Developing an Expanded Functional Classification System for More Flexibility in Geometric Design

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Contractor’s Final Report for NCHRP Project 15-52
Submitted January 2018
ACKNOWLEDGMENT

This work was sponsored by the American Association of State Highway and Transportation Officials (AASHTO), in cooperation with the Federal Highway Administration, and was conducted in the National Cooperative Highway Research Program (NCHRP), which is administered by the Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine.

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ACKNOWLEDGMENTS
The research reported herein was performed under NCHRP 15-52 by the Kentucky Transportation Center at the University of Kentucky and Nelson/Nygaard. The University of Kentucky is the contractor for this study, and Dr. Nikiforos Stamatiadis, Professor of Civil Engineering, is the principal investigator. The other contributing authors of this report are Adam Kirk, Don Hartman, Jeff Jasper, Samantha Wright, Michael King, and Rick Chellman.

The members of the Working Advisory Group have also provided continued input and assisted the team in refining the proposed classification scheme. The team expresses its gratitude to Mr. Scott Bradley, MNDOT; Mr. Pasco Bakotich, WSDOT; Mr. Robert Koehler, OKI MPO; and Mr. John Moore, KYTC; for their reviews and guidance. The authors would also like to acknowledge all members who participated in the survey. We would also like to thank the members of the Subcommittee on Geometric Design and its Chair, Mr. Jeff Jones, for their input in this process.

Finally, the contribution and guidance of the NCHRP Panel should be mentioned. Without their hard work and diligence in providing comments, this work would not have been successfully completed.
# TABLE OF CONTENTS

SUMMARY .................................................................................................................................... x

CHAPTER 1 INTRODUCTION AND RESEARCH APPROACH...................................................... 1
  Problem Statement ................................................................................................................ 1
  Research Objectives and Approach ....................................................................................... 2
  Organization of the Report ..................................................................................................... 3

CHAPTER 2 LITERATURE SYNTHESIS ..................................................................................... 5
  Functional Classification System ........................................................................................... 5
  Functional Classification for State Agencies ........................................................................ 11
  Functional Classification System Issues .............................................................................. 14
  Flexibility in Highway Design ................................................................................................ 22
  Summary .............................................................................................................................. 27

CHAPTER 3 EXISTING CLASSIFICATION USES ..................................................................... 29
  Participant Information ......................................................................................................... 29
  Classification System Impacts ............................................................................................. 29
  Alternative Functional Classification .................................................................................... 36

CHAPTER 4 ALTERNATIVE CLASSIFICATION SYSTEMS ...................................................... 37
  Existing Alternative Classification Systems .......................................................................... 37
  Additional Alternative Systems ........................................................................................... 109
  UKY/NN System-Independent Multimodal Classification Alternative ................................. 114
  Evaluation of Alternative Classification Systems ............................................................... 115
  Evaluation Summary .......................................................................................................... 120

CHAPTER 5 PROPOSED FUNCTIONAL CLASSIFICATION SYSTEM .................................. 125
  Alternative Classification System Development ................................................................. 125
  Expanded FCS Components ............................................................................................. 127
  Expanded FCS Modal Accommodations ............................................................................. 140
  Expanded FCS Matrix ........................................................................................................ 154
  Expanded FCS Application ................................................................................................ 155

CHAPTER 6 EXPANDED FCS IMPLEMENTATION ................................................................ 167
  Expanded FCS Implementation Impacts ............................................................................ 167
  Implementation Plan .......................................................................................................... 170
  FCS and Expanded FCS relationship ................................................................................ 172
  Pilot Implementation ........................................................................................................... 173
CHAPTER 7 CONCLUSIONS AND FUTURE RESEARCH ...................................................... 177

Conclusions ........................................................................................................................ 177
Future Research .................................................................................................................. 182

References ................................................................................................................................ 183

APPENDIX A
APPENDIX B

LIST OF TABLES
Table 1 U.S. Census Bureau urban area types defined by population range ......................... 8
Table 2 FHWA urban area types defined by population range ................................................. 9
Table 3 Summary of scores for FCS assessment .................................................................... 34
Table 4 AustRoads functional classification of rural roads ....................................................... 45
Table 5 AustRoads functional classification of urban roads ....................................................... 45
Table 6 Normal and EDD ........................................................................................................ 47
Table 7 Connection between land use context and street type................................................ 52
Table 8 Charlotte Guide and FCS relationship ...................................................................... 54
Table 9 Roadway design expectations and design elements by user group ......................... 55
Table 10 Land use contexts for creek overlay ....................................................................... 57
Table 11 Street types and design elements for roadway segments ....................................... 58
Table 12 Complete Streets Chicago context definition ......................................................... 63
Table 13 Complete Streets Chicago road function types ......................................................... 64
Table 14 Complete Streets Chicago and FCS relationship ..................................................... 65
Table 15 Complete Streets Chicago modal hierarchies ......................................................... 65
Table 16 Complete Streets Chicago assemblage table for Thoroughfare ............................ 67
Table 17 Complete Streets Chicago overlays ......................................................................... 69
Table 18 Context Zone description ....................................................................................... 72
Table 19 Thoroughfare type description ............................................................................. 74
Table 20 Thoroughfare and FCS relationships .................................................................... 75
Table 21 Design elements by thoroughfare type ................................................................. 76
Table 22 MassHighway area types and community contexts ................................................. 79
Table 23 MassHighway and FCS relationship .................................................................... 82
Table 24 Additional modal considerations and likely volumes / activity .............................. 83
Table 25 Context definition criteria and values .................................................................... 86
Table 26 Roadway categories .............................................................................................. 87
LIST OF FIGURES

Figure 1 Mobility and access proportion of service by functional class (FHWA, 1982) .......... 6
Figure 2 Example of Tennessee DOT guidance .................................................................. 13
Figure 3 Access and mobility proportioning (FHWA, 2013) .............................................. 18
Figure 4 US 460 at Salyersville, KY ............................................................................... 20
Figure 5 Hub and spoke road network ............................................................................. 20
Figure 6 Grid road network .............................................................................................. 21
Figure 7 State DOTs responding to survey ..................................................................... 30
Figure 8 Effects of classification on Programming ......................................................... 31
Figure 9 Effects of classification on Planning .................................................................. 32
Figure 10 Effects of classification on Design ................................................................. 32
Figure 11 Effects of classification on Construction ......................................................... 33
Figure 12 Effects of classification on Maintenance and Operations .............................. 33
Figure 13 Link and place axes of arterial streets ............................................................ 40
Figure 14 ARTISTS street classification table .................................................................. 40
Figure 15 Overview of ARTISTS approach fit into a complete decision and design process ... 42
Figure 16 Context categories for AustRoads road classification ..................................... 44
Figure 17 Design Domain concept, AustRoads Road Design Guide (2006) ....................... 48
Figure 18 Design Domain example for shoulder width, AustRoads Road Design Guide (2006) 48
Figure 19 Six-step process .............................................................................................. 50
Figure 20 Activity centers, corridors, and wedges growth framework ........................... 51
Figure 21 Modal orientation of street types ..................................................................... 57
Figure 22 Main street typical cross section ................................................................. 60
Figure 23 Avenue typical cross section .......................................................................... 61
Figure 24 Boulevard typical cross section ....................................................................... 61
Figure 25 Complete Streets Chicago design tree for pedestrian mode priority and Downtown .. 66
Figure 26 Development continuity ................................................................................. 71
Figure 27 Thoroughfare design stages ......................................................................... 77
Figure 28 Area types and built form illustrations ......................................................... 80
Figure 29 Matrix of context and road types ..................................................................... 88
Figure 30 Example of alternative cross section choices ................................................ 90
Figure 31 Example of relative modal importance .......................................................... 91
Figure 32 NACTO Downtown and Neighborhood street types ..................................... 94
Figure 33 NACTO Residential street types ..................................................................... 95
SUMMARY
The modern Functional Classification System (FCS) was developed in the 1970s as a basis for communication between designers and planners. It sought to establish a common framework for classifying roadways based on mobility and access. Since its inception, the application of the FCS has expanded, and is now used throughout the entire project development process and influences all transportation project development phases, from programming and planning through design and into maintenance and operation decisions. However, the focus of the FCS is narrow; as it balances only mobility and access. The limited contextual definitions (urban and rural), do not provide the dynamic range of design elements and guidance needed to balance other competing project needs.

The objective of this research is to develop a flexible framework that replaces the FCS and facilitates optimal geometric design solutions that take into account context, functions, and user needs. To develop this alternative classification system, a two-phased approach was employed. The first phase involved a literature review, a survey of transportation agencies/practitioners, identification of existing alternative systems, and an evaluation of those existing alternative systems and their components. Work during this phase identified promising elements to be considered for inclusion in the proposed system. In the second phase, the proposed alternative is fully developed, its implications for design are documented, and the effects on other areas are highlighted. The research team produced a new alternative classification system to aid designers in developing contextual designs that balance a range of user’s needs.

The literature review indicated that the FCS has assumed additional significance beyond its intended purpose: as a framework to identify the particular role of a roadway that moves vehicles through a network of highways. While the FCS is essential in defining the roadway network and identifying design expectations of users, several issues can arise in its broader application. Even though the urban/rural classification is essential when assigning jurisdictional roles, operational needs, and funding allocation, it does not provide for the range of perspectives essential for successful contextual design. There have been efforts to understand the implications of functional classification on highway agency roadway projects, but the studies that dealt with the issue did not offer a systematic and/or a complete approach towards a unified treatment of the roadway classification. The recent development of Context Sensitive Solutions and Practical Design (i.e., the development of targeted solutions to address contextual design within fiscal constraints) necessitated the review of current practices and applications of the FCS due to its potential limiting effects on the development of appropriately contextual designs.
The research team’s survey of transportation agencies focused on: 1) establishing how the FCS is put into practice among agencies, and 2) identifying the implications and potential issues as they manifest in design. An additional goal was to identify any efforts that agencies have undertaken which have resulted in an alternative classification system. The 267 respondents confirmed the pervasiveness of the FCS in all phases of project development and noted the wide-ranging impacts. The participants also identified familiar issues with the FCS, including its lack of distinction for suburban roadways, the absence of further differentiation within urban areas, the want of recognition of “Main Streets” requiring considerations beyond mobility and access, the use of typical templates that do not reflect the true context, the emphasis on vehicular needs and lack of consideration of other competing modes, the lack of distinction between local and regional travel, and the disconnect between land use (existing and planned) and classification.

Several agencies have developed alternative classification systems that address some of the issues noted above. Seventeen systems were identified and reviewed to determine elements that could be useful in establishing a range of options and in defining a new classification system. Seven of the systems are summarized, while a more thorough review and documentation of 10 systems was completed based on input from the Working Advisory Group. All systems have an expanded context definition, ranging from four to 11, and most have defined road functions that expand on the traditional three-tier approach of the arterial-collector-local system. The majority of these systems developed a matrix that correlates context and road types that in turn is tied to design elements (i.e., tables with values or design considerations, elements to be considered, and their range of values). For some systems, there is a third dimension in the classification where modal priorities or other factors such as jurisdiction and environmental aspects are considered. This is achieved by either the explicit inclusion for specific roadway types or through consideration within the design elements as modal priorities.

A set of objectives for a new classification system was developed with the assistance of the Working Advisory Group. They were used to develop the proposed system and ensure the accomplishment of the project’s research goal. These objectives are:

Primary:
- Improved Context Definition
- Ability for Multi-modal Prioritization (or balancing)

Secondary:
- Ease of Use
- Ability to Directly Relate to the FCS (traditional)
- Ability to Differentiate within Rural and Urban Applications
- Ability to Consider Project and System Level Needs

The proposed Expanded Functional Classification System (Expanded FCS) balances the simplicity of the traditional urban-rural classification with the need for expanded context categories. In this document, the term roadway is considered to include all facilities intended for travel in the right-of-way (e.g., travel lanes, shoulders, bicycle lanes, sidewalks).

**Roadway Context**

Three primary factors are used to determine context for the Expanded FCS:

- Density (existence of structures and structure types)
- Land uses (primarily residential, commercial, industrial, and/or agricultural)
- Building setbacks (distance of structures to adjacent roadways)

The Expanded FCS categories and their primary factors are as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>Density</th>
<th>Land Use</th>
<th>Setback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>Lowest (few houses or other structures)</td>
<td>Agricultural, natural resource preservation and outdoor recreation uses with some isolated residential and commercial</td>
<td>Usually large setbacks</td>
</tr>
<tr>
<td>Rural Town</td>
<td>Low to medium (single family houses and other single purpose structures)</td>
<td>Primarily commercial uses along a main street (some adjacent single family residential)</td>
<td>On-street parking and sidewalks with predominately small setbacks</td>
</tr>
<tr>
<td>Suburban</td>
<td>Low to medium (single and multi-family structures and multi-story commercial)</td>
<td>Mixed residential neighborhood and commercial clusters (includes town centers, commercial corridors, big box commercial and light industrial)</td>
<td>Varied setbacks with some sidewalks and mostly off-street parking</td>
</tr>
<tr>
<td>Urban</td>
<td>High (multi-story, low rise structures with designated off-street parking)</td>
<td>Mixed residential and commercial uses, with some intuitional and industrial and prominent destinations</td>
<td>On-street parking and sidewalks with mixed setbacks</td>
</tr>
<tr>
<td>Urban Core</td>
<td>Highest (multi-story and high rise structures)</td>
<td>Mixed commercial, residential and institutional uses within and among predominately high rise structures</td>
<td>Small setbacks with sidewalks and pedestrian plazas</td>
</tr>
</tbody>
</table>
It is appropriate to consider the future context that may be informed by comprehensive planning documents and/or area/district/corridor development plans. However, the viability of those plans must be tested against actual trends and implementation intent confirmed by a variety of stakeholders.

Roadway Types

Roadway types are defined based on their network function and connectivity. Existing roadway type names were utilized to allow for an easier transition to the proposed system as well as to retain consistency with existing programming and funding allocations and other uses of functional classification categories. The network is defined based on the national, regional, and local importance of the roadway. The connectivity identifies the types of activity centers and locales that are connected by the roadway. Key characteristics of each roadway type are defined below:

<table>
<thead>
<tr>
<th>Category</th>
<th>Network Importance</th>
<th>Typical Uses</th>
</tr>
</thead>
</table>
| Interstates/ Freeways/ Expressways | Corridors of national importance providing long distance travel | • Limited access  
• Through traffic movements  
• Primary freight routes  
• May support transit networks  
• No pedestrian or bike traffic  
• Guided by FHWA Design Standards |
| Principal Arterial        | Corridors of regional importance connecting large centers of activity | • Through traffic movements  
• Longer distance traffic movements  
• Long haul public transit buses  
• Primary freight routes |
| Minor Arterial            | Corridors of local importance connecting centers of activity | • Connections between local areas and network principal arterials  
• Connections for through traffic between arterial roads  
• Access to public transit and through movements  
• Pedestrian and bike movements |
| Collector                 | Roadways providing connections between arterials and local roads | • Carry traffic with trips ending in a specific area  
• Access to commercial and residential centers  
• Access to public transportation  
• Pedestrian and bicycle movements |
| Local                     | All other roads                                           | • Direct property access—residential and commercial  
• Pedestrian and bicycle movements |

It should be noted that Interstates/Freeways/Expressways are not addressed in the Expanded FCS and they are not included in the classification matrix since Federal Highway Administration (FHWA) standards govern their design.
In addition to the vehicular roadway types, network functionality is defined independently by corridor for transit, freight, bicycle, and pedestrian users. The level of modal priority on the corridor is defined as High, Medium, or Low based on the importance of the link to the individual mode system, as well as to existing or potential demand on the corridor. Modal systems are then applied as overlays to the vehicular FCS (shown above) to allow comprehensive understanding of all needs permitting the designer to balance modal priorities in a constrained environment. The correlation of context and roadway types and overlays results in the functional classification matrix allowing for the development of a multi-modal contextual based design. In every cell of the matrix, the various users (drivers, bicyclists, and pedestrians) are defined and their balancing characteristics are provided.

- **Drivers:** The metrics used to define the context-roadway interaction for drivers are the operating speed and the balance between mobility and access.
- **Bicyclists:** The context-roadway interaction is defined based on bicycle network classification categories and the amount of separation from motorized traffic.
- **Pedestrians:** The metrics used for the context-roadway interaction include volume of pedestrians using the facility and the required sidewalk width to accommodate them. Separation of the facility from the adjacent traffic is also considered.
- **Transit:** Transit accommodations range from minor lane widening if necessary, to include bus pull offs and separate lanes and/or facilities for express routes.
- **Freight:** Can typically be accommodated by establishing minimum lane widths, but also may be served with intersection treatments to ensure accommodated turning movements.

The specific user-related design considerations that should be addressed when balancing their needs to deliver a contextually appropriate multimodal design are incorporated in the complete Expanded FCS matrix. This presents the treatment options for each user (driver, bicyclist, and pedestrian) and identifies the interactions along the context and roadway type continuums.
Proper contextual roadway designs require an understanding of the needs of the potential roadway users and of the function of the roadway within its current and expected future context. The Expanded FCS and associated design matrix can identify the preliminary requirements for proper consideration of roadway context and user needs. This approach provides the framework for determining user needs and ordering user levels on a given roadway. It assumes the planner/designer can develop alternative system/network strategies for meeting all user needs. This process can provide input and refinement to the purpose and need statement that establishes the specific safety and mobility needs for the design to be developed. In the end, the final balancing of facilities to accommodate user needs becomes part of the process of following project development principles for achieving context sensitive solutions.

<table>
<thead>
<tr>
<th>Context Roadway</th>
<th>Rural</th>
<th>Rural Town</th>
<th>Suburban</th>
<th>Urban</th>
<th>Urban Core</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Principal Arterial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H speed H mobility-M access</td>
<td>L/M speed M mobility-H access</td>
<td>M/H speed M mobility-M access</td>
<td>L/M speed M mobility-M access</td>
<td>L speed M mobility-M access</td>
<td></td>
</tr>
<tr>
<td>P1, P2, P3, P4: Wide</td>
<td>P2: Min; P3: Wide, P4: Enhanced</td>
<td>P1, P2, P3: Wide, P4: Enhanced</td>
<td>P2: Min; P3: Wide, P4: Enhanced</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minor Arterial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H speed M mobility-M access</td>
<td>L/M speed M mobility-H access</td>
<td>M/H speed M mobility-M access</td>
<td>L/M speed M mobility-M access</td>
<td>L speed M mobility-M access</td>
<td></td>
</tr>
<tr>
<td>P1, P2: Min; P3, P4: Wide</td>
<td>P2: Min; P3: Wide, P4: Enhanced</td>
<td>P1, P2, P3: Wide, P4: Enhanced</td>
<td>P2: Min; P3: Wide, P4: Enhanced</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Collector</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M speed M mobility-M access</td>
<td>L speed M mobility-H access</td>
<td>M/H speed M mobility-M access</td>
<td>L speed M mobility-M access</td>
<td>L speed M mobility-M access</td>
<td></td>
</tr>
<tr>
<td>P1, P2: Min; P3, P4: Wide</td>
<td>P2: Min; P3: Wide, P4: Enhanced</td>
<td>P1, P2; Min; P3: Wide, P4: Enhanced</td>
<td>P2: Min; P3: Wide, P4: Enhanced</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Local</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M speed M mobility-M access</td>
<td>L speed M mobility-H access</td>
<td>L speed M mobility-H access</td>
<td>L speed M mobility-H access</td>
<td>L speed M mobility-H access</td>
<td></td>
</tr>
<tr>
<td>P1, P2: Min; P3, P4: Wide</td>
<td>P2: Min; P3: Wide, P4: Enhanced</td>
<td>P1, P2, P3: Wide, P4: Enhanced</td>
<td>P2: Min; P3: Wide, P4: Enhanced</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Speed, Mobility, Accessibility and Separation levels: H: High; M: Medium; L: Low
Bicycle Connectors: LC: Local; NC: Neighborhood; CC: Citywide
Pedestrian traffic levels: P1: rare/occasional; P2: low; P3: medium; P4: high
Pedestrian facility width: *: site specific considerations; Min: minimum; Wide: greater than minimum; Enhanced: wide for large congregating pedestrian groups
Pedestrian facility separation should be considered in conjunction with driver target speeds
A significant amount of thought has gone into possible alternatives to the FCS. This has yielded the Expanded FCS matrix that addresses the range of perceived shortcomings of the existing FCS. The proposed Expanded FCS takes advantage of the available forethought and provides an innovative framework that brings together context, road type/function, and user needs to establish multimodal design guidance and considerations to achieve enhanced solutions that are context sensitive. The Expanded FCS is a comprehensive alternative that can fit a variety of situations and can be used for individual projects or adopted by agencies for use on all projects in all phase of project development. It can be readily applied in a systematic manner by jurisdictions that have a need to develop innovative design solutions and have experienced the limiting effect of the current FCS.
CHAPTER 1
INTRODUCTION AND RESEARCH APPROACH

PROBLEM STATEMENT
The FCS was developed in the 1970s as a basis for communication between designers and planners (U.S. DOT, 1974). The system sought to establish a common framework for classifying roadways based on mobility and access. Since its inception, the application of the FCS has expanded. It is now used throughout the entire project development process, influencing all work phases, from programming and planning through design and into maintenance and operation decisions. Within design functions in particular, the FCS is often used to define the range of permissive or desired design elements, such as lane width, shoulder width or design speed. The limited range of functional classes, in addition to the severely limited contextual categories (urban and rural), often yields unresponsive designs focused solely on auto-centric travel. Standards based on the FCS often severely limit design choices when developing a transportation solution intended to: 1) meet the purpose and needs of today’s transportation projects, and 2) be adapted to the context in which they are expected to be successful. The FCS has been very useful in the past when the focus was on the automobile and the system was being addressed from a more regional system perspective.

In recent years, a significant emphasis has been placed on the development and expansion of flexibility in highway design to address competing project priorities. Flexible design has been the primary goal of Context Sensitive Design/Context-Sensitive Solutions (CSS), Practical Solutions, and Performance Based Practical Design (PBPD) initiatives that have been adopted by many state DOTs in recent years. Both approaches attempt to find the “right-sized” transportation solution for roadway users; the goal is for the solution to fit within the roadway environment. These approaches often examine the imperative of varying design elements needed to balance the unique requirements of the project, including the incorporation of a multimodal presence along the roadway. The narrow focus of the FCS, which considers only mobility and access, as well as its limited contextual definitions (urban and rural), does not provide the dynamic range of design elements and guidance needed to balance other competing needs. While there is a range of design values available, there is no clear way to systematically consider other users and set priorities for the adjustment of the geometric design to achieve an innovative or successful project within a more broadly defined sense of context, user needs, and function.

There are two prospective approaches to addressing the issues identified above. First, the FCS needs to be revised to reflect current trends in design practices and roadway uses (e.g.,
complete streets). Second, it is critical that a new classification system should be considered that better accommodates CSS and addresses multimodal mobility needs along with other competing factors. State and local agencies require guidance and information to define properly the functional classification of roadways in order to achieve an improved, more contextual geometric design. Moreover, contemporary issues in transportation and community planning, such as the declining balance of the Highway Trust Fund, the growing importance of land redevelopment as a means for local governments to increase its tax base and revenues, and an increasing public desire for transportation projects to accommodate multimodal uses, point to a need to reexamine the FCS and assess the viability of emergent alternative systems and approaches.

RESEARCH OBJECTIVES AND APPROACH
The objective of this research is to develop a flexible framework to replace the FCS that will facilitate optimal geometric design solutions that account for context, user needs, and functions. The new system will communicate improved information to the designer so that balanced designs can be achieved through documented prioritization of roadway users.

Researchers took a two-phased approach toward developing such a framework. The first phase involved a review and synthesis of literature that examined current uses of the FCS, a survey of transportation agencies to define existing issues and possible alternative schemes, and the evaluation and documentation of alternative schemes. In the second phase, the selected approach was detailed further and the potential impacts of the approach on other uses of the FCS were defined. Specifically, the work was completed through the following tasks, accomplished in two phases:

Phase I

- Task 1: Review of the traditional FCS and identification of its strengths and weaknesses as related to geometric design decisions.
- Task 2: Identification and description of existing alternative classification schemes and methods including those used by state DOTs and other agencies as well as the “new urbanism” approaches.
- Task 3: Documentation of promising approaches that account for roadway context, function of roadway for various users, and community goals.
- Task 4: Development of an interim report.
Phase II

- Task 5: Development of the panel-approved FCS including implementation approaches and guidance for developing design alternatives.
- Task 6: Description of potential impacts of the proposed functional classification on the uses of the current classification system.
- Task 7: Preparation of final report.

This research led to a FCS to aid and address issues in contextual design. The team accomplished this by first identifying and reviewing existing efforts and FCSs already in place. Then, they developed a FCS that would address current shortcomings of the design process. The proposed FCS (Expanded FCS) can be applied to all roads and could eventually replace the existing classification system. A separate guide has been developed that provides an in-depth discussion of the various components of the Expanded FCS. Two case studies that present the approach to be taken and how the Expanded FCS can be used to aid in the development of contextual design are included. This research strongly suggests a systematic, albeit gradual, effort in replacing the current FCS in order to allow for contextual designs. The results and guide presented here provide the foundation for this effort and showcase an opportunity for process improvement in contextual design.

ORGANIZATION OF THE REPORT

This report documents the findings of the research work completed during development of the Expanded FCS. The results of this research are included along with recommendations for future research. The components of this report are as follows:

- Chapter 2, Literature Synthesis — presents the current knowledge on benefits and other issues relative to functional classification.
- Chapter 3, Existing Classification Uses — documents the current uses of the functional classification based on a national survey.
- Chapter 4, Classification Schemes — presents the existing classification schemes and discusses their advantages and disadvantages.
- Chapter 5, Expanded FCS — presents the proposed FCS as a result of this research and identifies application issues.
- Chapter 6, Expanded FCS Implementation — discusses potential impacts from its implementation, and identifies required steps for implementation.
• Chapter 7, Conclusions — includes a summary of the study objectives, project findings, and recommendations for future research work.

• NCHRP Research Report 855: An Expanded Functional Classification System for Highways and Streets — includes a guide for applying the Expanded FCS and two case studies demonstrating its application.
CHAPTER 2
LITERATURE SYNTHESIS

The purpose of this literature review is to synthesize pertinent information, specifically, to examine the purpose and need that led to the development of the FCS, and to understand current FHWA thinking and policies. Additional focus is placed on critiques and analyses of roadway classification within the modern transportation sector.

It is useful to consider classification systems today in light of their original purpose and how this purpose has evolved to meet policy imperatives associated with development of the United States roadway system, especially in the second half of the twentieth century. An analysis clarifies the strong role these systems have played not only in transportation planning but also in design and programming of funds. This section presents the FCS approach and its historical background and discusses CSS issues that could potentially influence the classification system.

FUNCTIONAL CLASSIFICATION SYSTEM

Functional classification groups streets and highways into classes or categories based on two transportation functions of roads: mobility to and between locations and access to specific places or facilities from the road (FHWA, 1982). There are three primary classifications in the conventional system: arterial, collector, and local roads. This basic taxonomy has evolved since its first uses. For most applications, there are several subcategories, but each remains tied to a basic set of definitions for each of the three road types:

- **Arterials** serve a primary function of vehicle mobility, generally for longer trips at a more regional scale.
- **Collectors** serve a balance of regional and local trips and function, especially as transitions between local access streets and arterial mobility streets.
- **Locals** are oriented primarily toward access. As a rule, they tend to be designed for lower speeds and often (though not always) a more limited range of vehicles.

Figure 1 shows how arterials, collectors, and local streets balance access and mobility needs.
This general classification has driven functional classification programs since their emergence in the mid-twentieth century. Prior to the 1920s, highways and streets in the United States were constructed largely in response to emerging economic need but were not organized into a comprehensive system. Many state transportation agencies were still in their infancy at this time and only beginning to survey comprehensive needs for statewide transportation and mobility, and they received little guidance or direct assistance from the federal government. Highway construction projects typically occurred on an incremental basis, often with significant private funding and operation.

