Integrating Transportation and Green Infrastructure

SCVURPPP GI Workshop
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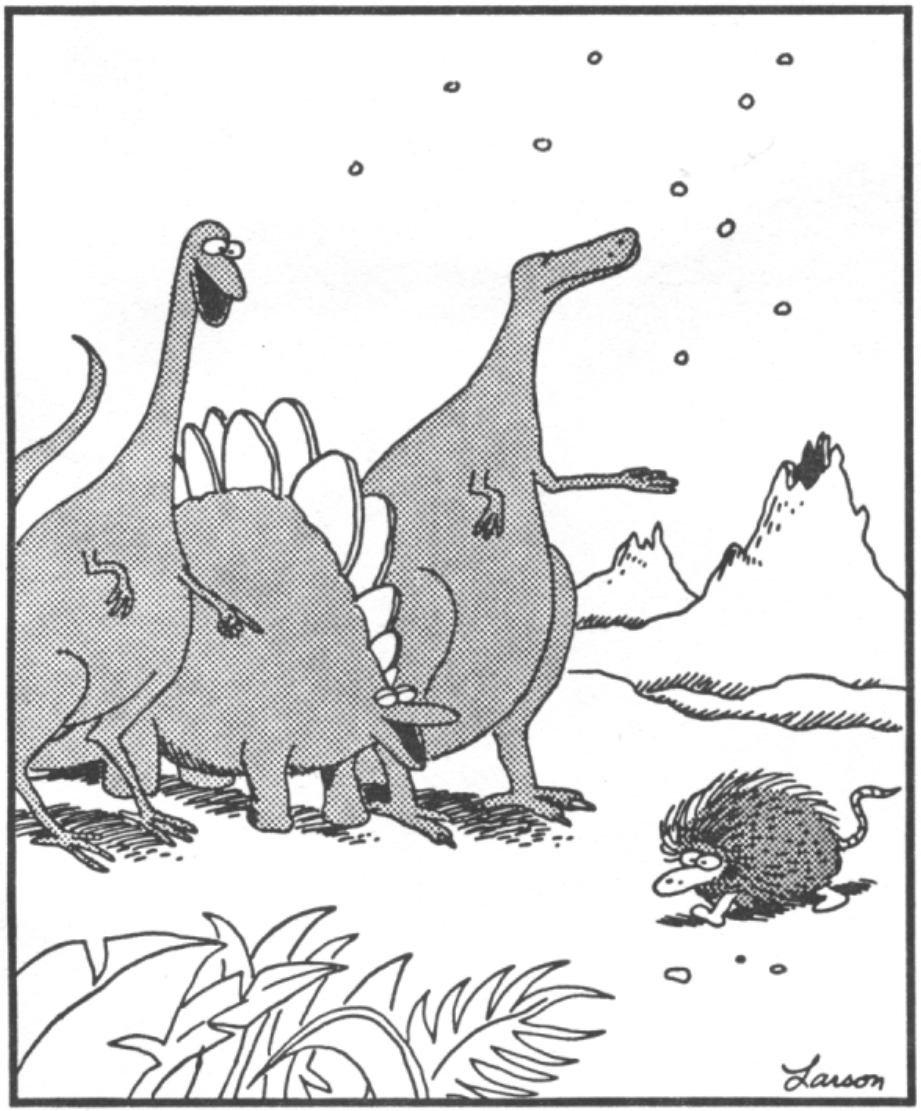
EOA, Inc.

Outline of Presentation

- Overview & Types of Green Street Systems
- Strategies and Approaches
- Local, State and National Guidance
- Pedestrian Infrastructure Types
- ADA Issues
- Cyclist Infrastructure Types
- Safe Routes to School, Transit & Parks
- Examples of Integrated Systems

The Autozoic Epoch is over!




PHONES

Green Street System Types

- Biotreatment:
  - Curb Extension
  - Sidewalk planter
  - Traffic Circle
  - Tree Trench
  - Rain garden
  - Stormwater CycleTrack
  - Shoulders/Ditches*

  *depends on various factors

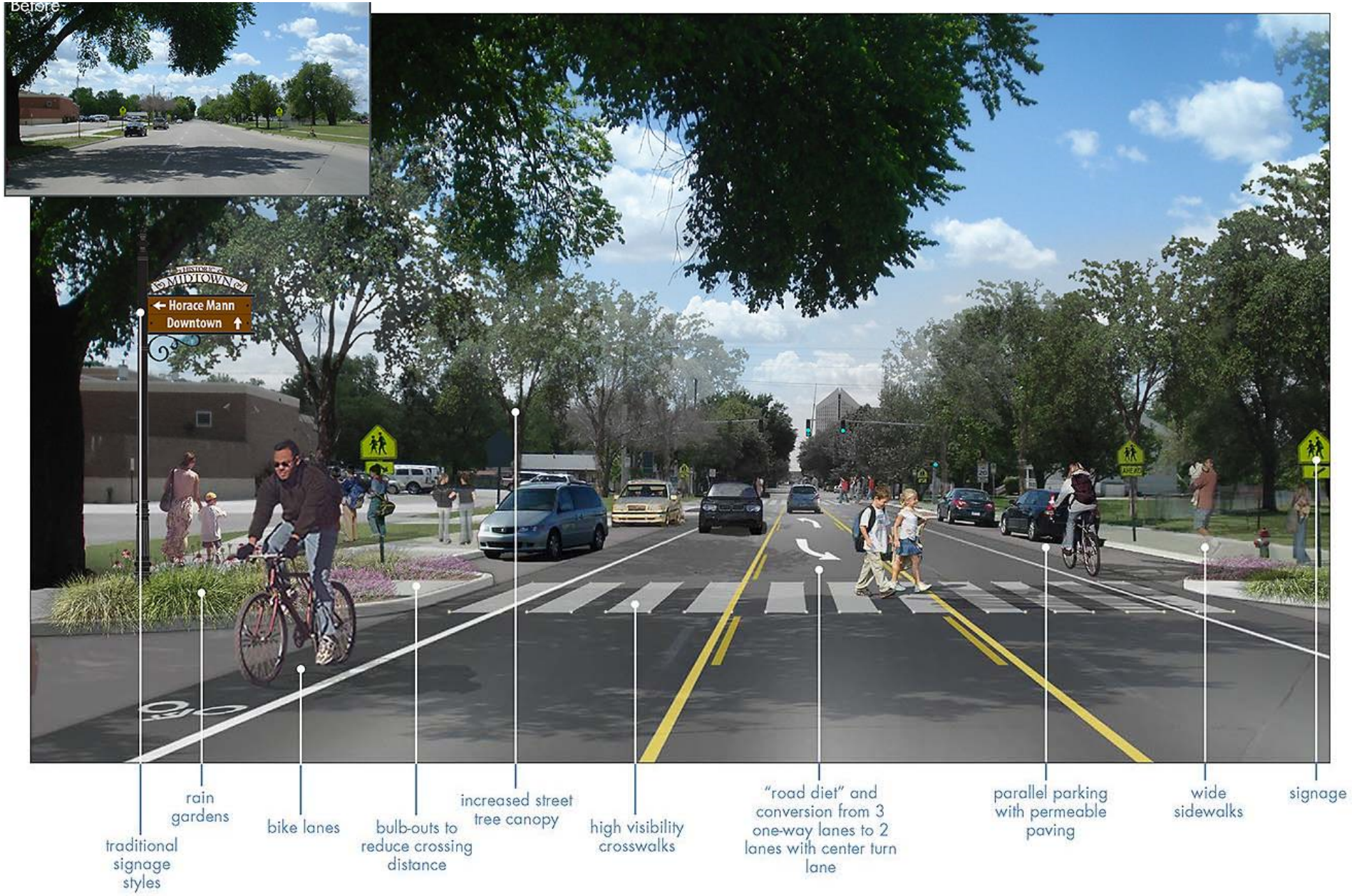
- Other Measures:
  - Pervious Pavement
  - Infiltration trench
  - Cistern/Rain Barrel
  - Proprietary Systems

Complete and Green Street Integration Strategies

- Road Diets
- Safety Improvements
- Complete Streets – Multi-modal
- Stacked Environmental Benefits
- Excess Impervious Surface

Graphic Approaches for Displaying GI Integration

- Roadway Cross Section (Wichita)
- Roadway Cross Section Matrix (San Diego)
- Roadway Types (Philadelphia)



