



Performance-based Geometric Design, Context Classification, & TDOT Project Scoping Guide

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Agenda

1

Performance-Based Geometric Design

- NCHRP Report 785

2

Context Classification

- NCHRP Research Report 1022
- NCHRP 20-44(51)

3

TDOT Project Scoping Guide

- State-oriented design guidance & criteria

4

Questions?

Performance-Based Geometric Design

NCHRP Report 785, Performance-Based Analysis of Geometric Design of Highways and Streets

NCHRP
REPORT 785

NATIONAL
COOPERATIVE
HIGHWAY
RESEARCH
PROGRAM

**Performance-Based Analysis
of Geometric Design
of Highways and Streets**

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

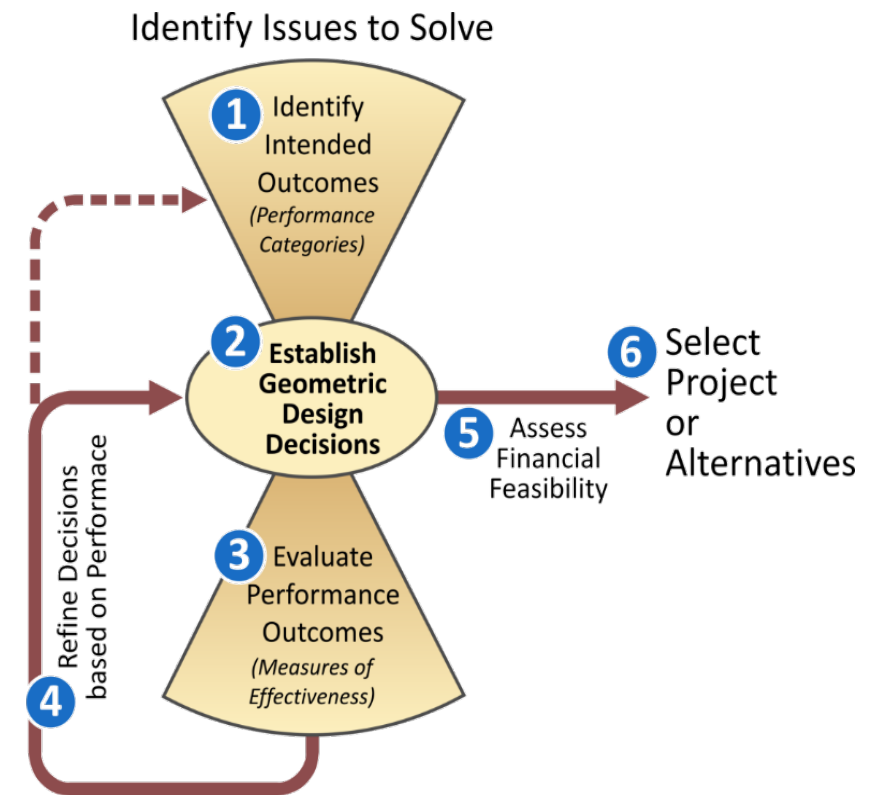
What is Performance-Based Design?

- Everyone is talking about it
 - AASHTO, FHWA, ITE, NACTO, NCHRP, State DOT
- What does it really mean?
- How do you implement it?



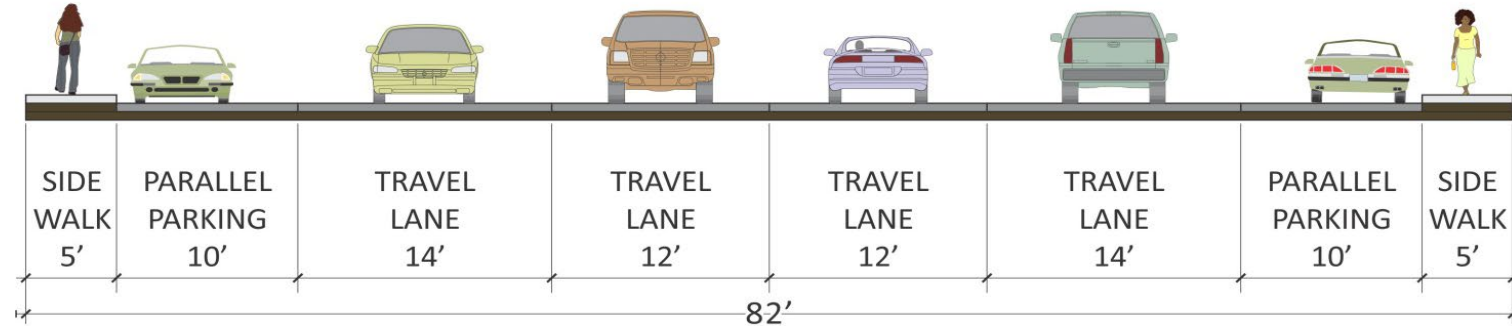
Performance-Based Design

1. Identify desired project outcomes
2. Establish design decisions
3. Evaluate the performance
4. Iterate and refine the design
5. Assess the financial feasibility
6. Select a preferred alternative that aligns with the desired outcomes