The passage of the Federal Aid Highway Act of 1921 marked the first use of a classification system to select roads that would be eligible for federal funding. It specified a relatively limited network of roads with national economic and logistical significance. After World War II, the development of the National Interstate Highway System augmented this federal-aid system and established the first comprehensive, self-sustaining funding program for highways, based primarily on revenue from taxes on motor fuels (Kane, 2003). Although implementation of this system initially focused on the construction of interstate highways, the Federal Government began to undertake an extensive effort to unite pre-existing surface highways into an overall system, which through subsequent highway funding legislation later evolved into the National Highway System (NHS) in the 1990s.

This formalization of a national system led to the establishment of a more standard FCS to drive funding allocations and decisions. Functional classification was increasingly used as a
management tool during this period, with state transportation agencies adopting functional classification as the basis for defining statewide systems that included roads outside of those on the nationally recognized system (FHWA, 1982). In addition, professional organizations such as the National Committee on Urban Transportation and the National Association of County Engineers promoted this system as a management tool for local governments. A joint publication of the American Association of State Highway Officials (the predecessor of today’s American Association of State Highway and Transportation Officials [AASHTO]) and the National Association of County Officials and National Association of County Engineers, A Guide for Functional Highway Classification, established the FCS model that modern practitioners are familiar with and defined a framework to apply this model to needs-based planning and forecasting, project development, and programming of funds (AASHTO, 1964).

The passage of the Federal Department of Transportation Act of 1966 led to a general shift in the administration of highways and roads by federal and state agencies. Two years later, the Federal-Aid Highway Act of 1968 mandated the use of a FCS, which included a study focused on the universal application of the system to all public highways and streets based on their most logical use in serving travel demands and local land uses. This study evaluated the consistency between past Federal-aid funding allocations and the development of an overall national system. This 1968 legislation and its successor, the Federal-Aid Highway Act of 1973, led to a more standard definition of classification types and a more focused understanding of the function of roads and streets. The national mandates contained in these legislative acts, which were carried out by state transportation agencies, effectively established this same system at the state level.

The functional classification labeling used at the federal level today reflects an expansion of the FCS model, so that it now recognizes more precise definitions of functions within each of the three primary classes. These distinguish between access-controlled and full-access roadways, urban and rural land use and development characteristics, and major and minor (or principal and secondary) status. This expanded definition helps roadway designers distinguish between different general purposes, but more specifically differentiates roadway types eligible for Federal-aid funding assistance. This also assists in maintaining the FHWA’s Highway Performance Monitoring System (HPMS), a database that contains information on how different roads in the Federal-aid system meet stated functional purposes.

As of 2010, the FCS as identified by the FHWA consists of seven basic classes:

1. Interstate Highways;
2. Other Freeways and Expressways;
3. Other Principal Arterials;
4. Minor Arterials;
5. Major Collectors;
6. Minor Collectors; and
7. Local Roads (FHWA, 2010a).

These classifications are applied to both urban and rural areas. The urban/rural designation – while independent of a roadway’s functional classification – is a significant factor in developing both the functional classification of a road in an urban/rural context and the designated design parameters within the AASHTO A Policy on Geometric Design of Highways and Streets, commonly referred to as the Green Book, and other state guidelines. States have the option of using census-defined urban boundaries to establish urban areas, or they may adjust the census-defined boundaries to be more consistent with transportation needs. States, through coordination with local planning partners, may adjust the urban area boundaries so that fringe areas having “…residential, commercial, industrial, and/or national defense significance” (as noted in the December 9, 1991 Federal-Aid Policy Guide), are included. On October 14, 2008, FHWA issued the memorandum "Updated Guidance for the Functional Classification of Highways" which stated, “Functional classification should not automatically change at the rural/urban boundary.” Essentially this guidance allows the expansion of the urban area but does not accommodate built urban forms below population densities identified in Table 1 and 2.

Table 1 U.S. Census Bureau urban area types defined by population range

<table>
<thead>
<tr>
<th>Census Bureau Area Definition</th>
<th>Population Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Area</td>
<td>2,500+</td>
</tr>
<tr>
<td>Urban Clusters</td>
<td>2,500-49,999</td>
</tr>
<tr>
<td>Urbanized Area</td>
<td>50,000+</td>
</tr>
</tbody>
</table>
Table 2 FHWA urban area types defined by population range

<table>
<thead>
<tr>
<th>FHWA Area Definition</th>
<th>Population Range</th>
<th>Allowed Urban Area Boundary Adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Area</td>
<td>5,000+</td>
<td>Yes</td>
</tr>
<tr>
<td>Small Urban Area (From Clusters)</td>
<td>5,000-49,999</td>
<td>Yes</td>
</tr>
<tr>
<td>Urbanized Area</td>
<td>50,000+</td>
<td>Yes</td>
</tr>
</tbody>
</table>

FHWA does not publish its own roadway design standards for the national system. It generally relies on the AASHTO Green Book as a central resource for guidance on design parameters (AASHTO, 2011). FHWA has adopted the 2001 Green Book as the standard for projects on the NHS. It is evident, based on standard interpretations of the AASHTO text, that the root concept of functional classification is highway-oriented.

The simplicity of the FCS allows for its widespread and consistent application among states. Of particular use is the application of functional classification in network planning and design, as the system ensures network continuity and connectivity. The road function can then be useful in helping the designers understand both the function and user of the roadway when designing it. For instance, as identified in the Guide for Achieving Flexibility in Highway Design, “local roads are driven primarily by familiar drivers making repeated trips. For such facilities, designers can generally be more open to design exceptions to address or accommodate a local constraint” (AASHTO, 2004a). As a result, functional classification has been explicitly recognized as having a relationship, and thus influence, on design of roadways (FHWA, 2013). The Green Book also underscores this relationship by stating “[the] first step in the design process is to define the function of the facility is to serve...The use of functional classification as a design type should appropriately integrate the highway planning and design process” (AASHTO, 2011). The Green Book provides for flexibility in highway design and has been supplemented by other publications that emphasize context sensitive design, but many state agencies’ design manuals contain specifications that are more rigid in order to produce more uniform project outcomes (FHWA, 2010b).

Over the years, functional classification has come to assume additional significance beyond its purpose as a framework for identifying the role of a roadway in moving motor vehicles through a network of highways. Functional classification carries with it expectations about roadway design, including its speed, capacity, design controls and criteria, and relationship to existing and future land use development. Federal legislation continues to use functional classification to determine eligibility for funding under the Federal-aid program. Transportation agencies describe roadway system performance, benchmarks, and targets by using functional classifications.
The universal application of the FCS has enabled its integration into many facets of local operations. Uses include local access management and traffic calming eligibility; grouping for operational and safety performances; and directing built form through local land use and/or zoning documents, subdivision regulations, and site development standards. The funding component of FCS almost ensures that it will be used locally, especially in jurisdictions that lack the wherewithal to develop their own system. The FHWA lists the general uses of the FCS within just the project development process as:

- **Program and Project Prioritization** — In a climate of constrained resources, functional classification often plays a role in prioritizing expenditures. Several transportation agencies have developed separate funding programs to support the roadway systems that serve their longest distance travel, a large proportion of which comprises the Principal Arterial system.

- **Asset Management** — Functional classification plays a role in transportation agencies’ asset management programs, as agencies generally work to preserve and protect their most important assets – those that serve the most people and goods.

- **Safety Programs** — Transportation agencies use functional classification to evaluate roadway safety and implement safety improvement programs. Agencies consider the type of roadway when evaluating the significance of crash rates. The typical safety improvement may also vary widely depending on the functional classification of a roadway. For example, speed reduction or signage improvements may be more effective in reducing crashes on a local road than on an arterial.

- **Highway Design** — There is a correlation between functional classification and design. As an illustration, lower-class roadways have lower speed limits, narrower lanes, steeper curves, etc., while higher-class roadways have higher speed limits, wider lanes and fewer sharp curves. The relationship between functional classification and highway design is discussed in the following section.

- **Bridge programs** — Functional classification often plays a key role in a state’s bridge program. For example, some states have set thresholds such as a functional classification of local with low traffic volume, for which one-lane bridges are acceptable.

- **Traffic control** — Some transportation agencies may use functional class to determine the most appropriate intersection control measure.
- **Maintenance** — Functional classification often influences resurfacing cycles, which is related to asset management and project prioritization. The classification of a roadway also affects general maintenance and snow/ice removal during inclement weather.

As agencies continue moving toward a more performance-based management approach, functional classification will be an increasingly important consideration in setting expectations and measuring outcomes for preservation, mobility and safety (FHWA, 2013).

**FUNCTIONAL CLASSIFICATION FOR STATE AGENCIES**

State transportation agencies have primary responsibility for transportation project development and implementation, including on the national system. As such, they have adopted policies, usually in the form of design manuals that largely follow the national-level guidance administered by AASHTO and FHWA. Many states have adopted the AASHTO Green Book design policy, whether in total or in part, for roadway projects. States with their own standards often refer to the Green Book as a general foundation for highway design guidance and may call on it for specific matters of design.

A review of state design manuals was aimed at identifying the current use of the FCS and its impact on design values and elements. The review examined each manual to: 1) determine whether the state uses the existing FCS as defined by the FHWA and in the Green Book, and 2) evaluate whether the manual provides specific guidance on design element values for each of the functional classification categories as defined in the Green Book (i.e., chapters 4, 5, and 6).

Forty-two state manuals were reviewed to address the two objectives noted above. The majority (38 of 42) use the same FCS for design. The exceptions are California, Connecticut, Massachusetts, and Texas. California uses a slightly different classification, where roadways are classified as freeways, expressways, highways as arterials, parkways, local streets or roads, and throughways. Connecticut uses roadside development density to refine functional classification, adopting three categories: rural open with moderate density and high density, intermediate suburban with less intense patterns of development, and built-up with typical downtown developments. Massachusetts has seized the concept of area type, which provides additional definition of the roadway context for functional classification (referred to in the manual as roadway types) and identifies three types with subcategories: urban; suburban with low density, high density, and village/town center; and rural natural, developed, and village. Texas also introduced the concept of suburban as an area type beyond rural and urban and distinguishes between two-lane and multi-lane rural roads.
Second, each manual was examined for whether there exists guidance for design element values in accordance to the classification system adopted. All manuals provide some guidance, provided in different formats. Some states duplicate the tables presented in chapters 4, 5, and 6 in the Green Book (e.g., Delaware, Ohio) while others summarize them in a tabular form (e.g., Maine, Tennessee, Kentucky) (Figure 2). States that have included additional categories also define design element values using both the functional classification and their additional categories. A few states (e.g., Connecticut, Indiana, and Texas) distinguish facilities based on their number of lanes and provide additional guidance based on this, while Florida imposes a similar distinction between divided and undivided. The flexibility noted for these recommendations varies among states, with some having a single value (e.g., Florida), while others have a range of desirable and minimum values for each category (e.g., Indiana).
Figure 2 Example of Tennessee DOT guidance
Several states have begun developing additional guidance policy documents for context sensitive designs, encouraging highway designers to incorporate environmental and community considerations into the interpretation of roadway design guidance. However, multiple states continue to use Green Book-based approaches that define functional classification, establish design values for each roadway component based on its guidance, and generally offer little flexibility in terms of how these design values are to be interpreted or modified outside of a design exception or waiver process.

Suburban Designation
Eight of the 42 state manuals include a suburban land use category along with the commonly used urban and rural framework. This is an important distinction that acknowledges the complex transportation needs and characteristics of suburban environments. In particular, these contexts are often characterized by traffic volumes comparable to those in urban environments, although often with a much smaller supporting local street network or clear transition between arterial, collector, and local roadways.

These design policy manuals also appear to acknowledge that an automobile-oriented pattern of land uses has driven local access needs throughout the roadway system, in effect keeping many roadways from truly operating in a manner consistent with the pure definition of their assigned functional classification. This applies especially to arterials, which often occupy a dual role for both mobility and access in suburban areas due, in part, to political and real estate market pressure to designate these areas for retail and commercial land uses. The speed implications of this dual function are particularly noteworthy, and design standards linked to an arterial classification (by nature oriented toward promoting mobility and throughput of traffic) are likely to emphasize higher speeds appropriate for regional arterials. These higher speeds contrast directly with the low-speed, turn-heavy travel patterns associated with local streets and access roads to private property.

Design guidance that includes a suburban designation has recommended different ways of reconciling this conflict. In most policy manuals, a different set of design elements are identified for inclusion in a roadway, such as medians to assist in access management or bicycle lanes on key corridors with multimodal demand.

FUNCTIONAL CLASSIFICATION SYSTEM ISSUES
As the FCS has become more pervasive throughout the project development process, several issues have emerged. Many of these arise due to the application of the FCS beyond its original
Misaligned Applications

One issue of concern with the FCS is that the decisions about the functional classification for a particular roadway are made typically in planning or programming stages and thus well in advance of fully understanding the project context and constraints. Classifying a roadway within a specific category occurs during the planning stages of the project based on network-wide needs and therefore represents its importance within the system-wide transportation needs of the area. But the FCS does not reflect the community goals and objectives at the local scale. Defining design elements by establishing the functional classification this early in the process runs counter to flexible and context sensitive design approaches, which gradually refine the design as the purpose and need, context, and constraints are refined throughout the entire project development process (Kirk et al., 2010). Moreover, as the FHWA (2013) established, “States should assign functional classifications according to how the roadway is functioning in the current year only.” However, this is in direct conflict with the highway design projects, which strive to meet demands for future years, whether that entails growing the system to increase the connectivity of a roadway segment or diminishing the importance of a road in the overall system because it will soon be bypassed.

One of the prevailing trends of the FCS — a system originally established to organize highways by the auto traffic they are expected to accommodate — has been its linkage to geometric design standards. This has become the default position, with variations achieved through administrative waivers and the granting of exceptions. However, in some states and agencies, variations are often denied.

The AASHTO Green Book provides for flexibility in highway design, and has been supplemented by other publications that emphasize context sensitive design. While design exceptions are frequently encouraged and sought out to provide balanced design features, there is a need to create a policy that establishes appropriately contextual design as the rule rather than the exception. Moreover, due to the nature of the AASHTO Green Book and state design manuals, state transportation agencies have come to depend on defined design guidelines as design standards to prevent the agency from incurring liability (Keuper, 2010). Even when street standards allow for flexibility, designer discretion, and engineering judgement, the designer often defaults to the maximum parameters for safe and efficient traffic movement (Taylor et al., 2002). With these standards often closely linked to functional classification, it has fostered a degree of
inflexibility in roadway design — especially in urban streets — that limits an agency’s inclination to explore multiple designs for a project. In some cases, guidance explicitly states that the design values established in these manuals are minimum values that should be met or be exceeded to achieve what is perceived the safest and most efficient design.

**Multimodal Design**

Another primary issue of concern with the FCS is its singular focus on automobile-centric travel. The FHWA’s Livability in Transportation Guidebook praises efforts to build a world class automobile travel system, though it states “we have not yet put the same effort into completing a system that works as well for walking, wheeling, or taking transit in most communities” (FHWA, 2010b). This is reinforced by the FHWA Highway Functional Classification: Concepts Criteria and Procedures, which states “Roadways serve two primary travel needs: access to/egress from specific locations and travel mobility” (FHWA, 2013). With recent refocusing on public spaces — including streets as activity centers, as well as the recent growth in pedestrian, bicycle, and transit usage for mobility — this circumscribed understanding of roadways is insufficient to provide guidance to planners and designers.

CSS has raised the issue of multimodal transportation facilities and emphasized the need to conceptualize roadways as facilities that move more than vehicles (Stamatiadis, 2005). Functional classification must address the needs of other users; pedestrian, bicyclist, and transit user mobility should be included when considering the classification of roadways. Even with the focus by many states and the FHWA on CSS, priority for alternative modes of transportation is not provided. As stated by the Institute of Transportation Engineers ([ITE], 2010) recommended practice, “even with the positive “Context Sensitive Design” emphasis, AASHTO Policies in urban areas are still fundamentally in conflict with many transportation design concepts found in the New Urbanism. Pedestrian mobility, the key to New Urban walkability, is not part of the roadway’s stated purpose. The purpose of each functionally classified roadway is defined by the degree to which it serves motor vehicle mobility.” This issue becomes critical in urban and suburban areas, as right of way becomes constrained and increased pedestrian, bike, and other modal needs increase (Taylor et al., 2002). Vehicular modes typically receive priority because the FCS is so pervasive throughout the entire project development process and no equivalent system exists to dampen its influence. Some state agencies are already addressing this deficiency and have revised their functional classification schemes. For example, Idaho has incorporated the ITE recommendations in designing urban thoroughfares (ITE, 2010) and redefined their classification system to be more responsive to various users (IDOT, 2009).
Hall (2003) identified four key factors explaining the conflicts between the Green Book policies and walkable, New Urbanism design:

1. Functional Classification is based on motor vehicle mobility.
2. Mobility is defined based on high vehicle speed.
3. Pedestrian comfort and safety are based on low vehicle speed.
4. Widening the intersection to accommodate more travel lanes to mitigate congestion often occurs to the detriment of pedestrians and cyclists. It is therefore essential to consider the context and purpose of a roadway and to recognize how the purposes of mobility and access are served.

These four factors are considered further in Chapter 4 of this report, where the objectives for a new classification system are developed.

The FCS has grown in importance as a management tool since its emergence, and federal transportation funding legislation continues to use it when selecting highways and streets that are eligible for Federal-aid assistance (FHWA, 2013). The Federal-aid system is defined in federal law as encompassing the Interstate Highway System and all other public roads not classified as local roads or rural minor collectors. This demonstrates a link between federal funding and a continued agency focus on higher-level roadways, and in many cases has applied the design standards and performance criteria that transportation agencies associate with functional classes in a variety of settings. More importantly, though, this legal definition provides the foundation for a critical link to the FHWA functional classification model in any state or local roadway planning or design, meaning that this model will continue to be used for practical purposes of highway classification, even when state- or local-level policymakers attempt to incorporate a greater degree of flexibility into the process.

One notable consequence of this continued reliance on the FHWA classification system is that a large share of highway funding resources continues to be concentrated on mobility-oriented corridors, even when planning occurs at a metropolitan or local level. Many of the challenges in roadway project planning and design that transportation agencies have encountered in recent years are related to the inherent conflict between access and mobility needs on arterial and collector roadways for all user groups, not just vehicles. Agencies that promote more flexible design guidance may not similarly offer funding flexibility.
**Access vs. Mobility**

Those with even preliminary knowledge of the FCS will be familiar with the balancing of mobility and land access as shown in Figure 1. It should be noted however, that this figure, which has come to almost singularly define the FCS, does not appear in the most recent edition of the FHWA Highway Functional Classification Concepts, Criteria and Procedures report (FHWA, 2013). In its place, Figure 3 has been used which still illustrates the trade-off between mobility and access, but recognizes the other factors that need to be considered when roadways are classified. While this new figure at least recognizes the environment in which the roadway access-mobility dynamic takes place, it does not provide guidance on meeting or balancing those needs within the FCS.

![Figure 3 Access and mobility proportioning (FHWA, 2013)](image)

The focus of the FCS on mobility and access addresses longitudinal design issues (design elements that extend the entire length of the roadway). Balancing roadway speed and capacity with intersection and access control also speaks to design issues. The identification of functional priority provided by the roadway classification can assist in balancing these needs. Moreover, the identification of the functions can provide guidance when establishing system continuity of roadway networks to provide efficient flow of vehicle traffic. However, today’s designers often face more complex demands, with competing users all striving to share the same space within the cross section of the roadway. Because roadways and streets are once again seen as activity centers, they play a far greater role and serve many more functions than merely auto access or throughput. Arterials, for example, play several different roles depending on their context. In a central business district, arterials serve multiple transportation modes, while in suburban areas they tend to serve primarily autos. While the stated purpose of arterials may be to serve as key
mobility corridors, in practice much of the land fronting arterials is zoned for commercial uses that require numerous access points. The problem of serving this dual function illustrates one of the shortcomings of using functional classification as a primary means of network planning (ARRB, 1979). While the FCS defines streets in terms of design and operational characteristics for the movement of vehicles, classification systems can also serve as a policy framework to consider issues such as pedestrian travel, driveway access, bus routing, on-street parking, snow removal priorities, traffic signal priorities, streetscape design, and traffic management (ITE, 2010).

Rural Community Issues
While functional classification is essential in defining the roadway network and identifying design expectations of vehicle users, several issues can arise during application, due to its general nature and broad-brush approach. The urban/rural classification is currently essential in assigning jurisdictional roles, operational needs, and funding allocation. However, it does not provide the perspective required to guide contextual design. The AASHTO Guide in Achieving Flexibility in Highway Design (2004a) identifies this issue and notes “that a roadway’s formal classification as urban or rural may differ from actual site circumstances or prevailing conditions.” An example includes a rural arterial route passing through a small town such as that shown in Figure 4. This shows an aerial view of Salyersville, KY (population 1,800), which is bisected by US 460 – a principal arterial through town. The route may not necessarily be classified as urban, but there may be a significant segment of the road along which the surrounding land use, prevailing speeds, and transportation functions share greater affinities with urban or suburban than typical rural areas. Designers need to recognize such situations and apply common sense judgments in interpreting design criteria and developing appropriate solutions or design approaches (AASHTO, 2004a). The FHWA Flexibility in Highway Design expounds upon this concept and identifies land use as “an important determinant of the function of the area’s roads.” It further states, “the functional classification of the highway system should relate to the level of development” (FHWA, 1997).
Urban Networks

In a rural roadway system, roads typically follow a tributary nature as classified by the FCS. However, in urban areas, due to the higher density of roadways, parallel and redundant routes (especially in a grid system), the road system does not easily fit into the local, collector, and arterial hierarchy. An ARRB (1979) report noted that “Road Systems, even consciously planned ones, are not wholly tributary in nature and in much of our existing urban areas, are not tributary at all”. This is demonstrated in Figure 5 and 6. Figure 5 illustrates the road network of Lexington, KY, which is based on a hub and spoke system, and fits a generalized arterial, collector, and local system. Although within the urban core, a grid system is in place.
Figure 6 however, shows the street system of Salt Lake City, UT, which is based entirely on a grid system. In this network, parallel and redundant routes exist for all directions. While some streets are identified as arterials or collectors, their designation is more driven by their design characteristics, i.e., number of lanes, capacity, speed, rather than their connectivity. However, many streets share design parameters and disperse traffic throughout the network, rather than concentrating traffic on a few select routes. This increases opportunities for walking and biking within the city.

![Figure 6 Grid road network](image)

Arising from some of these inconsistencies is the fact that classifying highways is not an exact science. The definitions used are relatively fluid and do not provide specific metrics. It should be noted though that the original intent of classification concepts was to maintain definitional flexibility, which explains why no specific metrics were included. Hall (2002) has summarized this result in stating “there is considerable indecision and ambiguity in roads serving different functions. The difficulties experienced in applying a conventionally defined hierarchy to an existing network suggest either that there are fundamental flaws in the road classification system used or that it is too ambitious to expect to define any system of classification precisely enough to serve as a basis for traffic policy”.

Over the past 40 years, the practice of classification has evolved in such a manner that functional classification now functions as surrogate for determining several design element values. Some states have then inverted this process by using these metrics to assist in classifying roadways. For example, the New Jersey and Pennsylvania DOTs have identified ranges of
operating speeds, volumes, intersection spacing, and travel lengths for their newly developed alternative classification scheme (NJDOT & PADOT, 2008). In addition to this general guidance, they have also specified design element value ranges for each of their proposed seven classes.

One can argue that the primary strength and weakness of functional classification is its simplicity (Aurbach, 2009). The FCS is a simple approach that uses vehicle access and mobility as its primary distinctions and rural/urban as its context. It is easy to understand and remember and this has provided consistent applications to fulfill network planning and funding needs. This simplicity aids in effective communication among policy makers, practitioners, and citizens. However, this simplistic approach does not recognize all of the other layers, users, and functions that a roadway must satisfy, and as such does not facilitate a holistic multimodal approach to designing roadways. One of the biggest issues is the urban/rural distinction and current use does not account for the complexity of built environments or the spectrum of land use and development types that are present from rural forests and farmlands to the urban core. Recognition of this shortcoming led to the creation of road typologies used in the Transect wherein the continuum of the land use and building density were considered to further refine and identify this complexity (Duany et al., 2003).

FLEXIBILITY IN HIGHWAY DESIGN

Over the past 30 years, Congress has passed a number of policy acts and regulations that have addressed the negative impacts of roadways. The Green Book has long recognized and promoted flexibility; however, many practitioners and agencies have viewed the recommended values of the Green Book as rigid standards. This is in agreement with the concept of nominal safety, where designs that are not standard-compliant are viewed as inappropriate. Practitioners guided from the nominal safety have expressed little concern for accommodating flexible designs to roadway surroundings. Moreover, they adhere to the notion that the recommendations of the Green Book have to be firmly applied, irrespective of project characteristics and location. This approach typically leads to wide swaths of pavement cutting through communities and natural resources – i.e., roadways that are not context sensitive.

The public and elected officials have also become more involved and aware of the issues that roadway projects may generate and have started questioning the basis for the resulting designs. The conflict between the practitioners and the community has often resulted in delaying or stopping projects due to the competing views between these parties. It became apparent that the current approach to addressing highway design should be reconsidered, and that new means and directions for solving such conflicts needed to be identified. In the 1960s the general public
began to voice concerns about the adverse environmental impacts of expanding the road network. This resulted in the passage of the National Environmental Policy Act in 1969, which had significant implications for roadway design and construction. Through various activities and efforts, CSS emerged that focused on project development actions.

The following sections review four efforts to address flexibility in highway design: CSS, Practical Design Solutions, Performance Based Design, and Complete Streets.

**Context Sensitive Solutions**

CSS was conceptualized to address perceived shortcomings related to design flexibility. The basic aim of CSS is to develop a project that balances the mobility, safety, environmental, and social needs. Its goal is to cultivate a project development process that provides an outcome, which harmonizes transportation requirements with community needs and values. The resulting solution should address the agency expectations to deliver an on-time and within-budget project along with the stakeholders’ expectations of addressing natural and human environment concerns and community expectations of delivering a project that will improve their quality of life.

A key factor in understanding the importance of CSS is recognizing that transportation projects are unique in terms of their nature, scope, and importance of issues. While some suggest that CSS is a process, it is in fact a set of principles that are applied during the project development and delivery processes that highway agencies currently have recourse to (Stamatiadis et al., 2009). The 15 CSS principles include the following:

1. Use interdisciplinary teams.
2. Involve stakeholders.
3. Seek broad-based public involvement.
4. Use a full range of communication strategies.
5. Achieve consensus on purpose and need.
6. Address alternatives and all modes.
7. Consider a safe facility for users and the community.
8. Maintain environmental harmony.
9. Address community and social issues.
10. Address aesthetic treatments and enhancements.
11. Utilize the full range of design choices.
12. Document project decisions.
13. Track and meet all commitments.
14. Use agency resources effectively.
15. Create a lasting value for the community.

CSS may, however, require significant changes in the focus and extent of some project development process actions. For example, adherence to CSS principles requires transportation agencies to solicit meaningful input from the public and stakeholders so that potential issues and concerns can be identified and addressed early in a project. To achieve this, all stakeholders must be identified and consulted with from the outset of a project, which may require improvement in the public involvement process. By viewing CSS as a set of principles, any agency can readily incorporate its principles into their existing project development process to bring about significant change and benefits to their organization and improve project outcomes.

The ultimate goal of CSS is to deliver a project that balances the needs of safety, capacity, environment, cost, community, and other project needs, resulting in a facility that is sustainable and creates a lasting value for the community. A CSS-enlightened professional might say that it is simply a matter of doing the right thing in the right place. To help stakeholders identify what the correct course of action is, Stamatiadis et al. (2009) identified 15 distinct and actionable principles of CSS projects. These principles establish a project development process that harmonizes transportation requirements with community needs and values.

