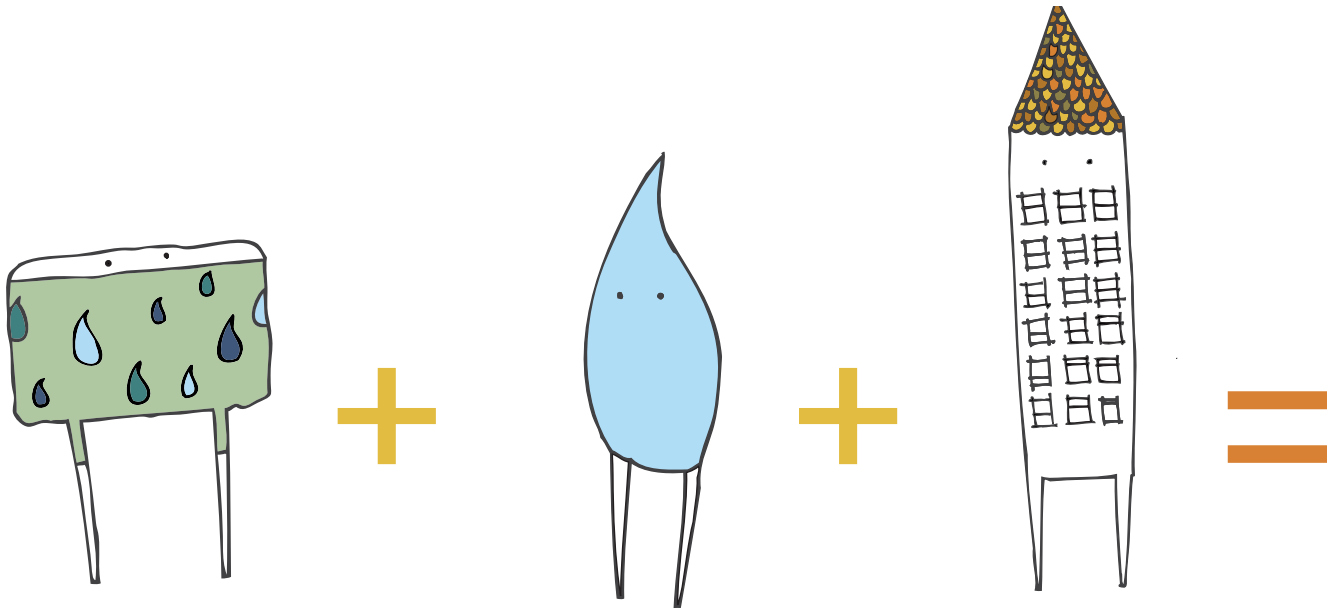
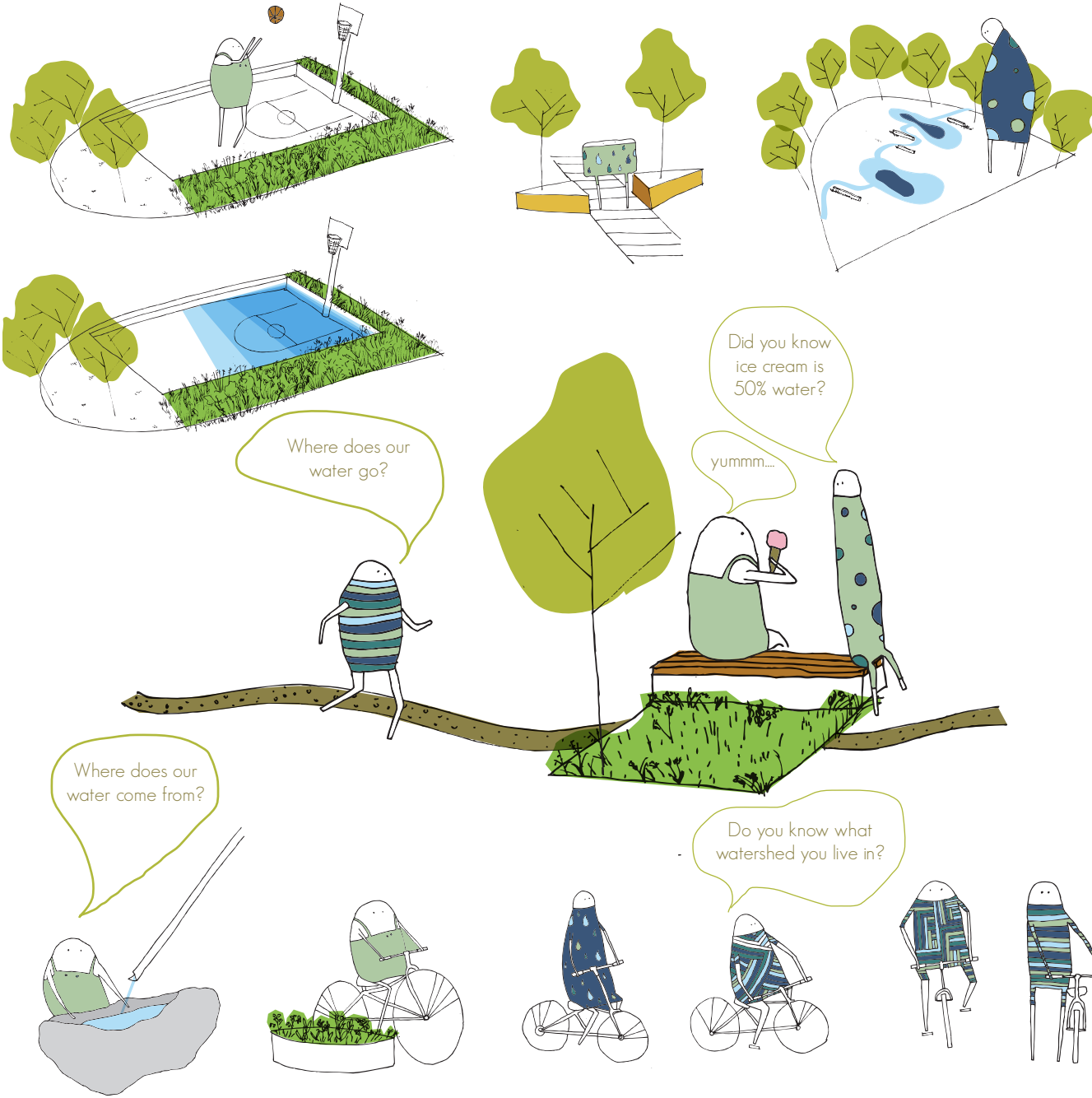


POROUS PUBLIC SPACE


Where does our water go?
Did you know ice cream is 50% water?
yummm....
Where does our water come from?
Do you know what watershed you live in?


I'll tell you the story of my water...
Oh boy, here we go again...
Can you imagine a world without water?
No way!

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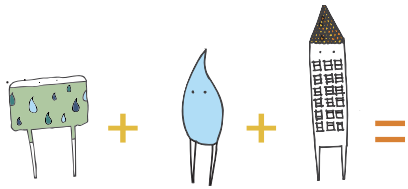
FOREWORD

How can design help us to regard stormwater as a resource rather than waste? How can the celebration of water bring people together in public space? How might a heightened awareness of water—positioned in its unique geophysical context—promote an urban life culture with an authentic sense of place?

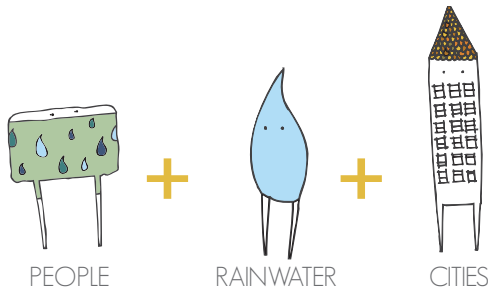
Interns Roxanne Lee and James Wohlers have created this whimsical guide to help planners, designers and citizens understand the urban design potential inherent in watershed contexts. The pair base their creative proposals upon research and inspirations from the US and abroad, and present several compelling case studies. You, the reader, will enjoy following their characters to imagine how your streets, plazas and neighborhoods can be conceived to create places that embody multiple meanings of porosity. The Green Futures Lab is pleased to sponsor and distribute this guide, with profound thanks to the ScanlDesign Foundation for funding the internships and publication, and to Louise Grassov from Schulze + Grassov, Copenhagen, for providing guidance along the way.

Enjoy imagining how your city's public spaces can invite both water and people to infiltrate and interact, in and for, great public spaces!

Nancy D. Rottle, RLA, FASLA
Director, UW Green Futures Research and Design Lab
Associate Professor, UW Department of Landscape Architecture



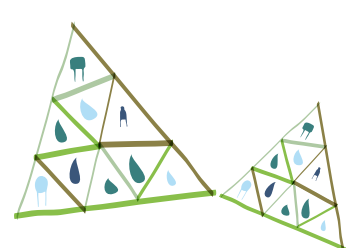
POROUS PUBLIC SPACE



What is Porous Public Space?

Our vision for porous public space interweaves people and rainwater, giving both space to thrive.

Porous public space breaks through the concrete crust, reconnecting urban rainwater to the complete hydrological cycle. It brings consciousness to urban rainwater, embedding its presence into our narrative and experience of daily life. Water is life.



Porous

A skeletal framework with small interstices through which water and air can pass

RAINWATER versus STORMWATER

Stormwater is rainwater in disguise. Rainwater is the main source of freshwater, which all life depends on. Let's plan for rainwater in creative and engaging ways to transform a perceived waste into a valued resource.

How to use this manual

This manual is a tool for reimagining our relationship to rainwater in cities. We have developed a framework for the design process, programming and evaluation of public porous space. We apply our framework to streets, plazas and neighborhoods.

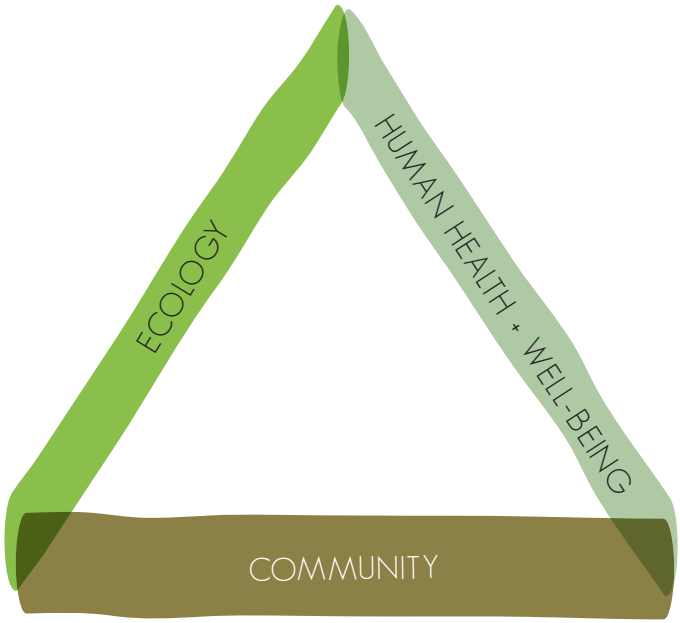
Porous Process

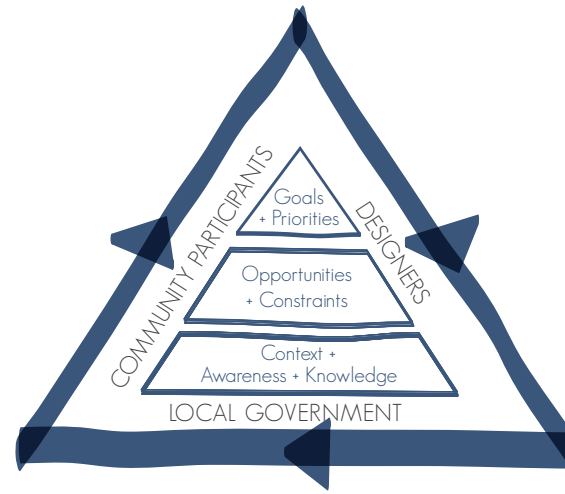
A collective, inclusive and transparent community-based design process.

Porous Public Space

A regenerative and adaptive place that interweaves people and rainwater.

The **framework** structures the community-based design **process**





FRAMEWORK

is based on three core values:

Ecology

Systems-based approach that supports ecological complexity, strengthening the urban ecosystem's collective ability to adapt to disturbances.

Community

Context responsive designs that build on local identity and meet community needs.

Human Health + Well-being

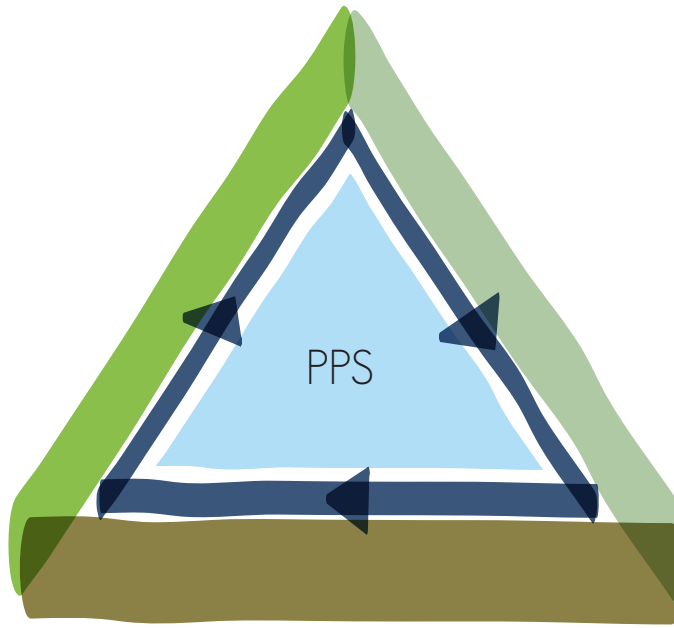
Improve the quality of health for people and urban ecosystems.

PROCESS

is collective and inclusive.

Design is a tool to solve problems. Collaboration between community participants and designers ensures that the problems being solved are meeting the community's priorities. It also democratizes the design process, so that places are designed for and by the local community who will use them.

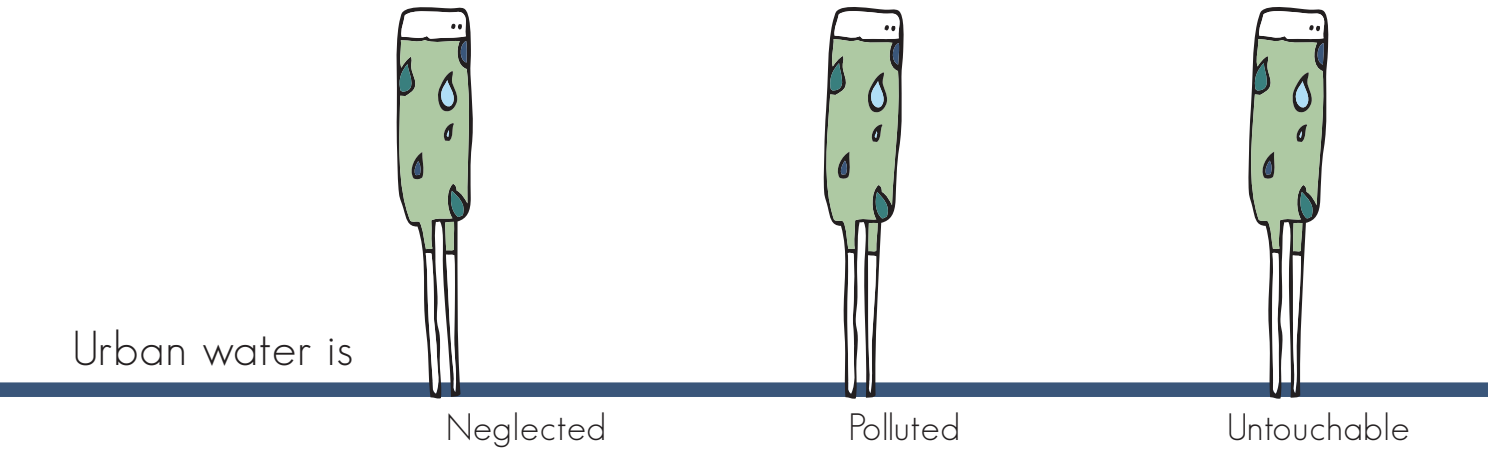
to create porous public **space**.

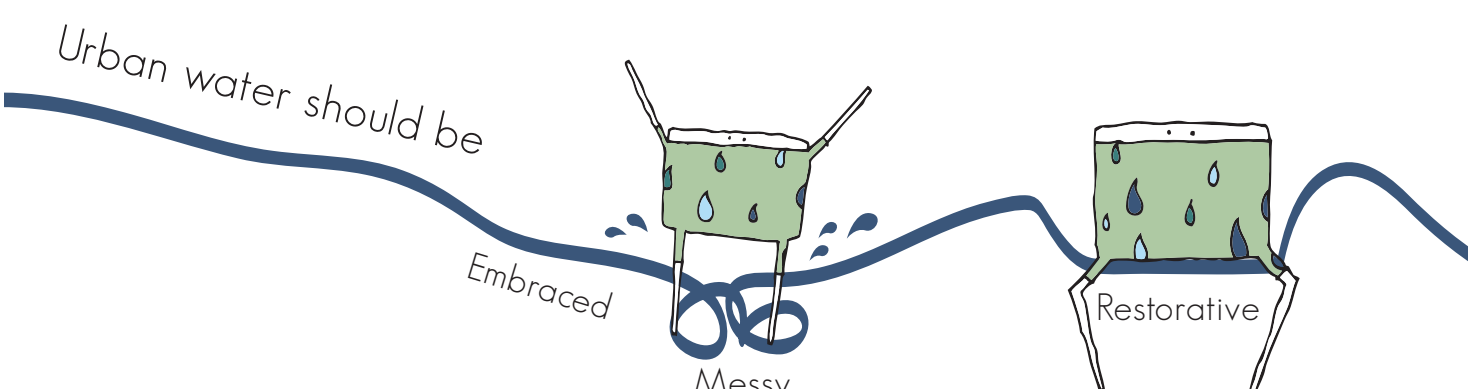


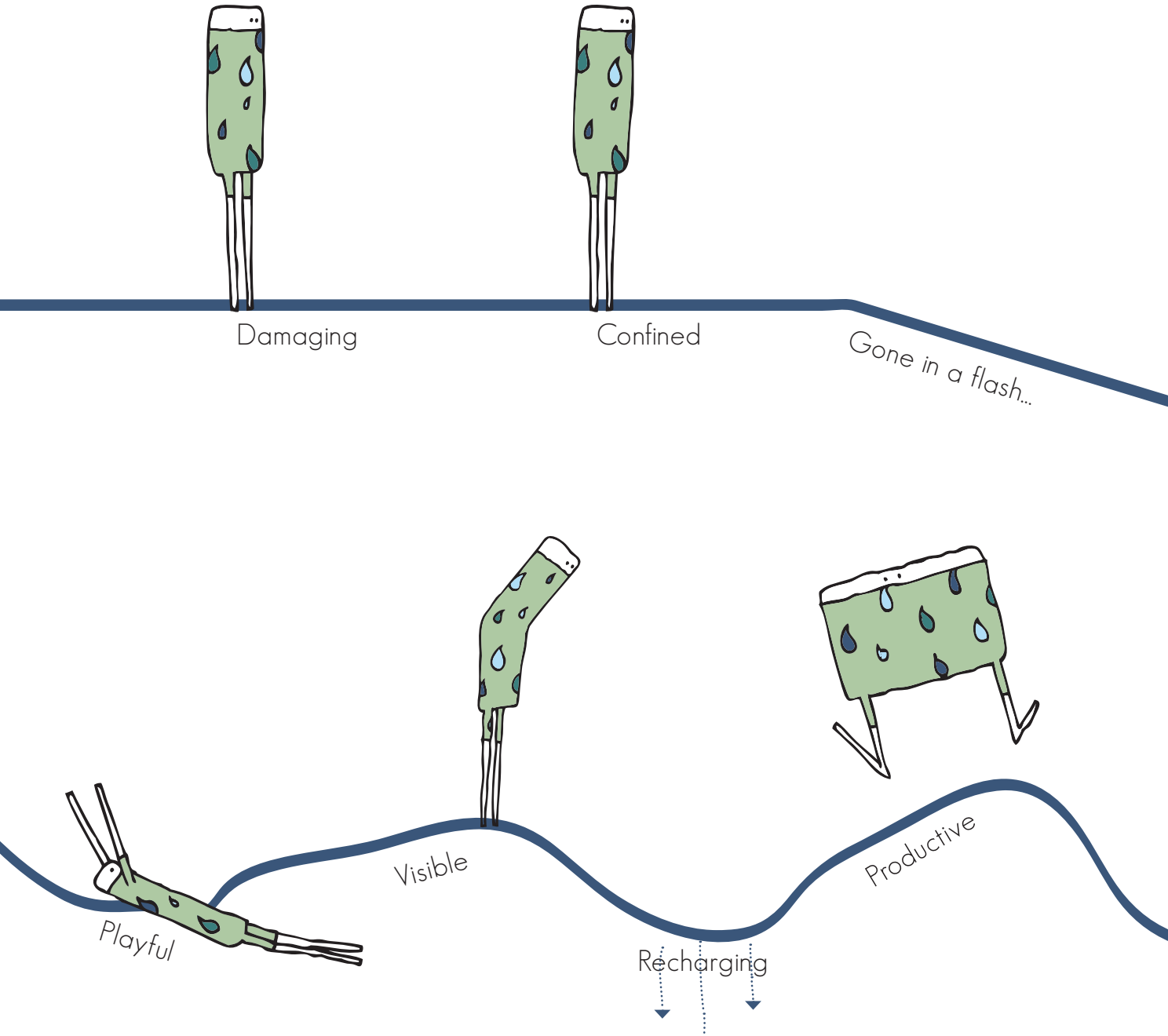
POROUS PUBLIC SPACE

people + rainwater + cities

Performance	Multifunctional and regenerative places that meet the social, cultural and ecological needs of our cities.
Legibility	Reveal, connect, embed water's footprint in our cultural consciousness and daily life.
Symbiosis	Improve the quality of life for all by designing healthy ecosystems for people and water.

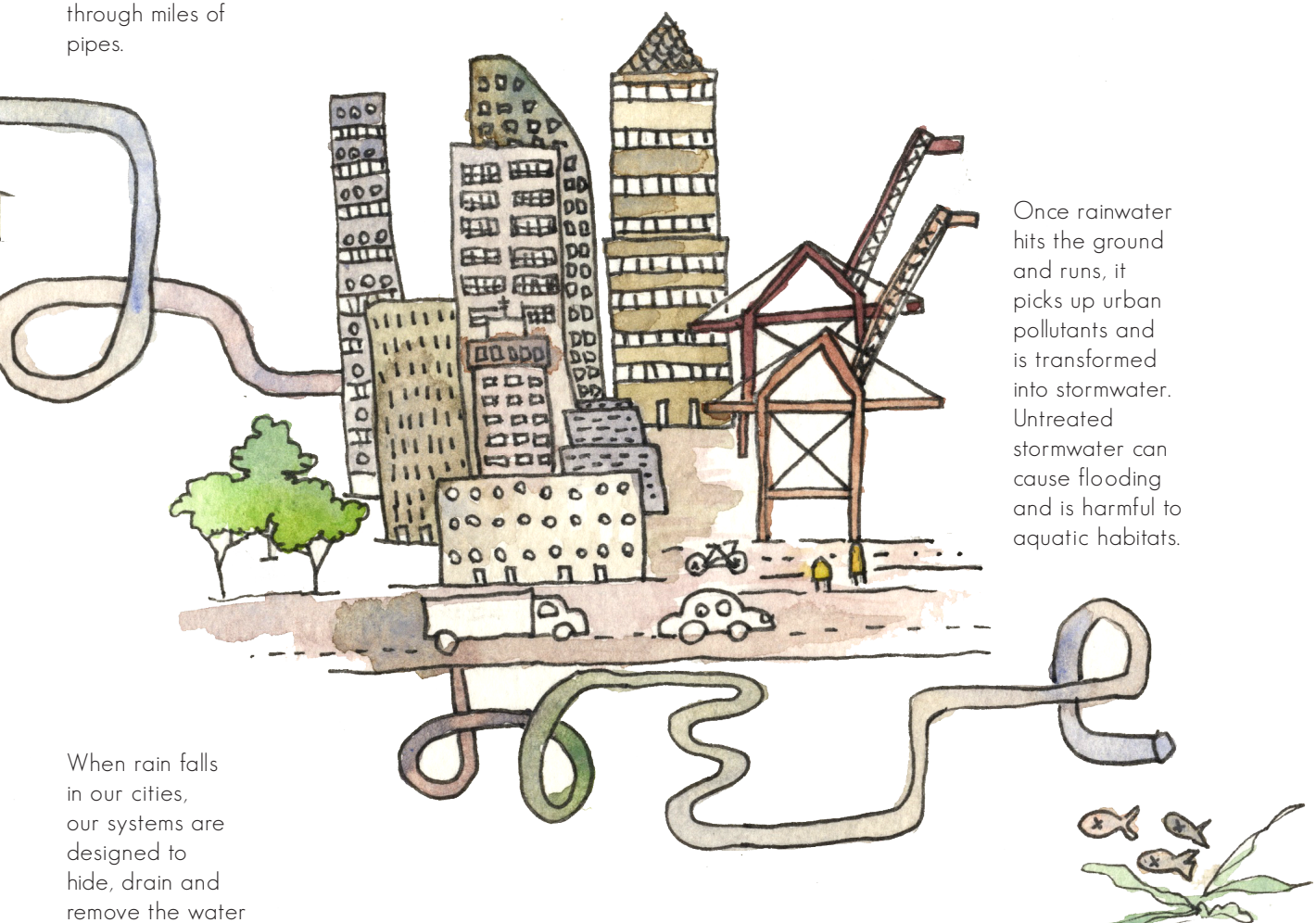

Urban water is
Neglected
Polluted
Untouchable


Urban water should be
Embraced
Messy
Restorative


Damaging
Confined
Gone in a flash...
Playful
Visible
Recharging
Productive

Currently, water flows down a broken loop system...

Our cities rely on distant sources of fresh water that are transported to our faucets through miles of pipes.



Once rainwater hits the ground and runs, it picks up urban pollutants and is transformed into stormwater. Untreated stormwater can cause flooding and is harmful to aquatic habitats.

