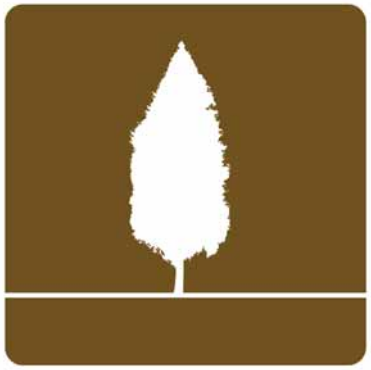
SUSTAINABLE STORMWATER:
a kit of parts approach

DRAFT

Rain Gardens

Vegetated Swales



Native Landscapes

Pervious Surfaces

Rainwater Collection

Naturalized Detention

Illustration showing post-construction sustainable stormwater and traffic-calming strategies along North Derbigny Street in the Lower Ninth Ward (Image created by Siteworks Studio for the L9SIP project).

This manual was developed by the Make It Right Foundation,
in support of the Lower Ninth Ward Sustainable Infrastructure Project.

Special thanks to the City of New Orleans Department of Public Works,
for providing the opportunity to explore these strategies
during the ongoing recovery and rebuilding process.

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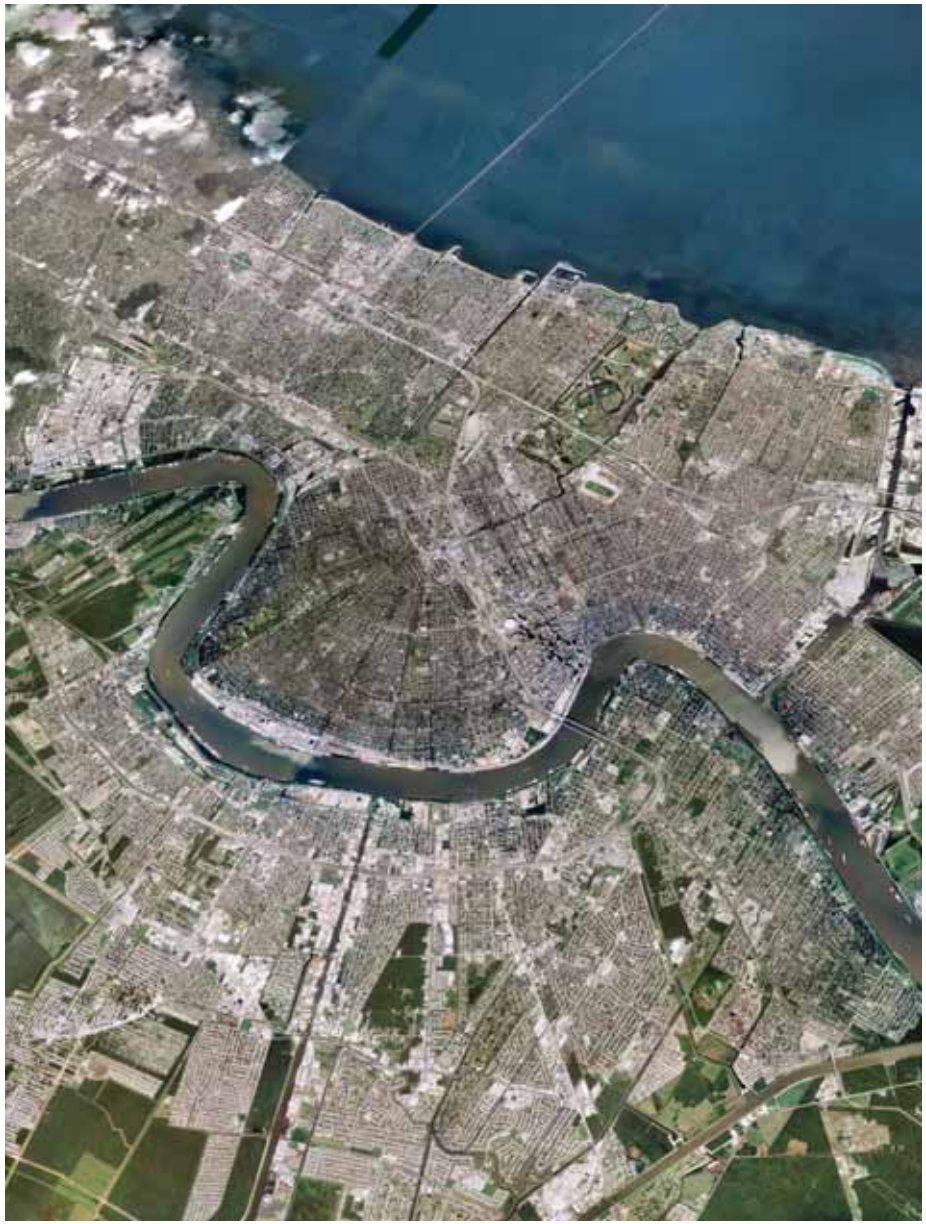
"Reduce the city's stormwater loads through the design of its new buildings and infrastructure. By reducing stormwater [runoff], the rate at which stormwater reaches pumps is reduced, lessening flooding and allowing use of smaller pumps operating at substantially lower cost."

US Green Building Council: New Orleans Principles
Principle #5, Recommended Action #8



The Greater New Orleans Metropolitan region is dependent upon an engineered drainage and pumping system to maintain the health, safety, and welfare of the population that has chosen to call New Orleans home. (Map from Google Earth).

Goals and Objectives of this Manual

This manual is intended to provide an overview of sustainable stormwater strategies to city officials, building professionals, neighborhood groups, and citizens with an interest in a more resilient and safer New Orleans.

The primary objective of this handbook are to identify a stormwater management "kit of parts" comprised of replicable strategies to be deployed alongside conventional stormwater management approaches. These strategies will be identified and described, and then shown within generalized New Orleans conditions to provide sense of contextual application.

Please note*:* this information is presented as an introduction to the principles of sustainable stormwater management. Prior to implementing any of the strategies outlined in this document, please consider seeking professional assistance to insure compliance with local building codes, to fully understand site conditions, and to identify site-specific opportunities and constraints related to stormwater management.

"New Orleans will always continue to require engineered drainage systems and pumps. However, stormwater engineering increasingly is adapting the lessons of natural systems to controlling and filtering runoff. These techniques can be applied at any scale, from the backyard rain gardens to streets and city parks…and will help the city manage water, mitigate flooding, and reduce subsidence."

New Orleans Master Plan & Comprehensive Zoning Ordinance

Lower Ninth Ward Sustainable Infrastructure Project

This manual was developed as a primer to the strategies recommended for implementation within the Lower Ninth Ward Sustainable Infrastructure Project (L9SIP), a city-funded pilot project begun in 2009 that seeks to explore a variety of stormwater management strategies along 8 blocks of the Make It Right project area. This project will include total street replacement, implementation of street side stormwater management techniques, trial usage of pervious concrete within the vehicular right of way, and traffic calming strategies.

The project goals, in short, are to reduce the quantity of stormwater runoff entering into the municipal storm sewer network, to increase water quality, and to enhance the neighborhood streetscape with regards to aesthetics, walkability, resiliency and passive survivability. Construction is expected to begin by winter 2010.

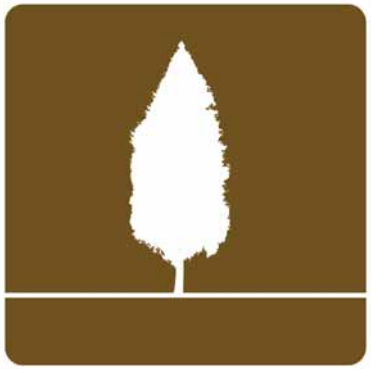
Project Goals:

- 10-year storm retention
- integration of habitat and ecology
- functional with contiguous and non contiguous lots
- integration of greenspace for retention/detention
- development of a replicable “kit of parts”

The Lower Ninth Ward Sustainable Infrastructure Project will explore a variety of innovative stormwater management practices within 8 linear blocks of the Lower Ninth Ward neighborhood of New Orleans, Louisiana. (Image created by Siteworks Studio for the L9SIP project)

Rain Gardens

Vegetated Swales



Native Plantings

Pervious Pavements

Rainwater Collection

Naturalized Detention/Retention

Sustainable Stormwater Management Goals

- ***Reduce Impervious Surfaces***: Roadways, driveways, parking lots, and rooftops contribute to increased runoff by shedding stormwater off their surfaces into adjacent drainage ways. By reducing the square footage of these surfaces, or by replacing them with pervious surfaces, stormwater runoff can be reduced.

- ***Slow Runoff:*** Increase the amount of time required for stormwater to runoff into municipal storm drains, thereby reducing the peak volume that occurs within the drainage system, helping to reduce downstream flooding. This can be accomplished in a variety of ways, including the construction of properly located rain gardens, the use of pervious paving strategies, and the use of cisterns or rain barrels.

- ***Increase Runoff Quality, Decrease Runoff Quantity:*** Through the thoughtful implementation of sustainable stormwater management strategies, the amount of stormwater runoff reaching city drains and pumps would be reduced, while the quality of stormwater runoff would be increased.