Practical Design and Solutions
Due to the increasing age of the United States’ transportation infrastructure and the increasing demand for travel, the need for ongoing road preservation, safety, and mobility projects has continuously increased. However, due to the financially precarious condition of most states, the availability of funds for such improvements has progressively diminished. In order to meet the challenge posed by increasing demands and limited financial resources, the planning, prioritization, and design of transportation infrastructure must be examined critically to deliver the most effective transportation system to the system users (Stamatiadis & Hartman, 2011).

Typical planning and design approaches may prioritize projects at the planning and programming stage in order to best address system needs; however, infrastructure designs are then developed with the intent of delivering optimal projects. While some general financial constraints may be used, this design approach can often result in an improperly designed roadway. Such projects reduce the effectiveness of available funds. In order to fully address the needs of a city, state, or national transportation system, the current roadway design approach must be re-examined with an eye toward optimizing the entire transportation system, rather than
merely optimizing individual project outcomes. This approach aims to achieve a solution that would result in the maximum rate of return on the individual project and not the maximum return possible.

As a result of this change in thinking, a few states have established initiatives geared toward designing more appropriately sized roadways. Most notably, the Missouri DOT has initiated a process that critically reviews projects, which has resulted in more right-sized roadways (MODOT, 2007). Missouri officials have stated that they want fewer great roads and more good roads that make a great system. This approach also allowed the DOT to address more roadway needs on a compressed schedule. To implement their approach, called “Practical Design,” officials reviewed the existing design standards and revised them in a way that addresses their concept in a new design manual. The Kentucky Transportation Cabinet has approached this issue differently. In place of minimum standards, the existing condition is established as the baseline design. A positive outcome is achieved when a project results in improvements beyond the existing conditions. The result is a disciplined planning and design approach that is not encumbered by arbitrary design guidelines, and which allows a project to achieve up to the maximum rate of return on investment (Stamatiadis et al., 2008). The primary difference between Practical Design, the term used by the Missouri DOT, and Practical Solutions, the term used by the Kentucky Transportation Cabinet, is the approach. Practical Design provides set design guidance; Practical Solutions provides principles that guide the design.

The most critical component of Practical Solutions in planning and design is the definition and clarification of the initial project concept. This is the cornerstone of the project, and it significantly contains or reduces a project’s cost and impact. The idea is to develop a more efficient solution by focusing on the project needs (specific goals and objectives) rather than on stripping down components of a typical design. The concept is developed with a clear understanding of the project objectives, and designed to address those objectives while balancing project factors and elements. This approach enables a complete examination and resolution of issues instead of simply identifying elements in piecemeal fashion for cost reduction.

Another focal point of Practical Solutions is how design guidelines and project needs are viewed. Rather than viewing design guidelines or performance measures as minimum thresholds that must be exceeded by the final design, Practical Solutions views them as targets for a design to achieve. Once the target is reached, increasing the investment (i.e. over-designing a project) will produce few or no additional benefits. When viewed as minimum thresholds, designs are often expanded to provide a better project, however, this often leads to improperly designed projects. Moreover, the funds spent on over-designed projects could have been directed toward other projects, which would have produced a much higher return on investment.
As with any project development process, the ultimate objective is to develop a project that addresses mobility, safety, community, and environmental goals. The Practical Solutions approach encourages the designer to use creative design and move away from the typical cross-section concept. Designers are frequently called upon to develop a solution that will consider and address conflicting elements by designing a roadway that balances these elements and constraints. Developing a new set of design element standards is unnecessary if Practical Solutions are to successfully realize their potential benefits. What is required is a procedure that assures that project goals/objectives are targeted using an accepted solution that balances all issues and constraints and identifies the points of diminishing returns for the project's elements.

**Performance Based Design**

Traditionally, efforts to achieve optimal solutions through flexible design approaches, such as CSS and practical design, have been met with fears regarding liability and safety concerns. However, applications of flexible design have increased as a result of better understanding of the substantive safety concept. This is related to the introduction of performance-based analysis tools that can be used to evaluate the ultimate operational and safety performance of a geometric design. These tools include the Interactive Highway Safety and Design Model, the Highway Safety Manual (AASHTO, 2010), FHWA’s Speed Concepts: Informational Guide (Donnell et al., 2009), and the most recent edition of the *Highway Capacity Manual* (TRB, 2010), which includes interactive relationships between vehicle, pedestrian, and transit modes on urban corridors. Based on the availability of these tools, it is now possible to design and analyze a roadway so that individual user needs are addressed within an economically or environmentally constrained location without merely selecting minimum design elements.

**Complete Streets**

Traditional street design in the United States has focused on moving vehicular traffic, with little regard to the roadway type or surrounding context. In recent years, a more comprehensive view of transportation users has been developed. The user categories include modes that are more diverse and the design approach reflects other considerations, such as public health, air quality, climate change, and neighborhood revitalization. In response to these ideas, Complete Streets aims to create more transportation choices while maintaining safety for each.

The National Complete Streets Coalition, which was established in 2005, recommends that Complete Streets be designed for the safe access and travel by pedestrians, bicyclists, motorists, transit users, and travelers of all ages and abilities (Reed & Baker, 2010). There are a
number of typical elements to consider when designing a Complete Street, and they may vary based on the roadway type and area context, including: pedestrian facilities (sidewalks, shared-use paths, crosswalks, median islands for refuge, pedestrian signals); bicycle facilities (paved shoulders, bicycle lanes, shared-use paths); and transit facilities (designated bus lanes, safe and accessible transit stops). Other roadway considerations include lane/median/shoulder width, turning lanes, curb extensions, and parking. The key to Complete Streets is balancing safety and convenience for the full cross-section of transportation users.

SUMMARY
The literature examined here indicates that FCS has assumed additional significance beyond its original purpose. While the FCS has been considered essential for defining the roadway network and identifying users' design expectations, several issues can arise in its application, due to its general nature and broad-brush approach. Even though the urban/rural classification is essential in assigning jurisdictional roles, operational needs and funding allocation, it does not provide the perspective required to implement contextual design.

For the past four decades, the FCS has anchored roadway design and project development for conventional transportation planning processes in the United States. It was intended to establish a functional framework that would enable design decisions equipped to address the full range of motorists needs for the street and road network, creating a reliable roadway system where travel purpose and roadway facility design had a clear and intuitive relationship. The FCS greatly expedited the development of the Interstate Highway and NHS and facilitated project delivery by establishing a straightforward system that let individual highway projects be analyzed and evaluated in the context of the larger transportation system.

As the role of flexible design in the project development process increased — with community needs viewed through the prism of context sensitive design/solutions and economic and system performance understood through Practical Design — the need to accommodate a wider range of design parameters has become apparent. At the heart of this issue is the recognition that streets and roads play a much larger role in the community and have a far greater impact, one that reaches beyond the edges of the pavement and which addresses the competing needs of access and mobility. This includes the demand to accommodate other modes such as pedestrian, bicycle, transit and others, as well as activity zones that serve commercial centers in the roadside environment. As the FCS dictates design, both directly through policy documents such as the Green Book and individual state policies, as well as indirectly by influencing practitioners' design choices, it is clear that the FCS falls short of addressing all these needs. This
is evidenced by its failure to recognize other modes of transportation, and through the limited context definition provided by the urban/rural classification. While procedures are in place to address these issues, such as the use of design exceptions, it is apparent that these are the exceptions — not the rule.
CHAPTER 3
EXISTING CLASSIFICATION USES

As part of this project, a survey was administered to state agencies and practicing professionals who deal with functional classification issues. The main goal of the survey was to establish how agencies practice functional classification and to identify how its implications and potential issues manifest in design. A secondary goal was to identify new efforts that agencies have pursued toward exploring an alternative classification system.

The survey was designed to first solicit information on the existing classification systems and then to identify possible new systems that agencies are considering. The survey was distributed to the AASHTO Committees on Design and Planning as well as to various other organizations including National Association of City Transportation Officials (NACTO), Association of Pedestrian and Bicycle Professionals, Center for New Urbanism (CNU), and ITE. Their responses are summarized in this chapter.

PARTICIPANT INFORMATION
A total of 267 participants responded to the survey. A plurality of respondents (39%) were employed in a state agency (representing at least 38 states, as shown in Figure 7), followed by consultants (32%) and city agencies (18%). There was an almost even split regarding the primary area of practice between design (50%) and planning (58%), with a smaller percentage (10%) indicating programming as their primary area (note: participants could select more than one entry). A significant number of respondents considered themselves part of upper management (20%), with nearly as large percentages indicating they were division managers (17%) or branch/section managers (16%). A significant portion (23%) also indicated they were project managers. A majority of the respondents (82%) had over 10 years of experience.

CLASSIFICATION SYSTEM IMPACTS
The next section of the survey asked about the influence of the FCS on project development activities. Responses were grouped into five areas: programming, planning, design, construction, and maintenance and operations. Each group was analyzed separately to determine whether specific issues arose within each phase. For all phases, many of the participants (close to or over 50%) indicated that federal reporting has an influence (or requirement) on the current system.
Figure 7 State DOTs responding to survey

*Programming*

Figure 8 shows the responses for the Programming phase. The majority of the respondents indicated that impacts were observable in the project definition or scope (81%). All other areas also exhibited large reported impacts. Additional comments indicated the potential for establishing design standards during this phase, and also noted that possible conflicts between state and local jurisdictions could arise over whether project design standards undermine community goals.
**Planning**

Figure 9 shows the responses for the Planning phase. The majority of the respondents indicated that impacts could be noted in the planning (84%) and development of the purpose and need statement (65%) as well as in corridor definition (62%). Functional classification may also impact project definition (62%) and project prioritization (48%). Public involvement and modal alternative evaluation also garnered a significant number of responses.

**Design**

Figure 10 presents the responses for the Design phase. The majority of the respondents answered that impacts could be noted in the selection of the design parameters (90%) and corridor definition (64%). Evaluation of alternative alignments (63%) and public involvement (39%) also ranked highly.
Planning

Purpose and Need

Project Definition

Prioritization

Corridor Definition

Alternative Evaluation-Analysis

Public Involvement

Federal Reporting

Other (please specify)

Figure 9 Effects of classification on Planning

Corridor Definition

Project Definition

Alternative Evaluation-Analysis

Public Involvement

Federal Reporting

Other (please specify)

Figure 10 Effects of classification on Design
**Construction**

Figure 11 presents the responses for the Construction phase. The majority of the respondents observed that impacts could be noted in the selection of the maintenance of traffic options (77%) and federal reporting (40%). Project scheduling (33%) also ranked highly.

![Figure 11 Effects of classification on Construction](image)

**Maintenance and Operations**

Figure 12 presents the responses for the Maintenance and Operations phase. The majority of the respondents indicated that impacts could be noted in the development of signal operations plans (60%) and scheduling of resurfacing (51%). Removal of snow or ice also ranked highly (45%).

![Figure 12 Effects of classification on Maintenance and Operations](image)
Design-Related Issues

The next question assessed the effectiveness of the FCS on various aspects of the design process. Participants evaluated its effectiveness on a 5-point scale. A weighted average was computed for each item with scores of 1 for “Not effective” and 5 for “Very effective”.

Average scores for all facets of the design process were above 2.5. This demonstrates that the FCS is somewhat (more than moderately) effective in addressing the issue of concern (Table 3). The design processes that scored the lowest were for providing guidance for transit, bikes and/or pedestrians (2.6), and for guidance on design decisions to balance modal benefits (2.6). An array of other issues has been identified with a low score of 1.9 indicating that the FCS does not effectively address them. Included in this category were the lack of distinction for suburban roadways, the lack of better classification for urban areas, no recognition of main streets requiring both mobility and access, the use of typical templates that do not reflect the classification (10 responses), the emphasis on vehicular needs and lack of consideration of other modes (16 responses), the lack of distinction between local and regional travel, issues with funding formulas, and the disconnect between (planned) land use and classification (8 responses).

Table 3 Summary of scores for FCS assessment

<table>
<thead>
<tr>
<th>Design Process Aspect</th>
<th>Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serving land use/context functions or needs</td>
<td>2.8</td>
</tr>
<tr>
<td>Guidance of design decisions involving transit, bikes, and/or pedestrians</td>
<td>2.6</td>
</tr>
<tr>
<td>Guidance of design decisions to balance modal benefits</td>
<td>2.6</td>
</tr>
<tr>
<td>Appropriate/optimal design elements for particular roadways</td>
<td>3.0</td>
</tr>
<tr>
<td>Ability to communicate with public</td>
<td>2.9</td>
</tr>
<tr>
<td>Differentiation of roadway classifications</td>
<td>3.5</td>
</tr>
<tr>
<td>Accurately describe and define roadway function</td>
<td>3.2</td>
</tr>
<tr>
<td>Collaborative planning with local agencies</td>
<td>3.1</td>
</tr>
<tr>
<td>Other</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Design Exception Controlling Criteria

Another question asked about the potential impact of the FCS on specific design criteria, specifically, the 13 controlling criteria used in design exceptions. Most of the respondents replied that their agency uses functional classification scheme-based criteria for design speed (67%), lane width (67%), and shoulder width (59%). For the remaining criteria, the response rate was approximately 50%, indicating that there is a large number of agencies that do not use criteria
based on functional classification. However, only 45% of the respondents answered this question. This could possibly indicate that these issues are so embedded in the culture that alternatives have not been considered.

**Functional Classification as Impediment**

The next question asked respondents to identify cases or examples where the FCS impeded the delivery of a context sensitive solution on a project. A total of 82 respondents (of the 187 responding to the question) indicated that the FCS had impeded designs. The comments are summarized in the following categories:

1. Urban designs result from urban designation of the roadway, which do not reflect the land use or development along the corridor. Frequently this necessitates higher design speeds that may conflict with community goals and needs.
2. The FCS requires the use of design exceptions to address roadway context. State and FHWA regional engineers may not see this favorably.
3. Practitioners use the FCS as a shortcut to select design values and this often conflicts with the roadway context. This in turn could result in contextual designs incompatible with community plans and land use goals.
4. Lane widths in urban areas are seen as fairly restrictive (as per the Green Book). This results in issues with local communities, especially where highways traverse built-up areas that have a rural classification but where the community desires a less rural design.
5. There is a lack of modal balance that specifically addresses the need for bicycles, pedestrians, and transit. Take for example a high-speed arterial through a main street with on-street parking and significant pedestrian traffic — this eliminates the possibility of bicycle lanes or dedicated transit facilities.
6. Corner radii result in higher turning speeds that affect pedestrian and bicycle safety.
7. Classification prohibits measures aimed at reducing speeds, such as medians with trees or gateway islands where a rural route enters a village.
8. There is a lack of subcategories in the Collector and Local classes. This is problematic, given that these deal with a great variety of contexts and require different roadside treatments.
9. There is no classification for suburban context.
10. There is no recognition of the Main Street concept for small rural communities, where, for example, a narrower cross section may be required to accommodate existing buildings and desired street parking, wider sidewalks, landscaping, and seating areas.

Of interest here are two responses that have a common theme. The first is from the Oregon DOT, where functional classification is augmented with: 1) the needs of potential users and 2) context before design features are defined. The second is from an anonymous user who promotes the idea of defining the purpose of the road, then balancing various user needs.

ALTERNATIVE FUNCTIONAL CLASSIFICATION

The next section of the survey queried for the presence of alternative classification systems and their effects on design. Twenty-eight respondents noted that their agency uses an alternative system. However, several were from the same agency (or state). As such, the total number of alternative systems is lower. The survey also asked for reasons why the alternative scheme was being developed. Most of the answers indicated the desire to address local needs, to provide for greater flexibility among categories, to better match land use, to address complete street functions and designs, to better define urban context and multimodal options, and to incorporate context sensitive design. A respondent from the Washington DOT indicated that the agency is in the process of developing an alternative classification system, which is anticipated to be in place in 2016.

To further explore the reasons underwriting the development of the alternative classification systems, the next question attempted to identify the specific shortcomings to be addressed by the respondent’s proposed systems. Most indicated the need to: 1) accommodate other modes, and 2) introduce context definitions for urban and suburban areas. Some also referenced CSS.
CHAPTER 4
ALTERNATIVE CLASSIFICATION SYSTEMS

EXISTING ALTERNATIVE CLASSIFICATION SYSTEMS
The project team identified 17 recently developed systems that rethink or have developed alternatives to the current FCS. After reviewing all 17, ten were selected for detailed investigation because they had improved context definition, accommodated modes in a holistic manner, or had design guidance based on context and roadway type. These systems represent the breadth of thinking on the subject, and have good geographic and jurisdictional distribution.

This section identifies alternative classification systems that agencies have implemented to address the shortcomings of the FCS. The various factors considered in each classification system are identified to determine how they define context. Other elements — beyond the access and mobility criteria currently used — are identified as well. Criteria were developed to evaluate the nine alternative classification systems. They focused on the following questions:

- How is context defined?
  - This addresses the range of contexts considered and the required data used to define them.

- How are modes accommodated?
  - This considers the efforts undertaken to address all users including vehicles, pedestrians, bicycles, transit, and any special users (e.g. trucks).

- How does the classification system impact geometric design?
  - This evaluates the impact of the system on the design choices and identifies the elements required to address potential modal priorities.

- What is the road function?
  - This identifies the roadway categories and their associated definitions as it relates to the overall roadway function within the transportation network.

Further, the strengths and weaknesses of each system are described. This discussion highlights which components could be incorporated into the proposed alternative system. The following systems are discussed in alphabetical order:

1. Arterial Streets Towards Sustainability (ARTISTS), European Union;
3. City of Charlotte, Urban Street Design Guidelines, North Carolina;
4. City of Chicago, Complete Streets Chicago, Illinois Department of Transportation;
5. ITE-CNU Designing Walkable Urban Thoroughfares, Institute of Transportation Engineers and Congress for New Urbanism;
6. Massachusetts, Project Development and Design Guide, Highway Division of the Massachusetts Department of Transportation (MassHighway);
7. Minnesota, Guide under Development, Minnesota DOT;
8. NACTO Urban Street Design Guide, NACTO;
9. Oregon, Highway Design Manual, Oregon DOT; and

The seven systems that were considered but not fully discussed here include:

1. Abu Dhabi, Urban Street Design Manual, Abu Dhabi, United Arab Emirates;
2. California, Main Street California: A Guide for Improving Community and Transportation Vitality, California DOT (Caltrans);
4. Los Angeles, LA Model Design Manual for Living Streets, LA County Department of Public Health;
5. United Kingdom, UK Manual for Streets, UK Department of Transport;
6. Vermont, Vermont State Design Standards, Vermont Agency of Transportation; and

ARTISTS
The Arterial Streets Towards Sustainability (ARTISTS) research initiative was sponsored by the European Union in 2004. It proposed a classification system that was sensitive to all users, not just vehicles. Underpinning it is a critical perspective that differs somewhat from what is used in the United States. ARTISTS began with the premise that urban street planning, design, and management lacks an adequate set of standards or parameters for arterial streets, even though these are critical components of urban transportation systems. A primary criticism of the United States’ FCS is that it is based on neither urban nor rural principles and thus ignores environmental context, with arterials in
the dominant position in a roadway hierarchy. More information can be found at http://www.transport-research.info/web/projects/project_details.cfm?id=14838.

What principally motivated the ARTISTS project was the growing recognition among national and local authorities that classifications do not always reflect actual street uses. Before this, the classification of streets in Europe arose from a similar need to define an overall system taxonomy, comparable to what the United States expressed in its 1968 and 1973 Federal-Aid highway legislation. These classification systems used identified streets to rebuild so they would primarily serve an automobile-oriented function, even if these streets were in a community context that generated a broader range of travel modes and roadway users. The ARTISTS project sought to acknowledge the role of streets as public spaces, especially as many of the streets that it studied had originally been constructed with civic purposes in mind and before widespread automobile use (Marshall et al., 2004).

**Context Definition**

The ARTISTS approach looks specifically at “arterial streets,” which are defined as “major streets that are multi-functional — combining a strategic network role with space for other activities, such as crossing movements, shopping, socializing, and other urban activities.” (Marshall et al., 2004) Examining these streets more closely, the ARTISTS approach scrutinizes arterial streets along two axes of context:

- **Link status** — the relative significance of a street section as a link in the network. The link status describes the significance of a street section as a component of the roadway network, with national and regional routes carrying greater weight in this system than city-specific or local routes.

- **Place status** — the relative significance of a street section as an urban place in the whole urban area.

If a street segment has a higher link status, more emphasis/street space may be allocated to through traffic, whereas a street segment with a higher place status may confer more emphasis/street space to pedestrians and other street activities (Figure 13).

ARTISTS uses two dimensions to describe a street rather than the one-dimensional lines they are often simplified into. This reinforces the possibility of the street as a “place” and works against the continued representation of the street as linear. Combined with the “place” status, this introduces a community context dimension absent from the FCS model, and recognizes that arterial streets are important community elements beyond transportation. This allows a model that gives the roadway
system (links) and context (places) equal weight in determining network importance and design criteria for streets.

Figure 13 Link and place axes of arterial streets

Road Function
The ARTISTS initiative was a research effort that provided a general outline for a more holistic and inclusive roadway classification system but in and of itself did not establish or codify one that has become official guidance. Critically, the ARTISTS classification model was presented as an extension of existing engineering-based classification systems, not as a total replacement. This is important in that it retains the technical expertise of transportation planners and engineers, but creates a framework by which these professionals share decision-making responsibility with urban planners. Figure 14 shows a classification table that a city could use to apply the ARTISTS

Figure 14 ARTISTS street classification table
approach to its city context. Types of streets are laid out according to their relative association with the “link” and “place” axes of the ARTISTS approach.

Modal Considerations
One of the most notable principles in the manual is its recommendation of a user-based hierarchy instead of conventionally classifying roads strictly based on their transportation function. This situates the pedestrian as the priority user on many residential streets, but also includes cyclists and vehicle parking as well as moving vehicles. The outcome of this approach is a separate set of design concerns for streets serving residential land uses, suspending the more conventional design factors for travel speeds and vehicle-carrying capacity on these streets in favor of factors that promote safety, control speeds, and accommodate the expected range of users. However, a specific modal hierarchy outside of this user-based focus is assigned at the discretion of the stakeholder applying the ARTISTS approach.

Design Elements
The ARTISTS framework does not provide specific design recommendations but instead outlines the decision-making process that its system is congruent with. This begins with an understanding that street design must consider both physical fit (i.e., is there actual space to accommodate different uses) and compatible use (i.e., the suitability for different uses to be located near each other). Considering the status of “link” and “place” for the street segment, the available street space, existing constraints, and existing users and interests adjudicate decisions between uses that conflict in the same street space. The ARTISTS approach emphasizes stakeholder outreach and sustainability to guide the design decision-making process, which aligns with the overall user-centered approach to ARTISTS. A flowchart of the design decision-making process is shown in Figure 15.
Strengths and Weaknesses
The ARTISTS approach main strength is flexibility. By keeping the underlying foundation of its viewpoint simple, mainly the dual attributes of “link” and “place,” the ARTISTS approach facilitates its application to a wide variety of existing street classification systems, allowing agencies and users to examine their streets through a new lens without completely overhauling their existing methodology. This flexibility means that the ARTISTS approach is very high level without outlining specific classifications or advancing particular design recommendations. Decisions about these are instead left to the decision maker who must use the ARTISTS approach as a loose guide that is used to inform design decisions.

In addition, by focusing attention on the individual, the ARTISTS approach takes the consideration away from individual modes and shifts it to the people within those modes. Thus, forcing street designers to remember who they are planning for makes their task more human-centered and grounds the decision-making process in questions of usability rather than just efficiency.

While the ARTISTS system provides a well thought out approach to classification, the system relies on an underlying classification and is narrowly focused on urban areas and arterial...
streets. Expansion of the concept to other contexts and roadway types may present an overly complex systems as ARTISTS identifies 25 unique place and link statuses for a singular roadway type and context. Furthermore, there is a lack of direct connection to design recommendations under the scope of this research. This system can be used to provide guidance and design element selection when overlaid to other alternative systems, but falls short in addressing the full context and user demands necessitated by the research objective.

*AustRoads Design Guide*

The road transportation and traffic agencies of Australia and New Zealand collaborate under the AustRoads association. Together they have developed a guidance document on road design. The organization has taken a similar approach to roadway classification as certain context sensitive design examples in the United States, referring to these as the Design Domain concept. Design Domain uses principles closely related to the Practical Design concepts in the United States, with “emphasis on developing appropriate and cost-effective designs rather than providing a design that simply meets 'standards'.” More information can be found at [http://www.austroads.com.au/road-construction/road-design/resources/guide-to-road-design](http://www.austroads.com.au/road-construction/road-design/resources/guide-to-road-design).

*Context Definition*

AustRoads’ Design Domains are based on the context established by the surrounding land use. A range of land uses, varying from extremely rural to the urban core, is used to understand the context in which the road segment is placed. Adapted from the U.S. Smart Code, Figure 16 shows six main context categories that can be used to describe the road context from very rural to the urban core (www.smartcodecentral.org).
Road Function
The guide recognizes many of the same factors in the FCS that more innovative American guidance documents have also articulated. The AustRoads Guide states “the functional classification of urban roads is usually less clear than that of rural roads, as urban roads generally are flanked by dense development that requires frequent access at the boundary of the road. Historical requirements for curbside parking and other uses (e.g. public transport routes or bicycle routes) further complicate functional definitions.” The FCS designation strikes at the guide’s core, although it emphasizes that all urban streets have a complex transportation function that requires thoughtful consideration, which entails going beyond a reliance on typical standards. By following the Design Domain concept, designers are, as previously noted, encouraged to create appropriate designs, and functional classification is relegated to a later discussion outside of the Design Domain text. Indeed, the principal references that the Guide makes to urban functional classification draw from references in U.S. documents and they adopt the FHWA model as a means of organizing individual roads within the overall system (Table 4 and 5).
Table 4 AustRoads functional classification of rural roads

<table>
<thead>
<tr>
<th>Road Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arterial Roads</strong></td>
<td></td>
</tr>
<tr>
<td>Class 1</td>
<td>Those roads, which form the principal avenues for communications between major regions, including direct connections between capital cities.</td>
</tr>
</tbody>
</table>
| Class 2             | Those roads, not being Class 1, whose main function is to form the principal avenue of communication for movements between:  
  - A capital city and adjoining states and their capital cities; or  
  - A capital city and key towns; or  
  - Key towns |
| Class 3             | Those roads, not being Class 1 or 2, whose main function is to form an avenue of communication for movements:  
  - Between important centers and the Class 1 and Class 2 roads and/or key towns; or  
  - Between important centers; or  
  - Of an arterial nature within a town in a rural area. |
| **Local Roads**     |             |
| Class 4             | Those roads, not being Class 1, 2, or 3, whose main function is to provide access to abutting property (including property within a town in a rural area). |
| Class 5             | Those roads, which provide almost exclusively for one activity or function, which cannot be assigned to Classes 1 to 4. |

Table 5 AustRoads functional classification of urban roads

<table>
<thead>
<tr>
<th>Type of Road</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled access highways (motorways or freeways)</td>
<td>Motorways and freeways have an exclusive function to carry traffic within cities and to ensure the continuity of the national or regional primary road system. As they are designed to accommodate through traffic, they do not offer pedestrian or frontage access.</td>
</tr>
<tr>
<td>Urban arterial roads</td>
<td>Urban arterial roads have a predominant function to carry traffic but also serve other functions. They form the primary road network and link main districts of the urban area. Arterial roads that perform a secondary function are sometimes referred to as sub-arterial roads.</td>
</tr>
<tr>
<td>Urban collector/distributor roads</td>
<td>These are local streets that have a greater role than others in connecting contained urban areas (e.g., residential areas, activity areas) to the arterial road system. Generally, consideration of environment and local life predominate and improved amenity is encouraged over the use of vehicles on these roads.</td>
</tr>
<tr>
<td>Urban local roads</td>
<td>These are roads intended exclusively for access with no through traffic function.</td>
</tr>
</tbody>
</table>

Modal Considerations

The Guide identifies three categories of road users:

- Users of motorized vehicles such as trucks, buses, cars, and motorcycles;
- Users of non-motorized or low-powered vehicles such as bicycles and powered wheelchairs; and
- Pedestrians.
The last two groups are classified as vulnerable and, at times, need independent facilities, but the Guide does not include a modal hierarchy.