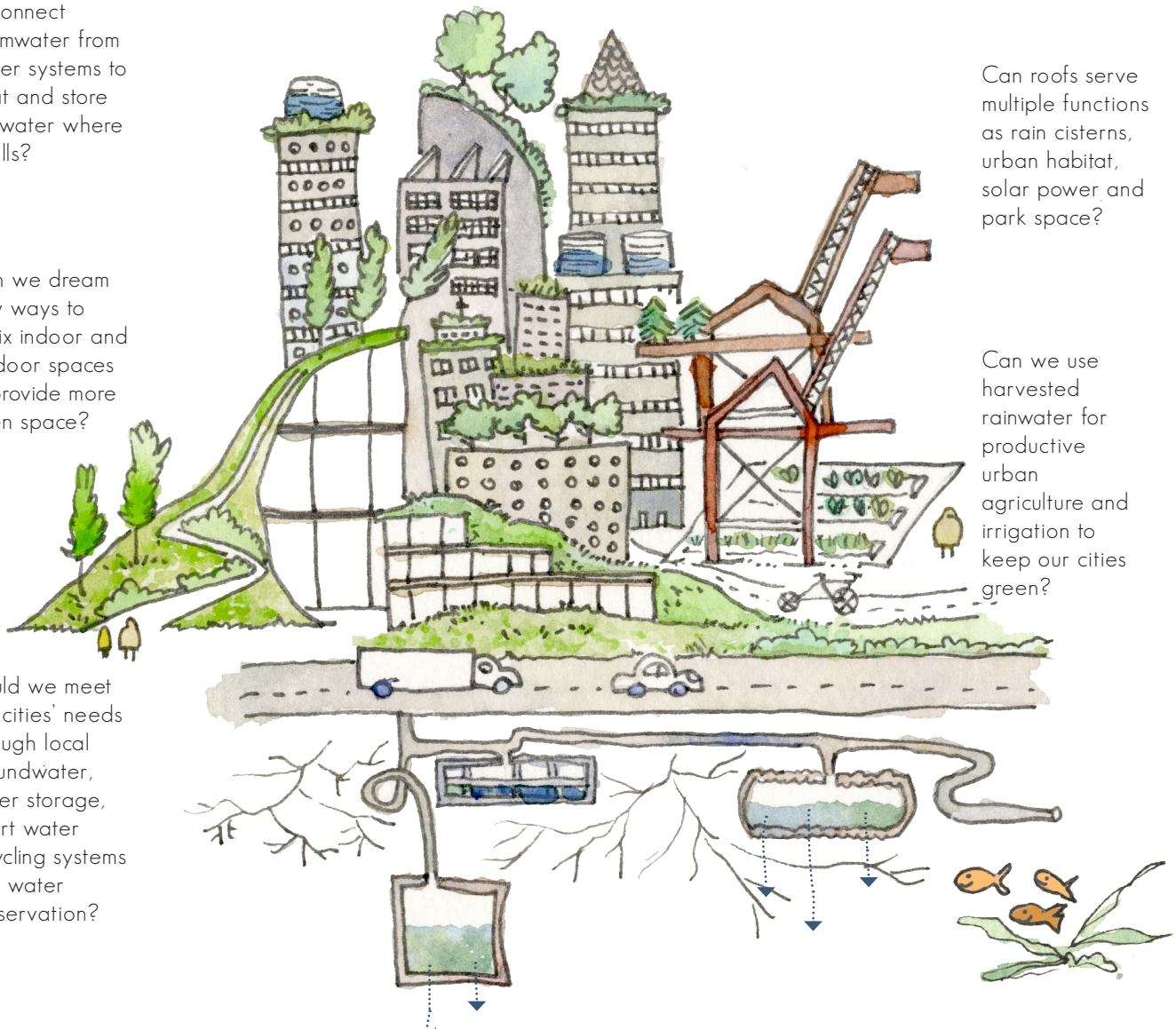
When rain falls in our cities, our systems are designed to hide, drain and remove the water as quickly as possible.

Can we reimagine water as a closed loop system?

Can we disconnect stormwater from sewer systems to treat and store rainwater where it falls?

Can we dream new ways to remix indoor and outdoor spaces to provide more open space?

Could we meet our cities' needs through local groundwater, water storage, smart water recycling systems and water conservation?



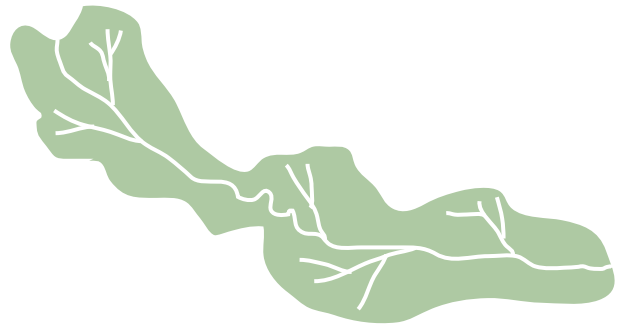
Can roofs serve multiple functions as rain cisterns, urban habitat, solar power and park space?

Can we use harvested rainwater for productive urban agriculture and irrigation to keep our cities green?

Seven principles that can be used to guide the design process or evaluate designed porous public spaces.

POROUS PUBLIC SPACE PRINCIPLES

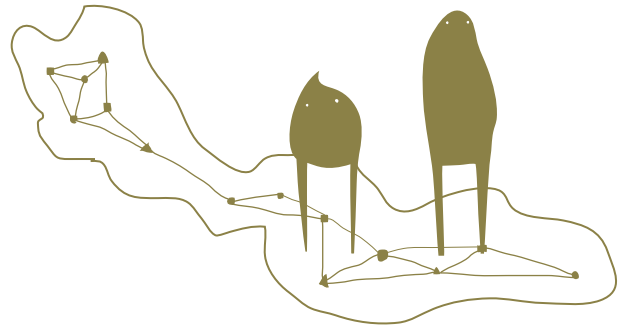
Design process and evaluation principles



WATERSHED SCALE PRINCIPLES
Design for the larger context

Porous public spaces are designed to improve the long term health of the entire watershed system.

Whole System



SITE SCALE PRINCIPLES
Water + People = Rich Public Life

Porous public spaces are designed to activate public space by bringing water and people together.

- Full Water Cycle
- Full Soil + Vegetation Cycle
- Human Health + Wellbeing
- Adaptive Design
- Community Engagement
- Maintenance, Monitoring + Evaluation

Watershed Scale Principles
Design for the larger context

Manage as one entire interconnected system

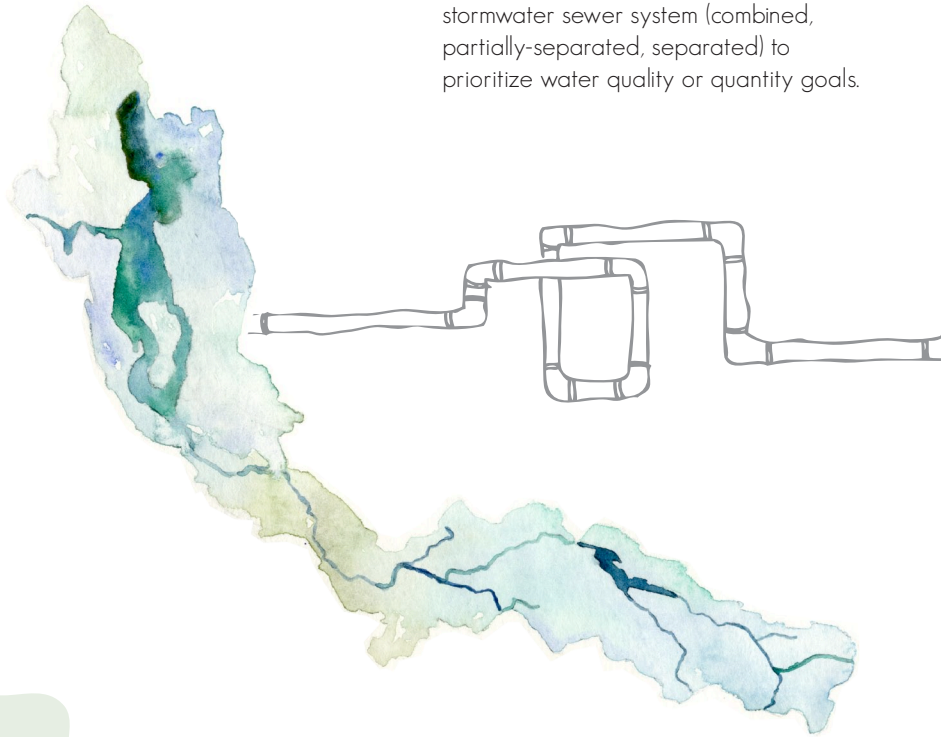
Porous public spaces are designed to improve the health of the entire urban watershed system. A healthy watershed provides ecosystem services that improve a city's ability to adequately respond, adapt and recover from annual precipitation as well as unpredictable climate induced disasters such as flooding, drought, rising temperatures and limited access to clean water or healthy food.

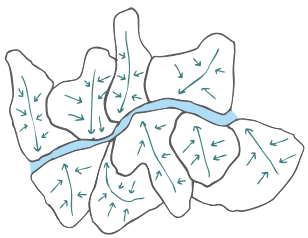
Healthy watershed ecosystem services:

- Clean, filter and store water
- Support local food production
- Provide biodiverse habitats
- Cycle nutrients
- Reduce flooding + erosion
- Absorb urban pollutants and greenhouse gases
- Regulate air temperature

Where does the water go?

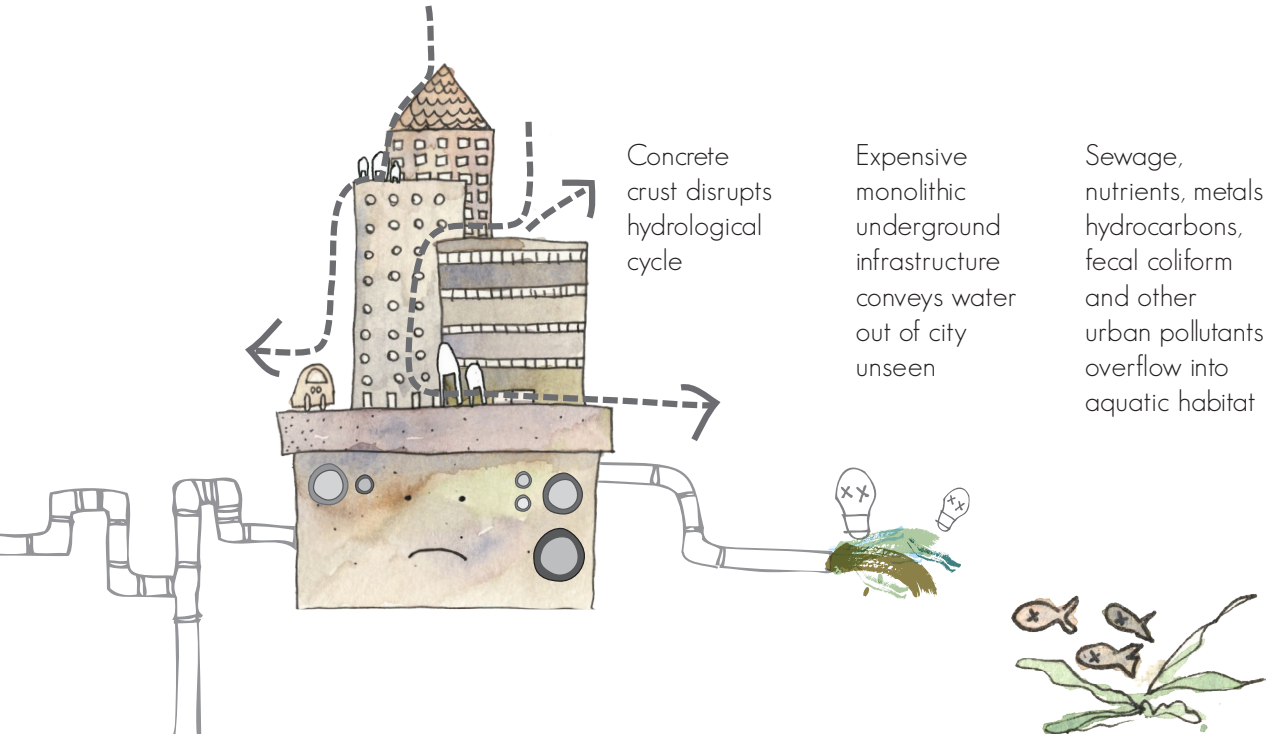
It's important to understand the existing stormwater sewer system (combined, partially-separated, separated) to prioritize water quality or quantity goals.





How does the water flow?

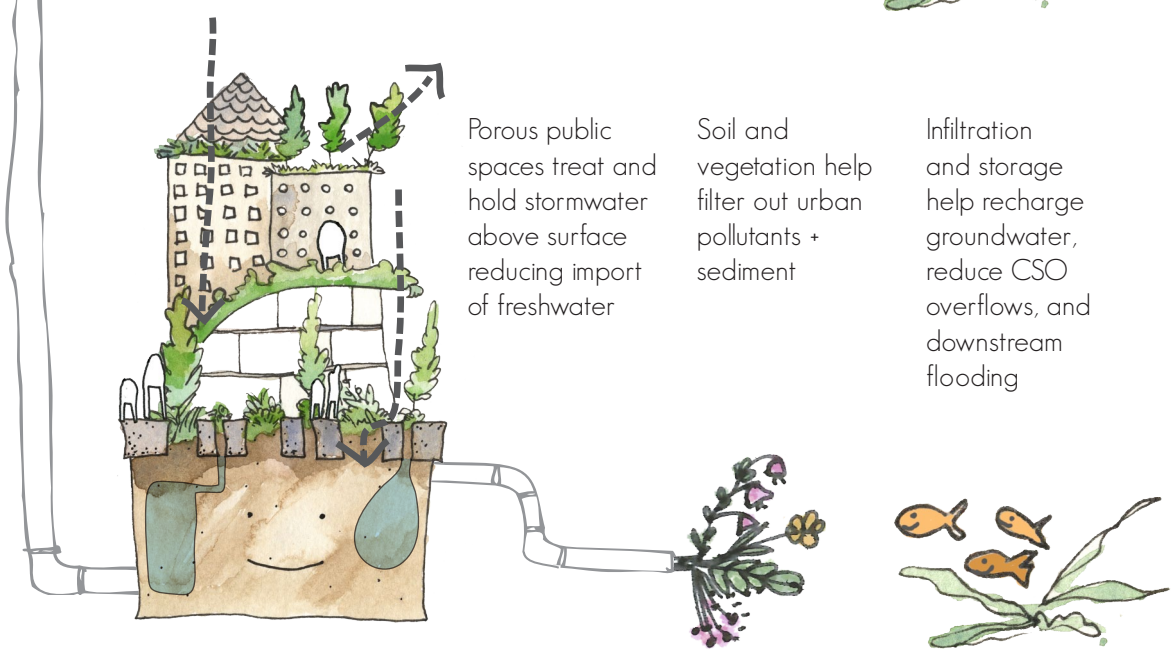
It's important to understand the surface and subsurface flow of water through a watershed to identify the most effective areas for treating rainwater at its source.



Concrete crust disrupts hydrological cycle

Expensive monolithic underground infrastructure conveys water out of city unseen

Sewage, nutrients, metals hydrocarbons, fecal coliform and other urban pollutants overflow into aquatic habitat



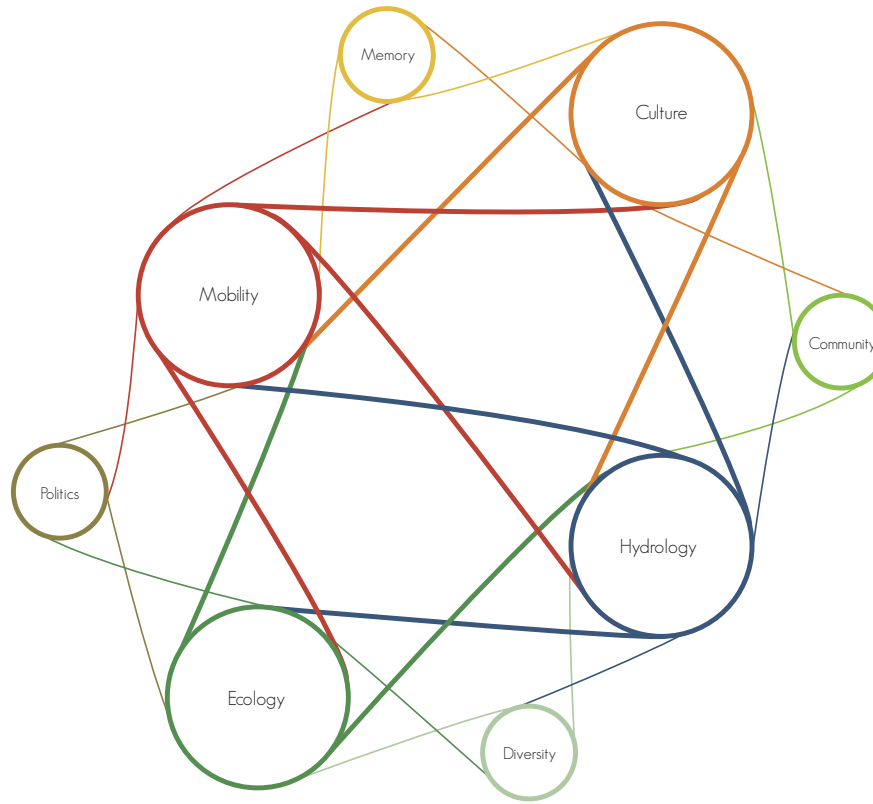
Porous public spaces treat and hold stormwater above surface reducing import of freshwater

Soil and vegetation help filter out urban pollutants + sediment

Infiltration and storage help recharge groundwater, reduce CSO overflows, and downstream flooding

Interconnected Systems

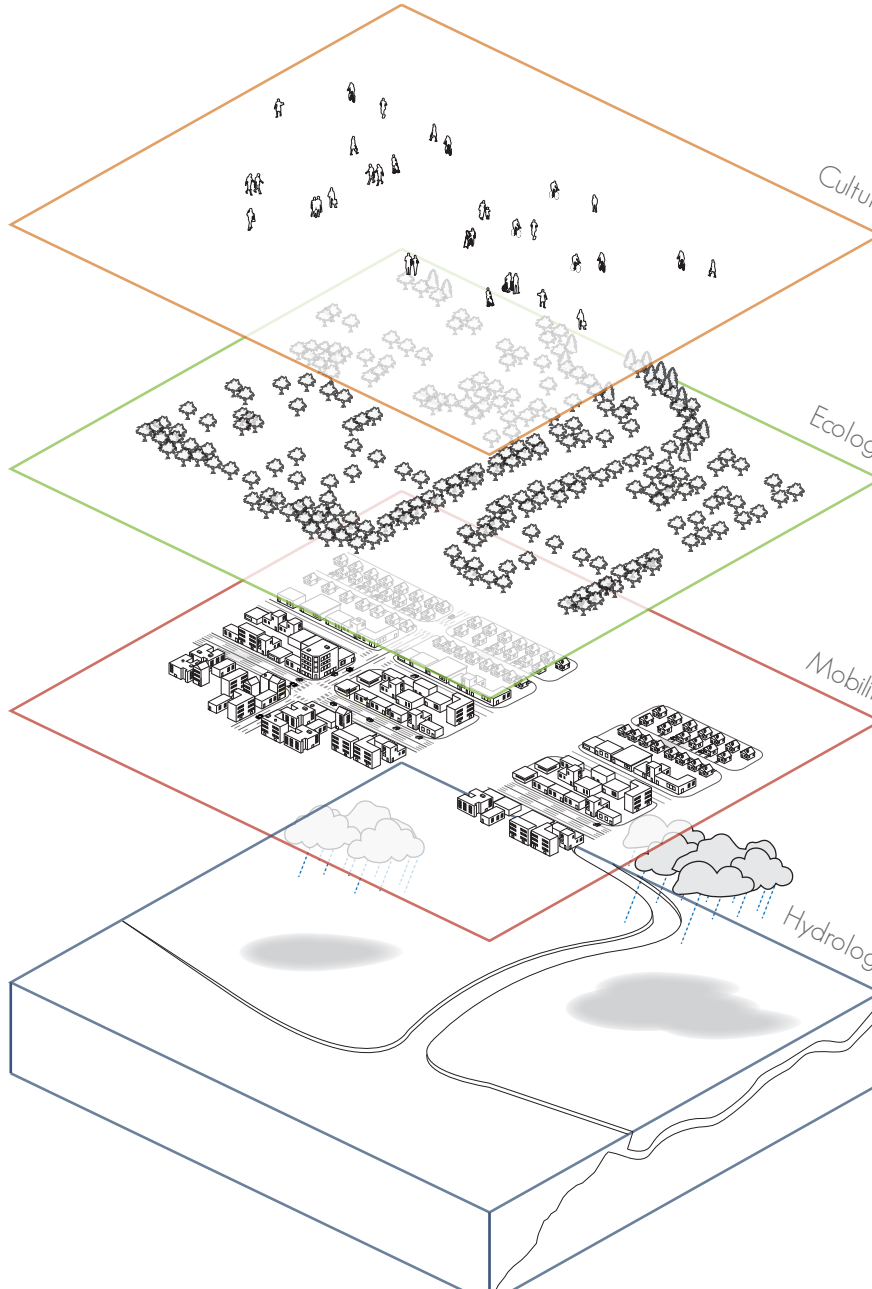
Designing for whole systems requires a systems-based approach to improving ecological infrastructures that collectively support an ecosystem's ability to recover and adapt to disturbances. A systems-based approach acknowledges that ecosystems are constantly in flux, while also understanding both upstream and downstream impacts. PPS strategies improve an ecosystem's ability to be flexible, reversible and evolving.



Interacting landscape-based systems are intertwined and inseparable.

WHOLE SYSTEM

Porous Public Spaces should look beyond the city and consider how changes to the local space will impact the health of the urban watershed in which it lies.


Culture
Ecology
Mobility
Hydrology

Site Scale Principles
Water + People + Vibrant Public Life

Zooming in on Urban Space

Human health and well-being is inextricably linked to the health of our environment. Goals of public porous space should focus on:

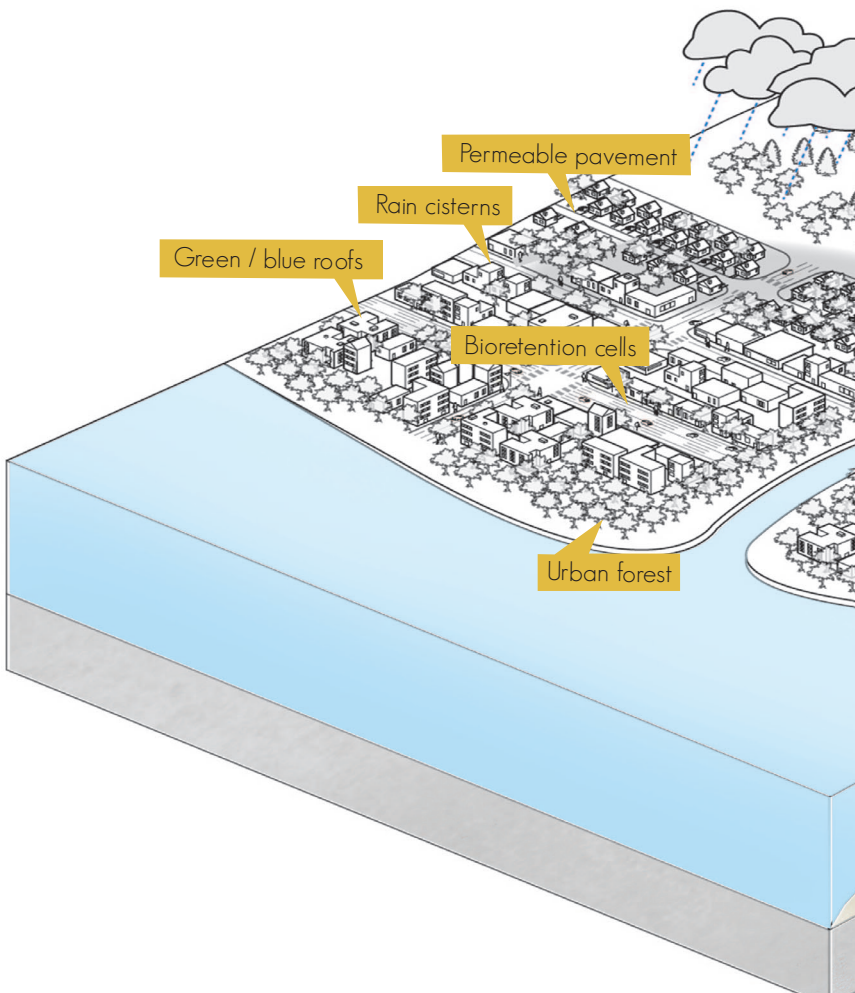
LEGIBILITY
Improve legibility of watershed health for public understanding and stewardship

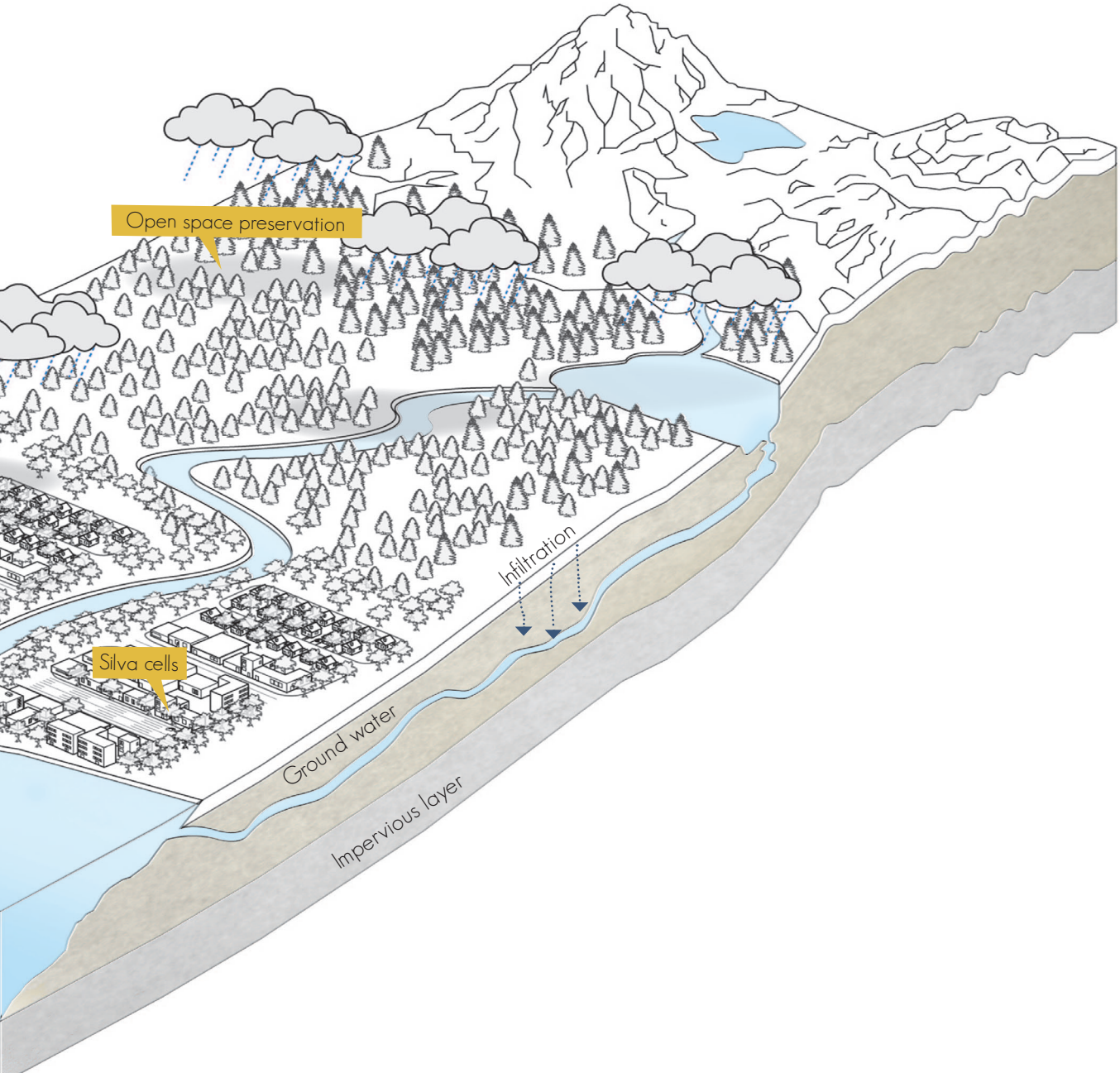
SYMBIOSIS
Create richer public life by focusing on programmatic and physical design elements that embed urban water into people's daily life

PERFORMANCE
Improve the ability of urban watersheds to adapt to disturbances and unpredictable impacts of climate change; and the ability of urban ecosystems to carry out ecosystem services that create more resilient urban networks

Porous Public Space improves:

- Understanding of urban watersheds
- Stewardship of water resources
- Social connectedness around rainwater
- Playful + educational interaction with urban water
- Civic + Community engagement




Open space preservation
Infiltration
Silva cells
Ground water
Impervious layer

Water

Designing for the full water cycle increases consciousness of urban rainwater, playfully engaging people with their five senses, while activating public space.