- ***Encourage infiltration into soils to reduce subsidence:*** Intentionally draining into rain gardens or vegetated swales allows runoff to infiltrate into the groundwater table and to be uptaken by trees and plants. The presence of groundwater can also help to mitigate subsidence in certain areas.

- ***Encourage Rainwater Reuse***: Currently, the potential for reuse of captured rainwater in New Orleans is limited to non-potable, outdoor uses, including landscape irrigation and car washing.

- ***Native Landscaping***: The use of native trees and landscape materials can help to uptake stormwater after rain events. A mature bald cypress tree can absorb hundreds of gallons of rainwater through its root systems during and after rain events, acting as a massive, living cistern. Natives are preferable because they are already suited to the climatic conditions of the region, and are more resistant to pests and diseases.

Strategy #1 | *Rain Gardens*

Rain gardens can take many shapes and sizes, and can be designed to function in a variety of ways. This rain garden in the Make It Right project area utilizes native plant species and is bordered by reclaimed concrete, helping to reduce minor flooding in the immediate vicinity. (photograph by Make It Right)

Description

Rain gardens are constructed depressions within the landscape that are built to capture and detain stormwater runoff. These areas are intended to hold standing rainwater for no more than 48 hours after a rain event. During that time, rainwater infiltrates into the water table, evaporates, or is absorbed by plants and trees. In addition, these landscape features are attractive habitats to birds and beneficial insects such as butterflies.

Implementation Strategies

Rain gardens can be deployed at a variety of scales depending on site constraints and conditions. Typical installations occur at points of discharge from gutter downspouts, or at strategic points within the public streetscape. In extreme rain events, rain gardens should be designed to overflow safely into the municipal drainage system.

Benefits

- Reduced stormwater runoff
- Increased groundwater quality
- Increased infiltration into groundwater table
- Reduced subsidence
- Increased environmental quality

Vegetated swales assist in conveying stormwater runoff downstream, while helping to filter contaminants and allow for absorption by plants and soils.

Vegetated swales can also act to intercept sheet flow from surfaces such as parking lots, helping to reduce runoff and filter contaminants.

Description

Vegetated swales, or bioswales, are similar to rain gardens, but they are linear features intended to convey stormwater towards a drainage feature, or intercept flow along the length of a parking lot or sports field. Vegetated swales encourage infiltration into the groundwater table, and help to filter contaminants out of stormwater prior to overflow into the city drainage system.

Implementation Strategies

Vegetated swales should be installed in situations where runoff is intended to be intercepted along or directed into a linear path. Typical installations occur along property lines, or within the public right of way on streets with fewer curb breaks and driveways. Runoff from the street can be redirected through the use of curb breaks. These features can also be installed in concert with an infiltration trench, or atop a subsurface storage device, both of which increase infiltration and detention capabilities of the system. Check dams may be used to encourage ponding along the length of the swale.

Benefits

- Reduced stormwater runoff
- Increased groundwater quality
- Increased infiltration into groundwater table
- Reduced subsidence
- Increased environmental quality

Strategy #3 | *Native Tree Plantings*

Native trees such as Live Oaks provide significant protection from violent winds, act as giant rainwater cisterns, increase air quality, store carbon from the atmosphere, provide shade and habitat for birds. (Photo by Flickr.com user "Drain" under a Creative Commons License for usage)

Description

Native plant selections are usually flood and drought tolerant, require less maintenance once they are established, and are naturally resistant to diseases and pests. Native trees and shrubs also act as living cisterns; mature trees are capable of absorbing thousands of gallons of stormwater after a single rain event.

Implementation Strategies

Not all trees and shrubs are created equal. Some species and varieties are better suited for certain conditions or can tolerate stresses better than others. Choose trees for their performative and aesthetic qualities, and place trees strategically for maximum benefit.

Consult with a licensed landscape architect, landscape contractor, or horticulturist for assistance with site analysis, plant selection, and installation.

Please note that all plantings within the public right of way should follow all City of New Orleans ordinances and requirements.

Benefits of the use of Native Trees

- Reduces runoff, which helps to minimize impacts of minor flood events
- Increases air quality through reduced particulate matter.
- Mitigates urban heat island effect and provides shade, reducing energy bills
- Protects from violent winds during hurricanes and tropical storms, reducing damage
- Has positive impact on property values and overall character of neighborhoods

Installation of a pervious concrete sidewalk within the Make It Right project area in the Lower Ninth Ward. (photograph by Make It Right)

A driveway utilizing open-cell pavers planted with grass. Open-cell pavers allow stormwater to infiltrate into the void spaces, while still providing a durable driving surface in low traffic situations such as driveways.

Description

Typical concrete or asphalt roadways and driveways are impervious surfaces that shed stormwater as runoff. Pervious solutions, including pervious concrete, the use of non-rigid pavers, and open-cell pavers help to reduce runoff from these surfaces by allowing stormwater to be absorbed into the ground.

Pervious paving strategies require removing particles and debris that accumulate and would otherwise clog the pores within the surface.

Implementation Strategies

Pervious concrete: The use of pervious concrete in the Greater New Orleans region has been showcased within the Make It Right project area, where it is used for the construction of sidewalks and driveways. It is also an integral component of the L9SIP, where it will be used on a trial basis within the roadway.

Pervious pavers: Pervious pavers can take on a variety of forms. Open-cell pavers, porous blocks, and non-rigid (mortarless) installation of pavers are the most commonly used. All of the above encourage infiltration and reduce runoff.

Expected Benefits

- Reduces impervious area
- Reduces runoff volumes
- Encourages rainwater infiltration
- Mitigates localized minor flood risk

Strategy #5 | *Rainwater Collection*

Rainwater collection systems allow for reuse of captured water and reduce the amount of runoff entering the municipal drainage system. (photograph by Flickr.com user BOBXNC under a Creative Commons license for usage)

Subsurface detention tanks can assume a variety of shapes and sizes. These structural arches are intended to be used beneath parking lots or other load bearing surfaces.

Description

Rainwater collection strategies are an important part of stormwater management, as they provide a means to reduce runoff volumes, allow for potential reuse of captured rainwater, and can take a variety of forms depending on site specific opportunities and constraints.

Implementation Strategies

Subsurface Storage: Through the placement of specialized tanks beneath the ground, rainwater can be collected on-site without sacrificing surface area. Once stored, stormwater can have the opportunity to infiltrate into the groundwater table, to be pumped to the surface for reuse, or trickle slowly into the municipal drainage system.

Cisterns & Rain Barrels: Usually attached to building gutter and downspouts, these features simply store rainwater for future use. Currently the reuse of rainwater in New Orleans is limited to outdoor, non-potable uses including irrigation and cleaning.

Expected Benefits

- Reduces runoff
- Increases storm delay
- Potentially reduces potable water usage
- Provides opportunity for rainwater reuse

Naturalized detention ponds can be used to store large volumes of stormwater runoff, while filtering contaminants out of the water and allowing for infiltration into the ground-water table.

Description

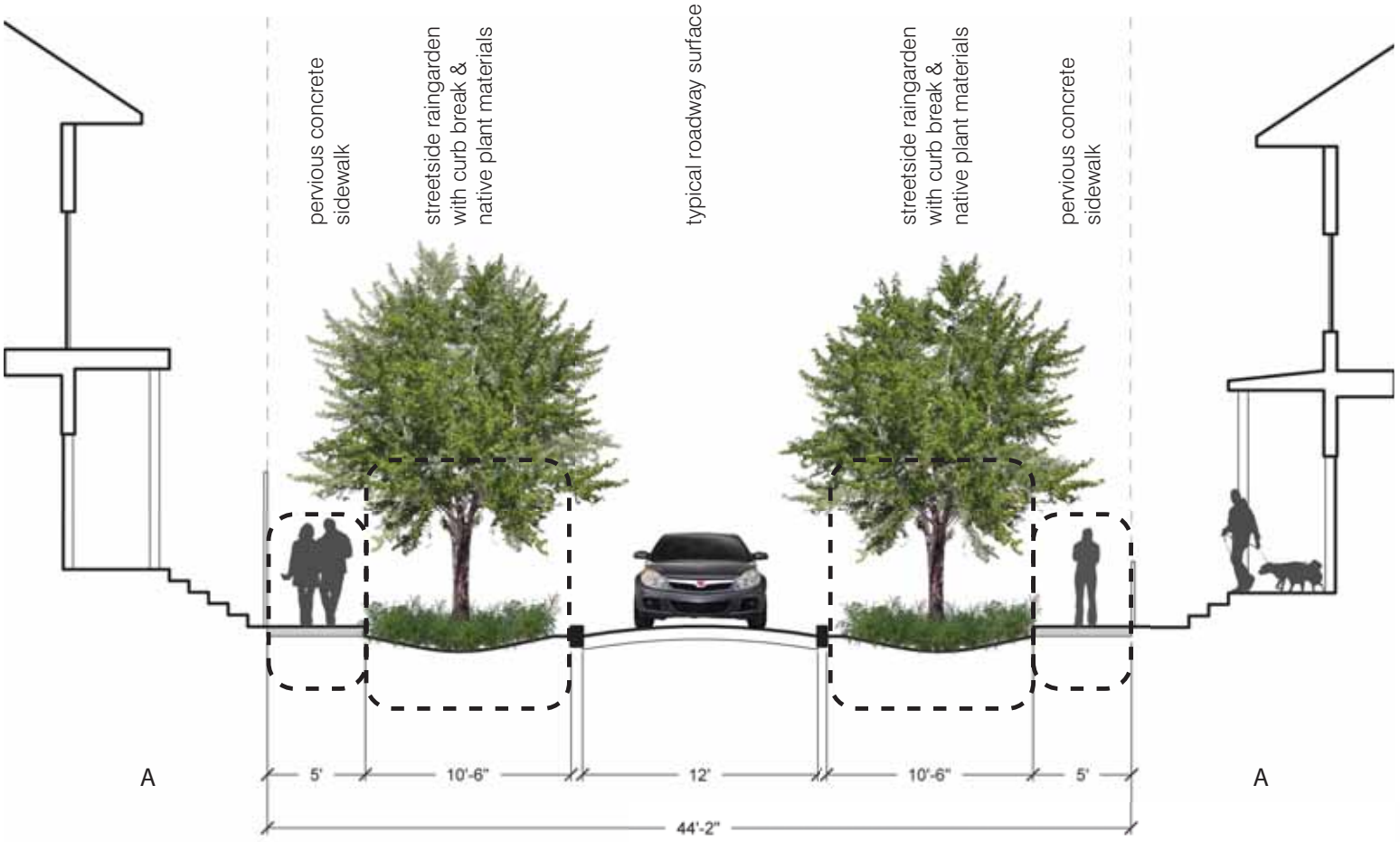
Naturalized detention ponds are large constructed depressions intended to mimic natural conditions, and serve as catchments for volumes of stormwater runoff. Detention ponds have an outlet for water to flow, at a reduced rate, into engineered stormwater systems. Retention ponds are usually disconnected from these systems, and hold water until it evaporates, infiltrates into the soils, or is absorbed by plants and trees. A naturalized detention or retention pond would be designed and constructed in a way that safely mimics naturally-occurring wetland environments.