**Design Elements**

The AustRoads Guide de-emphasizes the use of a classification system in roadway design. Instead, it describes the following considerations for designing a thoroughfare:

1. Strategic fit with relevant government policies, strategies and plans;
2. The nature and magnitude of transportation demand on a particular roadway;
3. Road safety;
4. Community views and expectations;
5. Travel times and costs;
6. Freight costs;
7. Public transport provision; and

Each of these eight categories is then discussed in greater detail throughout the Design Guide, with specific guidance on how they should influence particular design controls. However, these are organized at a general level under the Design Domain concept. Designers are asked to consider all design elements and find the best fit for the roadway's functional demands — and not simply follow standards or view design projects as merely the sum total of their parts. The Guide offers a process summarized in the following illustration and notes.

In addition to normal design domain, the AustRoads Guide introduces the Extended Design Domain (EDD). EDD is a range of design values below the minimum values traditionally specified for new roads in road design guidelines. Where used, EDD refers only to this extended range of values. The EDD concept uses values smaller than the practical lower limit in certain circumstances, provided they could be justified and defended based on engineering grounds and operating experience (Table 6). Use of the EDD’s values should be supported by a documented risk assessment that

- Justifies and recommends the values to be adopted for various design parameters.
- Demonstrates that adoption of lower values is in the overall community interest with respect to investment strategies, road safety strategies, and other strategies that relate to roads and road networks.
• Verifies that responsibility for the use of values within the EDD is taken corporately by the relevant road authority and is not placed on an individual designer.

Table 6 Normal and EDD

<table>
<thead>
<tr>
<th>Normal Design Domain</th>
<th>Extended Design Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>New construction ('green field' sites)</td>
<td>Assessment of existing roads.</td>
</tr>
<tr>
<td>Significant lengths of reconstruction of existing roads.</td>
<td>Improving the standard of existing roads in constrained situations.</td>
</tr>
<tr>
<td>New carriageway of a duplication.</td>
<td>New carriageway of a duplication in constrained situations.</td>
</tr>
<tr>
<td></td>
<td>Temporary situations (e.g. projects where it is known that imminent development will cause a permanent reduction in the operating speed).</td>
</tr>
</tbody>
</table>

The Design Domain is composed of a Normal Design Domain and an EDD, as illustrated in Figure 17. The lower regions of the Design Domain include values that are generally viewed as less safe or less efficient, but usually less expensive than those in the upper regions of the domain. Designers are encouraged to base their decisions on which values to adopt by using objective data on the changes in cost, safety, and levels of service prompted by changes in the design, together with cost–benefit analyses. Such data are not always available, particularly data that relate changes in the values associated with specific design elements and parameters to safety performance. Designers should therefore refer to relevant documents, including the AustRoad Design Guide and research reports, to assess the potential effects of changing values for the various design elements involved. An example of this concept is shown in Figure 18. The value limits for a particular criterion define the absolute range of values that it may be assigned. The design domain for a particular criterion encompasses the range of values, within these limits, that may practically be assigned to it.
Strengths and Weaknesses
The strongest statement in the Guide is “The Design Domain approach places emphasis on developing appropriate and cost-effective designs rather than providing a design that simply meets 'standards'.”
A major weakness is the heavy influence of U.S. standards reflected in the functional classification.

City of Charlotte
In 2007, Charlotte, North Carolina adopted a local set of design guidelines, the *Urban Street Design Guidelines*, which reflected the imprint of the Smart Growth and Context Sensitive Design movements from the 1990s and 2000s. These guidelines emerged in part as a means to implement the general goals and objectives of Charlotte’s Centers, Corridors, and Wedges regional growth policy as well as its Transportation Action Plan. These long-term plans envision transforming Charlotte into a thoroughly multimodal community. With respect to infrastructure investment, the plans clearly distinguish between areas of redevelopment and areas of neighborhood preservation. Both of these policy documents have extended beyond the realm of serving vehicle traffic. The Centers, Corridors, and Wedges strategy identifies major corridors as the basis for redevelopment. More information can be found at [charmeck.org/city/charlotte/planning/AreaPlanning/CentersCorridorsWedges/Pages/Home.aspx](charmeck.org/city/charlotte/planning/AreaPlanning/CentersCorridorsWedges/Pages/Home.aspx).

With this larger framework of community transition in mind, Charlotte developed their *Urban Street Design Guidelines* as a tool for more explicitly recognizing community context in street design and to integrate more flexibility into the design process. The guidelines are also intended to more clearly account for non-motorized transportation options, especially given that the city recognized the necessity of facilitating transit use — even on its existing local bus network — once it began a long-term program of developing premium transit capital projects. More information can be found at [charmeck.org/city/charlotte/Transportation/PlansProjects/Pages/Urban%20Street%20Design%20Guidelines.aspx](charmeck.org/city/charlotte/Transportation/PlansProjects/Pages/Urban%20Street%20Design%20Guidelines.aspx).

The city’s guidelines generally follow a context sensitive design process and instruct designers to identify local context as a *first step*. After this is done, a street is classified into one of five major types. They use a different nomenclature than the conventional FHWA classification, and streets are classified independently of the guidelines.

**Context Definition**
In the Charlotte Guide, land use context is the first component of the six-step process that defines the street type classification and selects the best cross section of roadways (Figure 19). The step-wise guidance for a context-based street network defines street types by:

1. Defining the existing and future land use and urban design context;
2. Defining the existing and future transportation context;
3. Identifying deficiencies;
4. Describing future objectives;
5. Recommending street classification and testing initial cross-section; and
6. Describing trade-offs and selecting cross-section.

Within a larger regional framework, Charlotte defined their long-term growth strategies under a framework for activity centers, growth corridors, and wedges - beginning in the 1990s. Figure 20 depicts the 2010 contexts. Under this framework the guidelines further elaborate upon these land use contexts, which are defined in the following manner:

- Transit Station Areas;
- Centers;
• Corridors;
• Non-residential uses (Areas of only commercial and office uses);
• Residential areas with more than five dwelling units per acre; and
• Residential areas with fewer than five dwelling units per acre.

Figure 20 Activity centers, corridors, and wedges growth framework

The connection between land use context and street type is described in Table 7.
Table 7 Connection between land use context and street type

<table>
<thead>
<tr>
<th>Land Use Context</th>
<th>Street Types</th>
<th>Link between Land Use Context and Street Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity Centers</td>
<td>• Main Streets</td>
<td>• Main Streets serve as pedestrian oriented activity centers, walking receives the highest priority of all the transport modes although they also serve transit, bicyclists, and automobiles.</td>
</tr>
<tr>
<td></td>
<td>• Avenues</td>
<td>• Avenues are found in a wide variety of land use contexts.</td>
</tr>
<tr>
<td></td>
<td>• Local Streets</td>
<td>• Local Office/Commercial Streets will apply to developments ranging from very pedestrian-oriented retail locations (similar to Main Streets) to business parks. The goal is to create a convenient and safe network of well-designed streets.</td>
</tr>
<tr>
<td>Transit Station Areas</td>
<td>• Local Streets</td>
<td>• Local Office/Commercial Streets will apply to developments ranging from very pedestrian-oriented retail locations (similar to Main Streets) to business parks. The goal is to create a convenient and safe network of well-designed streets.</td>
</tr>
<tr>
<td>Growth Corridors</td>
<td>• Avenues</td>
<td>• Avenues are found in a wide variety of land use contexts.</td>
</tr>
<tr>
<td></td>
<td>• Boulevards</td>
<td>• Boulevards are found in a variety of land uses and development intensities context but are not suited for land uses that would foster high volumes of pedestrians crossing from one side of the street to the other.</td>
</tr>
<tr>
<td></td>
<td>• Parkways</td>
<td>• Parkway design is better matched to land uses that depend on vehicle accessibility; types of uses may include regional or community malls, industrial or office parks, and some types of office/mixed-use/multi-use centers. Once a high level of pedestrian activity is developed roadways should be oriented away from the Parkway design.</td>
</tr>
<tr>
<td>Non-Residential Use</td>
<td>• Avenues</td>
<td>• Avenues are found in a wide variety of land use contexts.</td>
</tr>
<tr>
<td></td>
<td>• Boulevards</td>
<td>• Boulevards are found in a variety of land uses and development intensities but context are not suited for land uses that would foster high volumes of pedestrians crossing from one side of the street to the other.</td>
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</tr>
<tr>
<td>Residential Uses</td>
<td>• Avenues</td>
<td>• Avenues provide access from neighborhoods to other areas and infrequently through neighborhoods</td>
</tr>
<tr>
<td>(High Density)</td>
<td>• Local Streets</td>
<td>• Local Streets provide direct access to sites or land uses. Predominant land use along Local Residential Streets will be either single family or multi-family housing, with a full range of possible densities.</td>
</tr>
<tr>
<td>Residential Uses</td>
<td>• Avenues</td>
<td>• Avenues provide access from neighborhoods to other areas and infrequently through neighborhoods.</td>
</tr>
<tr>
<td>(Low Density)</td>
<td>• Local Streets</td>
<td>• Local Streets provide direct access to sites or land uses. Predominant land use along Local Residential Streets will be either single family or multi-family housing, with a full range of possible densities.</td>
</tr>
</tbody>
</table>
Road Function

Charlotte’s *Urban Streets Design Guidelines* define five street types that overlay atop existing classifications as the North Carolina DOT moves away from the traditional thoroughfare planning process. The terminology used and the way in which street types are presented in the guidelines, without specific reference to the FCS, is a new classification scheme for the street network. The five street types defined in the design guidelines are:

- **Main Streets** are “destination streets” that provide access to and function as centers of civic, social, and commercial activity. Main Streets are designed to provide the highest level of comfort, security, and access for pedestrians. Development along Main Streets is dense and focused toward pedestrian traffic. Because of their specialized function and context they represent a relatively small portion of Charlotte’s street network.

- **Avenues** serve a diverse set of functions in a wide variety of land use contexts, providing access from neighborhoods to commercial areas, and occasionally through neighborhoods. Avenues are the most common (non-local) street type in Charlotte serving a collector/connector function.

- **Boulevards** are designed to move larger volumes of vehicles as through traffic. Maintaining vehicular movement is a higher priority than with an Avenue, but safe travel for pedestrians and cyclists is still included in the design.

- **Parkways** are the most auto-oriented of the street types. Their primary function is to move motor vehicles within the city and region; parkways are also one of the least common street types in the City of Charlotte.

- **Local Streets** are the most common street type and provide access to residential, industrial, or commercial districts, as well as to mixed-use areas. Local streets have low vehicle volumes and provide safe travel for pedestrians and bicyclists. The guide outlines multiple cross-section designs to accommodate the range in local street right-of-way widths and adjacent land uses.

**Relationship to FHWA Functional Classification**

With the exception of Avenues and Local Streets, none of the streets types described in the guidelines have an explicit function akin to the FHWA classification (Table 8). The descriptions provided and the delineation of auto- and pedestrian-oriented street types suggest that Parkways
and Boulevards are similar to arterials, while Main Streets combine aspects of local and collector classifications.

Table 8 Charlotte Guide and FCS relationship

<table>
<thead>
<tr>
<th>FHWA Functional Classification</th>
<th>Charlotte Urban Streets Design Guidelines Street Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Main Street</td>
</tr>
<tr>
<td>Primary Arterial</td>
<td></td>
</tr>
<tr>
<td>Secondary Arterial</td>
<td></td>
</tr>
<tr>
<td>Collector</td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td></td>
</tr>
</tbody>
</table>

**Modal Considerations**

The Charlotte guidelines emphasize that streets are to be evaluated based on how they serve different groups, including motorists, pedestrians (and transit riders), transit operators, bicyclists, and people who live/work or use adjacent land. Guidelines describe the primary design expectations and design elements of each modal group (Table 9). Additionally, the guidelines acknowledge the conflicting expectations of user groups and suggest some design elements that can be used to alleviate these conflicts within reasonable limits to maintain safety.
<table>
<thead>
<tr>
<th>User Group</th>
<th>Roadway Design Expectations</th>
<th>Design Elements Developed to Address Expectations</th>
</tr>
</thead>
</table>
| **Motorists** | • Minimal travel delays  
• Minimal conflicts (affecting both delay and safety)  
• Consistently designed facilities | • Adding through or turn lanes to increase capacity/reduce delay  
• Make operational changes, including providing more green signal time to streets with higher traffic volumes  
• Reducing the wait time at signalized intersections for those motorists on higher volume streets  
• Constructing grade-separated intersections and roundabouts, rather than signal or stop controlled intersections, limits motorist delay and increases traffic flow  
• Bus pullouts to separate stopping transit vehicles from the travel lane and help reduce delay  
• Turn lanes separate turning vehicles from the through traffic to potentially reduce rear-end collisions  
• Medians separate opposing traffic streams  
• Greater sight distances to “see and be seen”  
• Street lighting to improve overall visibility  
• Clear zone adjacent to the outside travel lane provides a measure of “forgiveness”, should a vehicle actually leave the travel lanes |
| **Pedestrians** | • Short walking distances  
• Separation (or buffer) from moving traffic  
• Aesthetically pleasing surroundings and amenities  
• Protect from the elements  
• Walking is as safe as possible | • Short blocks with marked intersections  
• Safe mid-block crossings on longer blocks  
• Continuous walkway systems that connect door fronts with transit stops or other destinations  
• Pedestrian Buffers:  
  • Planting strips  
  • Bicycle lanes  
  • Landscaping  
  • On-street parking  
  • Street lighting and pedestrian scale lighting  
  • Increasing pedestrian visibility from adjacent land uses (by placing windows/doors/“eyes on the street”)  
  • Managing driveway access to minimize and control the locations of turning cars  
  • Provide median pedestrian refuge islands or curb extensions, to break up crossings into more easily manageable parts  
  • Reduce the number of travel lanes to reduce overall travel distance  
  • Smaller curb radii  
  • Provide sufficient signal timing so pedestrians don’t feel “trapped in an intersection.”  
• Aesthetic Design:  
  • Benches  
  • Trash receptacles  
  • Landscaping  
  • Urban design for adjacent development |
| **Transit Operators** | • Enough space to operate and maneuver their vehicles  
• Minimal conflicts with other travelers and with features along the sides of the street  
• Minimal travel delays, to help keep route operating on time | • Wide travel lane  
• Wide corner turning radii  
• Street signs, utility poles and on-street parking located to maximize clearance for side mirrors  
• Adequate merging distances.  
• Safe locations for bus stops  
• Provide signal priority for transit vehicles at intersections |
### Table 9 (continued) Roadway design expectations and design elements by user group

<table>
<thead>
<tr>
<th>User Group</th>
<th>Roadway Design Expectations</th>
<th>Design Elements Developed to Address Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transit Riders</strong></td>
<td>• Accessible bus stops&lt;br&gt;• Easy transfer connections&lt;br&gt;• Personal comfort and security while waiting for the bus</td>
<td>• Street and pedestrian-scale lighting&lt;br&gt;• Transit stop locations that are not isolated from land uses and other people&lt;br&gt;• Increased visibility through urban design (windows and doorways that face onto the street)</td>
</tr>
<tr>
<td><strong>Bicyclists</strong></td>
<td>• Well-connected network of bicycling facilities&lt;br&gt;• Safe travel routes&lt;br&gt;• Direct travel routes&lt;br&gt;• Particularly when bicycling for work, shopping and errands</td>
<td>• Space to maneuver&lt;br&gt;5’ lane width preferred&lt;br&gt;6’ lane minimum next to parked cars or on an uphill slope&lt;br&gt;• Designated bike lanes&lt;br&gt;• Pavement markings&lt;br&gt;• Street lighting&lt;br&gt;• Bike boxes and bike signals at intersections&lt;br&gt;• Buffers from travel lanes and parked cars</td>
</tr>
<tr>
<td><strong>Stakeholders of Adjacent Land Uses (Context Relevant)</strong></td>
<td>• Lighting&lt;br&gt;• Safe and contained travel ways&lt;br&gt;• Driveways (for access to their properties)&lt;br&gt;• Trees and landscaping&lt;br&gt;• Site design (commercial properties)</td>
<td>• Traffic calming devices&lt;br&gt;• Low design speeds&lt;br&gt;• Safe and convenient pedestrian crossings&lt;br&gt;• Reduced street widths&lt;br&gt;• Stakeholders typically:&lt;br&gt;  Oppose access controls (limiting driveways)&lt;br&gt;  Oppose median&lt;br&gt;  Want Turn Lanes&lt;br&gt;  Want Median Breaks to provide access to commercial properties&lt;br&gt;• Site Design Elements:&lt;br&gt;  Direct sidewalks to the street&lt;br&gt;  Sidewalks between buildings&lt;br&gt;  Sidewalks to parking areas&lt;br&gt;• Sidewalk amenity zones&lt;br&gt;• High quality street furnishings</td>
</tr>
</tbody>
</table>

Street types are highly correlated with modal considerations in the guide, although no modal hierarchies are outlined specific to either context or functional classifications. The guidelines present a spectrum of pedestrian-oriented to auto-orientation of the street types shown in Figure 21.
Design Elements
Once the street types are defined for a corridor, the key design control is employed. Surrounding land use context is only employed to define block lengths and creek crossings, and for distinctions between residential and office/commercial uses along local streets.

The guidelines also define overlays such as the natural street and creek network. Incorporating the historical and existing stream network with land use contexts operates as a design control with respect to the crossings and block spacing. Regular intervals for creek crossings are outlined in Table 10. Typically, creek crossings should occur with the same frequency as pedestrian and bicycle crossings. In most areas this is at an interval of no more than 1300 feet.

Table 10 Land use contexts for creek overlay

<table>
<thead>
<tr>
<th>Land Use/Location</th>
<th>Creek Crossing Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit Station Areas¹</td>
<td>650’ - 1300’ spacing</td>
</tr>
<tr>
<td>Centers¹</td>
<td>650’ - 1300’ spacing</td>
</tr>
<tr>
<td>Corridors¹</td>
<td>650’ - 1300’ spacing</td>
</tr>
<tr>
<td>Non-Residential Uses²</td>
<td>650’ - 1300’ spacing</td>
</tr>
<tr>
<td>Residential ≥ 5 dua (gross)</td>
<td>650’ - 2600’ spacing</td>
</tr>
<tr>
<td>Residential &lt; 5 dua (gross)</td>
<td>1300’ - 2600’ spacing</td>
</tr>
</tbody>
</table>

The guidelines are specific about the design elements to be incorporated by street type. This includes explicit design elements that should not be incorporated into streets. Table 11 describes
the priority design elements, design elements to consider, and inappropriate design grouped by street type. Design elements are further partitioned for intersections according to street type.

<table>
<thead>
<tr>
<th>Street Type</th>
<th>Priority Design Elements</th>
<th>Appropriate / Other Design Elements to Consider</th>
<th>Inappropriate Design</th>
</tr>
</thead>
</table>
| **Main Street** | • Posted Speed: 25 mph  
• Design Speed: 25 mph  
• Number of Lanes: 2, 3 with intermittent turn lanes/median  
• Lane Width: 13 feet  
• Sidewalk Clear Zone: 10 feet  
• Sidewalk Amenity Zone: 8 feet (not including sidewalk)  
• On-Street Parking: 7 feet  
• Curb Extensions at Mid-Block Crossings  
• Pedestrian Scale Lighting  
• Block Length: 400 feet | • Traffic Calming  
• Mid-Block Pedestrian Crossings  
• Angled Parking  
• Medians, minimum 6 feet  
• Median Planting | • Bus Stops/Bus Zones along segments  
Short block lengths so stops should be located at intersections  
• Bike Lanes  
Low operating speeds and wider mixed travel lanes  
• Planting Strips  
• Driveways  
• Pedestrian Refuges |
| **Avenues** | • Posted Speed: 25 - 30 mph  
• Design Speed: 30 - 40 mph  
• Number of Lanes: 2 - 4  
3 or 5 for intermittent turn lanes / landscaped islands  
• Lane Width: 11 feet  
• Bicycle Lanes: 4 – 6 feet  
• Sidewalk Clear Zone: 6 feet minimum  
• Planting Strips: 8 feet  
• Bus Stops: Higher Volume local + express services  
• Curb Extensions at Mid-Block Crossings  
• Street Lighting  
• Pedestrian Scaled depending on surrounding land use  
• Block Length: 600 feet maximum | • Medians, minimum 16 feet  
• Median Planting  
• Medians as Pedestrian Refuges  
• On-street parking: 7 feet  
• Curb Extensions where there is on-street parking  
• Curb Extensions at Mid-Block Crossings  
• Minimize Driveways  
• Mid-Block Pedestrian Crossings  
• Street Lighting  
• Pedestrian Refuges  
• Sidewalk Amenity Zone: 8 feet (not including sidewalk)  
• Traffic Calming | • Shoulders |
Table 11 (continued) Street types and design elements for roadway segments

<table>
<thead>
<tr>
<th>Street Type</th>
<th>Priority Design Elements</th>
<th>Appropriate / Other Design Elements to Consider</th>
<th>Inappropriate Design</th>
</tr>
</thead>
</table>
| **Boulevard**        | • Posted Speed: 35 - 40 mph  
       • Design Speed: up to 45 mph  
       • Number of Lanes: 4  
       • Medians, minimum 17 feet  
       • Median Planting  
       • Bicycle Lanes: 4 – 6 feet  
       • Sidewalk Clear Zone: 5 feet minimum  
       • Planting Strips: 8 feet  
       • Street Lighting  
       • Pedestrian Scaled depending on surrounding land use  
       • Block Length: 1000 – 1200 feet | • Pedestrian Refuges  
       • On- street parking: 7 feet  
       • Double tree rows  
       • Driveways  
       • Utilities placed underground  
       • Bus Stops: Higher Volume local + express services  
       • Mid-Block Pedestrian Crossings  
       • Traffic Calming | • Sidewalk Amenity Zone  
       • Shoulder  
       • Curb Extensions |
| **Parkway**          | • Posted Speed: 45 - 50 mph  
       • Design Speed: up to 55 mph  
       • Number of Lanes: 4 – 6  
       • Lane Width: 11 – 12 feet  
       • Medians, minimum 20 feet  
       • Median Planting  
       • Shoulder  
       • Separated shared use path for walking / bicycling: 10 feet  
       • Sidewalk Clear Zone: 5 feet (constrained conditions)  
       • Planting Strips: 8 feet  
       • Street Lighting  
       • Pedestrian Scaled at bus stops or on separated path  
       • Block Length: ½ mile | • Bus stops with pull-outs Utilities out of pedestrian / bicycle clear zones | • Driveways  
       • Bicycle Lanes (not along shared use paths)  
       • Sidewalk Amenity Zone  
       • Curb Extensions  
       • Traffic Calming  
       • Mid-Block Pedestrian Crossings  
       • Pedestrian Refuges |
| **Local Residential Streets** | • Posted Speed: 25 mph  
       • Design Speed: 25 mph  
       • Number of Lanes: 2  
       • Lane Width: 12 - 14 feet  
       • Sidewalk Clear Zone: 5 - 8 feet  
       • On-Street Parking: 7 feet  
       • Curb Extensions at Mid-Block Crossings  
       • Street Lighting  
       • Bus Stops  
       • Planting Strips  
       • Swales (storm water management)  
       • Driveways  
       • Traffic Calming  
       • Block Length: based on land use context | • Medians, minimum 8 feet  
       • Median Planting  
       • Sidewalk Amenity Zone | • Pedestrian Refuges  
       • Curb Extensions  
       • Bike Lanes  
       • Shoulder  
       • Mid-Block Pedestrian Crossings |
Table 11 (continued) Street types and design elements for roadway segments

<table>
<thead>
<tr>
<th>Street Type</th>
<th>Priority Design Elements</th>
<th>Appropriate / Other Design Elements to Consider</th>
<th>Inappropriate Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Commercial Roads</td>
<td>- Posted Speed: 25 mph&lt;br&gt;- Design Speed: 25 mph&lt;br&gt;- Number of Lanes: 2&lt;br&gt;- Lane Width: 12 feet&lt;br&gt;- Sidewalk Clear Zone: 5-8 feet&lt;br&gt;- On-Street Parking: 7 feet&lt;br&gt;- Curb Extensions at Mid-Block Crossings&lt;br&gt;- Street Lighting&lt;br&gt;- Bus Stops&lt;br&gt;- Planting Strips&lt;br&gt;- Driveways&lt;br&gt;- Traffic Calming&lt;br&gt;- Block Length: based on land use context</td>
<td>- Sidewalk amenity zone&lt;br&gt;- Medians, minimum 8 feet&lt;br&gt;- Median Planting</td>
<td>- Pedestrian Refuges&lt;br&gt;- Curb Extensions&lt;br&gt;- Bike Lanes&lt;br&gt;- Shoulder&lt;br&gt;- Mid-Block Pedestrian Crossings</td>
</tr>
</tbody>
</table>

Local Commercial Streets

<table>
<thead>
<tr>
<th>Street Type</th>
<th>Priority Design Elements</th>
<th>Appropriate / Other Design Elements to Consider</th>
<th>Inappropriate Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Industrial Roads</td>
<td>- Posted Speed: 25 mph&lt;br&gt;- Design Speed: 25 mph&lt;br&gt;- Number of Lanes: 2&lt;br&gt;- Lane Width: 12 feet&lt;br&gt;- Sidewalk Clear Zone: 5 feet&lt;br&gt;- On-Street Parking: 8 feet&lt;br&gt;- Planting Strips&lt;br&gt;- Driveways&lt;br&gt;- Street Lighting&lt;br&gt;- Block Length: 1000 feet maximum</td>
<td>- Bus Stops</td>
<td>- Traffic Calming&lt;br&gt;- Mid-Block Pedestrian Crossings&lt;br&gt;- Sidewalk Amenity Zone&lt;br&gt;- Medians&lt;br&gt;- Median Planting&lt;br&gt;- Curb Extensions&lt;br&gt;- Bike Lanes&lt;br&gt;- Pedestrian Refuges&lt;br&gt;- Shoulder</td>
</tr>
</tbody>
</table>

For all street types a typical cross section of design elements has been created (Figure 22 - 24).

![Figure 22 Main street typical cross section](image-url)
Strengths and Weaknesses

The Charlotte Urban Street Design Guidelines developed a new classification scheme for urban streets and contained detailed design elements and typical cross-sections for the new street types proposed. The street type overlay terminology was used to avoid conflicts with state guidance. The strength of the guidelines lies in modal priorities being located along a spectrum of street types, and not based on the context the street segment resides in or the roadway function. Further, clear descriptions of expectations and design elements are needed to create an ideal roadway experience for each user group; this offers a unique way to address multimodal design conflicts and community context.

The key weakness of the guidelines may be that they leave little room for flexible interpretation. There is also no mention of applying them to non-urban contexts.
Complete Streets Chicago was created in 2013 by the Chicago Department of Transportation to implement the city's complete streets policy. It involved a major restructuring of the agency and its project delivery process. The organization is part of a multi-pronged action agenda, which included Sustainable Urban Infrastructure Guidelines, Streetscapes Design Guidelines, Make Way for Play Guide, Bike Lane Design Guide, Tools for Safer Streets Guide, Chicago Pedestrian Plan, Streets for Cycling Plan 2020, Bike 2015 Plan, and 2015 Sustainable Chicago. More information can be found at www.chicagocompletestreets.org.

Complete Streets Chicago addresses functional classification through the use of typologies. A typology is a categorization or naming scheme. For example, arterial, collector, and local are types. The Chicago system uses two sets of types for each street, one describing its roadway form and function and the other its building form and function. These are essentially the link and place attributes of any given street.

Complementing the roadway and building form and function are a system of overlays. These are generally planning-level categories describing the various statutory, operational, and planning categories that impact design decisions. The number of overlays is open-ended and could be tied to a transportation master plan, zoning, economic development, community, or other efforts.

There is a fourth category in Complete Streets Chicago that describes intersections and crossings, but it is not necessarily salient to functional classification.

