



Living Infrastructure Design Guidance Project Update

May 6, 2026





Introduction



Project Background & Approach

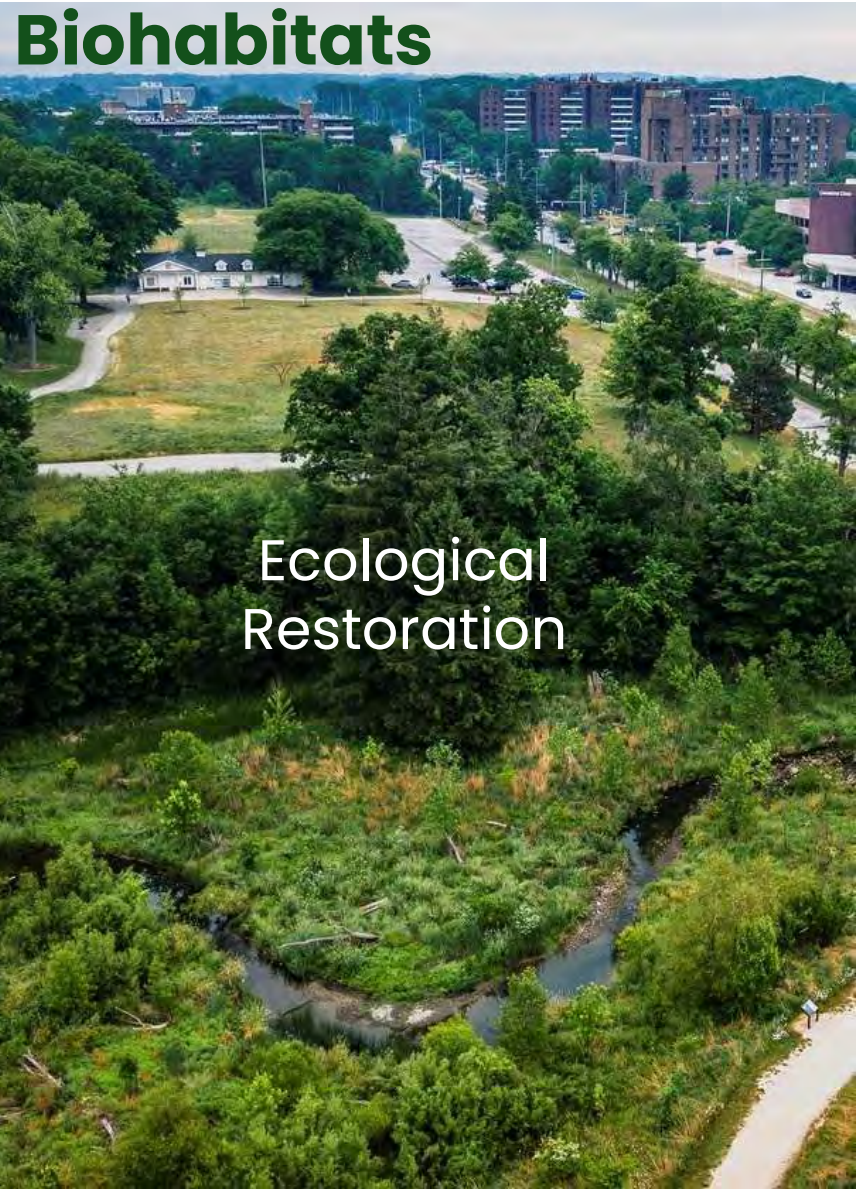


Design Guidance Overview



Discussion & Feedback

Biohabitats



Ecological
Restoration



Conservation



Climate
Adaption &
Resilience



Resilient
Water
Systems



Ecomimicry

Biohabitats

Biohabitats Core Team



Claudia Browne
PM/Water Resource Specialist



Susan Sherrod, PhD
Senior Ecologist/Technical Advisor



Mike Lighthiser, P.E.
Principal Engineer



Sydney Salzwedel
Water Resource Engineer

Biohabitats Technical Support



Bryan Arvai
Stormwater Engineer



Aiman Duckworth
Sr. Urban Ecologist &
Landscape Architect



Caroline Hildebrand
Ecologist/Researcher



Hanna Harper
GIS Specialist/Data Support

Project Purpose & Scope

Develop a Living Infrastructure **Framework & Ecological Guidelines for Development** for the 770-acre University District.

- ***Discovery***: Site assessment & analysis.
- ***Living Infrastructure Framework***: Conceptual water flow paths and priorities for green stormwater infrastructure & ecological enhancements.
- ***Ecological Design Guidelines***: Focused on nature-based solutions for biodiversity, green infrastructure, and adaptability to climate stress.