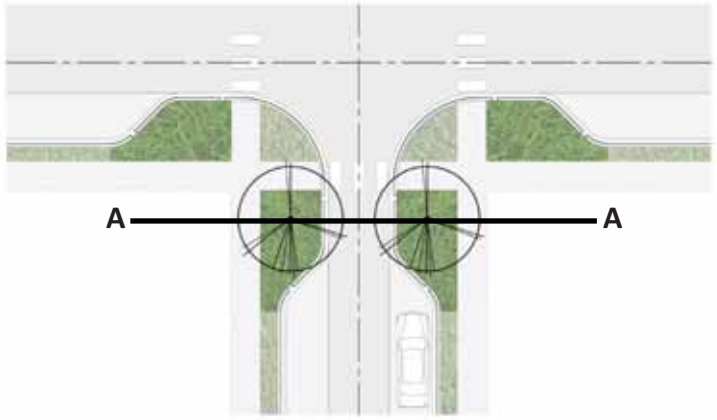
Installation Strategies

Site selection is critical for locating and installing such a feature. Many times, larger developments such as shopping centers or institutional buildings are required to provide space for stormwater detention and retention, to compensate for the large amount of stormwater runoff these buildings create. These features must be designed with a clear understanding of expected runoff volumes, subsurface soils and drainage characteristics, and capacity of adjacent stormwater utilities.

Expected Benefits

- Potential to capture, filter, and infiltrate large volumes of rainwater
- Provides a haven to ecologically significant plants and trees
- These features can be integrated into parks, greenway systems, and campuses, providing opportunities for passive recreation

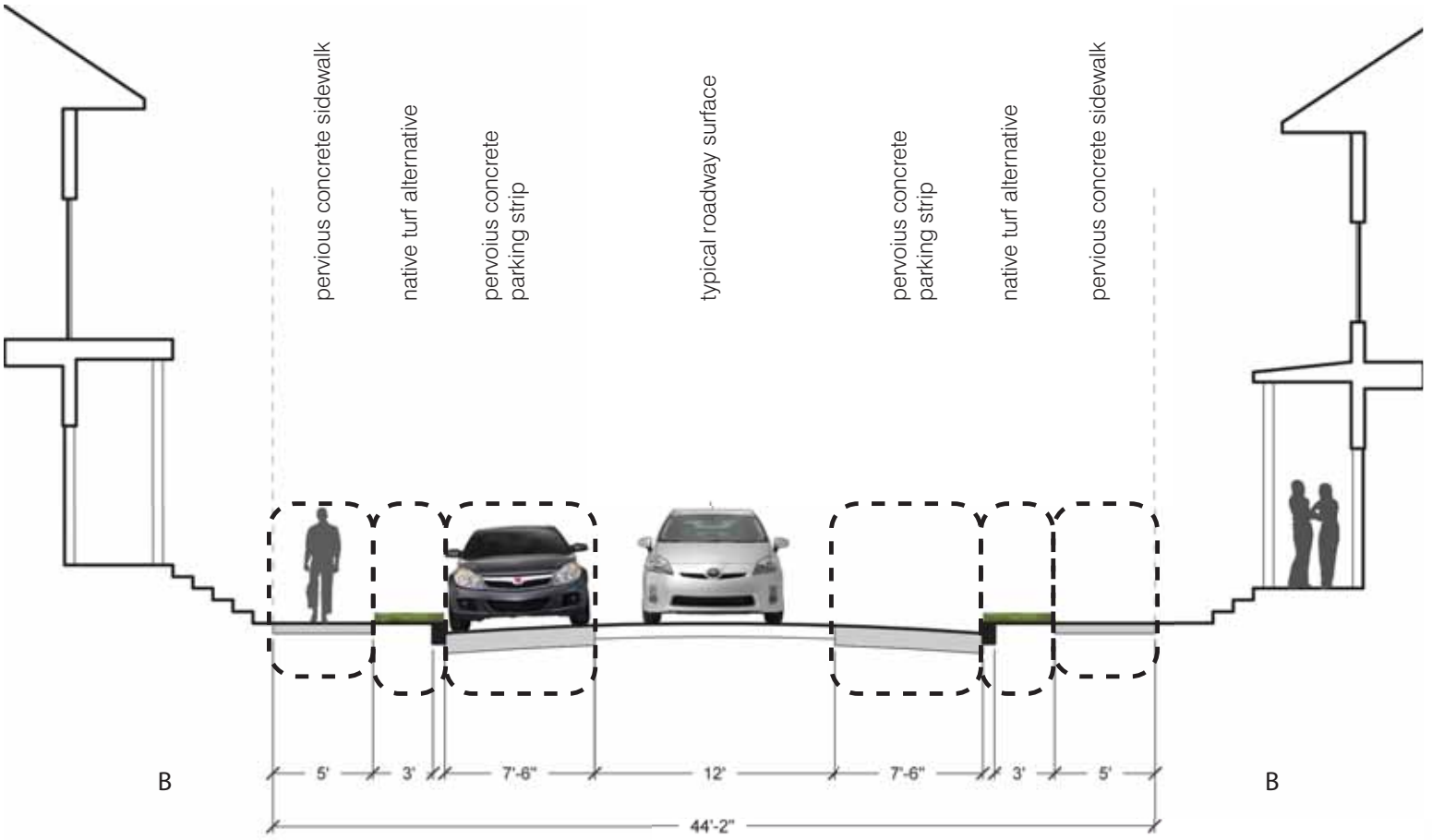


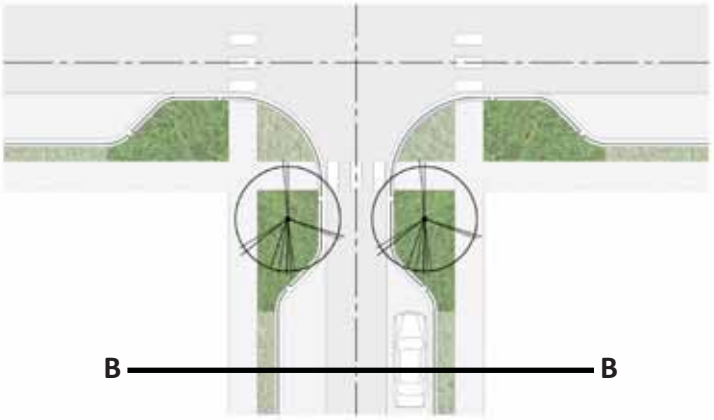


One-Way Local Street - Section BB

Features:

Pervious Sidewalks
Streetside raingardens within traffic-calming bumpouts
Native landscaping
Curb-breaks to facilitate drainage into rain gardens