Courtesy of City of Wichita

Wild Blue Flag Iris

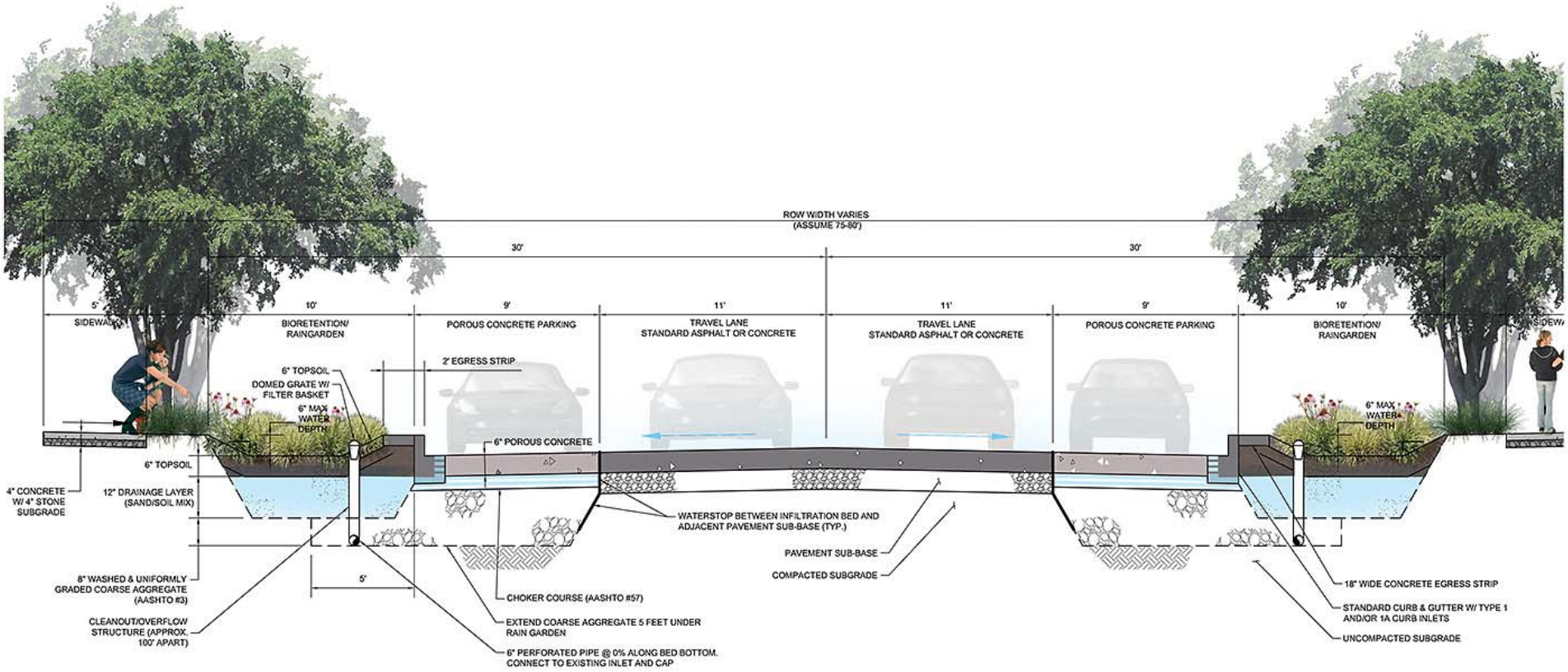
Fox Sedge

Lobelia Cardinalis

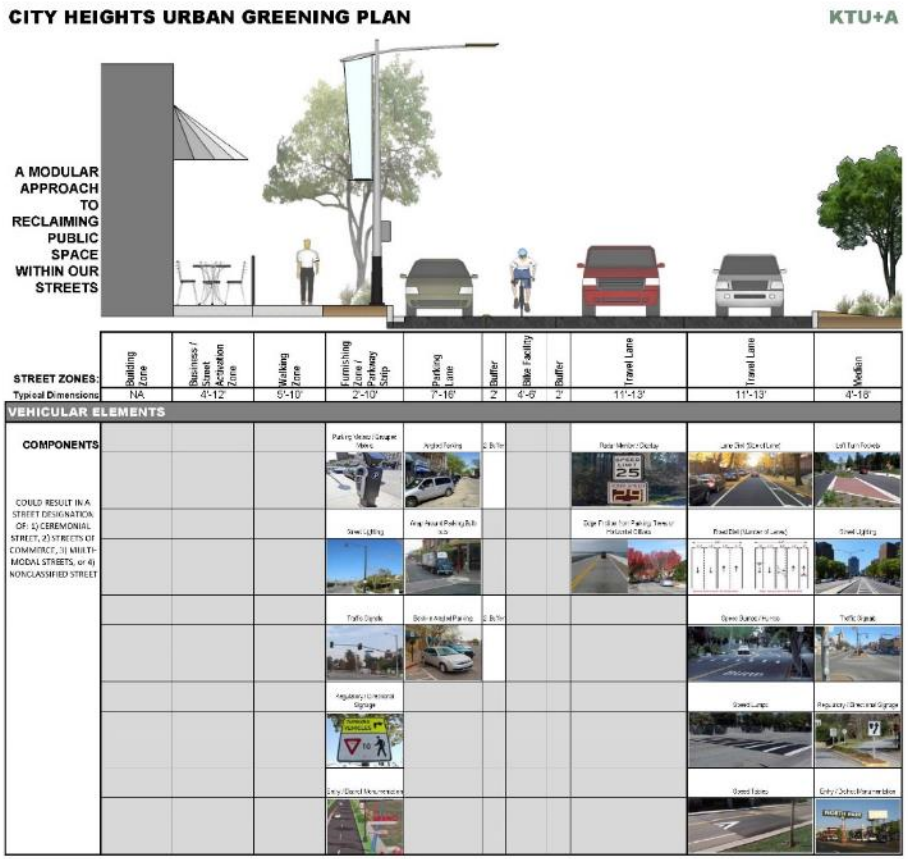
Coneflower

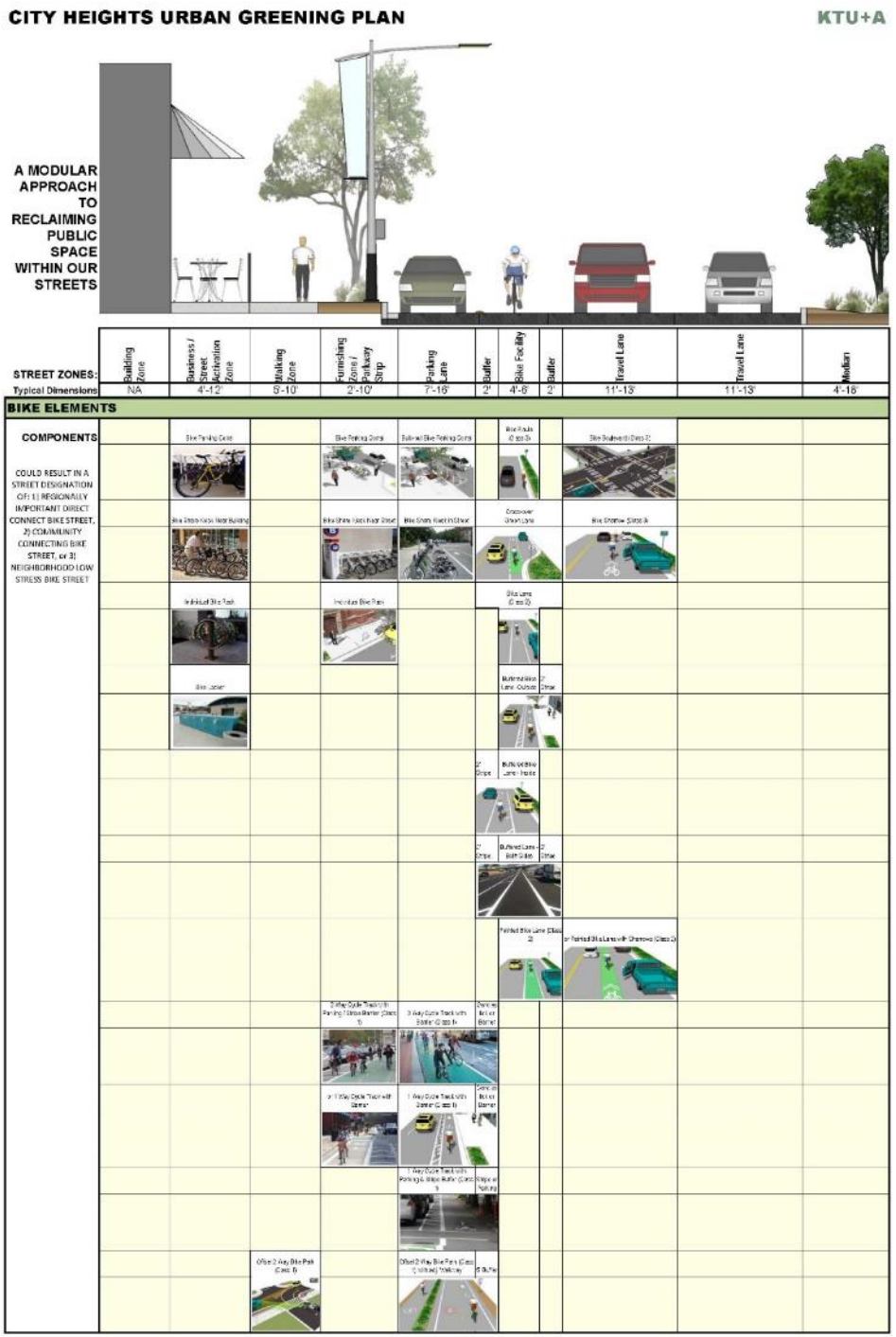
Swamp Milkweed

Common Boneset

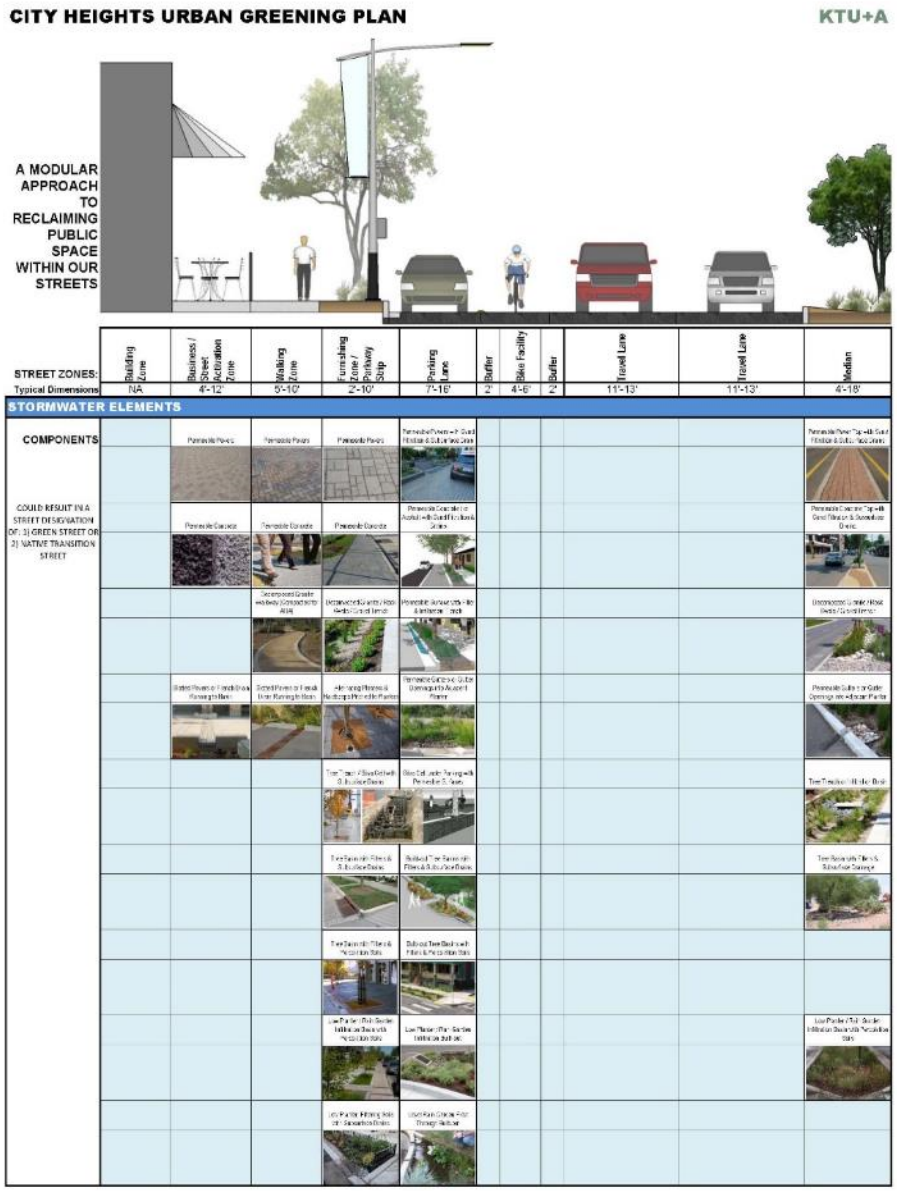


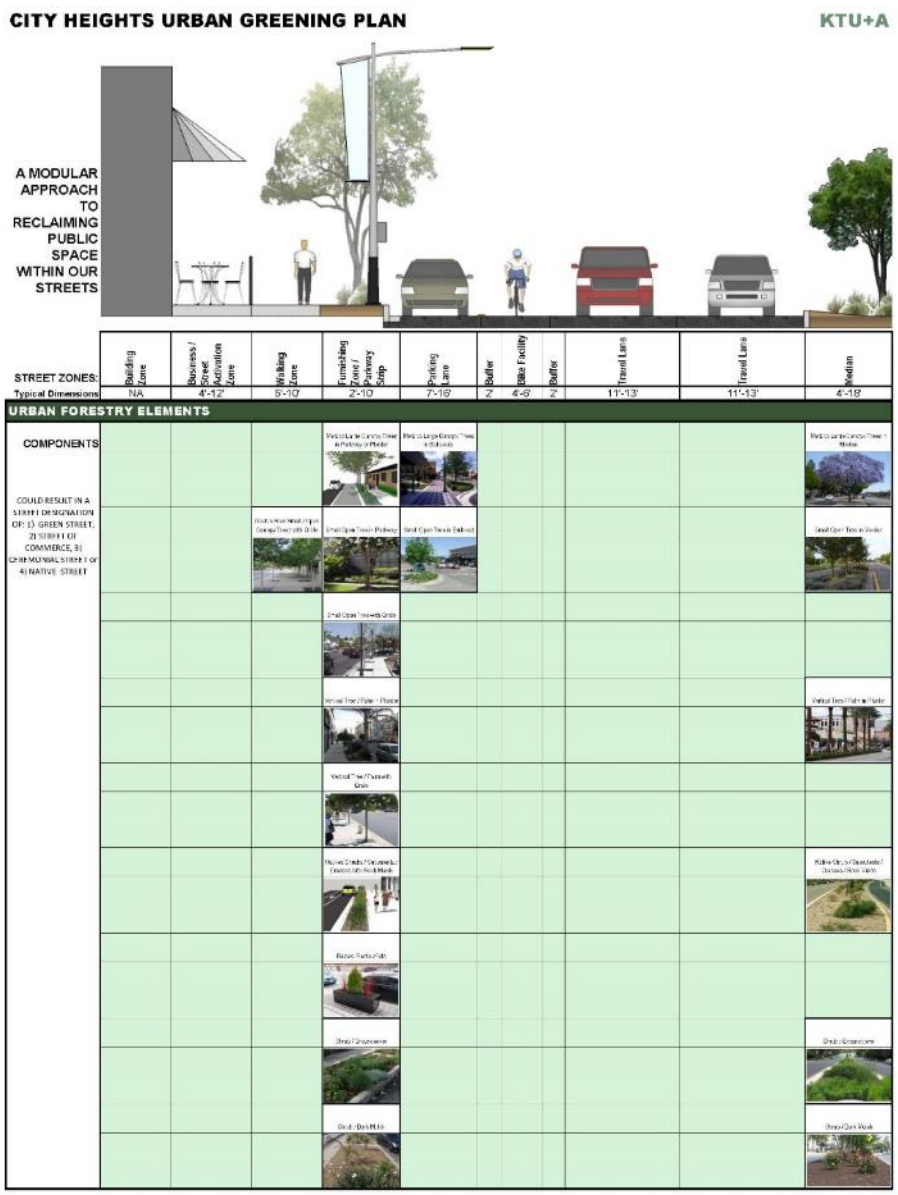
Courtesy of City of Wichita





Courtesy of City of San Diego





Courtesy of City of San Diego

CITY HEIGHTS URBAN GREENING PLAN

KTU+A

A MODULAR APPROACH TO RECLAIMING PUBLIC SPACE WITHIN OUR STREETS

STREET ZONES:	Building Zone	Business / Street Activation Zone	Walking Zone	Furnishing Zone / Parkway Strip	Parking Lane	Buffer	Bike Facility	Buffer	Travel Lane	Travel Lane	Median
Typical Dimensions	NA	4'-12'	5'-10'	2'-10'	7'-16'	2'	4'-6'	2'	11'-13'	11'-13'	4'-18'

STORMWATER ELEMENTS

COMPONENTS											
		Permeable Pavers	Permeable Pavers	Permeable Pavers	Permeable Pavers with Sand Filtration & Subsurface Drain						Permeable Pavers "Top with Sand Filtration & Subsurface Drains
											
COULD RESULT IN A STREET DESIGNATION OF: 1) GREEN STREET OR 2) NATIVE TRANSITION STREET		Permeable Concrete	Permeable Concrete	Permeable Concrete	Permeable Concrete for Asphalt with Sand Filtration & Swales						Permeable Concrete "Top with Sand Filtration & Subsurface Drains
											
			Decomposed Granite walkway (Compacted for ADA)	Decomposed Granite / Rock Swale / Gravel Trench	Permeable Pavers with Bio Infiltration Trench						Decomposed Granite / Rock Swale / Gravel Trench
											

4.4.4 Urban Arterial Street

Urban Arterial, from Figure 3

Stormwater Bump-out	
Midblock	●
Corner	●
Stormwater Tree Trench	●
Stormwater Tree	●
Planter	●
Permeable Pavement	●*
Green Gutter	●
Stormwater Drainage Well	●