PROJECT BACKGROUND & PROCESS



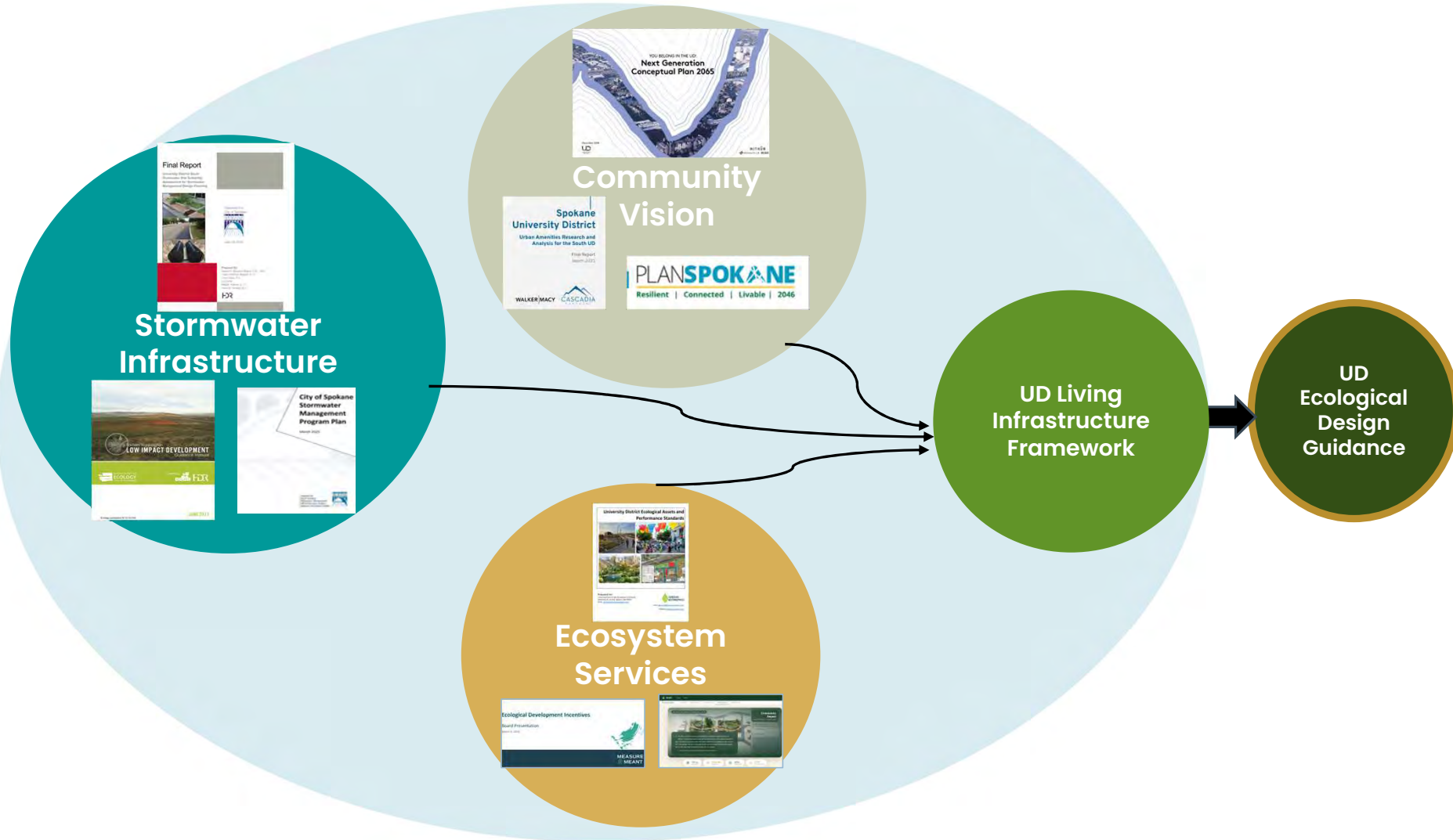
U Vision

"A thriving and sustainable hub of innovation, environmental health, and community activity."

U Vision 2044 Strategic Priority Plan (2023)



From Planning to Implementation Guidance



Living Infrastructure

A strategically planned and **managed network** of working landscapes, natural lands, and waterways at multiple scales that

- **conserve** ecosystem functions,
- **restore** ecosystem processes, &
- **regenerate** healthy, robust & **resilient** communities.

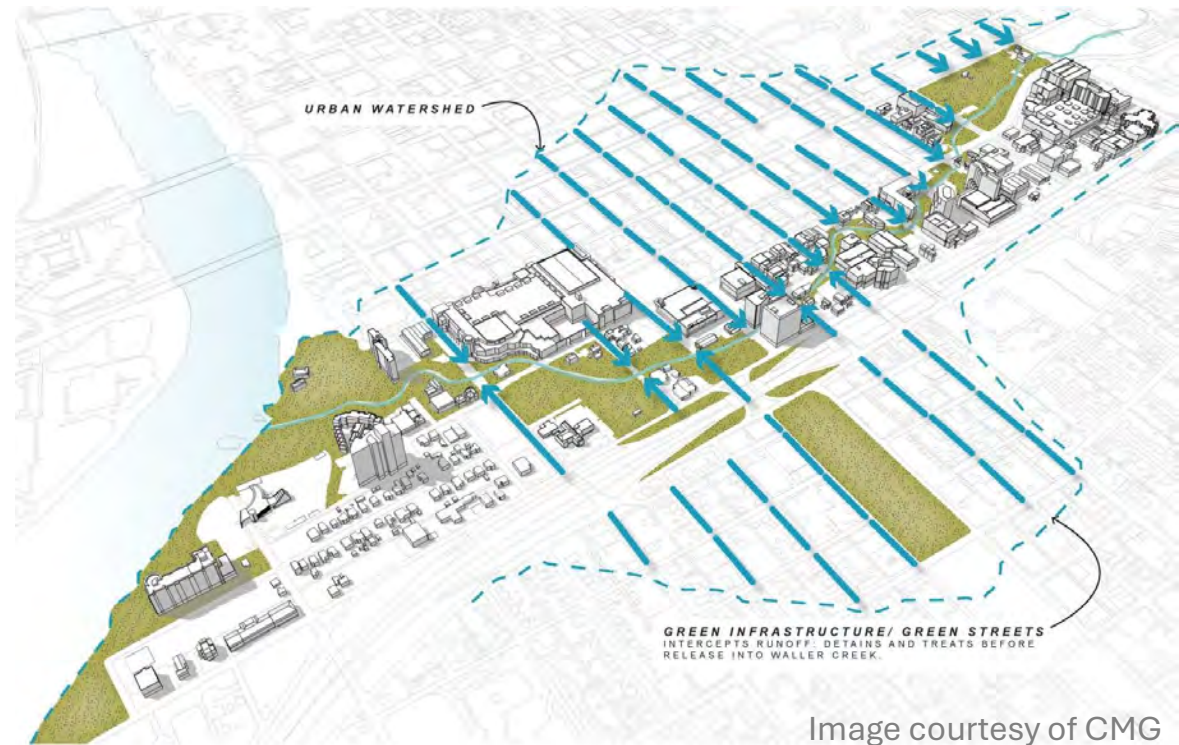
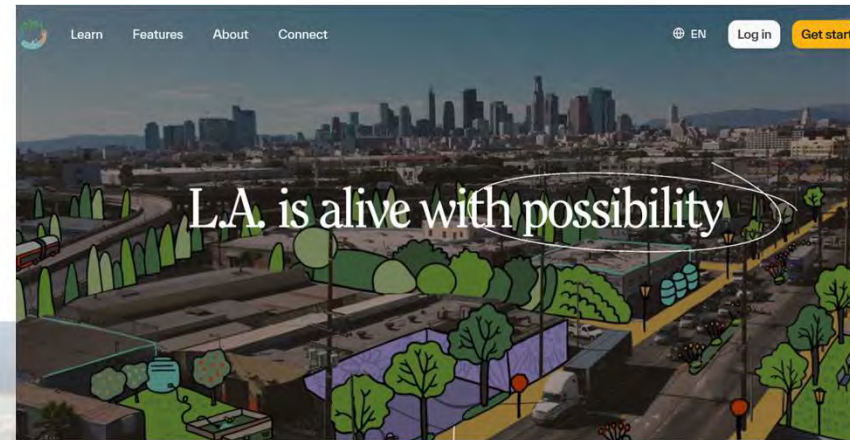


Image courtesy of CMG

Living Infrastructure Examples

Los Angeles created livinginfrastructure.org



HONOR PLACE GROW PARTICIPATION EMBODY JUSTICE FOSTER RESILIENCE REGENERATE LIFE

What is living infrastructure?

Article • 11 min read • 10.21.2024

A framework for climate-resilient communities

Living Infrastructure Examples



Wild Mile Chicago

The World's First Ever Floating Eco-Park

Chicago's Floating Wetlands



**Denver City Center
Pollinator Garden**



Denver's 16th Street Revival: The city's iconic landmark reawakens the art of public life and sets a new standard for green infrastructure.

Living Infrastructure Examples

 ResilienCity Park



Common Ground for People and Water

Living Infrastructure Benefits

Economic, Health & Safety Benefits of Investing in Nature

“Local public park and recreation agencies enrich community life while generating \$201 billion in economic activity and supporting 11 million jobs every year”

“Spending on conservation has strong return on investment... from 4:1 nationally (\$4 returned in natural services such as clean water and flood control for every 1\$ invested) to 1:1...”