The concrete encrusted surfaces of cities displace rainwater from the natural hydrological cycle. Designing living systems to respond and adapt to the movement of rainwater through space reconnects the urban hydrological cycle, recharging local groundwater, cleaning urban pollutants and increasing urban habitat. These living systems should be legible, to encourage people to connect their actions to the health of the urban watershed.

Recommendations:

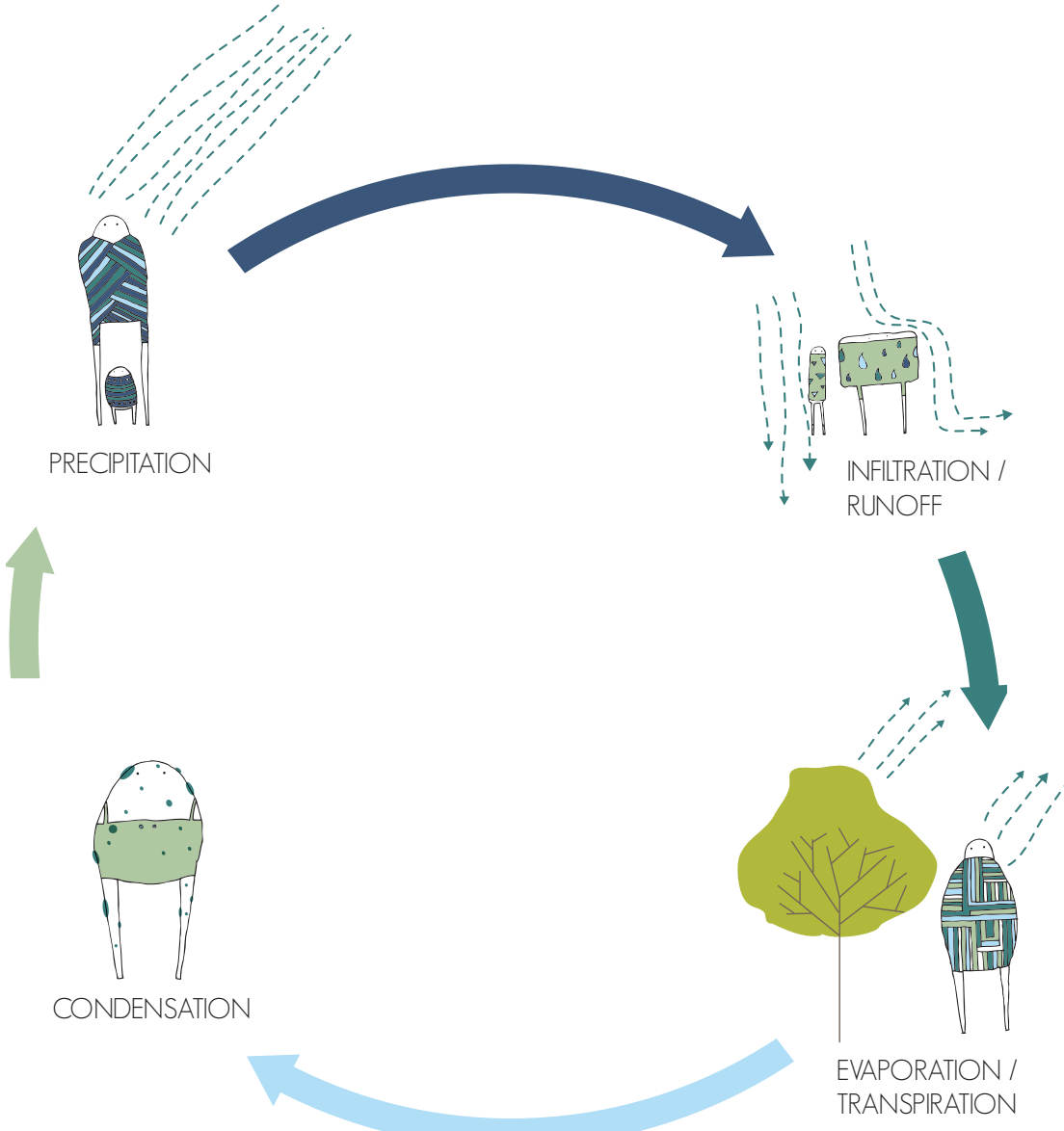
- Reduce precipitation runoff volumes, peak flows and pollutant discharges
- Increase filtration and mitigate elevated water temperatures caused by contact with impervious surfaces by infiltrating water on site
- Use rainwater harvesting systems to reduce runoff volumes
- Design the site to maximize the use of captured stormwater for landscape elements
- Design plantings, soil and other features to be self-sustaining with natural precipitation
- Water features intended for human contact may require additional treatment such as uv or thermal treatment

Uptown Normal: Cleaned stormwater used for fountain and streetscape irrigation (Image: Hoerr Schaudt)

Washington Canal Park: Captured, treated + stored stormwater used for fountains, irrigation, toilets + ice skating path (Image: Olin)

FULL WATER CYCLE

Porous Public Spaces should integrate rainwater, keeping it on the surface. Utilize strategies that reuse and infiltrate rainwater on site to clean and recharge groundwater, while revealing it for people to enjoy.


PRECIPITATION
INFILTRATION /
RUNOFF
EVAPORATION /
TRANSPIRATION
CONDENSATION

Soil

Healthy urban soils act like a sponge, supporting ecosystem functions that store and infiltrate urban rainwater, filter pollutants and prevent erosion, sedimentation and flooding. Soil microorganisms are effective at breaking down metals, pesticides, and pollutants, mixing organic material and increasing aeration.

Recommendations:

- Create a long term soil management plan
- Provide infiltration opportunities that use plants and healthy soils as biofilters
- Monitor and evaluate the concentration of pollutants in soil
- Increase interception and evapotranspiration with vegetated rainwater features and trees
- Limit disturbance of existing soil and plants throughout construction to protect existing ecosystem functions
- Improve the water-retention capacity of soil by increasing the organic matter content of the soil

Vegetation

Plants and their root systems are important for pollutant removal, water infiltration, sediment filtration, reduced water and climate temperatures and production of organic material. Increasing healthy plant ecosystems reduces the urban heat island effect by regulating local temperatures through evapotranspiration and shaded microclimates. Vegetation also provides habitat, food and shelter for urban wildlife and pollinators.

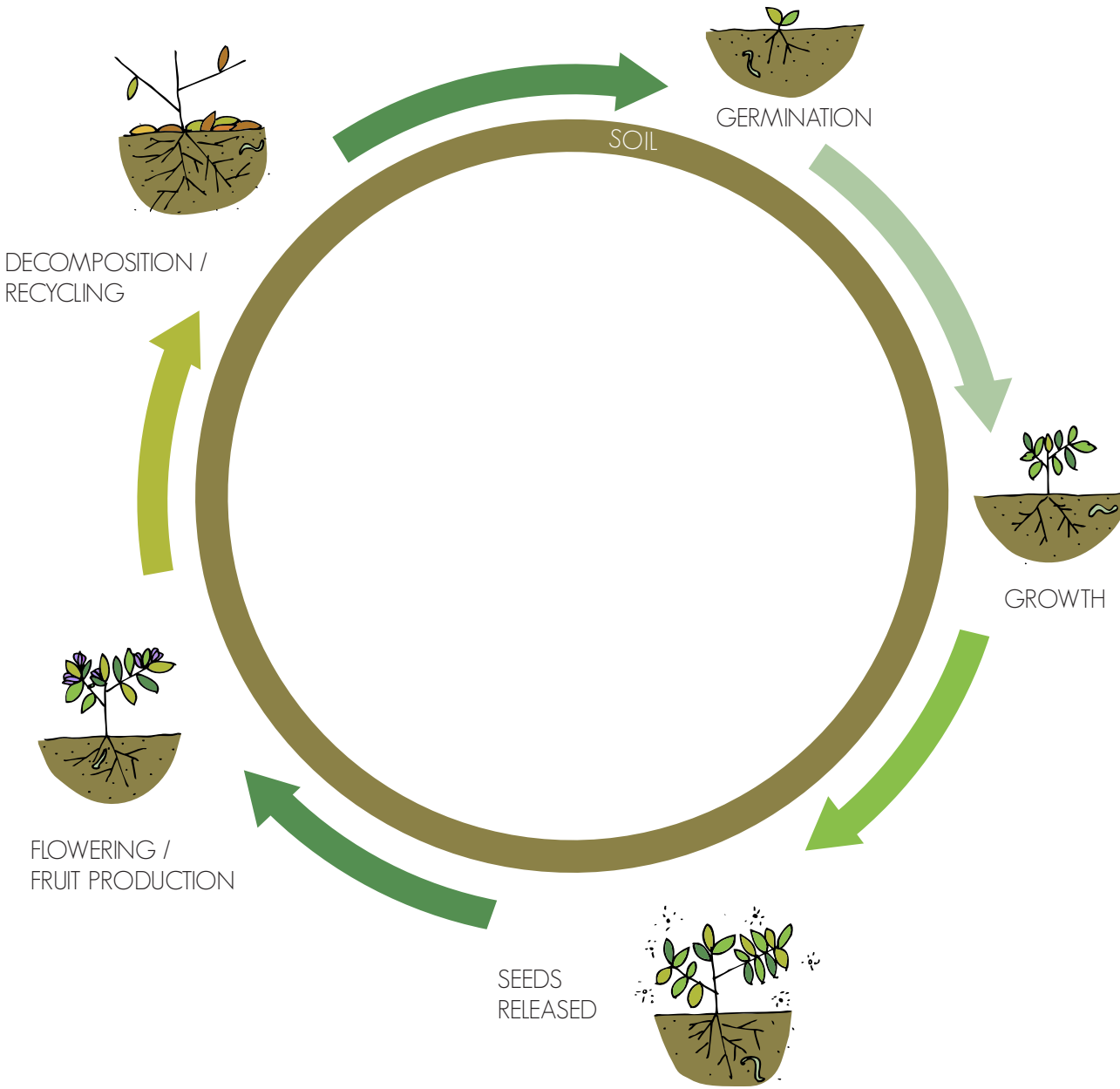
Designs should focus on increasing biodiversity by using native plants that have a tolerance for prolonged flooding, fluctuating water levels, sedimentation and urban pollutants. While native plants are a first choice, sometimes non-native plants are better adapted to these conditions, so well-informed plant selection and management is important.

Recommendations:

- Design to reveal seasonality and fluctuating water levels with plant palette
- Improve landscape performance and reduce resource use by installing plants that are appropriate for site conditions, climate and design intent
- Select appropriate vegetation features that can tolerate periodic inundation, soil saturation and pollutant load

FULL SOIL + VEGETATION CYCLE

The complex relationship between soil, plants and microbial communities are the foundation for green stormwater infrastructure. Landscape performance increases over time, improving the ecosystem's overall capacity to regulate water, nutrient, atmospheric gas and climate cycles.


SOIL
GERMINATION
GROWTH
SEEDS
RELEASED
FLOWERING /
FRUIT PRODUCTION
DECOMPOSITION /
RECYCLING

Accessibility/Safety

Accessibility allows a diversity of people to easily visit, use and traverse the space. Everyone should be able to access and enjoy public spaces. Safety also goes hand-in-hand with accessibility. Rainwater activates a space. Through conveyance, it contributes to movement, and through retention, it can support plants and habitat. High visibility from the edges of the space as well as lights at night also contribute to the perceived safety.

Recommendations:

- Allow users to navigate spaces according to their needs
- Connect to existing active sites and networks
- The safety of pedestrians comes first, then cyclists, then automobile drivers
- Rainwater retention facilities should have clearly marked edges

Well-being

A sunny spot on a beautiful summer day can attract many people. Likewise, a sheltered spot on a blustery day can be appealing. Porous Public Spaces should feature a variety of settings for pleasant and inclement weather. Connecting people to natural elements like water can alleviate stress and improve their physical well-being. Hearing the flow of water or feeling it run through your fingers rejuvenates and refreshes the mind and body.

Recommendations:

- Provide a variety of spaces to relax, either in sun or shade
- Place rainwater features in proximity to people
- Integrate planting with the flow of water and people
- Design spaces according to human scale
- Consider how water will sound as it hits a surface

Interaction

Public spaces may encourage people to navigate through a shared space with others. When rainwater is included in this encounter, it can enliven and bring identity to a space. Indeed, rainwater can be the centerpiece, drawing passersby to its motion and soothing sounds. Alternatively it can flow beneath ground, revealed intermittently to create points of interest around which people can gather. Rainwater helps define a space, providing opportunities for people to interact with it and each other.

Recommendations:

- Invite people to stay on site by providing a range of seating options
- Consider the distances at which people will engage each other
- Design flexible space for a diversity of necessary and spontaneous activities
- Consider how water will influence where paths cross

HUMAN HEALTH + WELLBEING

Porous Public Spaces contribute to public life and health through equitable and accessible use, mental/physical well-being, and possibilities for social interaction.

Accessibility - Malmö, Sweden

Skaters and Cyclists enjoy this plaza alongside children playing in the fountain.

Well-being - Cirkelbroen, Copenhagen, Denmark

Public space in Copenhagen where people can sit in the sun, feet dangling over the canal, as boats and kayaks pass by.

Interaction - Jægersborggade, Copenhagen, Denmark

The streets of Copenhagen are sometimes converted into gigantic block parties filled with food, drink, and laughter.

Redundancy

Porous public spaces should be designed with multiple connections to other facilities on- and off- site, expanding the city's collective ability to respond to seasonal precipitation events through a robust natural drainage network.

Recommendations:

- Design considering the function of interconnected green stormwater infrastructure (GSI) facilities on- and off- site
- Design facilities with fail safe overflows or underdrains
- Make legible the flow of water through various GSI facilities to bring awareness of how systems work together

Resilience

Design adaptable porous public spaces to support healthy watershed functions which slow, soak, spread, filter and harvest urban water to maximize ecological and social benefits. Use design strategies that improve the city's collective human and ecological capacity to respond, recover and thrive to disturbances.

Recommendations:

- Design GSI facilities that reveal the multiple ways it manages urban rainwater
- Design educational, interactive and investigative programming that reveal the movement of urban rainwater
- Signage and intuitive wayfinding to educate and encourage stewardship of local water resources

Distribution

Distribute GSI, focusing on a network of shallow decentralized facilities. Highly engineered deep facilities are expensive and focus on rapid water volume removal rather than treating pollutants or infiltrating stormwater. Distributed micro-facilities mimic natural ecosystems: slowing, dispersing, cleaning and storing urban rainwater on the surface.

Recommendations:

- Manage urban rainwater on the surface in multiple locations to reduce or eliminate contribution to sewer system
- Design decentralized GSI facilities that manage urban rainwater at the source

ADAPTIVE DESIGN

Increase capacity and connectivity of PPS sites to adapt and respond to varying duration, amount and intensity of precipitation. Design to reveal seasonal variation in precipitation, making legible the resilient, redundant and distributed GSI.

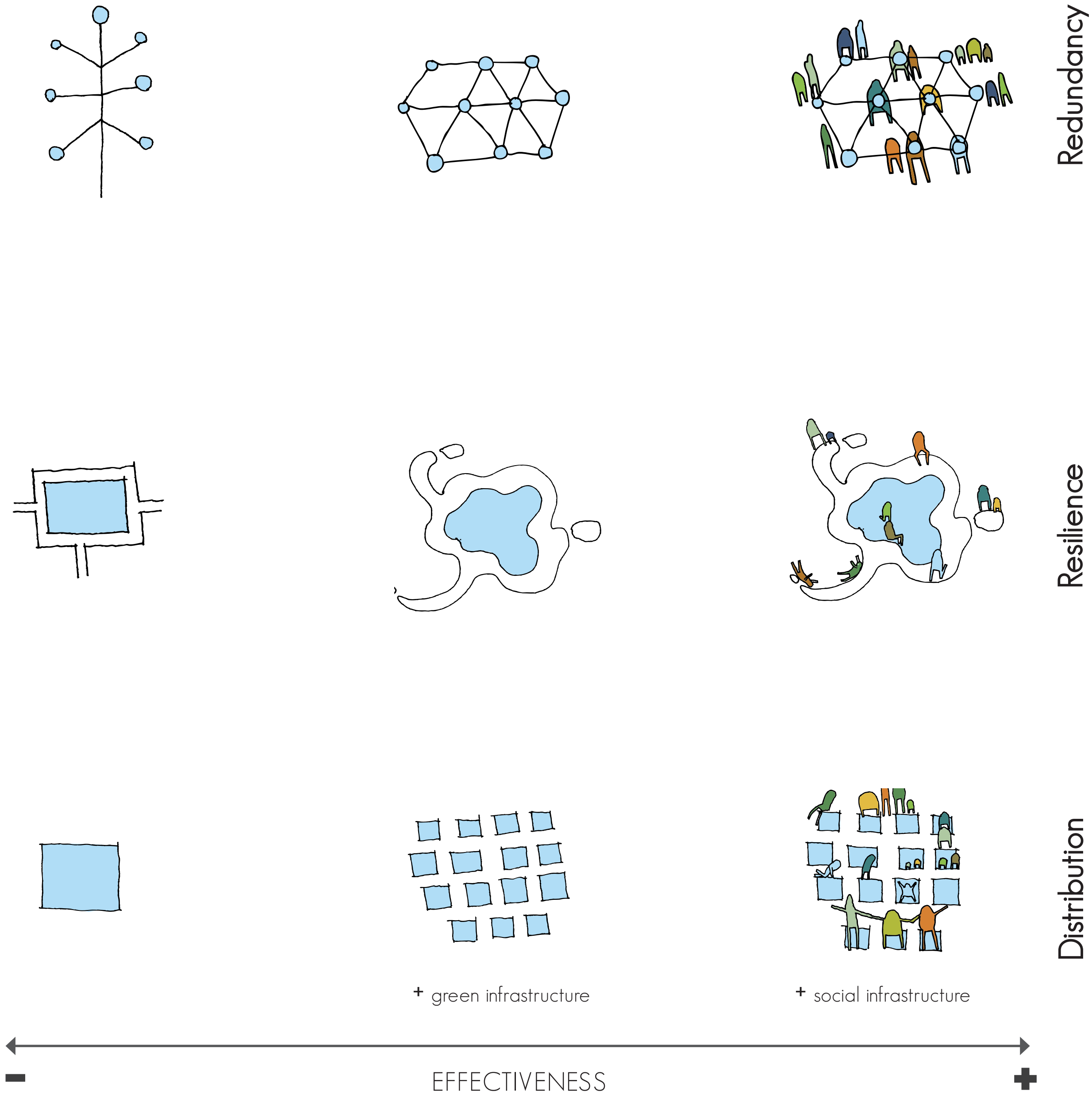


Diagram adapted from UACDC LID Manual

Porous Process

Collaborative community-based design is an inclusive process, that enriches the creation and experience of collectively designed places. Including all voices in the design process ensures that designers understand existing resources, goals and concerns. This process empowers participants with the tools to reimagine, constructively critique and prioritize programs, rooting places in community-specific character. Democratizing the design process expands the working knowledge base, creating robust site specific solutions that address the long-term human and environmental health of neighborhoods and encourages long-term local stewardship.

Community-based Design Process

Design is a tool to solve problems. We need to design collaboratively with communities in order to fully understand local problems and priorities.

Context Awareness Knowledge

Sharing knowledge + awareness in context of the site within the larger watershed system is important to build a larger working body of knowledge.

Opportunities + Constraints

Collective idea generation founded on shared knowledge is an iterative process to design strategies that help communities + designers solve problems.

Goals + Priorities

A clear understanding of the community's goals and priorities is the basis for beginning the collaborative design process to solve community specific problems.

COMMUNITY ENGAGEMENT

Porous Public Spaces should include the community's voice in the design process.

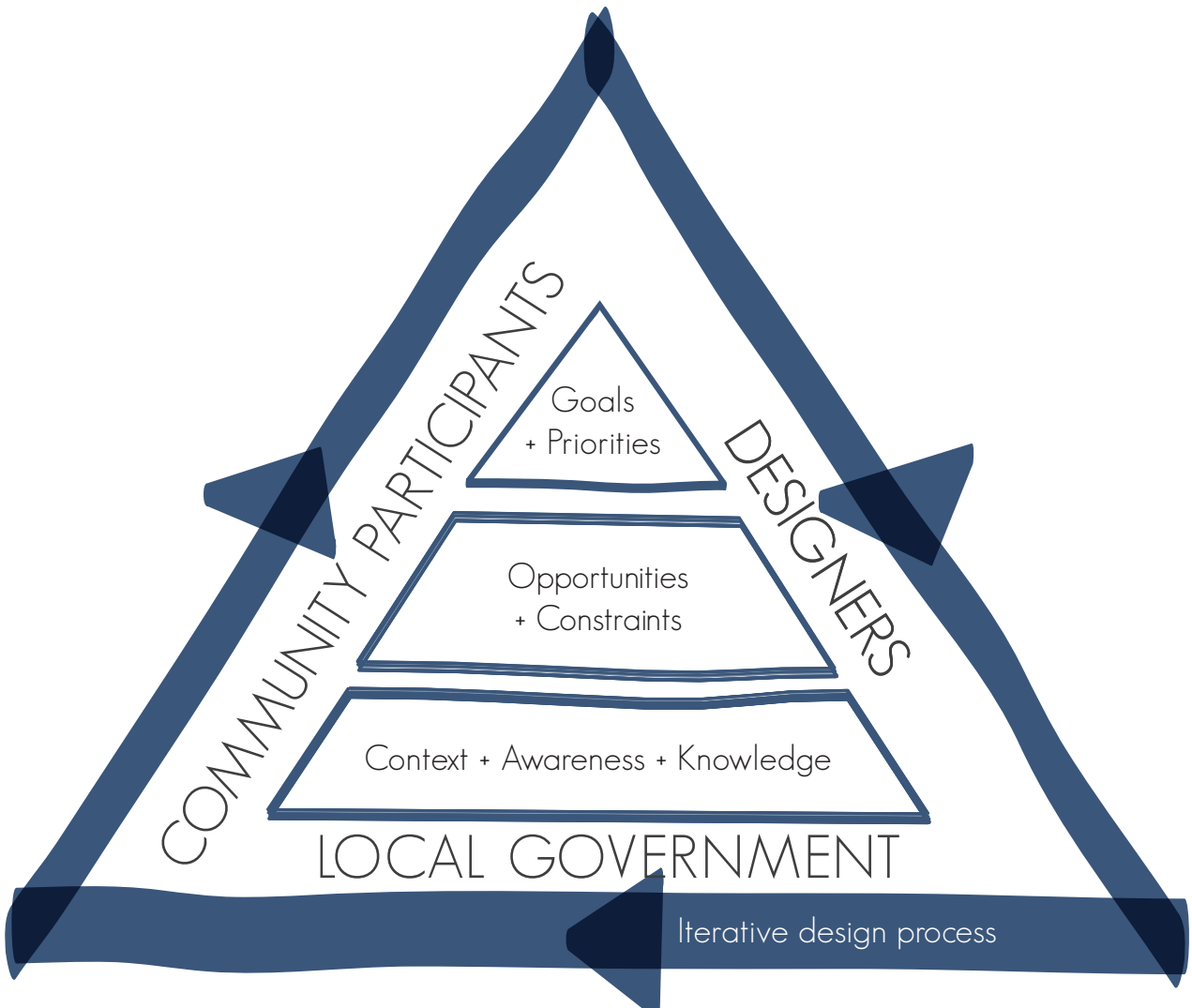

COMMUNITY PARTICIPANTS
DESIGNERS
Goals
+ Priorities
Opportunities
+ Constraints
Context + Awareness + Knowledge
LOCAL GOVERNMENT
Iterative design process

Image: Pomegranate Center

Porous public space uses a collection of green stormwater tools to address community identified goals, problems and priorities regarding watershed management, safe streets for bikes and pedestrians, recreational outdoor space, urban wildlife and native pollinator corridors.

The process of designing porous public spaces involves educating the community on the function, benefits and maintenance of GSI as well as understanding community priorities and using GSI as a way to address those priorities.

Recommendations:

- Get out into the community early
- Listen to and understand the concerns, goals and resources of the community
- Understand the aesthetic preferences of the community
- Introduce the problem you are trying to solve, before you present the solution
- Develop several different strategies for communicating with the public to make sure they feel heard (Community meetings, one-on-one or small group meetings, online surveys, paper mailings)
- Be clear with the community on:
  - How GSI works
  - What the community should expect to observe over time

Image: Detroit Collaborative Design Center

CASE STUDY

Woodward / 6-8 Mile Revitalization Plan
Detroit, Michigan

The Detroit Collaborative Design Center engaged with five business owners and thirty stakeholders for over 18 months to reimagine the 6 to 8 mile Woodward Corridor, which is a gateway to Detroit. The plan integrates green infrastructure, transit and public streetscape amenities, anchoring the design in community history and identity.

Maintenance

PPS change over time. Existing plants grow and spread, while new plants may take root. PPS requires both proactive (regularly scheduled) and reactive (unscheduled response) maintenance. Designs should reveal change over time, providing cues to growth and regeneration.

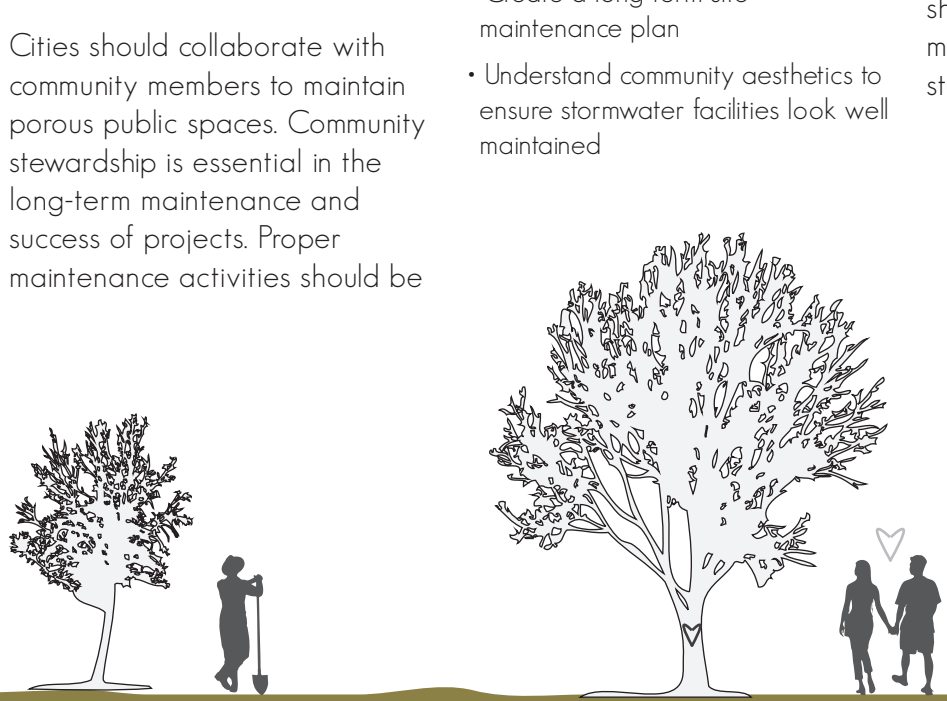
Cities should collaborate with community members to maintain porous public spaces. Community stewardship is essential in the long-term maintenance and success of projects. Proper maintenance activities should be outlined with all stakeholders: the community, designers + maintenance crew. A long-term maintenance plan is important to ensure continued effectiveness of stormwater features.

