



The Ecological City

Applying Nature-Based Design to Urban Places



Tidal wetlands at Brooklyn Bridge Park. © Julianne Schaer/Flickr



BIOPHILIA

WHAT IS BIOPHILIA?

“Biophilia...

is the innately emotional affiliation of human beings to other living organisms....

Life around us exceeds in complexity and beauty anything else humanity is ever likely to encounter.”

Edward O. Wilson
The Biophilia Hypothesis



CookFox Green Roof © CookFox Architects



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14 PATTERNS OF BIOPHILIC DESIGN

Nature In The Space

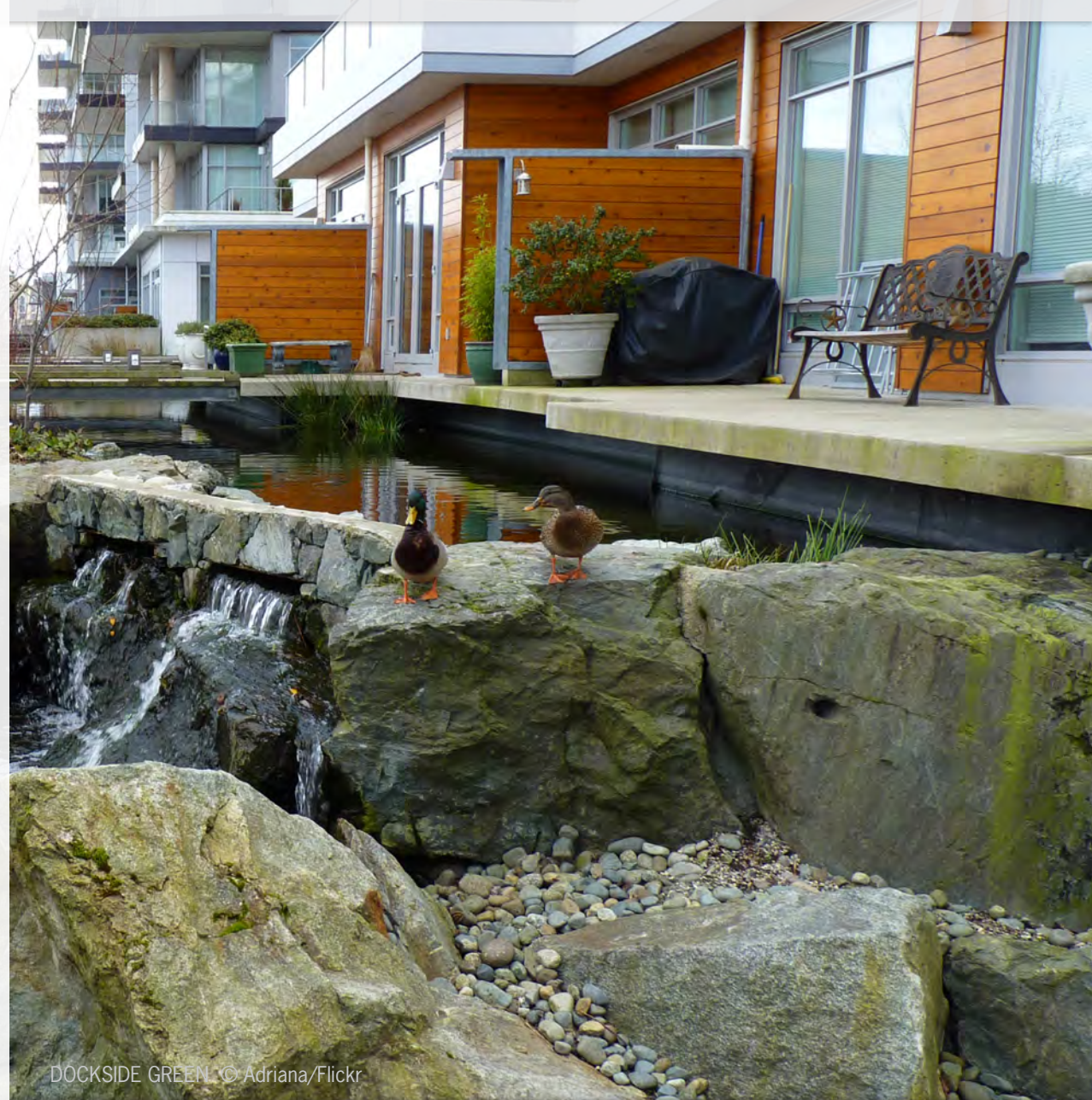
1. Visual Connection with Nature
2. Non-Visual Connection with Nature
3. Non-Rhythmic Sensory Stimuli
4. Thermal & Airflow Variability
5. Presence of Water
6. Dynamic & Diffuse Light
7. Connection With Natural Systems

Natural Analogues

8. Biomorphic Forms & Patterns
9. Material Connection with Nature
10. Complexity & Order

Nature Of The Space

11. Prospect
12. Refuge
13. Mystery
14. Risk



DOCKSIDE GREEN © Adriana/Flickr



BIOPHILIC DESIGN PATTERNS & BIOLOGICAL RESPONSES

14 PATTERNS		STRESS REDUCTION	COGNITIVE PERFORMANCE	EMOTION, MOOD & PREFERENCE
NATURE IN THE SPACE	Visual Connection w/ Nature	Lowered blood pressure and heart rate	Improved mental engagement/ attentiveness	Positively impacted attitude and overall happiness
	Non-Visual Connection w/ Nature	Reduced systolic blood pressure and stress hormones	Positively impacted cognitive performance	Perceived improvements in mental health and tranquility
	Non-Rhythmic Sensory Stimuli	Positively impacted heart rate, systolic blood pressure and sympathetic nervous system activity	Observed and quantified behavioral measures of attention and exploration	
	Thermal & Airflow Variability	Positively impacted comfort, well-being and productivity	Positively impacted concentration	Improved perception of temporal and spatial pleasure (alliesthesia)
	Presence of Water	Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure	Improved concentration and memory restoration; Enhanced perception and psychological responsiveness	Observed preferences and positive emotional responses
	Dynamic & Diffuse Light	Positively impacted circadian system functioning; Increased visual comfort		
	Connection w/ Natural Systems			Enhanced positive health responses; Shifted perception of environment
N. ANALOGUES	Biomorphic Forms & Patterns			Observed view preference
	Material Connection w/ Nature		Decreased diastolic blood pressure; Improved creative performance	Improved comfort
	Complexity & Order	Positively impacted perceptual and physiological stress responses		Observed view preference
NATURE OF THE SPACE	Prospect	Reduced stress	Reduced boredom, irritation, fatigue	Improved comfort and perceived safety
	Refuge		Improved concentration, attention and perception of safety	
	Mystery			Induced strong pleasure response
	Risk/Peril			Resulted in strong dopamine or pleasure responses

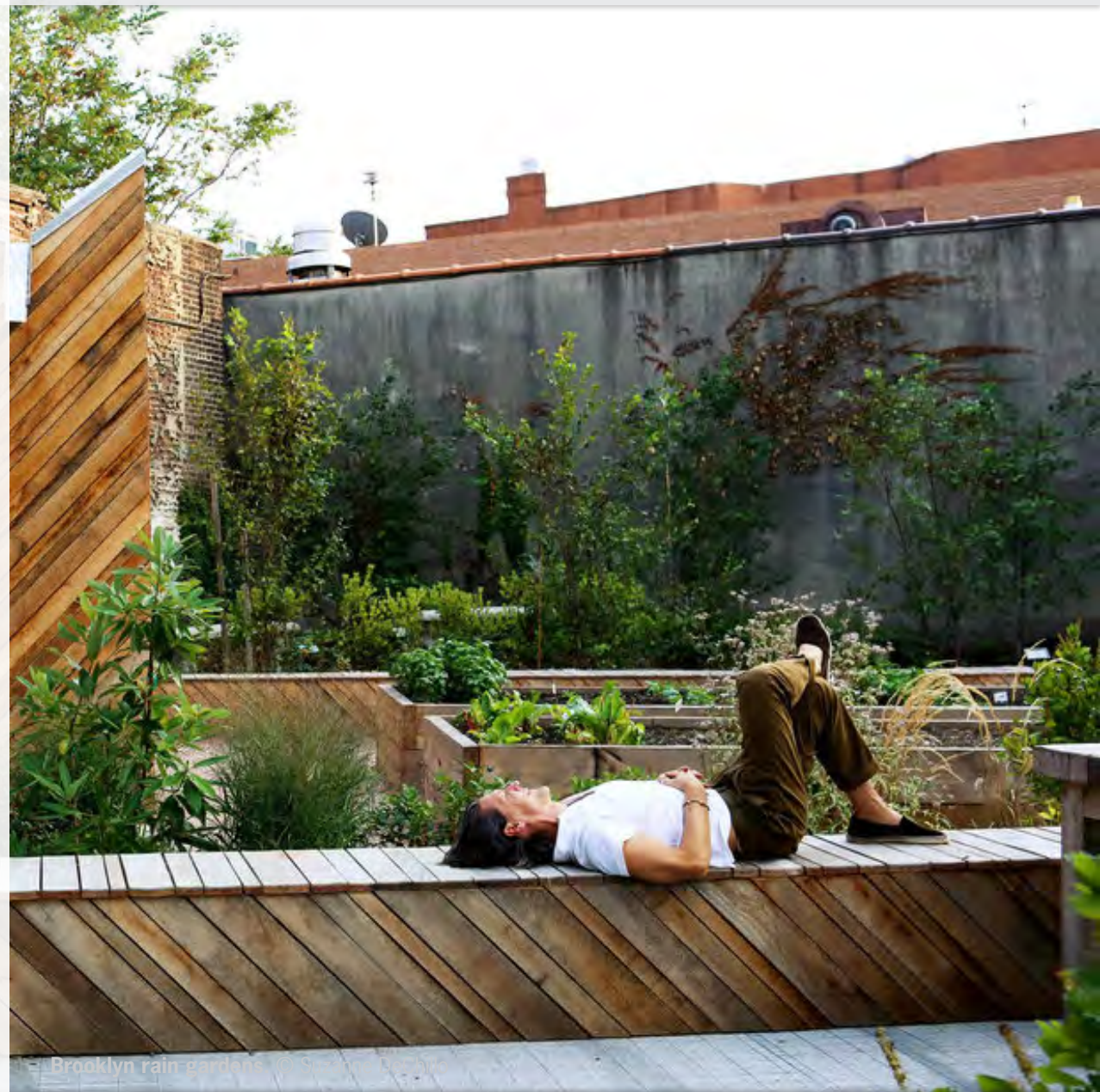
BIOPHILIC URBAN ACUPUNCTURE

WHAT IS BUA?

“BUA...

is the theory that threads and nodes of biophilic interventions in specific urban places can help improve people's moods, connect people to place, help improve mental health....

it is more effective in dense cities versus suburban places due to the ease of pedestrian mobility.