NATURE'S DIVIDENDS:



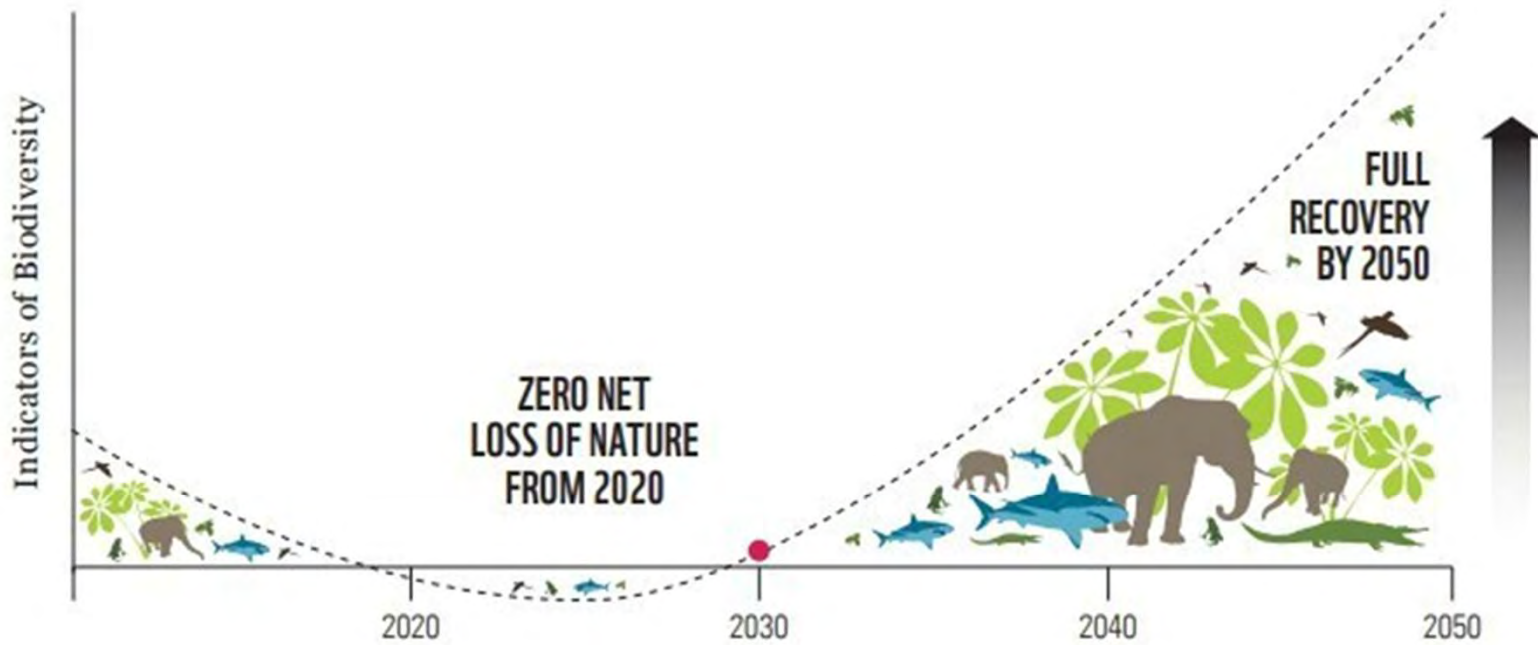
[Nature's Dividends: The Economic, Health, and Safety Benefits in Nature](#) (The Nature Conservancy, 2026)

Nature-Positive

30x30: REVERSE BY 2030 / RESILIENT BIOSPHERE BY 2050

Figure 23: Nature Positive by 2030

A measurable global goal for nature. Source: Locke et al. (2021)⁹⁹³.



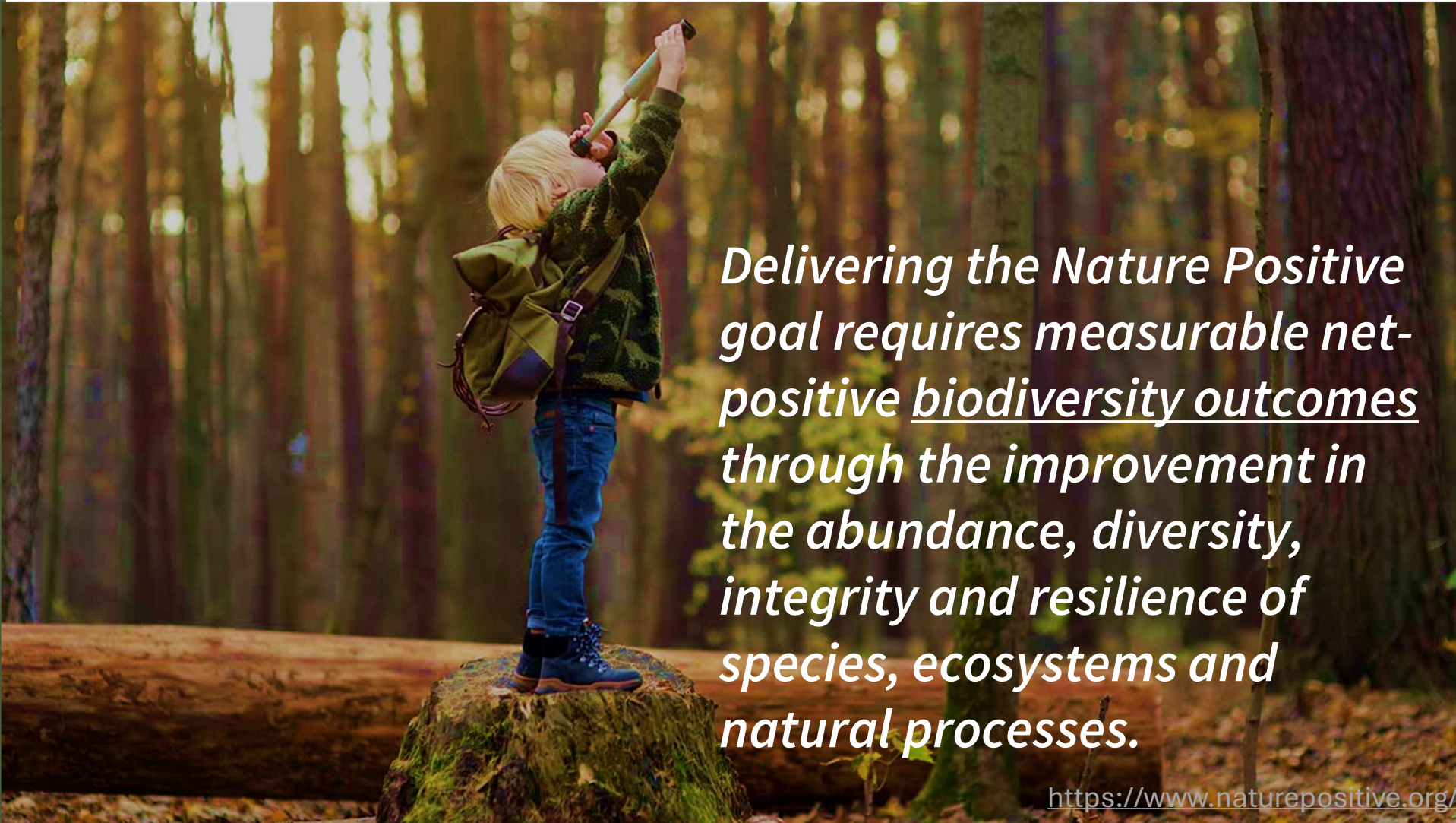
<https://www.naturepositive.org/The-Definition-of-Nature-Positive.pdf>