Recommendations:

- Create a long-term site maintenance plan
- Understand community aesthetics to ensure stormwater facilities look well maintained

Monitor + Communicate

PPS should be monitored to improve the body of knowledge on long-term social and ecological landscape performance. Measurements on water quality improvements should be publicly documented, communicating results to the community, designers and the local government. Monitoring should be inclusive of community members, encouraging stewardship of PPS.

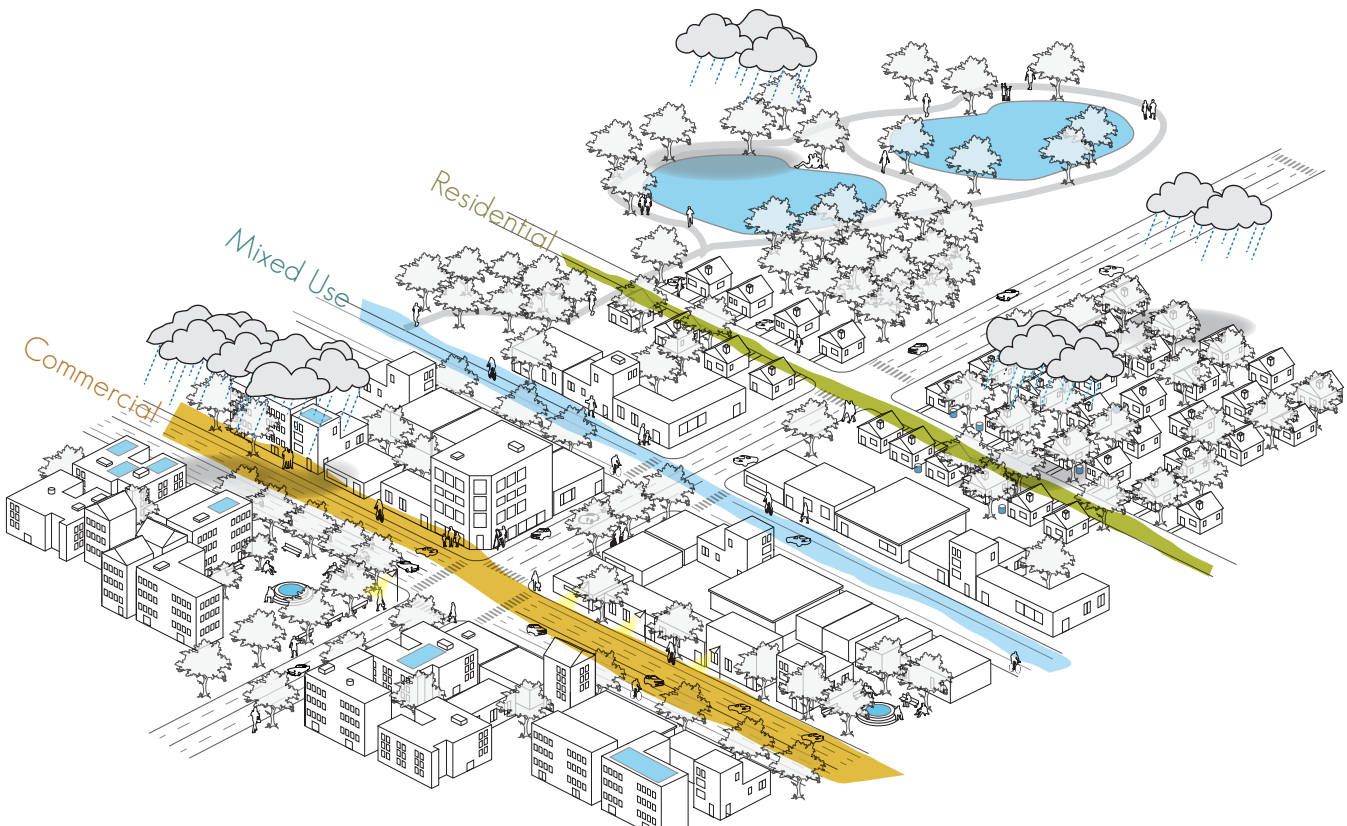


MAINTENANCE, MONITORING + EVALUATION

Appropriate maintenance practices should be outlined and communication established between parties for continued monitoring and evaluation of site performance.

Recommendations:

- Develop on long-term plan to monitor performance
- Partner with community organizations or local/state/federal ecology departments to fund monitoring
- Develop an educational component to share knowledge gained
- Collaborate with students, neighbors and interested parties to create a citizen science coalition to monitor systems


Residential
Mixed Use
Commercial

Applying PPS principles to

POROUS STREETS

Residential

/ PPS Retrofit of Existing Residential Street
/ Case Study: SEA Streets (Seattle, Washington)

Mixed Use

/ PPS Retrofit of Existing Mixed Use Street
/ Case Study: 21st Street (Paso Robles, California)

Commercial

/ PPS Retrofit of Existing Commercial Street
/ Case Study: Dogpatch 22nd Street Greening Master Plan (San Francisco, California)

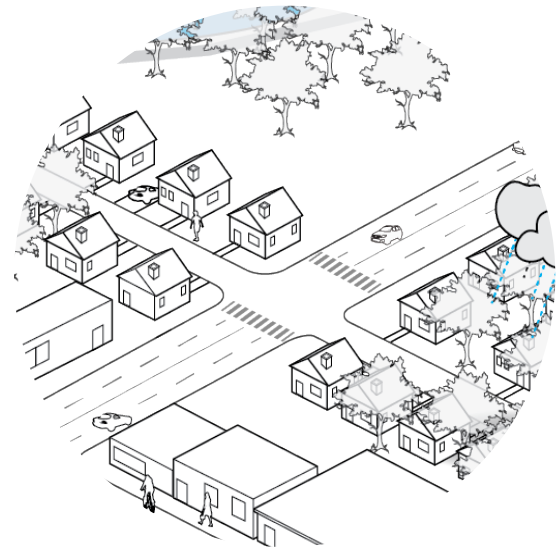

25% of our cities are
streets

Streets are the connective tissues that move us through our cities. They have historically been focused on mobility, moving people from point A to point B. This singular vision has contributed to the paving over of our cities. This has reduced or eliminated the urban watersheds ability to carry out the full hydrological cycle. Streets are designed for conveyance, relying on expensive, monolithic underground infrastructure to remove water from the city as quickly as possible.

As urban areas densify and the impacts of climate change become more severe and unpredictable, there is a pressing need to reimagine our streets as part of a multifunctional urban network that collectively improves the capacity for our city to respond and adapt to future social and environmental needs. Streets are being designed beyond single purpose thoroughfares to be multifunctional systems that mimic natural hydrological systems to manage stormwater, create safe pedestrian and bicycle zones, provide habitat to urban wildlife and sustain a rich public life. The educational and social benefits of engaging the public by revealing, enhancing and giving space back to water in an urban environment create a sense of empowerment and responsibility to simultaneously improve the quality our urban watersheds and our public realm.

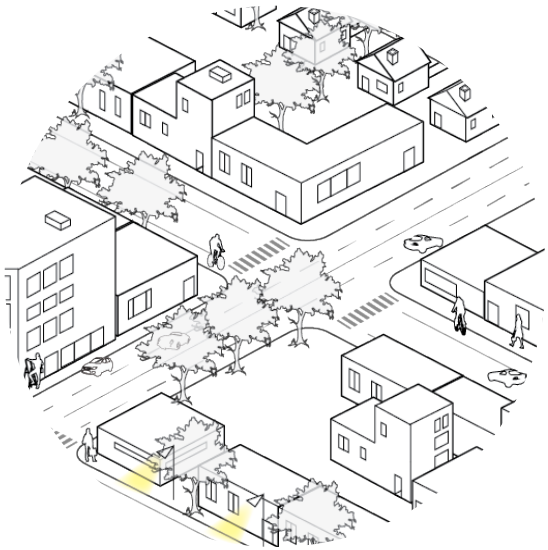
Porous Street Typologies

Our cities are composed of a diversity of street typologies. The principles of porous public space help reflect, foster and build vibrant public life for residential, mixed-use and neighborhood commercial streets.



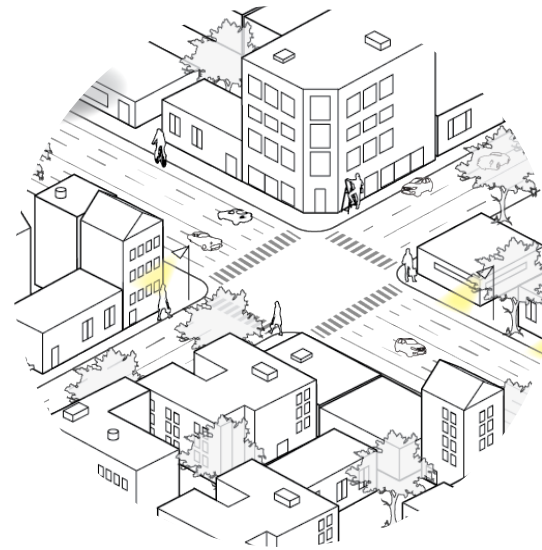
Residential

Design urban rainwater features on residential streets to improve the safety, comfort and aesthetics of residential places for neighbors to gather, sit, meet and play. From chatting with your neighbor while picking up mail, to volunteering with the neighborhood street garden group, to weekend block parties, these porous streets should use urban rainwater to engage community members, expanding their sense of ownership to include the street. The porous streets should use urban rainwater facilities to reduce traffic speeds, creating a safe shared space for pedestrians and bicyclists.



Mixed Use

Design urban rainwater facilities on mixed-use streets to create a comfortable and energetic place to live, work or play. Mixed-use streets have well-defined local character, blending housing, commercial, institutional, cultural and industrial uses. Porous mixed-use streets should integrate urban rainwater facilities with a generous pedestrian area that has well-defined active and passive zones for pedestrian and bicycle activity.



Commercial

Design urban rainwater facilities to support commercial street's vibrant public life. From a morning coffee at your favorite corner cafe to dropping your bike off at the bike mechanic to buying groceries, it is continuously active throughout the day. Porous commercial streets should integrate urban rainwater facilities with a generous pedestrian area that has well-defined active and passive zones for pedestrian and bicycle activity. Urban rainwater facilities should improve pedestrian safety for waiting and crossing zones. Parking and loading zones should be short-term.

Residential Street
Existing Conditions

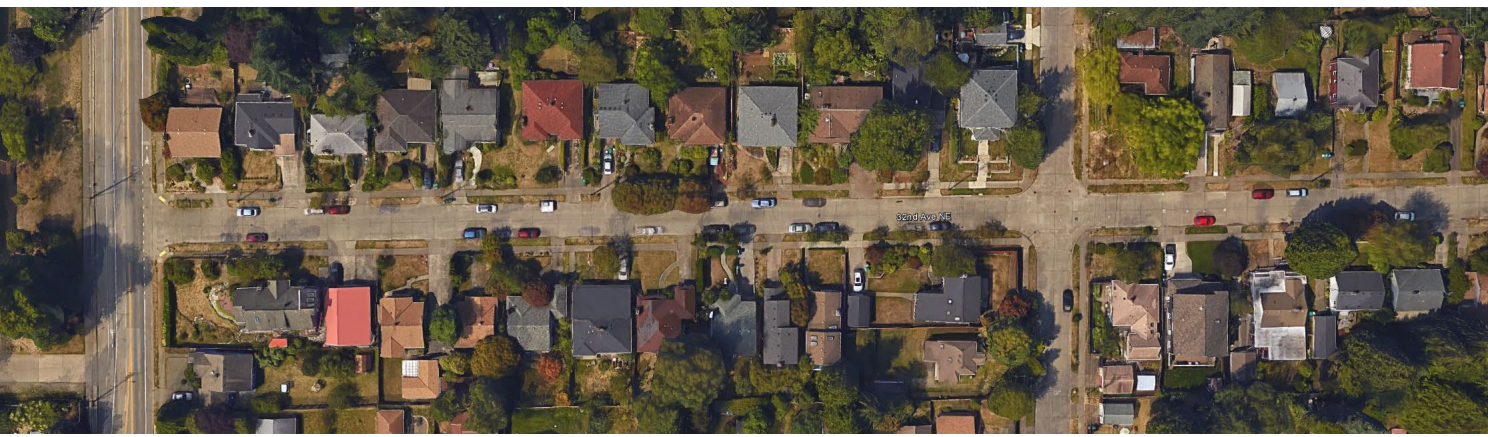


Image: Google earth

Typical Conditions

- Stormwater catch basins remove all stormwater below ground
- Car-dominated street design (parking, high speeds, etc)
- Lack of healthy street vegetation and trees
- Mostly impermeable surfaces

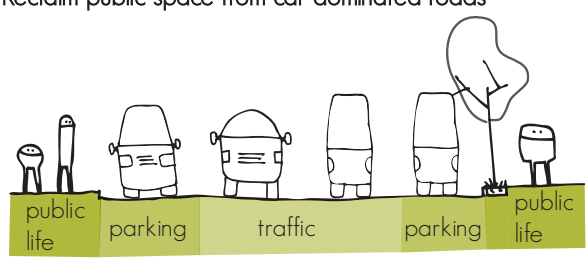
Design Considerations:

- Extensive community outreach and education should be done early and consistently
- Use multiple strategies to involve the community, people learn in different ways, so provide opportunities for diverse groups to get involved in the design process
- Focus on educating the community on the importance of ponding depths to ensure the community feels safe around standing water
- Use porous public space strategies to create safe pedestrian and bicycle zones by slowing car velocity

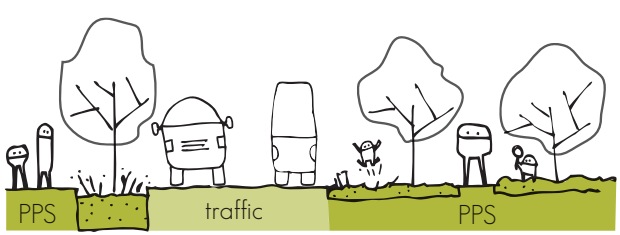
PPS Strategies

Use GSI to improve safety and livability of commercial streets

Reclaim public space from car dominated roads



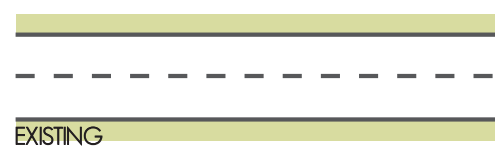
Streets dominated by cars



Streets for people + rainwater

Creating Pockets for People + Water

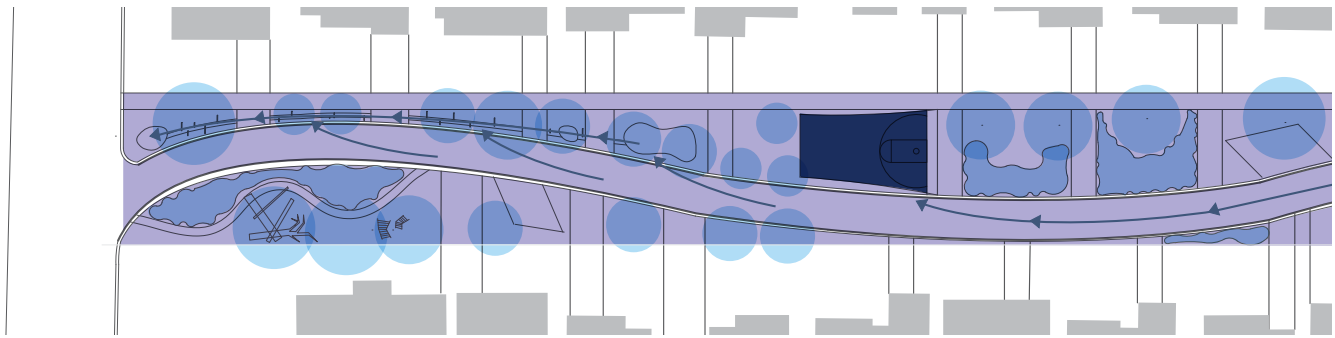
Oversized linear to curvilinear street



- Fast traffic
- Minimal public space
- Unsafe pedestrian + bike zones

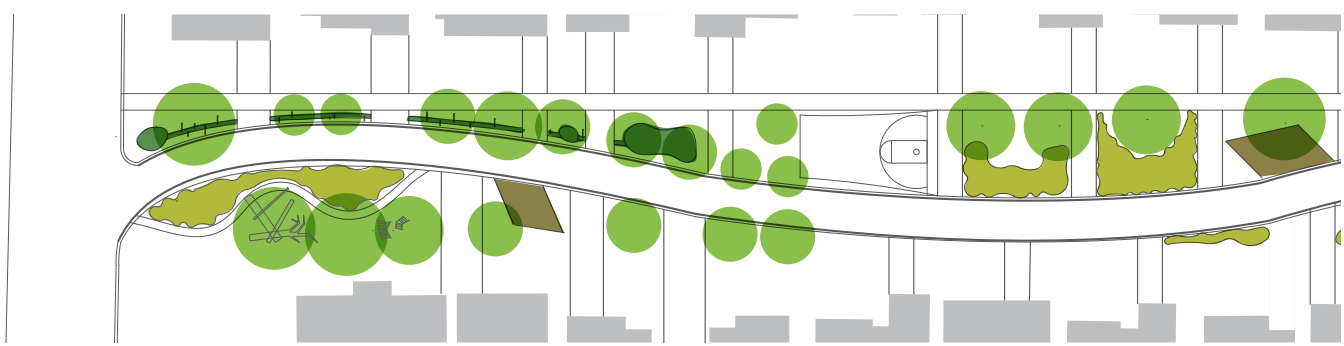
- Reduce road widths to slow traffic
- Curvilinear form to create pockets for PPS
- Safe pedestrian + bike zones

Residential Street
Porous Public Space Principles



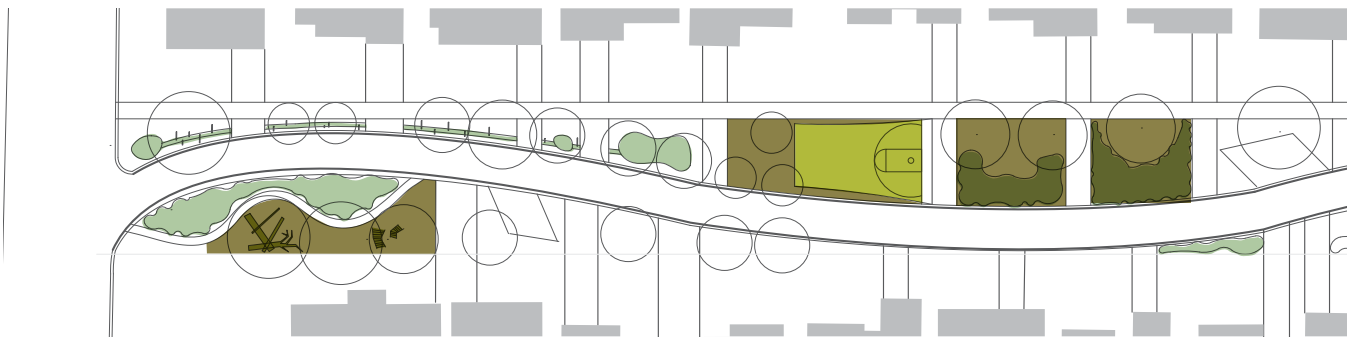
Full Water Cycle

- evaporation / interception
- infiltration / filtration
- storage / recycle



Full Soil + Vegetation Cycle

- existing + new trees
- pollinator pathway
- bioretention vegetation
- vegetated infiltration gaps

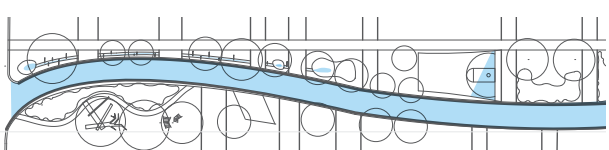


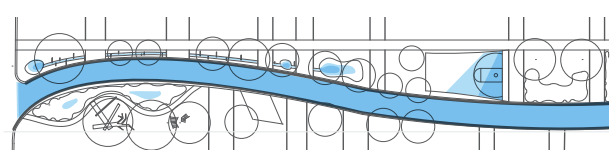
Human Health + Wellbeing

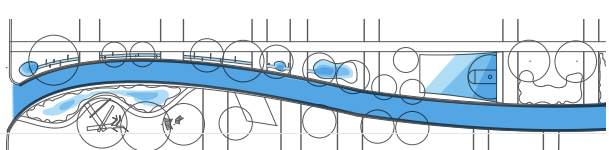
recreational / play space

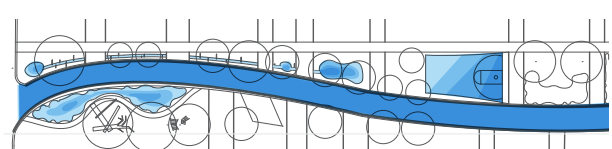
observe, identify + learn

places to stay





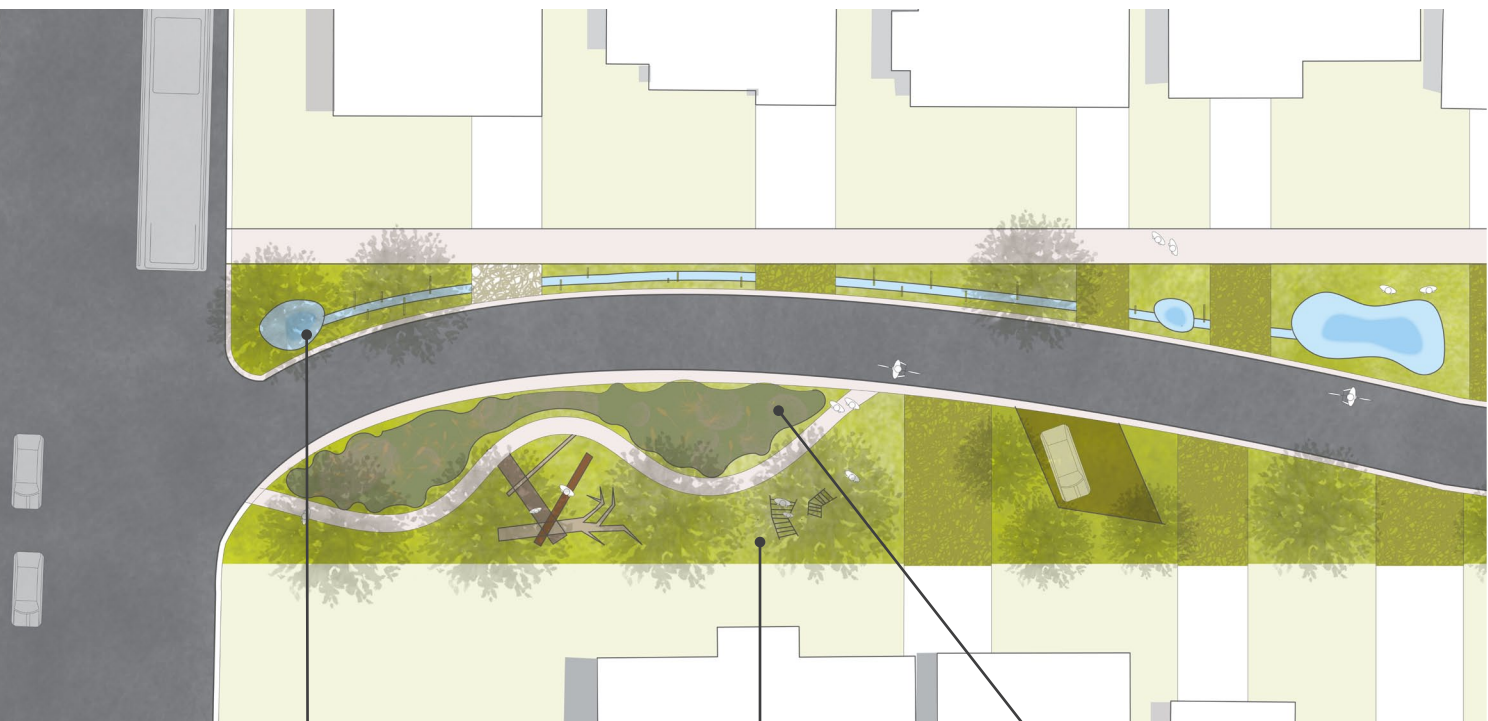


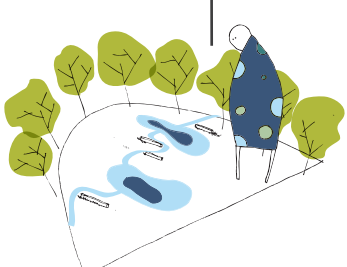


Adaptive Design

Residential Street
Retrofit

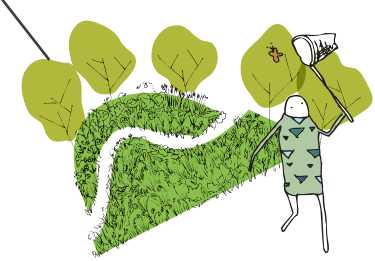
This street focuses on educating and engaging neighbors on the multiple benefits of healthy native vegetation through pocket parks for play, community gardens, native pollinators, gathering and rest. The curvilinear road creates porous public space pockets that act as a communally shared extension of your home while also creating safer streets by reducing car speed.