Brooklyn rain gardens © Suzanne Lurie





Metro Light Rail © Chronicle



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METRO LIGHT RAIL - PHX / TEMPE / MESA

Biophilic Urban Acupuncture:

- High Pedestrian Use
- Dwell Time
- Visual Connection with Nature
- Connection with Natural Systems
- Biomorphic Forms & Patterns
- Material Connection with Nature

Ancillary Benefits:

- Water Management
- Biodiversity / Pollinators
- Sense of Place
- Heat Island Mitigation
- Thermal Comfort



Metro Light Rail © Phoenix New Times





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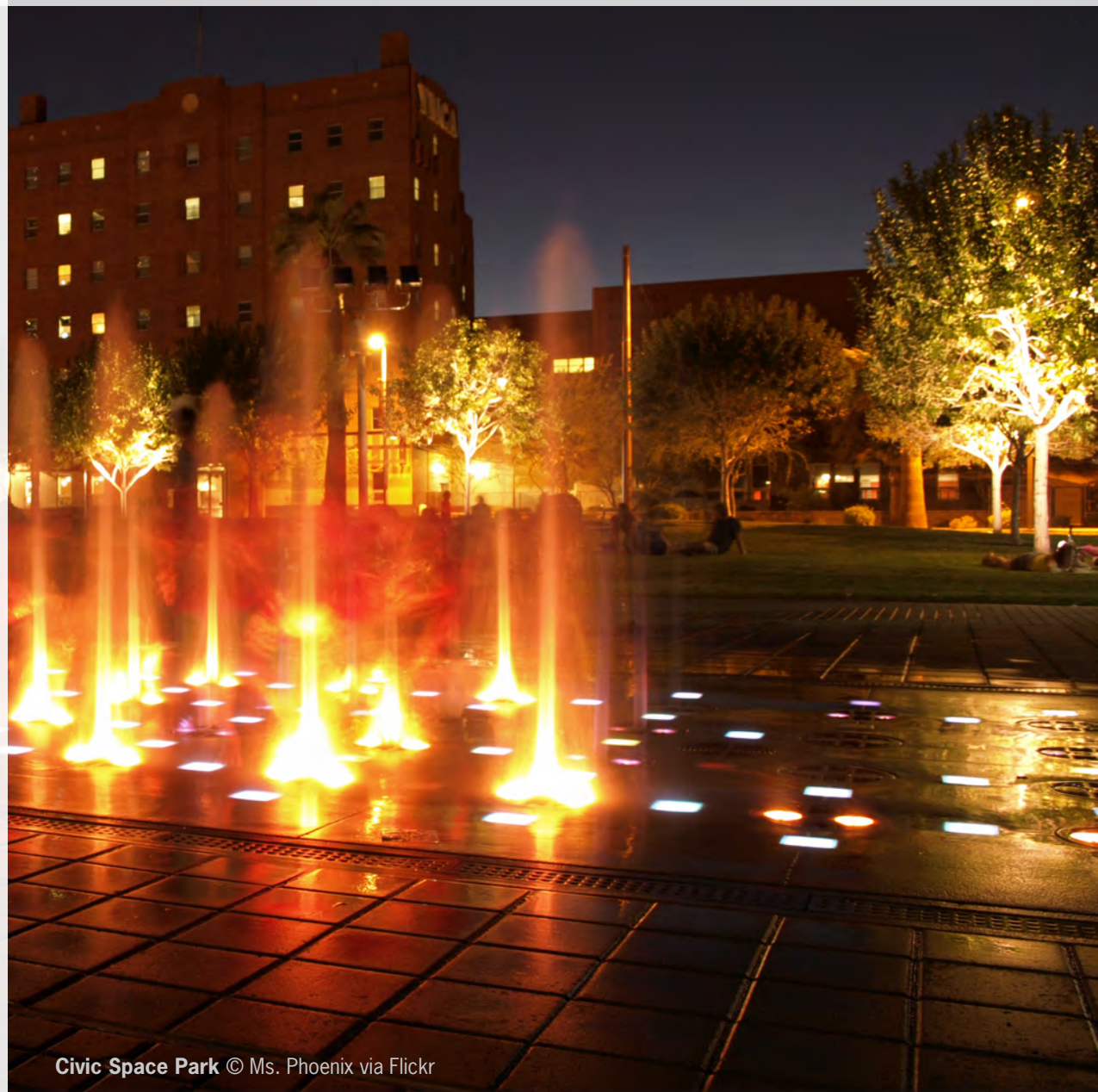
CIVIC SPACE PARK - PHX

Biophilic Urban Acupuncture:

- High Pedestrian Use
- Transportation Corridor
- Dwell Time
- Visual Connection with Nature
- Presence of Water
- Non-Rhythmic Sensory Stimuli
- Connection with Natural Systems
- Prospect

Ancillary Benefits:

- Water Management
- Biodiversity / Pollinators
- Sense of Place
- Heat Island Mitigation
- Thermal Comfort



Civic Space Park © Ms. Phoenix via Flickr





AZ Falls © Don Burnside via Flickr



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ARIZONA FALLS - SCOTTSDALE

Biophilic Urban Acupuncture:

- Cycling Corridor
- Dwell Time
- Visual Connection with Nature
- Presence of Water
- Connection with Natural Systems
- Non-Visual Connection with Nature
- Prospect

Ancillary Benefits:

- Water Management
- Energy Generation
- Biodiversity / Pollinators
- Sense of Place
- Thermal Comfort



AZ Falls © cygnusloc98 via Panoramio



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The HighLine © NYC Parks



THE ECOLOGICAL CITY

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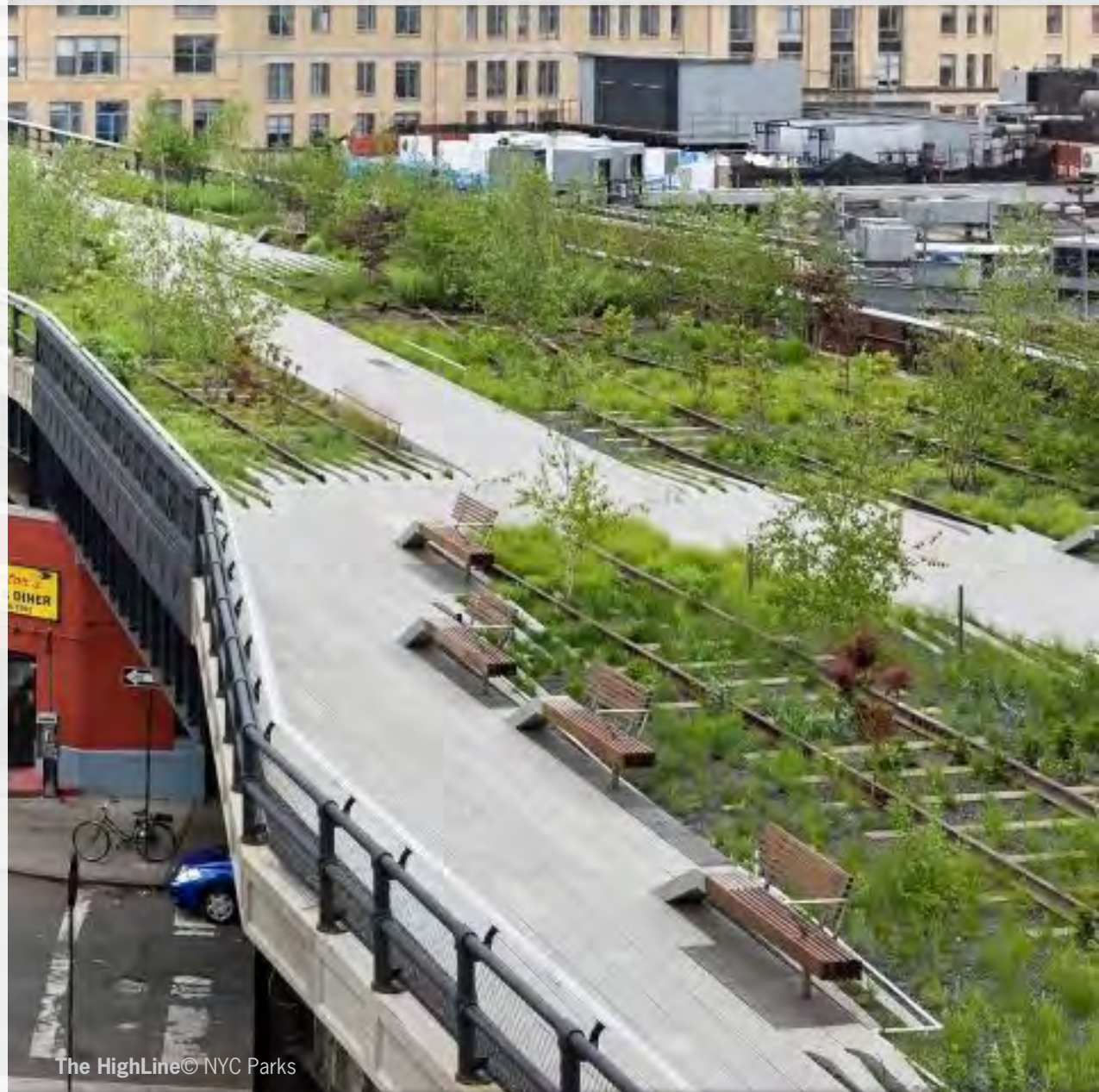
THE HIGHLINE - NYC

Biophilic Urban Acupuncture:

- High Pedestrian Use
- Transportation Corridor
- Dwell Time
- Visual Connection with Nature
- Non-Rhythmic Sensory Stimuli
- Presence of Water
- Connection with Natural Systems
- Prospect

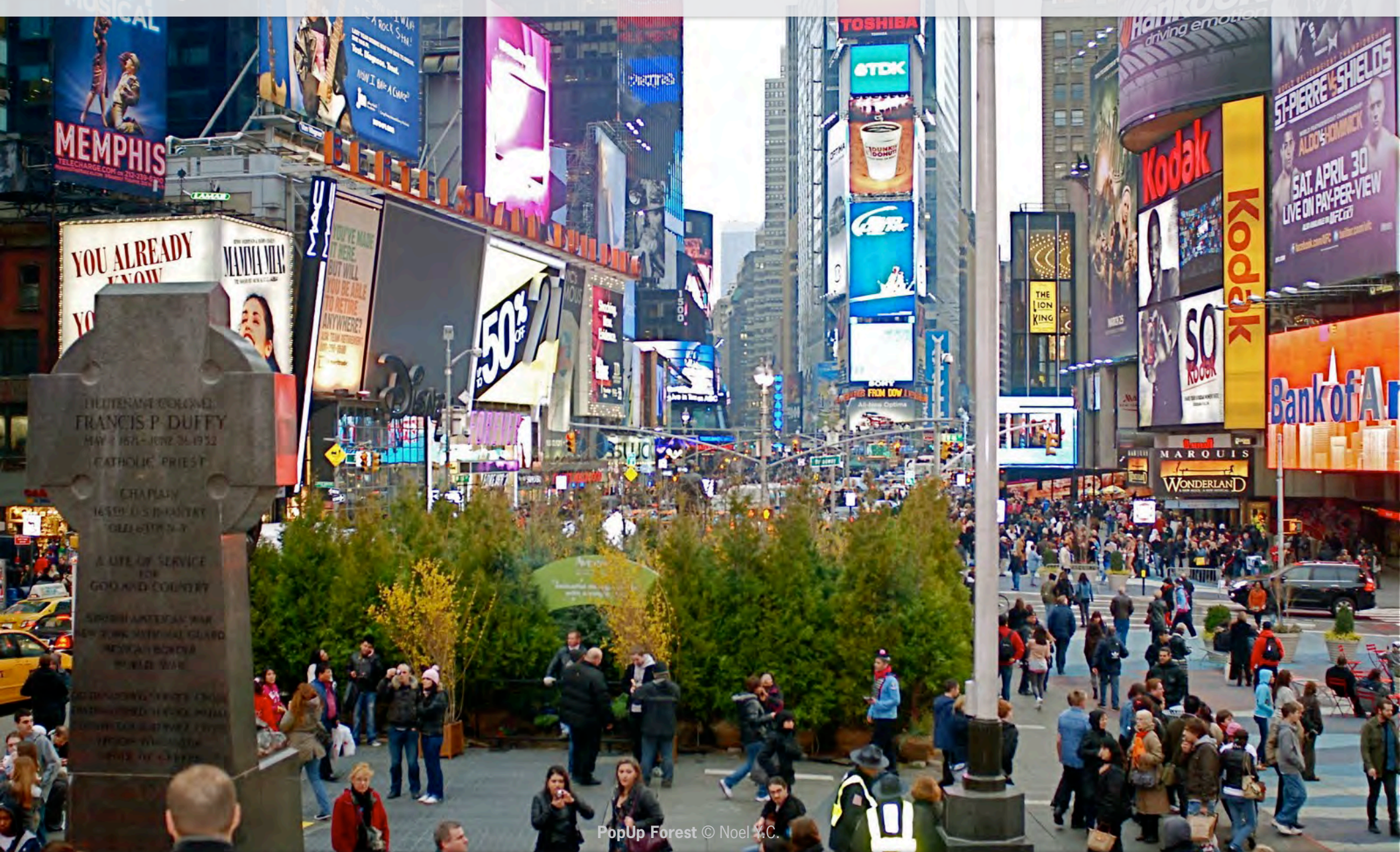
Ancillary Benefits:

- Water Management
- Biodiversity / Pollinators
- Sense of Place
- Heat Island Mitigation
- Thermal Comfort



The HighLine© NYC Parks





THE ECOLOGICAL CITY

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POPUF FOREST - NYC

Biophilic Urban Acupuncture:

- High Pedestrian Use
- Transit Hub
- Visual Connection with Nature
- Non-Rhythmic Sensory Stimuli
- Refuge
- Mystery

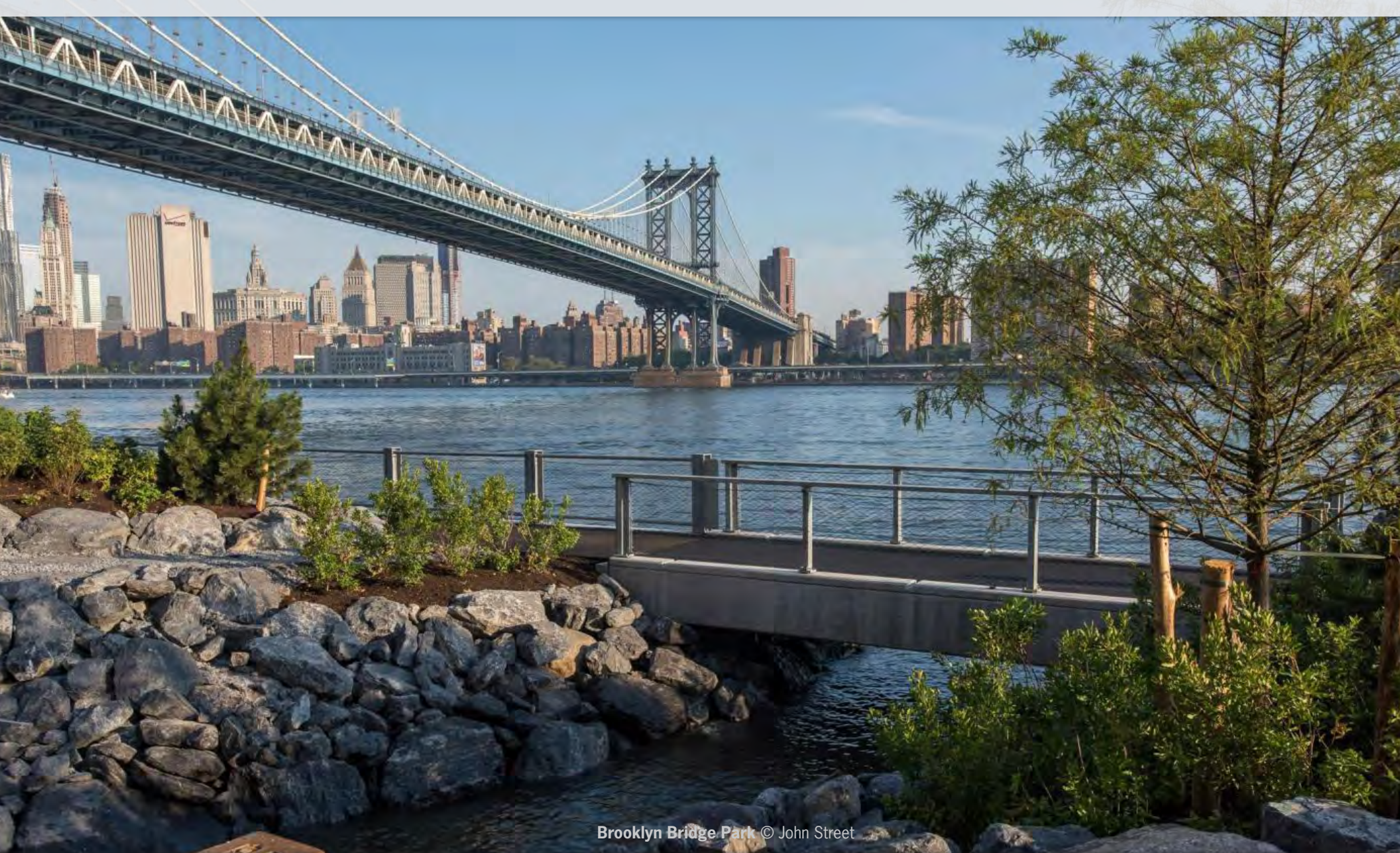
Ancillary Benefits:

- Biodiversity / Pollinators
- Heat Island Mitigation
- Thermal Comfort



PopUp Forest © Noel Y.C.





Brooklyn Bridge Park © John Street



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Applying Nature-Based Design to Urban Places

BROOKLYN BRIDGE PARK TIDAL MARSH - NYC

Biophilic Urban Acupuncture:

- High Pedestrian Use
- Dwell Time
- Visual Connection with Nature
- Non-Rhythmic Sensory Stimuli
- Connection with Natural Systems
- Material Connection with Nature

Ancillary Benefits:

- Biodiversity / Pollinators
- Water Management
- Heat Island Mitigation
- Thermal Comfort



Brooklyn Bridge Park © John Street





Bryan Park Subway © Jake Rajs



BRYANT PARK SUBWAY - NYC

Biophilic Urban Acupuncture:

- High Pedestrian Use
- Biomorphic Forms and Patterns



Bryant Park Subway © Samm Kuncce

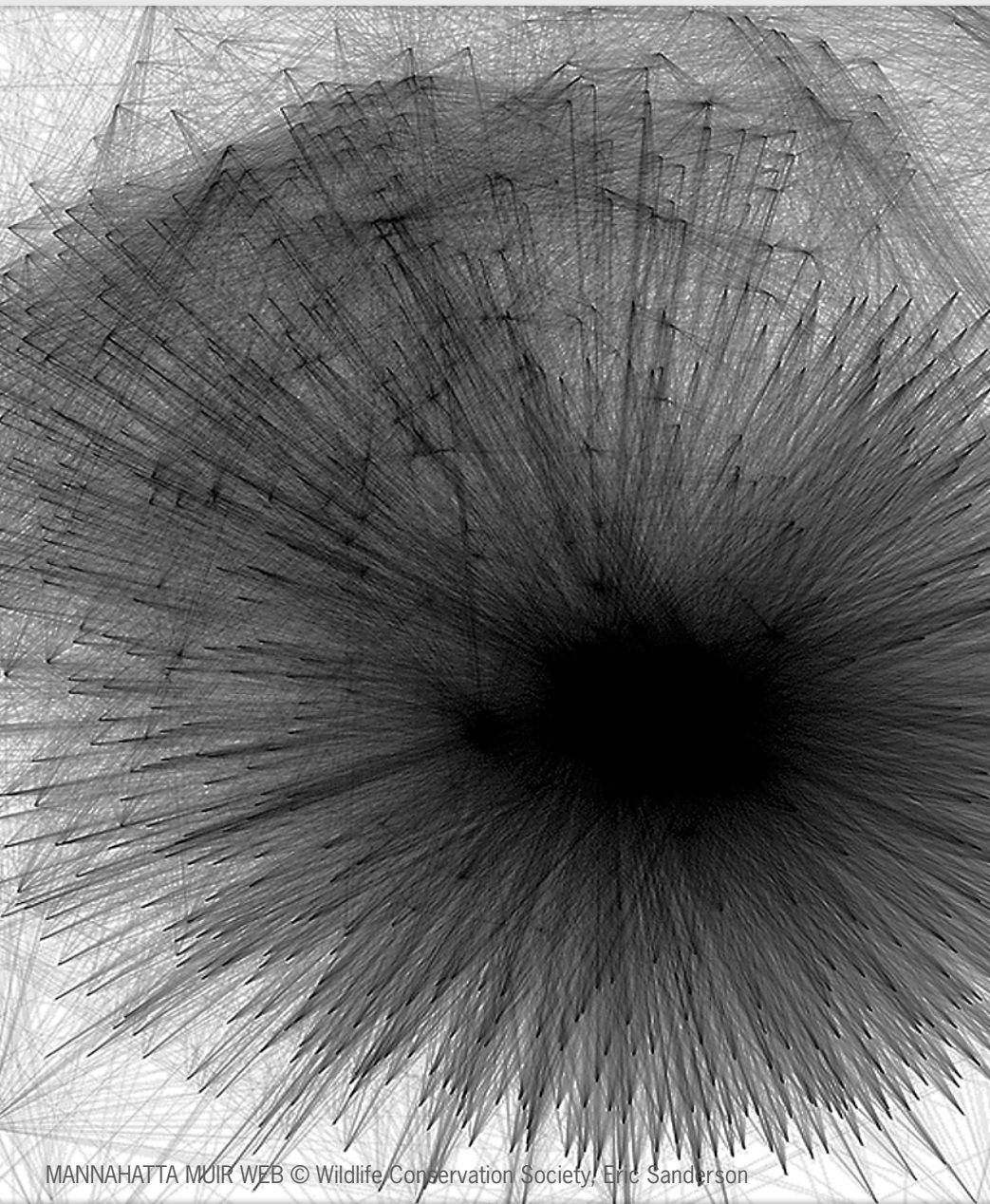


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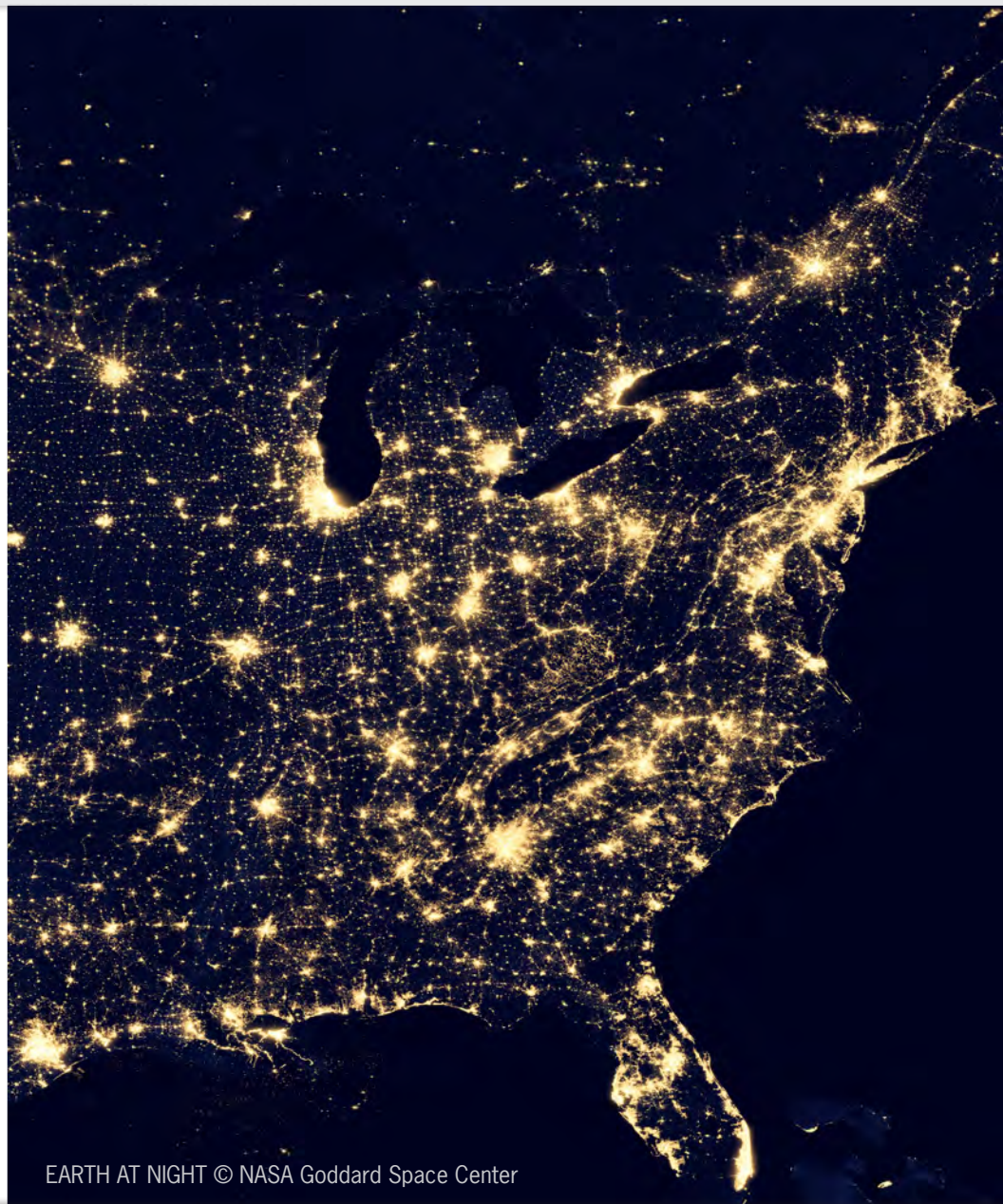
Applying Nature-Based Design to Urban Places

What is the “ecological” built environment?





MANNAHATTA MOIR WEB © Wildlife Conservation Society, Eric Sanderson



EARTH AT NIGHT © NASA Goddard Space Center



INTERCONNECTED

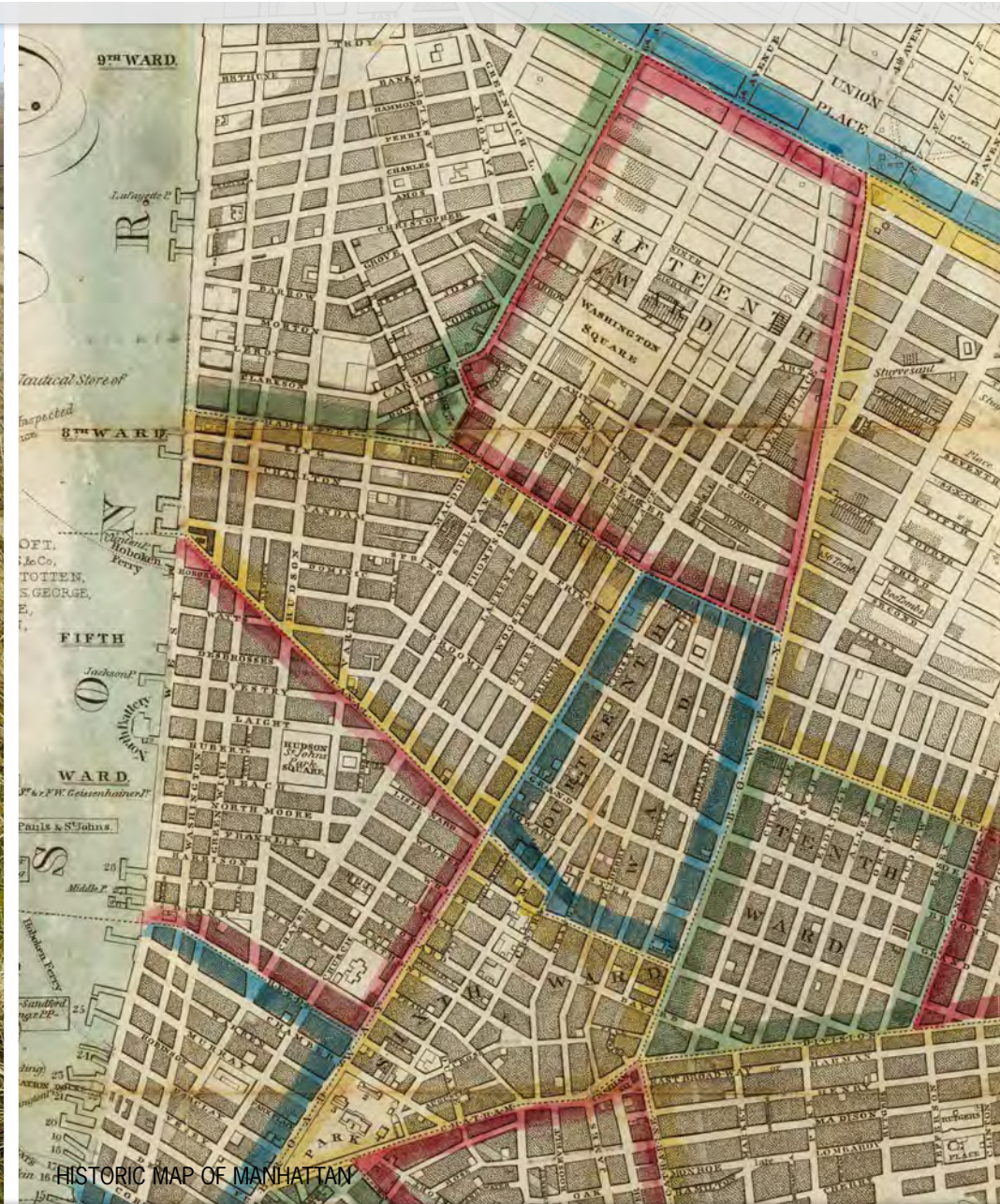
This city is dependent on resources from ecosystems across the globe.



MANHATTAN MUIR WEB © Wildlife Conservation Society, Eric Sanderson



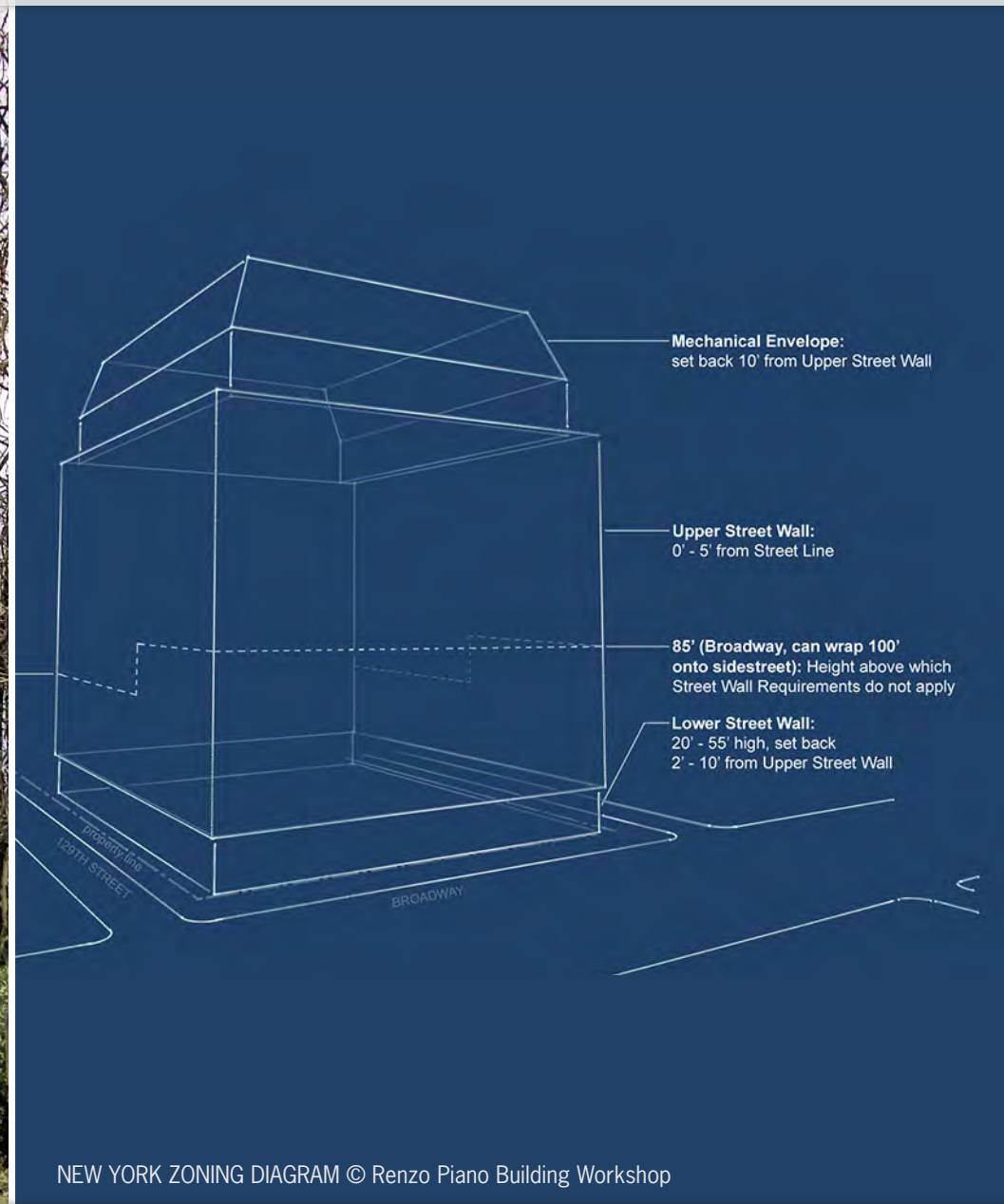
TRANSBOUNDARY



The city is divided up into parcels with independent jurisdiction and ownership.



GROUSE POND IN STANISLAUS NATIONAL FOREST © Stephen on Flickr



NEW YORK ZONING DIAGRAM © Renzo Piano Building Workshop



PROCESS DRIVEN

The evolutionary processes of the city are slowly encoded into regulatory and economic structures.



AMAZON IN ARGENTINA © NASA Goddard Space Center



1914 LA RIVER FLOODING © unknown origin



TEMPORALLY DYNAMIC

The city does not adapt well to changing ecosystems.

