Countermeasure Strategies for Pedestrian Safety

Road Diets

Matthew Ridgway

Fehr and Peers

October 6, 2015

Today's Presentation

- **Introduction and housekeeping**
- **Audio issues?**
  Dial into the phone line instead of using "mic & speakers"
- **PBIC Trainings and Webinars**
  www.pedbikeinfo.org/training
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- **PBIC News and updates on Facebook**
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- **Questions at the end**

Countermeasure Strategies for Pedestrian Safety Webinar Series

Upcoming Webinars

Marked Crosswalks

Thursday, October 15 (1:00 – 2:30 PM Eastern Time)

Curb Extensions

Tuesday, October 27 (1:00 – 2:30 PM Eastern Time)

Rectangular Rapid Flashing Beacons

Thursday, November 5 (1:00 – 2:30 PM Eastern Time)

To view the full series and register for the webinars, visit
www.pedbikeinfo.org/training/webinars_PSAP_countermeasurestrategies.cfm

ROAD DIET / LANE REDUCTION

DPS 201

WHY

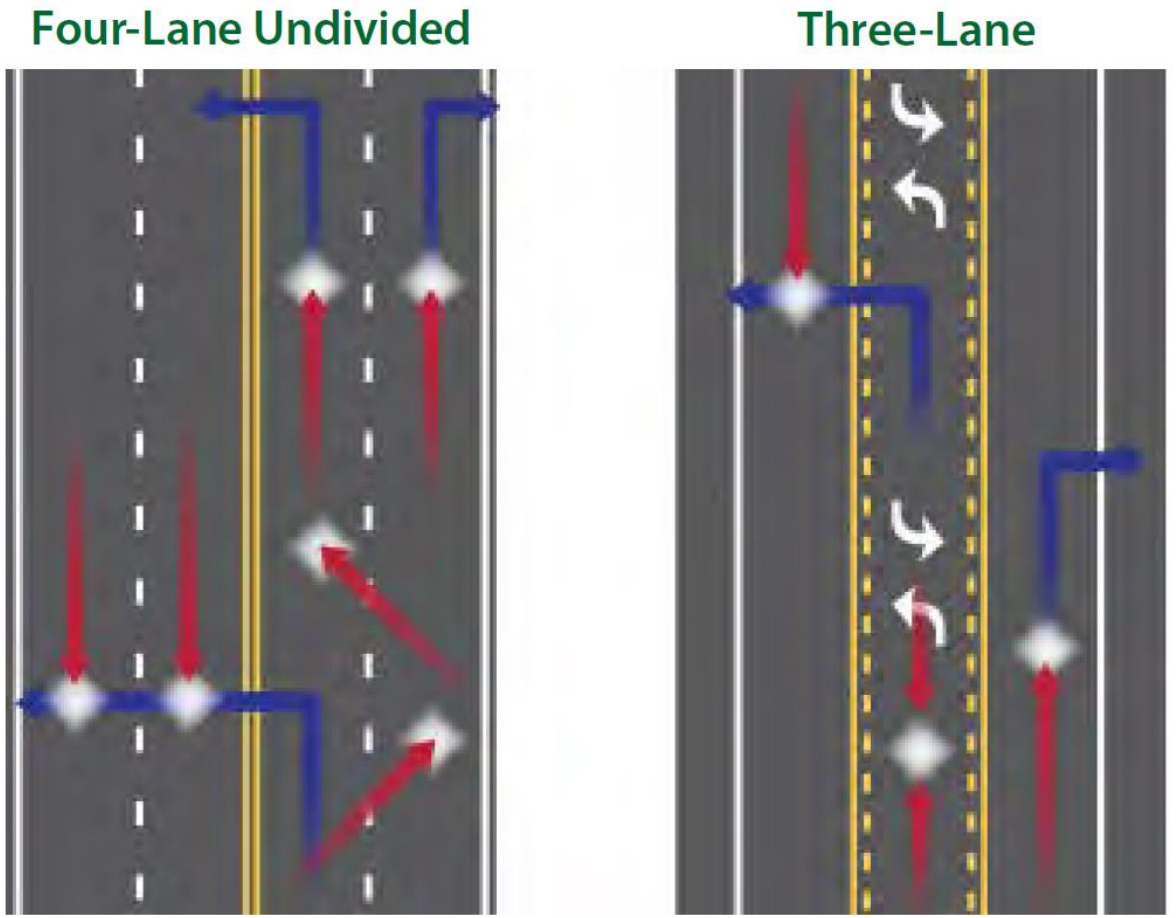


Figure 4. Mid-Block Conflict Points for Four-Lane Undivided Roadway and Three-Lane Cross Section (Adapted from *Welch*, 1999)

WHY

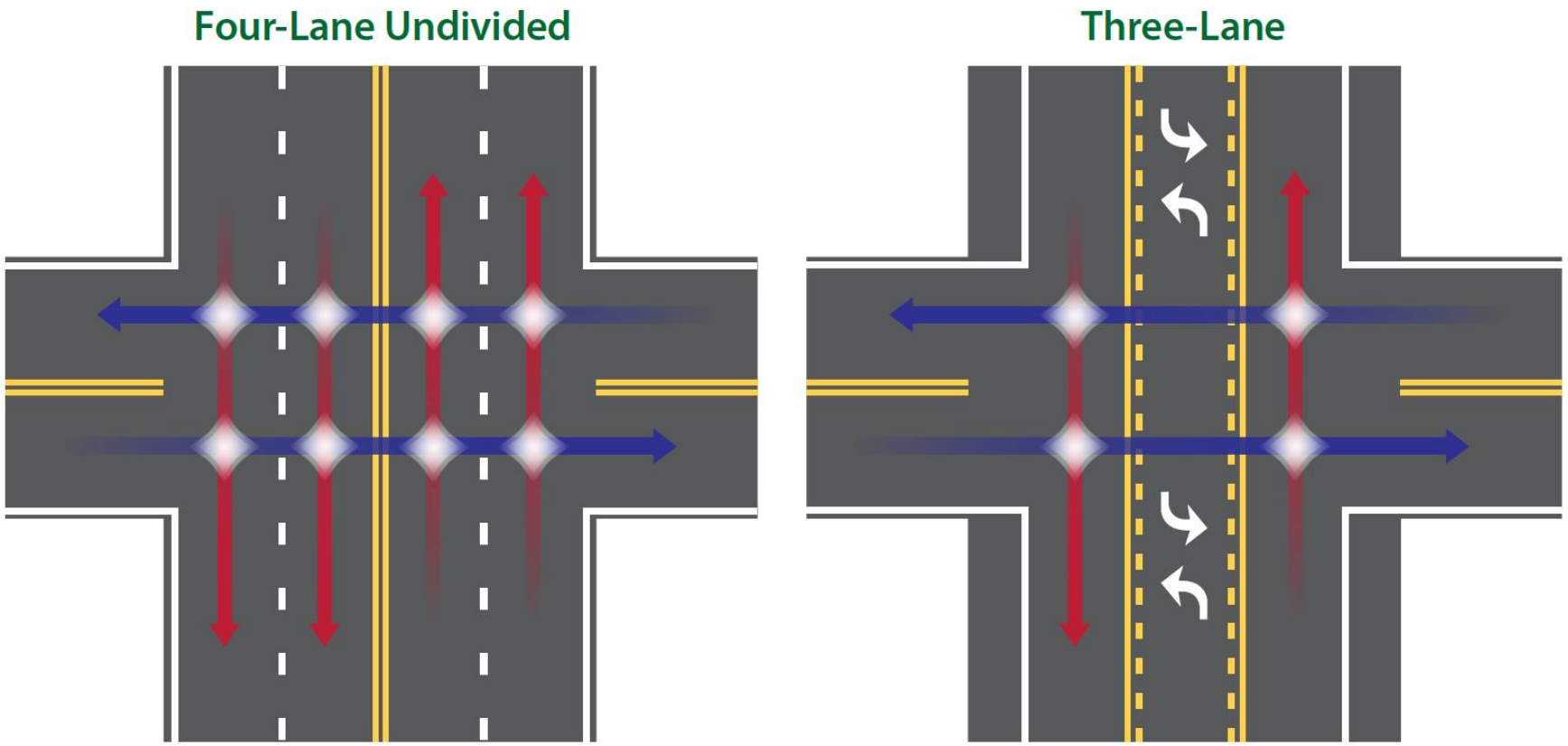


Figure 5. Crossing and Through Traffic Conflict Points at Intersections for a Four-Lane Undivided Roadway and a Three-Lane Cross Section (Adapted from *Welch*, 1999)