Context Definition

Complete Streets Chicago uses the following seven types to categorize street context: Neighborhood Residential, Neighborhood Mixed-Use, District Center or Corridor, Downtown, Institutional or Campus, Industrial, and Parks and Open Space (Table 12). As mentioned above, this is referred to as the building form and function. They describe a street’s land use, urban design, community, and place characteristics. Types are modeled on the CNU Transect system. They are somewhat density based, but not necessarily. Rather, they reflect building types. For example a campus has a similar relationship to the street, whether it is a university, hospital, or housing. Each generally has a main entrance and a perimeter fence. Downtown refers to any sort of high-density building and use. A street segment could have one or two place categories (e.g., if the land use on either side of the street is different).
Table 12 Complete Streets Chicago context definition

<table>
<thead>
<tr>
<th>Typology Name</th>
<th>Characteristics</th>
<th>Typical Zoning Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neighborhood Residential</td>
<td>• Single-family houses&lt;br&gt;• Low-density multi-family buildings&lt;br&gt;• Non-residential uses such as schools and churches</td>
<td>RS, RT</td>
</tr>
<tr>
<td>Neighborhood Mixed-Use</td>
<td>• Buildings with service and commercial uses on the ground floor that serve surrounding neighborhoods&lt;br&gt;• Residential or office uses above the ground floor</td>
<td>RM, B1, B2</td>
</tr>
<tr>
<td>District Center or Corridor</td>
<td>• Concentration of commercial uses that draw from a large area&lt;br&gt;• May be stand-alone commercial buildings&lt;br&gt;• May be part of mixed-use buildings</td>
<td>RM, B2, B3, C1, C2</td>
</tr>
<tr>
<td>Downtown</td>
<td>• High-rise mixed-use, residential, or office buildings centrally located within the city</td>
<td>DR, DS, DC, DX</td>
</tr>
<tr>
<td>Institutional or Campus</td>
<td>• Large-scale development (2+ acres) under unified control and organized like a campus&lt;br&gt;• Typically surrounded by gates and controlled-access</td>
<td>PD</td>
</tr>
<tr>
<td>Industrial</td>
<td>• Manufacturing, wholesale and industrial uses&lt;br&gt;• May be organized into a campus or industrial corridor&lt;br&gt;• Requires accommodation for large trucks.</td>
<td>C3, M2, M3, PMD</td>
</tr>
<tr>
<td>Parks and Open Space</td>
<td>• Intentional open spaces such as parks, forest preserves, and bodies of water&lt;br&gt;• Street entirely within or bordering a park&lt;br&gt;• Park-like medians</td>
<td>POS</td>
</tr>
</tbody>
</table>

**Road Function**

*Complete Streets Chicago* uses the following six types to categorize street function: Thoroughfare, Connector, Main Street, Neighborhood Street, Service Way, and Pedestrian Way, which are referred to as the *roadway form and function* (Table 13). They describe throughput, access, mobility, and operations. The first four types closely resemble the FCS class designations. Service Ways (which are essentially alleys) and Pedestrian Ways (promenades, walkways, paths, and greenways) are not typically considered in a functional class system, but are important network elements in Chicago. Generally, a street segment has only one function type.
### Table 13 Complete Streets Chicago road function types

<table>
<thead>
<tr>
<th>Typology Name</th>
<th>Definition</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoroughfare</td>
<td>• Widest right-of-way</td>
<td>Lanes 4+</td>
</tr>
<tr>
<td></td>
<td>• Raised medians</td>
<td>Target Speed 25-30 mph</td>
</tr>
<tr>
<td></td>
<td>• May have side medians, green space, large sidewalks</td>
<td>Blocks 660-1320 feet</td>
</tr>
<tr>
<td></td>
<td>• Serves through and local functions</td>
<td>ADT 20k and higher</td>
</tr>
<tr>
<td></td>
<td>• Not generally commercial</td>
<td>Flow 2 way</td>
</tr>
<tr>
<td></td>
<td>Lanes 4+</td>
<td>Target Speed 25-30 mph</td>
</tr>
<tr>
<td></td>
<td>Target Speed 25-30 mph</td>
<td>Blocks 660-1320 feet</td>
</tr>
<tr>
<td></td>
<td>ADT 20k and higher</td>
<td>Flow 2 way</td>
</tr>
<tr>
<td>Connector</td>
<td>• Main roads</td>
<td>Lanes 2 to 4</td>
</tr>
<tr>
<td></td>
<td>• May have median</td>
<td>Target Speed 20-30 mph</td>
</tr>
<tr>
<td></td>
<td>• Connects urban centers</td>
<td>Blocks 300-660 feet</td>
</tr>
<tr>
<td></td>
<td>• May be commercial</td>
<td>ADT 5-25K</td>
</tr>
<tr>
<td></td>
<td>Lanes 2 to 4</td>
<td>Flow 1 or 2 way</td>
</tr>
<tr>
<td></td>
<td>Target Speed 20-30 mph</td>
<td>Blocks 300-660 feet</td>
</tr>
<tr>
<td></td>
<td>ADT 5-25K</td>
<td>Flow 1 or 2 way</td>
</tr>
<tr>
<td>Main Street</td>
<td>• Serves mostly local traffic</td>
<td>Lanes 1 to 3</td>
</tr>
<tr>
<td></td>
<td>• Connects neighborhoods and commercial areas</td>
<td>Target Speed 15-20 mph</td>
</tr>
<tr>
<td></td>
<td>• May be commercial</td>
<td>Blocks 150-300 feet</td>
</tr>
<tr>
<td></td>
<td>Lanes 1 to 3</td>
<td>ADT 3-15k</td>
</tr>
<tr>
<td></td>
<td>Target Speed 15-20 mph</td>
<td>Flow 1 or 2 way</td>
</tr>
<tr>
<td></td>
<td>Blocks 150-300 feet</td>
<td>ADT 3-15k</td>
</tr>
<tr>
<td>Neighborhood Street</td>
<td>• Almost all local traffic</td>
<td>Lanes 1</td>
</tr>
<tr>
<td>Street</td>
<td>• Serve residential areas</td>
<td>Target Speed 10-20 mph</td>
</tr>
<tr>
<td></td>
<td>• No centerline or lane striping required</td>
<td>Blocks &lt;300 feet</td>
</tr>
<tr>
<td></td>
<td>Lanes 1</td>
<td>ADT &lt;6K</td>
</tr>
<tr>
<td></td>
<td>Target Speed 10-20 mph</td>
<td>Flow 1 or 2 way</td>
</tr>
<tr>
<td></td>
<td>Blocks &lt;300 feet</td>
<td>ADT &lt;6K</td>
</tr>
<tr>
<td></td>
<td>ADT &lt;6K</td>
<td>Flow 1 or 2 way</td>
</tr>
<tr>
<td>Service Way</td>
<td>• Narrow roadway</td>
<td>Lanes 1</td>
</tr>
<tr>
<td></td>
<td>• No sidewalks</td>
<td>Target Speed 5-10 mph</td>
</tr>
<tr>
<td></td>
<td>• Provides a short service link between two streets</td>
<td>Blocks NA</td>
</tr>
<tr>
<td></td>
<td>Lanes 1</td>
<td>ADT NA</td>
</tr>
<tr>
<td></td>
<td>Target Speed 5-10 mph</td>
<td>Flow 1 or 2 way</td>
</tr>
<tr>
<td></td>
<td>Blocks NA</td>
<td>ADT NA</td>
</tr>
<tr>
<td>Pedestrian Way</td>
<td>• Pedestrian passageway or walkway</td>
<td>Lanes NA</td>
</tr>
<tr>
<td></td>
<td>• Not necessarily along a typical roadway</td>
<td>Target Speed NA</td>
</tr>
<tr>
<td></td>
<td>• Pedestrian access between buildings</td>
<td>Blocks NA</td>
</tr>
<tr>
<td></td>
<td>Lanes NA</td>
<td>ADT NA</td>
</tr>
<tr>
<td></td>
<td>Target Speed NA</td>
<td>Flow NA</td>
</tr>
</tbody>
</table>

**Relationship to FHWA Functional Classification**

*Complete Streets Chicago* addresses the relationship between its typology system and the FCS. It states that coding projects by their functional class is required for federal funding, and it provides a conversion table (recreated in Table 14). The agency intends to use this to maintain project funding from state and federal sources.
Modal Considerations

*Complete Streets Chicago* uses *modal hierarchies* to inform design and operation decisions. There are a multitude of decisions made during the life of a project — from project selection to lane width to signal timing to restriping — and establishing a hierarchy ensures that the decision made supports the complete streets effort. Examples of hierarchies are listed in Table 15. Freight is not listed because it is cross-modal — goods are delivered in Chicago by rail, truck, bike, and on foot.

**Table 15 Complete Streets Chicago modal hierarchies**

<table>
<thead>
<tr>
<th></th>
<th>Default</th>
<th>Along a major transit corridor</th>
<th>Along a bicycle priority street</th>
<th>In an industrial corridor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian</td>
<td>Transit</td>
<td>Bicycle</td>
<td>Pedestrian</td>
<td>Pedestrian</td>
</tr>
<tr>
<td>Transit</td>
<td>Pedestrian</td>
<td>Bicycle</td>
<td>Pedestrian</td>
<td>Pedestrian</td>
</tr>
<tr>
<td>Bicycle</td>
<td>Bicycle</td>
<td>Transit</td>
<td>Bicycle</td>
<td>Bicycle</td>
</tr>
<tr>
<td>Automobile</td>
<td>Automobile</td>
<td>Automobile</td>
<td>Transit</td>
<td>Transit</td>
</tr>
</tbody>
</table>

Design Elements

*Complete Streets Chicago* uses design trees to collate mode hierarchy and typology (function and context) and derive cross-sections. Figure 25 demonstrates this process for a pedestrian-priority street in a downtown context. Depending on the function of the street, a particular cross-section is derived (see next section).
Complete Streets Chicago contains precise language on cross-section elements, intersections, and geometric/operational policies, some of which is tied to the classification schemes described above.

In general, travel lanes should be 10 feet wide, with an 11-foot lane allowed for a truck or bus route. Narrower lanes are encouraged on Main Streets, Neighborhood Streets, and Service Ways. Lane widths are as follows:

- Thoroughfare: 10-11 feet;
- Connector: 9-11 feet; and
- Main Street: 9-10 feet.

Target speeds (equal to or less than the speed limit) are as follows:

- Thoroughfare: 25-30 mph;
- Connector: 20-30 mph;
- Main Street: 15-25 mph;
- Neighborhood Street: 10-20 mph; and
- Service Way: 5-10 mph.

Design vehicles are listed as per the typology of the receiving street:
• Thoroughfare: WB-50;
• Connector: BUS-40;
• Main Street: SU-30;
• Neighborhood Street: DL-23 (a new design vehicle based on a United Parcel Service P-80 truck);
• Service Way: DL-23; and
• Right/left turn on red is to be limited from 6 AM to midnight along streets with the Pedestrian (P) Streets or Bicycle Priority Street overlay.

Cross-section dimensions are listed for Thoroughfares, Connectors, Main Streets, and Neighborhood Streets; however, they are not dictated. "Project managers are charged with developing cross-sections which respect the hierarchy and typology." There is a discussion on assemblage — the art of adding, subtracting, and combining widths to arrive at a complete street and examples given that:

• The target auto/bike shared lane is 14 feet.
• The combination of travel and parking lanes next to one another should be no less than 18 feet (11-foot travel and 7-foot parking or 10-foot travel and 8-foot parking.

Table 16 Complete Streets Chicago assemblage table for Thoroughfare
Overlays

*Complete Streets Chicago* uses a series of overlays to capture external information related to street design. Overlays could be anything from state route designation to routes identified on master planning documents, to historic designation (Table 17). The thinking is that practitioners benefit when all considerations for a particular street are assembled in one place. At the beginning of a project, the project manager would assemble all of these overlays into one GIS map. The requirements of each overlay would then influence design decisions. A street segment could have none, one, or many overlays (for example a street can be a state route, truck route and transit-priority street, or a street could have no such designation).
<table>
<thead>
<tr>
<th>Typology Name</th>
<th>Source</th>
<th>Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Route</td>
<td>Illinois DOT</td>
<td>Approximately 37 percent of Chicago's major roadways are under state jurisdiction. This limits the city’s ability to control and maintain its street network. An inter-agency directive provides guidance on when and how to use jurisdictional transfer for such streets.</td>
</tr>
<tr>
<td>County Route</td>
<td>Cook County</td>
<td>Most county highways within the city fall into one of two categories: 1) county jurisdiction maintained by the city, and 2) municipal extensions of county highways that are under city jurisdiction. Chicago DOT (CDOT) effectively controls these streets; coordination with the County is often a formality.</td>
</tr>
<tr>
<td>Truck Route</td>
<td>Chicago DOT</td>
<td>CDOT maintains a GIS layer of truck routes. In additional to being designated as a truck route, there should be at least 5% multiple-unit truck traffic.</td>
</tr>
<tr>
<td>Snow Route</td>
<td>Chicago DOT</td>
<td>There are two types of snow routes in Chicago: 1) where parking is restricted from Dec 1 to April 1, and 2) where parking is restricted when 2” or more of snow accumulates. Snow plowing is planned for and accommodated on these routes.</td>
</tr>
<tr>
<td>Strategic Regional Arterials (SRAs)</td>
<td>Chicago Metropolitan Agency for Planning, Illinois DOT</td>
<td>Streets designated to carry higher volumes and speeds as a complement to the expressway system. Parking and traffic signals are restricted. It is questionable whether SRAs conform to the City's complete street policies.</td>
</tr>
<tr>
<td>Mobility Priority Streets</td>
<td>Chicago Zoning Ordinance</td>
<td>Connect commuter rail stations with the downtown employment core. Section 17-4-0600 of the Chicago Zoning Ordinance designates Mobility Streets and requires 14’ sidewalks to accommodate special pedestrian movement needs.</td>
</tr>
<tr>
<td>Pedestrian Priority Street (P-street)</td>
<td>Chicago Zoning Ordinance</td>
<td>Sections 17-3-0500 and 17-4-0500 of the Chicago Zoning Ordinance designate Pedestrian Streets for Chicago's best examples of pedestrian-oriented shopping streets. Curb cuts are not allowed and other building design standards (setbacks, window transparency) are also required.</td>
</tr>
<tr>
<td>Bicycle Priority Street (proposed)</td>
<td>Chicago DOT</td>
<td>CDOT will identify select corridors where cycling will be prioritized ahead of other modes, which will influence the modal hierarchy and subsequent design.</td>
</tr>
<tr>
<td>Transit Priority Street (BRT) (proposed)</td>
<td>Chicago DOT, Chicago Transit Authority</td>
<td>CDOT &amp; CTA will identify select corridors where transit will be prioritized ahead of other modes, which will influence the modal hierarchy and subsequent design.</td>
</tr>
<tr>
<td>Historic Boulevard System</td>
<td>Chicago Housing &amp; Economic Development</td>
<td>Chicago's historic boulevards are listed on the National Register for Historic Places and are a defining characteristic of the city's street network.</td>
</tr>
<tr>
<td>Transit-Oriented District (EI stops) (proposed)</td>
<td>Chicago DOT, Chicago Transit Authority, Chicago Housing &amp; Economic Development</td>
<td>These areas require special considerations for riders who arrive on foot, by bicycle, bus or taxi. The City has a working group to formally zone these areas.</td>
</tr>
<tr>
<td>Home Zone (shared street) (proposed)</td>
<td>Chicago DOT</td>
<td>Home Zone is a new type of street to be developed by CDOT. It is a residential street, maybe with some commercial, that uses physical traffic calming techniques to slow vehicles to walking speed. Typically it is a shared space with no separation between modes.</td>
</tr>
</tbody>
</table>
**Strengths and Weaknesses**

The main strength of *Complete Streets Chicago* is that it is written from a practitioner’s standpoint, and is currently being integrated into the agency’s operations. Similar efforts to date have been somewhat esoteric and lacking in detail. This document is very precise in its details and applications.

While the document is detailed, it is not prescriptive. Indeed, it challenges designers to produce streets that meet the overarching priorities of the agency, and in this instance, complete streets. This is a performance- or metric-based model. Other efforts are either too prescriptive (often listing minimum standards, which then become the maximum depending on the proclivity of the practitioner), or completely neglect critical details.

Specific to functional classification, the document plainly states how it intends to refocus street design away from functional classification:

"Historical focus on roadway characteristics such as traffic volume, speed and functional classification does not always yield complete streets. Using typologies inverts this approach: design decisions are informed by roadway context and by a hierarchy of mode prioritization, switching the “burden of proof” for design from traffic measurements and functional classification to place making and community preferences."

The main weakness of the document is that it lacks the visualizations found in more recent efforts, and it is too "inside baseball" for many to appreciate its value.

**ITE-CNU Designing Walkable Urban Thoroughfares**

The ITE, in a joint effort with the Congress for New Urbanism, developed a recommended practice in 2010 called *Designing Walkable Urban Thoroughfares* as a tool for designing urban streets that are compatible with and supportive of the surrounding context and community. More information can be found at [http://library.ite.org/pub/e1cff43c-2354-d714-51d9-d82b39d4dbad](http://library.ite.org/pub/e1cff43c-2354-d714-51d9-d82b39d4dbad).

*Designing Walkable Urban Thoroughfares* introduces a design framework based on the idea of context zones and identifies a set of thoroughfare types consistent with the diverse characteristics found in urban areas. Context zones are used to categorize urban development patterns into discrete ranges of density and intensity of development. Context is defined both by the design of the thoroughfare itself and the adjacent buildings, land use types, and surrounding district. Thus, a thoroughfare’s design may change along its length as context changes.
Context Definition

*Designing Walkable Urban Thoroughfares* uses context zones to describe the physical form and character of a place. This includes the intensity of development within a neighborhood or along a thoroughfare. Context zones are applied at the community level, but for the purposes of thoroughfare design, they are interpreted on a block-by-block basis to respond to specific physical and activity characteristics. A total of seven context zones are defined: four within the urban context (including suburban and low-density urban fringe uses), two within the rural context (though it is noted that these are not the focus of the effort), and a district category (to be assigned as applicable). Figure 26 graphically represents context zones, and Table 18 provides detailed written descriptions. Context zones are proposed as an important determinant of basic design criteria in traditional urban thoroughfares. They meant to refine the “rural” and “urban” classifications that are critical for selecting design criteria in the Green Book (AASHTO, 2011).

![Figure 26 Development continuity](image)

Figure 26 Development continuity
Table 18 Context Zone description

<table>
<thead>
<tr>
<th>Context Zone</th>
<th>Distinguishing Characteristics</th>
<th>General Character</th>
<th>Building Placement</th>
<th>Frontage Types</th>
<th>Typical Building Height</th>
<th>Type of Public Open Space</th>
<th>Transit (Where Provided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1 Natural</td>
<td>Natural landscape</td>
<td>Natural features</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Natural open space</td>
<td>None</td>
</tr>
<tr>
<td>C-2 Rural</td>
<td>Agricultural with scattered development</td>
<td>Agricultural activity and natural features</td>
<td>Large setbacks</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Agricultural and natural</td>
<td>Rural</td>
</tr>
<tr>
<td>C-3 Suburban</td>
<td>Primarily single family residential with walkable development pattern and pedestrian facilities; dominant landscape character includes scattered commercial uses that support the residential uses, and connected in walkable fashion.</td>
<td>Detached buildings with landscaped yards, normally adjacent to C-4 zone. Commercial uses may consist of neighborhood or community shopping centers, service or office uses with side or rear parking.</td>
<td>Varying front and side yard setbacks</td>
<td>Residential uses include lawns, porches, fences and naturalistic tree planting. Commercial uses front onto thoroughfare.</td>
<td>1 to 2 story with some 3 story</td>
<td>Parks, greenbelts</td>
<td>Local, express bus</td>
</tr>
<tr>
<td>C-4 General Urban</td>
<td>Mix of housing types including attached units, with a range of commercial and civic activity at the neighborhood and community scale.</td>
<td>Predominantly detached buildings, balance between landscape and buildings, presence of pedestrians</td>
<td>Shallow to medium front and side yard setback</td>
<td>Porches, fences</td>
<td>2 to 3 story with some variation and few taller workplace buildings</td>
<td>Parks, greenbelts</td>
<td>Local, limited stop bus rapid transit, express bus; fixed guideway</td>
</tr>
<tr>
<td>C-5 Urban Center</td>
<td>Attached housing types such as townhouses and apartments mixed with retail, workplace and civic activities at the community or sub-regional scale.</td>
<td>Predominantly attached buildings, landscaping within the public right of way, substantial pedestrian activity</td>
<td>Small or no setbacks, buildings oriented to street with placement and character defining a street wall</td>
<td>Stoops, dooryards, storefronts and arcaded walkways</td>
<td>3 to 5 story with some variation</td>
<td>Parks, plazas and squares, boulevard median landscaping</td>
<td>Local bus; limited stop transit or bus rapid transit; fixed-guideway transit</td>
</tr>
<tr>
<td>C-6 Urban Core</td>
<td>Highest-intensity areas in sub-region or region, with high-density residential and workplace uses, entertainment, civic and cultural uses.</td>
<td>Attached buildings forming sense of enclosure and continuous street wall landscaping within the public right of way, highest pedestrian and transit activity</td>
<td>Small or no setbacks, building oriented to street, placed at front property line</td>
<td>Stoops, dooryards, forecourts, storefronts and arcaded walkways</td>
<td>4+ story with a few shorter buildings</td>
<td>Parks, plazas and squares, boulevard median landscaping</td>
<td>Local bus; limited stop transit or bus rapid transit; fixed-guideway transit</td>
</tr>
</tbody>
</table>

Districts: To be designated and described locally, districts are areas that are single-use or multi-use with low-density development pattern and vehicle mobility priority thoroughfares. These may be large facilities such as airports, business parks and industrial areas.

(Based on transect zone descriptions in SmartCode Version 9.2, 2008. Source: Duany Plater-Zyberk & Company.)

Shaded cells represent Context Zones that are not addressed in this report.
Road Function
Thoroughfare type is the primary driver of design in *Designing Walkable Urban Thoroughfares*. It governs the selection of the thoroughfare’s design criteria and, along with the surrounding context, is used to determine the thoroughfare’s physical configuration. Design criteria and physical configuration address which elements are included in the design and selection of dimensions. Seven thoroughfare types are identified, however, the primary focus of the guidance is:

- Boulevard — Walkable, medium speed (35 mph or less), divided arterials.
- Avenue — Walkable, low to medium speed (25-35 mph) collectors or arterials.
- Street — Walkable low speed (25 mph) streets serving direct property access.

These thoroughfare types typically serve a mix of modes, including pedestrian, bicycle users, private motor vehicles (for passenger and freight) and transit. Table 19 describes thoroughfare types commonly used in the United States.
Table 19 Thoroughfare type description

<table>
<thead>
<tr>
<th>Thoroughfare Type</th>
<th>Functional Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway/Expressway/</td>
<td>Freeways are high-speed (50 mph+) controlled-access thoroughfares with grade-separated interchanges and no pedestrian access. Includes tollways, expressways and parkways that are high- or medium-speed (45 mph+), limited-access thoroughfares with some at-grade intersections. On parkways, landscaping is generally located on each side and has a landscaped median. Truck access on parkways may be limited.</td>
</tr>
<tr>
<td>Parkway</td>
<td></td>
</tr>
<tr>
<td>Rural Highway</td>
<td>High-speed (45 mph+) thoroughfare designed both to carry traffic and to provide access to abutting property in rural areas. Intersections are generally at grade.</td>
</tr>
<tr>
<td>Boulevard</td>
<td>Walkable, low-speed (35 mph or less) divided arterial thoroughfare in urban environments designed to carry both through and local traffic, pedestrians and bicyclists. Boulevards may be long corridors, typically four lanes but sometimes wider, serve longer trips and provide pedestrian access to land. Boulevards may be high-ridership transit corridors. Boulevards are primary goods movement and emergency response routes and use vehicular and pedestrian access management techniques. Curb parking is encouraged on boulevards. Parallel access lanes are separated from the through lanes by curbed islands with landscaping; these islands may provide transit stops and pedestrian facilities. Multiway boulevards often require significant right of way.</td>
</tr>
<tr>
<td>(see Chapters 8, 9 and 10</td>
<td></td>
</tr>
<tr>
<td>for design guidance)</td>
<td></td>
</tr>
<tr>
<td>Avenue</td>
<td>Walkable, low-to-medium speed (25 to 35 mph) urban arterial or collector thoroughfare, generally shorter in length than boulevards, serving access to abutting land. Avenues serve as primary pedestrian and bicycle routes and may serve local transit routes. Avenues do not exceed 4 lanes, and access to land is a primary function. Goods movement is typically limited to local routes and deliveries. Some avenues feature a raised landscaped median. Avenues may serve commercial or mixed-use sectors and usually provide curb parking.</td>
</tr>
<tr>
<td>(see Chapters 8, 9 and 10</td>
<td></td>
</tr>
<tr>
<td>for design guidance)</td>
<td></td>
</tr>
<tr>
<td>Street</td>
<td>Walkable low speed (25 mph) thoroughfare in urban areas primarily serving abutting property. A street is designed to (1) connect residential neighborhoods with each other, (2) connect neighborhoods with commercial and other districts and (3) connect local streets to arterials. Streets may serve as the main street of commercial or mixed-use sectors and emphasize curb parking. Goods movement is restricted to local deliveries only.</td>
</tr>
<tr>
<td>(see Chapters 8, 9 and 10</td>
<td></td>
</tr>
<tr>
<td>for design guidance)</td>
<td></td>
</tr>
<tr>
<td>Rural Road</td>
<td>Low speed (25 to 35 mph) thoroughfare in rural areas primarily serving abutting property.</td>
</tr>
<tr>
<td>Alley/Rear Lane</td>
<td>Very low-speed (5 to 10 mph) vehicular driveway located to the rear of properties, providing access to parking, service areas and rear uses such as secondary units, as well as an easement for utilities.</td>
</tr>
</tbody>
</table>

Shaded cells represent thoroughfare types that are not addressed in this report.

Relationship to FHWA Classification

*Designing Walkable Urban Thoroughfares* maintains the FCS, but serves in a secondary role compared to design criteria established using thoroughfare types. Table 20 shows the relationship between thoroughfare types and the FCS. In general, boulevards serve an arterial function, avenues may be arterials or collectors and streets typically serve a collector or local function in the network.
Table 20 Thoroughfare and FCS relationships

<table>
<thead>
<tr>
<th>Functional Classification</th>
<th>Thoroughfare Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FREEWAY/EXPRESSWAY/PARKWAY</td>
</tr>
<tr>
<td>Principal Arterial</td>
<td>X</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td></td>
</tr>
<tr>
<td>Collector</td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td></td>
</tr>
</tbody>
</table>

*Shaded cells represent thoroughfare types that are not addressed in this report.*

Modal Priorities

*Designing Walkable Urban Thoroughfares* does not explicitly prioritize modes within the corridor; it identifies the roadway and street side/frontage elements recommended for each thoroughfare/context zone category. It recognizes that all elements may not be accommodated within a given right-of-way and provides guidance accordingly. A series of cross sections are presented, organized as per the following four scenarios:

1. Optimal conditions — sections without right-of-way constraints that can accommodate all desirable elements;
2. Predominant — representing sections of the predominant right-of-way width in the corridor that accommodate all of the higher-priority elements;
3. Functional minimum — representing a typically constrained section where most of the higher priority elements can be accommodated; and
4. Absolute minimum — representing severely constrained sections where only the highest-priority design elements can be accommodated without changing the type of thoroughfare.

Design Elements

Design elements for thoroughfare types are identified and provide a range of operating speeds, number of lanes, and modal considerations (Table 21). The overall focus of the approach is not on establishing a prescriptive design element list. Rather, it attempts to describe context sensitive design approaches to meet the overall objectives of projects. The proposed design process
consists of the five stages shown in Figure 27. While this report simplifies the process into five discrete stages, the thoroughfare design process is an iterative one that requires collaboration with the public, stakeholders, and a multidisciplinary team of professionals.