GOALS OF ECOLOGICAL DESIGN AT TERRAPIN

1. Connect Humans to Natural Systems
2. Establish Ecological Functions and Processes On-site and Align The Built Environment To Regional Ecosystems
3. Integrate Outsourced Ecosystem Impacts Into Design, Planning, and Decision Making

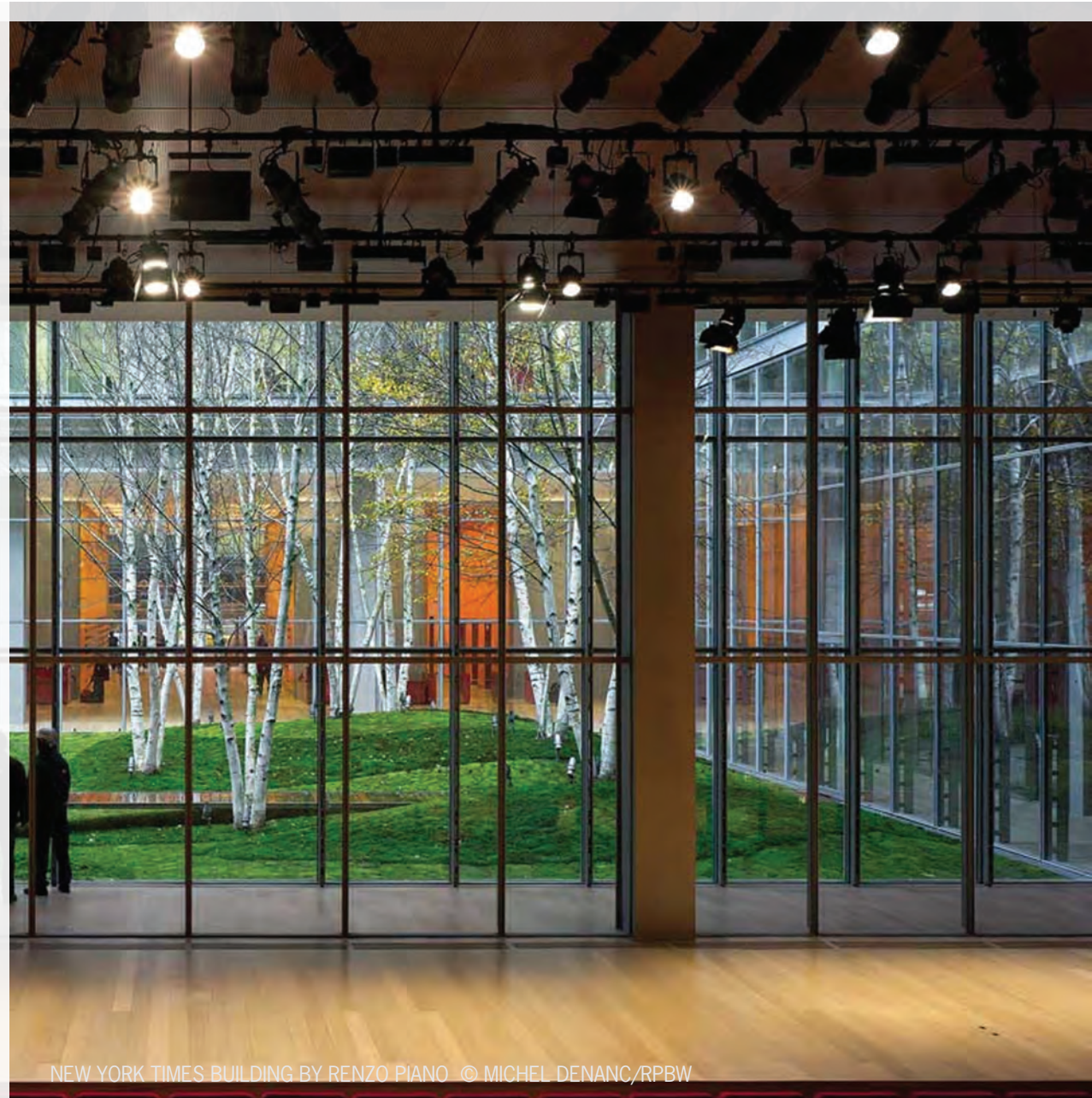


Parco Valentino, Piani Resinelli, Italy.



FRAMEWORK FOR AN ECOLOGICAL BUILT ENVIRONMENT ("PHOEBE")

**Goal: Connect Humans to Natural
Systems**



NEW YORK TIMES BUILDING BY RENZO PIANO © MICHEL DENANC/RPBW



ECOSYSTEM SERVICES



FORAGED FOODS

- Mushrooms
- Fruits: Nuts and Berries Maple Syrup
- Leafy Greens: Nettle, Fiddle heads, Dandelion
- Roots and tubers
- Stocked fish, aquaculture, game and fowl



RAW MATERIALS AND FUELS

- Wild florals
- Timber from tree clearing
- Furniture grade woods
- Fuel woods from understory
- management and thinning
- Rapidly renewable materials: coppicing
- Biomass > Energy



MANAGING ECOSYSTEM CHARACTERISTICS

- Integrated Pest Management with Bats, Dragonflies, Perch, Pickerel, and other predators
- Restoring understory and selective daylighting
- Cultivating habitats: butterfly, vernal pools, pond, meadow
- Removing invasives and highlighting charismatic natives (Hudsonia)





©Jeff Stvan/Flickr



©habeeb/Flickr



THE ECOLOGICAL CITY

Applying Nature-Based Design to Urban Places

FRAMEWORK FOR AN ECOLOGICAL BUILT ENVIRONMENT ("PHOEBE")

**Goal: Establish Ecological
Functions and Processes On-site
and Align The Built Environment To
Regional Ecosystems**



TANNER SPRINGS BY ATELIER DREISEITL, PORTLAND, OR © GREENWORKSPC.



GOALS OF ECOLOGICAL DESIGN

BLANDINGS TURTLE



WATERSHED CAPACITY

Establishing baseline capacities of the watershed.

Types of capacity:

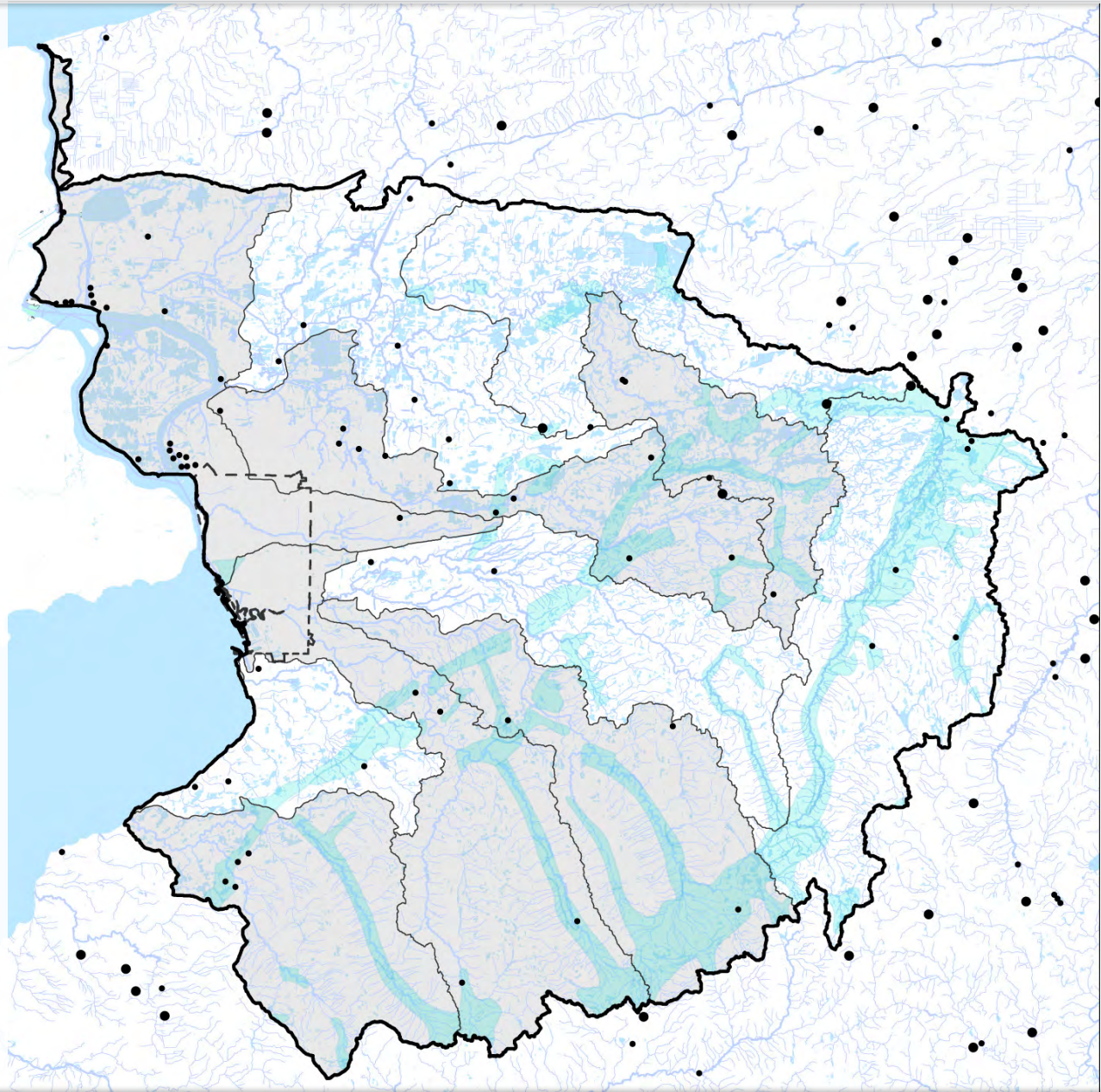
- volume of precipitation
- groundwater resources
- tolerable storm surge in waterways
- tolerable pollutant loading

For infrastructure:

Types of capacity:

- potable supply
- waste-water treatment
- storm sewer system
- restricted chemicals

Riverkeeper helps make the connections between watershed health and provisioning capacity. Goes beyond current regulatory structures.



WATERSHED CAPACITY

Establishing baseline capacities of the watershed.