● Recommended

● Possible, but there is prob

● Not recommended

Figure 4.9 – Urban Arterial Street — Existing Conditions

When evaluating this street segment, the following characteristics are highlighted:

- Urban Arterial street in a mixed residential and commercial neighborhood
- Two-lane cartway with two lanes of parking, two bike lanes, and sidewalks
- High demand for street parking
- Uniform sidewalk cross slope toward street; street crowned in middle

Courtesy of City of Philadelphia

Figure 4.9 – Urban Arterial Street — Existing Conditions

Courtesy of City of Philadelphia

Courtesy of City of Philadelphia

Figure 4.10 – Urban Arterial Street — Rendered Visualization of Selected GSI System

Figure 4.10 – Urban Arterial Street — Rendered Visualization of Selected GSI System

Imagining this street retrofitted with green stormwater infrastructure, the Water Department highlights the following points:

- This street type may be an ideal setting for corner bump-outs, as turning radii are often easier to accomodate on wide streets. Corner bump-outs may also improve the pedestrian experience and make street crossings safer. Mid-block bump-outs can be considered if street width and parking demand allows. Refer to the Complete Streets Design Handbook, Section 4.7.1.
- Tree trenches can be used if utility conflicts are limited.
- Stormwater trees may be considered in neighborhoods where many utility laterals make tree trenches infeasible.
- Planters can be considered if a more decorated streetscape is desired.
- Sidewalks may be wide enough to accommodate SMPs without exceptions to the Complete Streets Design Handbook, Section 4.3.2.

Stormwater Tree

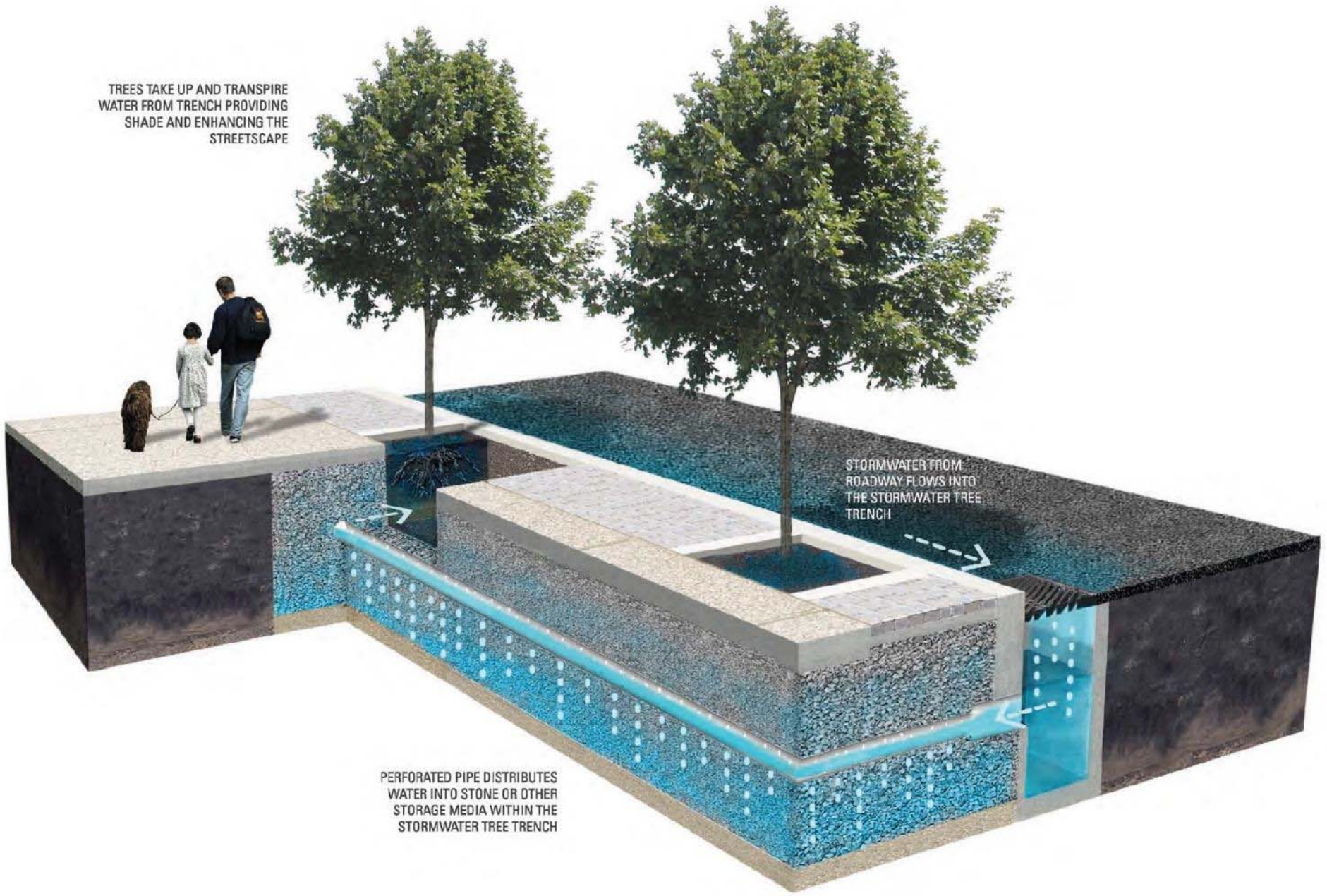
Stormwater Tree Trench

Corner Bump-out

Three-Dimensional View of a Stormwater Tree

Courtesy of City of Philadelphia

Figure 2.4: Three-Dimensional View of a Stormwater Tree Trench



Courtesy of City of Philadelphia

Corner Stormwater Bump-out

Courtesy of City of Philadelphia

Local, State and National Roadway Design Standards

- Local Design Standards (such as San Jose DOT's Geometric Design Guidelines)
- CA Highway Design Manual (HDM)
- CA Manual on Uniform Traffic Control Devices (MUTCD with CA supplement)
- AASHTO (A Policy on Geometric Design of Highways and Streets – "Green Book")
- NACTO Design Guides

National Association of City Transportation Officials (NACTO)

- Urban Street Design Guide
- Transit Street Design Guide
- Urban Bikeway Design Guide
- Stormwater Guide (coming out in May)

Urban Street Design Guide

Pedestrian Infrastructure Types

- Sidewalks, Shoulders & Curbwalks/Stepouts
- Paseos, Plazas and Parklets
- Mass Transit Boarding Areas
- Intersection Treatments
- Mid-block Crossings
- Alleys, Trails and Multi-use Paths
- Pedestrian Priority Zones and Woonerfs
- Bridges, Stairs, Ramps and Elevators
- Building Entrances, Parking Lots & Driveways

Pedestrian and Cyclist Benefits of Stormwater Curb Extensions

- Physical separation of pedestrians from street
- Does not reduce sidewalk area
- Shortens unprotected crossing distances at intersections
- Traffic calming measure – slows motor vehicles
- Curb extensions should not impede on bicycle facilities