WHY

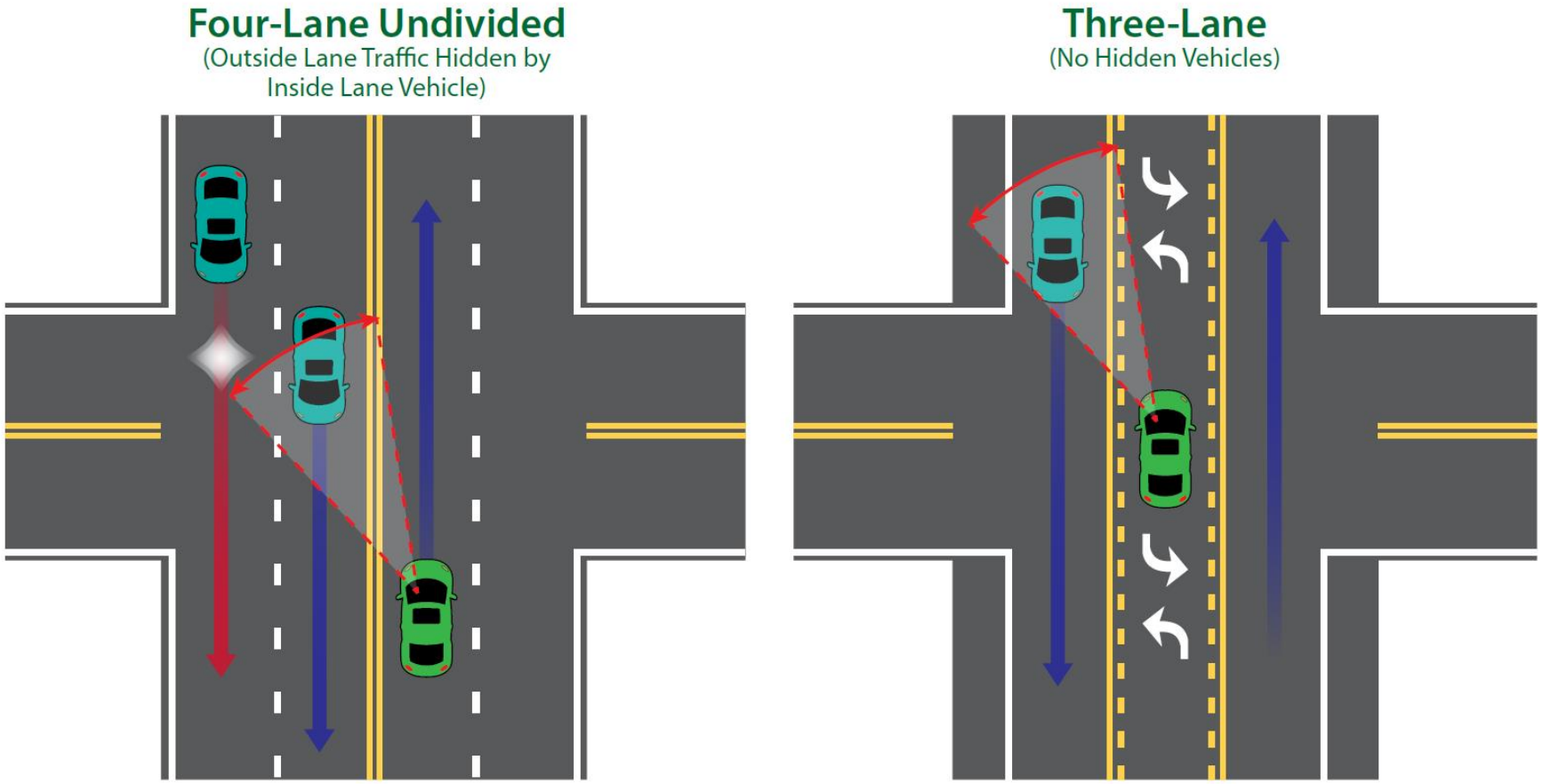
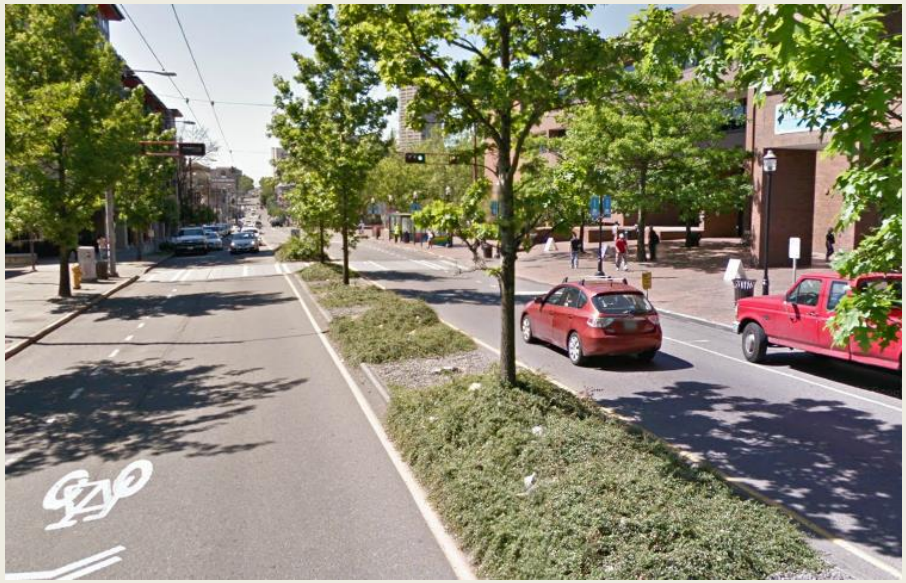


Figure 6. Major-Street Left-Turn Sight Distance for Four-Lane Undivided Roadway and Three-Lane Cross Section (Adapted from *Welch*, 1999)

PEDESTRIAN BENEFITS

Components of road diet projects associated with increased pedestrian safety:

- Decreases number of vehicle lanes to cross
  - Reduces the multiple-threat situation
- Provides room for a pedestrian crossing island
- Improves speed limit compliance and decrease crash severity
- Creates a buffer between pedestrians and vehicular traffic through addition of on-street bike lanes or on-street parking.

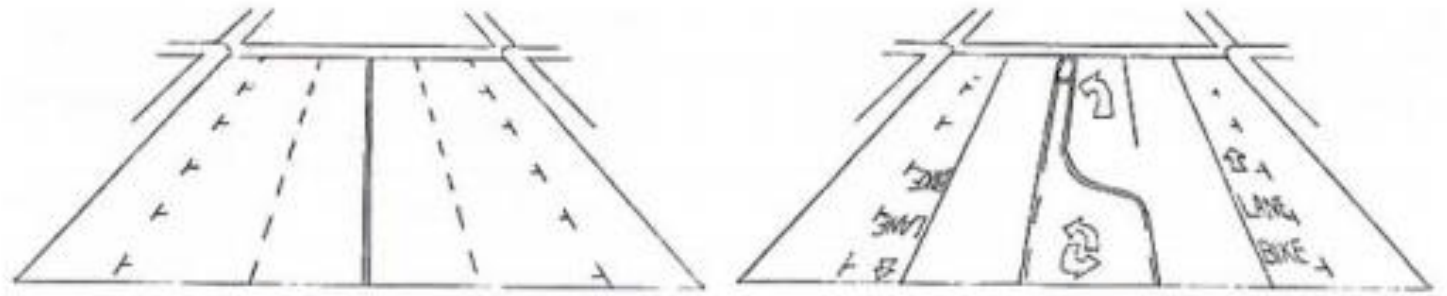


CASE STUDY: ROAD DIET (SAN FRANCISCO, CA)

Why a Road Diet?

- Community recognized need to accommodate other road users
- Large number of pedestrian attractors led to conflicts
- Bicycle community wanted dedicated bicycle lanes

Figure 1 – Drawings of Valencia Street Before and After the Bike Lanes



Before *After*

Source: Sallaberry, 2000, p. 20

CASE STUDY: ROAD DIET (SAN FRANCISCO, CA)

Problem/Background

- Valencia Street part of San Francisco's Mission District
- 1.8 miles long
- 4-lane road with 22,000 ADT
- High pedestrian, bicycle, bus activity but lacked supporting infrastructure

Before

CASE STUDY: ROAD DIET (SAN FRANCISCO, CA)

Details

- In 1999, 4 lanes restriped to 2 lanes + bicycle lanes and center turn-lane
  - Trial basis
- Speed limit lowered from 30 to 25 mph
- Signal timing altered to minimize loss of capacity
- Made permanent after year trial
- Initial cost: $130,000
  - Paint and sign work, & labor spent writing an impact report

Before

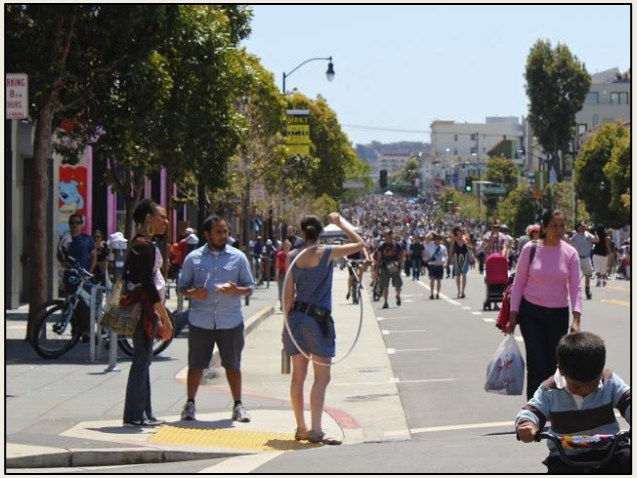
After

CASE STUDY: ROAD DIET (SAN FRANCISCO, CA)