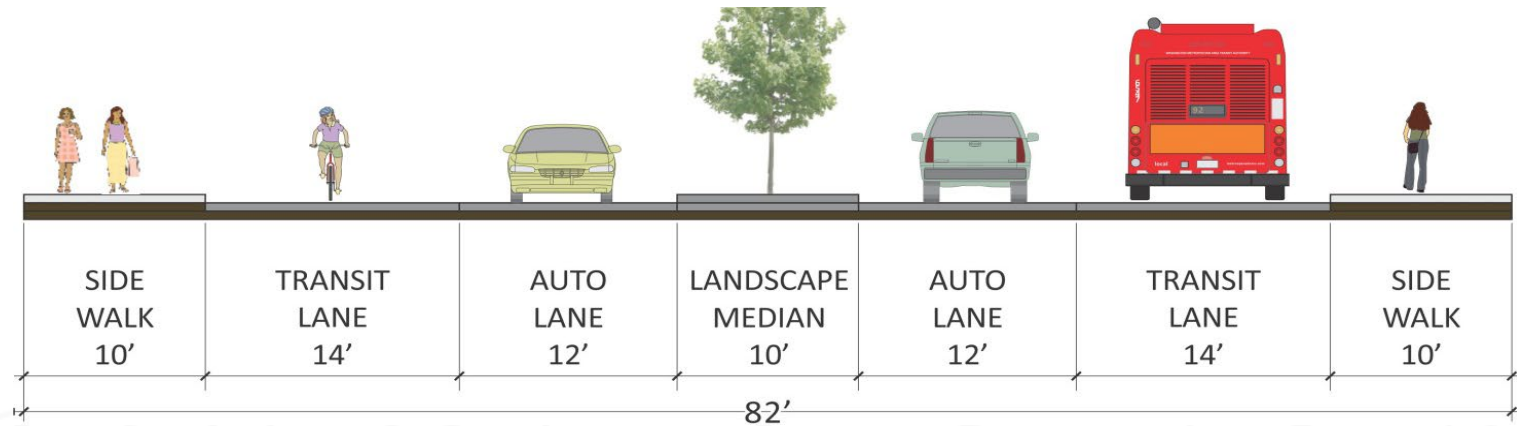


Performance-Based Design gives you choices

Existing Conditions

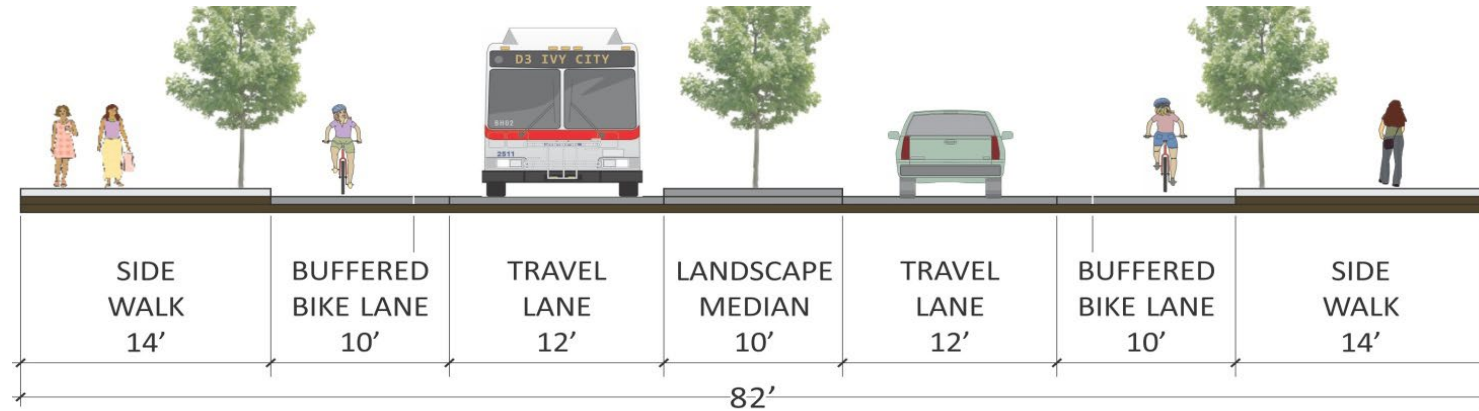


Alternative 1:
Transit Oriented

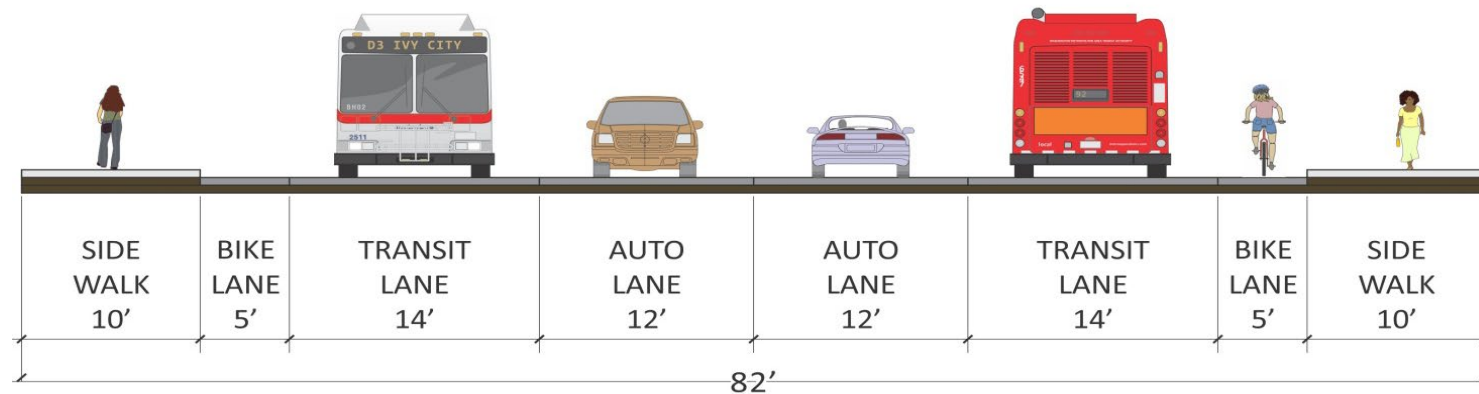


Performance-Based Design gives you choices

Alternative 2:
Bicycle and
Pedestrian
Oriented



Alternative 3:
Hybrid of Transit,
Pedestrian &
Bicycle





“...Performance-based analysis is a principles-focused approach that looks at the outcomes of design decisions as the primary measure of design effectiveness...”



What are your goals?

- **Design standards** make meeting standards the goal.
- With **performance-based design**, your desired outcomes are the goal.



Context Classification

NCHRP Research Report 1022, Context Classification Application: A Guide

NCHRP 20-44(51), Developing Training Materials to Implement Context Classifications

NCHRP
Research Report 1022

National
Cooperative
Highway
Research Program

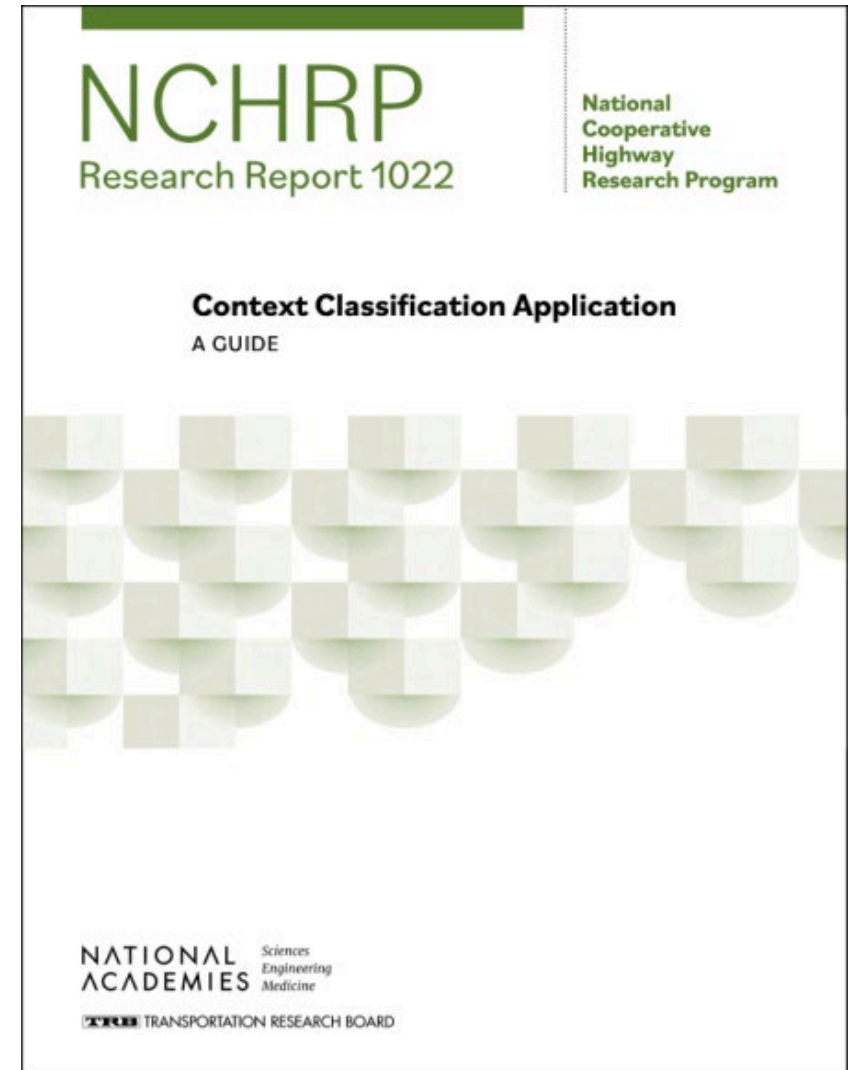
Context Classification Application
A GUIDE