Table 21 Design elements by thoroughfare type

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway</td>
<td>4 to 6+</td>
<td>45–65</td>
<td>Express</td>
<td>Required</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Optional separated pathway or shoulder</td>
</tr>
<tr>
<td>Expressway/Parkway</td>
<td>4 to 6</td>
<td>45–55</td>
<td>Express</td>
<td>Required</td>
<td>No</td>
<td>No</td>
<td>Optional separated pathway or shoulder</td>
<td>Regional truck route</td>
</tr>
<tr>
<td>Boulevard</td>
<td>4 to 6</td>
<td>30–35</td>
<td>Express and Local</td>
<td>Required</td>
<td>Limited</td>
<td>Optional</td>
<td>Sidewalk</td>
<td>Regional truck route</td>
</tr>
<tr>
<td>Multifamily Boulevard</td>
<td>4 to 6</td>
<td>25–35</td>
<td>Express and Local</td>
<td>Required on access lanes</td>
<td>Yes from access lane</td>
<td>Yes on access roadway</td>
<td>Sidewalk</td>
<td>Regional route/local deliveries only on access roadway</td>
</tr>
<tr>
<td>Avenue</td>
<td>2 to 4</td>
<td>25–30</td>
<td>Local</td>
<td>Optional</td>
<td>Yes</td>
<td>Yes</td>
<td>Sidewalk</td>
<td>Bike lanes or shared</td>
</tr>
<tr>
<td>Street</td>
<td>2</td>
<td>25</td>
<td>Local or none</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Sidewalk</td>
<td>Shared</td>
</tr>
<tr>
<td>Rural Road</td>
<td>2</td>
<td>25–35</td>
<td>Local or none</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Shared or shoulder</td>
</tr>
<tr>
<td>Local Street</td>
<td>2</td>
<td>25</td>
<td>Local or none</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Sidewalk</td>
<td>Shared</td>
</tr>
<tr>
<td>Alley/Path Lane</td>
<td>1</td>
<td>5–10</td>
<td>None</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Shared</td>
</tr>
</tbody>
</table>

Shaded cells represent thoroughfare types that are not addressed in this report.

Notes:
[1] Boulevard, Multifamily Boulevard, Avenue, and Street thoroughfare types have sidewalks on both sides. Sidewalk width varies as a function of corner zone, fronting land use and other factors.
[2] Freight movement is divided into three categories: 1) Regional truck route, 2) Local truck route and 3) Local deliveries only. Cells show highest order of truck movement allowed.
Strengths and Weaknesses

The principal strength of Designing Walkable Urban Thoroughfares is its expansion of the context zones beyond the existing binary urban/rural definition, and the expansion of the roadway design elements to include street side design. However, it does not entirely address rural contexts or all roadway categories.

The design approach of Designing Walkable Urban Thoroughfares is unique in that it moves past prescriptive design elements and instead focuses on a comprehensive design approach based on a context sensitive design/solutions framework. This is further reinforced by the identification of design elements within different constrained environments, highlighting ideal, constrained and minimal thoroughfare designs. While these can serve as starting points for the design process, and modal priorities can be inferred from the design elements characterizations, they may not provide guidance on critical issues, such as when one mode or activity must be prioritized over another due to community requests or some other contextual need.
Massachusetts
The Highway Division of the Massachusetts Department of Transportation (MassHighway) revised its statewide design policy manual in 2006. This was driven in part by recognition of the agency’s challenges in developing projects for a variety of community contexts.

The Project Development and Design Guide (2006) takes a different approach to functional classification from the conventional model of associating classes with design controls, advising designers to tailor project design to actual project needs by use of the project development process and not to rely on a single set of design controls for a given functional class. More information can be found at http://www.massdot.state.ma.us/highway/DoingBusinessWithUs/ManualsPublicationsForms/ProjectDevelopmentDesignGuide.aspx.

Context Definition
MassHighway’s Project Development and Design Guide delineates context based on level of development and surrounding land uses. Distinctions between community contexts (referred to as “area types”) are made based on built form with a particular focus on building setbacks and property frontages (Table 22). As a result, the MassHighway guide identifies a more diverse range of land use contexts, from low-intensity rural environments to highly dense, highly populated urban areas (illustrated in Figure 28).
Table 22 MassHighway area types and community contexts

<table>
<thead>
<tr>
<th>Environmental Context</th>
<th>Area Types</th>
<th>Land Use Considerations</th>
<th>Built Form Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>Natural</td>
<td>• Forest</td>
<td>• Frontages generally less than 200 feet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Farmland</td>
<td>• Right-of-way constrained by built environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Open Spaces</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rural Village</td>
<td>• Low intensity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Commercial</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Civic Uses</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Mixed Uses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rural Developed</td>
<td>• Low-density residential</td>
<td>• Large setbacks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Infrequent commercial activity</td>
<td>• Significant tree cover of property frontages</td>
</tr>
<tr>
<td>Suburban</td>
<td>High Density</td>
<td>• Commercial strip development</td>
<td>• Large setbacks for commercial development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Low density residential</td>
<td>• Residential frontages less than 200 feet</td>
</tr>
<tr>
<td></td>
<td>Village/Town Center</td>
<td>• Moderate density</td>
<td>• Uniform building setbacks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Commercial</td>
<td>• Residential frontages less than 200 feet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Residential</td>
<td>• Right-of-way constrained by built environment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Mixed Uses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low Density</td>
<td>• Low density</td>
<td>• Residential frontages more than 200 feet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Residential</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Infrequent commercial</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>Urban Park</td>
<td>• Open space</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Urban Residential</td>
<td>• High density Residential</td>
<td>• Common building scale</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Common setbacks (flush frontages)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Central Business District</td>
<td>• High density Mixed Use</td>
<td></td>
</tr>
</tbody>
</table>
The guide stipulates that area types be selected before choosing a design based solely on roadway type. Context is the primary influence over the types of modal considerations and the corresponding design elements to include in order to meet activity needs for each mode.
Road Function
MassHighway’s Project Development and Design Guide employs the FCS designations, referred to as roadway types. They are based on a facility’s role in the state and regional transportation system. The six types include:

- **Freeways** are primarily for interstate and regional travel (high regional connectivity at high speeds with limited access to adjacent land and limited access for pedestrians and bicyclists).
- **Major arterials** service statewide travel as well as major traffic movements within urbanized areas or between suburban centers (high regional connectivity at a wide range of speeds, and a lower level of local access than roadway types that occupy a lower spot on the hierarchy).
- **Minor arterials** link cities and towns in rural areas and connect major arterials within urban areas (high to moderate regional connectivity at a wide range of speeds, and moderate degrees of local access).
- **Major collectors** link arterial roadways and provide connections between cities and towns (moderate to low regional connectivity at a wide range of speeds, and higher degree of local access than arterials and freeways).
- **Minor collectors** connect local roads to major collectors and arterials (lower regional connectivity at lower speeds and higher degrees of local access than the previous roadway types).
- **Local roads and streets** are not intended for regional connectivity (low speeds with a high degree of local circulation and access).

Relation to FHWA Functional Classification
The MassHighway guide outlines a functional classification scheme that is practically a one-to-one conversion of the FHWA classification system, although it also sub-classifies collectors (Table 23).
Modal Considerations

Modal needs beyond vehicular traffic are considered but not prioritized in *MassHighway’s Project Development and Design Guide* (Table 24). For example, while natural rural areas are likely to have little commuter or daily pedestrian travel, users may be attracted to low-volume roadways for scenic travel or recreation. Emphasis is placed on accommodating all roadway users and determining early in the process the composition and expected volumes of different users.
Table 24 Additional modal considerations and likely volumes / activity

<table>
<thead>
<tr>
<th>Area Type</th>
<th>Additional Modes Considered</th>
<th>Corresponding Volumes / Modal Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Natural</td>
<td>• Pedestrians</td>
<td>• Low</td>
</tr>
<tr>
<td></td>
<td>• Bicyclists</td>
<td>• Low</td>
</tr>
<tr>
<td></td>
<td>• Transit</td>
<td>• Infrequent if at all</td>
</tr>
<tr>
<td>Rural Village</td>
<td>• Pedestrians</td>
<td>• High compared to other rural area types</td>
</tr>
<tr>
<td></td>
<td>• Bicyclists</td>
<td>• Low – activity within Village</td>
</tr>
<tr>
<td></td>
<td>• Transit</td>
<td>• Infrequent if at all</td>
</tr>
<tr>
<td>Rural Developed</td>
<td>• Pedestrians</td>
<td>• Moderate</td>
</tr>
<tr>
<td></td>
<td>• Bicyclists</td>
<td>• Low – though more than Natural areas</td>
</tr>
<tr>
<td></td>
<td>• Transit</td>
<td>• Infrequent if at all</td>
</tr>
<tr>
<td>Suburban Low Density</td>
<td>• Pedestrians</td>
<td>• Moderate – more than Rural Developed</td>
</tr>
<tr>
<td></td>
<td>• Bicyclists</td>
<td>• Moderate – more than Rural Developed</td>
</tr>
<tr>
<td></td>
<td>• Transit</td>
<td>• Infrequent</td>
</tr>
<tr>
<td>Suburban Town Center</td>
<td>• Pedestrians</td>
<td>• High compared to other suburban area types</td>
</tr>
<tr>
<td></td>
<td>• Bicyclists</td>
<td>• High compared to other suburban area types</td>
</tr>
<tr>
<td></td>
<td>• Transit</td>
<td></td>
</tr>
<tr>
<td>Suburban High Density</td>
<td>• Pedestrians</td>
<td>• Low to Moderate (if facilities are present)</td>
</tr>
<tr>
<td></td>
<td>• Bicyclists</td>
<td>• Low to Moderate (if facilities are present)</td>
</tr>
<tr>
<td></td>
<td>• Transit</td>
<td>• Low</td>
</tr>
<tr>
<td>Urban Park</td>
<td>• Pedestrians</td>
<td>• High due to path network</td>
</tr>
<tr>
<td></td>
<td>• Bicyclists</td>
<td>• High due to path network</td>
</tr>
<tr>
<td>Urban Residential</td>
<td>• Pedestrians</td>
<td>• High</td>
</tr>
<tr>
<td></td>
<td>• Bicyclists</td>
<td>• High</td>
</tr>
<tr>
<td></td>
<td>• Transit</td>
<td>• High</td>
</tr>
<tr>
<td>Central Business District</td>
<td>• Pedestrians</td>
<td>• High</td>
</tr>
<tr>
<td></td>
<td>• Bicyclists</td>
<td>• High</td>
</tr>
<tr>
<td></td>
<td>• Transit</td>
<td>• High, due to high capacity transit and intermodal hubs</td>
</tr>
</tbody>
</table>

Design Elements

Design elements are not linked to roadway type within MassHighway’s Project Development and Design Guide. It states that classification serves as a starting point, but designers should not let it be the sole design control. The guide accentuates other key decision points during project development that define design parameters for a project. The selection of design elements is to take place through consultations with community members, users, and project reviewers to “determine the roadway characteristics and appropriate design considerations to serve both the regional purpose of the roadway and its role in the local setting.”

There is one specific link between community context and design speed. The guide encourages designers to attentively consider context when selecting the speed. Minimum design standards are outlined for pedestrian and bicycle infrastructure, however, they are not directly associated with functional classifications or specific contexts. The purpose of these standards is to help designers identify best practices when a roadway serves additional modal needs.
Overlays

MassHighway’s *Project Development and Design Guide* contains overlays for parkways, historic boulevards, and access control.

The guide defines *parkways* as a unique roadway type. It is essentially an overlay on arterial function classes. The distinction of parkways is largely due to the presence of urban highways that pass through large parklands in major cities, such as Boston. Parkways can also include historical boulevards established under the Boulevard Act of 1894.

Access control is influenced by roadway type and area type, although it can be designated based on local statues, zoning, and right-of-way purchases on existing roadways. The overlay of the existing regulations with respect to access control is typically the product of

- **Statutory control** that limits access only to public road crossings on a rural or urban arterial highways.
- **Zoning regulations** that control roadway adjacent property developments so that major generators of traffic will not develop — these regulations are at the discretion of the local government.
- **Driveway regulations** that control the geometric design of an entrance, driveway spacing, and driveway proximity to public road intersections.

Strengths and Weaknesses

MassHighway’s *Project Development and Design Guide* expands upon the place-based contexts of urban, suburban, and rural designations to develop a nuanced approach to land use context and the built environment. Associated with each area type is the acknowledgment that pedestrian and bicycle travel must be taken into account, even in less populated rural areas that are not usually considered amenable to multimodal access.

The guide refers directly to the FCS and does not propose an alternative, although it does indicate that roadway designers should not use this as the primary means of selecting design controls.
Minnesota DOT

Minnesota DOT is in the process of developing a Guide based on a revised classification. Its aim is to aid planning and design. Currently, the Guide is 80% developed and the information presented here reflects this status. The complete guide is expected in 2017. Minnesota DOT’s goal was to develop a document that could help designers and planners deliver projects that address the Complete Streets concepts that Minnesota DOT adopted in 2013.

The Guide identifies a set of principles that emphasize a process-driven approach and that rely on CSS concepts. Its core principles center on the importance of taking a multimodal approach to address modal needs, using a collaborative framework to promote inter-agency coordination, using a place/context approach to define the uniqueness of each location, and considering network connectivity with an “across and along” approach. In an effort to address these issues, the Guide redefines context and road typology.

Context Definition

Context areas are defined in Minnesota’s guide based on land use, building form, and frontage type. These variables exist along a continuum. Context areas include: Large Urban Downtown, Urban Commercial Corridor, Urban Residential Area, Industrial Area, Suburban Town Center, Suburban Commercial Corridor, Suburban Residential, Small Downtown or Main Street, Rural Transition Area Agricultural or Rural, and Natural or Recreational. Each context is defined based on qualitative descriptions of land use, building form, and typical frontage type (Table 25). The guide also recommends that designers and planners observe that roadway context changes over the length of a corridor, and that a project should be designed in accordance with the area so that the road aligns with its spatially variable characteristics.
Table 25: Context definition criteria and values

<table>
<thead>
<tr>
<th>Place Type</th>
<th>Description</th>
<th>Building Form</th>
<th>Frontage Type</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Large Urban Downtown</strong></td>
<td>• Diverse uses with regional draw</td>
<td>• Urban form building siting and massing</td>
<td>• Storefronts and some residential at street level</td>
<td>Minneapolis, St. Paul, Duluth, Rochester</td>
</tr>
<tr>
<td></td>
<td>• Residential, commercial, and institutional uses</td>
<td>• Small or no setbacks</td>
<td>• Landscaped buffer areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• High to medium density with mixed uses within/among structures</td>
<td>• Buildings oriented to the street</td>
<td>• Sidewalks on both sides of street, often without boulevards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Significant pedestrian and transit orientation and high traffic volumes</td>
<td>• Large buildings (5 to 60+ stories)</td>
<td>• Some on street parking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Typically good street grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Often special event centers including convention centers, sports facilities, etc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Urban Commercial Corridor</strong></td>
<td>• Prominent destinations within a city</td>
<td>• Urban building form and sitting</td>
<td>• Storefronts</td>
<td>Excelor Boulevard (St. Louis Park)</td>
</tr>
<tr>
<td></td>
<td>• Mix of uses with commercial uses dominating,</td>
<td>• Shallow to medium setback</td>
<td>• Landscaped buffer</td>
<td>Superior Street (Duluth)</td>
</tr>
<tr>
<td></td>
<td>• High to medium density with mixed uses within/among structures</td>
<td>• Buildings oriented to street</td>
<td>• Sidewalks on both sides of street, often without boulevards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Primary transit corridors with moderate to high auto traffic</td>
<td></td>
<td>• Parking lots or on-street parking</td>
<td></td>
</tr>
<tr>
<td><strong>Urban Residential Area</strong></td>
<td>• Primarily neighborhood residential with medium-</td>
<td>• Urban residential building form</td>
<td>• Grass yards</td>
<td>Lyndale neighborhood (Minneapolis) south of Lake Street</td>
</tr>
<tr>
<td></td>
<td>to high-density housing</td>
<td>• Shallow to medium setback</td>
<td>• Porches</td>
<td>66th Street (Richfield)</td>
</tr>
<tr>
<td></td>
<td>• Some public uses such as open space, parks, and schools</td>
<td>• Buildings oriented to street</td>
<td>• Garages</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• May be primary transit corridor and moderate traffic volume</td>
<td></td>
<td>• Typically sidewalks with boulevards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Medium to high pedestrian traffic</td>
<td></td>
<td>• On-street parking</td>
<td></td>
</tr>
<tr>
<td><strong>Industrial Area</strong></td>
<td>• Industrial/commercial areas without residential</td>
<td>• Typically 1- to 3-story large industrial buildings</td>
<td>• May not have sidewalks</td>
<td>Terminal Drive industrial area (Eagan)</td>
</tr>
<tr>
<td></td>
<td>• High- to medium-density structures</td>
<td>• Shallow to medium setbacks</td>
<td>• Typically minimal landscaping</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• High freight truck traffic volume</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Suburban Town Center</strong></td>
<td>• Prominent community destinations</td>
<td>• Suburban form building siting</td>
<td>• Storefronts</td>
<td>Arbor Lakes (Maple Grove)</td>
</tr>
<tr>
<td></td>
<td>• Low to medium density with mixed uses within/among structures, Mostly retail</td>
<td>• Small setbacks</td>
<td>• Landscaped buffer areas</td>
<td>West End (St. Louis Park)</td>
</tr>
<tr>
<td></td>
<td>• Typically auto oriented with pedestrian comfort</td>
<td>• Buildings oriented to the street</td>
<td>• Parking lots or on-street parking</td>
<td></td>
</tr>
<tr>
<td><strong>Suburban Commercial Corridor</strong></td>
<td>• Regional or neighborhood destinations</td>
<td>• Various, generally large single-story retail buildings with large surface parking lots</td>
<td>• Grass yard</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Typically commercial with retail, entertainment, and office uses.</td>
<td>• Large setbacks</td>
<td>• Porches</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Often “big box” retail centers, office parks, etc.</td>
<td>• Commercial frontage</td>
<td>• Garages</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Medium- to low-density structures</td>
<td></td>
<td>• Typically medium to large setback</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Typically designed to be accessible by car and arranged along internal street systems</td>
<td></td>
<td>• Parking areas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• May include bicycle and pedestrian facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Suburban Residential</strong></td>
<td>• Primarily neighborhood residential with low-density housing</td>
<td>• Suburban residential building form and sitting</td>
<td>• Storefronts</td>
<td>Robert Street (West St. Paul)</td>
</tr>
<tr>
<td></td>
<td>• Some public uses such as open space, parks, and schools</td>
<td>• Small or setbacks</td>
<td>• Landscaped buffer areas</td>
<td>Division Street (St. Cloud)</td>
</tr>
<tr>
<td></td>
<td>• Typically designed to be accessible by car and arranged along internal street systems</td>
<td>• Buildings oriented to the street</td>
<td>• Parking lots</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• May include bicycle and pedestrian facilities</td>
<td>• Wide roadways access and parking are important</td>
<td>• Landscaped buffer areas or fences</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Typically has on-street parking and sidewalks</td>
<td></td>
<td>• Often no sidewalks</td>
<td></td>
</tr>
<tr>
<td><strong>Small Downtown or Main Street</strong></td>
<td>• Diverse uses with a large draw from surrounding rural areas</td>
<td>• Urban form building siting and massing</td>
<td>• Front yard</td>
<td>Woodbury</td>
</tr>
<tr>
<td></td>
<td>• Downtown or main street character distinguishes from other areas</td>
<td>• Small or no setbacks</td>
<td>• Porches</td>
<td>Richfield</td>
</tr>
<tr>
<td></td>
<td>• Accommodates residential, commercial, retail, entertainment, institutional uses</td>
<td>• Buildings oriented to the street</td>
<td>• Garages</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Low to medium density with mixed uses within/among structures</td>
<td></td>
<td>• Typically low traffic volumes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Often 2 to 4 stories with commercial on the ground floor and offices or residencal above</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Typically has on-street parking and sidewalks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Rural Transition Area</strong></td>
<td>• Predominantly residential neighborhoods, some retail, restaurants, and offices</td>
<td>• Varies</td>
<td>• TH 61 (Mesilla)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Small retail establishments sometimes occupy principal corners</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Agricultural or Rural</strong></td>
<td>• Predominantly cultivated or unimproved lands</td>
<td>• Few buildings</td>
<td>• Farm land</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Few houses and structures dotting a farm or natural landscape</td>
<td>• Large setbacks</td>
<td>• TH 52 in Goodhue County</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• May need to accommodate farm vehicles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Typically low traffic volumes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Natural or Recreational</strong></td>
<td>• Predominantly natural (wetlands, woodlands, meadow, etc.), scenic, or recreational areas</td>
<td>• Few buildings</td>
<td>• Treeslopen space</td>
<td>TH 61 along North Shore’ Lake Superior</td>
</tr>
<tr>
<td></td>
<td>• Few structures with an emphasis on maintaining the natural landscape</td>
<td>• Large setbacks</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• May need to accommodate recreational users (bikers, hikers, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Road Function

Minnesota’s guide recognizes the main problems with the FCS. Classification does not always reflect the roadway context or the need for multimodal considerations. The guide develops a new set of road typologies that is correlated with the existing classification system (Table 26). The description applied to each roadway type is based on facility type, level of access control, and overall function and purpose. Two Arterial types are defined: Urban and Suburban. Each has a slightly different definition, with Urban Arterials incorporating consideration of pedestrians and bicycle use. These categories can be used to bridge the difference between the roadway types, as defined by the guide, and the FCS.

Table 26 Roadway categories

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Description</th>
<th>Equivalent Functional Class</th>
<th>Example Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeway</td>
<td>Divided highway with high speed/vehicle traffic volumes</td>
<td>Principal Arterial</td>
<td>I-90, TH-62</td>
</tr>
<tr>
<td></td>
<td>Full access control (grade-separated intersections)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Typically supported by a parallel arterial system</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connections to large regional activity centers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>May include managed lanes or transitways in urban areas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expressway</td>
<td>Divided highway with high speed/vehicle traffic volumes</td>
<td>Principal Arterial</td>
<td>TH-66, TH-62</td>
</tr>
<tr>
<td></td>
<td>Some access control with some at-grade crossings</td>
<td>Minor Arterial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Typically supported by a parallel arterial system</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connections to large regional activity centers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-Volume Highway</td>
<td>Paved highway (divided or undivided), with low vehicle traffic volumes</td>
<td>Principal Arterial</td>
<td>TH-71</td>
</tr>
<tr>
<td></td>
<td>Some access control points are prevalent</td>
<td>Minor Arterial</td>
<td>TH-1</td>
</tr>
<tr>
<td></td>
<td>Minimal supporting networks</td>
<td>Collector (major/minor)</td>
<td>Pilot Knob Road (Eagan)</td>
</tr>
<tr>
<td></td>
<td>Connections to medium to small regional activity centers</td>
<td></td>
<td>Vicksburg Road (Plymouth)</td>
</tr>
<tr>
<td>Suburban Arterial</td>
<td>Paved highway (divided or undivided), with high vehicle traffic volumes</td>
<td>Minor Arterial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Some at-grade access points are prevalent</td>
<td>Collector (major/minor)</td>
<td>Pilot Knob Road (Eagan)</td>
</tr>
<tr>
<td></td>
<td>No local grid network</td>
<td></td>
<td>Vicksburg Road (Plymouth)</td>
</tr>
<tr>
<td></td>
<td>Connections to regional or neighborhood activity centers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban Arterial</td>
<td>Paved highway (divided or undivided) with moderate traffic volumes and</td>
<td>Minor Arterial</td>
<td>Franklin Avenue (Minneapolis)</td>
</tr>
<tr>
<td></td>
<td>higher pedestrian, bicycle, and transit volumes</td>
<td>Collector (major/minor)</td>
<td>Robert Street (St. Paul)</td>
</tr>
<tr>
<td></td>
<td>At-grade access points are prevalent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connected grid network</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connections to regional or neighborhood activity centers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector-Connector</td>
<td>Undivided roadway with low to medium vehicle traffic volumes and</td>
<td>Minor Arterial</td>
<td>Penn Avenue (Richfield)</td>
</tr>
<tr>
<td></td>
<td>often high pedestrian and bicycle use. May be a primary transit route</td>
<td>Collector (major/minor)</td>
<td>Marshall Street (St. Paul)</td>
</tr>
<tr>
<td></td>
<td>At-grade access points are prevalent</td>
<td>Local Road/Street</td>
<td></td>
</tr>
<tr>
<td></td>
<td>May or may not be supported by a grid network</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connections to neighborhood or local activity centers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Street-Road</td>
<td>Undivided roadway with low vehicle traffic volumes. May have moderate</td>
<td>Minor Arterial</td>
<td>Urban Avenue (Minneapolis)</td>
</tr>
<tr>
<td></td>
<td>pedestrian and bicycle use</td>
<td>Collector (major/minor)</td>
<td>Chestnut Lane (Maple Grove)</td>
</tr>
<tr>
<td></td>
<td>May or may not be supported by a grid network</td>
<td>Local Road/Street</td>
<td>Chicago Avenue (Barrington)</td>
</tr>
<tr>
<td></td>
<td>Connections to other neighborhoods and neighborhood activity centers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The proposed road categories are intended to correlate to the context of the area to define the various roadway types. This system is currently under development (Figure 29).
Design Elements
The Minnesota guide identifies a list of key principles that designers should be mindful of when developing alternative solutions. These include prioritizing community values, understanding the corridor users, selecting the lowest reasonable targeted operating speed and design vehicle, allocating space to most vulnerable road users, beginning with the smallest number of lanes with the smallest dimensions, and taking stock of how operations vary across the day. The guide includes a set of values for typical cross-sectional elements to inform design where ranges for the values are provided (Table 28).
Table 27 Typical dimension for cross section elements

<table>
<thead>
<tr>
<th>Cross-Section Elements</th>
<th>Typical Widths</th>
<th>Factors to Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian Realm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Frontage Zone/Shy Zone</td>
<td>1.5-2'</td>
<td>Building (or other obstructions) setback from edge of right-of-way; none required when adjoining area is open</td>
</tr>
<tr>
<td>- Through Pedestrian Zone</td>
<td>5-10'</td>
<td>Pedestrian volumes; wider needed in urban or recreation areas; 4' minimum ADA pat</td>
</tr>
<tr>
<td>- Planting/Furnishing Zone</td>
<td>5-8'</td>
<td>Trees require more width or structured soils</td>
</tr>
<tr>
<td>- Edge Zone</td>
<td>1.5'</td>
<td>Very low speeds might justify smaller setback</td>
</tr>
<tr>
<td>Bicycle Facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Multimodal Trail</td>
<td>8-15'</td>
<td>Bicycle and pedestrian volumes and bicycle speeds</td>
</tr>
<tr>
<td>- Bike Lane</td>
<td>5-6'</td>
<td>Typically incorporates curb and gutter; traffic speeds and volumes a consideration; proximity to parked vehicles</td>
</tr>
<tr>
<td>- Buffer</td>
<td>2-3'</td>
<td>Traffic speeds and volumes; proximity to parked vehicles</td>
</tr>
<tr>
<td>- Shy Zone</td>
<td>0-2'</td>
<td>Building (or other obstructions) setback from edge of right-of-way; none required when adjoining area is open</td>
</tr>
<tr>
<td>Curb and Gutter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Curb reaction distance</td>
<td>1-2'</td>
<td>Not an issue in low speed conditions; 1' reaction to raised medians desirable</td>
</tr>
<tr>
<td>- Curb and Gutter</td>
<td>1.5-6'</td>
<td>Placement of drainage; type of facility used; wide gutter pan can be used for bike lane</td>
</tr>
<tr>
<td>Parking Lane</td>
<td>7-10'</td>
<td>Travel speeds, typical types of parked vehicles; urban or rural drivers; next to bike lane or travel lane; combined width more important than single lane width</td>
</tr>
<tr>
<td>Shoulder</td>
<td>0-10'</td>
<td>Typical not needed in low speed conditions; bicycle use on shoulder with 4' minimum paved</td>
</tr>
<tr>
<td>Travel/Turn Lanes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Travel Lanes</td>
<td>9-12'</td>
<td>Traffic speed and volume; large truck volumes; proximity to parked vehicles and/or bike lanes; combined width more important than single lane width</td>
</tr>
<tr>
<td>- Turn Lanes</td>
<td>9-12'</td>
<td>Large truck volumes; urban drivers can tolerate narrower widths; combined width more important than single lane width</td>
</tr>
<tr>
<td>- Medians</td>
<td>4-10'</td>
<td>Medians associated with turn lanes are typically two feet narrower than turn lane to allow for 1' curb reaction; planted medians should be minimum 6-8' with trees (narrower requires structured soils); 6' minimum for pedestrian refuge</td>
</tr>
</tbody>
</table>

*This table is not all inclusive and should not be viewed as absolute requirements – each situation is unique and may require different priorities, facilities and unique solutions.