Results

- Success
  - No real change in ADT
  - Large increase in cycling & pedestrian activity
  - Reduction in collisions
  - Aided revitalization of area
- Four years after, a survey of business owners along Valencia Street found general support*
  - 65% felt bicycle lanes had positive impact on their business, only 4% said it had negative impact
  - 65% would support more traffic calming

**Source: Emily Drennen, "Economic Effects of Traffic Calming on Urban Small Business"*

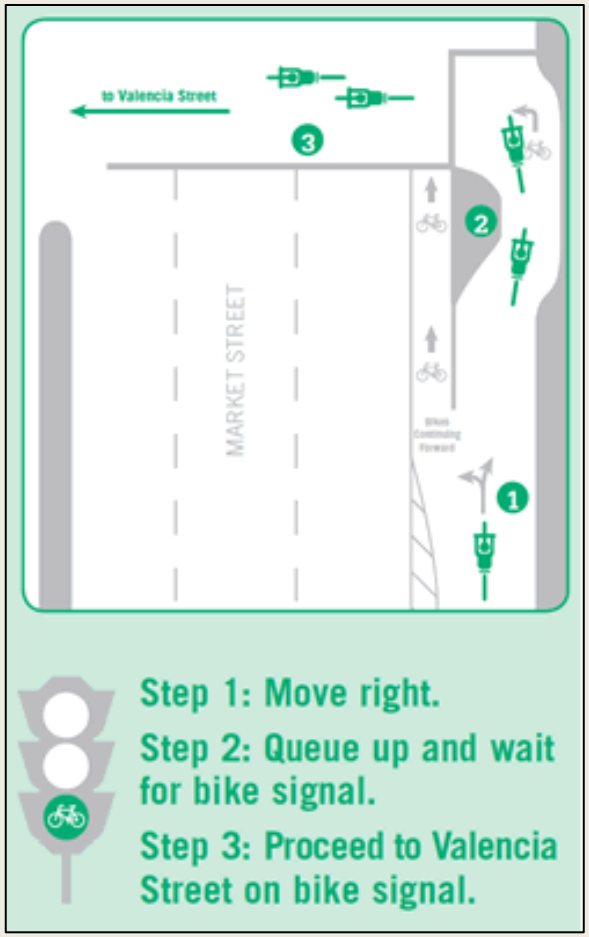


CASE STUDY: ROAD DIET (SAN FRANCISCO, CA)

Results

- City implemented more changes in 2010:
  - sidewalks and bike-lanes widened
  - bulb outs, streets trees, lighting, and public art added
- Became place to try new treatments such as bicycle "green wave" and bicycle bays

Sign indicating the street is set for "green wave" speeds



Sign illustrating a bicycle bay

ROAD DIET / LANE REDUCTION: SAFETY

- Narrowing the roadway cross section from four lanes to three lanes (two through lanes with center turn lane) has been associated with a 29% decrease in all crashes.

Countermeasure: Road diet (Convert 4-lane undivided road to 2-lanes plus turning lane)

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type
0.71 [B]	29	★★★★★	All	All	Minor Arterial	Urban

Research

- Harkey, D., Srinivasan, R., Baek, J., Council, F. M., Eccles, K., Lefler, N., ... & Bonneson, J. A. (2008). Crash Reduction Factors for Traffic Engineering and ITS Improvements. *Final Report National Cooperative Highway Research Program (NCHRP) Project*, 17-25.

ROAD DIET / LANE REDUCTION: SAFETY

- Converting roadway cross-section from four lanes to three lanes (two through lanes with center turn lane) has been associated with a 37% decrease in all crashes.
  - Urban areas

Countermeasure: Narrow cross section (4 to 3 lanes with two way left-turn lane)

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Roadway Type	Area Type
0.63	37	★★★☆☆	All	All	Not specified	Urban

Research

- Gates, T. J., Noyce, D. A., Talada, V., and Hill, L., "The Safety and Operational Effects of "Road Diet" Conversion in Minnesota." 2007 TRB 86th Annual Meeting: Compendium of Papers CD-ROM, Vol. TRB#07-1918, Washington, D.C., (2007)

ROAD DIET / LANE REDUCTION: SAFETY

- Converting roadway cross-section from four lanes to three lanes (two through lanes with center turn lane) has been associated with a 53% decrease in all crashes.
  - Suburban roadways

CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference
0.47	53	★★★★☆	All	All	Suburban	Persaud et. al, 2010

Research

- Persaud, B., Lana, B., Lyon, C., and Bhim, R. "Comparison of empirical Bayes and full Bayes approaches for before–after road safety evaluations." Accident Analysis & Prevention, Vol. 42, Issue 1, pp. 38-43 (2010)

COLLISION REDUCTIONS FROM SEATTLE ROAD DIETS

Data on Street Conversions - Seattle, Washington					
ROADWAY SECTION	DATE CHANGE	ADT (BEFORE)	ADT (AFTER)	CHANGE	COLLISION REDUCTION
Greenwood Ave. N, from N 80th St. to N 50th St.	April 1995	11872	12427	4 lanes to 2 lanes plus TWLTL plus bike lanes	24 to 10 58%
N 45th Street in Wallingford Area	December 1972	19421	20274	4 lanes to 2 lanes plus TWLTL	45 to 23 49%
8th Ave. NW in Ballard Area	January 1994	10549	11858	4 lanes to 2 lanes plus planted median with turn pockets as needed	18 to 7 61%
Martin Luther King Jr. Way, north of I-90	January 1994	12336	13161	4 lanes to 2 lanes plus TWLTL plus bike lanes	15 to 6 60%
Dexter Ave. N, East side of Queen Anne Area	June 1991	13606	14949	4 lanes to 2 lanes plus TWLTL plus bike lanes	19 to 16 59%
24th Ave. NW, from NW 85th St. to NW 65th St.	October 1995	9727	9754	4 lanes to 2 lanes plus TWLTL	14 to 10 28%
Madison St., from 7th Ave. to Broadway	July 1994	16969	18075	4 lanes to 2 lanes plus TWLTL	28 to 28 0%
W Government Way/Gilman Ave. W, from W Ruffner St. to 31st. Ave. W	June 1991	12916	14286	4 lanes to 2 lanes plus TWLTL plus bike lanes	6 to 6 0%
12th Ave., from Yesler Way to John St.	March 1995	11751	12557	4 lanes to 2 lanes plus TWLTL plus bike lanes	16 to 16 0%
				Total	185 to 122 34%