NATIONAL ACADEMIES Sciences
Engineering
Medicine

TRANSPORTATION RESEARCH BOARD

Background

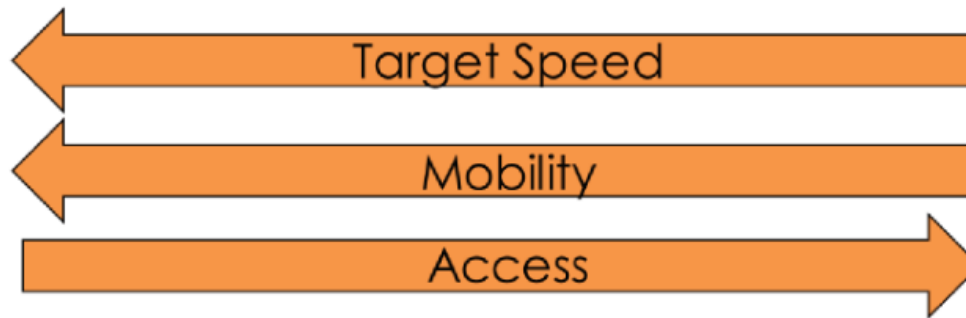
- NCHRP Research Report 855: An Expanded Functional Classification System for Highway and Streets
- NCHRP Research Report 1022: Context Classification Application: A Guide provides information to help state, regional, and local practitioners identify the appropriate context
- NCHRP 20-44 (51) created training materials to help agencies outline a path forward to implementation



NCHRP 855

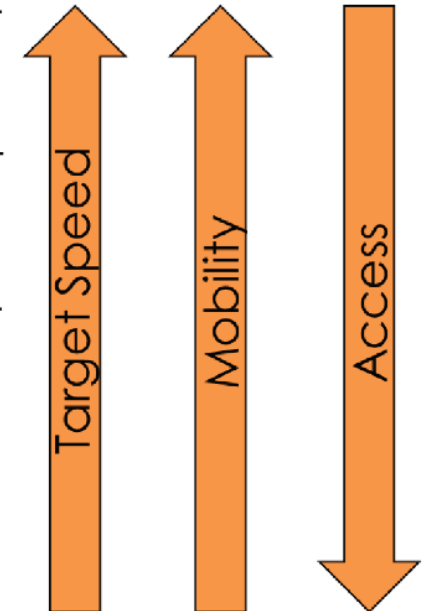
Relationship to functional classification

Context \ Roadway	Rural	Rural Town	Suburban	Urban	Urban Core
Principal Arterial	H speed H mobility- L access	L/M speed M mobility- H access	M/H speed M mobility- M access	L/M speed M mobility- M access	L speed M mobility- M access



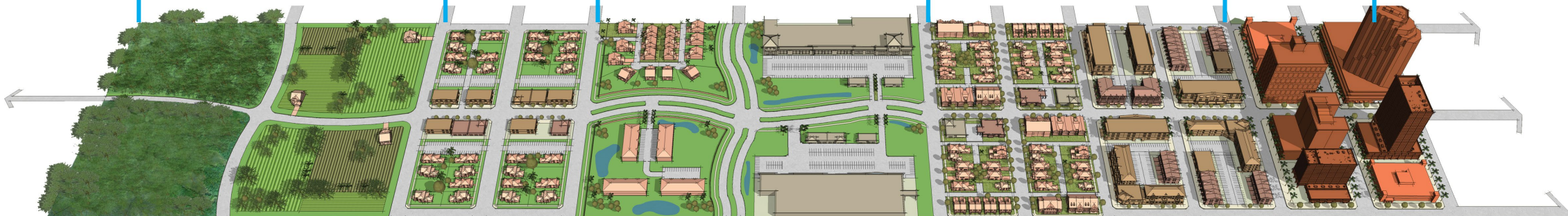
H = high, M = medium, L = low

Context \ Roadway	Rural
Principal Arterial	H speed H mobility- L access
Minor Arterial	H speed H mobility- M access
Collector	M speed M mobility- M access
Local	M speed M mobility- M access



H = high, M = medium, L = low

Green Book 1-6	Rural			Urban						
SmartCode (2003)/ITE/CNU (2010)	Natural	Rural		Suburban			General Urban	Urban Center	Urban Core	Special District
Massachusetts (2006)	Rural Natural	Rural Developed	Rural Village	Low Density	Town Center	High Density	Urban Residential	Urban Park	Commercial Business District	
Pennsylvania/New Jersey (2008)	Rural			Suburban Neighborhood	Suburban Corridor	Suburban Center	Town/Village Neighborhood	Town/Village Center	Urban Core	
California (2016)	Natural	Developing	Rural Main Street	Suburban Low Density	Suburban High Density		Urban Low Density		Urban High Density	
Florida (2017)	Natural	Rural	Rural Town	Suburban Residential	Suburban Commercial	Urban General	Urban Center	Urban Core	Special District	
Minnesota (2018)	Natural	Rural	Rural Crossroad	Suburban Residential	Suburban Commercial	Urban Residential	Urban Commercial	Urban Core	Industrial Warehouse	
Green Book 7/ NCHRP 855 (2018)	Rural		Rural Town	Suburban			Urban		Urban Core	
Oregon (2019)			Rural Community	Suburban Fringe	Suburban Residential Corridor	Suburban Commercial Corridor	Urban Mix		Downtown/ Commercial Business District	
Washington (2019)	Rural			Suburban			Urban		Urban Core	
AASHTO TCGD (2019)	Rural & Natural Areas		Rural Town	Suburban			Urban		Urban Core	Industrial, Warehouse, or Port
Maryland (2019)	Rural		Traditional Town Center	Suburban		Suburban Activity Center	Urban Center		Urban Core	
Pennsylvania (2020)	Rural		Rural Town	Suburban			Urban		Urban Core	
NCHRP 1022 (2021)	Rural		Rural Town	Suburban			Urban		Urban Core	Special Context
Nevada (2022)	Natural	Rural	Rural Town	Suburban Residential	Suburban Commercial	Urban General	Urban/ Small Town Center		Urban Core	Entertainment District
Maine (2024)	Rural		Rural Town	Village	Suburban			Urban		