The guide discusses some potential impacts of modal choices on each design element. Figure 30 illustrates possible trade-offs among the modes, which affect cross section design decisions.
Figure 30 Example of alternative cross section choices
A central concern of the guide is the selection of desired (target) operating speed. The underlying idea behind this concept is to design a roadway so that its physical design will influence the speed of vehicles. There is discussion about the need for selecting this speed and how its choice will affect the design element values selected in order to achieve the desired operating speed. The Guide also has a section dealing with design flexibility and how selection of design values can address context and road typology without providing specific values to be used.

Modal Considerations
Minnesota’s guide addresses multimodal concerns by evaluating modal importance on a per segment basis. Project corridors are divided into contextual and road type segments and the relative modal importance for each segment is assessed using a slider scale (Figure 31). The importance of each mode is defined based on land use context (Table 25) transportation context (i.e., road typology, Table 26), community importance, modal plans, network linkages, existing conditions, and existing use.

Strengths and Weaknesses
A key strength of Minnesota’s approach is its classification scheme that expands the definition of context so it is not restricted by a binary choice of urban/rural. The addition of nine categories that redefine suburban, urban and rural contexts, and small urban town, provides additional contexts that could facilitate improved contextual designs. Another strength of the proposed system is the development of a conversion table between the FCS and roadway types. This enables the
continued use of the current system in various areas (as needed) while providing additional flexibility that accounts for the varied needs of roadway types. The pictorial matrix, which is still being developed (Figure 29), will correlate context with road types and provide visual clues to identify the context and roadway environments, which is another critical strength of the system. Contextualizing modal considerations on a per segment basis is another strength of the proposed classification because it considers modal choices at the micro-level and bases them on particular segment needs.

At this point, there are no identified weaknesses of the proposed approach.

**NACTO Urban Street Design Guide**

NACTO developed the Urban Street Design Guide (USDG) in 2013. The guide is touted as a blueprint for designing 21st-century streets where people can walk, bike, drive, park, take transit, and socialize. Divided into six chapters, the guide focuses on types of streets; street design elements including lane widths, sidewalks, and curb extensions; interim design strategies such as parklets and temporary street closures; types of intersections; intersection design elements such as crosswalks and pedestrian islands; and design controls, the criteria used to measure a street’s success. The guide provides case studies from around the country as well as implementation tools. More information can be found at [http://nacto.org/usdg/](http://nacto.org/usdg/).

The NACTO USDG captures an important truth of street design: "classification schemes, in and of themselves, are rarely adequate as a design tool for the diversity of situations to be encountered on city streets." Functional classification propagates the use of auto-centric, highway-based design controls such as design speed, horizontal curvature, and stopping sight distance. Most city streets exist in much more complex environments. Their rights of ways may be fixed. Competition for curb space defies the throughput-access axis. Walking, cycling, transit, freight, and driving networks overlap and intertwine. Streets are used differently at different times of the day, week, and year. The challenge is to develop a workable system, which serves as an extension of a city’s goals such as "safety, economic growth, development, and urban design."

**Context Definition**

The NACTO USDG states "context is a crucial, yet often overlooked, parameter in designing streets. Street design should both respond to and influence the desired character of the public realm." It does not posit a context-specific classification system for urban streets; however, it includes a catalogue of streets. Each street type is described based on their context and function — i.e., their location, what they contain, and their primary uses. The USDG includes
recommendations related to each street type, with transition steps described for some. The 13 street types, along with selected recommendations, are listed below. Illustrations of some of these are shown in Figure 32 and 33.

- Downtown 1-Way Street — accept peak-hour congestion in exchange for on-street parking, dedicated transit lanes and protected bike lanes.
- Downtown 2-Way Street — encourage off-peak freight delivery.
- Downtown Thoroughfare — add a central median.
- Neighborhood Main Street — perform a road diet.
- Neighborhood Street — add raised crosswalks.
- Yield Street — ensure that sidewalks are privileged over driveways.
- Boulevard — add trees.
- Residential Boulevard — convert central median into park space.
- Transit Corridor — add bus rapid transit.
- Green Alley — add rain gardens and other storm water management devices.
- Commercial Alley — facilitate deliveries by hand truck or bike.
- Residential Shared Street — introduce chicanes and other traffic calming devices.
- Commercial Shared Street — utilize street furniture to demarcate walking path.

In addition to these 13 street types, the guide samples other context categories: Commercial, Industrial, Residential, City, Town, Village, Campus, Cultural, Institutional, Center, Corridor, District, Downtown, Low-Density, Marketplace, Mixed-Use, Neighborhood, Park, Urban, and Workplace.
Figure 32 NACTO Downtown and Neighborhood street types
Road Function
The NACTO USDG embeds function into the respective street types. As described below, the guide offers a wealth of design guidance that is not specific to a particular street type. Instead this guidance is general enough that it can be applied to most streets and street intersections. The thought behind this philosophy is that contexts and functions overlap so much on city streets that design concepts apply everywhere.

The guide also samples a number of classification systems used by cities: Avenue, Boulevard, Street, Arterial, Collector, Local, Alley, Lane, Main, Connector, Major, Multi-Way, Thoroughfare, Transit, Auto-Oriented, General, Multi-modal, Parkway, Paseo, Pedestrian, Shared, and Slow.

Modal Hierarchy
The NACTO USDG has multimodal origins. It contains many recommendations to consider how a particular design or operation decision affects all modes. Highlights include:

- On signalization: "use signal priority tools, such as leading pedestrian intervals, synchronized signals for bicycles, or transit signal priority along corridors with established or desired modal priority."
- On design hour: "Collect multimodal data over 2–3 hours of peak traffic activity to better understand how traffic behaves through an entire rush-hour period."
- On multi-modal level of service: "A street with low “person delay” is not necessarily a great street..."

The NACTO USDG mentions that many cities have developed street classification systems and that some use overlays. This is where one would discuss modal priorities, special uses, and historic designations. It samples a number of overlays used by cities: Country Route,
State Route, Sanitation Route, Snow Route, Truck Route, Ceremonial, Economic, Historic, Scenic, Bicycle Priority, Driving Priority, Pedestrian Priority, Transit Priority, Home Zone, Pedestrian District, and Transit-Oriented.

Design Elements
The NACTO USDG offers a number of recommendations for design elements. They are generally not tied to street function or context. Highlights include:

- 10-foot travel lanes, with 11-foot for truck or bus routes and 9-foot in select locations.
- 7 to 9-foot parking lanes.
- 5 to 7-foot pedestrian through zones on residential sidewalks; increase to 8–12 feet in commercial areas.
- No clear zones adjacent to the travelled way.
- Extensive use of curb extensions.
- Judicious use of traffic calming devices such as speed tables, chicanes, and mini-roundabouts.
- Pedestrian safety islands on streets with three or more lanes.
- Minimal corner radii, based on design speeds (Figure 34). "A large corner radius should not be used to facilitate a truck turning from the right lane into the right lane."
- Reduce speeds at intersections with insufficient sight distance.
- Shorter signal cycles.
- Understand safety implication of speeds (Table 28).

**Turning Speed**
The formula for calculating turning speed is:

\[
R = \frac{V^2}{15 (0.01E + F)}
\]

- \(R\) = Centerline turning radius (effective)
- \(V\) = Speed in miles per hour (mph)
- \(E\) = Super-elevation. This is assumed to be zero in urban conditions.
- \(F\) = Side friction factor

<table>
<thead>
<tr>
<th>V (MPH)</th>
<th>E</th>
<th>F</th>
<th>R (FT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0</td>
<td>0.38</td>
<td>18</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
<td>0.32</td>
<td>47</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
<td>0.27</td>
<td>99</td>
</tr>
<tr>
<td>25</td>
<td>0</td>
<td>0.22</td>
<td>174</td>
</tr>
</tbody>
</table>

Figure 34 NACTO Guide corner radius
Design vehicles are tied to street type. The DL-23 (a new design vehicle) is recommended for Neighborhood and Residential Streets. The SU-30 is recommended for Downtown and Commercial Streets. The WB-50 is suggested for designated truck routes. The BU-40 is suggested for designated bus routes.

**Strengths & Weaknesses**

The main strength of the NACTO USDG is that it advances progressive design guidance. It is unabashedly geared toward city streets and does not bend to highway engineering orthodoxy. Whether its guidance can be transferred to an alternative classification scheme remains an open question.

**Oregon**

The Oregon DOT adopted a Highway Design Manual in 2003 that used additional classifications beyond urban, suburban, and rural to define roadway context. The agency mainly focused on urban highways and arterials. The breadth of land use designations has been retained in the agency’s still-current 2012 manual, with specific guidance for design based on a variety of community context types for both state designated urban highways (defined under the 1999 Oregon Highway Plan [OHP]) and non-designated highways and arterials. The main purpose of the context types is to recognize the role of access in roadway design, irrespective of whether the principal purpose of the roadway is focused on access or mobility. More information can be found at [http://www.oregon.gov/odot/hwy/engservices/pages/hwy_manuals.aspx#2012_English_Manual](http://www.oregon.gov/odot/hwy/engservices/pages/hwy_manuals.aspx#2012_English_Manual).

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Table 28 NACTO Guide design speed implications

<table>
<thead>
<tr>
<th>SPEED (MPH)</th>
<th>STOPPING DISTANCE (FT)*</th>
<th>CRASH RISK (%)†</th>
<th>FATALITY RISK (%)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>10–15</td>
<td>25</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>20–25</td>
<td>40</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>30–35</td>
<td>75</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>40+</td>
<td>118</td>
<td>90</td>
<td>85</td>
</tr>
</tbody>
</table>

* Stopping Distance includes perception, reaction, and braking times.
† Source: Traditional Neighborhood Development: Street Design Guidelines (1999), ITE Transportation Planning Council Committee SP-B.
Context Definition

Crucial to defining context for urban (non-freeway) highways and arterials is assigning the OHP and urban growth boundary overlay designations, described under Overlays. Developed in 1999, the OHP defined long-range transportation policies and funding strategies for Oregon’s State Highway System. Highways detailed in this earlier plan are referred to as OHP-Designated Urban Highways. All highways and arterials not designated under OHP have different contextual design.

OHP Designated Urban Highways

The Oregon Highway Design Manual defines three place contexts for OHP-Designated Urban Highways: Special Transportation Areas (STAs), Urban Business Areas (UBAs), and Commercial Centers (CCs). Each designation is qualified by critical factors in land use and transportation dynamics that a designer should consider. The manual underlines the importance of including pedestrian, bicycle, and transit-friendly features in the overall roadway design for STA-specific projects. The UBA designation refers primarily to auto-oriented commercial corridors within state-designated urban growth boundaries. Roads that fall under this heading need to balance moving through traffic with providing access to properties. The CC designation is applied to regional-scale commercial land use areas with limited land use access but direct connection to a regional mobility network – typically, commercial development at freeway interchanges (Figure 35).

Figure 35 Intersection of Contexts along OHP Designated Urban Highways within the Urban Growth Boundary (UGB)
Non-designated Highways & Arterials
For non-designated OHP urban highways and arterials the context categories are:

- **Downtown / Central Business District** — densely urbanized areas with closely spaced buildings. They may look similar to STAs but have not been designated as such by the Oregon Transportation Commission.

- **Developed Areas** — areas where much of the land adjacent to the roadway is developed at urban intensities and only a few parcels are vacant.

- **Urban Fringe / Suburban** — areas that lie between the urban growth boundary and more developed areas.

Road Function
The Oregon Highway Design Manual does not propose an alternative classification system. The manual's focus is on highways and arterial roadways within urbanized areas and adapting design standards to the surrounding land use and environmental context.

Relationship to FHWA Functional Classification
The classification system is nearly identical to the FCS with additional designations for major and minor collectors (Table 29). Local roads are not mentioned and this is likely due to the fact that State DOTs do not typically have jurisdiction over local roadways.

Table 29 Oregon DOT and FCS relationship

<table>
<thead>
<tr>
<th>Oregon DOT Highway Design Guide</th>
<th>Interstate</th>
<th>Expressways</th>
<th>Highways</th>
<th>Principal Arterials</th>
<th>Minor Arterial</th>
<th>Major Collector</th>
<th>Minor Collector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freeway / Expressway</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Arterial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary Arterial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collector</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Modal Considerations
Modal priorities are not explicitly stated in the Oregon Highway Design manual. However, considerations for multiple modes are an aspect of each design context. For example, the required
design standards for each context include a sidewalk with a minimum width of six feet. Wider facilities are required in more densely urbanized areas. The manual recommends using wider shoulders or bicycle lanes in place of roadway shoulders for all contexts. A separated bicycle facility is required for arterial roadways in Urban Fringe/Suburban Areas. Further, the manual strongly recommends ensuring access to and circulation of transit.

Design Elements

Design elements for non-interstate highways and arterials are based on contextual definitions alone. Design elements outlined include:

- Design speeds;
- Lane widths;
- Median widths;
- Bicycle facilities;
- Sidewalk widths and separated sidewalks (buffer zone of planting/landscaping);
- On-street parking and dimensions; and
- Left or right turn banks.

Figure 36 illustrates the design requirements for an urban business area.

<table>
<thead>
<tr>
<th>Design Elements</th>
<th>Design Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30 mph</td>
</tr>
<tr>
<td>Travel Lane</td>
<td>12'</td>
</tr>
<tr>
<td>Right Turn Lane</td>
<td>12' plus shoulder</td>
</tr>
<tr>
<td>Left Turn Lane</td>
<td></td>
</tr>
<tr>
<td>Right Side Shoulder/Bike Lane</td>
<td>6'</td>
</tr>
<tr>
<td>Left Side Sight Distance</td>
<td>1'</td>
</tr>
<tr>
<td>Median Striped Median/Multi-Lane Continuous Left Turn Lane Raised Curb Median</td>
<td>2'</td>
</tr>
<tr>
<td></td>
<td>15' Travel lane to travel lane</td>
</tr>
<tr>
<td>Maximum Separation</td>
<td>4%</td>
</tr>
<tr>
<td>Maximum Degree of Curvature</td>
<td>19°</td>
</tr>
<tr>
<td>Maximum Grade</td>
<td>8%</td>
</tr>
<tr>
<td>Curbside Sidewalk</td>
<td>6'</td>
</tr>
<tr>
<td>Separated Sidewalk</td>
<td>N/A</td>
</tr>
<tr>
<td>On-street Parking</td>
<td>N/A</td>
</tr>
<tr>
<td>Vertical Clearance</td>
<td>See Chapter 4, Section 4.5.1</td>
</tr>
</tbody>
</table>

Figure 36 Urban business area design elements
The nodal nature of CCs precludes defining roadway design elements; rather the focus of the manual is on internal circulation of vehicles, bicyclists, and pedestrians. The manual states that CCs should be planned and developed to ensure the following:

- Convenient circulation within the center, including pedestrian and bicycle access and circulation.
- Provisions for transit access in urban areas planned for fixed route transit service.
- Shared parking and a reduction in parking to accommodate multimodal elements where alternate modes are available.
- A high level of regional accessibility.

Overlays

Key overlay distinctions in Oregon’s manual are the Urban Growth Boundaries and the OHP. In 1973, the Oregon Legislature adopted the first statewide urban growth boundaries. For each major city, the urban growth boundary restricts commercial and intensive residential development to these boundaries so that natural resources and agricultural land are preserved. Highways and arterials within the Urban Growth Boundary are the focus of urban highways in the manual. The OHP designated specific state highways for long-term planning and funding strategies in 1999. These highways will have their context defined using the Special Transportation Area, Urban Business Area, and CCs classifications.

Other overlay distinctions with a focus on the use of highways include:

- Freight Routes;
- Scenic Byways with coastal and mountain highways with scenic views; and
- Lifeline Routes with emergency routes for high impact earthquakes or flooding.

For freight routes, Oregon’s manual discourages reducing design standards and carrying capacity, acknowledging that the transport of goods throughout the state and region is important to local economies. The manual provides a caveat where safety or other modal access requires a reduction in freight vehicle carrying capacities. The manual states that the designation of Scenic Byways and Lifeline routes do not impact the design of urban arterials and highways, with the exception of maintaining structures critical to accessibility for emergency situations on Lifeline routes. However, these structures are not clearly defined.
Strengths and Weaknesses

Oregon’s system does not deviate from the FHWA’s classification model, with an urban/rural dichotomy of land use designations – although the more expansive set of types and areas promotes flexibility and roadway designs that are more responsive to local needs. Oregon’s unique overlay of urban growth boundaries strengthens the distinction between urban/suburban contexts and rural areas. Additionally, the guide integrates the nuance of nodal activity centers by focusing attention on circulation design considerations for CCs.

Functional classification is not the core design control in Oregon’s manual – land use context and existing regulatory overlays are the basis for highway and arterial design. Final design is based on context classifications that rely on regulatory statutes, prior planning, and the existing user base (e.g., current transit corridors) without clearly articulated modal priorities.

Pennsylvania and New Jersey DOTs

Pennsylvania’s (PennDOT) and New Jersey’s DOTs developed the Smart Transportation Guidebook in 2008 as part of their efforts to implement CSS. Their goal was to develop a document that could assist designers and planners in developing projects that respond to community, environmental, and transportation contexts. PennDOT has adopted the Guidebook as interim design policy guidance. The Guidebook is available at http://www.state.nj.us/transportation/community/mobility/pdf/smarttransportationguidebook2008.pdf.

The Smart Transportation Guidebook identifies principles that emphasize CSS applications to better define the issues of the project. The principles include the ideas of contextual designs and solutions, multimodal planning, and targeted solutions. As part of complying with these principles, the Guidebook articulates that there is need to improve the definition of project context. The basic idea is to incorporate land use into context definition.

Context Definition

Context areas are defined according to land use and level of development, which exists along a continuum. Categories include Rural, Suburban Neighborhood, Suburban Corridor, Suburban Center, Town/Village Neighborhood, Town Center, and Urban Core. Critically, even these are defined along a continuum because their boundaries can be fluid. This recognition affects what design elements should be considered. Each context is defined based on quantifiable characteristics such as density level, building coverage, lot size and frontage, block dimensions, maximum height, and minimum/maximum setbacks (Figure 37). The guidebook also recommends that designers and planners consider these using a broad approach, since adhering to a narrow
definition of each category may lead to more frequent changes in design elements (recommended minimum length for a context area is 600 feet). When development is planned for an area but has not yet taken place, land use context should be defined based on that anticipated development.

For each context, there is a short narrative description that provides details of its characteristics. These are summarized below:

- Rural — Few houses, low density, mainly farm land and natural areas, little to no commercial development and population of built-up areas less than 250 people.
- Suburban Neighborhood — Low-density housing, neighborhood setting, large lot size, and community facilities (schools, churches, libraries, etc.).
- Suburban Corridor — Land use predominantly commercial (big box stores), some housing developments with primary access to frontage roads.
- Suburban Center — Mixed-use development (residential, office, commercial retail, etc.), some pedestrian accommodation, and presence of parking areas
- Town/Village Neighborhood — Residential neighborhoods, some retail and restaurants, possible street parking, and sidewalks present.
- Town/Village Center — Mixed use, high-density area, some parking, and public buildings.
- Urban Core — Downtown areas with high density.
Roadway Types

The Smart Transportation Guidebook recognizes the problems with the FCS. It indicates that according an oversized role to select characteristics (e.g., length, traffic volumes) could result in designs that conflict with community needs or goals. It also addresses the need to distinguish between local and regional travel. A new road typology has been developed that correlates to the existing classification system (Table 30).

Table 30 Roadway categories

<table>
<thead>
<tr>
<th>Roadway Class</th>
<th>Roadway Type</th>
<th>Desired Operating Speed (mph)</th>
<th>Average Trip Length (mi)</th>
<th>Volume</th>
<th>Intersection Spacing (ft)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial</td>
<td>Regional</td>
<td>30-55</td>
<td>15-35</td>
<td>10,000-40,000</td>
<td>660-1,320</td>
<td>Roadways in this category would be considered &quot;Principal Arterial&quot; in traditional functional classification.</td>
</tr>
<tr>
<td>Arterial</td>
<td>Community</td>
<td>25-55</td>
<td>7-25</td>
<td>5,000-25,000</td>
<td>300-1,320</td>
<td>Often classified as &quot;Minor Arterial&quot; in traditional classification but may include road segments classified as &quot;Principal Arterial.&quot;</td>
</tr>
<tr>
<td>Collector</td>
<td>Community</td>
<td>25-55</td>
<td>5-10</td>
<td>5,000-15,000</td>
<td>300-660</td>
<td>Often similar in appearance to a community arterial. Typically classified as &quot;Major Collector.&quot;</td>
</tr>
<tr>
<td>Collector</td>
<td>Neighborhood</td>
<td>25-35</td>
<td>&lt;7</td>
<td>&lt;8,000</td>
<td>300-660</td>
<td>Similar in appearance to local roadways. Typically classified as &quot;Minor Collector.&quot;</td>
</tr>
<tr>
<td>Local</td>
<td>Local</td>
<td>20-30</td>
<td>&lt;5</td>
<td>&lt;3,000</td>
<td>200-660</td>
<td></td>
</tr>
</tbody>
</table>

The table provides the basic definition for each roadway type based on operating speeds, trip length, volume and intersection spacing. Critically, there are two community types — Community Arterial and Community Collector. As the table indicates, each is defined on the basis of their unique characteristics. However, the Collector category has two definitions, which are differentiated based on the road type: Community Collector and Neighborhood Collector. These categories can be used to bridge differences between its definition of roadway types and the FCS’s.

The proposed road categories are correlated with an area’s context to define the various roadway types and allow for a combination of both elements (Figure 38).
Importantly, the proposed typology is an overlay for individual projects and does not replace the FCS. The design values and ranges recommended in the Guidebook are inconsistent with those found in the AASHTO Green Book (Table 32).

In addition to the road types noted here, there is a recognition of Main Street as a separate category due to its ability to support more sustainable communities, and because of the potential to increase walking, biking and transit use, and vehicular trip chaining. Characteristics associated with a typical Main Street include wide sidewalks and regular pedestrian activity, mostly commercial and civic uses, high building density, street furniture and public art, heavy use of on-street parking, speeds of 30 mph or less, and preferably no more than two travel lanes, although three to four lanes appear occasionally.

**Design Elements**
The guidebook contains a set of suggested values for the various design elements based on the context categories it defines. In general, these follow the values in the AASHTO Green Book, but they reflect greater flexibility and a deeper consideration of the context. Table 31 lists the salient values for arterials.
Table 31 Design matrix example

<table>
<thead>
<tr>
<th>Region</th>
<th>Urban Core</th>
<th>Town/Village Center</th>
<th>Suburban Center</th>
<th>Suburban Neighborhood</th>
<th>Rural</th>
<th>Regional Arterial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane Width¹</td>
<td>10 to 12</td>
<td>10 to 12</td>
<td>11 to 12</td>
<td>11 to 12</td>
<td>11 to 12</td>
<td>11 to 12</td>
</tr>
<tr>
<td>Paved Shoulder Width</td>
<td>8 to 10</td>
<td>8 to 10</td>
<td>8 to 10</td>
<td>8 to 10</td>
<td>8 to 10</td>
<td>8 to 10</td>
</tr>
<tr>
<td>Parking Lane²</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Bike Lane³</td>
<td>5 to 6</td>
<td>6</td>
<td>5 to 6</td>
<td>5 to 6</td>
<td>5 to 6</td>
<td>6</td>
</tr>
<tr>
<td>Median</td>
<td>4 to 6</td>
<td>4 to 6</td>
<td>4 to 6</td>
<td>4 to 6</td>
<td>4 to 6</td>
<td>4 to 6</td>
</tr>
<tr>
<td>Buffer4</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>4 to 6</td>
</tr>
<tr>
<td>Clear Sidewalk Width</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>4 to 6</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Curb Return</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>6</td>
<td>6 to 10</td>
<td>6 to 10</td>
</tr>
<tr>
<td>Total Sidewalk Width</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>10 to 14</td>
<td>9 to 14</td>
<td>9 to 14</td>
</tr>
<tr>
<td>Desired Operating Speed</td>
<td>35-40</td>
<td>35-40</td>
<td>35-40</td>
<td>35-40</td>
<td>35-40</td>
<td>35-40</td>
</tr>
</tbody>
</table>

1. 12 mph is preferred for regular transit routes, and heavy truck volumes > 5%. Particularly for speeds of 35-40 mph or greater.
2. Shoulders should only be included in urban contexts as a part of the trip.
3. Shoulders should be used to accommodate pedestrians.

Notes:
- Speeds are for standard urban contexts.
- Widths and speeds are subject to change based on local traffic conditions.
- Urban contexts include downtown areas, midtown areas, and urban centers.
- Suburban contexts include suburban centers and suburban corridors.
- Rural contexts include rural areas.
- Regional arterials are major arterials that serve regional traffic patterns.
There is some discussion about the potential impacts of modal choices on each design element. For example, in determining the lane width, one needs to consider the context area, presence of bus and freight activity, and bicycle treatment. Further discussion covers multiple roadway (lane width, parking lane, shoulder width, bike lane, median, and travel lanes) and roadside (clear sidewalk width, buffer, shy distance, and total sidewalk width) elements. There is also a statement indicating that considering all these elements does not necessarily stipulate they all have to be present at the end, given that balances and priorities must be accounted for as well.

The guidebook includes additional design recommendations for specific road types including Main Streets, Industrial Streets, and Rural Crossroads.

An issue central to the guidebook concepts is that the operating speed should be a key design constraint. That is, a roadway should be designed so it will be difficult for vehicles to travel above the design speed. There is discussion about the effects of selecting design element values and their influence on operating speeds. This provides a qualitative basis to determine the values that are used when selecting the appropriate operating speed.