Ped Safety: SW Curb Extension

Campbell

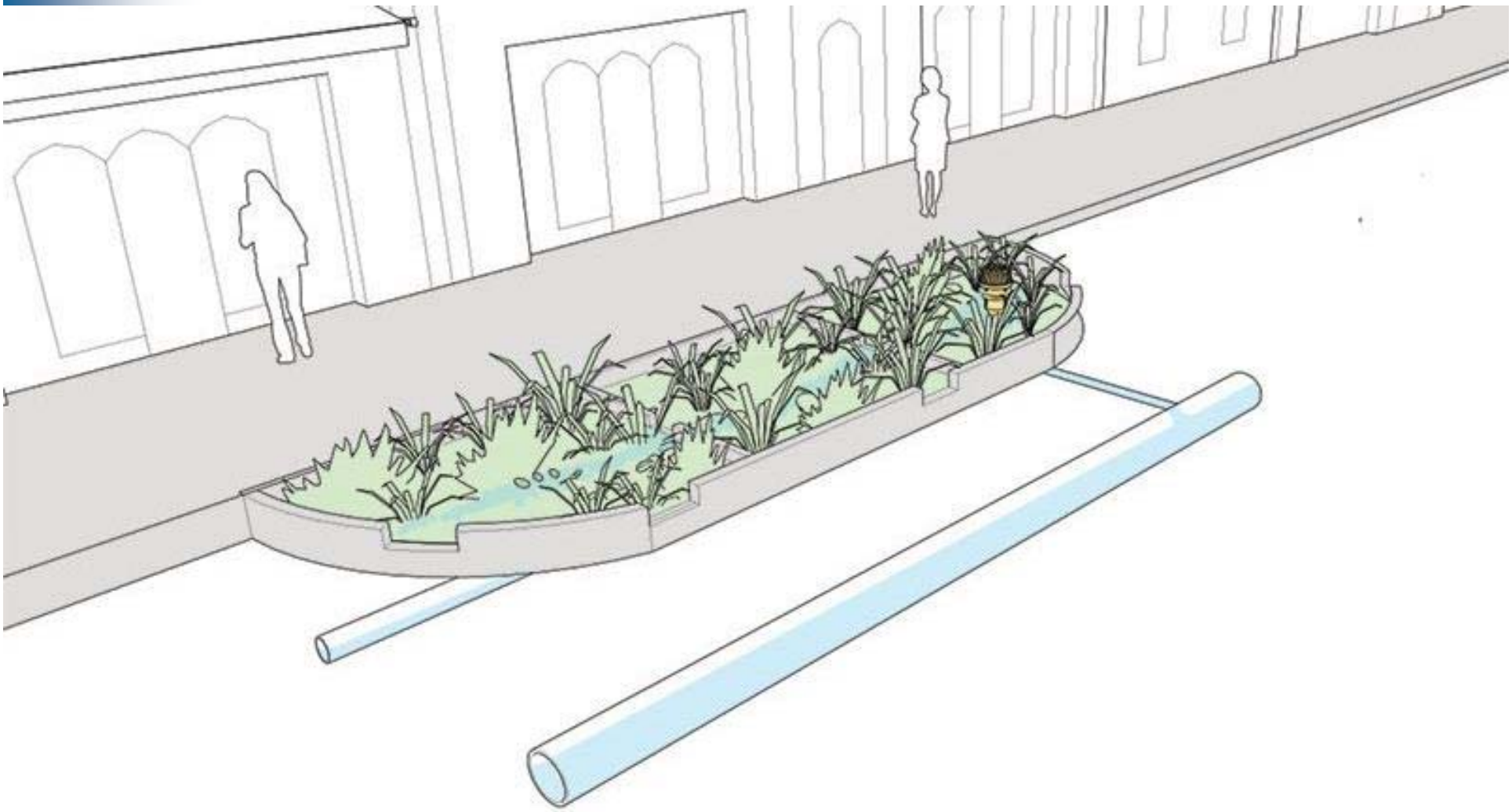
NACTO Lane Width Recommendations

- 10 foot lane widths in urban areas improve street safety without impacting traffic operations
- Truck or transit routes can use one travel lane of 11 feet in each direction
- Narrower travel lanes (9–9.5 feet) can be effective as through lanes in conjunction with a turn lane
- Wider lanes correlate with higher speeds

Traffic Speed Reduction: Curb Extensions and GI

- Stormwater Curb Extension
- Bus Curb Extension
- Chicane
- Pinchpoint
- Gateway