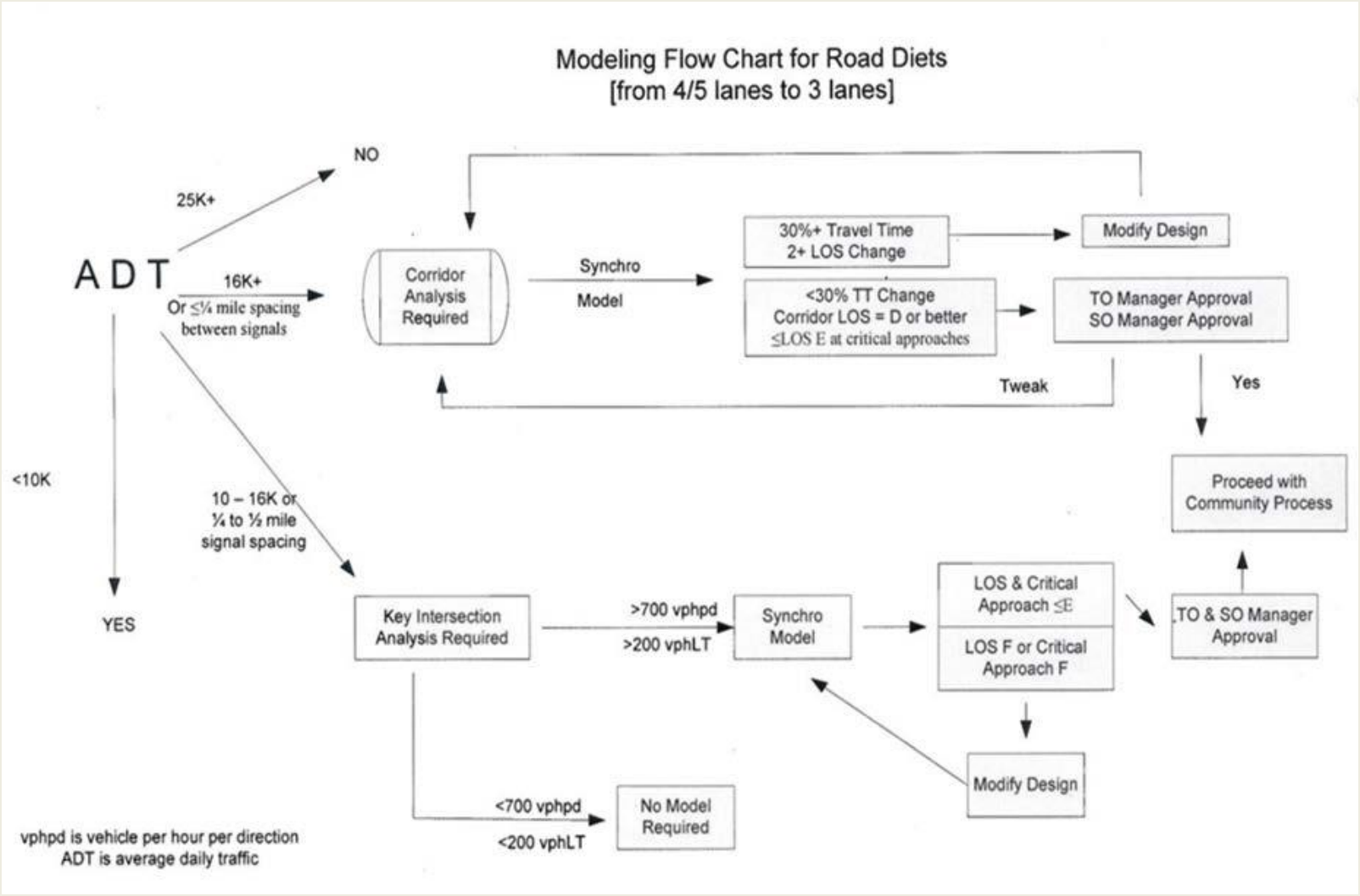
WHEN

- The roadway has a moderately high density of driveways and other uncontrolled access
- Crash severities are high
- Speeding contributes to safety problems
- Pedestrians and others crossing/accessing the main corridor are affected by the higher exposure of crossing
- Multiple lanes exist on each approach
- No center turn lane exists
- Frequent crash types exist that are most amenable to reduction through a road diet (opposing left-turn, sideswipe, pedestrian, rear-end)
- Complete streets policy direction with focus on active transportation comfort

ROAD DIET IMPLEMENTATION CONSIDERATIONS

Road Diet Implementation Considerations														
	Maximum Volume, ADT	Maximum Peak Volumes, DHV	Minimum Lane Width, ft			Crash History	Vehicle Speed	Number of Lanes	Turning Volumes	Freight Usage	Presence of Transit	Presence of Bicycles	Travel Time or LOS	Accessibility
			Through	Left/Right	Bicycle									
Chicago DOT	●	●	●	●	●	●			●					
Seattle DOT	●					●	●	●		●	●		●	●
City of Lansing, MI	●		●	●	●									
Michigan DOT						●			●		●		●	●
Delaware Valley Regional Planning Commission	●								●				●	
City of Las Vegas, NV							●					●		●
Genesee County (MI) Metropolitan Planning Commission	●		●			●	●							

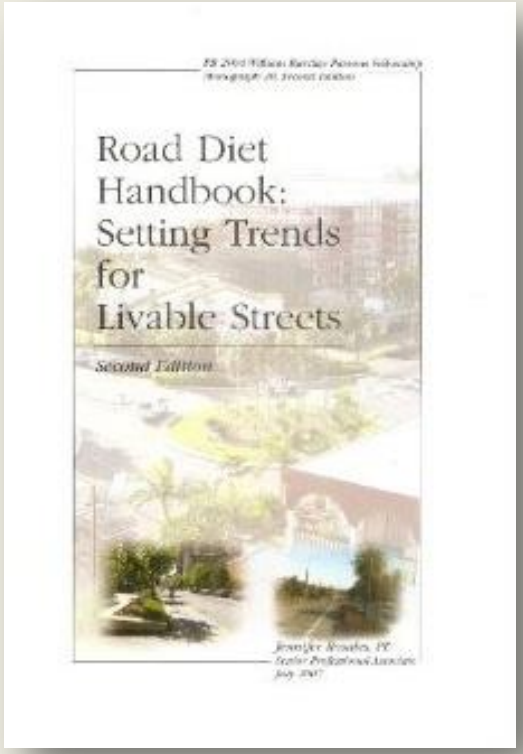
CITY OF SEATTLE

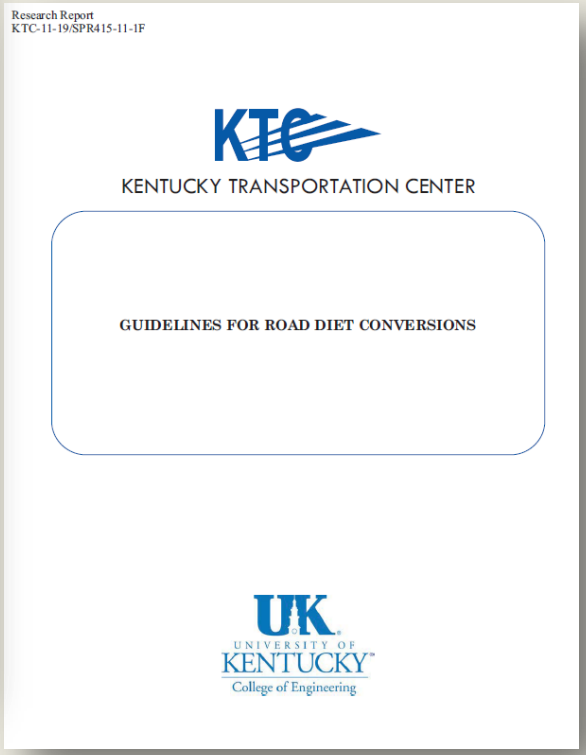


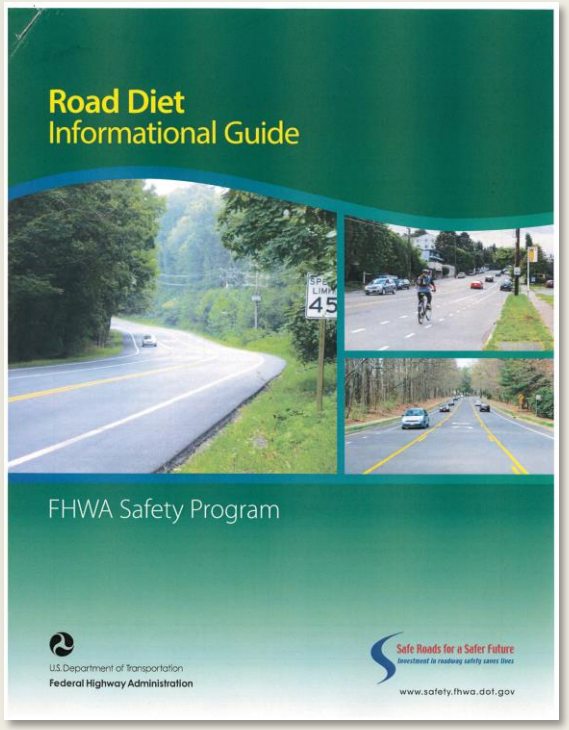
RESEARCH

- **Road Diet Conversions: A Synthesis of Safety Research**
  - May 2013 Libby Thomas, Senior Associate, UNC HSRC
  - FHWA DTFH61-11-H-00024
- Each potential road diet should be vetted on a case by case basis.
- Case study and modeling results suggest
  - Caution warranted when volumes approach 1,700 vehicles in the peak hour or range of 20,000 to 24,000 ADT
  - (HSIS, 2010; Knapp and Giese, 2001; Welch, 1999).

GUIDELINES

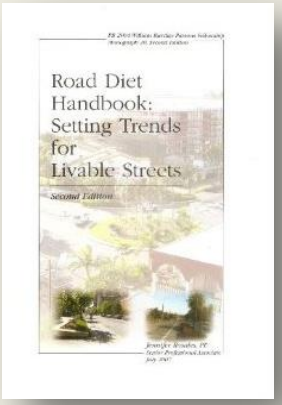

Road Diet Handbook: Setting Trends for Livable Streets
Second Edition


Research Report
KTC-11-19/SPR415-11-1F
KENTUCKY TRANSPORTATION CENTER
GUIDELINES FOR ROAD DIET CONVERSIONS
UK
UNIVERSITY OF KENTUCKY
College of Engineering


Road Diet
Informational Guide
FHWA Safety Program
U.S. Department of Transportation
Federal Highway Administration
Safe Roads for a Safer Future
www.safety.fhwa.dot.gov

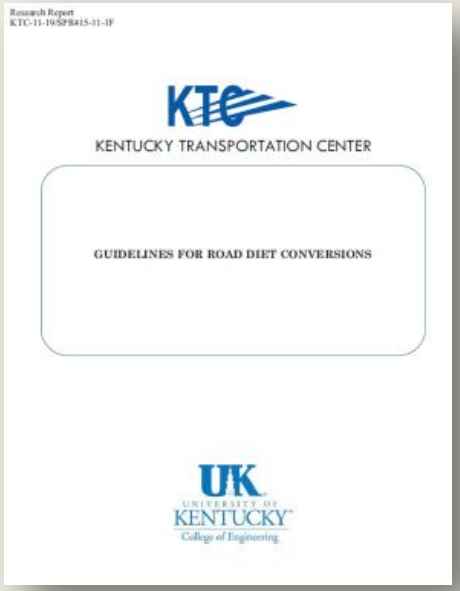
ROAD DIET HANDBOOK: SETTING TRENDS FOR LIVABLE STREETS

- Jennifer A. Rosales, P.E.
- A comprehensive guide for planners, engineers, & designers to help make decisions on applicability of road diets.
- Contains information on:
  - Planning
  - Analysis
  - Design
  - Implementation
  - Results of previous research
  - Significant gaps in the field
- Analyses of safety and traffic operations
- Livability considerations
- Case study evaluations
- Lessons learned from experience
- Guidelines for identifying & evaluating potential road diet sites & typical cross-sections
- Overall guidelines for implementation.