Graphic adapted from NCHRP Research Report 1022

CONTEXT

CONTEXT Examples – URBAN



CONTEXT Examples – URBAN CORE



CONTEXT Examples – RURAL



CONTEXT Examples – RURAL Town



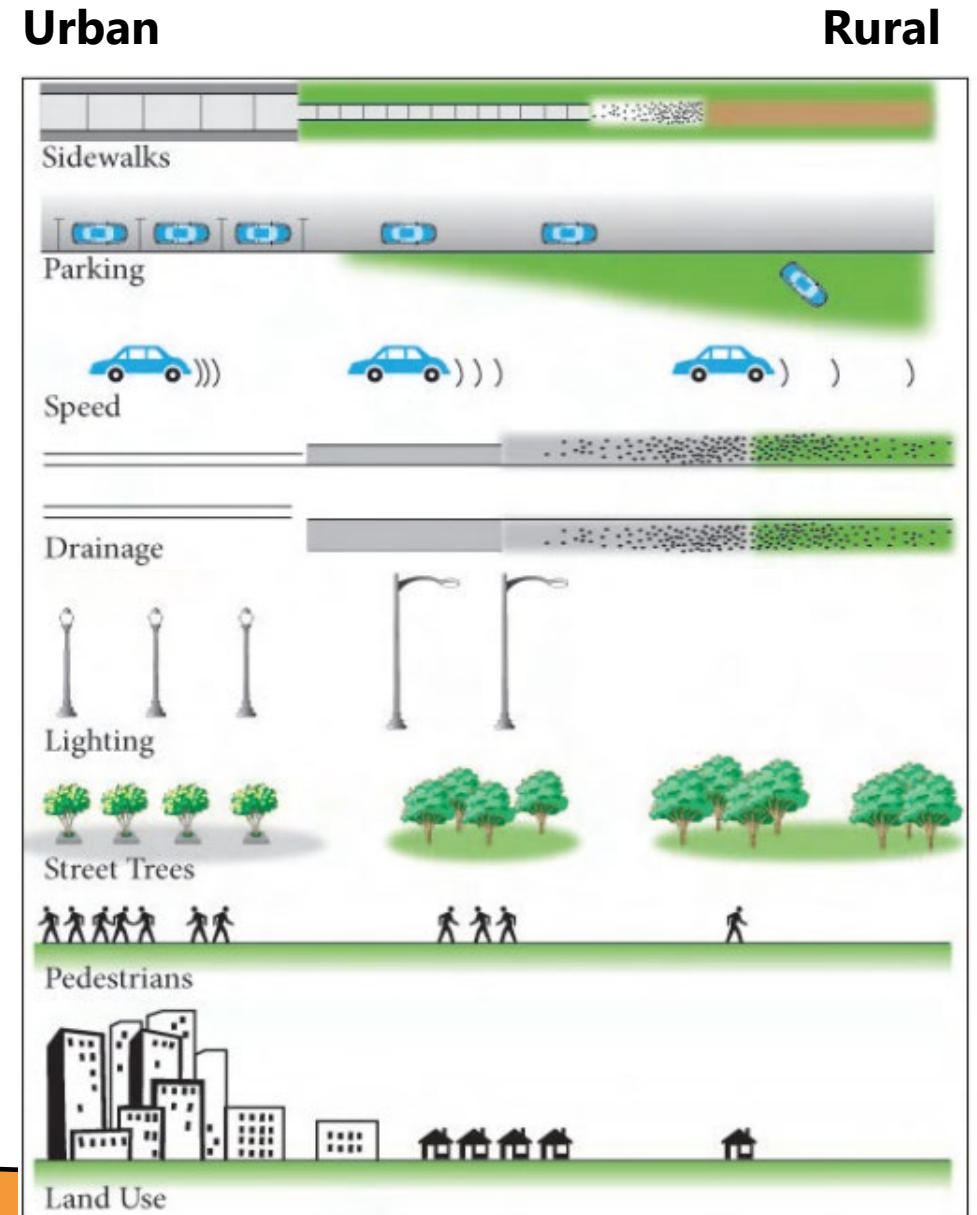
CONTEXT Examples – SUBURBAN



Benefits of context classification

- A mechanism for adapting design solutions to specific contexts
- Provides a language to describe how and why places are different
- Strong relationship between speed and overall multimodal safety

Graphic from PENNDOT
Smart Transportation
Guidebook



Tennessee Department of Transportation (TDOT)

Project Scoping Guide (PSG)

