existing mission and work, including neighborhood stabilization and blight reduction. By designing pilot projects for multiple community benefits—water management as well as neighborhood revitalization—NORA was able implement projects with existing available funding sources, such as U.S. Department of Housing and Urban Development grants. *Credit: NORA*

4 DESIGNING SITES FOR SUSTAINABLE OUTCOMES

Developing designs for pocket prairies that provide resilience benefits, are feasible to maintain, and consider the local community can increase the longevity of a prospective pocket prairie.

Considering Site Needs & Existing Conditions to Guide Design

Designing pocket prairies that are built to last involves designing for resilience benefits, designing with sustainable management and maintenance practices in mind, and tailoring design to the local context of the site. This involves looking at historic habitat types within the site and their adjacency to waterways, soil type, and using historic images as evidence. To ensure designs are considering site needs and existing conditions, project team members involved in design can visit sites (with the landowner and manager if possible), take photos and notes, and ask questions to better understand the different variables associated with the site. These include but are not limited to: topography and hydrology of site, how people already use the site, how design can maintain familiarity and enhance their experience, and the site's current management and maintenance regimes (considering how new design could minimize the amount of extra labor required).

Understanding site needs and existing conditions can support the development of designs that are implementable and consider hydrologic systems and other infrastructure that the site already contains.

Respecting Neighborhood Context

Providing space for the community to have an active role in design encourages a sense of community pride and ownership over the new space that can in turn promote positive stewardship in the long-term.[32] Pocket prairies adjacent to trails, other recreation features, or open space that is used by the community may contain buffers between the pocket prairie and the utilized spaces that are more frequently mowed. This is normally done to maintain visibility, and also to ensure the community feels safe. The exact buffer size between the pocket prairie and regularly mowed grass can be discussed with the neighboring community and based on what the community and users are most comfortable with.

Consulting the surrounding community about their collective height tolerance for pocket prairie plants can help ensure that a new pocket prairie will be welcomed by people in the area. Often, engagement and design are not linear processes, and flexibility in both design and implementation can provide more space for community input throughout many phases of a project. The specific planting designs, implementation and establishment strategies, and management regimes will vary between sites based on their neighborhood contexts as much as their physical characteristics.

Urban Prairie at New Hope
Houston, TX

Before installing the Urban Prairie at New Hope, partners toured sites with similar characteristics to gain a better understanding of maintenance requirements, as well as potential benefits. *Credit: Yaneth Calderon*

5 ESTIMATING COSTS

The total costs associated with prairie implementation and ongoing management will differ depending on size, location, and a variety of other factors.

Whistlestop Prairie in Hermann Park, Credit: Jaime Gonzalez

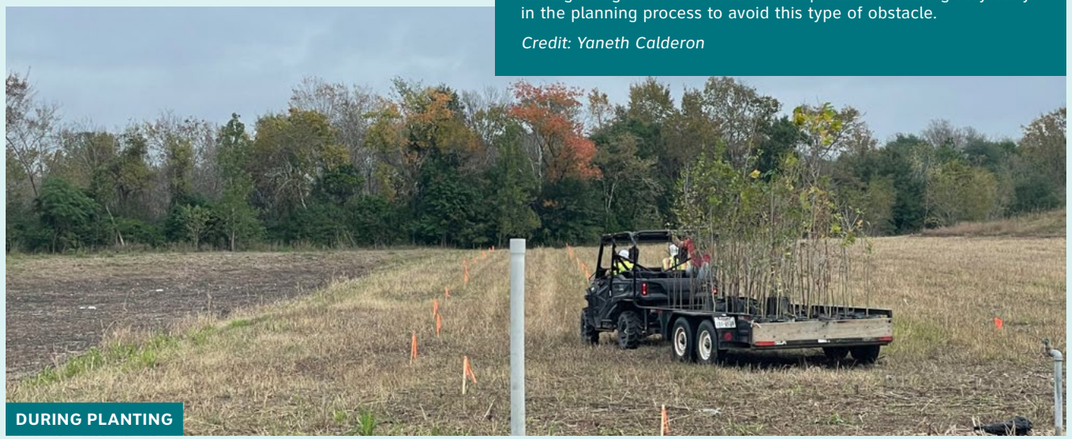
Estimating costs for a pocket prairie project involves estimating not only the costs of plants, seeds, herbicide, and other materials needed for installation and management, but also for unexpected costs. Some examples of unexpected costs include having to amend soil, move dirt, source plants or seeds from more expensive suppliers, or move or work around pre-existing structures in a park space. Costs also include interpretive signage and programming.