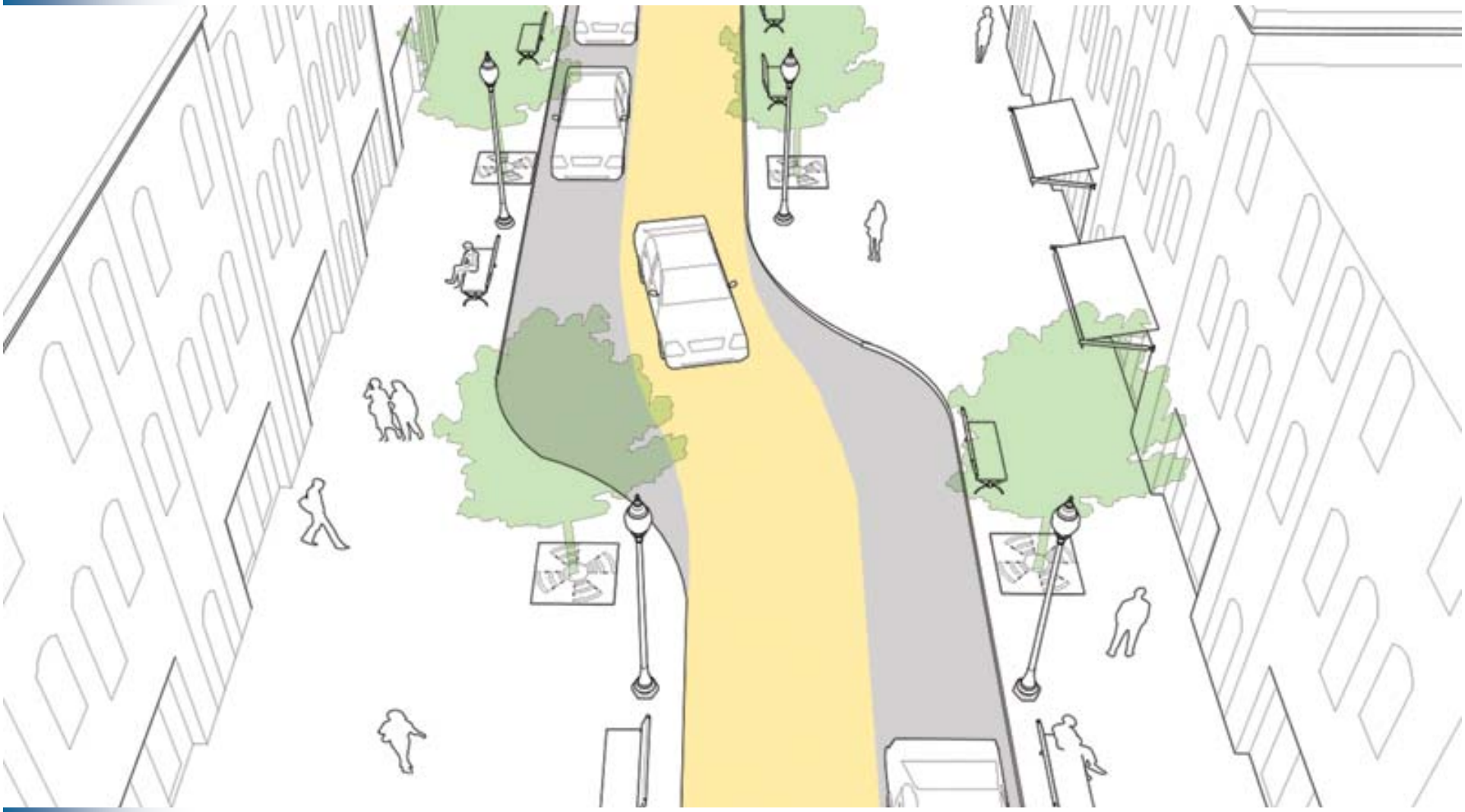
Stormwater Curb Extension



Bus Curb Extension

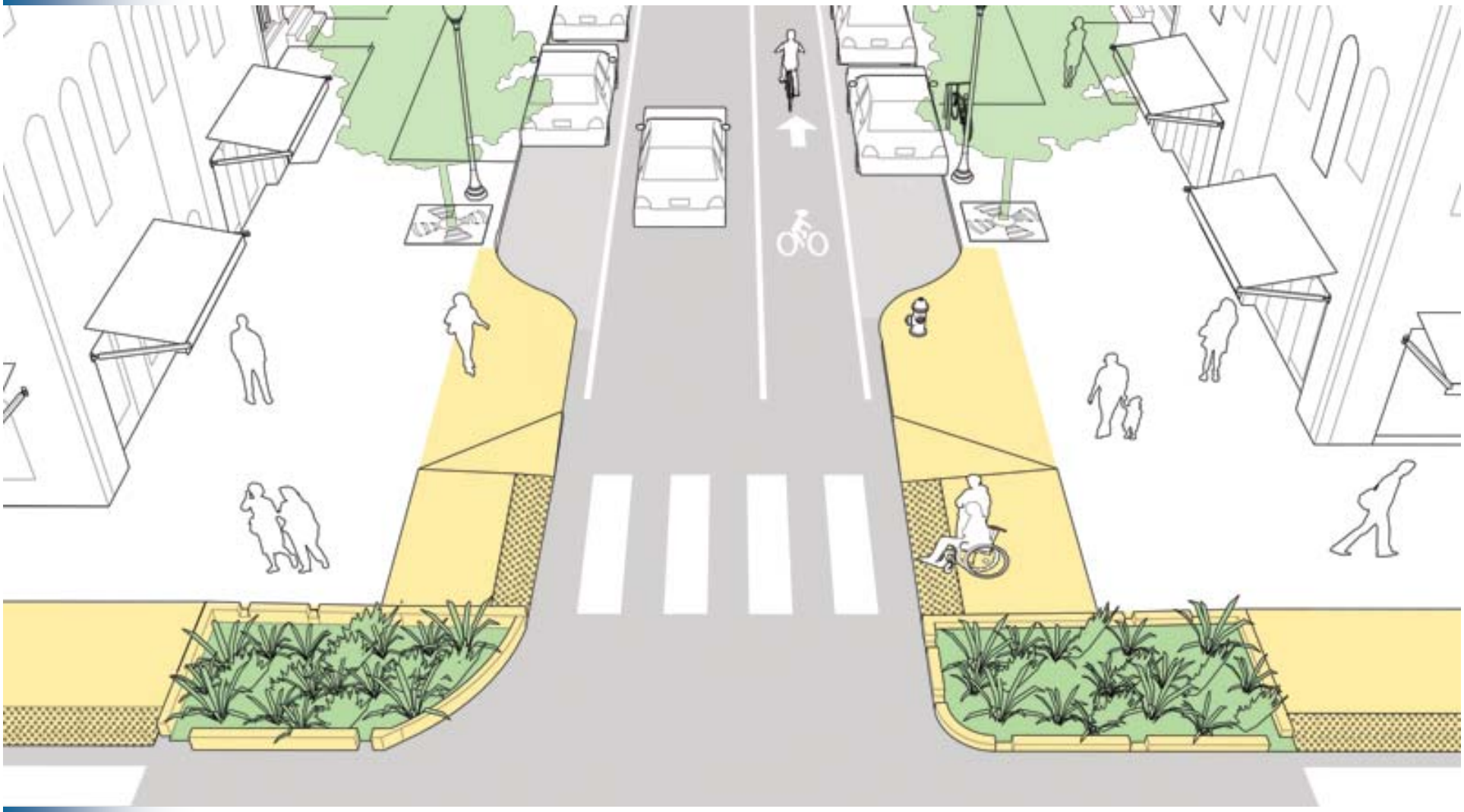
Portland

Chicane



Pinchpoint

Gateway



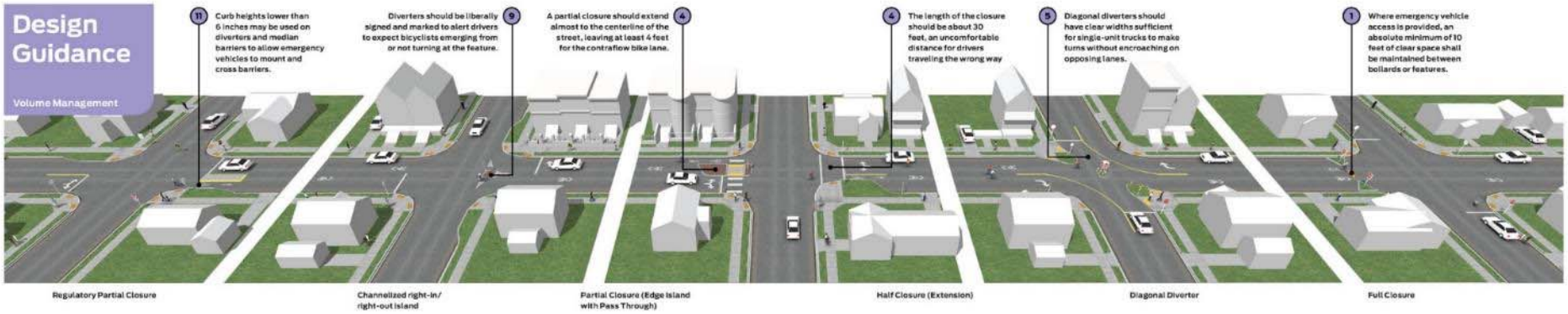
Crossings

- Raised Intersection
- Raised Crosswalk
- Speed Table*

(*not always used for a crossing)

Speed Table

Traffic Volume Reduction Guidance



Required Features

1. Where emergency vehicle access is provided, an absolute minimum of 10 feet of clear space shall be maintained between bollards or features. The presence of mountable curbs, flexible or collapsible objects, or restricted lanes may reduce space requirements.
2. Volume management treatments shall provide bicycle access, either through a 4-foot minimum contra-flow bike lane or a 5- to 6-foot opening between vertical curbs.

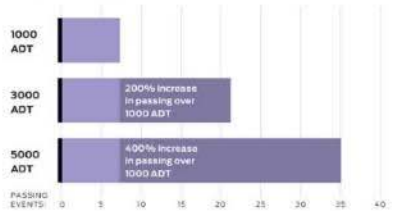
Recommended Features

3. Appropriate signs should be used to prohibit undesired automobile movements and access while permitting desired bicycle access.[84]
4. For a partial closure, the curb extension or edge island should extend almost to the centerline of the street, leaving at least 4 feet for the contraflow bike lane, and the adjacent travel lane may be narrowed through the closure. The length of the closure should be about 30 feet, an uncomfortable distance for drivers traveling the wrong way.
5. Diagonal diverters, median barriers, and forced-turn islands should have clear widths sufficient for single-unit trucks to make turns without encroaching on opposing lanes.
6. Volume control measures should not be used along primary emergency response routes. See route planning and speed management for a discussion of designating an emergency response network and minimizing impacts to emergency vehicles along bicycle boulevards.
7. Traffic volumes on other parallel non-arterial streets should be monitored to determine the impacts to volumes, which may require further mitigation. Neighbors and nearby businesses should be consulted to build support for volume management treatments prior to implementation.
8. Appropriate education for use of proposed treatments should be provided to neighbors and others who are likely to use the corridor.
9. Closures and diverters should be liberally signed and marked to alert drivers to expect bicyclists emerging from or not turning at the feature.

Optional Features

10. The partial closure curb extension or edge island may be tapered to deflect drivers to the right as they approach the feature.
11. Curb heights lower than 6 inches may be used on diverters and median barriers to allow emergency vehicles to mount and cross berriers.
12. Bollards may be used for diagonal diverters, but 5 feet should be provided between them to accommodate one direction of bicycle travel.
13. Measures may be implemented on a trial basis to gauge resident support prior to finalizing the design. Temporary closures can be created with construction barrels or planters; however, an unappealing design aesthetic may diminish residents' opinions.
14. Channelizing devices may be used along a center line to preclude turns or along lane lines to preclude lane changing, as determined by engineering judgment.[83]
15. Consider defining a threshold of acceptable motor vehicle volume impacts to traffic on adjacent streets when using speed and volume management.[84]

Depending on motor vehicle volumes, a bicyclist will be passed by a car going the same direction this many times during a 10 minute trip:

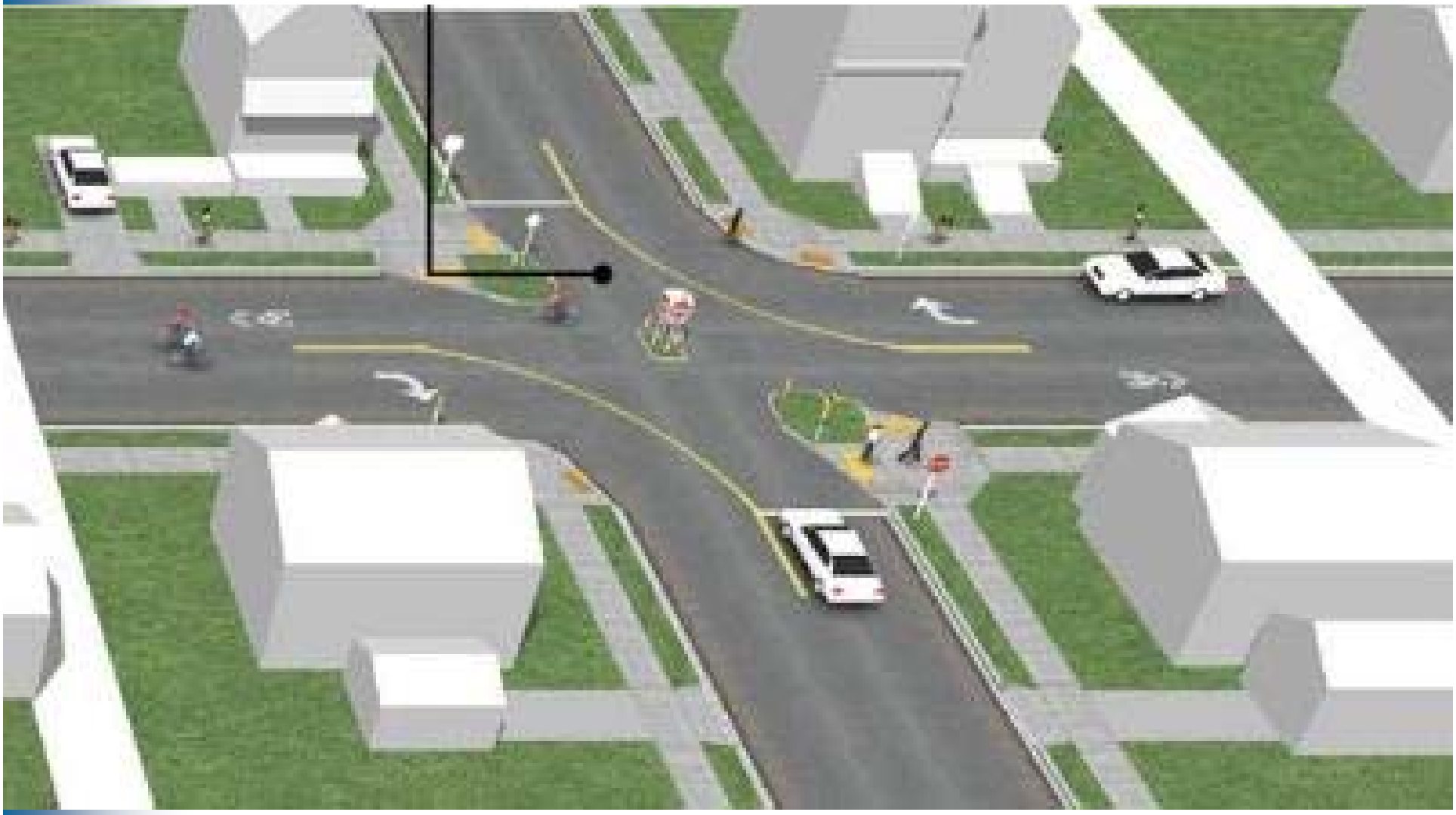


Values shown assume 20 mph posted speed. Loose street peak hour is 10 percent of ADT, 10 percent of peak hour traffic is in the peak direction. Cars are evenly spaced along the street; no platooning. 10 minute bicycle headway peak hour. Cars are traveling the posted speed limit (speed management techniques may be necessary). Note: Cars may pass bicyclists more or less frequently depending on how well these assumptions reflect reality.