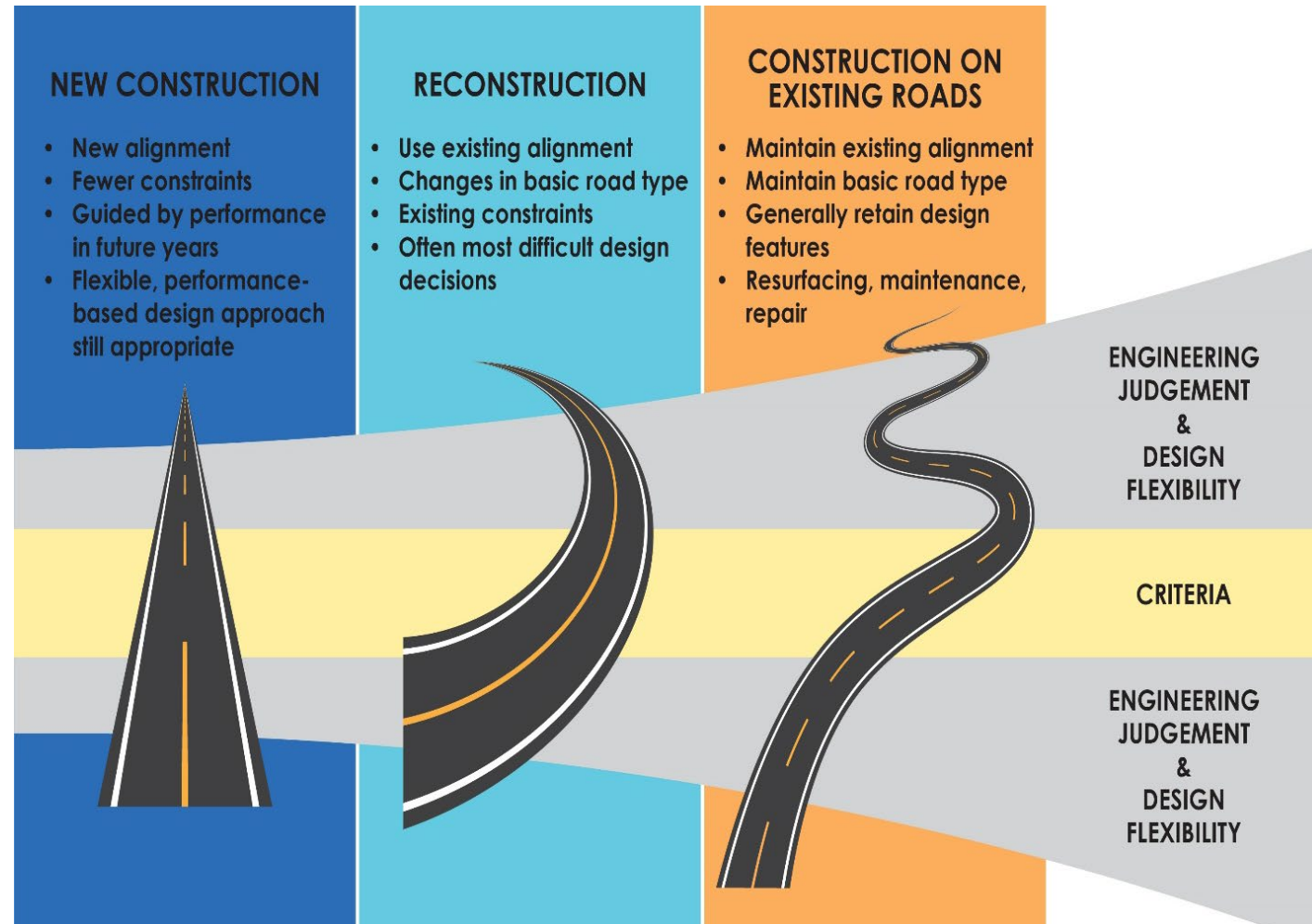


TDOT PROJECT SCOPING GUIDE

SEPTEMBER 2024

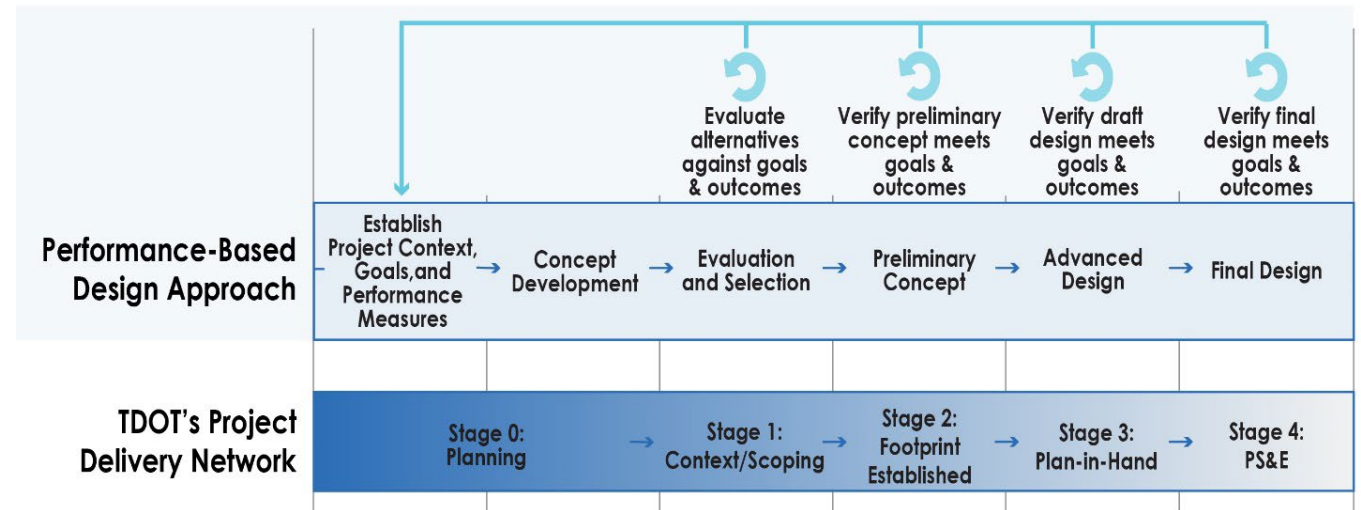
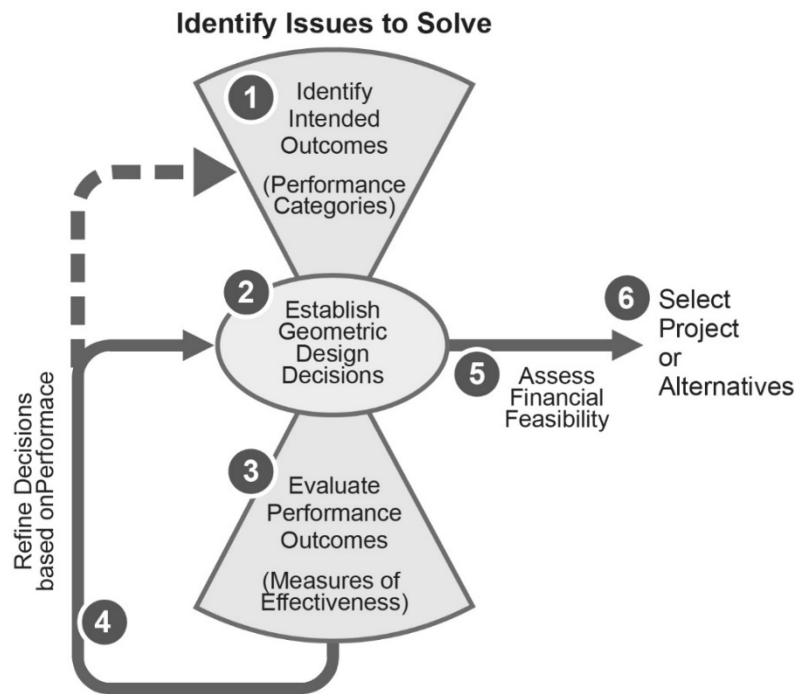
Chapter 1: Introduction and Overview

- Project Types
- Roadway Users
- Project Development Process
- Key Terminology
- Tort Liability
- Relevant Resources



Chapter 2: Decision-Making Framework and Documentation

- Performance-Based Design Approach
- TDOT Design Decision-Making Framework



Chapter 2: Decision-Making Framework and Documentation

Table 2-2: Examples of Performance Categories and Measures

Performance Category	Example Performance Measure
Safety	<ul style="list-style-type: none"> • Conflict point analysis • Pedestrian and bicycle intersection evaluation (TDOT <i>20-Flag Intersection Evaluation Guide</i>) • Vehicle speeds • Crossing distances • Crash history (severity and type of crash) • Calibrated safety performance functions (<i>Highway Safety Manual</i>) • Crash reduction factors
Mobility/Traffic Operations	<ul style="list-style-type: none"> • Average Daily Traffic (ADT) threshold values • Capacity Analysis for Planning of Junctions (CAP-X) • Volume-to-capacity (v/c) ratio • Travel delay • Corridor travel time • Travel time reliability (review of available existing data and estimated microsimulation data) • Level of service (LOS) • Queue lengths (50th or 95th percentile) • Design vehicle
Footprint	<ul style="list-style-type: none"> • Right-of-way • Property acquisition impacts • Utility conflicts • Access management issues
Structural Capacity	<ul style="list-style-type: none"> • Design life • Ability to widen the structure