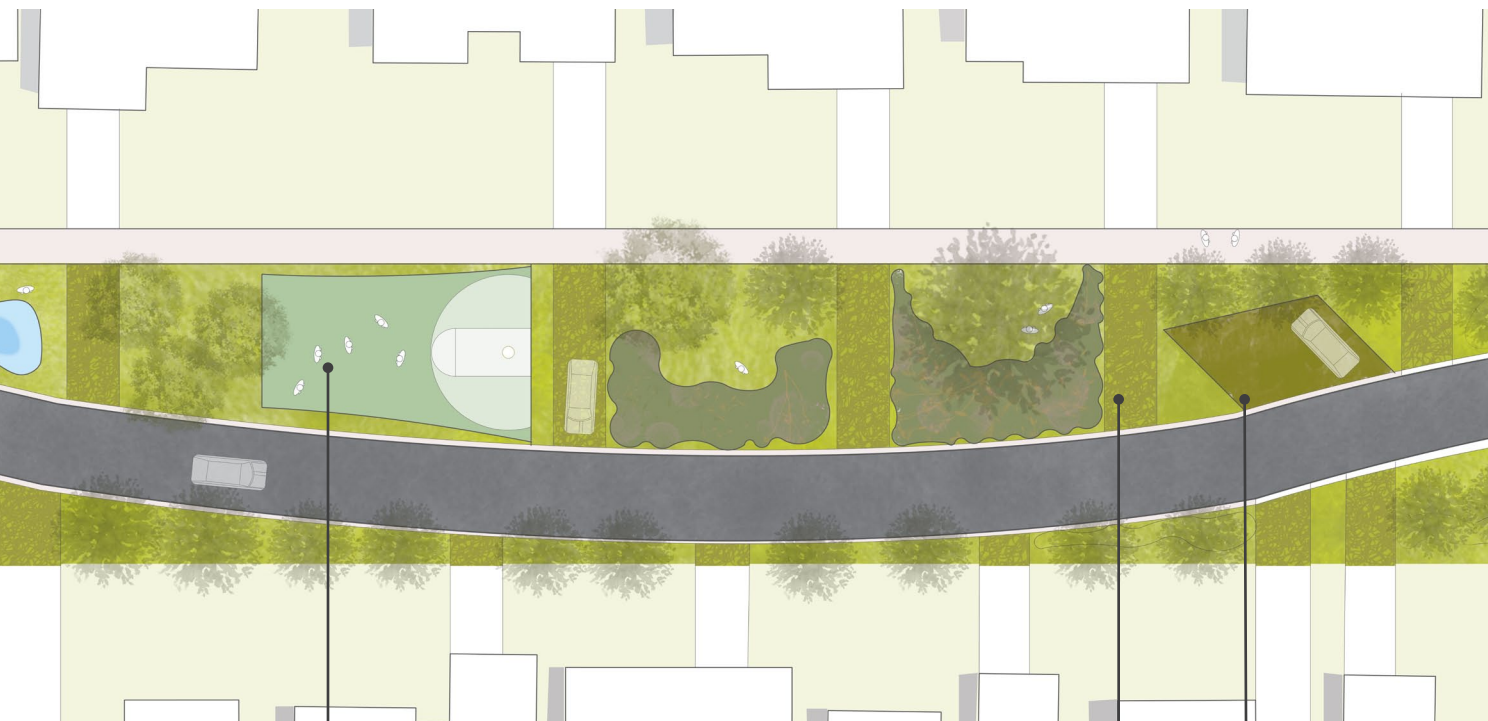


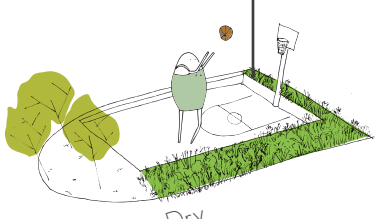
Bioretention cell

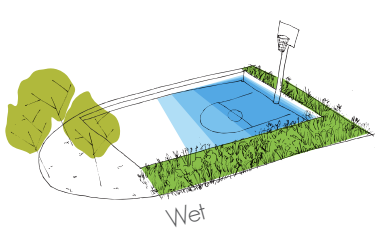
Natural Playground



Pollinator Pathway



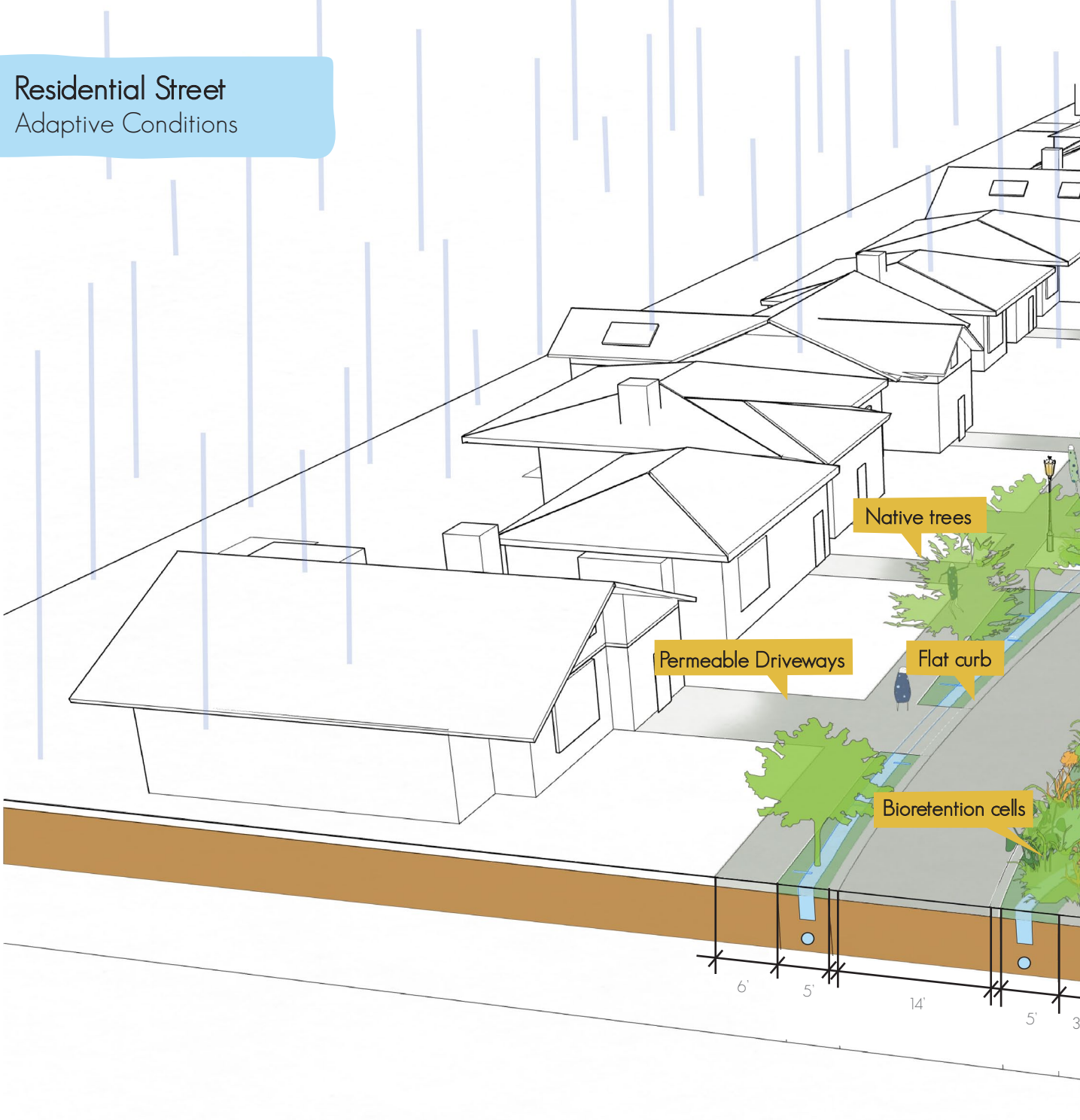


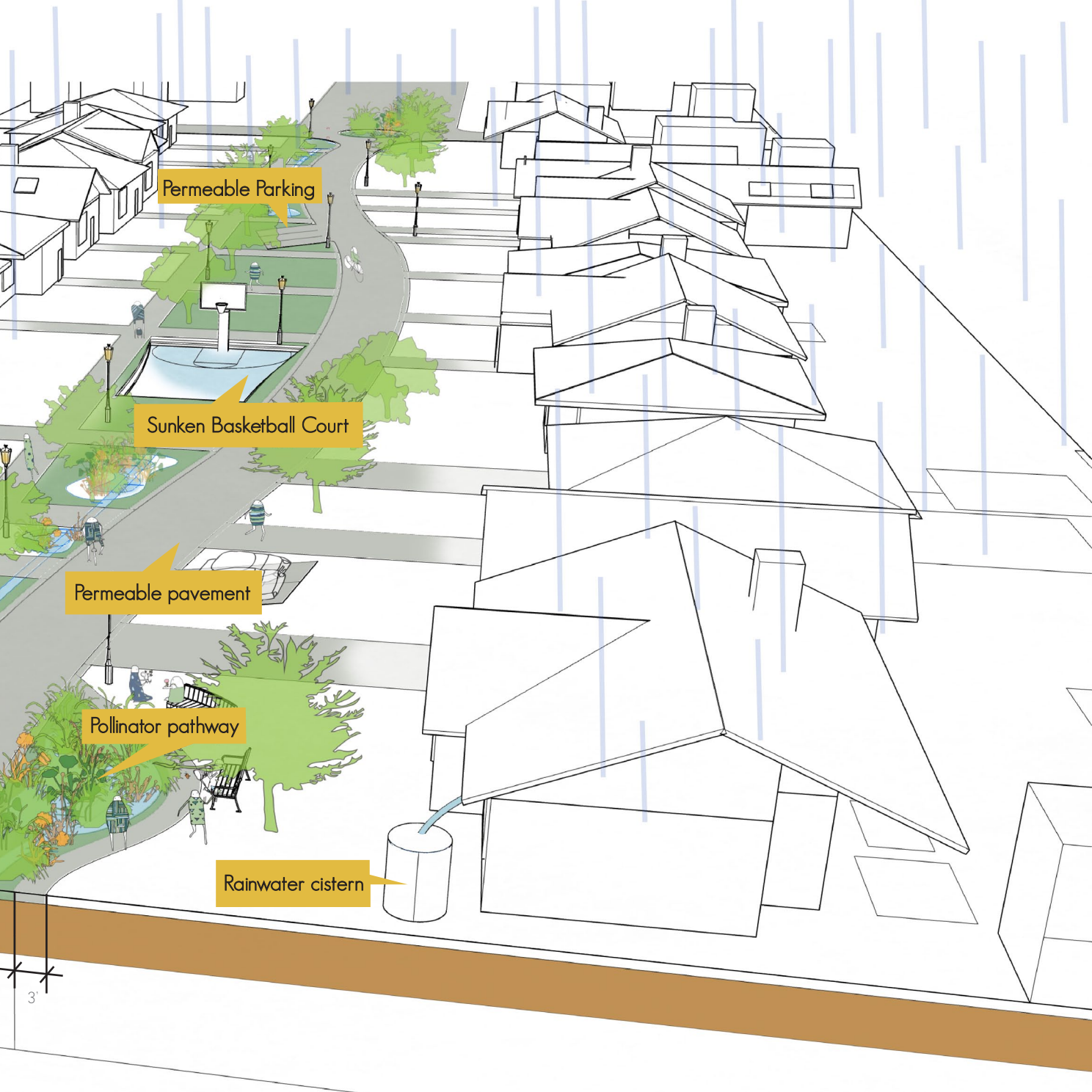


Sunken Basketball Court

Permeable Pavers

Residential Street
Adaptive Conditions




Permeable Parking
Sunken Basketball Court
Permeable pavement
Pollinator pathway
Rainwater cistern
3'

CASE STUDY

SEA Street

Seattle, Washington

Image: Seattle Public Utilities

Project Details

Project Partners	Seattle Public Utilities
Client	Seattle residents
Type of Project	Residential Street
Time frame	Completed 2001
Cost	$850,000
Annual rainfall	37.5 inches
Main Concept	An attractive, meandering street that restores natural drainage systems and calms traffic while inviting the community to linger and get to know each other.

Image: Seattle Public Utilities

Project summary

Seattle's pilot Street Edge Alternatives Project (SEA Streets) transforms a typical grid system street into an innovative curvilinear street the reduces stormwater volume leaving the street by 99%. It also improves water quality, reduces downstream impacts to local creek, creates safer pedestrian sidewalks, calms traffic speeds, creates habitat and improves the neighborhood aesthetics.

Design Opportunities

- Wide existing street
- Resident buy-in to redesign
- Residents willing to give up some on-street parking to make space for bioswales.

Design Constraints

- Car dominated street design
- Unsafe pedestrian walkways
- Street stormwater flowing to Piper's creek, altering water quantity and quality

Image: Seattle Public Utilities

"SEA street is the most commendable project I've seen since I've been perspective, from a transportation perspective and from a community

Whole System

The project focused on improving upper watershed flow volumes. The street reduces peak flow volumes and discharges to the downstream receiving creek by retaining and infiltrating rain on the street.

Full Water Cycle

The street's impervious surfaces were reduced to 11% of a traditional street, minimizing stormwater quantity. Bioretention swales were built along the road to use surface retention to improve water quality and manage a 2-year, 24-hour storm event.

Full Soil + Vegetation Cycle

Native soil was mixed with organic compost to improve water holding capacity and plant growth. The design team focused on retaining large existing trees. Over 100 evergreen trees and 1100 shrubs were added to the streetscape.

Human Health + Wellbeing

Tree canopy provides shade and respite during summer heat while absorbing air pollutants and rainfall. A curvilinear street slows traffic and provides a more varied experience for pedestrians.

on the commission. It has potential from the environmental building perspective."

Ralph Cipriani
Seattle Design Commission

Community Engagement

SEA street was a collaboration between Seattle Public Utilities and the community. The process and finished street design creates environmental awareness and stewardship, growing community members' awareness of their context within the larger watershed. Many of the neighbors have become actively involved in improving water quality in Piper's Creek.

Adaptive Design

The street reduces the problem of stormwater by reducing impervious surfaces, while creating bioretention swales along roadways that can store, clean and filter stormwater from varying storm events.

Maintenance, Monitoring + Evaluation

A maintenance agreement between Seattle Public Utilities and the community was created to share responsibilities for vegetation and general street maintenance. After two years of monitoring, data showed that 99% of stormwater volume entering the sewer system was reduced.

Image: Seattle Public Utilities

Lessons Learned

A pilot project created through collaborative efforts between the city and the residents to improve watershed health and community livability by reimaginging the form and function of a right of way.

Mixed Use Street
Existing Conditions

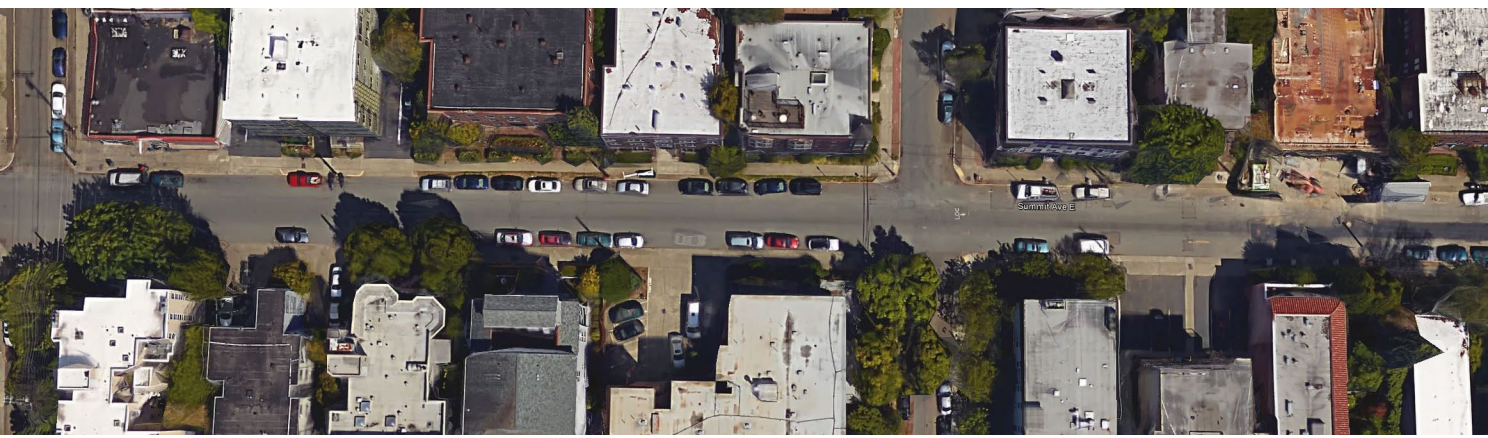


Image: Google earth

Typical Conditions

- Unsafe bicycle paths
- Stormwater catch basins that remove all stormwater below ground
- Uninspired pedestrian realm
- Car-dominated street design (parking, high speeds, etc)
- Lack of healthy street vegetation and trees
- Mostly impermeable surfaces

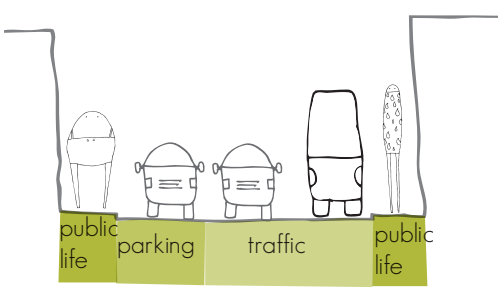
Design Considerations:

- Design should be flexible, rearrangeable and adaptable according to the changing needs of the residences, businesses, and cultural institutions
- Use porous public space strategies to create safe pedestrian and bicycle zones by slowing car speed
- Need to thoroughly understand below ground utilities
- Potentially contaminated urban soils are not suitable for infiltration

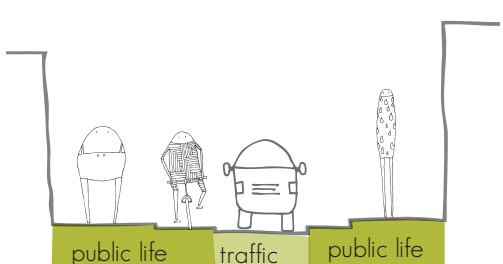
PPS Strategies

Use GSI to improve safety and livability of commercial streets

Reclaim public space from car dominated roads



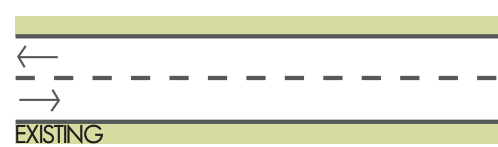
Streets dominated by cars



Streets for people + rainwater

Streets for who?

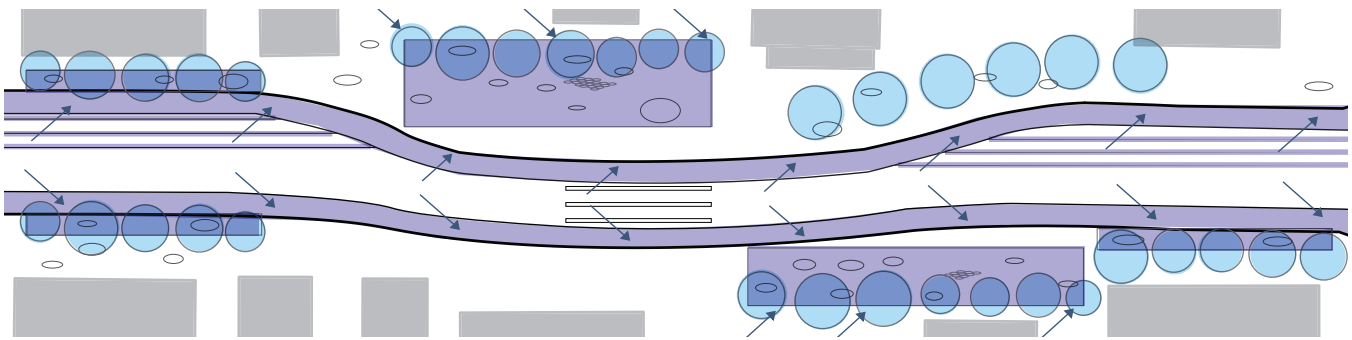
Low traffic two-way transformed into one-way street



- Fast traffic
- Minimal public space
- Unsafe pedestrian + bike zones

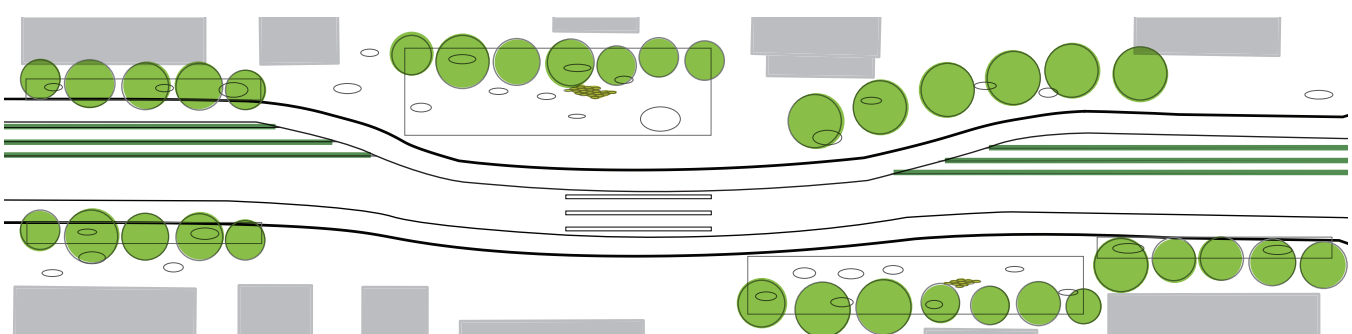
- Road squeeze to slow traffic + create safer ped crossing
- Adaptable road buffer acts as flexible programmable space + short-term parking

Mixed Use Street
Porous Public Space Principles



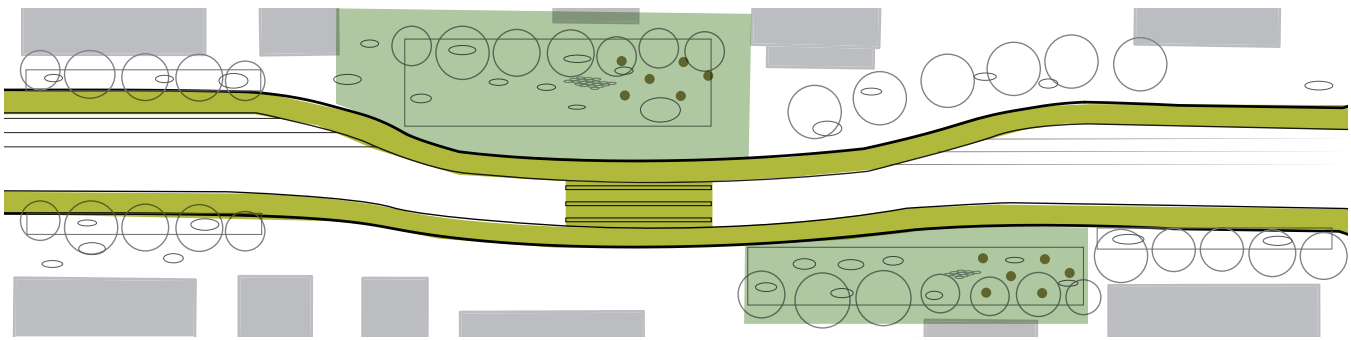
Full Water Cycle

- evaporation / interception
- infiltration / filtration



Full Soil + Vegetation Cycle

- existing + new trees
- bioretention vegetation
- vegetated infiltration gaps

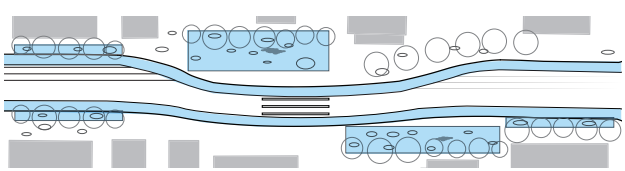


Human Health + Wellbeing

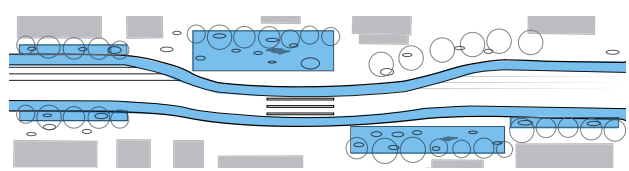
flexible space

safe pedestrian + bike transit

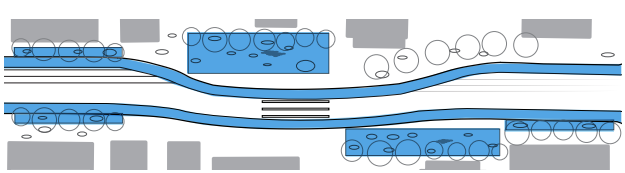
Places to stay



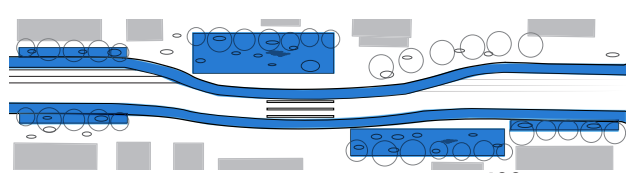
2 year storm



10 year storm



50 year storm

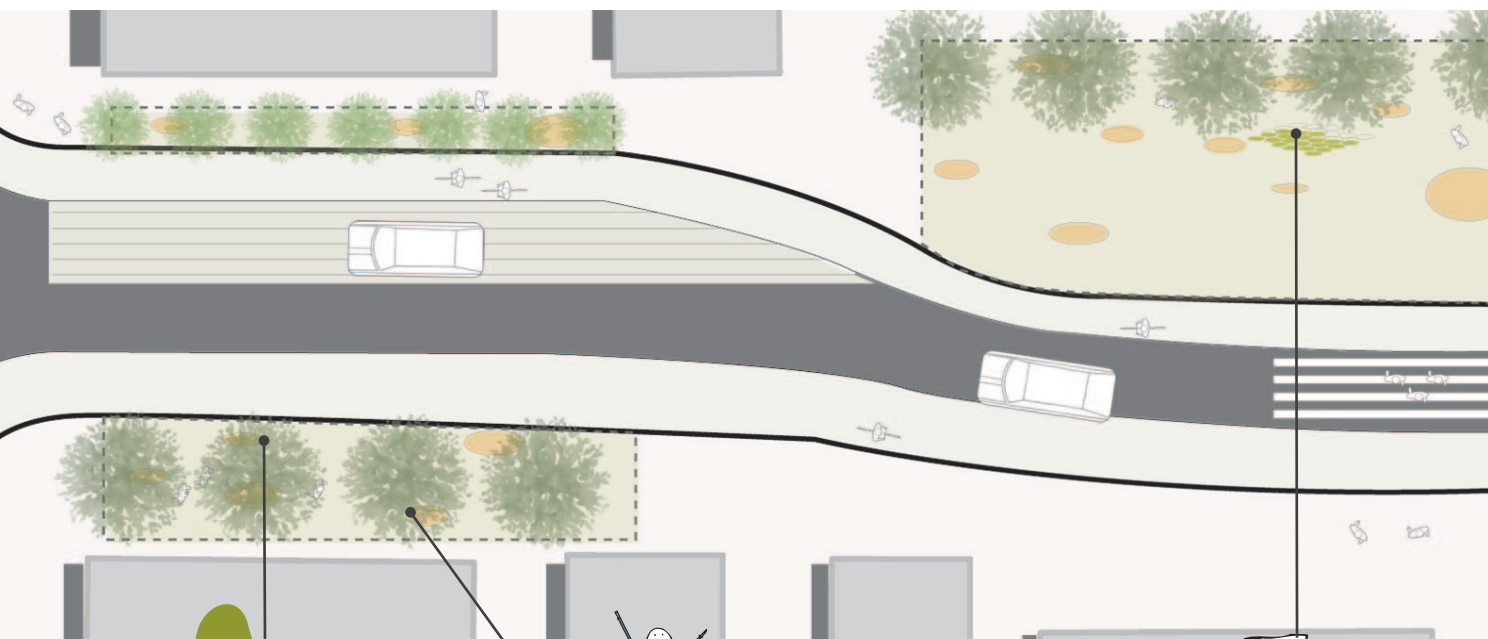


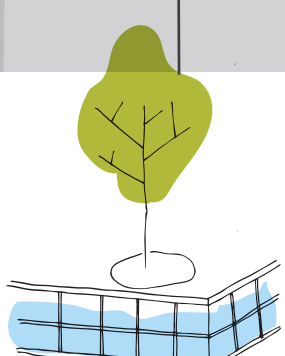
100 year storm

Adaptive Design

Mixed Use Street
Retrofit

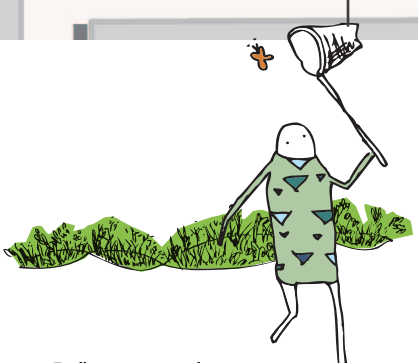
This street focuses on how collective creativity can thrive by educating, exposing and revealing water quality and storage through the artful interventions of making music and interactive light sculptures. The subtle curves in the road create pockets for porous public space as well as reduce car speed. A seamless street with programming that responds according to commercial and residential activity. The street lies flat with no curbs to create a sense of shared space across the entire street.