Because pocket prairies require a high level of maintenance within the first few years of planting, it is important to consider the cost of maintenance in any budget proposal related to pocket prairie implementation. A healthy pocket prairie budget usually accounts for at least the first 2–5 years of establishment and maintenance, and because of inflation and the fluctuating prices of materials, pocket prairie projects will always require unique cost estimates that consider the timing for implementation and other contextual factors like seed and planting types.

Estimating costs based on pre-existing, comparable projects and using generalized costs per unit of area (sq. ft, acre, etc.) can also support early iterations of a draft pocket prairie project budget. However, this method has a high level of uncertainty, and a proposed budget will require more detail as the planning phase evolves and more information is gathered. Cost estimate calculators tailored to the implementing organization and the places from which they source material and labor can also serve as a helpful foundation for estimating costs—though they require consistent updates (sometimes even monthly, or as soon as costs begin to shift significantly).

Urban Prairie at New Hope
Houston, TX

BEFORE PLANTING



DURING PLANTING

AFTER PLANTING

The pocket prairie at New Hope is planted in a detention basin, and therefore includes a gradient of plants from hydric plants in the basin, to erosion-prevention plants on the banks, to upland plants on the edges. This pocket prairie includes educational programming and is surrounded by many other complementary features such as a learning lab, pollinator garden, and composting infrastructure.

One major challenge related to planning and implementation of this pocket prairie involved the need for soil amendments before proceeding with any sort of installation. Due to its history as a salt dome and oil extraction site, the area had high salinity levels, heavy clays, and other contaminants. The soil was deficient in nutrients and the detention pond in the middle of the land also lacked topsoil, as it had been extracted for flood control purposes. Because of this, the soil required extensive treatment, which delayed installation and introduced a large, unexpected cost for this project's budget. Regardless, this pocket prairie has so far been a success, and is well received by the community. The project managers agree on the need to incorporate soil testing very early in the planning process to avoid this type of obstacle.

Credit: Yaneth Calderon

6 SITE PREPARATION & POCKET PRAIRIE INSTALLATION

It is important to understand and plan for the amount of resources, labor, and time it will take to prepare a site and install a pocket prairie early in the planning process.

Site preparation for a prospective pocket prairie will look different based on the site's existing conditions but will almost always involve preparing the seedbed to reduce weeds and create a suitable environments for the native seeds and plants that will eventually be installed. Because the first few years after a pocket prairie's installation are more labor intensive and require significant weeding, soliciting volunteer labor and getting the surrounding community involved can be cost effective and serve as a positive community-building activity.

Permitting is another piece of the site preparation process that requires time and resources, and is important to consider early in the design process. Basic permits for demolition, curbs, driveways, and other site infrastructures necessary to the site function will require permitting through the City of Houston's Permitting Center. If a pocket prairie is being utilized as a GSI feature for an adjacent structure or parking area, a catch basin or drainage area permit may be required. Potential site amenities associated with public pocket prairies—such as bus shelters, bicycle racks, or drinking fountains—may require permitting depending on their locations on the site and overall design. Additionally, grants for different remediation efforts may be available through the Houston Permitting Center for sites that qualify. Permitting processes may be different depending on land ownership. Resources and support for permitting are available through the Houston Permitting Center's website.[33]

Credit: City of Houston

Clinton Park
Houston, TX

Volunteer labor from the local community is both an opportunity to reduce the cost of prairie installation, and a chance to build community buy-in at a particular site. This photo shows volunteers supporting prairie installation at Clinton Park in Houston.
Credit: Houston Parks and Recreation Department

7 PLANNING FOR LONG-TERM MANAGEMENT & SUCCESS

Successful pocket prairies include plans for longer-term management that are both detailed and adaptive to allow for shifts in management as a pocket prairie evolves.

Understanding current management and maintenance regimes is an essential part of the planning and design process. Initiating communication with the managers of the site in question can ensure that all aspects of the site's maintenance regime are accounted for and will help the planner or implementer better understand the resources available and where supplemental resources might be necessary. Considering how new design could minimize the amount of extra labor required for a pocket prairie or other small-scale nature-based solutions can help planners and implementers avoid over-promising and developing designs that are ultimately not feasible.