Design Roadway User	<ul style="list-style-type: none"> • Pedestrian and bicycle quality of service • Connectivity • Type of pedestrian and bicycle facilities
Financial Investment	<ul style="list-style-type: none"> • Life cycle cost • Construction cost • Benefit-to-cost ratio
Environmental Considerations	<ul style="list-style-type: none"> • Vehicle miles traveled (VMT) • Congested vehicle miles traveled • Greenhouse gas emissions • Other emissions and particulate matter • Transit accessibility • Mode share • Impacts to wetlands or other environmentally-sensitive areas
Other Site-Specific Considerations	<ul style="list-style-type: none"> • Livability • Walkability • Economic revitalization • History (e.g., protection of a tree) • Heritage

Chapter 3: Identifying Design Year Context

Context Classification	Land Use	Density of Structures	Building Setback	Block Size	Access Control	Parking Location	Pedestrian Activity	Bicycle Activity	Transit	Utilities	Landscaping
Rural	<p><i>Potential Existing and Future Characteristics of Contexts for TDOT Roadways</i></p>										
Rural Town											
Suburban											
Urban											
Urban Core											



Chapter 4: Multimodal Planning and Design

- Pedestrian and Bicycle Safety and Experience
- Pedestrian Design
- Bicycle Design
- Shared-Use Path
- Crossings
- Transit Design



Safe Road Users

The Safe System approach addresses the safety of all road users, including those who walk, bike, drive, ride transit, and travel by other modes.



Safe Vehicles

Vehicles are designed and regulated to minimize the occurrence and severity of collisions using safety measures that



Safe Speeds

Humans are unlikely to survive high-speed crashes. Reducing speeds can accommodate human injury tolerances in three ways: reducing impact forces,



Safe Roads

Designing to accommodate human mistakes and injury tolerances can greatly reduce the severity of crashes that do occur. Examples include physically separating people traveling at different speeds, providing dedicated times for different users to move through a space, and alerting users to hazards and other road users.



Post-Crash Care

When a person is injured in a collision, they rely on emergency first responders to quickly locate them, stabilize their injury, and transport them to medical facilities. Post-crash care also includes forensic analysis at the crash site, traffic incident management, and other activities.

BICYCLIST DESIGN USER PROFILES

Interested but Concerned

51%-56% of the total population

Often not comfortable with bike lanes, may bike on sidewalks even if bike lanes are provided; prefer off-street or separated bicycle facilities or quiet or traffic-calmed residential roads. May not bike at all if bicycle facilities do not meet needs for perceived comfort.

Somewhat Confident

5-9% of the total population

Generally prefer more separated facilities, but are comfortable riding in bicycle lanes or on paved shoulders if need be.

Highly Confident

4-7% of the total population

Comfortable riding with traffic; will use roads without bike lanes.



LOW STRESS TOLERANCE

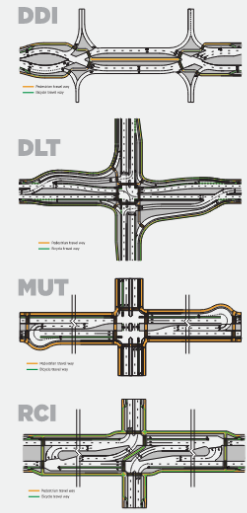
HIGH STRESS TOLERANCE

Sources: FHWA

Chapter 5: Intersection Planning and Design

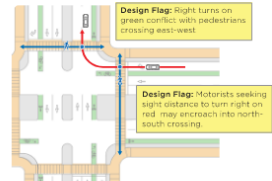
ALTERNATIVE INTERSECTION CONFIGURATIONS

- Diverging Diamond Interchange (DDI)
- Displaced Left Turn (DLT)
- Median U-Turn (MUT)
- Restricted Conflict Intersection (RCI)



PEDESTRIAN AND BICYCLE SAFETY DESIGN FLAGS 20

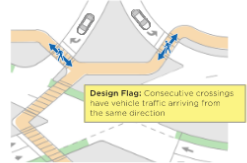
1. Motor Vehicle Right Turns



2. Uncomfortable/Tight Walking Environment



3. Nonintuitive Motor Vehicle Movements



20 PEDESTRIAN AND BICYCLE SAFETY DESIGN FLAGS

The design flag method is based on National Cooperative Highway Research Program (NCHRP) Project 07-25 on Pedestrian and Bicycle Safety at Alternative and Other Intersections and Interchanges.

4. Crossing Yield- or Uncontrolled Vehicle Paths

Design Flag: Yield-controlled or uncontrolled movements conflict with pedestrian movements.

5. Indirect Paths

Design Flag: Indirect paths create out-of-direction travel for pedestrians.

6. Executing Unusual Movements

Design Flag: In most local contexts, pedestrians do not expect to cross mainline traffic to continue along mainline road.

7. Multilane Crossings

Design Flag: Long multilane crossings increase exposure and may result in multiple threat situations.

8. Long Red Times

Design Flag: Large intersections with multi-phase signals and heavy vehicle movements can result in long red times and high delay for pedestrians and bicyclists.

9. Undefined Crossing At Intersections

Design Flag: There is no defined crossing for pedestrians or bicyclists to cross the main street resulting in undefined space, even if many states consider these unmarked locations "legal crossings".

10. Motor Vehicle Left Turns

Design Flag: Crossing Pedestrians and bicyclists are at risk from left-turning drivers seeking gaps in oncoming traffic.

11. Intersecting Driveways and Side Streets

Design Flag: Driveway traffic looking left in preparation for a right turn may not expect bicycle and pedestrian traffic from their right.

12. Sight Distance for Gap Acceptance Movements

Design Flag: Unsignalized crossings should be designed with adequate sight distance for a safe crossing and for drivers to yield.

13. Grade Change

Design Flag: Interchange over pass may have significant grade, affecting walking and biking experience.

14. Riding in Mixed Traffic

Design Flag: Riding in mixed traffic at high speeds or volumes can be stressful and creates safety concerns for bicyclists.

15. Bicycle Clearance Times

Design Flag: Without adequate clearance, right-turning vehicles may start moving just as bicycles arrive at conflict point.

16. Bicyclist Crossing Motor Vehicle Travel Lane(s)

Design Flag: Bicyclists trying to turn left from the main line (blue) or side street (green) need to cross over motor vehicle travel lanes with considerable speed differential.
(Note that off-street facilities are also provided in this design, mitigating the design flag.)

17. Channelized Lanes

Design Flag: Bicyclists turning right, share channelized lane with motor vehicles traveling at higher speeds.

18. Turning Motorists Crossing Bicycle Path

Design Flag: A right-turning vehicle crossing the bicycle path can create a "right hook" conflict. This can happen at shared through/right lanes, or channelized lanes without deceleration lane.