KENTUCKY TRANSPORTATION CENTER GUIDELINES FOR ROAD DIET CONVERSIONS

- Looks at operational and safety aspects to assist in preliminary determination whether a road diet is appropriate
- Cross-section designs
- Transition to and from the road diet section
- Flow chart for determining appropriate action
- Identified gap in Rosales Road Diet guidelines
  - Did not provide specific guidance regarding volumes or left-turn percentages indicating when such a project could result in improved operational and safety conditions



KENTUCKY TRANSPORTATION CENTER GUIDELINES FOR ROAD DIET CONVERSIONS

Typically, road diet conversions will operate at acceptable levels as long as the signalized intersections do not present any operational problems (Welch 1999)

Table 1 Level of service and maximum sum of critical lane volumes at signalized intersections

Level of Service	Traffic Flow Condition	Volume to Capacity Ratio	Critical Lane Volumes (vph)		
			Two-Phase	Three-Phase	Multiphase
A	Stable	<.6	900	855	825
B	Stable	<.7	1050	1000	965
C	Stable	<.8	1200	1140	1100
D	Unstable	<.85	1275	1200	1175
E	Capacity	<1.0	1500	1425	1375

Source: Messer and Fambro, 1977

KENTUCKY TRANSPORTATION CENTER GUIDELINES FOR ROAD DIET CONVERSIONS

DELAY COMPARISON 3-4 LANES WITH SIDE STREET VPH

Table 2 Range of delay differences by side street volume

Side Street (vph)	Min (sec)	Max (sec)	Avg (sec)
300	-2.4	3.4	0.98
700	-4.5	3.6	0.50
1300	-9.5	15.5	0.94

KENTUCKY TRANSPORTATION CENTER GUIDELINES FOR ROAD DIET CONVERSIONS

MAIN STREET SIDE STREET SIGNALIZED INTERSECTION GUIDELINES

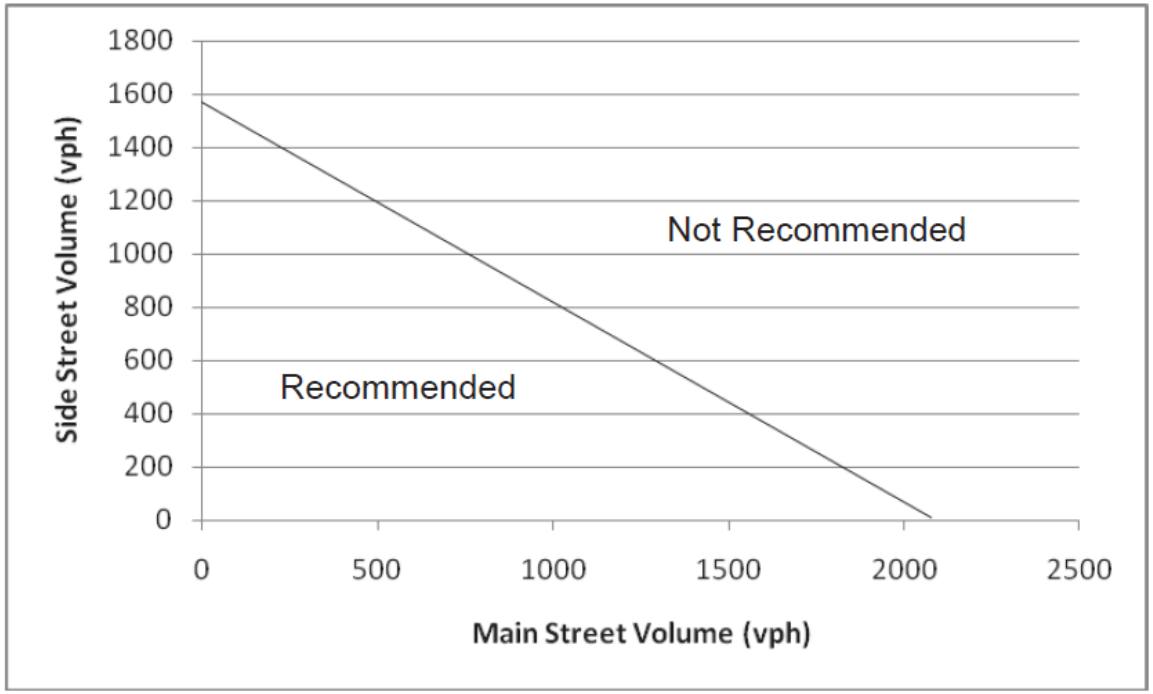


Figure 9 Guideline for operational performance at signalized intersections

KENTUCKY TRANSPORTATION CENTER GUIDELINES FOR ROAD DIET CONVERSIONS

QUEUE DIFFERENCE 3-4 LANES WITH SIDE STREET VPH

Table 3 Range of average queue differences by side street volume

Side Street (vph)	Min (veh)	Max (veh)	Avg (veh)
300	-1	1	0.07
700	-2	2	0.03
1300	-3	3	0.30

ROAD DIET CANDIDATE GUIDELINES

- ADT (Road Diet Candidate)
  - 20,000 or less[1]
  - 23,000 or less[2]
- Peak hourly volume (Road Diet Candidate)
  - 1,700 or less[1]
  - 1,500 – 1750 or less depending on[2]:
    - Percentage of left turns at intersection
    - VPH on side street
- Case with higher ADT
  - Lake Washington Blvd. Kirkland, WA[3]
    - Initial volume of 23,000 vehicles per day
    - Increased nearly 26,000 after conversion
    - During one period about 30,000 vehicles per day

1. Rosales 2. Kentucky 3. Burden and Lagerwey (1999)

CONSIDERATIONS

- What are the non-intersection turning volumes and patterns
  - Driveway density
  - Left turns in and out
- Are there frequent-stop and slow-moving vehicles?
  - Buses
  - Mail
  - Double parked vehicles
  - Buggies
  - Delivery trucks
  - Agriculture
- Is there a lot of weaving?
- What are the speeds?