Nature Positive Outcomes

Background

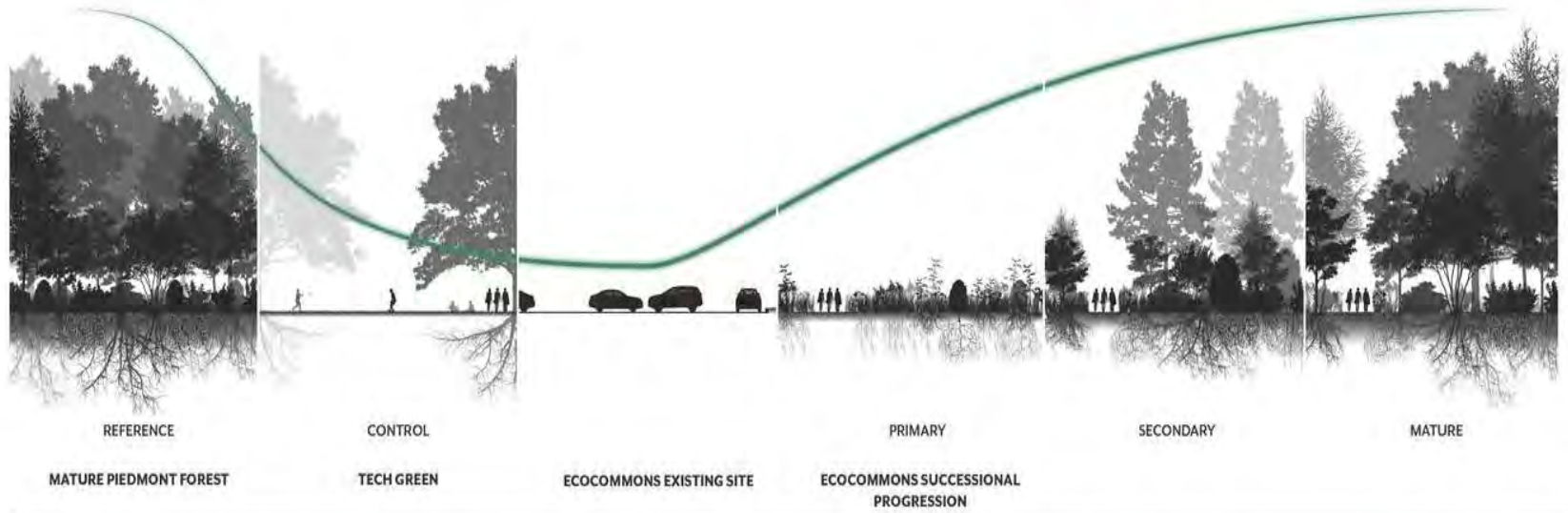
Delivering the Nature Positive goal requires measurable net-positive biodiversity outcomes through the improvement in the abundance, diversity, integrity and resilience of species, ecosystems and natural processes.

<https://www.naturepositive.org/>



Changes Through Time

Georgia Tech EcoCommons
Atlanta, GA, Biohabitats



| | REFERENCE MATURE PIEDMONT FOREST | CONTROL TECH GREEN | ECOCOMMONS EXISTING SITE | ECOCOMMONS SUCCESSIONAL PROGRESSION | SECONDARY | MATURE |
|--------------------------------|-------------------------------------|-----------------------|--------------------------|--|--------------------|--------------------|
| CARBON STORAGE + SEQUESTRATION | ████████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ |
| POLLINATORS | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ |
| BIODIVERSITY | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ |
| HEAT ISLAND | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ |
| FILTERING AIR POLLUTION | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ |
| FILTERING WATER | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ |
| AVOIDED RUNOFF | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ |
| RESPIRE | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ |
| MENTAL RESTORATION | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ | ██████████████████ |

Image courtesy of: Nelson Byrd Woltz Landscape Architects

Remnant Landscapes in the UD

Prairie
Native, historic



Riparian buffer

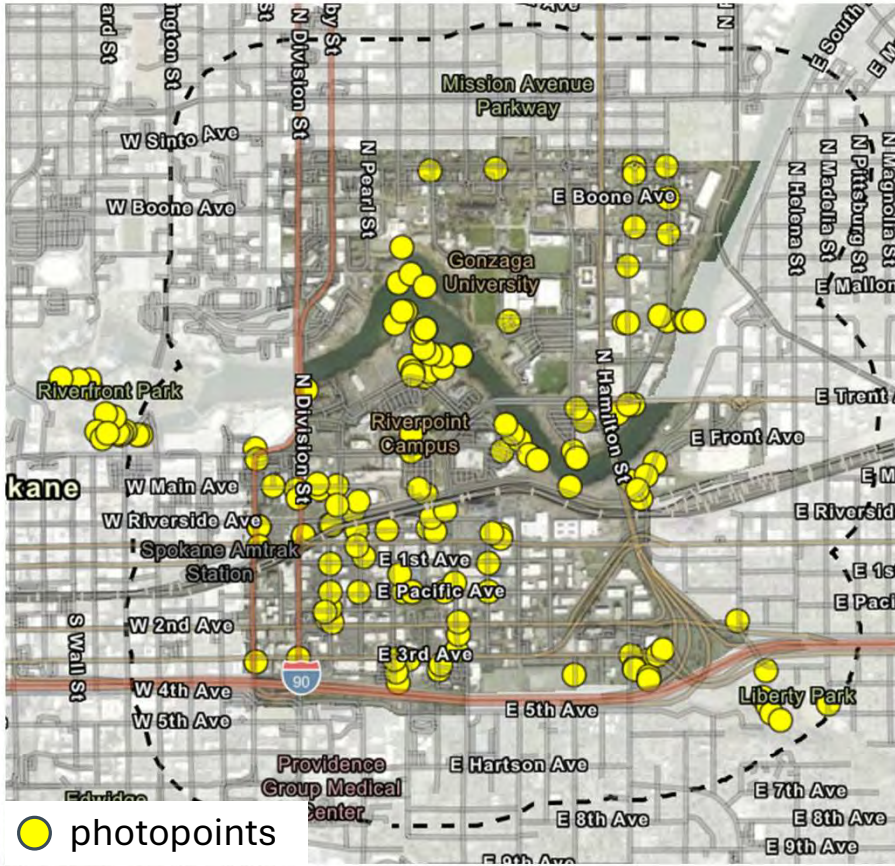


Images courtesy of High Line Canal Conservancy

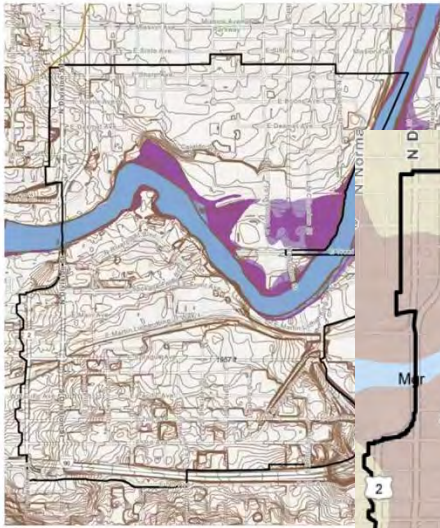
Industrialization/Urbanized
(1946)