19. Riding between Travel Lanes, Lane Additions, or Lane Merges

Design Flag: Bicyclists ride between motor vehicle lanes with faster-moving vehicle traffic on both sides.

20. Off-Tracking Trucks in Multi-Lane Curves

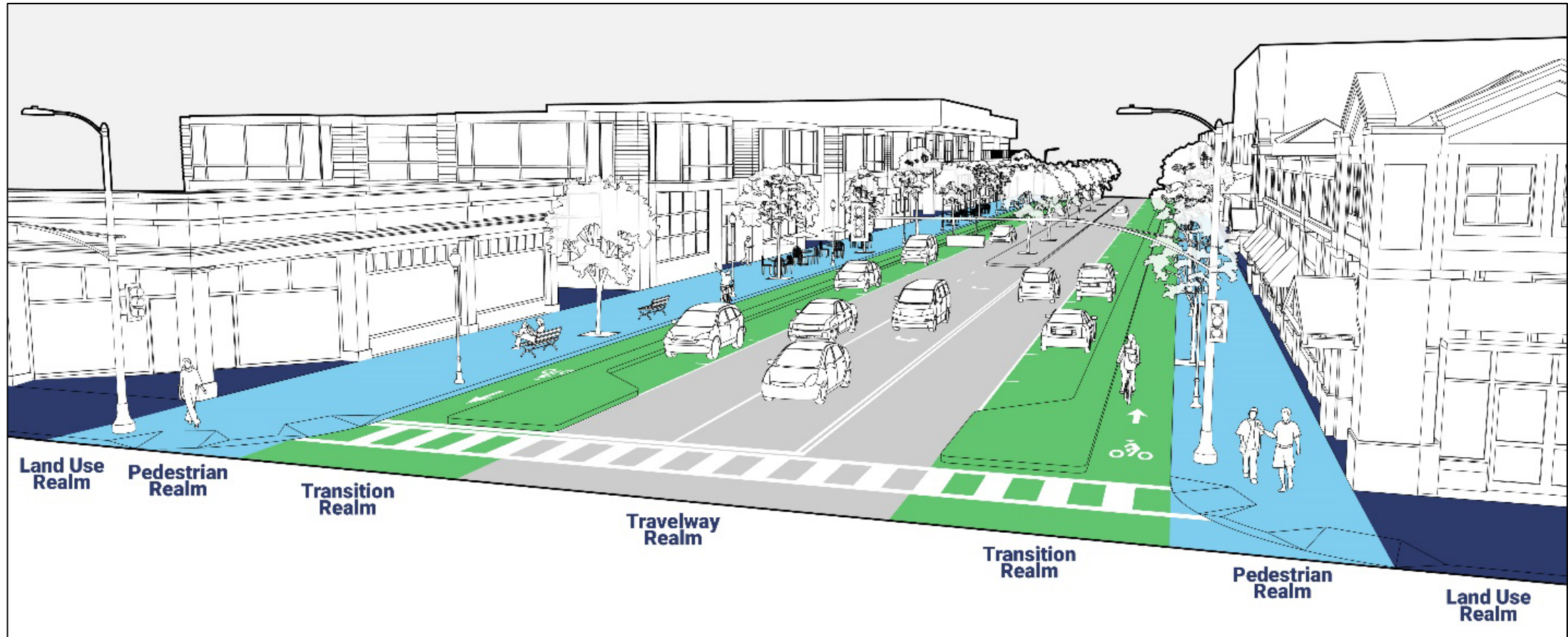
Design Flag: Trucks making U-turns may overtrack into bike lane.

#	Flag Description	Pedestrian	Bicycle
1	Motor Vehicle Right Turns		
2	Uncomfortable/Tight Walking Environment		
3	Unsignalized Motor Vehicle Movements		
4	Crossing Yield- or Uncontrolled Vehicle Paths		
5	Indirect Paths		
6	Executing Unusual Movements		
7	Multilane Crossings		
8	Long Red Times		
9	Undefined Crossing At Intersections		
10	Motor Vehicle Left Turns		
11	Intersecting Driveways and Side Streets		
12	Sight Distance for Gap Acceptance Movements		
13	Grade Change		
14	Riding in Mixed Traffic		
15	Bicycle Clearance Times		
16	Bicyclist Crossing Motor Vehicle Travel Lane(s)		
17	Channelized Lanes		
18	Turning Motorists Crossing Bicycle Path		
19	Riding between Travel Lanes, Lane Additions, or Lane Merges		
20	Off-Tracking Trucks in Multi-Lane Curves		

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20-Flag Training Material from NCHRP Research Report 948

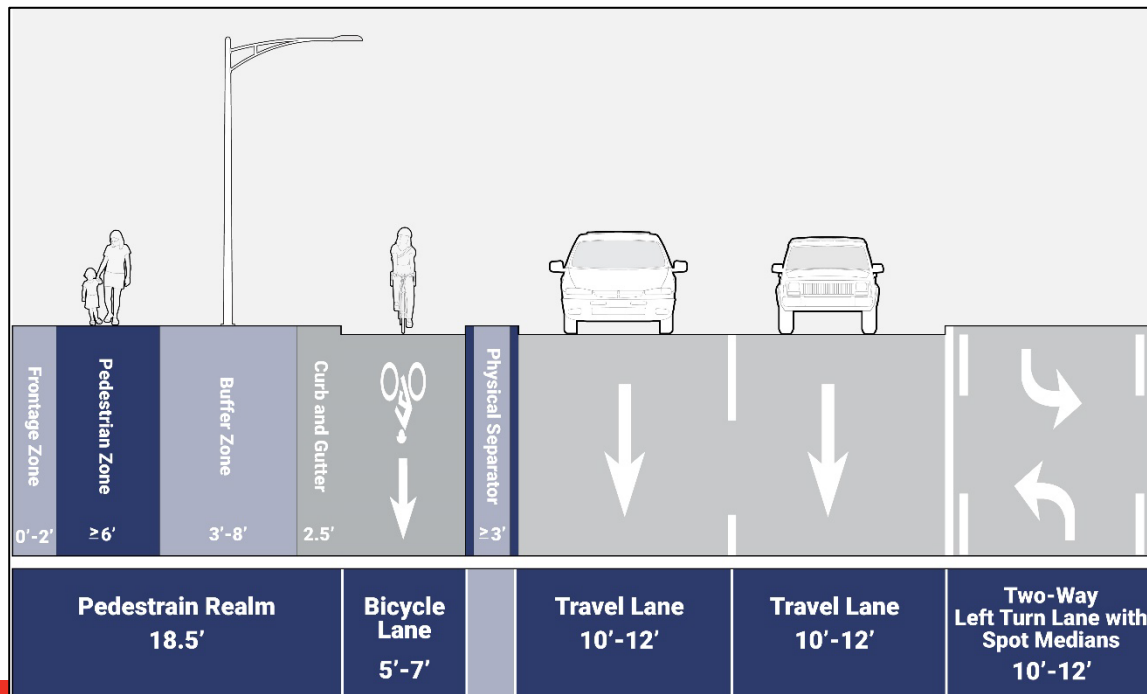
Chapter 6: Context Design Guidance and Criteria