INTERSECTIONS

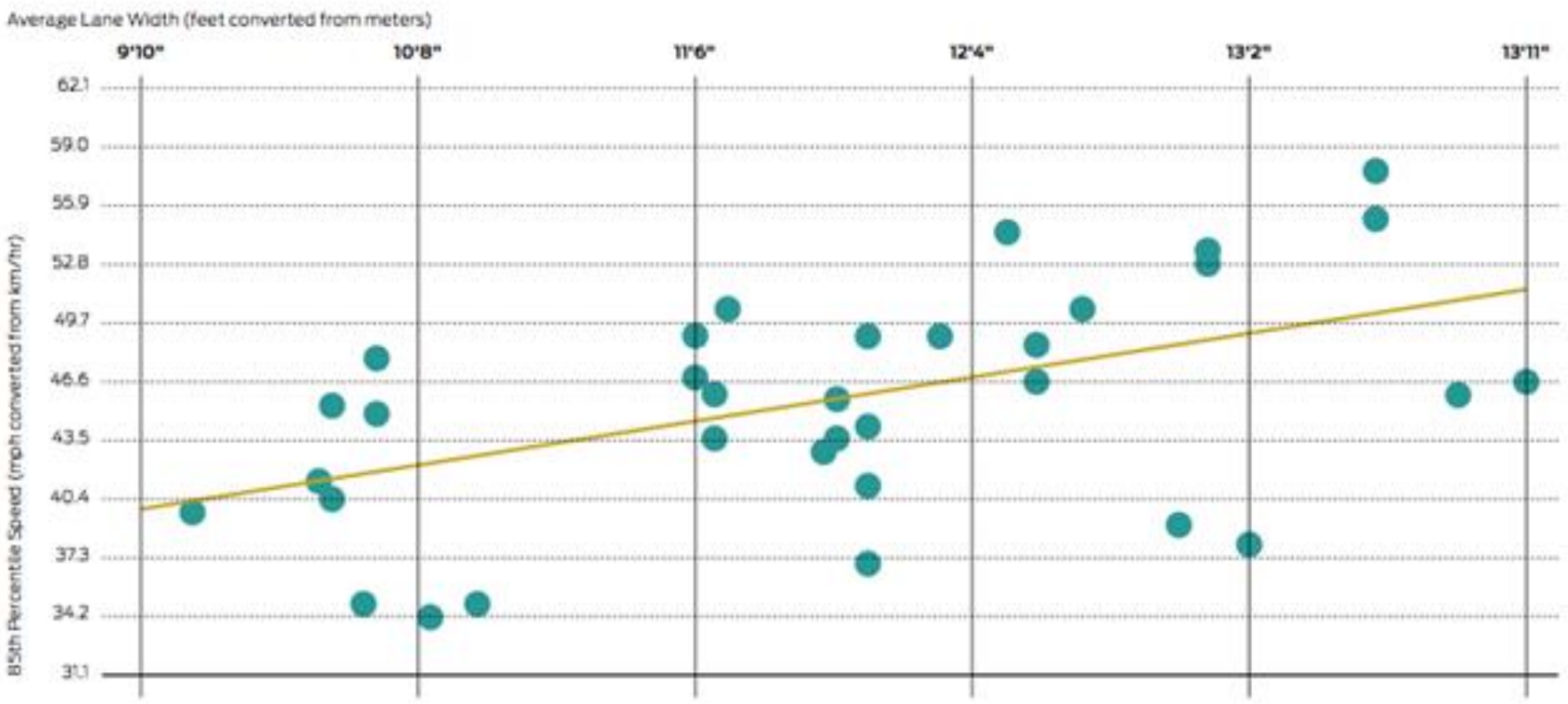
- Signal timing or phasing changes at intersections to optimize operations and safety benefits
- Roundabouts

SIMULATION SOFTWARE

- CORridor SIMulation (CORSIM)
- VISSIM
- Safety Surrogate Assessment Model (SSAM)

DESIGN CONSIDERATIONS

WIDER LANES = HIGHER SPEEDS



"As the width of the lane increased, the speed on the roadway increased... When lane widths are 1 m (3.3 ft) greater, speeds are predicted to be 15 km/h (9.4 mph) faster."

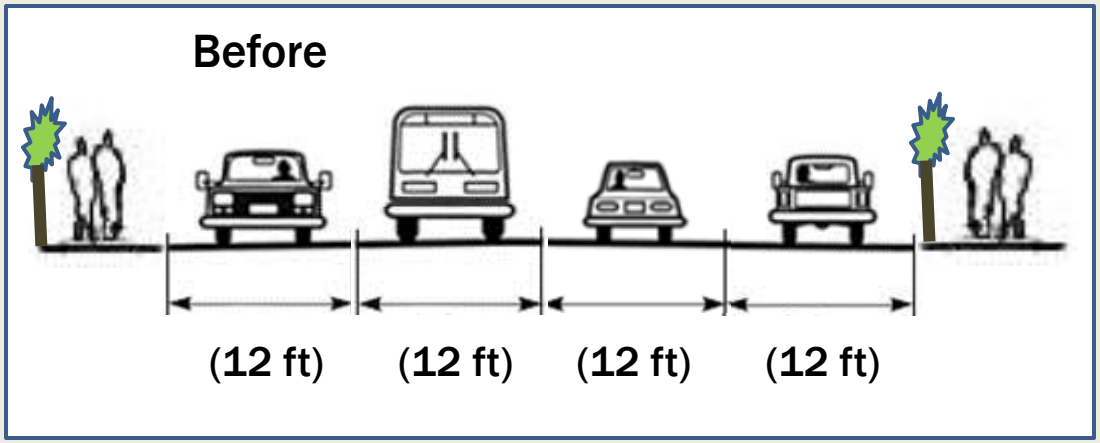
Regression Line

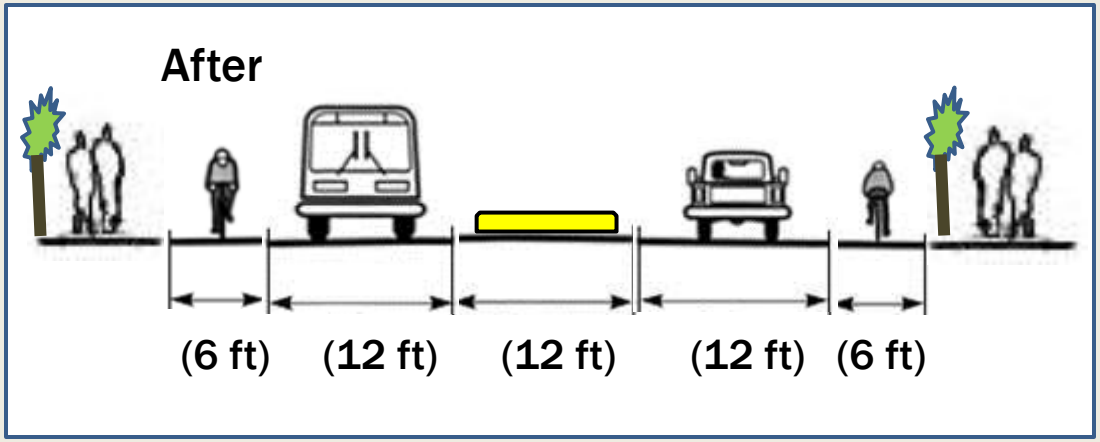
85th Percentile Speed of Traffic

Source: "Design Factors That Affect Driver Speed on Suburban Streets", TRR 1751 (2000)

CROSS SECTIONS 48 FEET

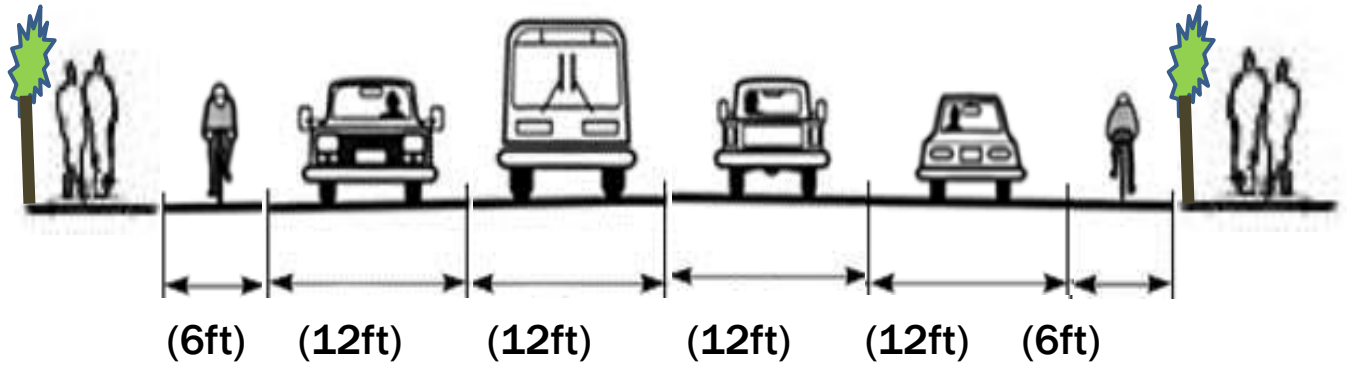
- 48 feet curb-to-curb with no parking
- Sidewalks buffered in the Road Diet
- Space for pedestrian island