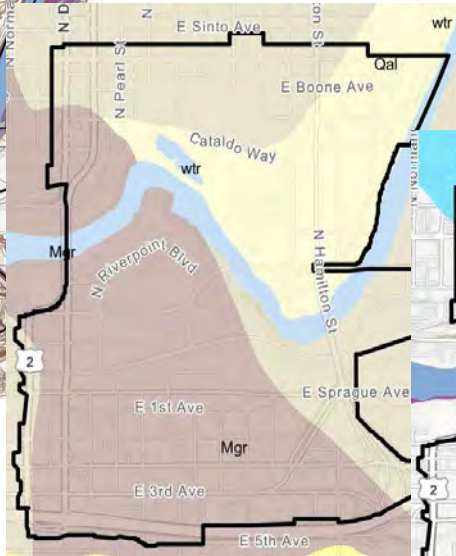
Existing conditions analysis



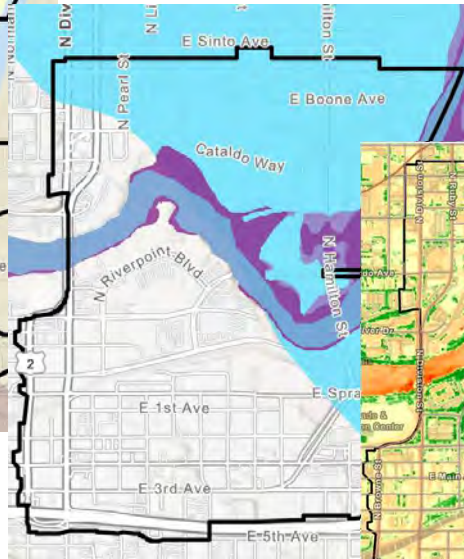
Existing conditions analysis



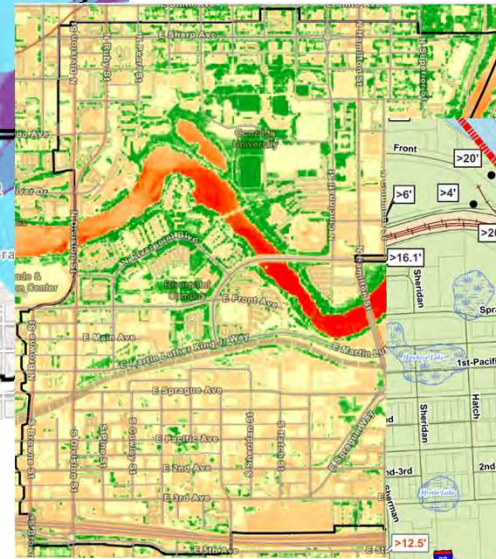
Topography



Geology



Aquifer & Floodplain



Vegetation & Habitat

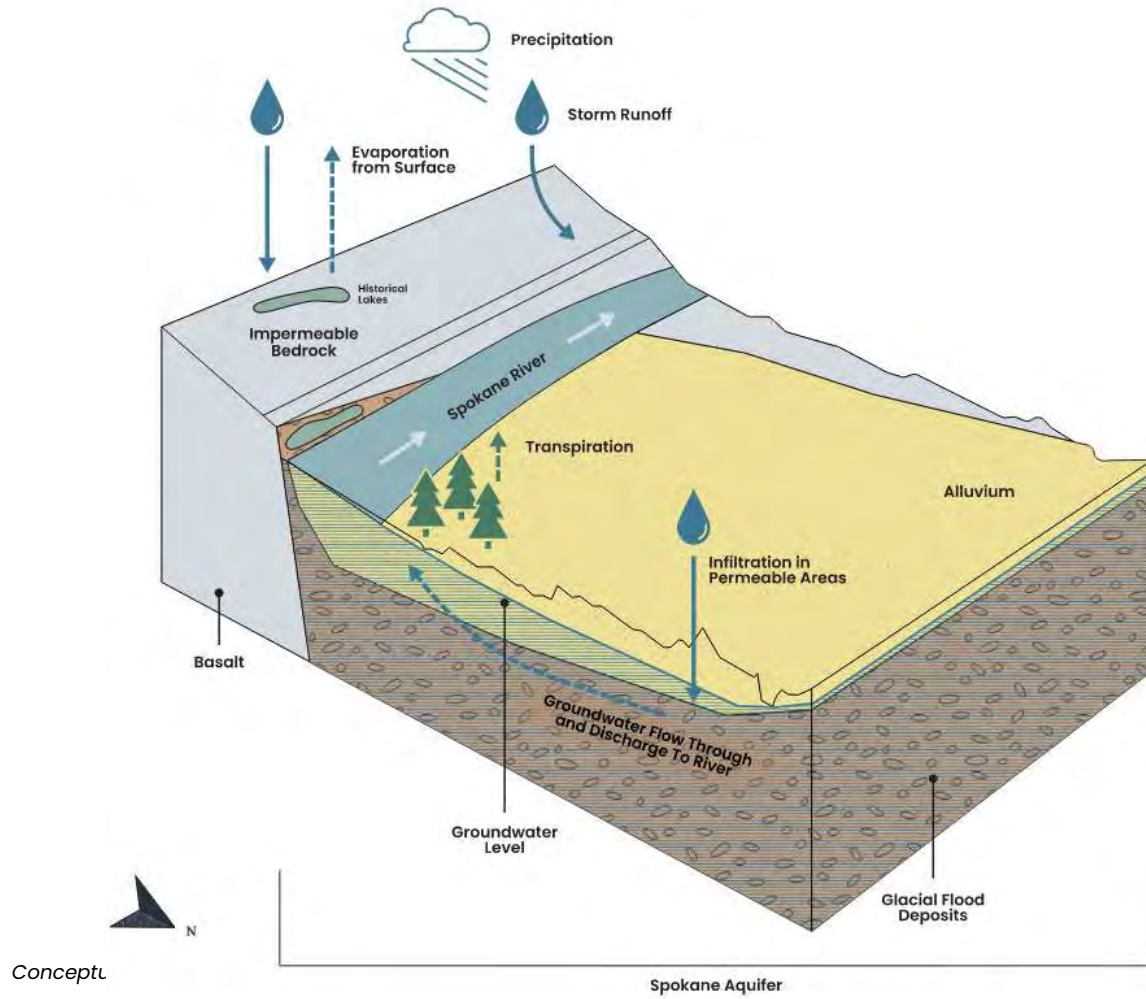


Historic lakes

Hydrogeologic zones



Water flow paths: surface water/groundwater system

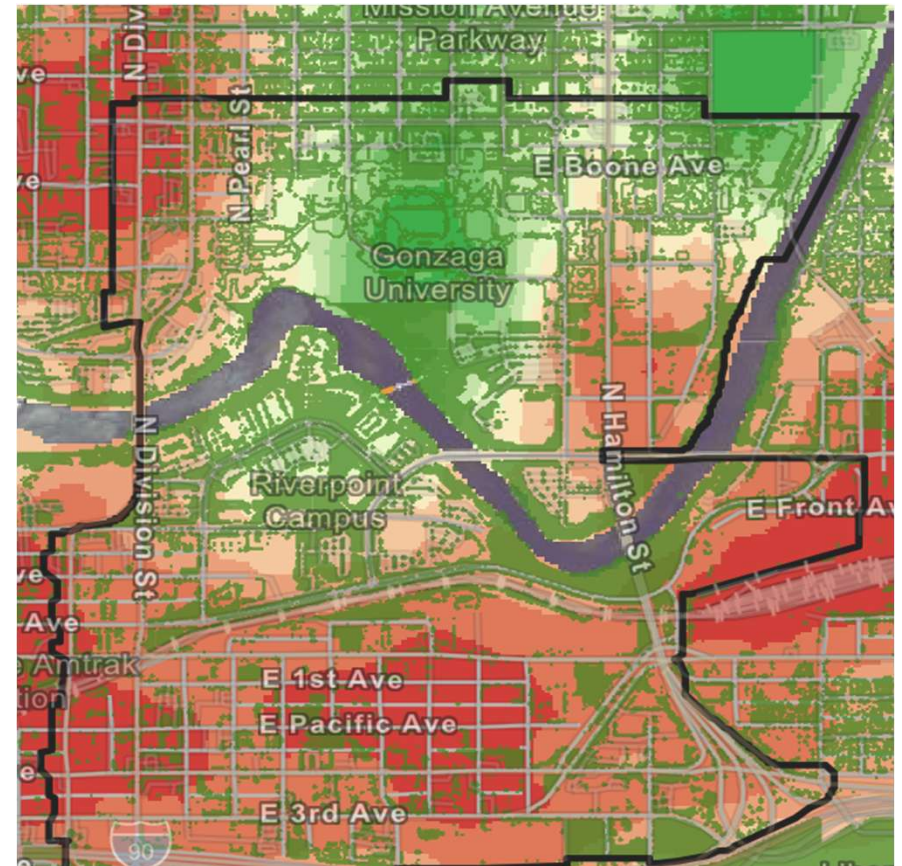


Wildlife habitat & pollinator forage

- Native bees used to help characterize habitat value
- Map of forage density (greenness) provides measure of habitat opportunities & needs

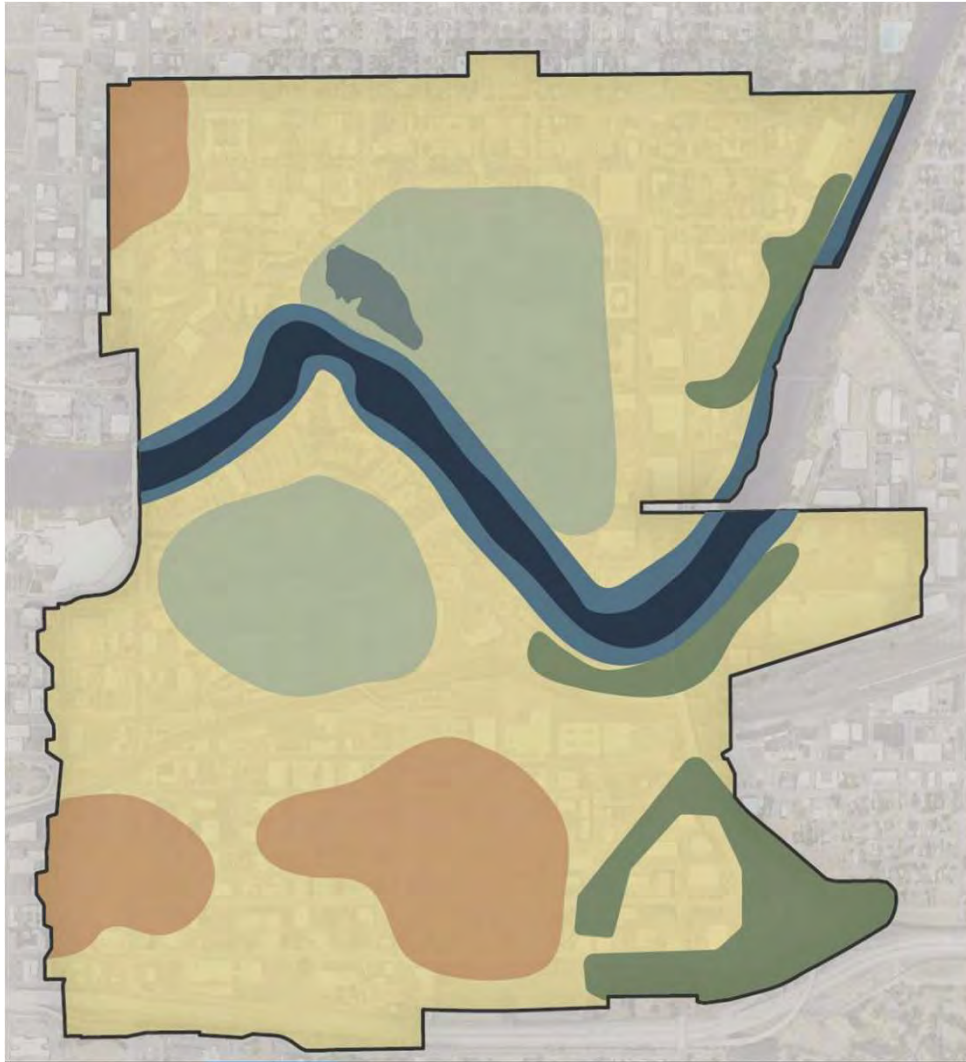


Short-range bees (Halictid):
medium sized, specialists, **250m distance**



Potential pollinator forage heat map. Green indicates denser opportunities, while red indicates little or no opportunities.

Framework: Potential Ecological Priority Areas (draft)



-  Restore areas of pollinator forage opportunities = Wildflowers, grasses, shrubs, & trees
-  Improve riparian & river health = Riparian forest buffer creation
-  Creates green street corridors = GSI, shade canopy enhancements, low maintenance landscape
-  Create connected open spaces (UD goal of 30%)
-  Increase biodiversity with green neighbor partners = Turf transformations, GSI, canopy support

Framework: Plant Community Opportunities

Gravel & Crevice Gardens



Prairie & Shrub Steppe



Pollinator Gardens



Riparian & Wetland



Ponderosa Pines



Urban Forest



| | Gravel & Crevice Gardens | Prairie & Shrub Steppe | Pollinator Gardens | Riparian & Wetland | Ponderosa Pines | Urban Forest |
|-----------------------------------|--------------------------|------------------------|--------------------|--------------------|-----------------|--------------|
| Moisture Needs | | | | | | |
| Trees/Temperature Regulation | | | | | | |
| Stormwater Management | | | | | | |
| Biodiversity (flora, fauna, soil) | | | | | | |
| Carbon Sequestration | | | | | | |
| Pollination | | | | | | |
| Maintenance | | | | | | |

A photograph of a lush garden with tall grasses and a building in the background. The scene is brightly lit, suggesting a sunny day. The grasses are a mix of green and yellow, indicating they might be in a transitional season. The building in the background has a dark facade and several windows. The overall atmosphere is serene and natural.