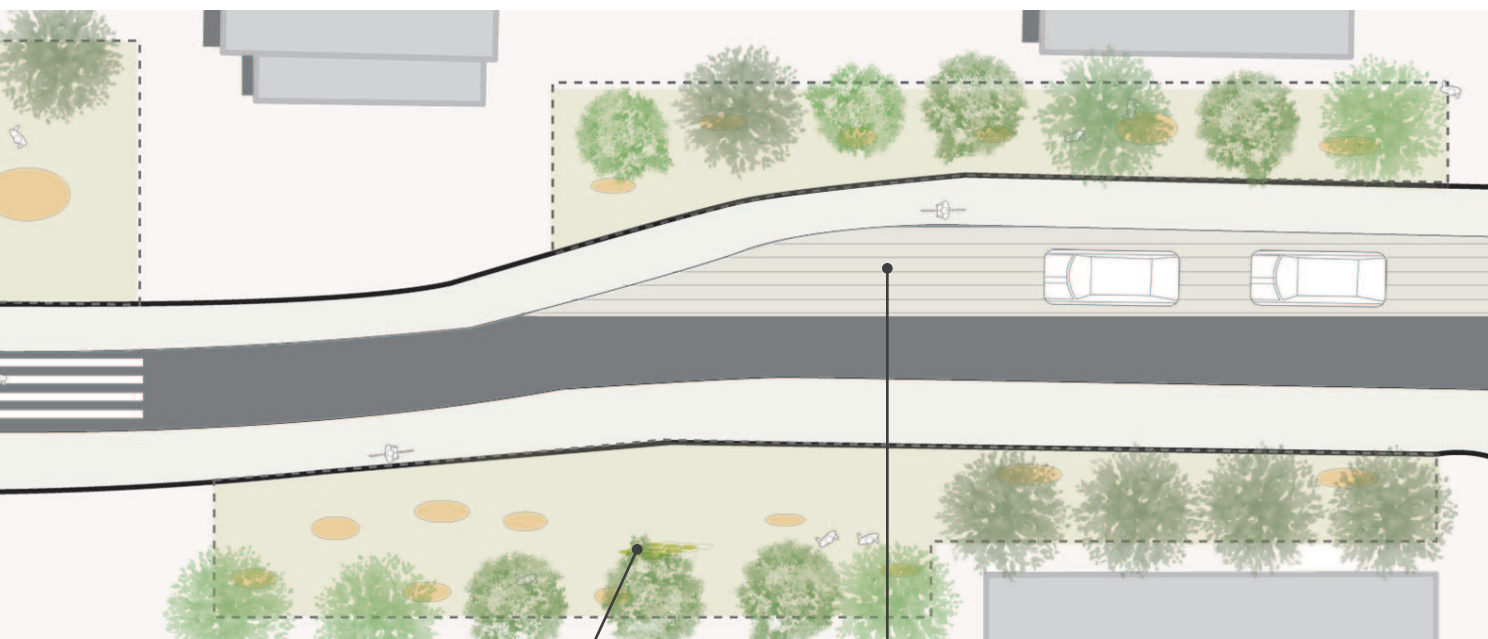


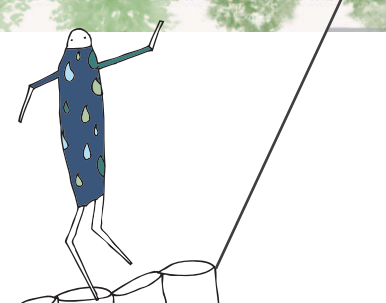
Silva cells

Interactive light sculpture reflect water quality

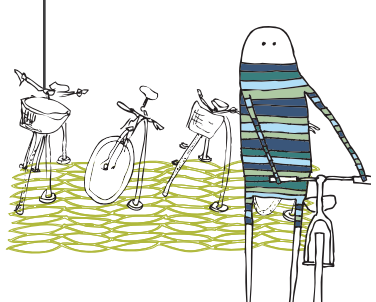


Pollinator pathways



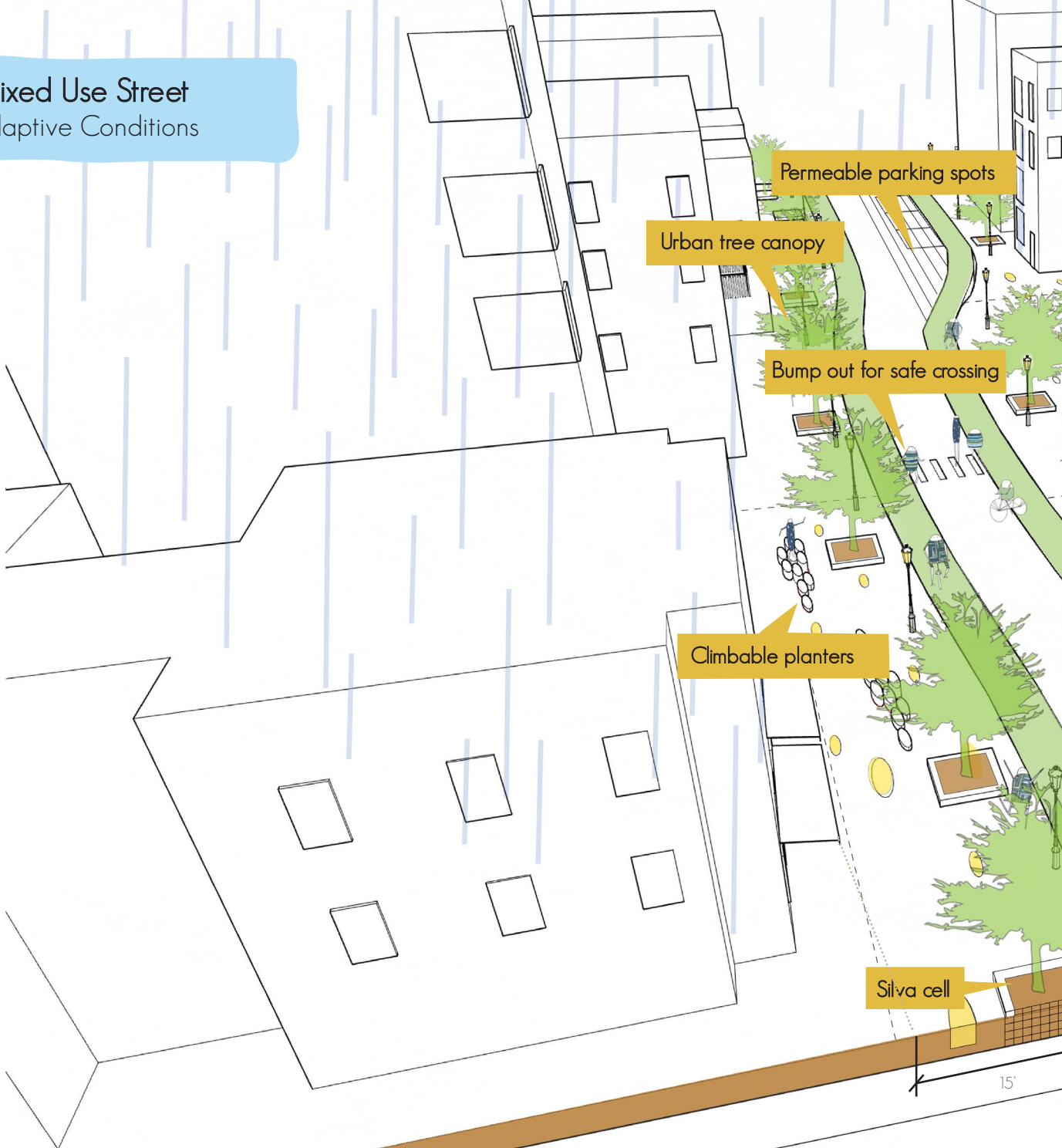


Climbing play structures



Permeable bike parking

Mixed Use Street
Adaptive Conditions




Permeable pavement
Water quality indicator lights
6'
22'
6'
15'

CASE STUDY

21st Street

Paso Robles, California

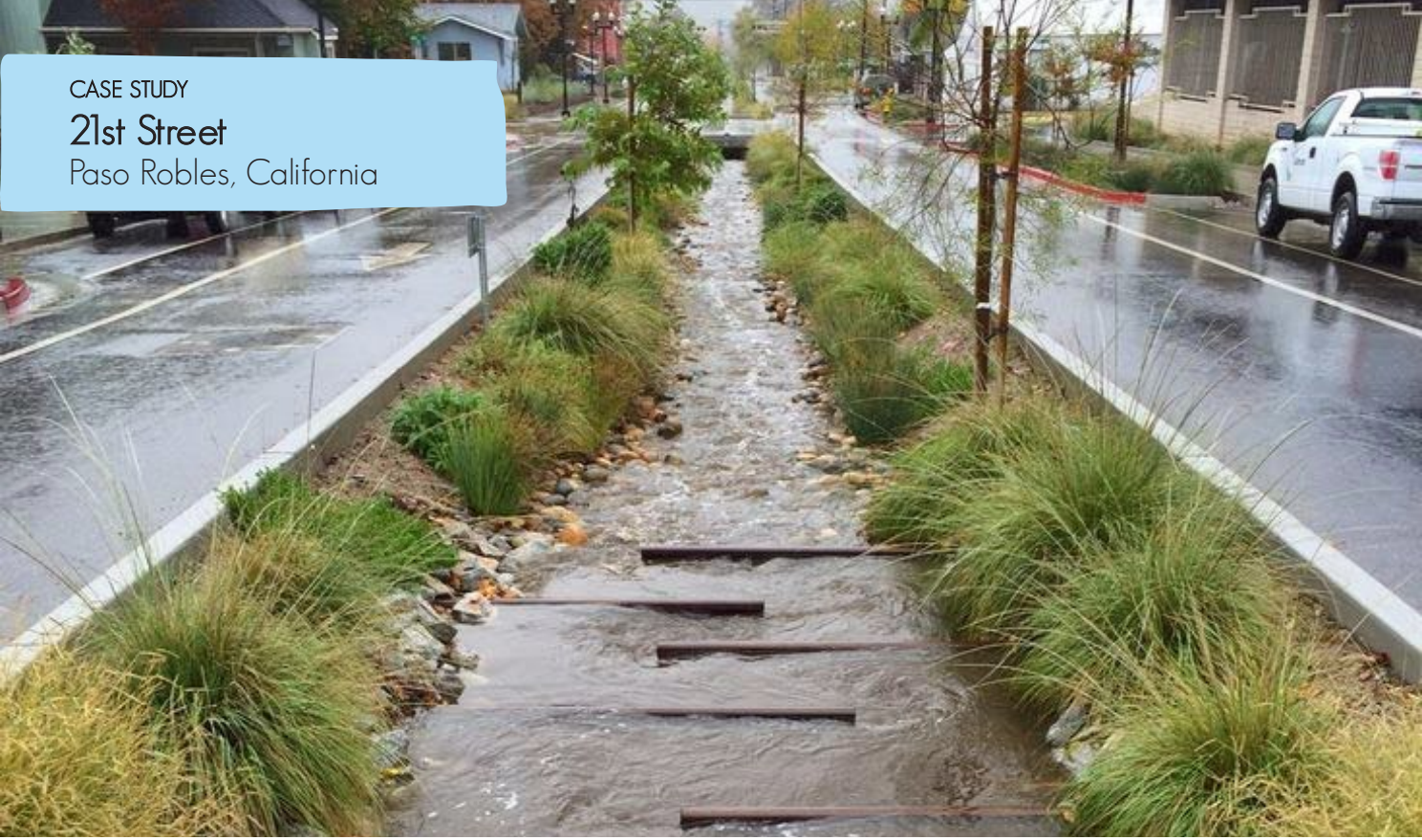


Image: MIG | SvR

Project Details

Project Partners	MIG	SvR; Cannon, Local Engineer and LA Company
Client	City of Paso de Robles
Type of Project	Commercial and Residential Street
Time frame	2010-2011
Cost	2.5 million USD
Annual rainfall	14.11 inches
Main Concept	Retrofit a street plagued by frequent flooding, converting it into a green street outfitted with facilities for managing rainwater and facilitating public life.

Image: MIG | SvR

Project summary

21st street in Paso Robles, CA, once inundated by cars and water, now caters to pedestrians and bicyclists while artfully managing the quality and quantity of stormwater runoff as well as the overflow from nearby Mountain Springs Creek via a landscaped median channel.

Design Opportunities

- Reestablish historic creek bed
- Host community workshops throughout design process
- Partner with local firm, Cannon
- Reference intersecting railroad tracks

Design Constraints

- Accommodate multi-modal transportations
- No existing traffic calming measures in place
- Frequent disturbance caused by floods

"Truly 'complete streets' such as 21st Street recognize the right of way as a can reinforce the community's urban design framework by providing multi-modal the right of way."


Image: Cannon


Image: Cannon

Whole System

Rain runoff is treated at the same time as overflow from Mountain Springs Creek. This creek once ran through the site and the landscaped median channel reflects that history, mimicking the flow of the creek watershed.

Full Water Cycle

The median channel connects to the existing creek, channelling high-volume, high-velocity water flow while recharging groundwater through underlying infiltration trenches and engineered mixes of soil.

Full Soil + Vegetation Cycle

"Carefully engineered" soil mixes were used to grow native, drought-tolerant plants. Existing trees like the native oaks were preserved in addition to eighty-one new trees planted to provide shade and canopy cover.

Human Health + Wellbeing

Automobiles controlled the space due to a wide, open street, and were thus encouraged to drive at high speeds. The design reclaims the space for pedestrians and cyclists, providing gathering spaces and artful use of materials.

valuable public realm rich with potential interacting programs. Streetscapes
l mobility, streetside gathering places, and natural drainage infrastructure in

Tom von Schrader PE
MIG | SvR

Image: Cannon

Community Engagement

The city of Paso Robles chose to partner with local firm, Cannon, and to meet with the local community in order to assess their needs. This process lasted 6-8 months in which the design team would go back and forth, listening to the community, bringing their ideas back to the drawing board and then back again.

Adaptive Design

Multiple methods of treatment and catchment were implemented to help the street manage an increased frequency in heavy rain events in addition to upstream discharge from Mountain Springs creek.

Maintenance, Monitoring + Evaluation

A regulatory group is needed to keep people accountable. Monitoring of the site has been documented presently through mostly anecdotal methods.

Lessons Learned

Integrating green stormwater infrastructure with other necessary street-related functions requires compromise. At 21st Street, however, the teams utilized green stormwater infrastructure in a way that not only manages stormwater effectively but complements mobility, accessibility, and habitat.

Commercial Street
Existing

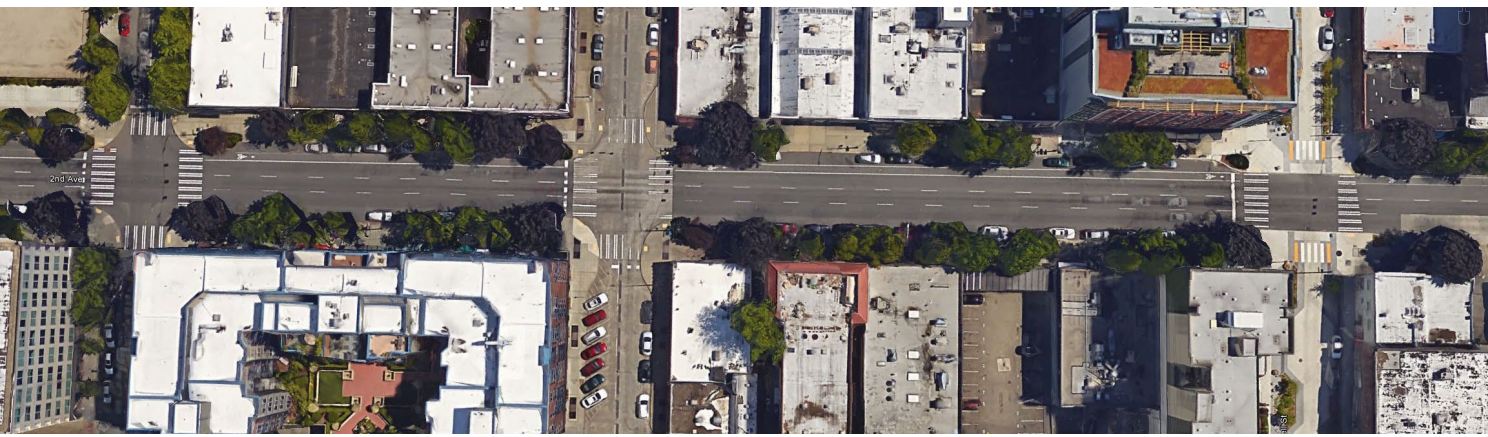


Image: Google earth

Typical Conditions

- Unsafe bicycle paths
- Stormwater catch basins that remove all stormwater below ground
- Uninspired pedestrian realm
- Sidewalks solely for movement, not programmed to encourage people to stay
- Car-dominated street design (parking, high speeds, etc)
- Lack of healthy street vegetation and trees
- Mostly impermeable surfaces
- Unsafe pedestrian and bicycle crossings

Design Considerations:

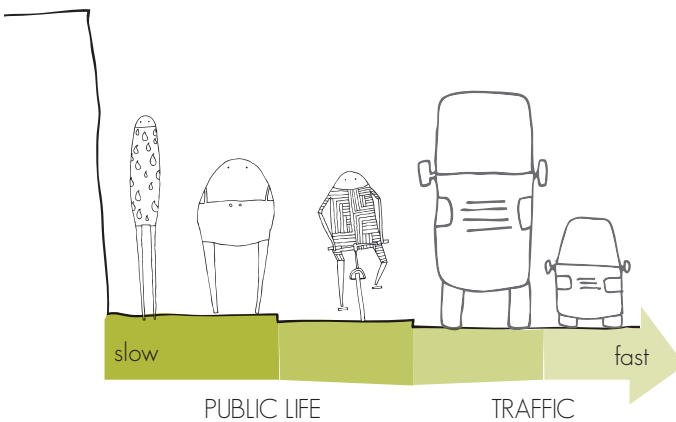
- Generous pedestrian sidewalks allow space to design passive pedestrian zones for green stormwater infrastructure
- High activity increase the visibility and interaction between people and water
- Need to thoroughly understand below ground utilities
- Potentially contaminated urban soils are not suitable for infiltration
- More hardscape and highly engineered stormwater solutions are appropriate for this street type

PPS Strategies

Use GSI to improve safety and livability of commercial streets

Prioritize Space for Public Life

Planning for different speeds: Slow to fast



Reclaim public space from car dominated roads

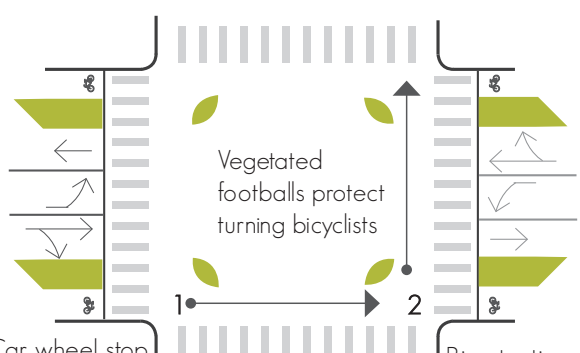
Increase public space for flexible programming

- Fast traffic
- Minimal public space
- Unsafe pedestrian + bike zones

- Reduce road widths to slow traffic
- Shift lane to increase public space
- Safe pedestrian + bike zones

Protected Bicycle Intersections

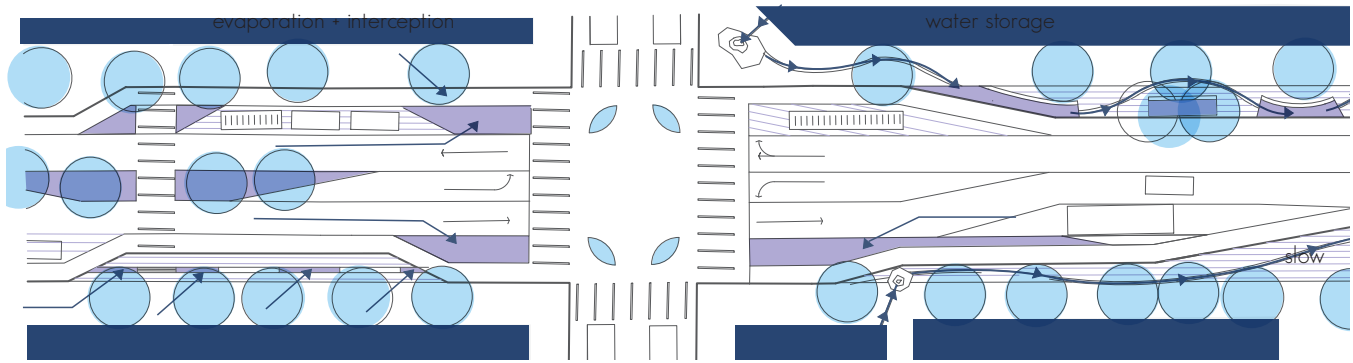
Small Changes Can Improve Safety



Car wheel stop behind bike + pedestrian crossing to increase their visibility

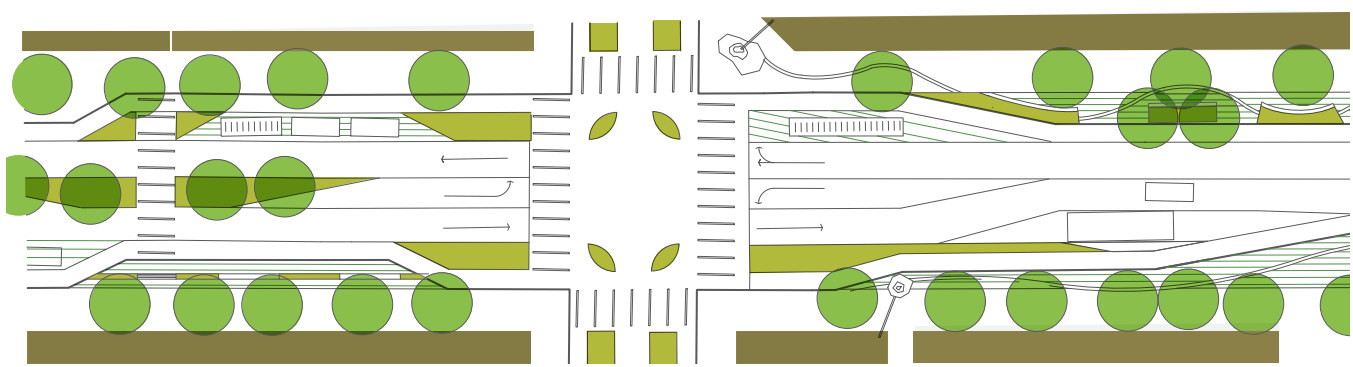
Bioretention areas separate bike lane from cars

Commercial Street
Porous Public Space Principles



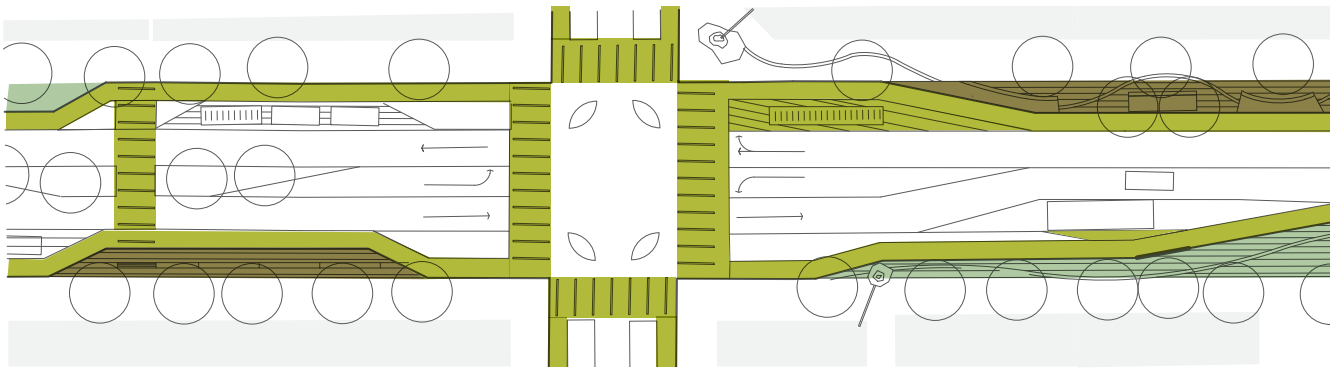
Full Water Cycle

- evaporation / interception
- infiltration / filtration
- storage / recycle



Full Soil + Vegetation Cycle

- existing + new trees
- bioretention vegetation
- blue / green roof
- vegetated infiltration gaps