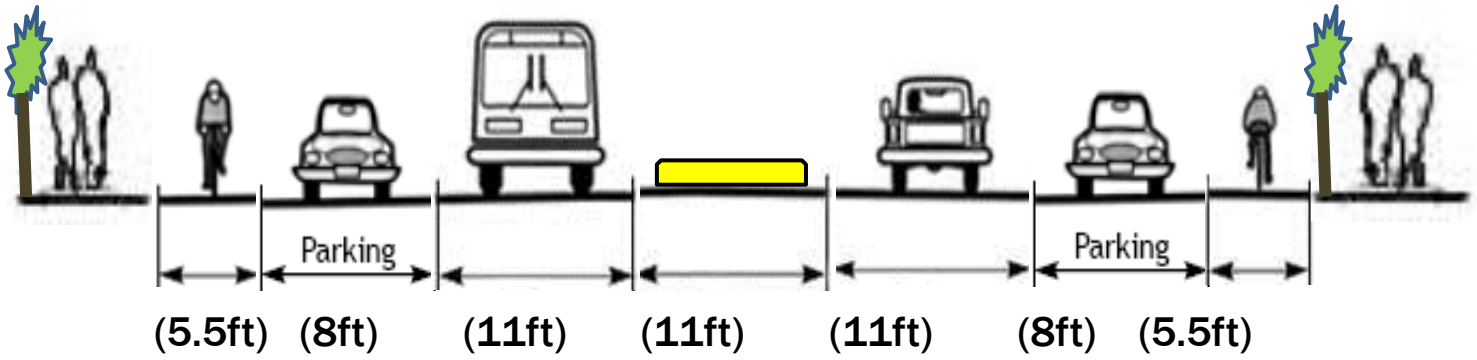


CROSS SECTIONS 60 FEET

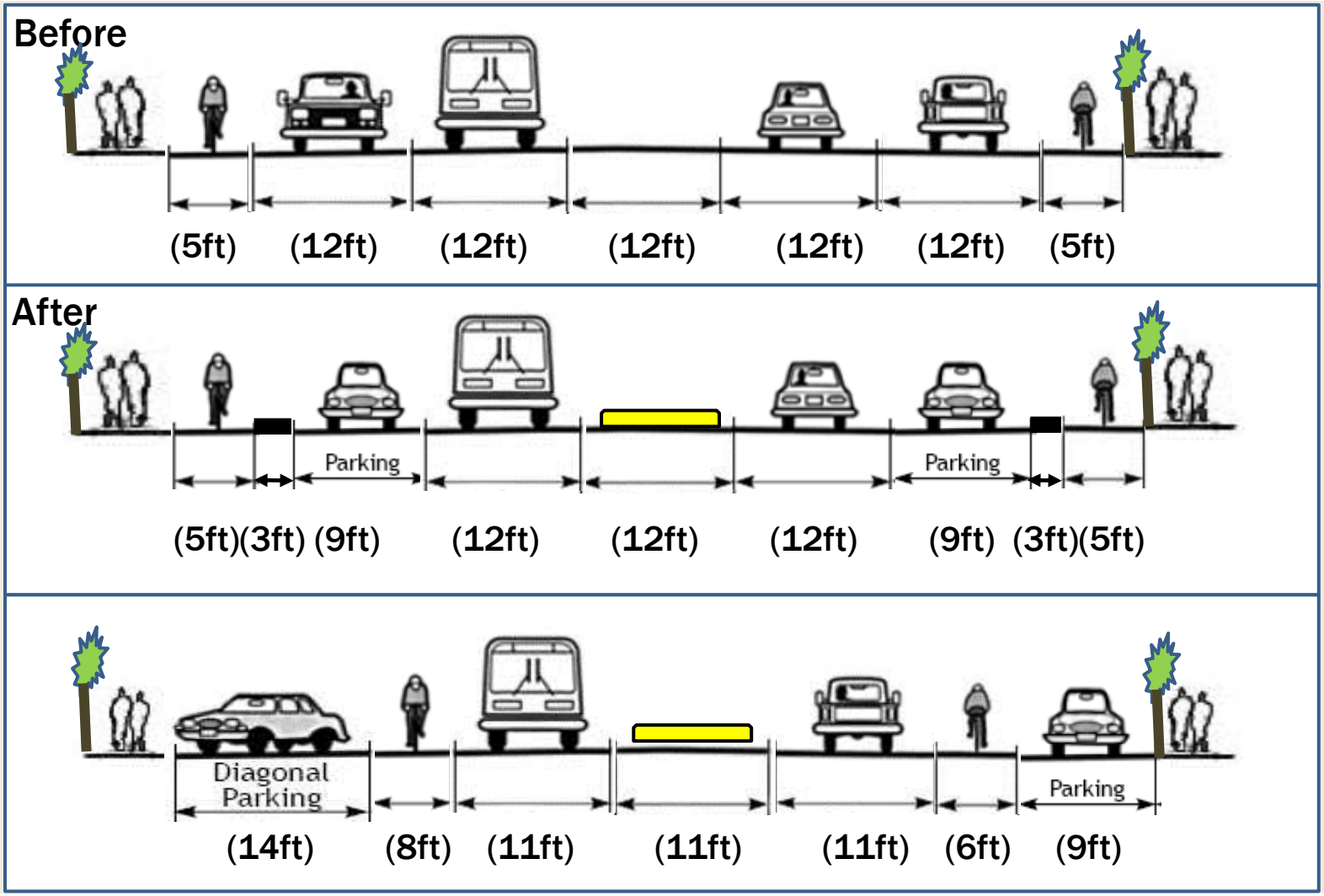
Before



After

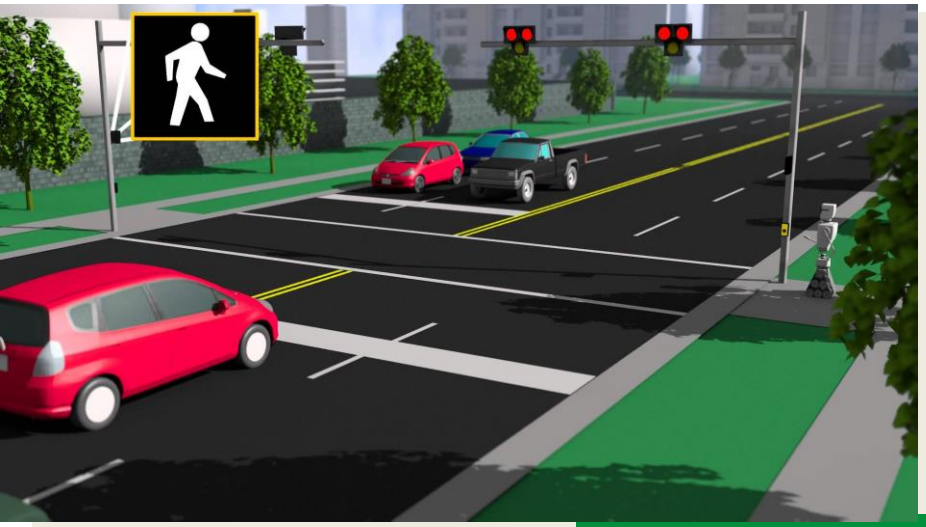


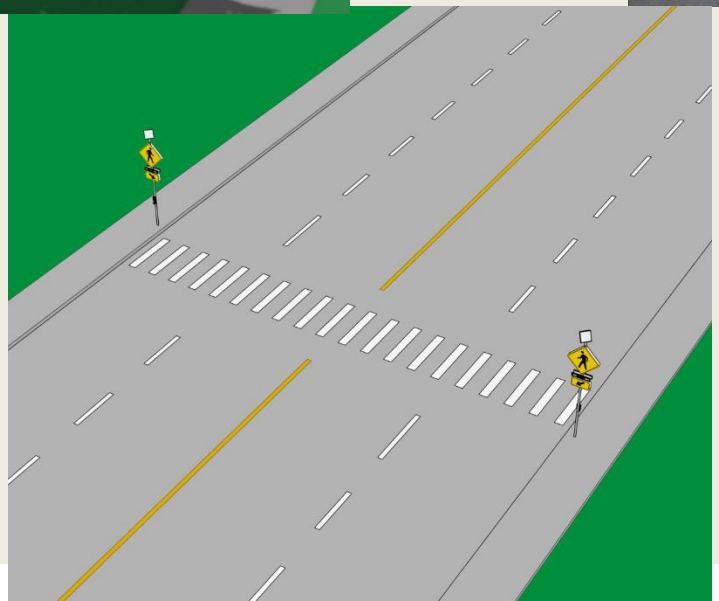
CROSS SECTIONS 70 FEET



TYPICAL INTERSECTION TREATMENTS

OPPORTUNITY TO ENHANCE CROSSWALKS

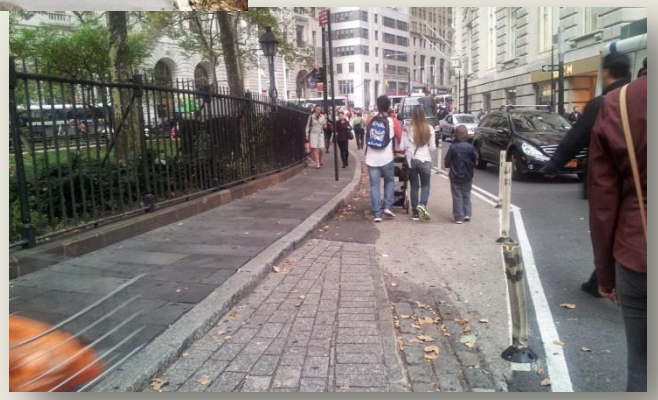




OPPORTUNITY TO WIDEN SIDEWALKS

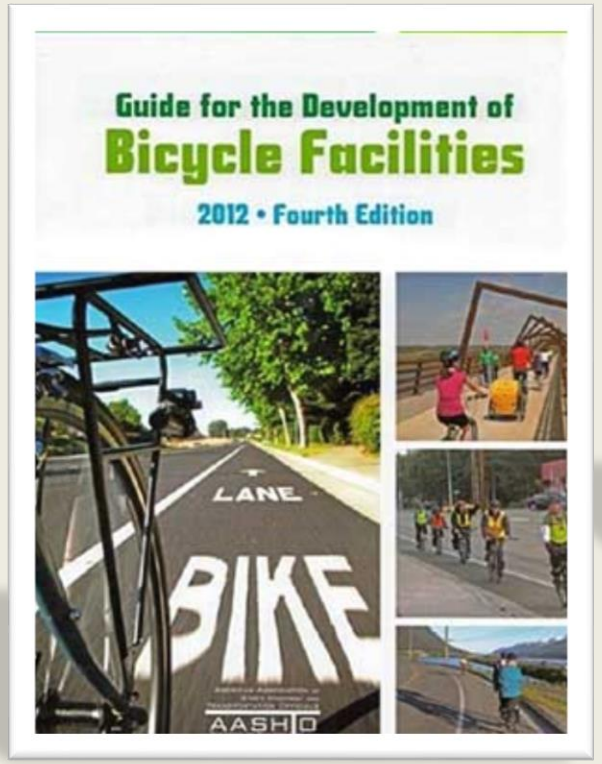
- Although higher cost sidewalks can be widened