DESIGN GUIDANCE OVERVIEW

Landscape Typology Examples

Purdue Sustainable SW Plan- Kit of Parts

| | |
|--|--|
| BUILDING ENTRIES | Key building arrival areas highlighted by paving, accent planting, and seating areas. |
| BUILDING YARDS AND FOUNDATIONS | Landscape spaces at base of buildings and extending out to streets or other campus spaces. These spaces are passive in function and simple in landscape treatment. |
| BUILDING ROOFS | Impervious cover that offers an opportunity to extend campus landscape to upper levels and collect stormwater runoff. |
| BACK OF HOUSE/SERVICE | Loading docks and service drives internal to campus which require adequate screening, signage, and pedestrian accommodation. |
| SURFACE PARKING LOTS | Paved parking lots which require adequate planting to provide shade and manage stormwater. |
| STREETS | Multi-modal corridors that provide access to buildings and spaces, primarily characterized as including street trees and accent plantings or lawn. |
| INTERCOLLEGIATE ATHLETICS | Campus space which is reserved for Intercollegiate Athletics and/or Recreational Sports purposes. |
| RECREATION & INTRAMURAL ATHLETICS | Large scale, active open spaces that serve recreational purposes. Lawn and accent tree plantings are the dominant landscape elements. |
| GREEN BELT | Wooded and natural landscape buffer on the University's south and west edges against US-231. |
| RIPARIAN | Stream corridors that collect and convey stormwater. |



NEIL ARMSTRONG HALL OF ENGINEERING
(front entry yard and foundation)

Photo Credit: Purdue Marketing + Communications

| | |
|--|---|
| BUILDING ENTRIES <ul style="list-style-type: none"> Hovde Hall France Cordova Recreational Sports Center Armstrong Hall |    |
| BUILDING YARDS & FOUNDATIONS <ul style="list-style-type: none"> Purdue Memorial Union Cary Residence Hall Hillenbrand & Harrison Residence Halls |    |
| BUILDING ROOFS <ul style="list-style-type: none"> Horticulture building Windsor Residence Hall Owen Residence Hall |    |
| BACK OF HOUSE/SERVICE <ul style="list-style-type: none"> Tarkington & Wiley Halls Whistler Hall, Agriculture Administration, & Forestry building |   |
| SURFACE PARKING LOTS <ul style="list-style-type: none"> Ross-Ade Stadium south lot France Cordova Recreational Sports Center Discovery Park lot |    |
| STREETS <ul style="list-style-type: none"> Martin Jischke Drive Waldron Street 3rd Street |    |
| INTERCOLLEGIATE ATHLETICS <ul style="list-style-type: none"> Lambert, Mackey, Ross-Ade Rankin Track Northwest Athletics Complex |    |
| RECREATION & INTRAMURAL ATHLETICS <ul style="list-style-type: none"> Intramural Gold playing fields Intramural Black playing fields |   |
| GREEN BELT <ul style="list-style-type: none"> US 231 |  |
| RIPARIAN <ul style="list-style-type: none"> Todd's Creek at Horticulture Park Todd's Creek at Pickett Park Todd's Creek at golf course |    |

Landscape Typology Examples

SITE TYPES

- Brownfields and Recovered Sites
- Restoration Areas
- Waterfronts
- Passive Landscapes
- Active Recreation Areas
- Playgrounds
- Pocket Parks & Plazas
- Streetscapes
- Parks Over Structures

NYC High Performance Landscapes




Aligning Typologies with Existing UD Plans & Eastern WA Guidance

| |
|---|
| <p>BMP Name Bioretention</p>  <p>Picture Source: City of Spokane</p> |
| <p>BMP Name Bio-Infiltration: Vegetated</p>  <p>Picture Source: Aimee Navickis-Brasch</p> |

HDR



Next Gen Plan: UD Climate Resilience & Nature-based Strategies (Mithun)



CHAPTER 4: LID BMPs

- 4.1 Introduction
- 4.2 Amending Construction Site Soils
- 4.3 Dispersion
- 4.4 Bioretention
- 4.5 Trees
- 4.6 Permeable Pavement
- 4.7 Vegetated Roofs
- 4.8 Minimal Excavation Foundations
- 4.9 Rain Water Harvesting

Eastern WA LID

Ecological Design Typologies-draft

| Ecological Design Guide Typologies* | Living Infrastructure Objectives | | |
|---|----------------------------------|--------------------------------|--------------|
| | Cooling | Water Connectivity and Quality | Biodiversity |
| Streetscape Greenways (Street Tree Canopy) | | | |
| Bioretention & Bioinfiltration (Blue-green stormwater) | | | |
| Resilient Parks & Open Space (Clean Water Parks) | | | |
| Biodiverse Riverfront (Urban Forest) | | | |
| Pollinator Pockets (Rainwater Harvesting) | | | |
| Shoreline & Edge Wetlands (Future) | | | |

*Related nature-based strategies (Next Generation Plan)

Ecological Guidance Template

1. Purpose
2. Ecological & Well-Being Benefits
3. Ecological Design Elements & Considerations
4. Context & Site Analysis
5. Maintenance & Adaptive Mgmt Considerations
6. Additional Resources

Streetscape Greenways

Create habitat and shade along sidewalks and streets through well-designed planting

Purpose

Landscaping enhancements along streets, such as tree beds and vegetated swales, provide relief from extensive paving and urban heat. Green streetscapes also create habitat opportunities for plants, pollinators, and birds in a cityscape.

Ecological & Well-Being Benefits

- Habitat corridors improve green network connectivity
- Support for native & climate-adapted vegetation
- High-functioning soils
- Capture airborne & possibly waterborne pollutants
- Mitigate heat islands
- Dampen street noise
- Outdoor seating along the street
- Can calm traffic
- Can separate bike and car lanes
- Improved aesthetic can support local businesses and increase property value

Ecological Design Elements & Considerations

Streetscape greenways are created by planting areas between the sidewalk and the street or in the median. The plant communities can vary based how much water they receive, design goals, and other factors, and may include drought-tolerant pollinator gardens, multi-layered tree beds, and herbaceous swales. These greenways can also combine purposes, such as with

bioretention and bioinfiltration (see fact sheet), especially if the street is crowned.



Depressed median for stormwater treatment (Bernalillo County [NM] Technical Standards App. A, 2022)

The major features of a streetscape greenway are curbs at least 6" high for traffic protection, underlying materials that allow drainage, and large enough planting areas to support above- and belowground plant growth.

Soil. Soil quality should have good horticultural qualities (pH, organic matter, nutrients, texture, etc.). Soils should be tested before planting to ensure they can support an installed plant community.

Soil should be at least 18" deep for herbaceous species and shrubs and at least 24" deep for trees. More rooting volume is generally better, especially for trees. Soil volume can be increased by increasing curb height, excavation, or using suspended pavement, e.g., Silva cells. These engineered pavements meet street load requirements

and sometimes can create more rooting volume than excavation. Additional benefits of suspended pavement are that it can help with stormwater capture (if desired), and tree roots won't cause sidewalk heaving.

Plant Selection & Habitat Types. Plants with appropriate mature heights and widths should be used, and laid out in consideration of pedestrian safety and driver views. Utility lines need to be considered for tree height, and if green streetscapes are to receive snowmelt, salt-tolerant species should be selected. See [attached] plant list for appropriate species.

Trees should share space with other trees and plants. Individual tree pits are not recommended, as these are low-biodiversity, stressful for the trees, and relatively high maintenance.

In addition to pollinator gardens, multi-layered mini-forests, and herbaceous swales, plant communities can be designed for other goals such as sensory experiences, nutrient uptake, and education.

Context & Site Analysis

Street crossings can serve dual purpose as curb cuts.

(See also excerpts on siting from local HDR study¹ in Attachment 1.)

Retrofit Assessments. Streets that are best candidates for retrofitting to have greenways include:

- Overly wide streets or needing a "road diet"
- In areas where biophilic opportunities are limited
- Connections between green spaces
- Roundabout centers can be a habitat stepping stone between greenways

Existing trees and their surrounding soils should be preserved if streetscape construction is a retrofit.

Sizing. Street greenways need to be deep and wide enough to ensure that the plant community grows and thrives, at least 3 feet. Length of the greenway is limited by site constraints (e.g., crossroads, crosswalks, other infrastructure) and maintenance resources. |

Maintenance Considerations

Planting adjacent to or in a road is challenging for vegetation and managers. These areas are hot and stressed by pollution, salt, and possibly foot traffic and dog waste. They also collect litter.