Types of capacity:

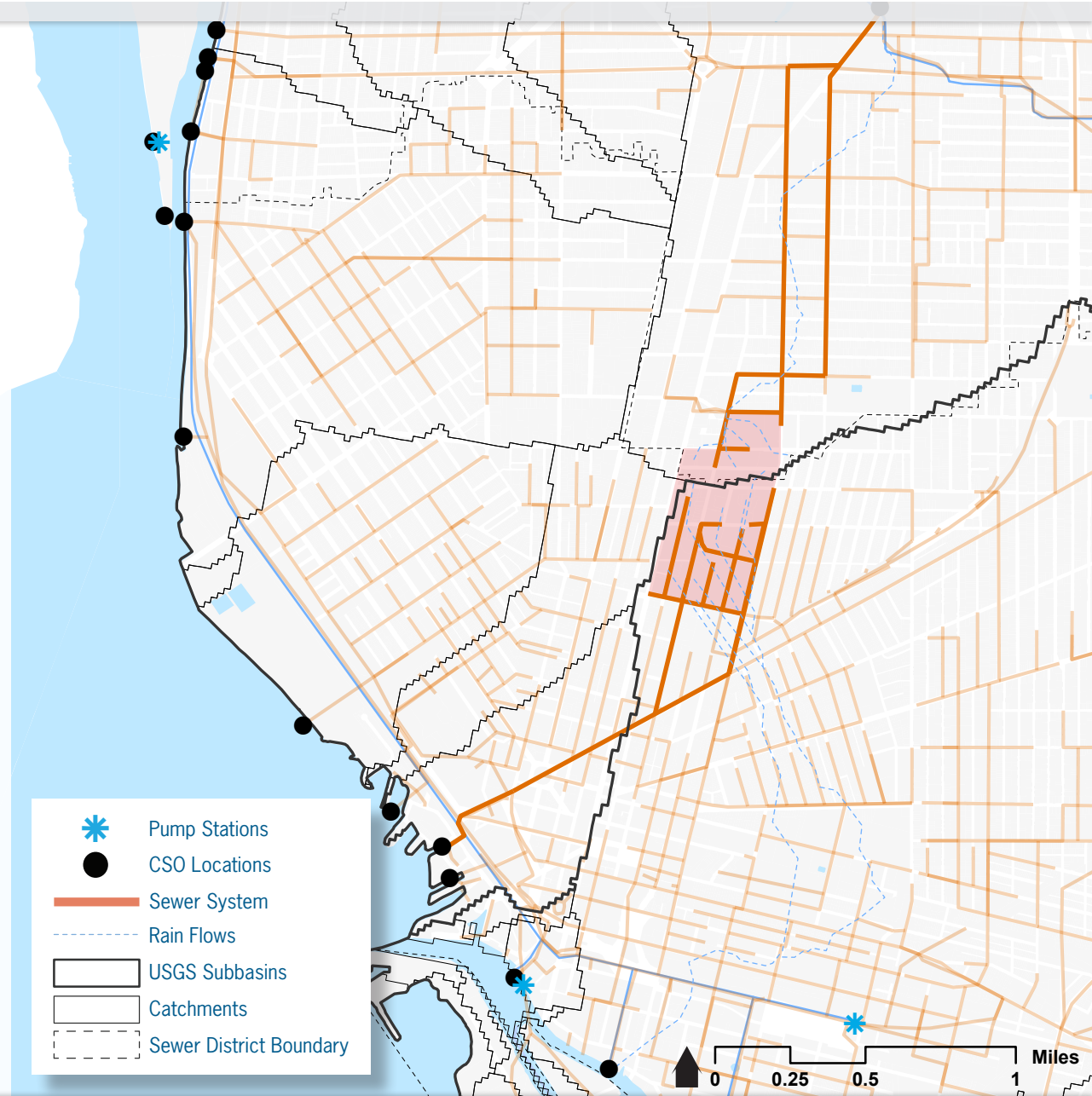
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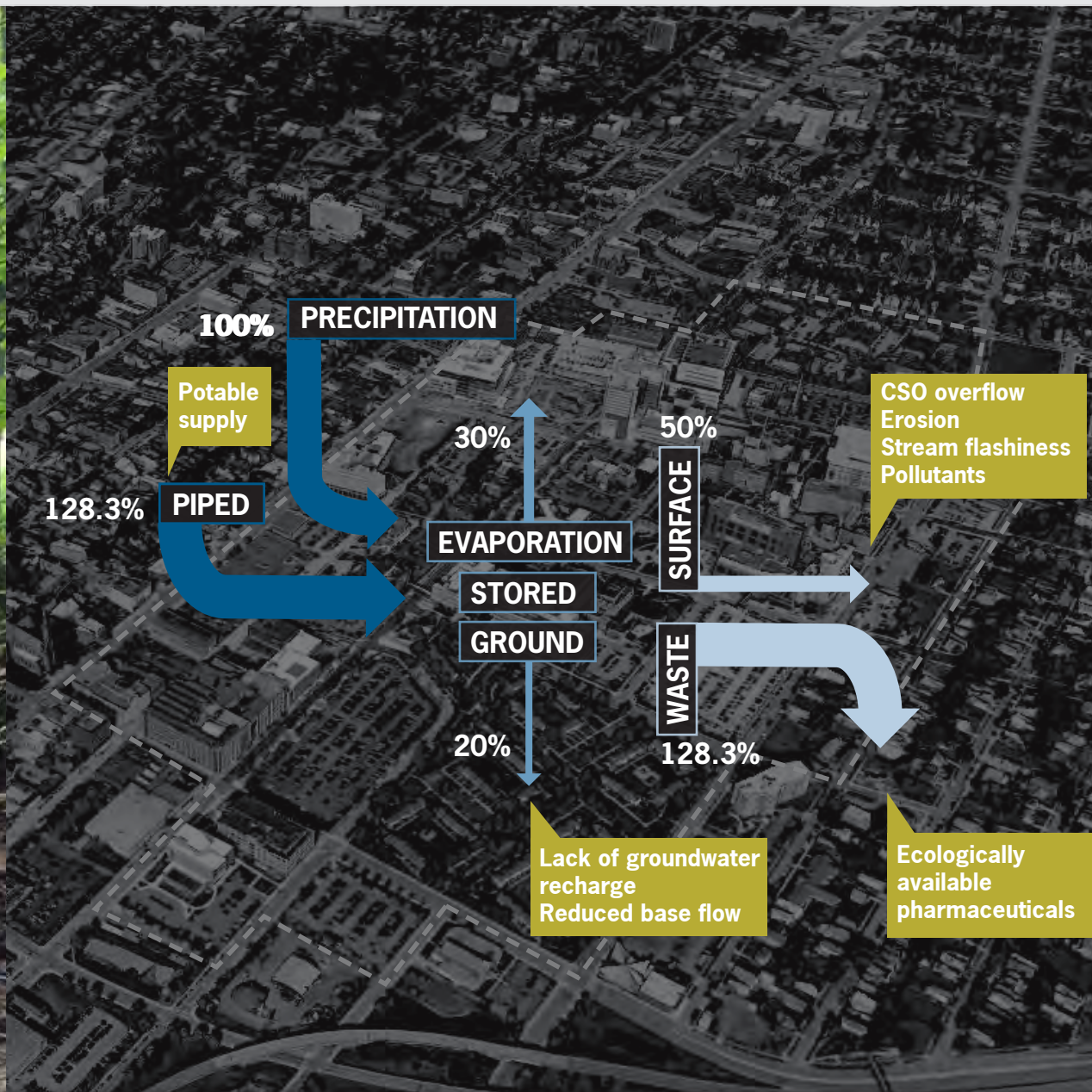
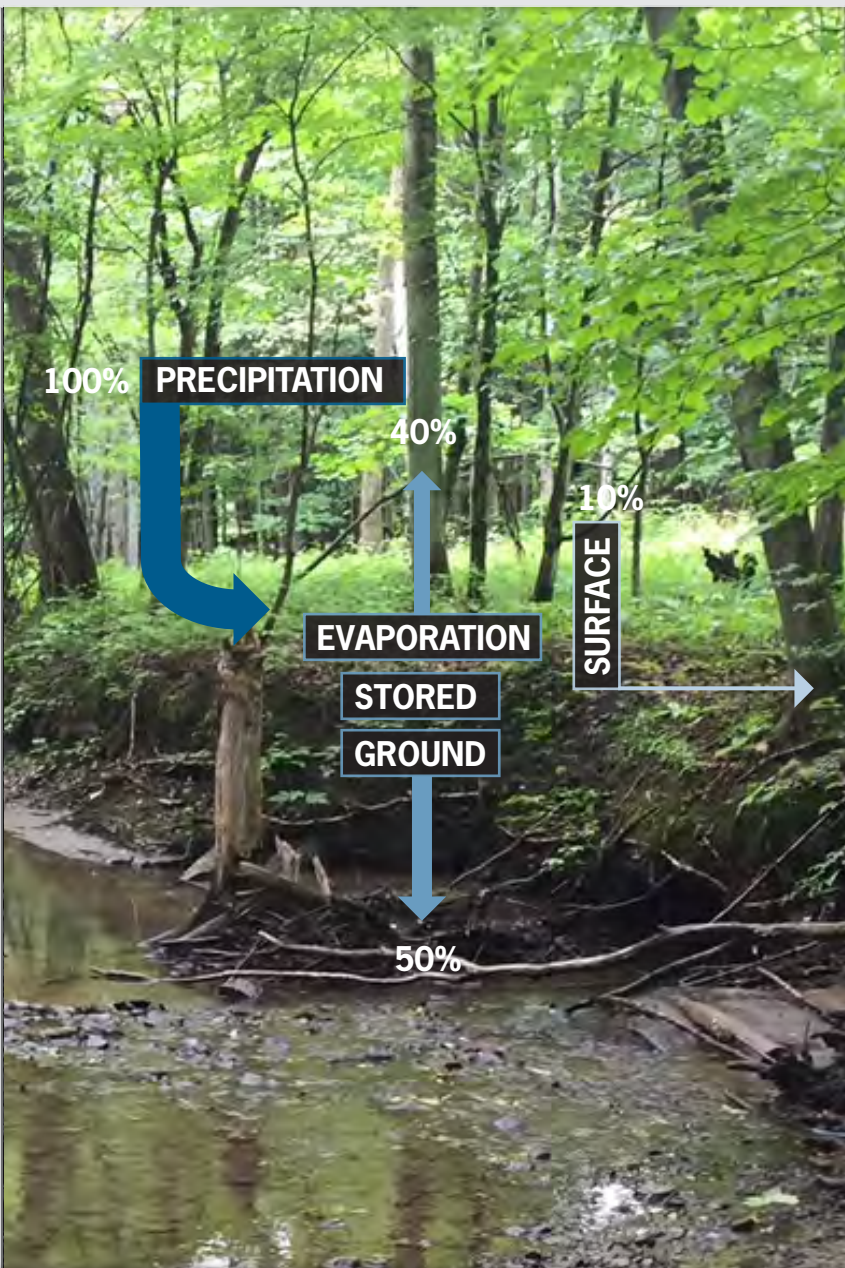
For infrastructure:

Types of capacity:

- potable supply
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WATER SYSTEMS FLOWS AND TEMPORAL PRESSURES

Climate Change:

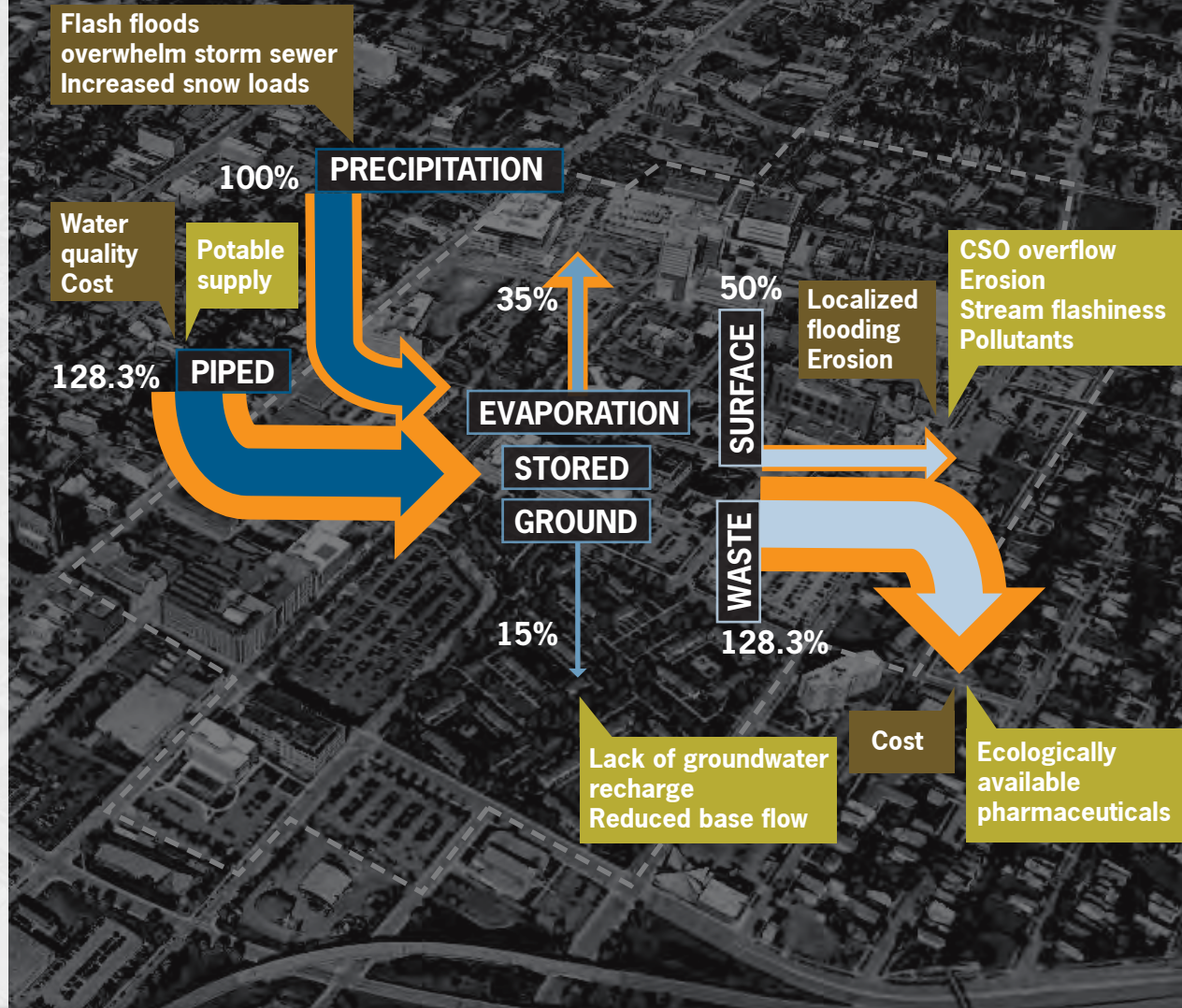
- increased precipitation
- increased snow load
- warmer summers (more cooling demand and higher evap)

Land-use change:

- increased surface runoff
- decreased groundwater recharge

Demographic Change:

- on the medical building green roof
- building retention basins



PHOEBE (THE BIRD)

Phoebes are part of the tyrant flycatcher (Tyrannidae) family found in the Americas.

- Phoebes nest not only in natural settings, but on built structures such as bridges, buildings & culverts.
- Phoebes are in the conservation category of “Least Concern” because their populations and ranges have expanded with human development.

These birds achieve the highest aspiration of our ecological design framework: a successful interplay between the human built environment and natural ecosystems.



Phoebe nest. © Bgbloggin/Flickr.



FRAMEWORK FOR AN ECOLOGICAL BUILT ENVIRONMENT ("PHOEBE")

**Goal: Integrate Outsourced
Ecosystem Impacts Into Design,
Planning, and Decision Making**



THE BAGGER 288 BUCKET EXCAVATOR



GOALS OF ECOLOGICAL DESIGN



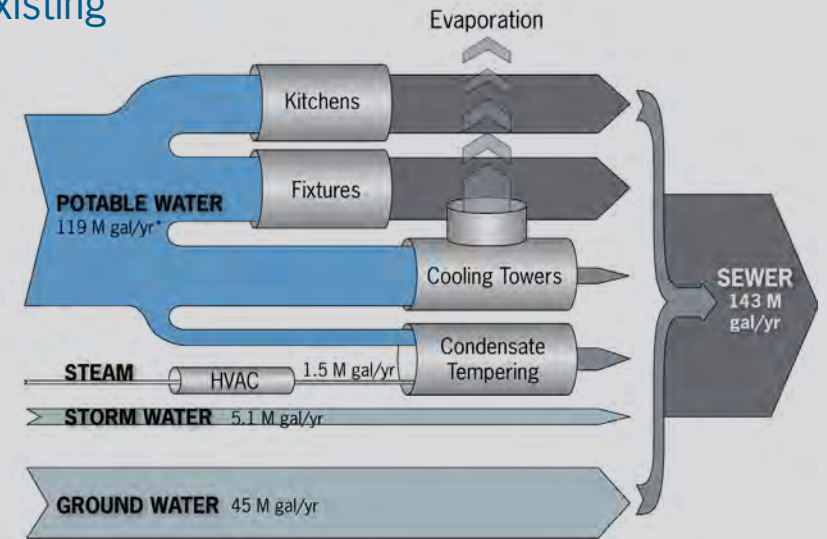
PAGES FROM MANNAHATTA © ERIC SANDERSON



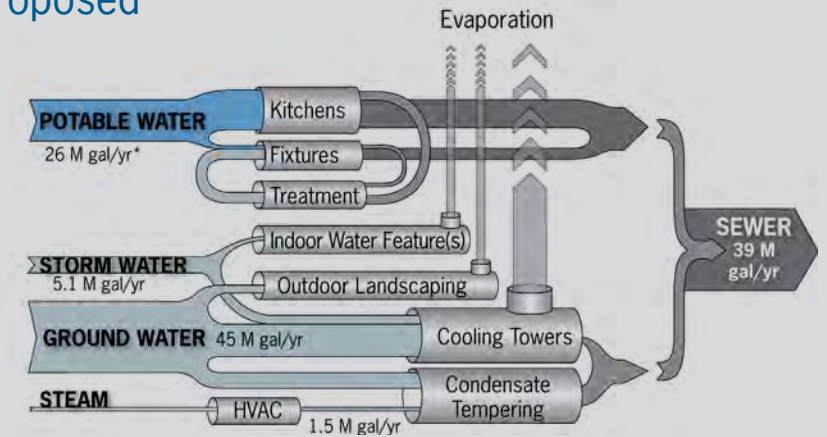
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Existing



Proposed



● Stocks

- Genetic Resources
- Biomass
- Groundwater/
Water in Plants
- Energy Storage
- Gases
- Nutrients

Inputs ▶

Precipitation/Water Vapor

Solar Energy

Ambient Gases

Nutrient Deposition

Outputs ▶

Evaporation/Run-off

Heat Energy

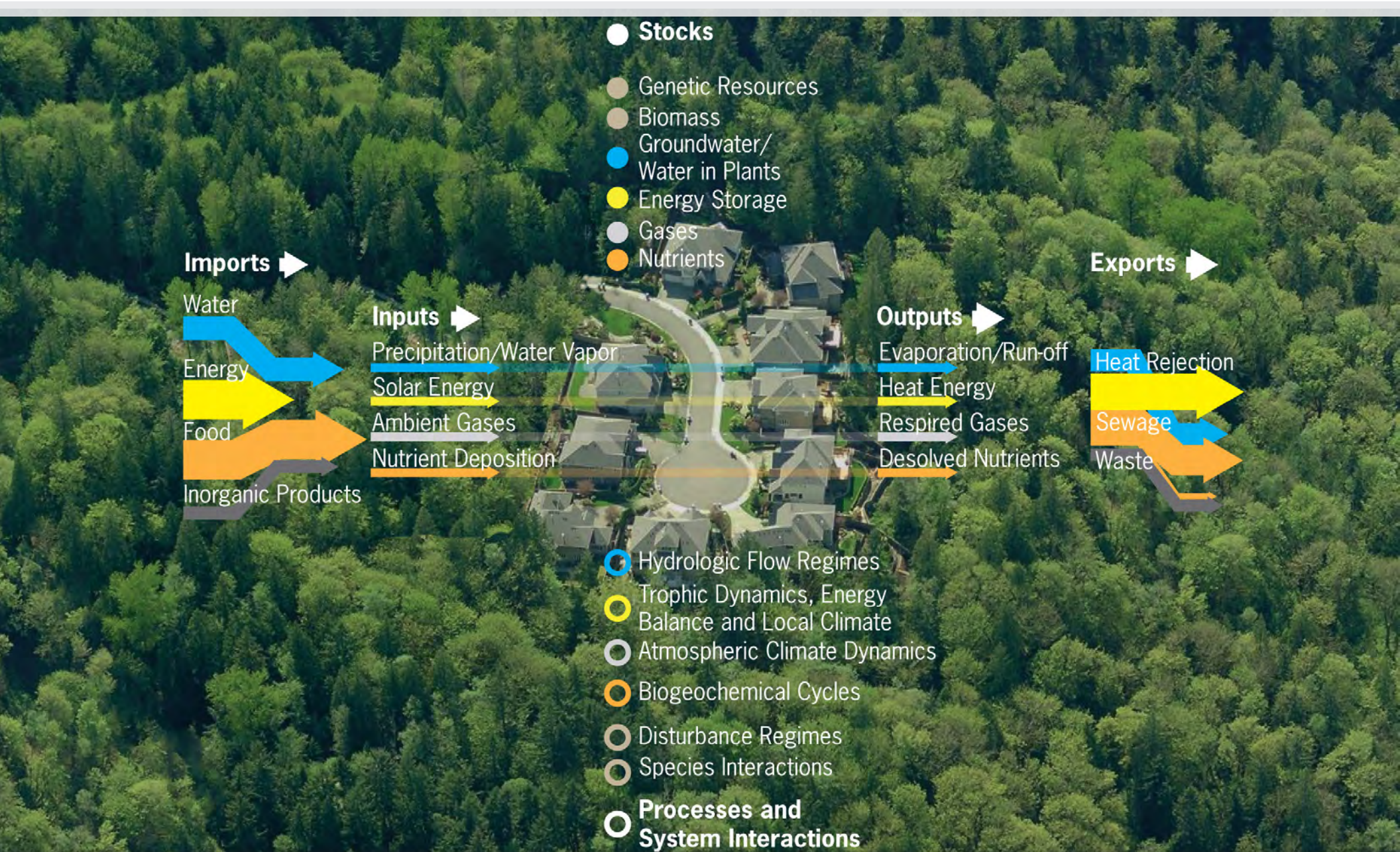
Respired Gases

Dissolved Nutrients

- Hydrologic Flow Regimes
- Trophic Dynamics, Energy
Balance and Local Climate
- Atmospheric Climate Dynamics
- Biogeochemical Cycles
- Disturbance Regimes
- Species Interactions