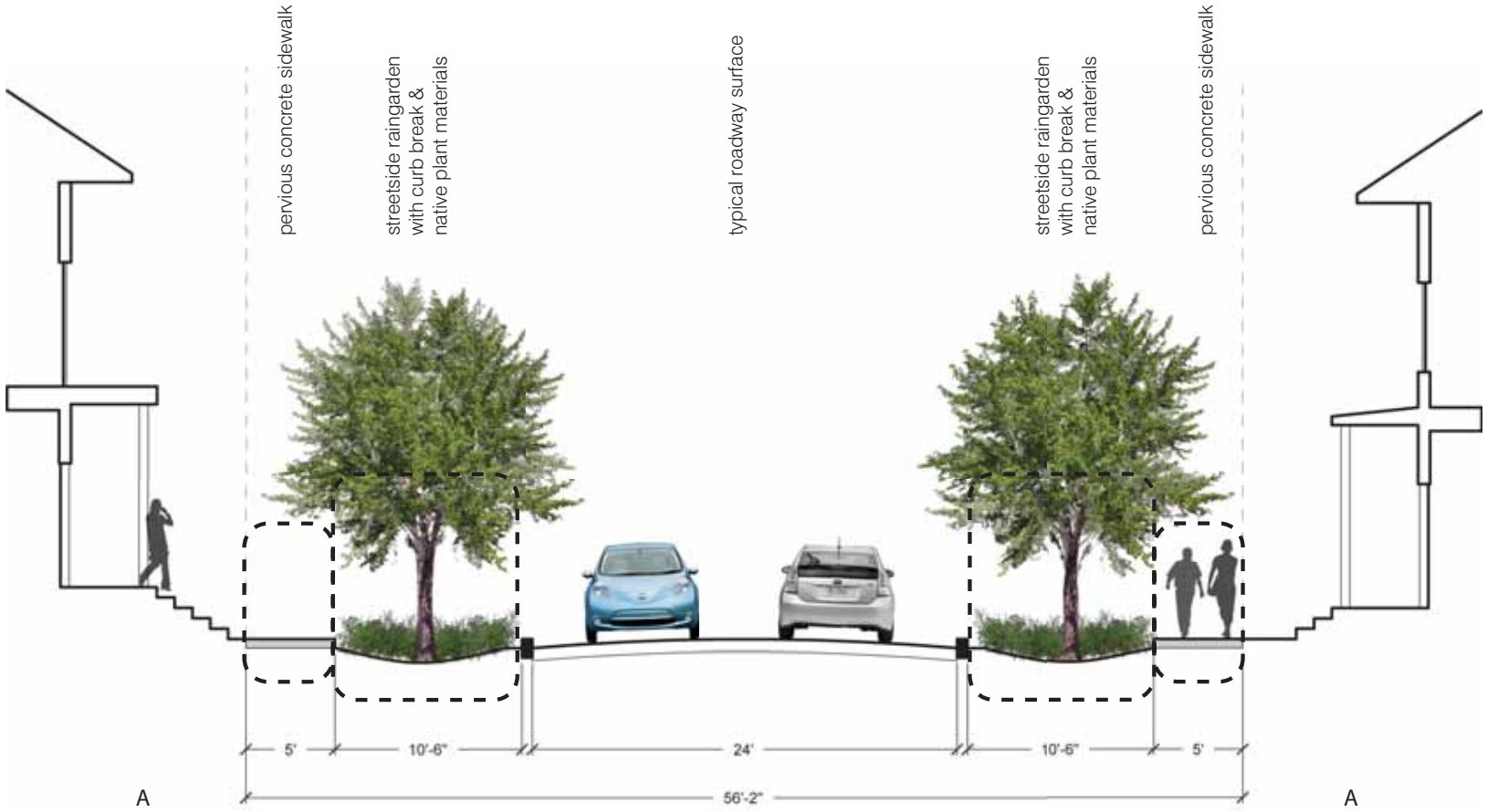


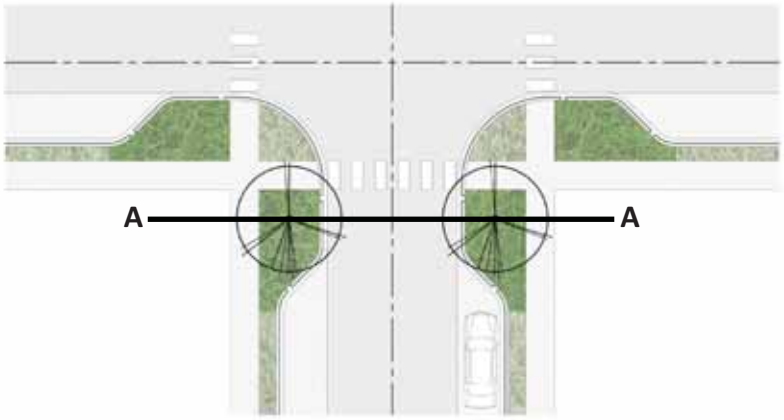


One-Way Local Street - Section AA

Features:

Pervious Sidewalks
Native groundcover
Pervious Parking Shoulder



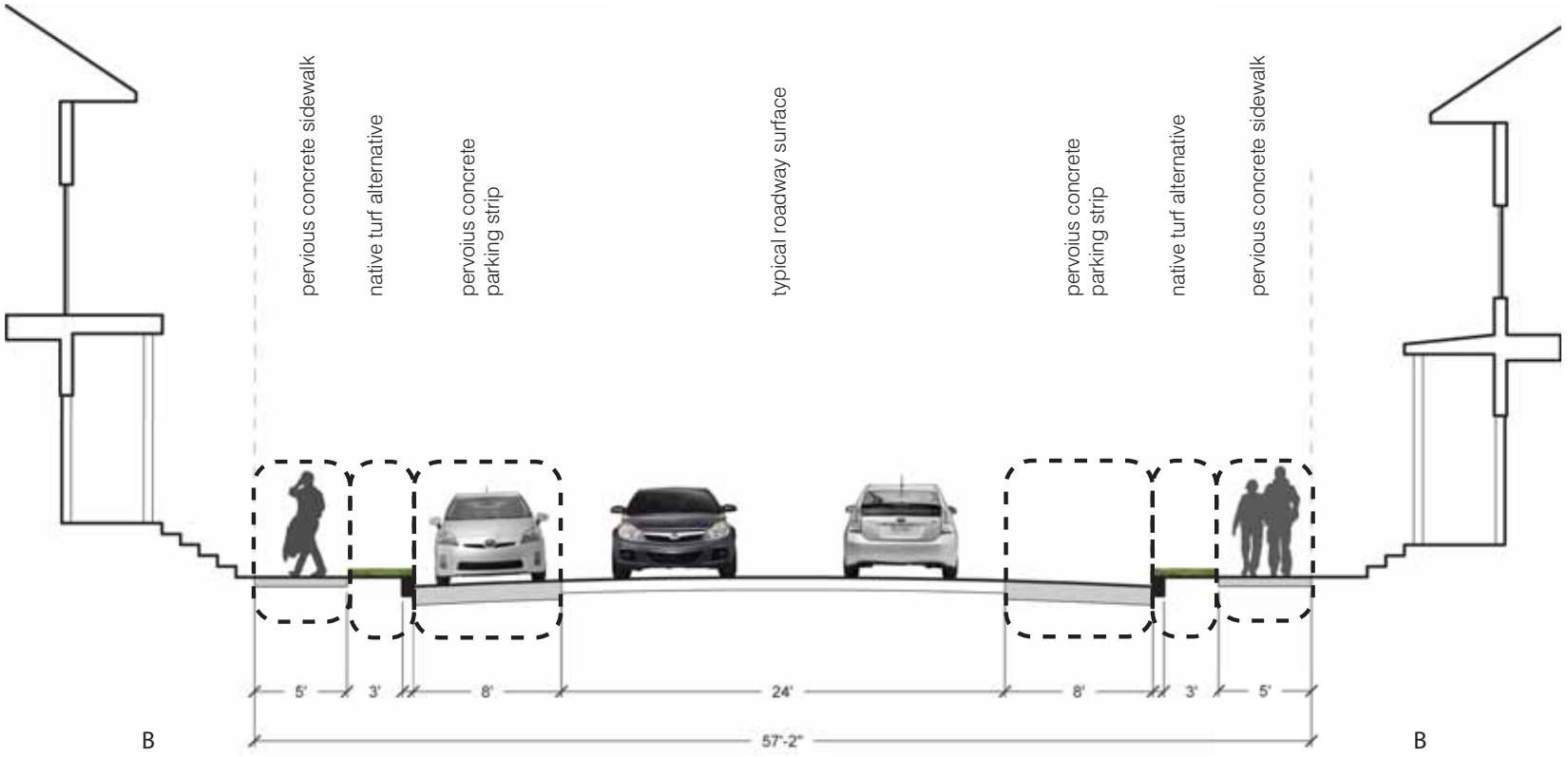


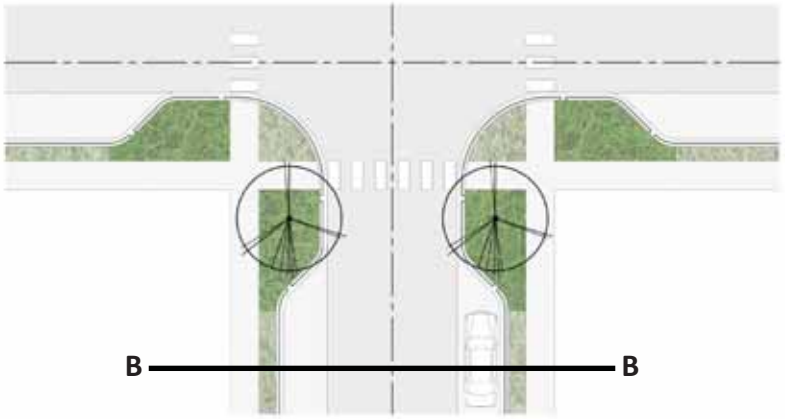
MAKE IT RIGHT

Two-Way Local Street - Section AA

Features:

Pervious concrete sidewalk
Streetside raingardens within traffic-calming bumpouts
Native landscaping
Curb-breaks to facilitate drainage into rain gardens

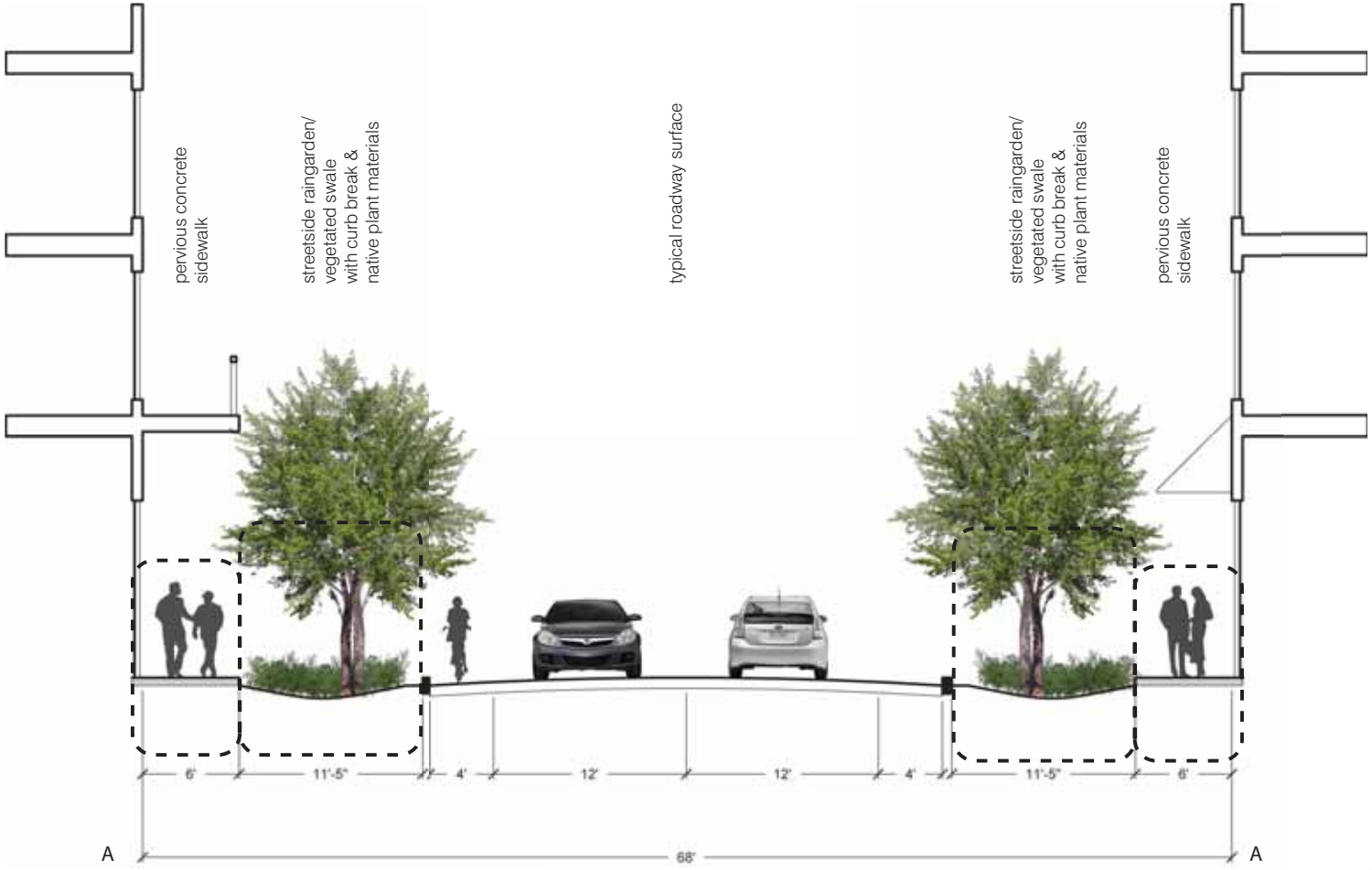


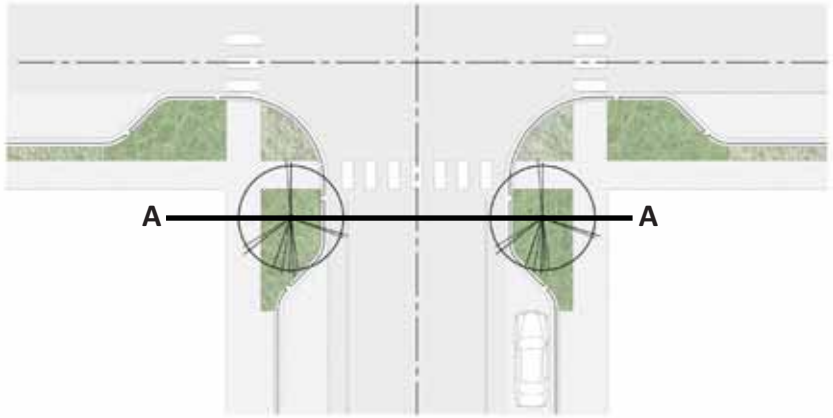


Two-Way Local Street - Section BB

Features:

Pervious concrete sidewalk
Native groundcovers
Pervious concrete parking strip

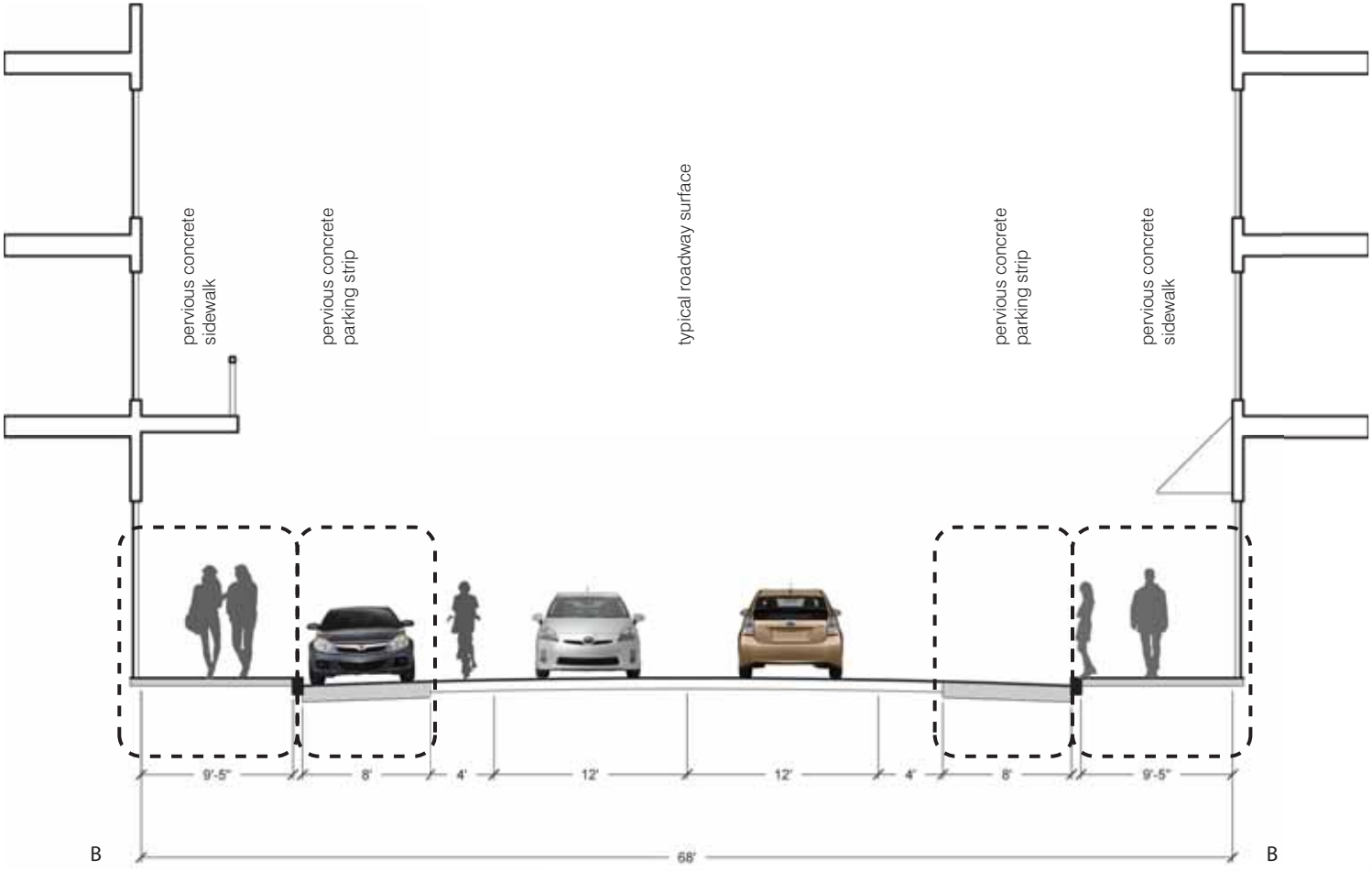


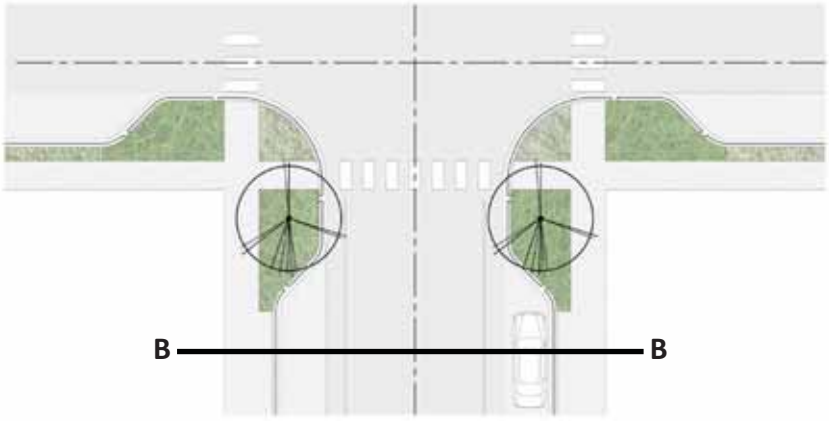


Major Street - Undivided - Section AA

Features:

Pervious concrete sidewalk
Streetside raingardens within traffic-calming bumpouts
Native landscaping
Curb-breaks to facilitate drainage into rain gardens

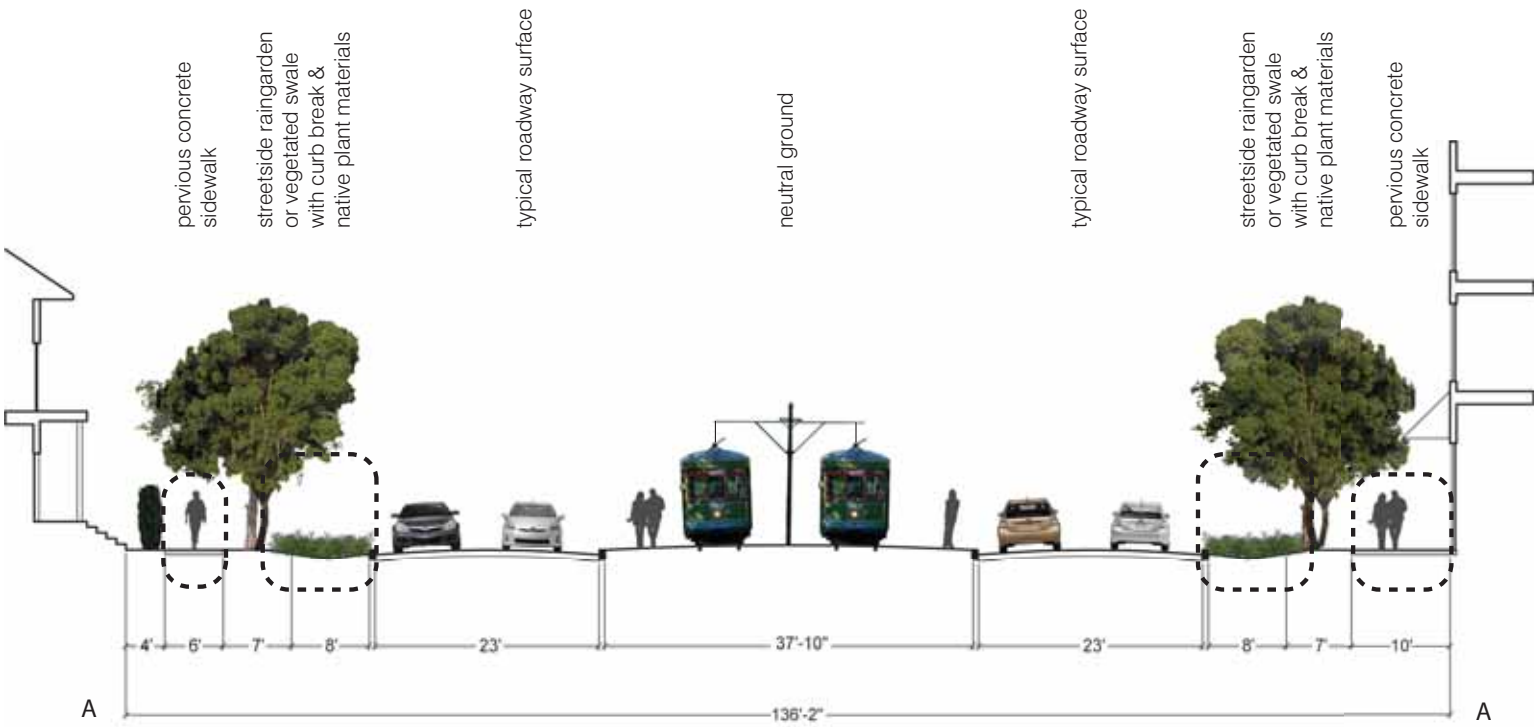




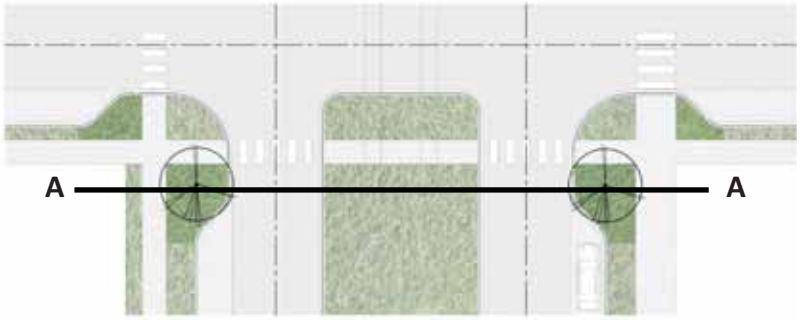
Major Street - Undivided - Section BB

Features:

Pervious concrete sidewalk
Native groundcovers
Pervious concrete parking strip

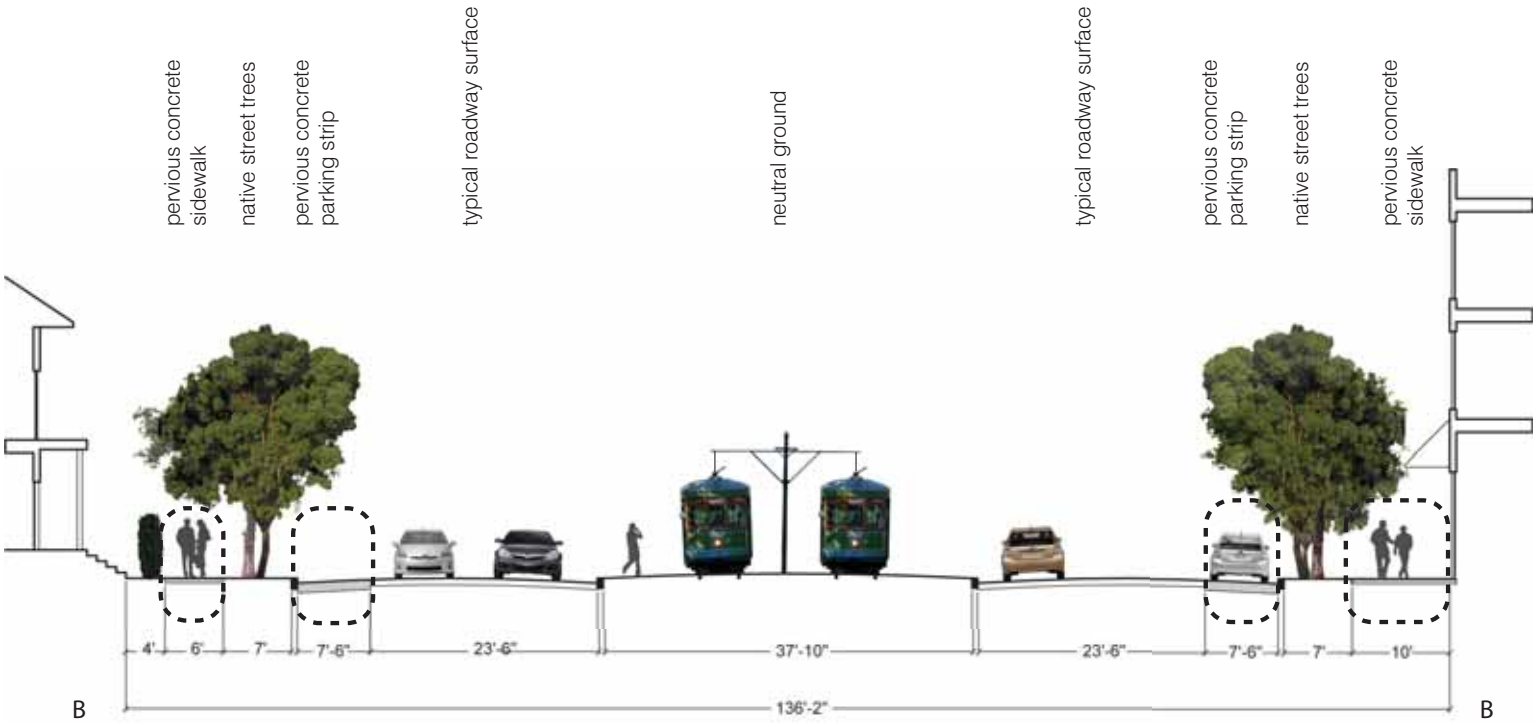


Major Street with Neutral Ground - Section AA

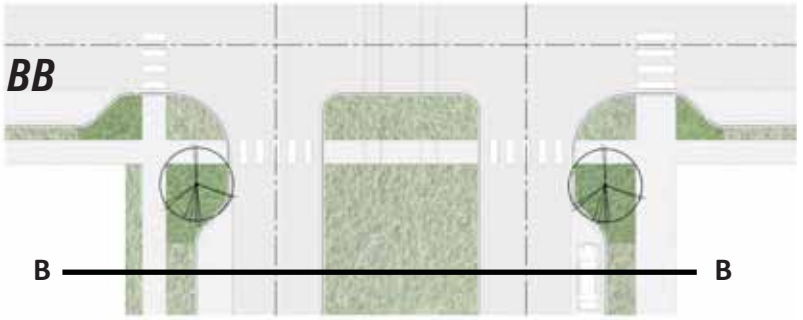


Features:

Pervious concrete sidewalk
Streetside raingardens within traffic-calming bumpouts
Native landscaping
Curb-breaks to facilitate drainage into rain gardens

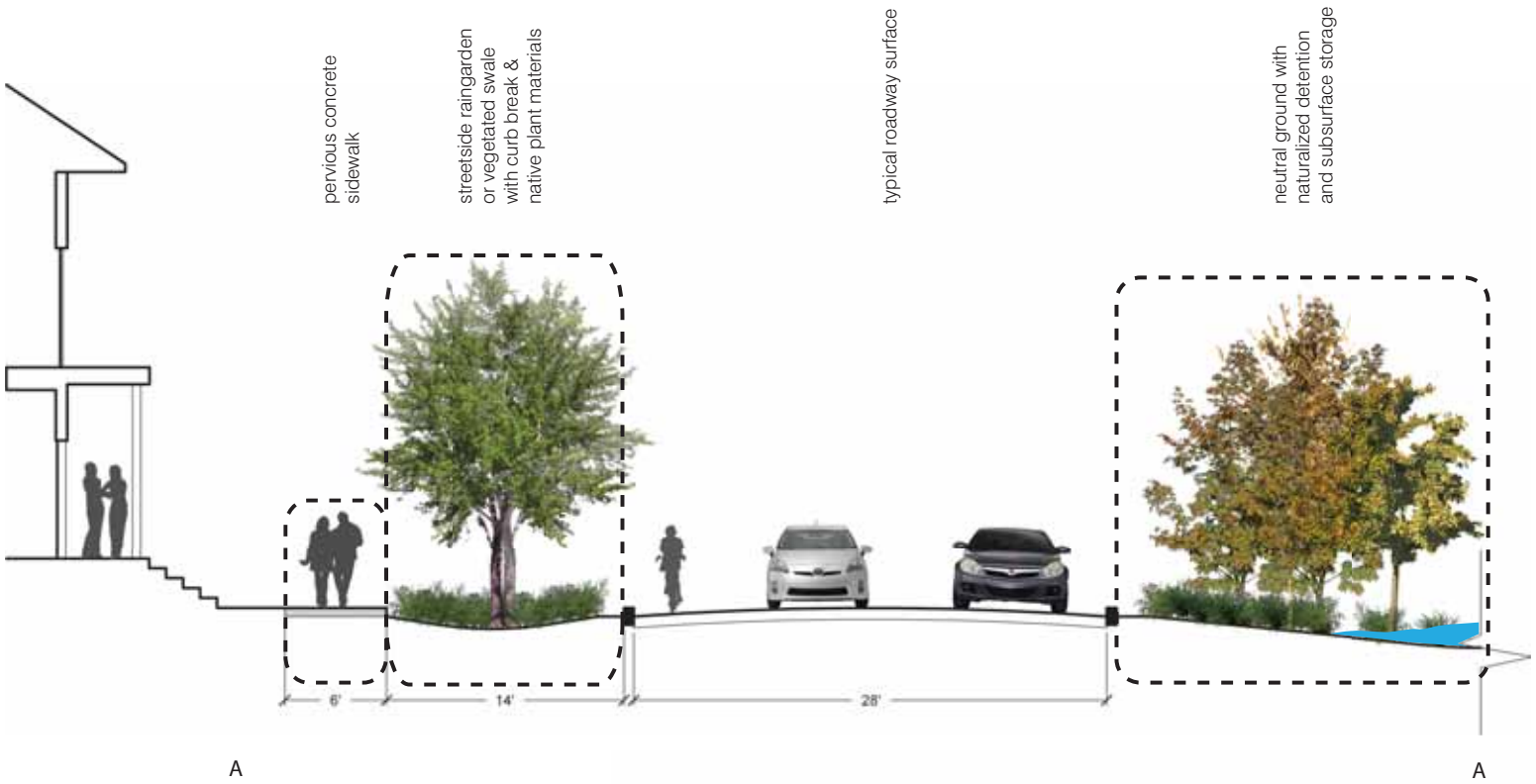


Major Street with Neutral Ground - Section BB



Features:

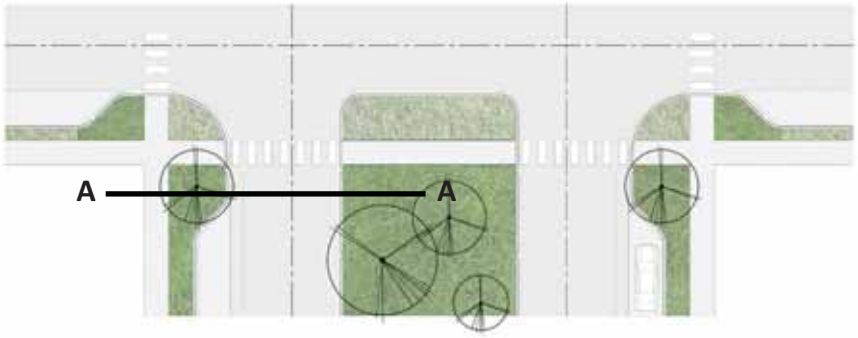
Pervious concrete sidewalk
Native street trees
Pervious concrete parking strip