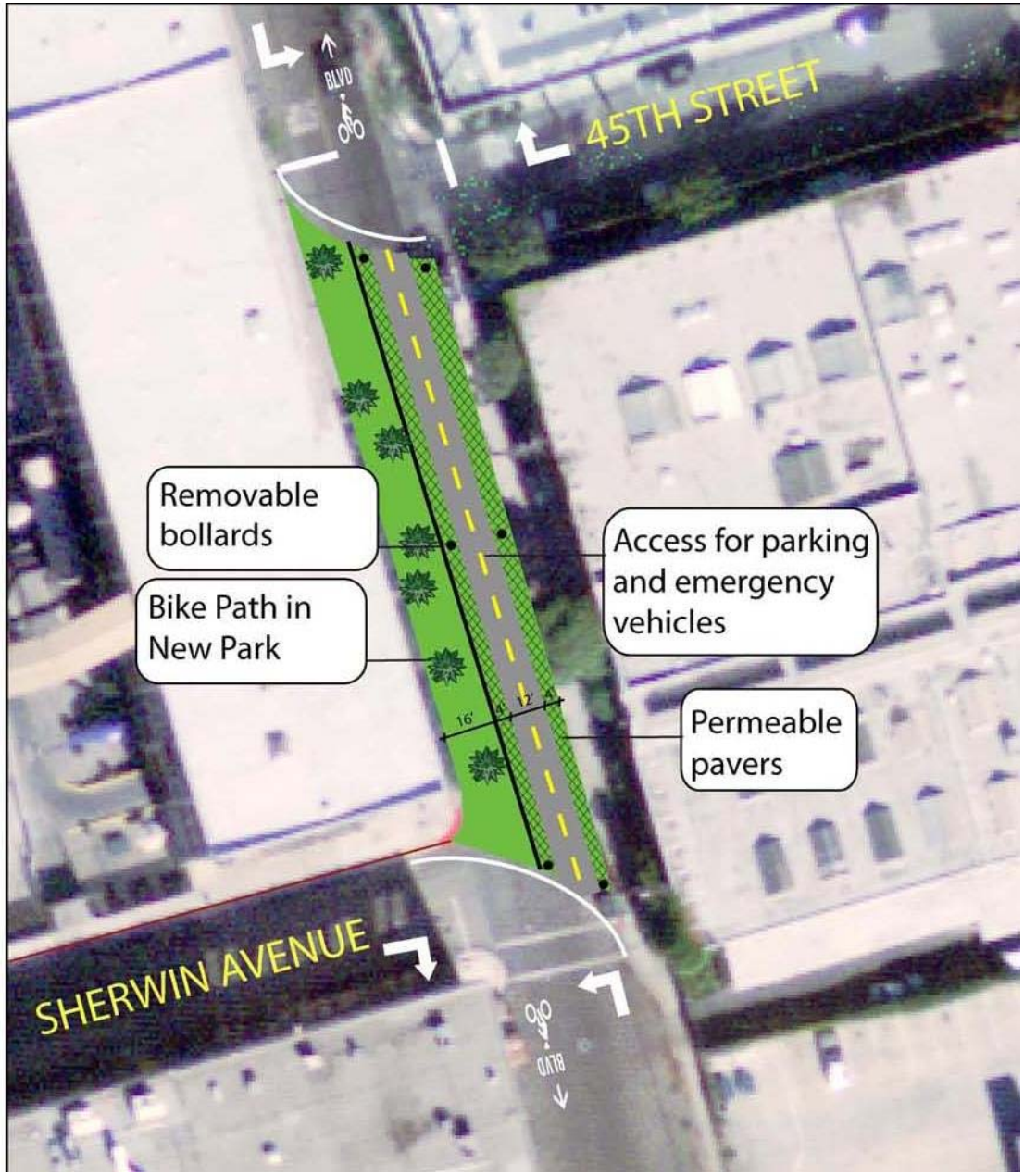
Diverters/Closures

- Partial Closure
- Full Closure

Partial



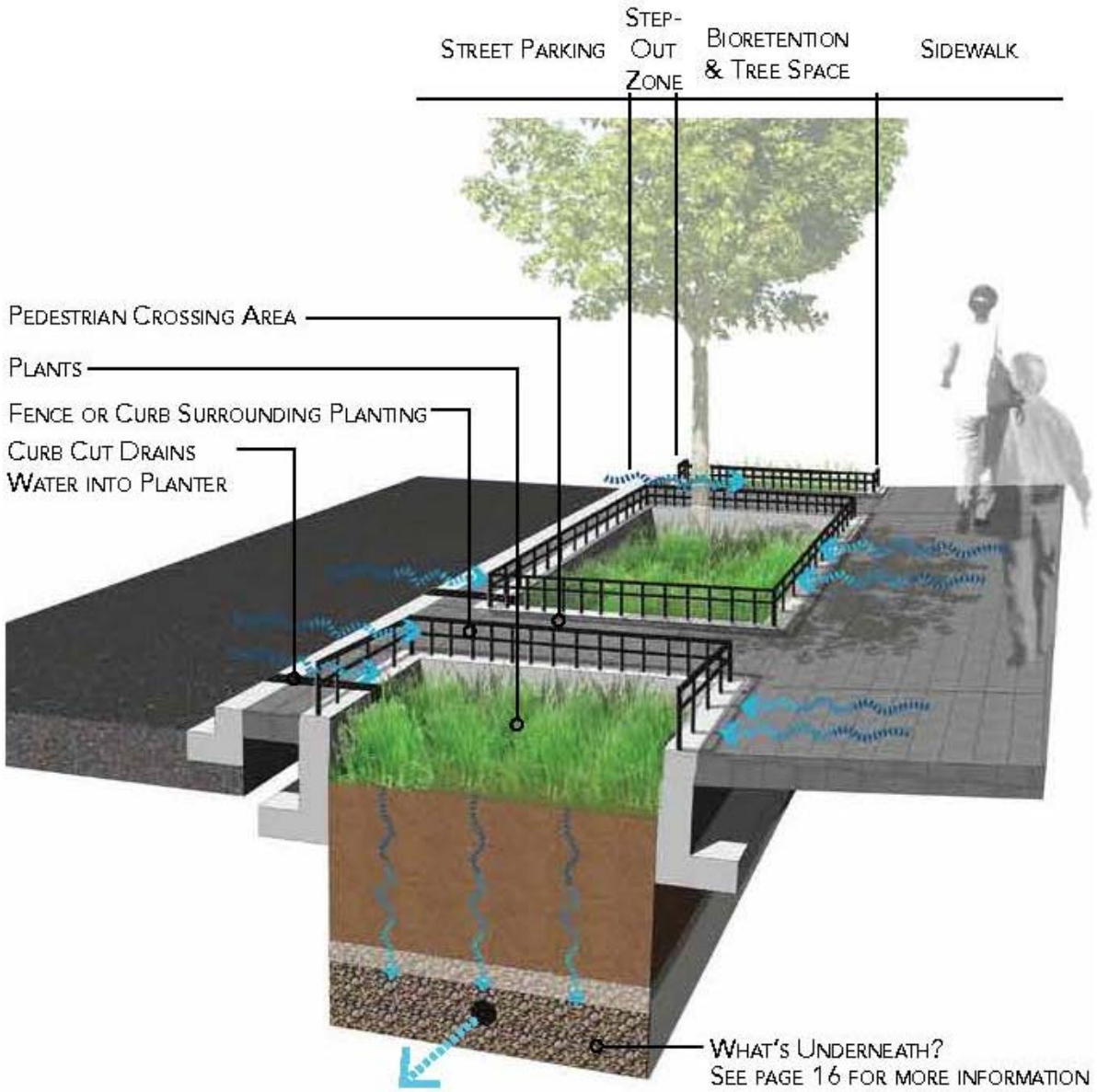
Full Closure


45TH STREET
SHERWIN AVENUE
Removable bollards
Bike Path in New Park
Access for parking and emergency vehicles
Permeable pavers
16'
4'
12'
4'

ADA Issues in GI Design

- Curb ramp grades, length & interface with street
- Paving roughness and joint gaps/spaces
- Sidewalk clear path of travel and width minimum
- Path of travel from on-street parking lane to sidewalk with bioretention blocking path
- Trip and fall hazards
- Excessive system and ponding depth
- Vision impaired community issues
  - Grade changes around bioretention areas
  - Grade changes within bioretention areas
  - Fencing and curbing around bioretention

Bioretention Planter with Step-Out Zone



Where to Use?