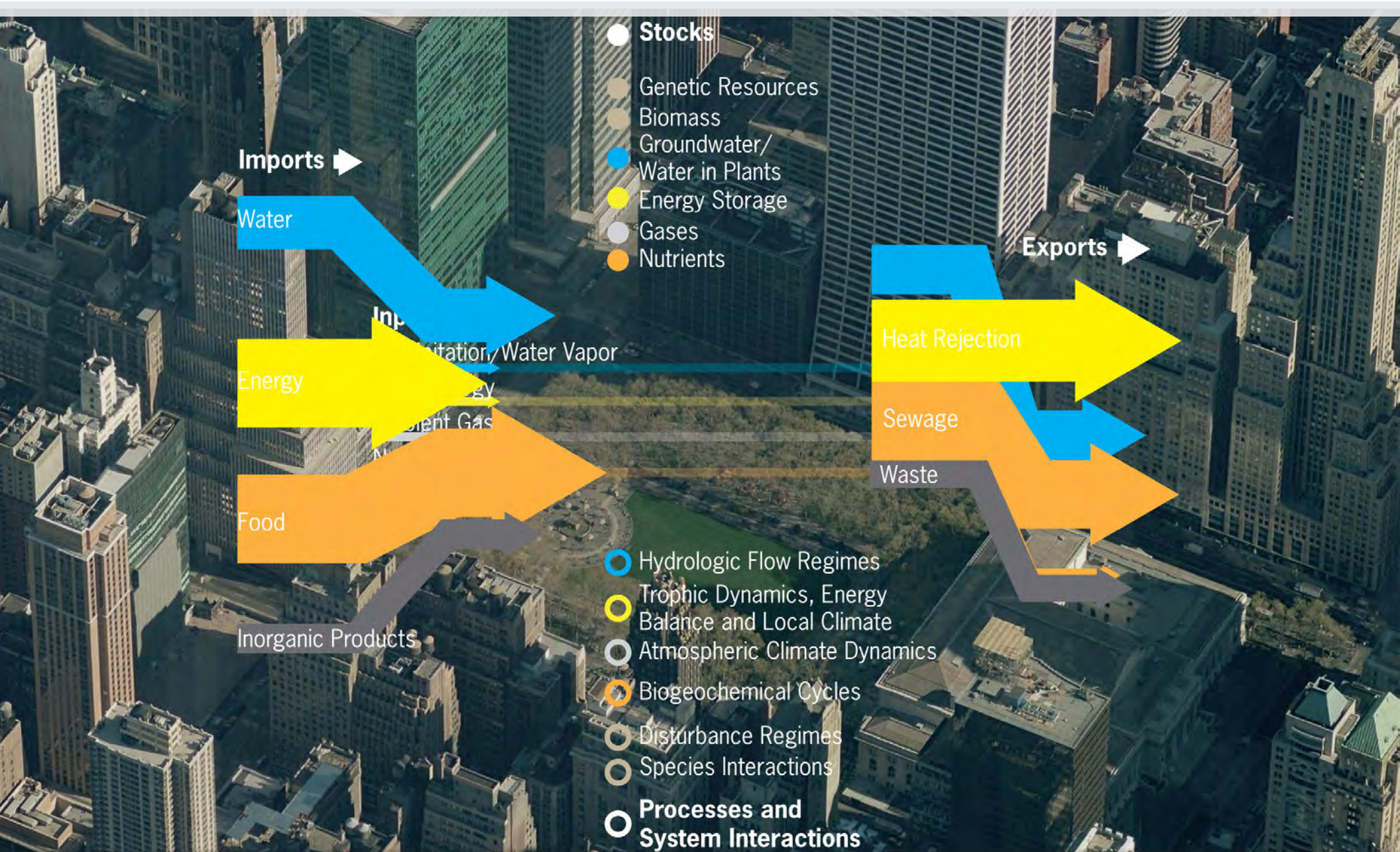
○ Processes and System Interactions





STOCKS AND FLOWS SUBURBAN

The flow of materials and energy in early development.



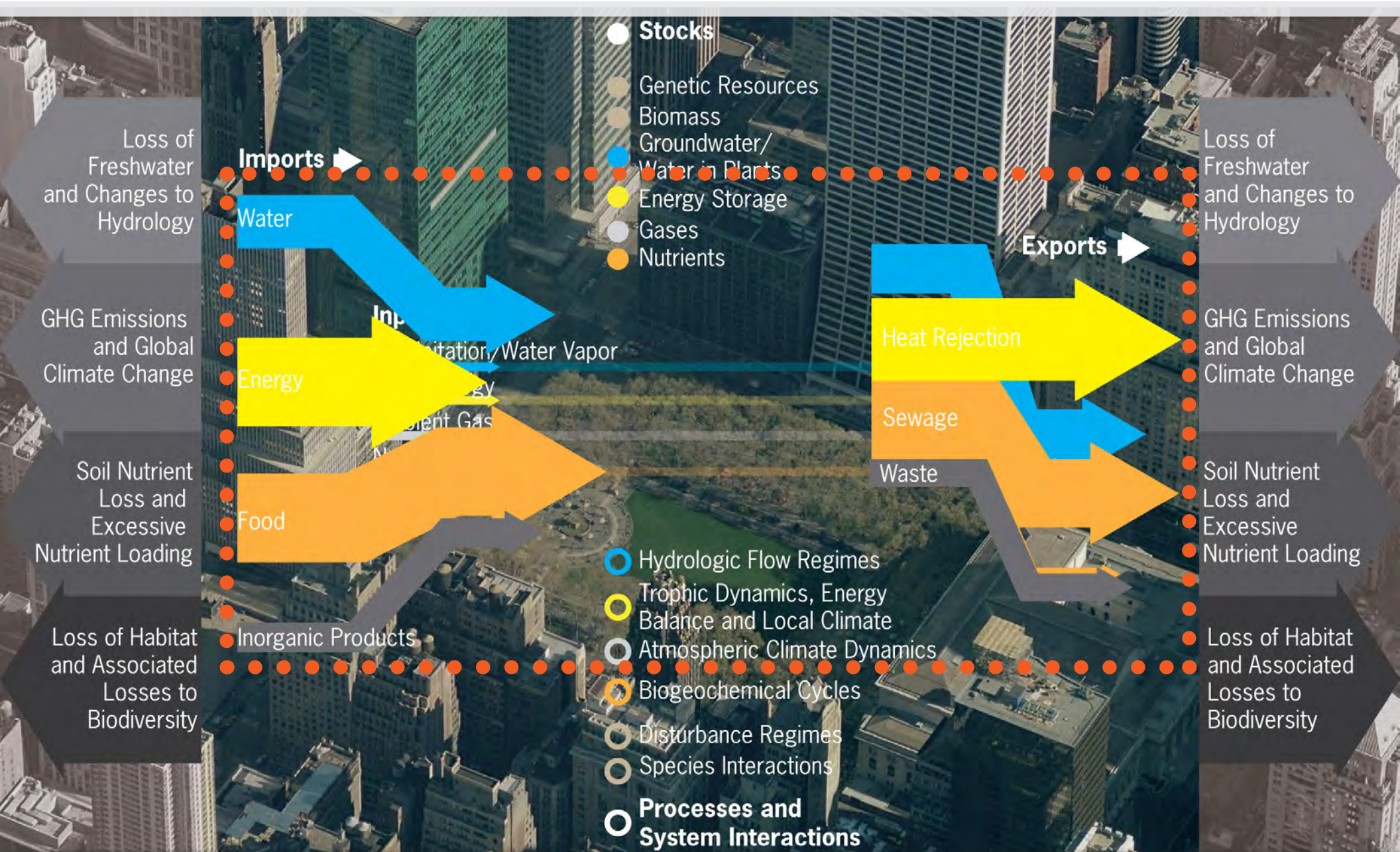
STOCKS AND FLOWS URBAN

The flow of materials and energy in dense cities.



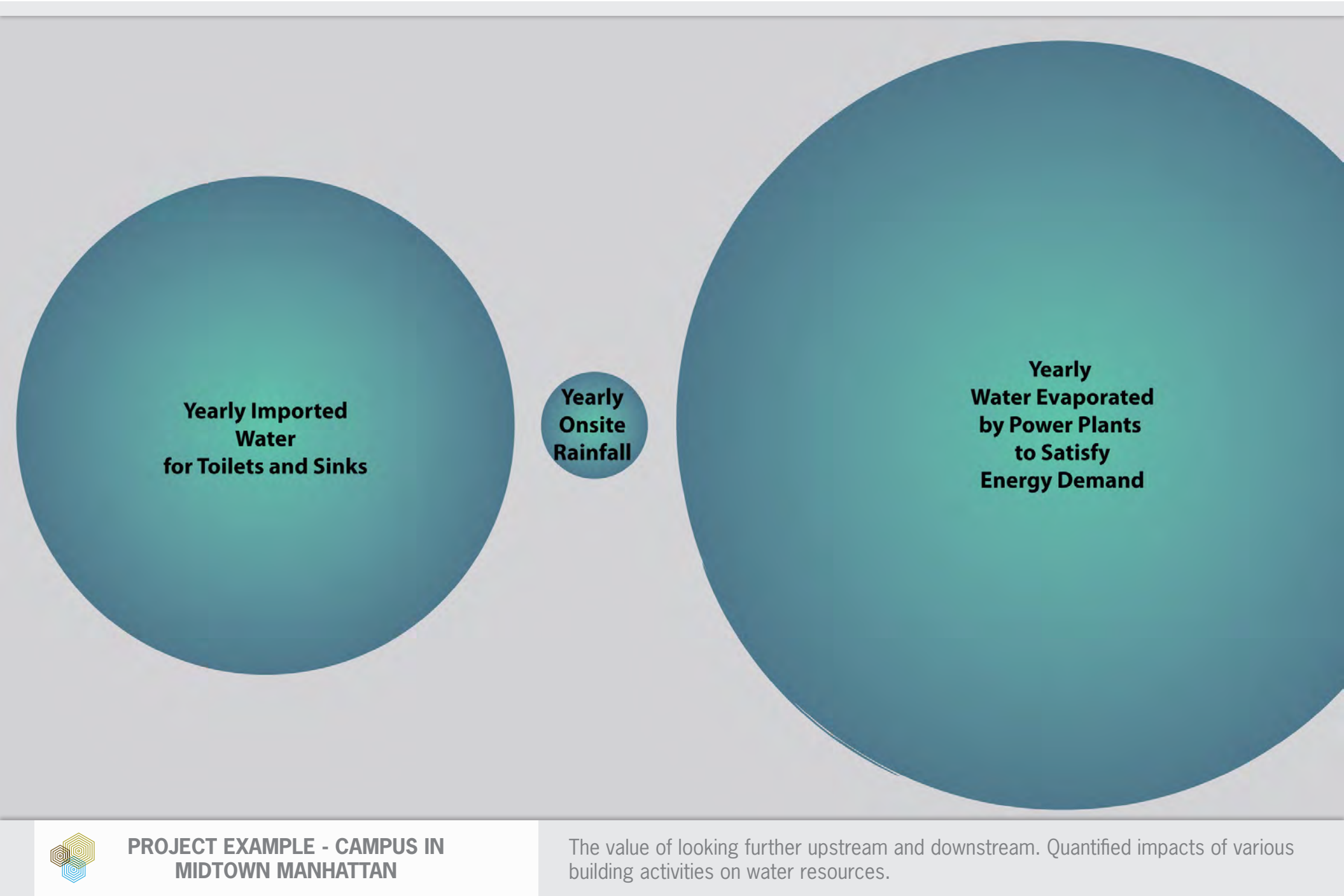
UPSTREAM AND DOWNSTREAM

Upstream environmental impacts associated with cities.



TYPICAL PROJECT BOUNDARY

Upstream environmental impacts associated with cities.



The infographic consists of three teal-colored circles of different sizes arranged horizontally. The leftmost circle is medium-sized and contains text about imported water. The middle circle is the smallest and contains text about onsite rainfall. The rightmost circle is the largest and contains text about water evaporated by power plants. The circles are set against a light gray background.

**Yearly Imported
Water
for Toilets and Sinks**

**Yearly
Onsite
Rainfall**

**Yearly
Water Evaporated
by Power Plants
to Satisfy
Energy Demand**



Building Boundary

Building Operational
Values

% Energy Reduction
% Water Reduction
% Waste Recycled
% Organic Food
% Reduction in
Wastewater



Whole Ecosystem

Ecosystem Impact
Measures

GHG Emitted
Loss of Freshwater Resources
Change in Stream Hydrograph
Land-use Footprint
Change in Biodiversity
Contribution to Local Heat Island





“THE PHOTOSYNTHETIC VENEER, THE VEGETAL WORLD, MUST NOT BE OVERLAID BY A MAN-CAUSED OPAQUE VENEER.”

-PAOLO SOLERI

Civic Space Park © Architect



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