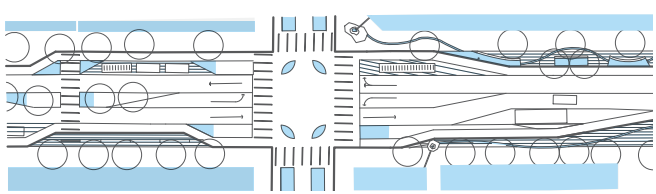


Human Health + Wellbeing

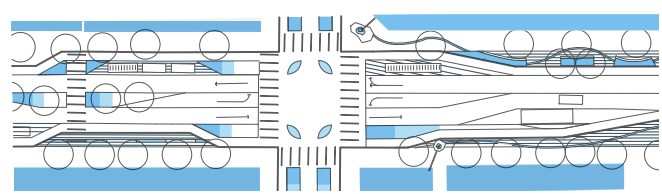
flexible space

safe pedestrian + bike transit

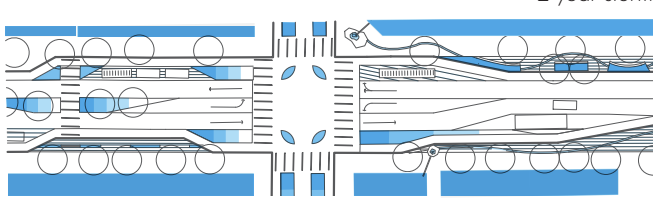
Places to stay



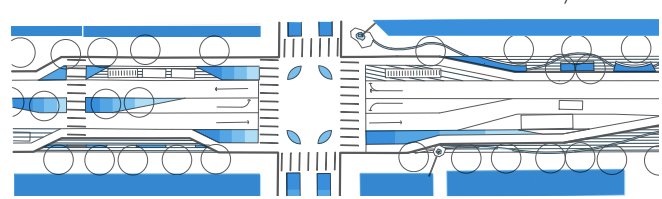
2 year storm



10 year storm



50 year storm

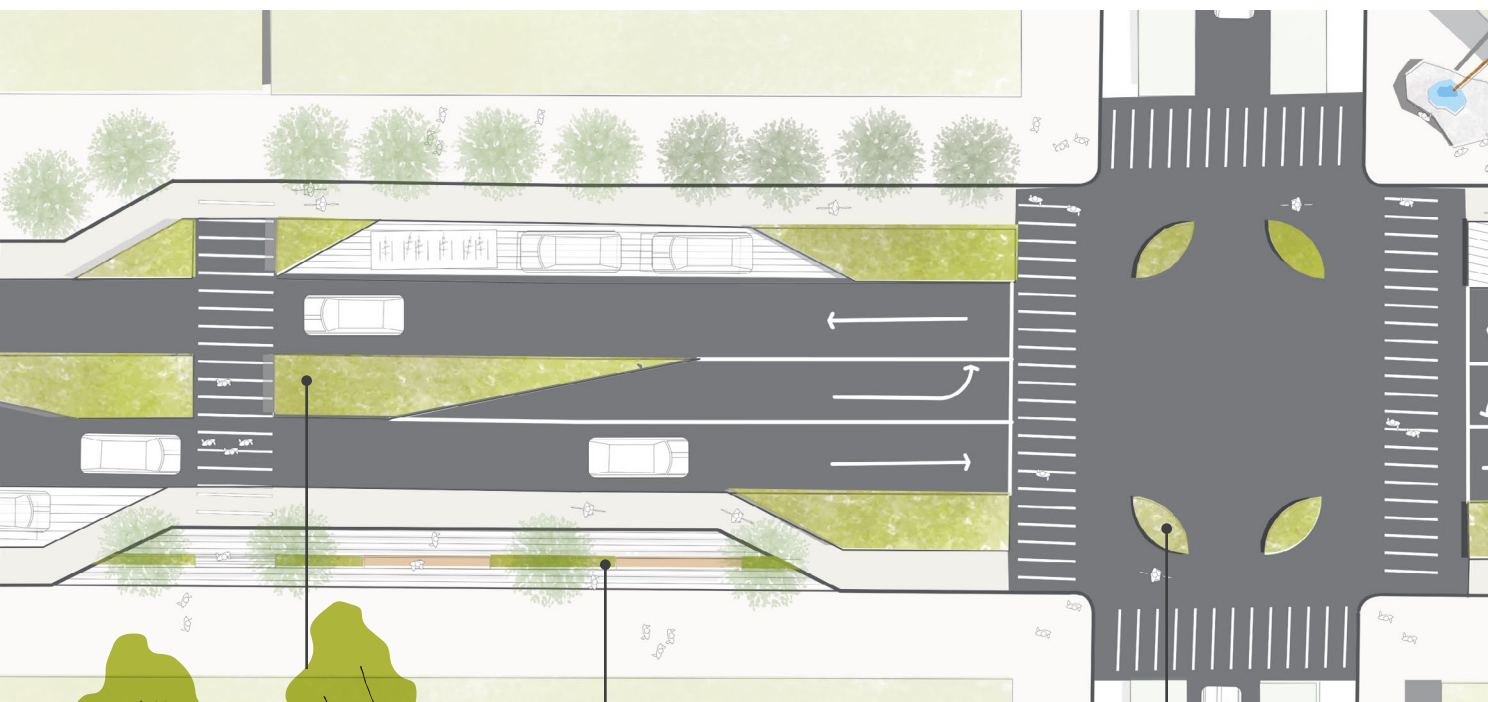


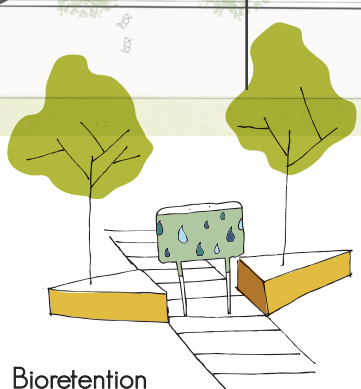
100 year storm

Adaptive Design

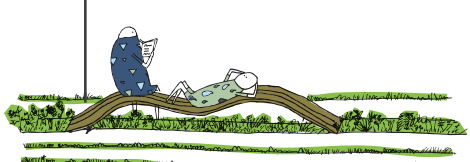
Commercial Street
Retrofit

This street encourages you to use all five of your senses to find, investigate and interact with urban rainwater, encouraging you to take a pause from your daily life to see rain running from above, to smell rain hitting the soil, to hear it meandering below your feet and to observe water fluidly moving through the city. This street heavily focuses on using green stormwater infrastructure to prioritize and create safe pedestrian, bicycle and bus facilities.

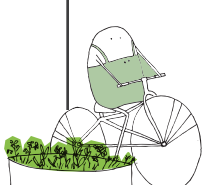




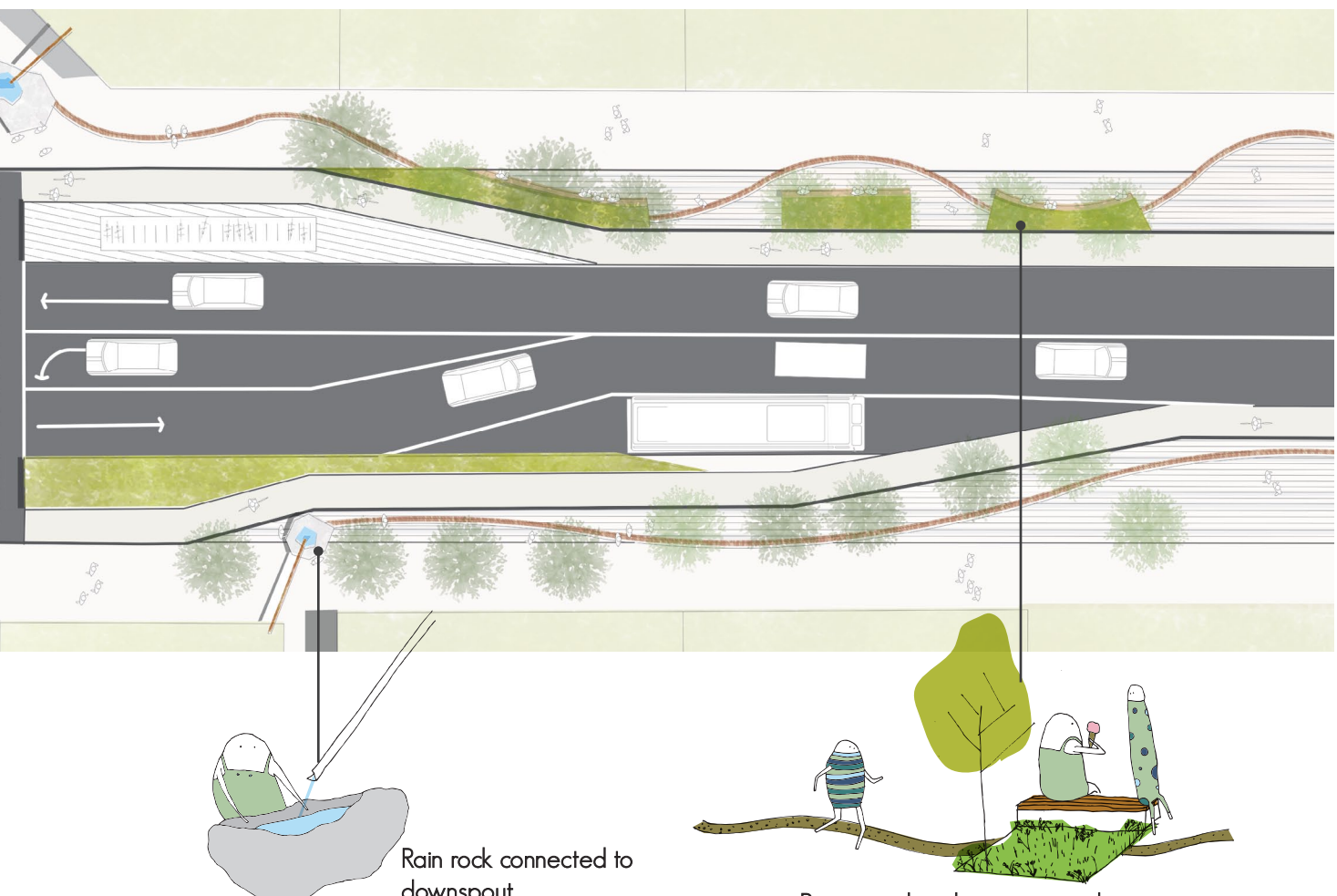
Bioretention pedestrian islands



Integrated vegetation and seating



Vegetated footballs for safe bicycle crossing



Rain rock connected to downspout

Rain runnels to bioretention planter

Commercial Street
Adaptive Conditions


Rain rock
Bioretention cells
Bike football planters
Green / blue roof
Bioretention pedestrian island
Vegetated infiltration gaps
Permeable pavement
9'
12'
9'
14'

CASE STUDY

Dog Patch 22nd Street Greening Master Plan

San Francisco, California

Image: Fletcher Studio

Project Details

Project Partners	GreenTrustSF, San Francisco Parks Trust, Fletcher Studio, Nelson Nygaard Consulting and the Dogpatch community
Client	GreenTrustSF - Central Waterfront + San Francisco Parks Trust
Type of Project	Master Plan
Time frame	2007-2011: Master Plan; TBD 2016: Construction
Cost	Estimated $3.5 million
Annual rainfall	23.64 inches
Main Concept	Community-based process to design a green street

LEGEND

- Permeable Bulb-out
- Infiltration Planter
- Parklet
- Tree Basin
- Permeable Driveway
- Bike Rack
- Park
- Bioswale
- Trench Drain
- Public Community Space
- Street Furniture
- Street Light
- Public Art
- Bus Stop Shelter

Project summary

A two year collaborative process to create a plan for improvements to transform 22nd street into a model green street. The contextually sensitive process has a shared goal of maximizing ecological, safety and community benefits. Multifunctional green street facilities were designed to work together as a network.

Design Opportunities

- Designated historical district with many businesses
- Multiple forms of public transit
- Wide streets to expand sidewalks
- Mature trees + varied street vegetation

Design Constraints

- Fast driving speeds, decreasing pedestrian safety
- Storm drains become clogged and flood the street
- Lack of street vegetation and permeable surfaces
- Proximity to I-280: unfriendly underpass, noise/water/air/particulate pollution
- Muni mini park is underused, neglected + mostly hardscape

Image: Fletcher Studio

Whole System

Tools and strategies were aimed to address multiple systems: vegetation, water, and human activity. The strategies increase native drought tolerant vegetation, widen sidewalks to improve public space, create safer mobility for pedestrians and bikes, and improve water quality by increasing permeable surfaces and reducing stormwater runoff.

Full Water Cycle

They focused on improving water quality and recharging groundwater to minimize sewer/stormwater overflows in the SF Bay. They focused on increasing pervious surfaces by 400% and decreasing impervious surfaces by 10%.

Full Soil + Vegetation Cycle

Their objectives were to expand landscaped areas, increase native vegetation planting, and increase biodiversity.

Human Health + Wellbeing

Their plan focuses on providing increased open space to support community and civic interaction and identity, enhancing the everyday quality of life for San Francisco residents, while decreasing the likelihood of pedestrian and bicycle injuries.

Community Engagement

Collaborating with a diverse group of Dogpatch residents was a high priority for the working group. A series of community workshops facilitated an iterative process to gain insight from the community that was foundational for the master plan. Some of the community engagement tools used were: interactive mapping, discussion and review, and children's comments.

Adaptive Design

Distributed approach to stormwater management by an overall increase in permeable surfaces. Increasing sidewalks to improve multifunctional use for flexible programming and stormwater management.

Maintenance, Monitoring + Evaluation

To be defined as the project has not been built yet

Image: Fletcher Studio

Lessons Learned

A long-term planning and community engagement process provides a strong foundation for a robust neighborhood master plan.

Using PPS principles to evaluate

POROUS PLAZAS

Case Studies

/ **Pavement to Parks (Plazas)** (San Francisco, California)
/ **Uptown Normal** (Normal, Illinois)
/ **Water Square Benthemplein** (Rotterdam, Netherlands)

Plazas bring people together. They are large gathering spaces between buildings and streets that provide places to pause, read a book, meet a friend for lunch or people watch. They are active spaces that engage all our senses through varied public life activities from festivals, farmer's markets, street artists and food carts.

Porous plazas imagine how rainwater can be embedded into the form and function of these common spaces. Designing with the needs of both people and rainwater in mind, porous plazas actively improve the health of the urban watershed while simultaneously creating vibrant social gathering spaces. Porous plazas are nodes within the larger network of porous streets, where large quantities of rainwater can be creatively managed.

Porous plazas encourage people to interact with water through their senses: sight, sound, taste, touch and hear. Embedding the presence or absence of rainwater into the experience of everyday life creates consciousness of the built environment's impact on the hydrological cycle and the larger watershed.

The case studies presented here highlight how rainwater can transform a plaza. They demonstrate various contexts where urban rainwater facilities are integrated in order to enhance cultural and social activities, improving social connectedness and understanding of urban watershed health.

CASE STUDY

Pavement to Parks

San Francisco, California

Image: Brian Kuslerv

Project Details

Project Partners	SF Planning Dept, SF Public Works, SF Municipal Transportation Agency, SF Parks Alliance, Ocean Ave Community Business District, Youth Art Exchange and more
Client	SF Communities
Type of Project	Public street + right-of-way improvements
Time frame	Temporary to permanent interventions
Cost	Varies per project
Annual rainfall	23.64 inches
Main Concept	Community-based quick open space prototyping

Image: City of San Francisco - Pavement to Parks Program

Project summary

A collaborative city-wide effort to reclaim underutilized areas of streets and right-of-ways to create tactical interventions for improving public life, safe pedestrian activities, bicycle transit, increase vegetation, neighborhood interaction and support local businesses. Experiments are implemented in phases to monitor their success. If the plazas are highly valued by the community, they can become permanent.

Design Opportunities

- Quick low-cost urban prototyping
- Flexible + reversible interventions
- Improve underutilized urban spaces
- Build on pre-existing community support
- Support local businesses

Design Constraints

- Mandate to use materials that already exist in the city
- Lack of street vegetation + permeability

Image: Steven Kyle Weller

"If parklets are just one more thing to do along the street, like putting in an they're seen as representing our right as citizens to shape our environment

Whole System

SF's street network takes up more area than all the SF parks combined. The program addresses this by identifying and collaborating with neighborhoods to increase open space.

Full Water Cycle

Since plazas begin as temporary interventions, designs that integrate urban rainwater are focused on increasing permeability and vegetation with mobile planters that intercept and store rainwater.

Full Soil + Vegetation Cycle

Proposals are required to use materials that the city already has, using local municipal compost and drought-tolerant plants. Fruit bearing plants and trees are encouraged to improve the edible landscape of the city.

Human Health + Wellbeing

The City's goal is to improve and increase open space for neighborhoods that are lacking parks or greenways.

awning, then they're not that big of a deal. They're important when and prod cities to do better."

Blaine Merkel
Gehl Studio

Image: City of San Francisco

Image: City of San Francisco

Community Engagement

Plaza proposals are required to have pre-existing community support. The program's goal is to mobilize volunteers who want to improve their neighborhood. A programming and activation plan must be submitted which identifies community outreach events once the plaza is built.

Adaptive Design

The program uses the city as a learning lab to create quick, low-cost and flexible urban prototypes that respond to the lack of open space, unsafe bicycle zones and sterile pedestrian sidewalks. This builds a distributive network of rapid and temporary public space improvements throughout the city.

Maintenance, Monitoring + Evaluation

Interventions are monitored in phases to gauge their success: from a week long to year long and finally, if successful, they can become permanent. A maintenance plan must be submitted with the project proposal.

Lessons Learned

Quick low-cost urban prototyping mobilizes community members, empowering them with actionable tools to improve public space in their neighborhoods.

CASE STUDY

Uptown Normal

Normal, Illinois

Image: Scott Shigley

Project Details

Project Partners	Hoerr Schaudt Landscape Architects; City of Normal, IL
Client	Normal, IL
Type of Project	District redevelopment; street redesign
Time frame	2002 - 2010
Cost	Uptown Normal redevelopment: $15.5 million; Uptown Circle: $1.5 million
Annual rainfall	35.98 inches
Main Concept	Channel stormwater from two streets to create a space that doubles as a plaza and traffic circle

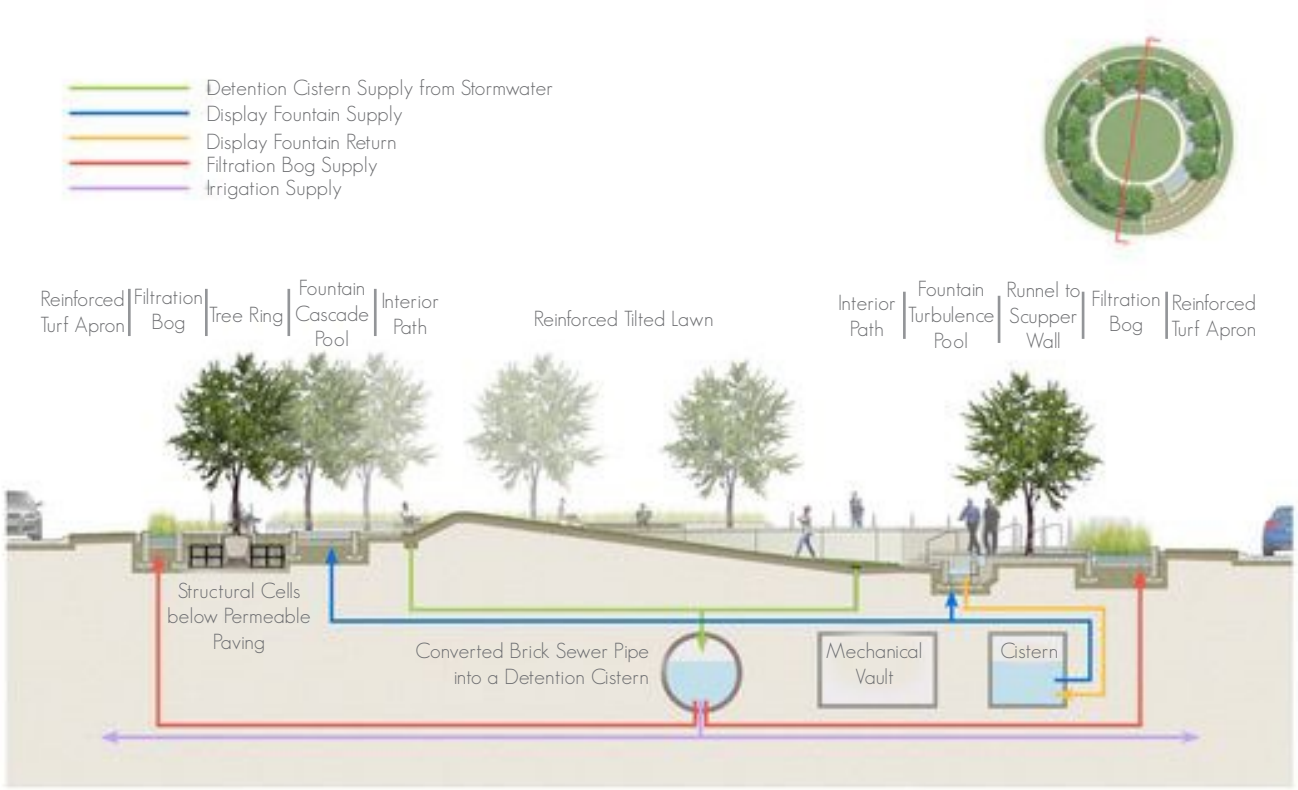


Image: Hoerr Schaudt

Project summary

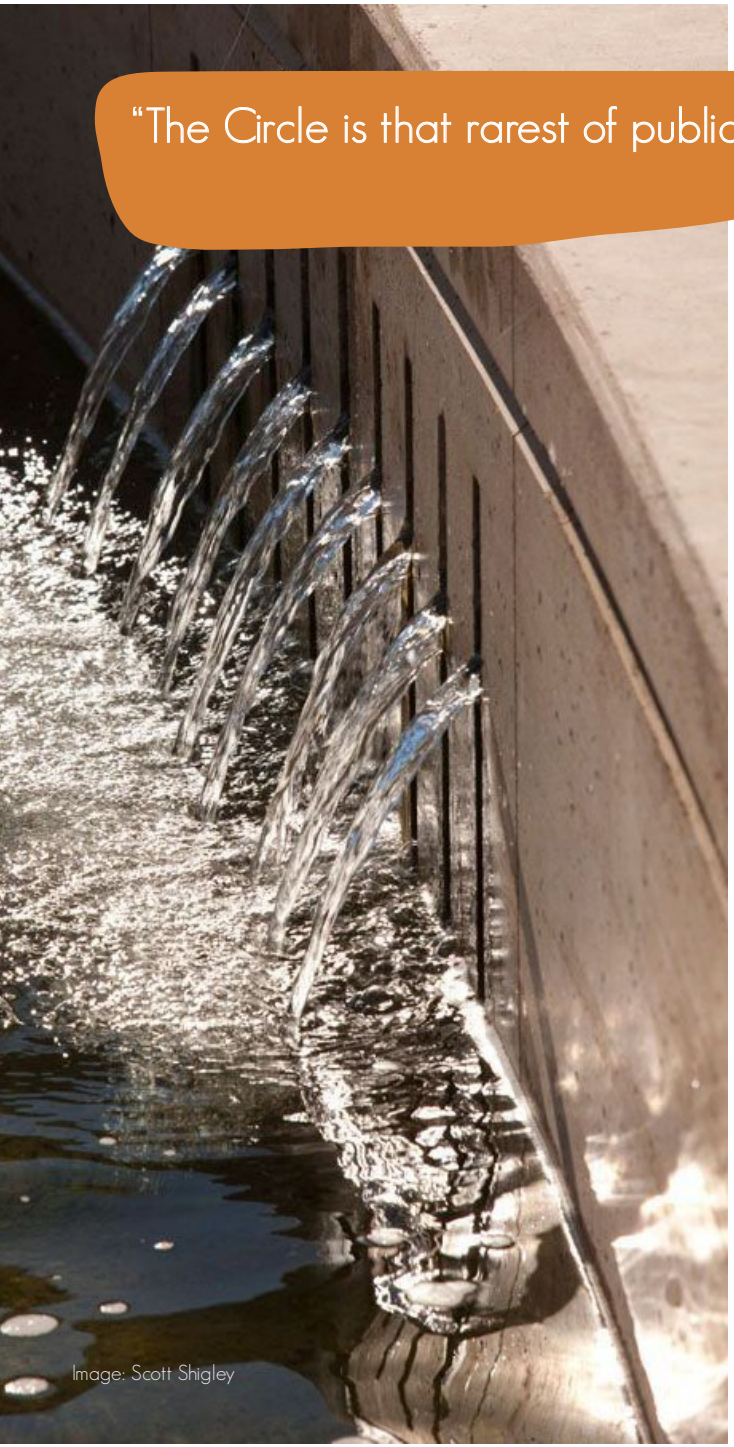
At its core the Circle helps direct and calm traffic. However, below the surface, a closed water system collects stormwater from adjacent streets and stores it in a 75,000 gallon cistern. This cistern detains and cleans water by sending it through terraced filtration bogs and an underground reservoir where it is treated by a UV filter, finally being distributed as a shallow stream for visitors to splash and play in.

Design Opportunities

- Update stormwater management practices
- Resolve lack of community space
- Rethink existing intersection as a uniter, not divider
- Utilize traffic calming device as public gathering space

Design Constraints

- Busy intersection in downtown area
- Poor existing traffic circulation
- Stormwater must be thoroughly cleaned before people are allowed to directly interact with it



"The Circle is that rarest of public amenities – a water feature that can

Whole System

The site directs street runoff into silva cells and planted areas, blocking 1.4 million gallons of stormwater from entering the city's storm sewer system. This water instead recharges groundwater and reduces stormwater runoff effects on the area's watershed.

Full Water Cycle

In the Circle, stormwater is collected in a 75,000 gallon cistern and then cleansed via a series of terraced filtration planters filled with bog plants. Subterranean sand and UV filters finish the treatment process, allowing people to touch and play with the water.

Full Soil + Vegetation Cycle

The filtration system improves water quality by eliminating about 91% of total suspended solids, 79% of total phosphorous, and 64% of total nitrogen from stormwater with each pass.

Human Health + Wellbeing

Flowing stormwater runs around the edge of the circle mitigating noise pollution from nearby traffic and providing a source of play for visitors. To further reduce unpleasant noise, a "reverse-shingle" fountain floor creates audible sounds of water.

safely be enjoyed physically as well as visually and aurally."

Hoerr Schaudt Landscape Architects

Community Engagement

The community was involved during the design process and helped guide decision-making for the primary water feature. Initially, the designers thought the fountain feature should run dry but some community members preferred to have access to water at all times. So potable water now reinforces stormwater, keeping the fountain wet even in dry conditions.

Image: Scott Shigley

Adaptive Design

Native plants were chosen as they need less water than ornamentals. In addition, 67 new trees have more than adequate amounts of root space due to the silva cell, which keeps soil from compacting over time.

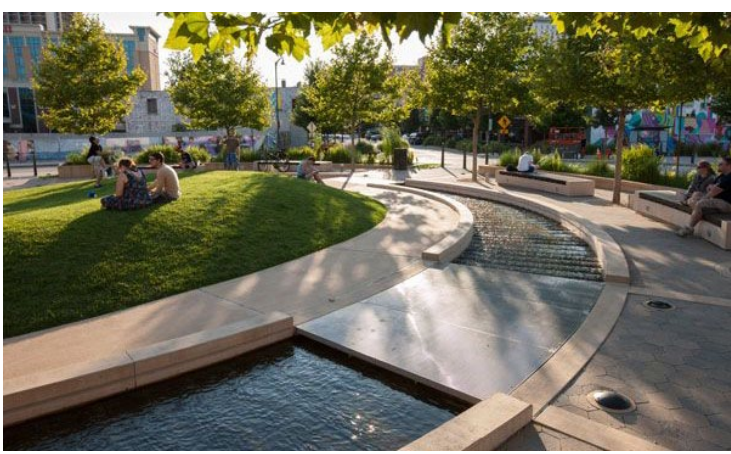


Image: Scott Shigley

Maintenance, Monitoring + Evaluation

The community volunteers to help maintain the space by removing litter. Debris and litter build up in the plaza, clogging water filters at a fast rate. To keep it functioning properly, water filtration equipment must be maintained frequently.

Lessons Learned

Visitors to the Circle interact with the water feature in unforeseen ways. For instance, goldfish somehow found their way into the water feature and this proved to be a delightful and surprising experience for those who witnessed it.

CASE STUDY

Water Square Benthemplein

Rotterdam, Netherlands

Image: Jeroen Munsch

Project Details

Project Partners	City of Rotterdam Engineering Bureau Baptistry: Anouk Vogel; Color advice: Annet Posthumus; Social feedback: Arnold Reijndorp & Machiel van Dorst; Design team: De Urbanisten
Client	City of Rotterdam, Rotterdam Climate Initiative
Type of Project	Public Plaza
Time frame	2011-2013
Cost	$5,051,700
Annual rainfall	32 inches
Main Concept	Convert a drab, underused square into an active, multifunctional space that provides recreation for youth and collection for rainwater.