Cross Section Realms

Chapter 6: Context Design Guidance and Criteria

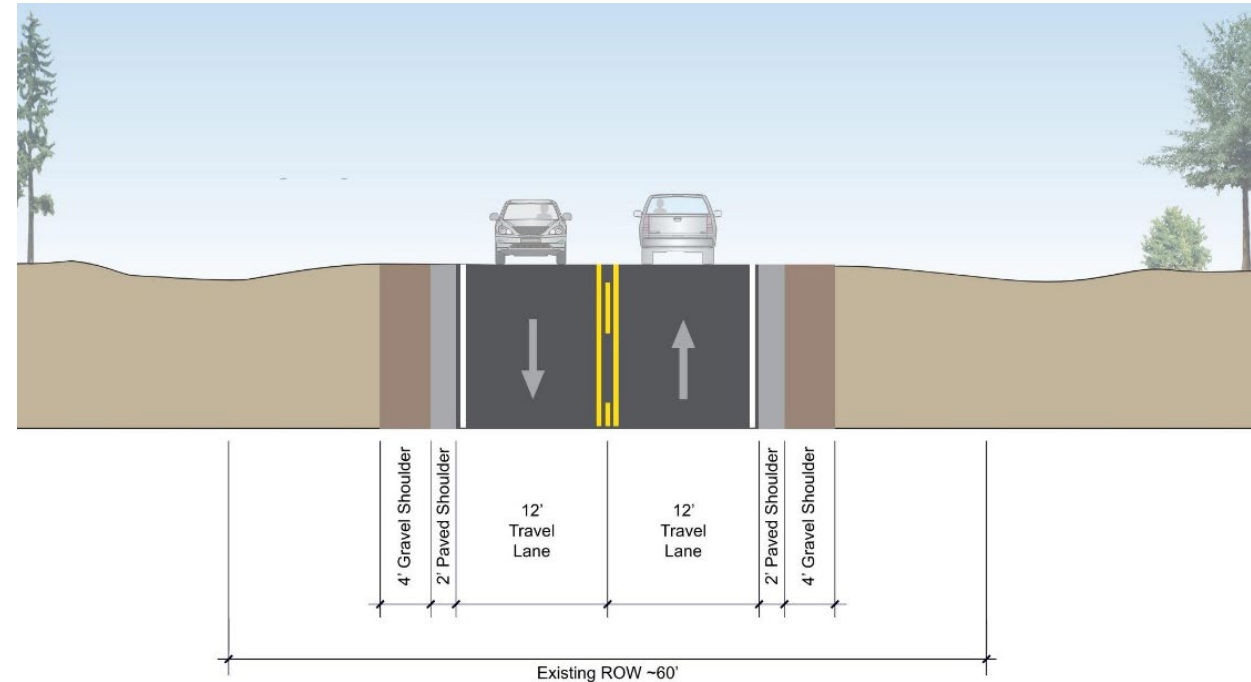
- Suburban Context Example



Design Element	Local	Collector	Arterial
Travelway Realm			
Number of Lanes	2	Primarily 2-4	Primarily 2-4 ¹
Travel Lane Width²	9'-11', 11' if transit	10'-12', 11'-12' if transit	10'-12', 11'-12' if transit
Right-Turn Lane Width	9'-11'	10'-12'	10'-12'
Left-Turn Lane Width	9'-10'	10'-11'	11'-12'
Two-Way Left-Turn Lane Width	10'-11'	10'-12'	11'-14'
Left Side Shoulder on Divided Roadways (paved)	N/A	N/A	0-2'
Right Side Shoulder (paved)	2'-4'	4'-6'	Curbed: 4-6' Flush: 10-12'
Shy Distance	0'-1'	0'-1'	0'-2'
Median³	Flush: 0'-2'	Raised: 6'-22'	Raised: 6'-22'
Transition Realm			
Bicycle Facility Type and Width (not including buffer)^{4, 5}	On-street bicycle lane: 4'-5' Shared lane markings if target speed is 25 mph or less and two-lane roadway	Separated bicycle lane: 5'-7' if one-way or 8'-12' if two-way On-street bicycle lane: 4'-5'	Separated bicycle lane: 5'-7' if one-way or 8'-12' if two-way
Buffer⁶ and Separation	Striping: 0'-3'	Striping: 2'-3' Physical: ≥3' and may include raised island, flexible delineator posts, concrete barrier, guardrail, and vegetation	Striping: 2'-3' Physical: ≥3' and may include raised island, flexible delineator posts, concrete barrier, guardrail, and vegetation
Parallel On-Street Parking⁷	Limited and typically informal	7'-8', where provided	7'-8', where provided

Chapter 7: Case Studies

- **Case Study #1:** High-speed rural arterial transitioning to a Suburban context.
- **Case Study #2:** Urban Road Diet to manage speeds and improve pedestrian and bicycle facilities.



Chapter 7: Case Studies

Performance Measure	SAFETY Improvement Rating		
	Low	Medium	High
Expected reduction in operating speeds	Project includes 0-1 treatments with documented effectiveness at speed reduction.	Project includes 2 treatments with documented effectiveness at speed reduction.	Project includes 3 or more treatments with documented effectiveness at speed reduction.
Anticipated change in crashes	Project is not anticipated to reduce crashes.	Project has a moderate value crash reduction factor.	Project has a high value crash reduction factor.
Pedestrian assessment	Project provides a facility of minimum width.	Project provides a wider facility with horizontal separation.	Project provides a wider facility with horizontal and vertical separation.
Bicyclist assessment	Project provides a facility of minimum width.	Project provides a wider facility with horizontal separation.	Project provides a wider facility with horizontal and vertical separation.

Performance Measure	ENVIRONMENTAL AND ROW IMPACTS Improvement Rating		
	Low	Medium	High
Property impacts due to right-of-way acquisition	Right-of-way acquisition impacts the function and/or structures on adjacent properties	Right-of-way acquisition required but no impacts to function and/or structures	No right-of-way acquisition
Level of impact to environmental features	Significant environmental impacts that require extensive mitigation	Minimal environmental impacts that can be mitigated	No environmental impacts

Chapter 7: Case Studies

Performance Measure		Alternative Improvement Ratings		
		1	2	3
Safety	Expected reduction in operating speeds	L	H	H
	Anticipated change in crashes	M	H	H
	Pedestrian assessment	L	H	H
	Bicycle assessment	L	H	M
Livability	Community feedback on how the design alternatives maintain the character of the roadway	L	M	H
Modal Integration	Consistency with modal considerations for Suburban context	L	M	H
Operations	Design year volume-to-capacity ratio	H	H	L
	Expected change in travel time reliability	H	H	L
Environmental and ROW Impacts	Property impacts due to right-of-way acquisition	M	H	M
	Level of impact to environmental features	L	M	H
Feasibility	Expected project cost	M	L	H
	Anticipated construction feasibility	M	M	L



Questions?

Thank You!

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