- Wide sidewalk area with adjacent on-street parking.
- High-volume pedestrian areas.
- Areas with other streetscape features (lights, bike racks, bus stops, etc.).

Limitations

- Do not disturb existing, mature trees.
- Provide low fence or curb for pedestrian safety.

Common Design Issues

Pedestrian Safety: Bioretention areas in the streetscape can have dropped or sloped sides. Short fences or curbs prevent pedestrians from slipping into a recessed area. Bioretention with side slopes can use a small step-out area in place of a fence or curb. When bioretention is next to street parking areas, a step-out zone of 12-36 inches must be provided to allow access from vehicle to sidewalk. Crossing areas must be provided between street parking and the sidewalk.


STREET LIGHT
SIDEWALK
STREET TREE
STREET PARKING


Greening the Public Space
Permeable Pavement In Pedestrian Crossing
Curb
Bioretention Planting
Step Out Zone
Curb Cut with Metal Trench Drain Cover

Cyclist Infrastructure Types

- Class 1 – Paths
- Class 2 – Lanes
- Class 3+ – Bike Boulevards (Enhanced Rts.)
- Class 3 – Routes
- Class 4 – Protected Bikeway (Separated)
- Intersection Treatments
- Sidewalks (Where Allowed)
- Bridges and Ramps
- Cycle Parking Areas

Road Diet: Bike Lane & SW Planter

Campbell

Bike Safety: CycleTrack Planter

Emeryville

Bike Safety: CycleTrack Tree Filter

Seattle

Caltrans Grants: Active Transportation Program

- Functional Landscaping
  - Stormwater curb extensions for SRTS
  - Filter strips used as cycletrack protection?
- Non-Functional Landscaping
  - Parking areas used for cycletrack protection
  - Decorative landscaping
- 5% allowed for non-functional landscaping
- Pervious paving?

Safe Routes to Schools, Transit and Parks

- SRTS – Intersection curb extensions, mid-block crossings and traffic calming measures such as chicanes and diverters
- SRTT – Curb extensions, pervious pavement and tree filters at improved transit stops
- SRTP – Traffic circles, Tree filters and rain gardens in park land near crosswalks.


San Mateo

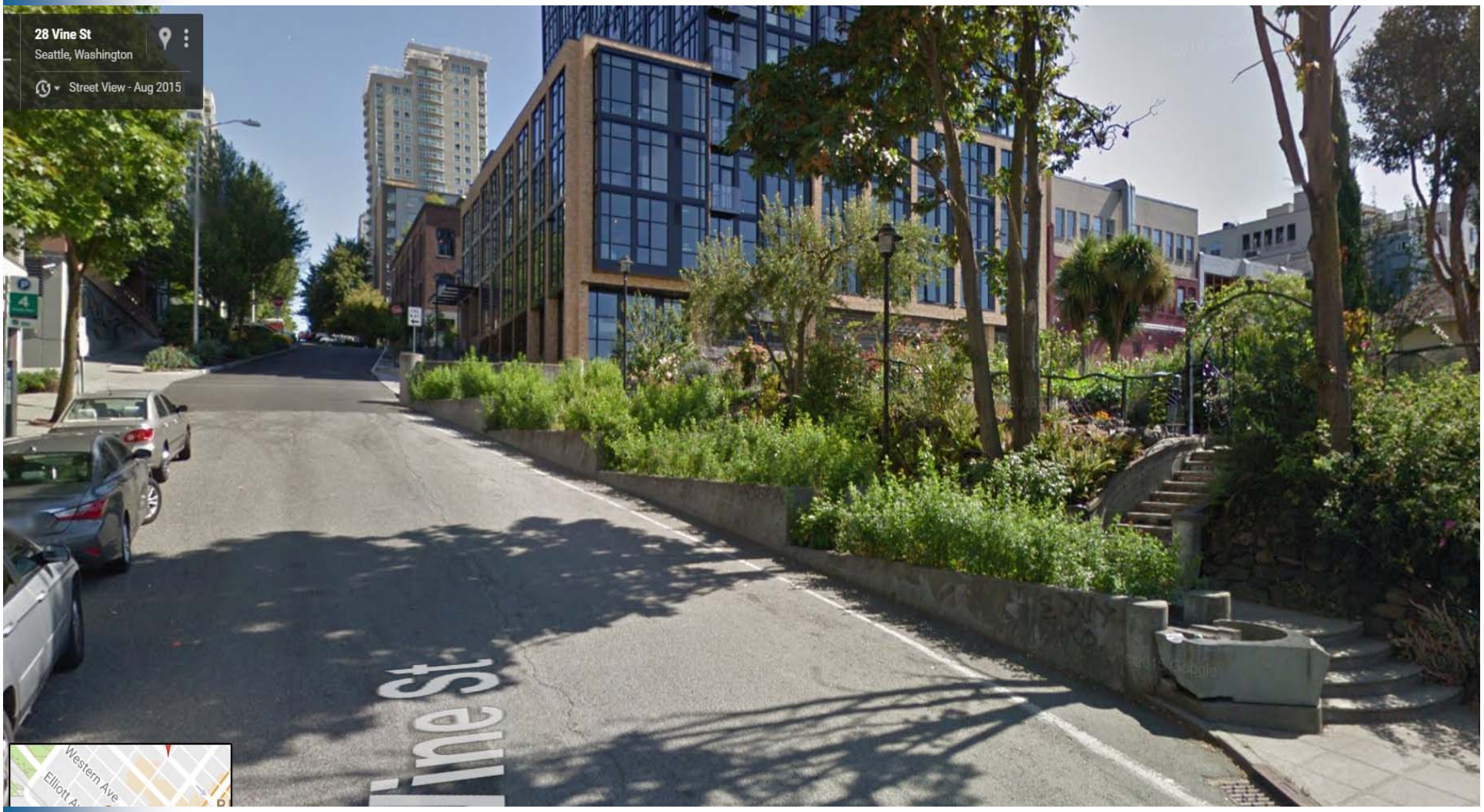
San Mateo

Designs for Sloped Streets

- Underground check dams
- Above ground check dams
- Modular systems
- Non-infiltrating systems
- Terraced systems


TAQUERIA
CAN-CUN


San Francisco


28 Vine St
Seattle, Washington
Street View - Aug 2015
Western Ave

Seattle

"Mr. Osborne, may I be excused?
My brain is full."

Other Examples of Integrated Systems

Green Railways

New Orleans

SRTP: Path-Rain Garden

El Cerrito

Improved Curb Ramp with Pervious Paving in Parking Lane

Berkeley

Improved Walk and Bike-ability with Infiltration Trench

San Jose

Bay Area Case Studies of Integrated Systems in Retrofit Projects

Retrofit Example #1 - Colma

- Road Diet
- Stormwater Curb Extensions
- Bike Lanes
- New Sidewalk on one side
- On-Street Parking added
- Pedestrian Safety - Mid-block crossings
- 2014

Before: two vehicle travel lanes in each direction, sidewalk only on south side, no on-street parking and no cross-walks.

Credit: CSG Consultants

After: one vehicle travel lane in each direction, new bike & parking lanes, new sidewalk on north side, protected mid-block crossing with rectangular rapid flashing beacon (RRFB) & stormwater curb extensions with trees.

Example #2 - Emeryville

- Phased Project:
  - First - a Road Diet for Cyclists
  - Then - a Pedestrian Safety Project
  - Finally - a Green Street
- Bay-Friendly Landscaping
- No irrigation
- Many Lessons Learned (aka mistakes)
- 2011

Before

After Road Diet

Complete and Green

Example #3 - Campbell

- Road Reconstruction Project
- Stormwater sidewalk planters, curb extensions and tree filters
- Bike lanes
- Bay-Friendly rated landscape
- 1st Bay Area GI GreenRoads certified project: silver
- 2016

Example #4 – Palo Alto

- Neighborhood Infrastructure Project
- Localized Flooding Issues
- Stormwater curb extensions
- Permeable Paver Crosswalks and Path
- No Stormdrain for underdrain connection
- Drywell Drainage Columns


Miramonte
400
Castilleja
Ave
1600
STOP


Castilleja

Example #5 - Emeryville

- Bike-Ped Grant Project
- Road Diet with Raised 2-way Cycle Track
- Added Stormwater Planter
- Bay-Friendly Landscaping
- Bay Trail Gap Closure
- Funded by $500k Countywide Bicycle Grant
- 2016


SAN FRANCISCO
Bay Trail
To Bay
Bridge Trail


TRADER JOE'S
TRADER JOE'S


BIKE
PATH
KEEP
RIGHT
DO NOT
ENTER
BIKES OK
Bay Trail


Black Bear
Diner


BAY ST
SIGNAL
YIELD TO PEDS
14

Thank you!

Peter Schultze-Allen
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