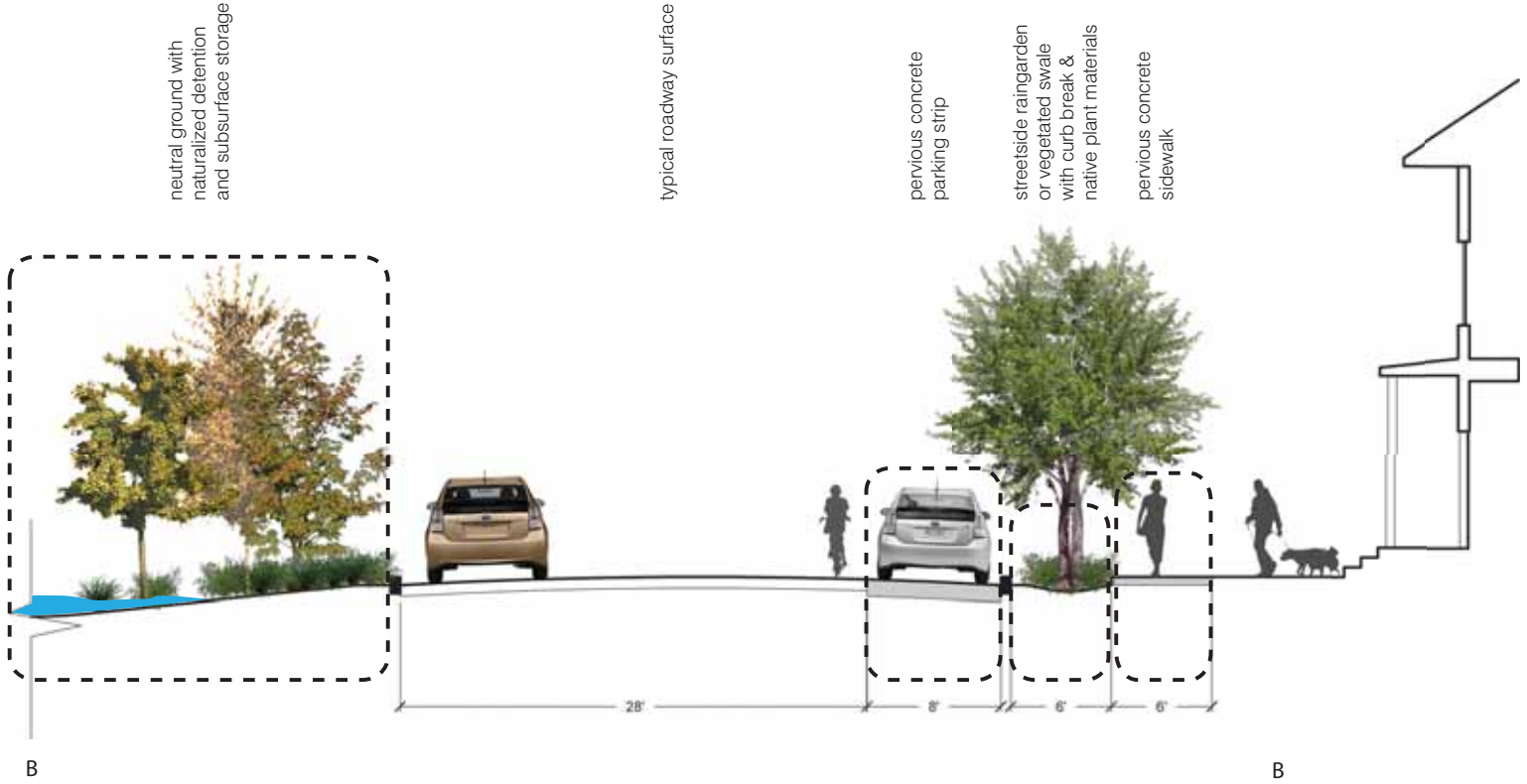


Urban Divided Highway - Section AA

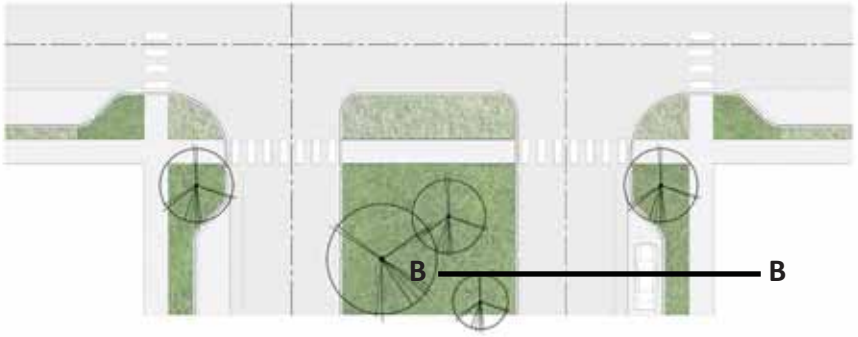
Features:

Pervious concrete sidewalk
Streetside raingardens within traffic-calming bumpouts
Native landscaping
Curb-breaks to facilitate drainage into rain gardens
Naturalized detention within the neutral ground





Urban Divided Highway - Section BB



Features:

Pervious concrete sidewalk
Streetside raingardens within traffic-calming bumpouts
Native landscaping
Curb-breaks to facilitate drainage into rain gardens
Naturalized detention within the neutral ground

Benefits to a New Approach

- ***reduced reliance on the drainage and pumping system:*** Due to the extreme geography of the Greater New Orleans Region, the city has no other option than to rely upon engineered drainage and pumping systems. Through the proper application of techniques outlined within this guide, this reliance can reduced.

- ***reduced carbon footprint & cost savings to the city:*** Pumping stormwater out of the city requires tremendous investment in maintenance of pump systems, as well as energy costs (electricity and generation) and related carbon footprint. By reducing the amount of stormwater entering into the storm sewer network, the pumps work less, saving energy, wear & tear, and maintenance costs.

- ***reduced rate of subsidence***: For a variety of factors related to soils, geology, and hydrology, many areas of New Orleans are threatened by subsidence. Many relate this phenomenon to hydrologic changes caused by the construction of protective levees/floodwalls and the extensive drainage and pumping network. Overly relying on pumping has lowered groundwater tables, one of the causes of subsidence in this region. By encouraging stormwater to infiltrate into the groundwater table, there is evidence that the rate of subsidence may be reduced.

- ***enhanced quality of life***: In municipalities where sustainable stormwater management strategies have been deployed, there are tangible benefits for local residents and the city in general. These include:
    - Increased protection from minor flood events
    - Increased efficiency of existing infrastructure
    - Increased environmental quality (specifically water quality)
    - Increased property values

Supplemental Information

Historic Reliance on pumping and conveyance

The history of New Orleans is intricately connected to its relationships with adjacent waterways. Early drainage projects sought to channel water and waste to the edges of the city. As the drainage system became more comprehensive, and advances were made in pumping technology, areas that were formerly undeveloped due to persistent flooding were drained and made available for urban/suburban growth. Along with the construction of protective levees and floodwalls, New Orleans drainage became primarily reliant on a system of canals and pump stations that could push water outside of the city's protective walls. New Orleans is situated in a subtropical, deltaic environment that has been urbanized through tremendous investment in flood protection, drainage and pumping infrastructure. Chosen for its proximity to the Mississippi River and Lake Pontchartrain, the defensible location of New Orleans was and is ideal for commerce, shipping, industry, and tourism. The city, however, is vulnerable to minor and moderate flooding, and is susceptible to the impacts caused by hurricanes and tropical storms.

Conventional Stormwater management

Conventional stormwater management methods collect water flowing off impervious surfaces, convey it, and then discharge it into adjacent streams, rivers and wetlands. Many of these methods, often called "hard" engineering solutions, aim to alleviate problems on individual sites but often lead to a number of larger environmental problems such as increased flooding potential downstream, increased soil and stream bank erosion to greater runoff volume and velocity, contaminated fresh water resources, and interruption of the natural groundwater process.

Conventional approaches to stormwater management in New Orleans have focused upon surface draining stormwater to storm drains, which convey water via pipe to pump stations, where it is piped over protective floodwalls into adjacent water bodies. Some estimates claim that 85% of all stormwater is pumped out of the city, while 15% is retained, where it evaporates, infiltrates into soils, or is uptaken by trees and plants. Dependence upon this drainage and pumping infrastructure is incredibly costly, in terms of energy needed to power massive pumps, amount of carbon released during power generation, and impacts on water quality in areas where pumps discharge.

Typical pump station in New Orleans. Canals are used to direct stormwater into these energy-intensive pump stations, which discharge stormwater over protective levees into adjacent waterways during storm events.

"Whereas a historian might point to the Civil War as the watershed event in the history of New Orleans, a geographer or urban planner may identify a less-famous but equally influential event, at least upon the city's physical growth; the development of the world-class drainage system that removed standing water and rainfall from the backswamps and eventually opened them up for residential development."

-Richard Campanella
Time and Place in New Orleans:
Past Geographies in the Present day
pg. 53

Citywide Planning Initiatives

Introduction

Post-Katrina, the City of New Orleans has been the subject of a variety of recovery and rebuilding plans. Many in the city considered the recovery process an opportunity to rethink many of the city's institutions and practices, including its approach to stormwater management. Some of the plans and recommendations that emerged from these planning initiatives advocate for the use of more sustainable approaches to stormwater management as a means to make the city more resilient, more efficient, and more environmentally sound.

The New Orleans Principles

The New Orleans Principles were developed during a US Green Building Council (USGBC) Planning Charrette that occurred on November 9-11, 2005. The principles were recommended guidelines for the recovery and rebuilding of New Orleans. (those in blue have specific applications related to stormwater management).

1: "Respect the rights of all citizens of New Orleans"
2: "Restore natural protections of the Greater New Orleans region"
3: "Implement an inclusive planning process"
4: "Value diversity in New Orleans"
5: "Protect the city of New Orleans"
6: "Embrace smart redevelopment"
7: "Honor the past; build for the future"
8: "Provide for passive survivability"
9: "Foster locally owned, sustainable businesses"
10: "Focus on the long term"

New Orleans Master Plan and Comprehensive Zoning Ordinance

Approved by the City Planning Commission on January 26, 2010, this document outlines both general and neighborhood specific strategies regarding future land use, development, and zoning. Chapter 8: Green Infrastructure: Parks, Open Space, and Recreation, Goal 3, Bullet 4 states:

"New Orleans will always continue to require engineered drainage systems and pumps. However, stormwater engineering increasingly is adapting the lessons of natural systems to controlling and filtering runoff. These techniques can be applied at any scale, from the backyard rain gardens to streets and city parks… and will help the city manage water, mitigate flooding, and reduce subsidence."

- ***National Advocates***
- *Environmental Protection Agency -*
- *www.epa.gov/nps/lid/*

- *Sustainable Sites Initiative*
- *http://www.sustainablesites.org*

- *United States Green Building Council LEED*
- *http://www.usgbc.org*

- *Ladybird Johnson Wildflower Center*
- *www.wildflowers.org*

- ***Precedent Projects***
- *Portland, Oregon Bureau of Environmental Services*
- *http://www.portlandonline.com/bes/*

- *Chicago Green Alleys Program*
- *http://www.egov.cityofchicago.org/*

- *10,000 Rain Gardens - Kansas City, Mo*
- *http://www.rainkc.com/*

- ***Local Organizations***
- *Groundworks New Orleans*
- *http://groundworkusa.org/*

- *Lousiana State University Ag Center*
- *http://www.lsuagcenter.com*

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