Image: De Urbanisten

Project summary

The water square: a new type of public space that brings together people and water. In dry conditions, the Water Square acts as a normal public space, providing room for recreation and gathering. However, when the sky goes dark and rain begins to fall, the recreation spaces become basins that detain rainwater, halting and slowing the normal runoff process.

Design Opportunities

- Bring together different groups of people who occupy adjacent buildings
- Orient space according to needs of young people
- Draw water from rooftops of surrounding buildings
- Create a landmark within the district

Design Constraints

- Three distinct catchment areas help break up space
- The water square will occasionally be unusable for recreation
- Basins require maintenance after rain events

Whole System

Water square Benthemplein is the first large scale plaza that helps Rotterdam cope with the more frequent heavy rainfall. It is one piece of an integrated water management plan that Rotterdam has devised.

Full Water Cycle

Rainwater visibly flows from the surrounding buildings, down the façades and through wide open runnels, eventually reaching one of the two smaller basins. In case of heavy rainfall, water can pass from the shallower basins to the deeper one via a water wall.

Full Soil + Vegetation Cycle

The deeper basin holds water for 36 hours before releasing it to the city sewers. In contrast, the two shallower basins release water to an underground filtration device, which then gradually seeps into the groundwater. Groundwater then feeds the city's trees and plants.

Human Health + Wellbeing

Each pool has been outfitted with high-activity programs: a pedestal rises out of one pool for dancing, a second pool features an open playing area for football, basketball, or volleyball, and the last pool contains ramps and stairs for skaters and BMX biking. Tiered seating accompanies each pool as well, allowing others to sit and watch the activities that are happening around them.

Community Engagement

A participatory process brought together designers, users and neighbors of the space. These groups participated in three workshops to determine the needs of the space. For a more vibrant space, a unanimous decision was made among the different groups that young people should lead the process and that the space should be influenced by seasonal cycles of water.

Adaptive Design

When rain falls, the plaza undergoes a drastic transformation. Play spaces become basins that detain rainwater, capable of temporarily holding up to 1,800 cubic meters of water, which is about 11,250 bathtubs worth of water.

Maintenance, Monitoring + Evaluation

Litter like leaves accumulate in the basins and can clog drain inlets. For people to play there, the basins need to be cleared of debris on a regular basis. Conversation is happening in order to improve this process to make sure the space still feels open and welcoming after a rain event.

Image: Jurgen Bals

Lessons Learned

Young people have made a profound impact on this space. They helped lead the participatory process and their influence is represented in the high-activity programming. The inclusive design process culminated in a result that accommodated people of all ages with a focus on the youth living in the area.

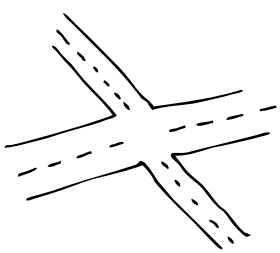
Putting it all together

POROUS NEIGHBORHOODS

Case Studies

/ Ballard Natural Drainage Systems, Phase 1 (Seattle, Washington)
/ Tabor to the River (Portland, Oregon)
/ Zoho District (Rotterdam, Netherlands)

PUTTING IT ALL TOGETHER



Porous Streets

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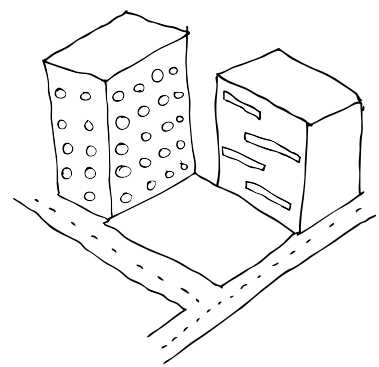

Porous Plazas

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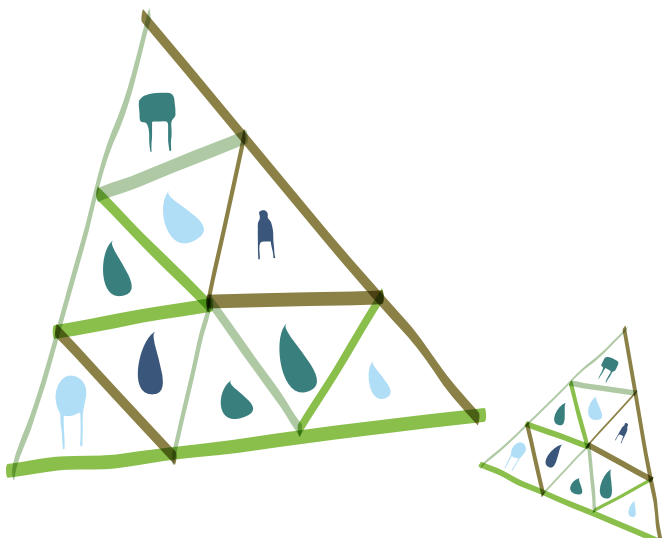


The porous framework that creates

Porous Neighborhoods

Porous neighborhoods use site scale porous streets and plazas to create a redundant, resilient, and distributed urban rainwater framework. Collectively, porous neighborhoods address subbasin and watershed health goals.

The case studies presented highlight how neighborhood scale action collectively strengthens the porous framework that improves overall watershed health by interweaving social and ecological goals of both people and rainwater.

CASE STUDY

Ballard Natural Drainage Systems (Phase 1)

Seattle, Washington

Image: Seattle Public Utilities

Project Details

Project Partners	Seattle Public Utilities
Client	Ballard Community
Type of Project	Green street neighborhood network
Time frame	March 2009 - December 2010
Cost	$1.4 million of American Reinvestment and Recovery Act (ARRA) loans/grants + $500,000 for retrofits
Annual rainfall	38.6 inches
Main Concept	Neighborhood green street network to reduce CSO

Image: HPI Green

Project summary

The Ballard natural drainage systems project uses a distributed network of green streets to prevent combined sewer overflows (CSO) that endanger Salmon Bay with raw sewage and stormwater. The project (phase I and II) aims to collectively infiltrate, clean and store six million gallons of stormwater throughout the basin to protect the bay.

Design Opportunities

- Wide streets - lots of space for GSI
- Increase native plants + trees in ROW
- Educational tool to teach about the bay's health

Design Constraints

- One-tenth an inch of rain can cause CSO overflow in this basin
- Quick timeline for ARRA loan/grants
- Areas of poor infiltration + perched groundwater over glacial till soils

Image: KPLU

"This project has highlighted the need to outreach and engage the and review the technical assumptions and data with the project team."

Whole System

The quick ARRA timeline limited the project's ability to do a thorough evaluation of each raingarden's site specific water and soil systems. The lack of accurate infiltration, subsurface and groundwater data impacted the overall success of the project.

Full Water Cycle

Bioretention cells were designed to infiltrate 95% of the stormwater volume. After installation, monitoring showed that 30% infiltrated as planned, 30% infiltrated too slowly and 30% were not infiltrating at all.

Full Soil + Vegetation Cycle

The bioretention cells that were non-draining or slow-draining were due to poor infiltrating soils and/or perched or mounded groundwater conditions over glacial till soils. After installation, heavy rains created deep ponding as the vegetation was not fully grown.

Human Health + Wellbeing

The community perceived the ponding bioretention cells as a hazard for drowning for young children and elderly, mosquitos and smell.

community early and often, not try to rush things, and to continue to go back

Green Stormwater Infrastructure Program
Seattle Public Utilities

Community Engagement

The City acknowledges they should have done more rigourous community engagement from the beginning. They now recommend: to engage the community 2 years before project design meetings, develop several strategies to communicate and educate the community on the problem before presenting a solution.

Image: Seattle I Do That

Adaptive Design

Bioretention cells were not designed for redundancy in terms of designing a fail safe for long-standing water to be removed with an underdrain or overflow backup.

Image: City of Seattle

Maintenance, Monitoring + Evaluation

The community was frustrated about the under performing bioretention cells and demanded they be fixed or removed. The retrofit design manages 64% of the original stormwater management goal (from 59,000 gals to 38,000 gals).

Lessons Learned

Early and sustained community engagement with accurate soil and hydrological data is foundational to successful neighborhood scale GSI. Monitoring and evaluating GSI projects and continually adapting them from previous lessons learned strengthens a program's long-term success.

CASE STUDY

Tabor to the River

Portland, Oregon

Image: Nancy Rottle

Project Details

Project Partners	City of Portland, Bureau of Environmental Services and Portland communities
Client	Portland
Type of Project	Integrated watershed management plan
Time frame	2007 - 2025
Cost	Grey only solution $144 million VS grey+green solution $81 million = $63 million savings
Annual rainfall	35.98 inches
Main Concept	An integrated watershed management plan

Image: Portland Environmental Services

Project summary

An integrated watershed management plan by the city and community to create adaptable and sustainable solutions that work towards a healthier urban watershed, more livable neighborhoods, more vibrant business districts and cleaner rivers and streams.

Design Opportunities

- Expand stormwater management beyond individual lots or single street intersections
- Reduce traditional grey infrastructure costs by $63 million
- Strengthen local expertise of consulting + contracting industries
- Educate the community on the multifunctional benefits of GSI
- Provide opportunities for communities to do their part in watershed health

Design Constraints

- Combined sewer overflows
- Existing monoculture of invasive plants
- Sedimentation in river endangers aquatic species

Image: Portland Environmental Services

"People are part of our infrastructure. We use green stormwater success of green infrastructure and healthy neighborhoods."

Whole System

The project defined goals and strategies for a healthy urban watershed instead of starting with regulations that needed to be satisfied. This scalar approach helped create a robust systems-based strategy that worked on both the large system and site scale.

Full Water Cycle

Green stormwater facilities in the right-of-way and on private property increased and improved areas for watershed processes to manage rainfall on site.

Full Soil + Vegetation Cycle

The program recruited volunteers to remove invasive species and replaced them with diverse native plants to improve wildlife habitat. Native plants have more complex root systems that improve soil's ability to manage water. The program goal is to plant 3,500 trees.

Human Health + Wellbeing

The program goal is to build 500 green streets and 100 private stormwater projects to create safer streets and neighborhoods.

infrastructure to build social infrastructure. Community is key to long-term

Community Engagement

Equal amount of time was spent working with the community as with engineering and design. The time and money invested early on in education has helped the neighborhood realize and define program goals. Key relationships developed and fostered with K-12 schools, the university, neighborhoods, bike groups, businesses and community groups. A range of outreach tools were used to ensure all voices were heard.

Adaptive Design

The program distributes green stormwater facilities, relying on a network of systems that provide multiple benefits: improving communities and the urban watershed.

Maintenance, Monitoring + Evaluation

The program partnered with local universities to help with long-term program evaluation. The university curriculum also uses Tabor to the River as a case study and helps with mapping. Community members chose the plant palette to encourage stewardship and long-term maintenance.

Portland Bureau of Environmental Services

Image: Portland Environmental Services

Image: Portland Environmental Services

Lessons Learned

A watershed-based approach integrated with intensive outreach has long-term ecological and social benefits.

CASE STUDY

Zoho District

Rotterdam, Netherlands

Image: De Urbanisten

Project Details

Project Partners	De Urbanisten, Nico Adriaanse Stichting (NAS) and Rotterdam Community Advocates
Client	Rotterdam North District and Rotterdam Climate Proof
Type of Project	District and City Climate Proofing
Time frame	2014-ongoing
Cost	Varies according to project
Annual rainfall	32 inches
Main Concept	Utilize existing Rotterdam Climate Adaptation strategy to retrofit a district filled with hardscape and bring together diverse groups of neighbors

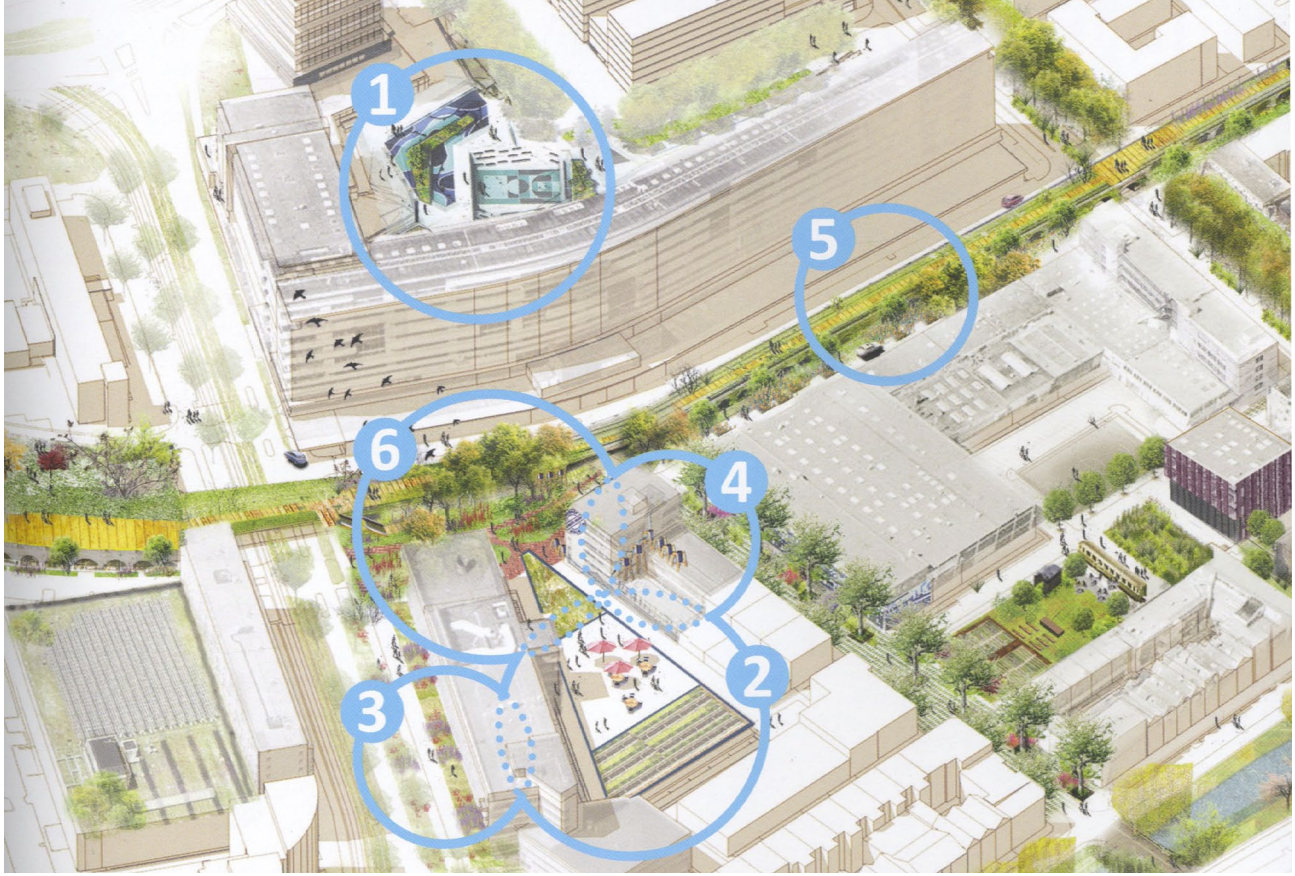


Image: De Urbanisten

Project summary

The Climate Proof Zoho district plan follows and executes principles outlined by the Rotterdam Climate Adaptation Strategy. Beginning with the Benthemplein Water Square in 2011, Zoho is the primary testing ground for a series of interventions intended to turn Rotterdam into an adaptive, vibrant city that can cope and thrive in the face of climate change.

Accomplished Work:

1. Benthemplein Water Square
2. Polder Roof
3. Katshoek Rain(a)way Garden
4. Zoho-Rainbarrel
5. Greening Hofbogen
6. Zoho-Raingarden

Design Opportunities

- Diversify modes of input and participation
- Transform underused, hardscaped spaces into lush, permeable green space

Image: De Urbanisten

Whole System

Interventions, large and small, in the Zoho district work together to "climate proof" Rotterdam and its watershed, making certain it continues to manage stormwater as well as provide engaging public space for its inhabitants well into the future.

Full Water Cycle

In Rotterdam, there can sometimes be too much water in the system, other times however there is not enough. Projects therefore intend to curtail the stress put on sewage system during heavy rainfalls by retaining rain water on site. The effects of drought can be handled in a similar fashion.

Full Soil + Vegetation Cycle

Depaving plays a crucial role in climate proofing Zoho district. At the entrance to the district stands the Zoho Raingarden, a large welcoming area that has been depaved with help from the community. Soil, once depraved of sunlight, now allows new plants to take root and helps recharge groundwater. The raingarden can adapt to dry or wet conditions thanks to an array of drought-tolerant and moisture-loving plants.

Human Health + Wellbeing

Increased temperatures can be felt in urban conditions. The Polder Roof design addresses this by converting the top of a parking garage into a permeable, shaded surface in which people can gather and rainwater can soak in.

Community Engagement

Participation from the community has been integral to the success of Zoho district. For example, the first phase of the Zoho Raingarden, including depaving and planting of a 100 square meter area only took two days and cost absolutely nothing thanks to volunteer efforts from many different community groups.

Adaptive Design

Zoho district currently faces three challenges: more frequent heavy rainfalls, prolonged periods of drought, and increased temperatures related to heat stress. A wide distribution and diversity of projects make this district plan robust and able to respond to each challenge appropriately.

Maintenance, Monitoring + Evaluation

Designing maintenance plans also occurs in this ongoing process. At the pop-up raingardens, NAS, a social work organization has taken charge of maintenance. To assist NAS, De Urbanisten created a maintenance instruction folder to facilitate future care of the raingarden and even provided instruction classes for them!

Image: De Urbanisten

Lessons Learned Drawing upon the energy and knowledge of different community members and combining large-scale interventions with quick wins produces results that boost a district's health and adaptability.

PLACES TO INSPIRE YOU

A street that shifts car lane to gain space for public life
Gammel Kongvej, Copenhagen
Image: europi.com

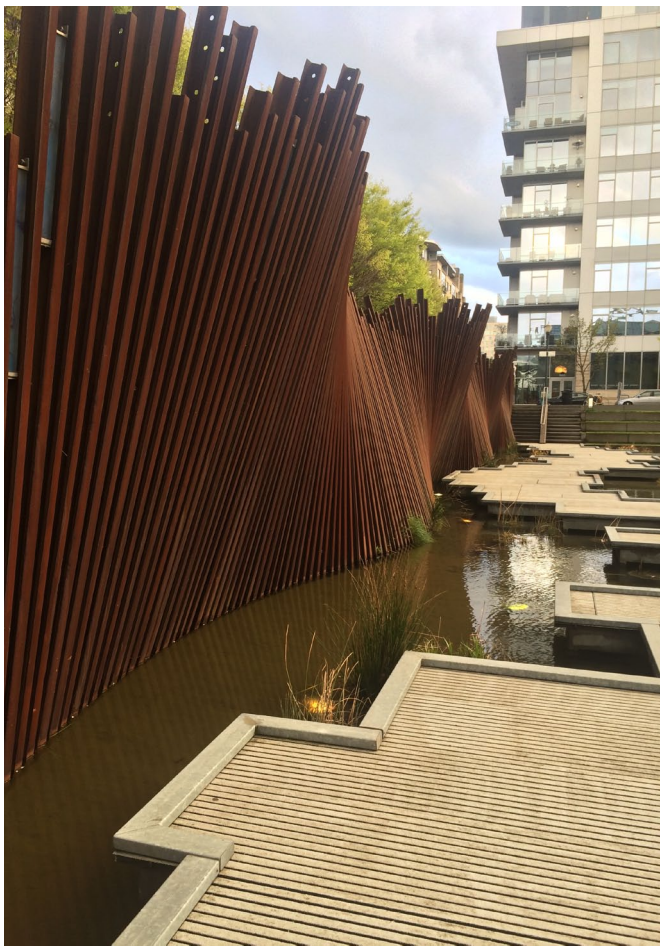
Distributed microfacilities to manage water
Passeig de St Joan boulevard, Barcelona, Spain
Image: Lola Domenech

Dutch Bicycle Footballs
Rotterdam, Netherlands
Image: protectedintersection.com

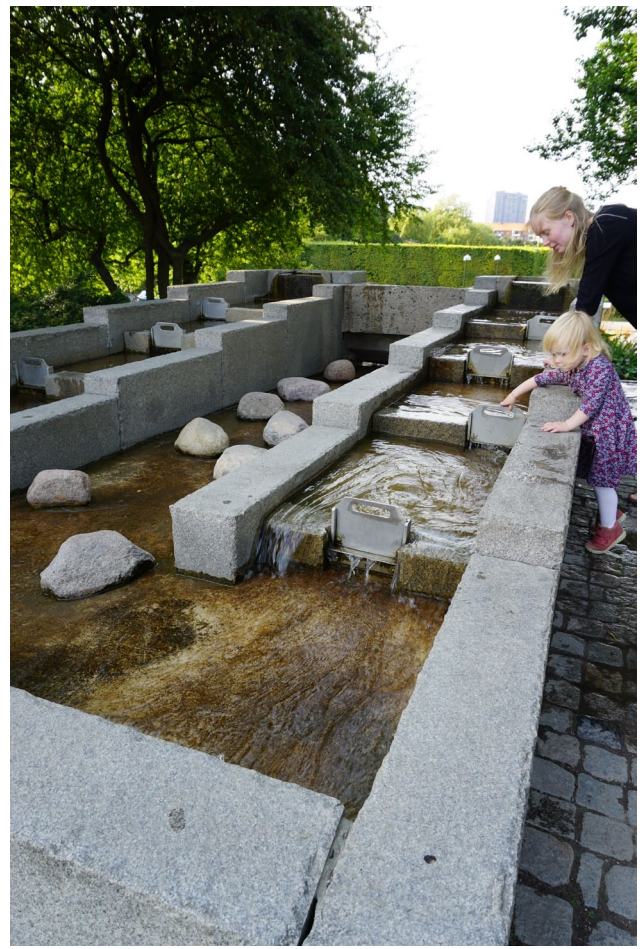
Image: streets.nm

Copenhagen Climate Resilient Neighborhood
Sankt Kjelds, Copenhagen, Denmark
Images: Tredje Natur

PLACES TO INSPIRE YOU



Artful, "floating" pontoon set above a wetland
Tanner Springs Park, Portland, Oregon
Image: James Wohlers



Interactive concrete cascade
Pildammsparken, Malmö, Sweden
Image: James Wohlers

A brownfield becomes new public space using reclaimed water
East Bay Plaza, Olympia, Washington
Image: Robert W. Droll, ASLA

Large pools fed completely by rainwater
Potsdamer Platz, Berlin, Germany
Image: Atelier Dreiseitl

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THANK YOU TO THOSE WHO TOOK TIME TO CHAT WITH US:

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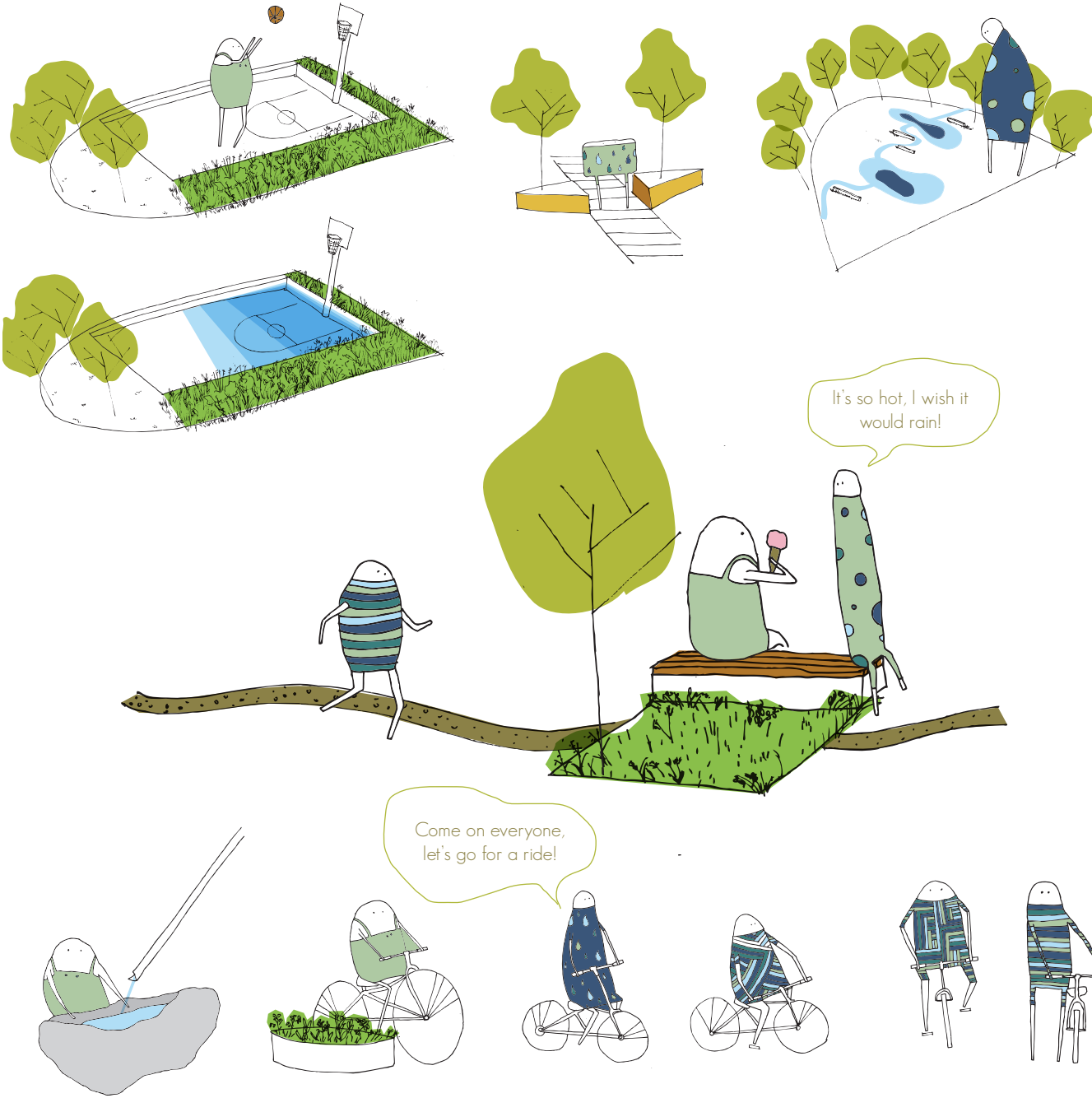
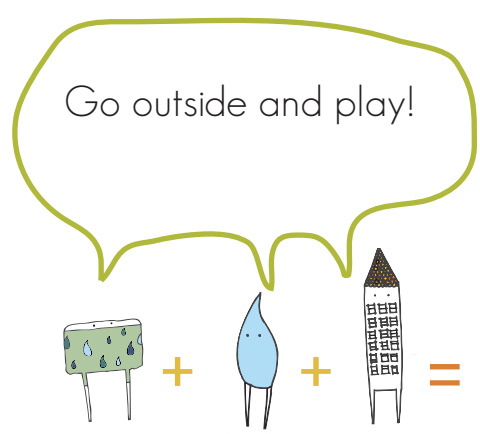

It's so hot, I wish it would rain!
Come on everyone, let's go for a ride!


Ah... water...
Do you feel that?
It's about to rain!
Bye! See you next time!



POROUS PUBLIC SPACE

UW GREEN FUTURES LAB