Considering Scale

The size of the pocket prairie, its context, and its maintenance provider will inform the pocket prairie's management regime. While traditional remnant or restoration prairies can be burned as part of the management plan, pocket prairies will likely require mowing and weeding. Regular lawn mowers cannot be used to maintain pocket prairies without being properly cleaned first, as they can easily spread seeds from plants or weeds that will outcompete prairie plants. A successful prairie involves maintenance providers that understand and follow best practices for the management of smaller pocket prairie planting types—including developing adaptive management plans that replicate the seasonality of natural processes as best as possible.

Accounting for Early Management

Because the pocket prairie ecosystem is particularly delicate at its inception, specific precautions must be taken to ensure successful establishment. In the first 2–5 years of a pocket prairie's existence, it is especially prone to weeds and disruption or encroachment from non-prairie plants. Monitoring establishment during at least the first two growing seasons is critical. It is important that maintenance providers are able to identify and flag any non-native, invasive, or nuisance weed species for removal before they have the chance to establish and spread. If chemical controls such as herbicides are deemed necessary, certified professionals can apply them under proper conditions, and in as limited a manner as possible. When a mower is used on a non-prairie site or a pocket prairie site that has a lot of woody/invasive plant encroachment, it must be thoroughly cleaned before it is used to mow a pocket prairie to ensure that adverse seeds are not carried over into the pocket prairie ecosystem. Depending on the size and location of the pocket prairie, for the first few years, support from volunteers can cut down on high management costs associated with planting and weeding.

Establishing an Adaptive Management Plan

Because a prospective pocket prairie's location and surrounding ecology will inform its unique maintenance, management, and monitoring needs, an adaptive management plan is critical to incorporate into any pocket prairie implementation effort. Adaptive management plans (usually developed for a year-long cycle) may include but are not limited to the following: site inspections, vegetation surveys, plans to spray invasive species herbicide, seeding, planting, mowing, or grazing. Scheduling these different adaptive management strategies is most effective when the lifecycles of the plant species present are considered and the seasonality of natural management regimes are replicated as effectively as possible.[34]

Sylvan Rodriguez Park
Houston, TX

Sylvan Rodriguez Park is a restored prairie that is about 76 acres and includes additional features like prairie potholes. Though the prairie at Sylvan Rodriguez Park is not a pocket prairie, there are still many best practices that can be borrowed when planning for installation and management of a pocket prairie. HPARD manages Sylvan Rodriguez Park, but intentional relationships with volunteers—particularly from the local conservation community—during the seeding and early maintenance phases helped the department reduce the amount of labor needed to establish the prairie and pull up weeds until prairie plant species were able to dominate. *Credit: Houston Parks and Recreation Department*

8 MONITORING SITES & COMMUNICATING BENEFITS

When communities, partners, and funders are more informed about specific, quantifiable benefits, pocket prairie projects are more easily replicated in other neighborhoods with less skepticism and more enthusiasm and involvement.

Aligning Benefits With Community Needs and Funding Sources

Integrating landscape performance into the design process is becoming increasingly important. Evaluating landscape performance requires identifying performance objectives by investigating the project goal, the design intent, and the expected and unanticipated outcomes of the project. While the environmental performance objectives such as stormwater management and net zero goals are more frequently set and more straightforward to measure, "specific performance objectives are rarely set for social and economic outcomes."[35] On-site monitoring data, along with direct observation, user surveys, and interviews, can be utilized as primary sources for evaluating landscape performance. This data helps in understanding the impact of a landscape project more clearly by comparing performance before and after interventions, against benchmarks or accepted standards, or in relation to more conventional landscape design approaches.[36]

To assess potential benefits during project design, project teams can replicate the analysis methods described on pages 21–22 to categorize and group similar types of spaces in order to better understand their unique needs, and use comparable scoring across data inputs to more systematically consider approaches to their solutions. For more information about how to apply clustering and scoring analyses that were used to prioritize pilot sites for this study to maximize resilience benefits, see *Houston Pocket Prairies: Site and Benefit Evaluation.*

Monitoring and communicating tangible, quantifiable benefits to the public—specifically the communities surrounding the pocket prairie—is important to help build understanding about the ways in which pocket prairies can yield multiple benefits (e.g., gallons of water detained, number of sightings for a species, amount of heat reduced in a certain area, increased trail usage via trail user counts). Monitoring and communicating benefits can also be critical for reporting on federal grants that were used for pocket prairie implementation and can help support additional federal grant applications related to pocket prairie planning, design, or implementation. Robust monitoring data and proven benefits can help make the case for additional funding requests (whether federal, state, or local). Thermal cameras are an example of a type of instrument that can be used to support monitoring.