Washington D.C
Sherman Ave. NW



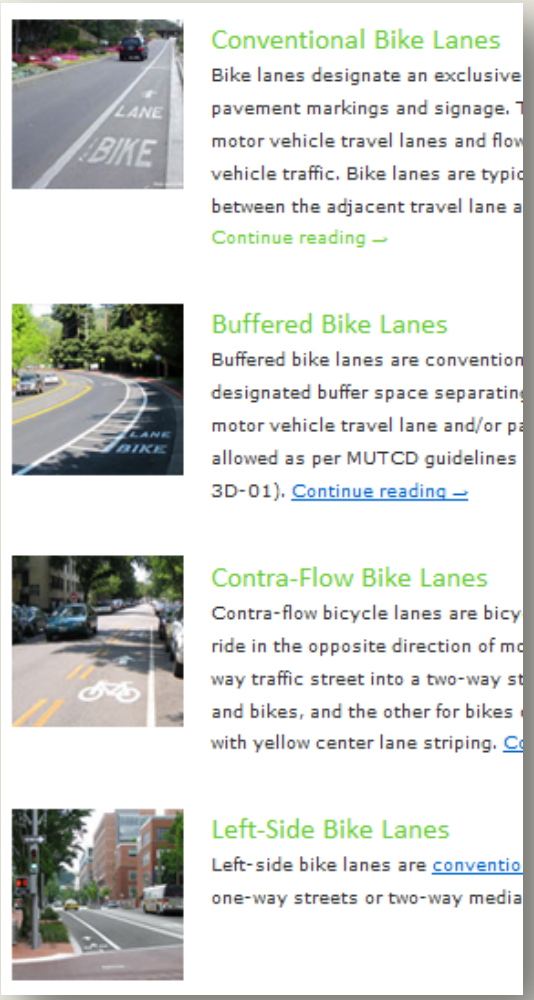
- Lower cost option NYC Low Cost sidewalk widening with delineator posts

BIKE FEATURES



http://nacto.org/cities-for-cycling/design-guide/

Warning: Check traffic control against the MUTCD



Conventional Bike Lanes

Bike lanes designate an exclusive
pavement markings and signage. T
motor vehicle travel lanes and flow
vehicle traffic. Bike lanes are typic
between the adjacent travel lane a
Continue reading →

Buffered Bike Lanes

Buffered bike lanes are convention
designated buffer space separating
motor vehicle travel lane and/or pa
allowed as per MUTCD guidelines
3D-01). Continue reading →

Contra-Flow Bike Lanes

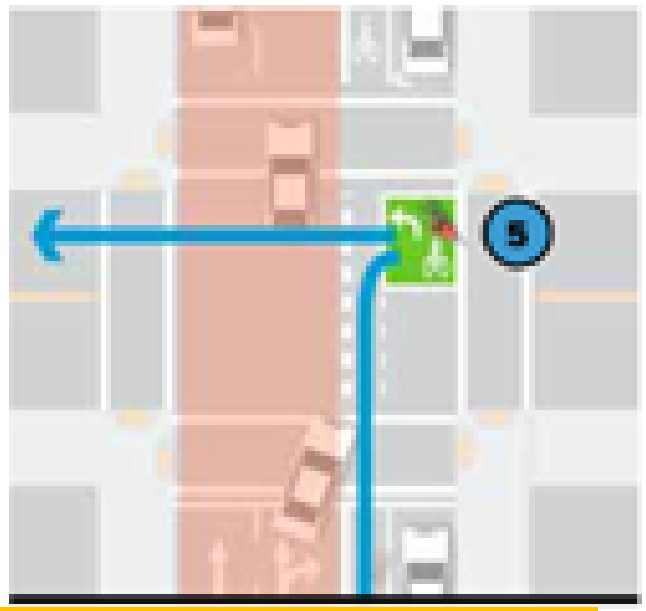
Contra-flow bicycle lanes are bicy
ride in the opposite direction of mo
way traffic street into a two-way st
and bikes, and the other for bikes
with yellow center lane striping. Co

Left-Side Bike Lanes

Left-side bike lanes are conventio
one-way streets or two-way media

INTERSECTION CROSSING MARKINGS

TWO-STAGE TURN QUEUE BOXES



Parking Lane Configuration

Experimental

BACK IN ANGLED PARKING

BACK-IN ANGLE PARKING

Pros

- Better visibility getting back into traffic
  - See cars and bicyclists
- More vehicle parking spaces than parallel
- Open car door(s) lead kids to sidewalk
- Loading items into trunk is safer

Cons

- Some people will need practice
- Furniture zone items might get hit
- Exhaust from running cars at sidewalk
  - Consider outdoor café's

BACK-IN ANGLED PARKING
PUBLIC EDUCATION AUSTIN TX

COST

- Road diets can be low cost if planned in conjunction with reconstruction or simple overlay projects, since a road diet mostly consists of restriping
  - May involve other costs such as signal head relocation

BEST PRACTICE

- Know well in advance of when road reconstruction and overlay projects will be initiated to evaluate for Road Diet.
- Obtain input from the community stakeholders, and ensure the appropriate elements are included in the project.
- Classic four-to-three-lane Road Diet is very compatible with single-lane roundabouts

CASE STUDY

CASE STUDY
NICKERSON STREET, SEATTLE, WA

Nickerson Street Before:

Nickerson Street After:

PROJECT GOALS

- Improve pedestrian safety
- Add marked crosswalks
- Reduce exposure to multiple threat collisions
- Increase driver compliance with the posted speed limit
- Reduce speed

SPEED

85th Percentile Speed between 3rd Avenue W and 6th Avenue W *Speed in miles per hour*			
	Before	After	Change
Westbound	40.6	33.1	-18%
Eastbound	44.0	33.3	-24%

Speeders *Percent driving over the speed limit*			
	Before	After	Change
Westbound	88%	32%	-64%
Eastbound	91%	34%	-63%

Top End Speeders *Percent 10+ mph over the speed limit*			
	Before	After	Change
Westbound	17%	1.4%	-92%
Eastbound	38%	1.5%	-96%

COLLISIONS

- Two new marked crosswalks at Dravus St & 11th Ave W
- Preliminary collision statistics show a substantial reduction in collisions after the project was completed

Change in Number of Collisions on Nickerson from 13th Ave W to N Florentia St after Rechannelization		
5-Year Average	One Year Post-Project	Percent Change
10-18-2004 to 10-18-2009	10-18-2010 to 10-18-2011	
33.6	**26**	-23%

ADT

- 2009 (Before)
  - Approximately 18,500 vehicles per weekday between 3rd Ave W and 6th Ave W.
- August 2011 (After)
  - Approximately 18,300 vehicles recorded in at the same location

Nickerson Traffic Volume			
	Before	After	Change
AM Peak	816	733	-10%
PM Peak	915	927	+1%
Average Weekday	18,563	18,364	-1%

FREIGHT USE

- Freight vehicles of all types on Nickerson St rose slightly after the Road Diet
  - Trucks still account for about 5% of vehicles
- Large trucks account for about 2% of total traffic
  - Some large trucks continue to use Nickerson St both as a through route and to access the Queen Anne neighborhood via 3rd Ave W

QUESTIONS / RESOURCES

- *Road Diet Handbook: Setting Trends for Livable Streets*
  - *(Rosales)*
- Guidelines for Road Diet Conversions
  - Kentucky Transportation Center
  - http://www.ktc.uky.edu/projects/guidelines-for-road-diet-conversions/
- Road Diet Information Guide
  - FHWA (Anticipated to be released October 2014)
- PEDSAFE Case Studies
  - http://www.pedbikesafe.org/PEDSAFE/casestudies.cfm?op=C&subop=b&CM_NUM=19
- AASHTO Guide for the Development of Bicycle Facilities (2012 Edition)
  - https://bookstore.transportation.org/collection_detail.aspx?ID=116
- NACTO Urban Bikeway Design Guide

Thank You!

- **Archive at www.pedbikeinfo.org/webinars**
  - Downloadable/streaming recording and presentation slides
- **Questions?**
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