Irrigation is necessary for plant establishment, and the continued growth of those that are not drought-tolerant. Assume a 2-year establishment period for herbaceous species, 3-5 years for shrubs, and 5 or more years for trees. Irrigation should be programmed according to stormwater inputs and/or soil moisture, according to the needs of each planting.

WATERFRONTS



New York is surrounded by water bodies, and piers and wharfs for shipping, fishing, and boat building were once the city's connections to the world. As the city developed, the waterfront was converted to industrial uses and highways; gradually New Yorkers were cut off from the shorelines, the waters, and the adventures of the sea.

Today New York City is redefining its relationship to waterfronts, as evidenced by a wave of waterfront parks, greenways, ferries, kayak launches, marinas, and even residential development. Waterfront parks offer a tremendous opportunity for people to experience panoramic views to the horizon, the smell of salt water, the sound of waves. They can wade, fish, paddle, board, or launch a vessel.

At the same time these uses need to be balanced with the preservation of natural shorelines, wetlands, and scenic beauty. New York City's 1982 Waterfront Revitalization Program addressed the need for balance by establishing goals for protecting coastal ecological systems, providing water access, improving water quality, preventing flooding and erosion, and

enhancing scenic, historical, and cultural resources.⁶ This plan included a range of waterfront edge conditions, from restored planted and sloped edges to engineered bulkhead walls, all serving different functions and meeting different needs. Designers need to address both the public and ecological needs of waterfronts, looking for synergistic opportunities such as waterfront structures that improve marine habitat.

PRIORITY CONSIDERATIONS

REVIEW PRIOR PLANS, INITIATIVES, AND REGULATIONS

- Review existing master plans that may have defined uses, connections, materials or conventions.
- Review 197-a plans and research community initiatives. Waterfronts should address the concerns of the neighborhood and express the identities of the neighborhoods they pass through.

- Review regulations that control waterfront development, including those of the Department of Environmental Conservation, the New York Department of State, and the US Army Corps of Engineers.

SOFTEN WATER EDGES

Natural shoreline edges can promote flood mitigation, provide marine habitat, and improve water quality.

- Where possible, remove bulkhead edges and pull back shorelines with shallow grading to create diverse shoreline habitats.
- In areas with limited space, consider creating wetlands along the waterside of bulkheads.

DESIGN FOR CONTINUITY BETWEEN MULTIPLE WATERFRONT PARKS

Linear waterfront parks can be used to provide continuous paths for bicycles and pedestrians.

- Research greenway plans, look for opportunities to connect greenway paths, and make connections to adjacent neighborhoods.
- Be wary of creating conflicts with pedestrians.
- Keep commuting or high speed bikes separated from pedestrian paths.
- Use consistent signage along multiple parks to guide users.

EXPLORE SURROUNDING AREAS FOR VEGETATION MOVEMENT OPPORTUNITIES OR CONCERNS

Linked parks provide connectivity for plant species to spread seed and for insects and birds to travel. However, this can be both problematic and beneficial, as both desirable and undesirable species can spread.

- Encourage native species to migrate to new areas by mimicking the conditions of successfully established habitat nearby.
- Create barriers for the spread of invasive species.
- Minimize site disturbance adjacent to invasive species, to discourage their spread.

ENHANCE HABITAT OPPORTUNITIES

- Connect with other patches of habitat whenever possible, prioritizing areas adjacent to existing habitat for expansion.
- For river corridors, consider enhancing conditions that encourage fish migration.
- Selectively remove overhead cover.
- Remove upstream migration blockages; provide mitigation such as fish ladders.
- Provide vegetation along water edges for fish protection from predators.
- In linear parks organized around water, consider watershed impacts.



The design for Harlem River Greenway replaced collapsing steel sheeting with porous edges (including gabion baskets filled with oyster shells) to help clean the river water, restore floodplain functions, improve near-shore habitat and allow a safer approach to Manhattan by kayak.

- Design for higher peak flows in areas where upstream development causes increased runoff.
- Increase planting areas that can capture stormwater.
- Design water edges that can withstand heavy flows and absorb and slow runoff.

COMPLY WITH THE WATERFRONT REVITALIZATION PROGRAM AND COASTAL MANAGEMENT PROGRAM POLICIES

- Restore underutilized areas.
- Maximize water-dependent and recreational uses.
- Minimize damage from flooding and erosion, focusing on nonstructural technologies.
- Implement nonstructural measures.
- Maximize the extent of natural resources.
- Adhere to water quality standards and avoid the discharge of hazardous substances into coastal waters.
- Promote compatible land uses with surrounding properties.
- Avoid impacts to navigable waters.

© City of New York Department of City Planning Waterfront Revitalization Program, <http://home2.nyc.gov/html/dcp/html/wfrp/wrp.shtml>

Plant list & example layouts

Figure 24. Example plant palette and layout for Native Prairie/Shrub Steppe.

Shrubs: Big sagebrush, antelope bitterbrush, rabbitbrush



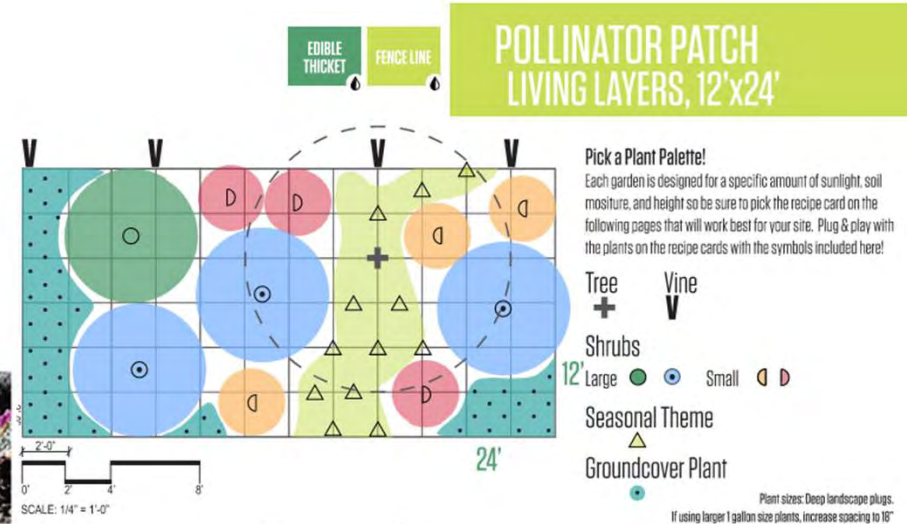
Grasses: Bluebunch wheatgrass, needle and thread, squirreltail, Sandberg bluegrass



Forbs: Nuttall's larkspur, longleaf phlox, Mariposa lily, silky lupine, arrowleaf balsamroot, Pursh's locoweed



Example layout



DISCUSSION & FEEDBACK



Next steps

- Incorporate feedback
- Develop graphics
- Submit draft
- Address review comments
- Deliver
- UD shares with stakeholders



Feedback Questions:

The UD is positioning itself as a leader in innovative, sustainable urbanism...

- Which stakeholders need to be engaged early to ensure success?
- Where do you see this creating competitive advantage—or not?
- Where do you see potential community resistance—or strong support?
- How should this be governed—board adoption or management-led?





Thank you!

Claudia Browne

cbrowne@biohabitats.com

Susan Sherrod

ssherrod@biohabitats.com