Facilitating Community Science

Community science can benefit both the residents conducting the science and the pocket prairie itself. Providing community members and visitors with an organized structure needed to facilitate community science—for example, collecting and reporting observational data on number of species, plant growth, etc., can support education for interested community members; including both adults and young people.

Gulfton Bus Shelter
Houston, TX

The Gulfton neighborhood in Houston—a neighborhood that is significantly warmer than the coolest parts of Harris County—contains several busy, paved roads that retain heat, and very few trees. To address heat issues in Gulfton, stakeholders, residents, non-profits, and government agencies came together to design interventions that included the addition of native plants and modular shade structures to bus stops, among other projects. *Rendering of Bus Shelter Green Roof for Greener Gulfton Plan, Credit: Ultrabarrio*

9 DEVELOPING POCKET PRAIRIE IDENTITY ACROSS SITES

Building buy-in, providing access and education, and creating opportunities for a pocket prairie's visibility promotes positive connections between pocket prairies and surrounding communities, and may lead to a sense of ownership among the pocket prairie's neighbors and visitors.

Building Buy-In

Often, successful implementation and longevity of a pocket prairie is dependent on its visibility and neighborhood buy-in. Though maintenance is often organized by the implementing agency/organization, the level of buy-in within the surrounding neighborhood can impact whether a pocket prairie thrives over time, and the level of benefit it provides to the community.

A bioswale with prairie plantings implemented and maintained by HCFCD in the Brenwood neighborhood of Harris County has become part of the neighborhood's identity and has provided multiple benefits to residents that walk along the trail adjacent to the feature.

Providing Access & Education

Pocket prairies can provide multiple benefits to a community, and these benefits can be more easily realized when access and education are part of the planning process rather than an afterthought. Ensuring access to transit and early formation of partnerships with local education organizations can expand the reach of a pocket prairie; helping to achieve multiple benefits. Local education organizations can use the space surrounding a pocket prairie to instruct on local history, ecology, social science, and more. The Native Plant Society of Texas even has curriculum resources that include pocket prairie gardening activities and lessons.[38]

Creating Visibility

Despite their multiple benefits, when context is not provided to communities that are unfamiliar with pocket prairie functions, residents can be skeptical of their benefits. Local Houston prairie experts have noted from experience that pocket prairies are most welcomed and successful when the implementers ensure that: 1) the pocket prairie is distinguishable (i.e., it has a memorable name, educational or interpretive signage, etc.), and 2) the connection between the new pocket prairie and Houston's historical native prairie landscapes and culture is clearly made.

Strategic signage with educational components can increase visibility, and also serve as an important marker for a pocket prairie throughout times of the year that it is mowed and its flowering plants are not in bloom. According to "Here in Houston," the environmental education resource hub created in 2016, interpretive signs are most effective when they are colorful, concise, and memorable.[39] In terms of choosing which information to include in pocket prairie signage, this is highly dependent on the type of message the pocket prairie implementer wants to communicate to neighbors and visitors. "Here in Houston" notes that there are many different messages that different community members respond to—for example: how pocket prairies support wildlife, how they are historically connected to ancient prairies, how pocket prairies provide resilience benefits like stormwater retention, or the fact that there is already an entire network of pocket prairies and larger remnant and restoration prairies around Houston.

Jefferson Prairie
Houston, TX

Jefferson Early Learning Center, a 1.8-acre pocket prairie owned and operated by the Alief Independent School District, is an educational landscape at an urban preschool. Located in an area where many students and community members do not have easy access to nature, the design of this landscape is inspired by Houston's traditional native prairies and incorporates nature-based learning programming and bioswales for collecting, storing, and filtering the site's stormwater runoff. *Credit: PBK/Wade Griffiths*

HCFCD Brenwood Bioswale Site
Houston, TX

After noticing that a dirt trail alongside the bioswale with native plantings was frequently used, the neighborhood's Municipal Utility District (MUD) President worked with neighbors to install a more permanent trail feature and outdoor exercise equipment to encourage continued use of the area surrounding the feature. Instead of solely providing stormwater retention, heat mitigation, and habitat connectivity benefits, this pocket prairie is now also associated with recreation and other social benefits. *Credit: Harris County Flood Control District*

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