Modal Considerations
The Smart Transportation Guidebook lacks discussion of how modes are specifically addressed within each context. Modes are defined generically during the selection of various design element values (as noted above for the case of lane width choices). The guidebook does not systematically evaluate priorities among modal choices, however, reference to the presence of other modes is implicitly defined in Table 32.
Table 32 Cross section elements

<table>
<thead>
<tr>
<th></th>
<th>Paved Shoulder</th>
<th>Parking Lane</th>
<th>Bike Lane</th>
<th>Median (physical or two-way left turn lane)</th>
<th>Sidewalk*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regional Arterial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommended for rural, suburban corridor; suburban neighborhood contexts</td>
<td>Evaluate for urban contexts</td>
<td>Evaluate for urban contexts and urban contexts</td>
<td>Recommended for multi-lane roads; evaluate on other roads</td>
<td>Recommended for urban contexts; recommended for suburban contexts as appropriate</td>
<td></td>
</tr>
<tr>
<td><strong>Community Arterial</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommended for rural, suburban corridor contexts; evaluate for suburban neighborhood contexts</td>
<td>Recommended for urban contexts; evaluate for suburban center, suburban neighborhood contexts</td>
<td>Evaluate for suburban and urban contexts</td>
<td>Recommended for multi-lane roads; evaluate on other roads</td>
<td>Recommended for urban contexts; recommended for suburban contexts as appropriate</td>
<td></td>
</tr>
<tr>
<td><strong>Community Collector</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommended for rural and suburban corridor contexts; evaluate for suburban neighborhood</td>
<td>Recommended for urban, suburban center contexts; evaluate for suburban neighborhood contexts</td>
<td>Evaluate for suburban and urban contexts</td>
<td>Recommended for multi-lane roads</td>
<td>Recommended for urban contexts; recommended for suburban contexts as appropriate</td>
<td></td>
</tr>
<tr>
<td><strong>Neighborhood Collector</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommended for rural, suburban corridor contexts</td>
<td>Recommended for urban, suburban center, suburban neighborhood contexts</td>
<td>Evaluate for suburban and urban contexts</td>
<td>Consider primarily for aesthetic enhancement</td>
<td>Recommended for urban contexts; recommended for suburban contexts as appropriate</td>
<td></td>
</tr>
<tr>
<td><strong>Local</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluate for rural contexts</td>
<td>Recommended for urban, suburban center, suburban neighborhood contexts</td>
<td>Typically not needed</td>
<td>Consider for aesthetic enhancement only</td>
<td>Recommended for urban contexts; recommended for suburban contexts as appropriate</td>
<td></td>
</tr>
</tbody>
</table>

*Sidewalks are recommended as part of State and Federally funded roadway projects in suburban contexts unless one or more of the following conditions is met: • pedestrians are prohibited by law from using the roadway • the cost of installing sidewalks would be excessively disproportionate to the need or probable use. • sparsity of population or other factors indicate an absence of need.

**Strengths and Weaknesses**

A strength of the Smart Transportation Guidebook lies in its expanding of the idea of context beyond the urban/rural binary. The addition of the suburban categories, as well as town/village corridors, provides additional contexts that could facilitate improved contextual designs. Another strength of the proposed system is it develops a direct relationship between the FCS and roadway types. This allows for the continued use of the current system while providing additional flexibility regarding the varied needs associated with different roadway types. A third strength is the development of a pictorial matrix that correlates context with road types. It also establishes additional visual clues to identify the context and roadway environments.

A weakness of the system is its failure to explicitly treat modal issues and its incorporation of design values that require the establishment of modal priorities. The implicit inclusion of the modes in the design element tables is inadequate to accord a role to modes that could require a solution that addresses modal choices. A second weakness is the duplication of the design values...
from the AASHTO Green Book in the design matrices. The inherent flexibility of the Green Book remains, but the potential tendencies to use the higher ends of the ranges may limit matrices' utility. Finally, because the classification has not been fully adopted in the DOT's design manual, it is rendered a somewhat ineffective policy.

ADDITIONAL ALTERNATIVE SYSTEMS
The six remaining alternative classification systems are briefly summarized in this section. Because these systems address a partial aspect of one of the objectives, a full evaluation is not provided here.

*Abu Dhabi*


Street families (street types) are defined for each street segment by the surrounding land use context and transport capacity (Table 33). Land use contexts are based on the built environment. Categories include: no active frontage, industrial, residential (1-3 building stories), commercial (1-3 stories), town (3-6 stories), and city (7 or more stories). Transport capacity is defined along two dimensions — vehicle priority and number of travel lanes. After combining this information, street families are generated.

Design elements such as operating speeds, pedestrian needs, frontage lanes (access for parking or travel for bicycles and medians), and travel way (roadway) geometry are defined for each street family.

Modal priorities are applied to all streets in this order: pedestrians, transit users, bicyclists, and motor vehicles. Priorities are applied to all streets and may contradict distinctions within the transport capacity dimension and therefore, design controls. Non-driving options must be at least as active as private motor vehicle use, irrespective of street type.
California DOT (Caltrans) began developing CSS for highway and arterial roadway design in 2005. Caltrans has focused on design and policy principles for main streets that are “both a community street and a State highway [that] typically have motorized traffic speeds of less than 40 miles per hour and serve pedestrians, bicyclists, transit riders and drivers” (Caltrans, 2014). Caltrans has produced an internal Main Street Listing containing conventional state highways that serve as main street gateways or commercial corridors for community throughout California. The Main Street Listings database specifies opportunities to implement principles and strategies outlined in Main Street, California: A Guide for Improving Community and Transportation Vitality. These opportunities are available to Caltrans staff and are shared with community partners. More information can be found at [http://www.dot.ca.gov/hq/LandArch/mainstreet/main_street_3rd_edition.pdf](http://www.dot.ca.gov/hq/LandArch/mainstreet/main_street_3rd_edition.pdf) and [http://www.dot.ca.gov/hq/tpp/offices/ocp/css.html](http://www.dot.ca.gov/hq/tpp/offices/ocp/css.html).

Caltrans does not specify modal priorities or hierarchies. Rather, the Main Street program focuses on incorporating complete streets, traffic calming design concepts, and increased livability through multimodal choice grounded in community needs. The guide’s livable street design elements focus on the following principles:

- Balanced Main Street Roadways and Intersections that addresses the needs of all modes of travel.
- Design for Bicyclists that introduces and improves bicycle access along Main Street corridors.
• Design for Pedestrians that elevates the importance of pedestrian and street landscape design while providing access for individuals with limited physical mobility.

• Connections to Public Transit that improves transit access along Main Street corridors.

• Innovative Devices and Products that pilot new traffic control technologies.

All of the design elements and principals outlined in the guide have been incorporated into Caltrans design manuals and standards, including, the Highway Design Manual, State Manual on Uniform Traffic Control Devices, and the Project Development Procedures Manual.

The Main Streets program does not propose an alternative classification system; instead, the design guidance is geared toward transforming streets presently classified as state highways by using context sensitive design. The Main Street designation is an overlay on California’s existing functional classification that parallels the FCS class distinctions.

Connecticut

Connecticut Department of Transportation’s Highway Design Manual closely follows the FCS; however, the manual specifies that the basic urban-rural division of contexts is not sufficiently representative of a highly developed state (like Connecticut). Instead, it uses three area types: built-up areas (the most urban - typically downtowns and other major activity centers), intermediate and suburban areas that are home to less intense patterns of development but still in areas with higher traffic volumes, and rural areas entirely outside of cities and towns (CTDOT, 2003). More information can be found at www.ct.gov/dot/lib/dot/documents/dpublications/highway/cover.pdf, Section 6.

The manual specifies the incorporation of distinct cross-section elements based on each area type. For example, principal urban arterials design values differ from those for suburban, intermediate, and built-up area types. The manual lacks specific modal priorities, stating that, “all mobility modes should be considered in the development of project-specific plans” (CTDOT 2003).

LA Model Design Manual for Living Streets

The Los Angeles County Department of Public Health released the Model Design Manual for Living Streets in 2011. It focuses on all users of the public right-of-way and addresses landscaping, mobility, design, and the public involvement process. Although developed for Los Angeles County, it is intended to provide guidance on a national level. More information can be found at http://www.modelstreetdesignmanual.com/.
The manual’s contextual distinctions transcend the typical rural/suburban/urban model by incorporating Transects (see discussion above in 2.3). Because the built form changes along a roadway, a street segment may have multiple Transect classifications.

The manual offers a one-to-one translation of the FHWA arterial, collector, and local system: boulevards = arterials, avenues = collectors, streets = local streets. In addition, a fourth category includes alleys and lanes. In proposing these new names, the manual aspires to be more colloquial and less technocratic.

Overlays are defined for special streets (main streets, drives, transit malls, bike boulevards, festival streets, and shared spaces) and incorporate modal priorities. Modal priorities focus on non-motorized transportation by recommending maximum block lengths and maximum speeds, regardless of street type. Overlays are also defined for framework and non-framework streets. Framework streets connect neighborhoods, places, and districts, whereas non-framework streets serve as emergency vehicle routes. Traffic calming measures are recommended accordingly. The manual includes recommendations to make streets more lively, beautiful, economically vibrant, and environmentally sustainable, largely through innovative streetscape and roadway edge design.

**UK Manual for Streets**


In the manual, the context and function of streets are defined along two-dimensional hierarchies — place function and movement function. The street types defined using these gradients are:

- Motorways – high movement function, low place function;
- High streets – medium movement function, medium to high place function; and
- Residential streets – low to medium movement function, low to medium place function.

Once a road’s status has been established local authorities set objectives for particular sections of a street network and before they select design criteria (design speed, speed limit,
roadway geometry, etc.). Modal hierarchy, regardless of movement and place, follows this order: pedestrians, cyclists, public transport users, special service vehicles, and other motor traffic.

The manual outlines a process for master planning and the development of context sensitive local design codes. It proposes a fluid functional classification scheme that incorporates place and clearly defines modal priorities. It includes case studies and best practices to implement. A weakness is that its application is at the discretion of local authorities.

**Vermont**


The Vermont standards supplement FCS designations with their proprietary contexts: historic/archaeological sites, natural resources, recreation resources, scenic roadways, and villages and cities. They contain design guidance specific to Vermont (roadway and lane widths, turning radii, landscaping and streetscape elements) and describe conditions for their use. They emphasize flexibility as a key element of the project design process and place responsibility on project managers and designers to determine local context before selecting design controls. They do not specify modal priorities or hierarchies, however.

**Washington DOT**

Washington State DOT (WSDOT) is currently developing an alternative classification system to encourage more flexible and context sensitive design solutions. The WSDOT system was inspired by the New Jersey/Pennsylvania DOT Smart Transportation Guidebook. WSDOT, however, modified the land uses categories so they better fit land use patterns found in Washington. Though not complete, the system’s framework has been defined. Context is defined by both a land use category and a subcategory. Land use category is defined as either residential or commercial, while the sub-category uses three density classifications — Rural, Suburban, and Urban.
Descriptive characteristics of each land use context category and subcategory division will be developed to appropriately classify roadway segments.

Of particular note with the WSDOT alternative is that the goal is to explicitly state defined output for each classification. As such, target operating speed and the accommodated modes will be identified for each transportation category and land use context category/subcategory in the system. This approach enables clear communications about the desired transportation/street performance outcomes without being overbearingly prescriptive regarding the design elements needed to achieve those outcomes.

UKY/NN SYSTEM-INDEPENDENT MULTIMODAL CLASSIFICATION ALTERNATIVE
The alternative approach developed by the project team envisions that classifications will be developed for each user group or mode — not each roadway. As such, separate classifications may be developed for vehicle thoroughfares, pedestrian activity centers, bicycle routes, transit facilities, etc. The final designation could be selected by layering independent networks together (Figure 39). The designer would then develop the roadway by following these priorities. Defining functional classification and deriving design alternatives for each user function separately will allow for the establishment of a straightforward classification system. Providing separate classifications for each user will also establish priorities for individual corridors, which can then be addressed through design. This classification strategy will assist the designer in distributing design resources when availability is limited.

![Figure 39 Selection of composite functional classification](image-url)
A combination of this and other strategies could also be used. For example, pedestrian activity could be defined based on adjacent land use, while existing (or proposed) networks could define bicycle, transit, and freight. This concept would function similarly to the overlays used in the Chicago system. One advantage of this system is that parallel routes could prioritize different modes to accommodate users independently. For instance, one parallel route may have narrower lanes, slower design speeds, reduced capacity, and on-street bike lanes, while the other parallel route may use higher capacity thresholds to accommodate higher auto throughput.

**EVALUATION OF ALTERNATIVE CLASSIFICATION SYSTEMS**

The next step in this research was to critically evaluate the classification systems described in this chapter to identify which system components hold promise for developing an alternative scheme. The emphasis was on evaluating alternative schemes via context definitions, function definitions (per modal user group), inputs and methods, and impacts on project design. This allowed for a final recommended practice that incorporates the best practices of all systems in a holistic and cohesive manner.

To complete this task, a workshop was scheduled with the Working Advisory Group (WAG). Solicitation of the WAG members was through personal contacts, in agencies that have demonstrated activity in the area of FCS. A varied geographical representation was also desired. The participants included the Director of Planning for Kentucky Transportation Cabinet, the Director of CSS for MNDOT, the Director of Design for WSDOT, and the Director for the MPO Ohio–Kentucky–Indiana.

The goal of the workshop was to gain perspective from professionals and users of the FCS on existing alternative schemes and what components/elements should be considered for inclusion in a new classification system. The workshop objectives were to: 1) identify and prioritize objectives for an alternative classification system, 2) review current alternative systems, and 3) determine which of the current alternatives most closely align with the identified objectives. The workshop included project team presentations of the NCHRP project objective and work outline, literature review, and preliminary results from the user survey.

*Objectives for an Alternative Classification System*

To evaluate alternative classification systems, it is imperative to develop a set of criteria that would be conducive to a systematic evaluation. A set of objectives that an alternative classification system should meet was established. As noted above, the review of alternative systems focused on outlining context definition, the ability to consider and accommodate modal priorities, and
impacts of classification on design. These were the initial objectives of the system, and at the workshop the project team presented a preliminary framework of key objectives for additional refinement and evaluation. A facilitated discussion established the primary and subsidiary objectives. After discussion the preferred set of objectives was identified and rank ordered by consensus as follows:

**Primary**

- Improved context definition — the group recommended these elementary factors be considered for context definition: density, land use and activity, and access level.
- Ability for multi-modal prioritization — the modes to be considered include vehicles, pedestrians, bicycles, and transit.

**Secondary**

- Ability to consider system level needs — this refers to the ability of the classification system to communicate the importance of the roadway within the overall transportation system or transportation network.
- Ease of use — this concept considers data availability requirements to pursue classification, ability to be straightforward and widely understood, and capability for systematic application.
- Ability to differentiate rural and urban applications — this encompasses the requirement that different design elements be used or considered for urban and rural areas, respectively.
- Ability to Directly Relate to the FHWA FCS — the existing system should be maintained independently from the proposed system, but it should also be possible go back and forth between systems.

The last three secondary objectives emerged during discussion and reflect specific agency needs. For example, having the ability to relate the alternative system to the FCS is a result of the exiting funding structure for a project. Any new scheme should make allowances for these interactions.

*Current Alternative Systems Evaluation*

The group was instructed to score each alternative system using a five-point scale (1 = does not meet objective, 5 = exceeds the objective) bearing in mind the primary and subsidiary objectives.
After the meeting additional systems were identified and reviewed, and these were presented in the previous sections. The alternatives presented and discussed included:

1. California;
2. Oregon;
3. Massachusetts;
4. Pennsylvania/New Jersey;
5. NACTO;
6. Charlotte;
7. AustRoads;
8. ARTISTS;
9. Design Domains (a project team composite);
10. UKY/NN System;
11. Washington State;
12. Abu Dhabi; and

Workshop participants presented the alternatives. During the presentations the systems’ context treatment, design implications, and their various elements were identified. A discussion of the merits and components of each alternative followed each presentation and the WAG members then scored the alternative from 1 (does not meet objective) to 5 (fully meets objective). Scores were tabulated to assess how well the alternative schemes meet each objective (Table 34).
Table 34 Scoring of alternative classification systems

<table>
<thead>
<tr>
<th>Alternative Classification System</th>
<th>Composite</th>
<th>Context Definition</th>
<th>Modal Priorities</th>
<th>Ease of Use</th>
<th>Relate to FCS</th>
<th>Rural/Urban Project/System</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pennsylvania/New Jersey</td>
<td>4.38</td>
<td>3.38</td>
<td>4.31</td>
<td>3.75</td>
<td>2.25</td>
<td>3.25</td>
<td>21.31</td>
</tr>
<tr>
<td>Washington State</td>
<td>4.33</td>
<td>3.67</td>
<td>2.33</td>
<td>2.50</td>
<td>3.67</td>
<td>2.67</td>
<td>19.17</td>
</tr>
<tr>
<td>AustRoads</td>
<td>3.25</td>
<td>3.06</td>
<td>2.56</td>
<td>3.25</td>
<td>3.31</td>
<td>2.75</td>
<td>18.19</td>
</tr>
<tr>
<td>UKY/NN System</td>
<td>2.75</td>
<td>4.38</td>
<td>2.75</td>
<td>2.75</td>
<td>3.00</td>
<td>2.75</td>
<td>18.13</td>
</tr>
<tr>
<td>Massachusetts</td>
<td>3.38</td>
<td>2.38</td>
<td>3.25</td>
<td>3.75</td>
<td>3.25</td>
<td>1.75</td>
<td>17.75</td>
</tr>
<tr>
<td>California</td>
<td>4.00</td>
<td>3.25</td>
<td>1.69</td>
<td>3.00</td>
<td>3.50</td>
<td>2.13</td>
<td>17.56</td>
</tr>
<tr>
<td>Abu Dhabi</td>
<td>4.25</td>
<td>4.88</td>
<td>3.50</td>
<td>1.75</td>
<td>1.00</td>
<td>1.75</td>
<td>17.13</td>
</tr>
<tr>
<td>Oregon</td>
<td>4.00</td>
<td>2.00</td>
<td>3.50</td>
<td>3.00</td>
<td>2.50</td>
<td>2.00</td>
<td>17.00</td>
</tr>
<tr>
<td>NACTO</td>
<td>3.81</td>
<td>3.81</td>
<td>3.75</td>
<td>1.25</td>
<td>1.25</td>
<td>2.00</td>
<td>15.88</td>
</tr>
<tr>
<td>Design Domains</td>
<td>4.00</td>
<td>3.06</td>
<td>2.25</td>
<td>1.00</td>
<td>3.25</td>
<td>2.00</td>
<td>15.56</td>
</tr>
<tr>
<td>Charlotte</td>
<td>3.44</td>
<td>3.75</td>
<td>3.50</td>
<td>0.75</td>
<td>1.75</td>
<td>2.00</td>
<td>15.19</td>
</tr>
<tr>
<td>ARTISTS</td>
<td>3.50</td>
<td>2.13</td>
<td>2.75</td>
<td>1.88</td>
<td>1.88</td>
<td>2.25</td>
<td>14.38</td>
</tr>
<tr>
<td>Minnesota*</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>4.00</td>
<td>5.00</td>
<td>5.00</td>
<td>26.00</td>
</tr>
</tbody>
</table>

* The Minnesota system was only ranked by one WAG member and is not included in the partial comparisons

Table 34 indicates that there is a variety of systems that meet the objectives set forth. The objective of context definition is met best through the Pennsylvania/New Jersey system (first) and Washington State (second). The objective of modal prioritization is best achieved in the Abu Dhabi system and the UKY/NN System. For the secondary objectives, the Pennsylvania/New Jersey system meets the ease of use, ability to crosswalk, and project/system objectives; the Massachusetts system meets the ability to relate directly to FCS and California and Washington State systems meet the rural/urban applications. The highest scoring alternative was the Pennsylvania/New Jersey system. However, it fell short of meeting one primary objective (Modal Prioritization) and one secondary objective (Rural/Urban Applications). The alternative with the second highest overall score was the Washington system.

Based on the scoring a best composite alternative would include:

- Context Definition — Pennsylvania/New Jersey.
- Modal Prioritization — Abu Dhabi and UKY/NN System.
- Ease of Use — Pennsylvania/New Jersey.
• Direct Relation to FCS — Pennsylvania/New Jersey and Massachusetts.
• Rural/Urban Applications — California and Washington State.
• Project/System Context — Pennsylvania/New Jersey and AustRoads.

Selected Issues and Concerns Voiced During Group Discussion
The advisory group meeting was agenda-guided and facilitated, but it was open-ended enough to let members to voice their expert opinions in an unstructured format. Major comments related to the FCS and alternative classification systems were noted. They are summarized below.

• More texture is needed so the system can adequately describe transportation and land use relationship.
• Functional class is used in urban areas to determine/qualify for funding.
• Land use should be considered in terms of activity and movement to define context.
• All roads cannot serve all purposes – right-of-way is too constrained.
• State highways become main streets in some rural areas.
• Traffic projections do not always consider future densities – land use plans may help.
• Sometimes project-level and system-level needs compete with one another.
• We deal with simple and complex things; do not be afraid to be complex (if needed).
• Should we consider multimodal integration rather than prioritization?
• We need to consider generational/cultural change relating to transportation needs.
• Functional class does not capture driver expectations or driver perception.
• (City) Public works directors dislike functional class and consider it inapplicable to cities.
• Functional class is set a decade or more before project (design) is initiated.
• We need written descriptions and graphics (pictures/photos) to convey functional class.
• We lack modal priorities and ways to determine them.
• What is the business case for changing the FCS? – cost savings, safety performance.
• There is probably not one existing alternative that meets all needs.
• We need more in-depth urban settings and modal consideration in a new system.
• Urban spoke/wheel vs. grid system would react differently to the same FCS.
• Existing labels carry traditional definitions – fresh names would be better.
• How can we accommodate transitions and transition areas?
• Tables need description and visuals to avoid being taken out of context.
Concluding comments from the advisory group members focused on the need for an alternative classification system, what it must achieve and how it might work. The consensus was that none of the alternatives reviewed would suffice in their entirety. Advisory group members agreed that systems which treated the context of the urban and suburban areas more fully were preferable. They also expressed concern that the rural classification needed expansion. The need to include some attention to a hierarchy of modal systems was expressed and specifically the need for modal prioritization in urban areas. A special need to address transitional areas between classification categories was expressed. Generally, it was agreed upon that a hybrid system was called for, and that the typologies needed to be clearly evident and new terminologies possibly adopted. Discussion concluded with a focus on design implications. The need for design guidance using target speeds as well as a table of general design values was discussed. However, members strongly indicated that a thought process of design was most desirable and that a highly prescriptive table would be counterproductive.

EVALUATION SUMMARY
The various alternatives presented and discussed are summarized in Table 35.
<table>
<thead>
<tr>
<th>Classification System</th>
<th>Road Function</th>
<th>Context Definition</th>
<th>Modal Considerations</th>
<th>Design Elements</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARTISTS</td>
<td>Four categories divided in arterial and non-arterial and in roads/ways and streets</td>
<td>Five categories based on road location (National, City, District, Neighborhood, Local)</td>
<td>User-based hierarchy of modes considering road transportation function</td>
<td>No design recommendations</td>
<td>CD MP EU RF SIP RU</td>
</tr>
<tr>
<td>AustRoads</td>
<td>Very similar to US FCS of arterial, collector, local system</td>
<td>Six categories based on land use (Most rural &amp; natural; Rural, rural reserve; Suburban; General urban; Urban center; and Urban core)</td>
<td>Recognition of modes</td>
<td>Design Domain to consider all elements and find appropriate fit for road demands</td>
<td>CD MP EU RF SIP RU</td>
</tr>
<tr>
<td>Charlotte</td>
<td>Five categories for urban streets (Parkways; Boulevards; Avenues; Local streets; and Main streets)</td>
<td>Six categories based on land use and urban form (Activity centers; Transit station areas; Growth corridors; Non-residential uses; Residential; Residential Low-Density)</td>
<td>Emphasis on how streets serve users and modes with design guidelines for each mode</td>
<td>Design values for each context category with distinction between priority elements and elements to be considered; lists of inappropriate elements are provided</td>
<td>CD MP EU RF SIP RU</td>
</tr>
<tr>
<td>Chicago</td>
<td>Six categories for urban streets (Thoroughfare; Connector; Main street; Neighborhood street; Service way; and Pedestrian way)</td>
<td>Seven categories based on land use and urban form (Residential; Mixed-use; Commercial center; Downtown; Institutional or Campus; Industrial; and Parks)</td>
<td>Modal hierarchy is considered based on modal corridor and design decisions are based on design decision trees where choices are made based on modal priorities</td>
<td>Design elements tied to the classification scheme and based on the design decision trees that define typical cross sections</td>
<td>CD MP EU RF SIP RU</td>
</tr>
<tr>
<td>ITE-CNU</td>
<td>Seven categories (Freeway/Expressway/Parkway; Rural highway; Boulevard; Avenue; Street; Rural road; and Alley/Rear lane)</td>
<td>Seven zone categories based on character, building elements, frontage type and public space (Natural; Rural; Suburban; General urban; Urban center; Urban core; and Assigned district)</td>
<td>Recognition of modes; no explicit accommodation</td>
<td>Design elements are considering operating speeds, number of lanes and modal considerations</td>
<td>CD MP EU RF SIP RU</td>
</tr>
</tbody>
</table>

Notes: CD: Context definition; MP: Modal priorities; EU: Ease of use; RF: Relation to FCS; RU: Rural/urban coverage

- ● Meets objective;
- ○ Partially meets objective;
- ○ Does not meet objective
<table>
<thead>
<tr>
<th>Classification System</th>
<th>Road Function</th>
<th>Context Definition</th>
<th>Modal Considerations</th>
<th>Design Elements</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts</td>
<td>Traditional classification system of arterial, collector, local</td>
<td>Nine context levels based on land use and urban form (Urban Central Business District; Urban residential; Urban park; Suburban high density; Suburban village/town center; Suburban low density; Rural developed; Rural village; and Natural)</td>
<td>Modal choices are considered for each context and accommodation of roadway users is considered</td>
<td>Not linked to roadway type and designers need to consider the classification as a starting point; emphasis on selecting design speed considering context</td>
<td>● ● ● ● ● ●</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Eight categories correlated to FCS (Freeway; Expressway; Low-volume highway; Rural highway; Suburban arterial; Urban arterial; Collector-connector; and Local street-road)</td>
<td>11 context areas based on land use and urban form (Large urban downtown; Urban commercial corridor; Urban residential area; Industrial area; Suburban town center; Suburban commercial corridor; Suburban residential; Small downtown or Main street; Rural transition area; Agricultural or Rural; and Natural or Recreational)</td>
<td>Modal choices are considered for each roadway segment along a slider scale to determine their importance</td>
<td>A list of key cross section elements to be considered along with a range of values to be used is provided but not tied to classification; selection of desired operating speed central to choices</td>
<td>● ● ● ● ● ●</td>
</tr>
<tr>
<td>NACTO USDG</td>
<td>City specific</td>
<td>13 context levels ranging from downtown to neighborhood streets based on urban form</td>
<td>Modal choices are included in design elements</td>
<td>Design recommended values not tied to street function or context</td>
<td>● ● ○ ○ ○ ○</td>
</tr>
<tr>
<td>Oregon</td>
<td>FCS of arterial, collector, local</td>
<td>Six context categories based on land use (Special transportation areas; Urban business areas; Commercial centers; Downtown; Developed; and Urban fringe/suburban)</td>
<td>Considerations of modes are an aspect of each design context</td>
<td>Tables with design values (ranges) based on context definitions</td>
<td>● ○ ○ ● ● ●</td>
</tr>
<tr>
<td>Pennsylvania &amp; New Jersey</td>
<td>Five categories overlapping FCS (Regional arterial; Community arterial; Community collector; Neighborhood collector; and Local Street/Road)</td>
<td>Seven categories based on land use and urban density (Urban core; Town center; Town/Village neighborhood; Suburban center; Suburban corridor; Suburban Neighborhood; and Rural)</td>
<td>No specific modal considerations but presence of modes is considered in a generic manner by roadway function</td>
<td>Tables with design values (ranges) based on context definitions</td>
<td>● ○ ● ● ● ●</td>
</tr>
</tbody>
</table>

Notes: CD: Context definition; MP: Modal priorities; EU: Ease of use; RF: Relation to FCS; RU: Rural/urban coverage
- ● Meets objective; ○ Partially meets objective; ○ Does not meet objective
As Table 35 indicates, several systems achieve the objectives identified by the project team and WAG, though in different ways. These differences raise the following discussion points.

**Multimodal Priorities**

Several systems meet the objective of balancing multimodal priorities. Some systems, such as both the Pennsylvania and New Jersey DOTs Smart Transportation Guidebook accommodate modes such as pedestrians and bicycles based on the context definition of a road. This can then be balanced with the system-level function of the roadway. Other systems explicitly state a commitment to multimodal priorities, such as Abu Dhabi’s, which places pedestrian priority at the top and vehicle traffic at the bottom. Still others address multimodal needs independently, such as the Chicago and the UKY/NN systems, which designate modal needs street by street according to system needs, or the ITE-CNU system, which discerns modal needs through the community visioning process and CSS design approach. It is clear that a method of establishing modal priorities is necessary to counter the mono-modality of the FCS.

**Context Definition**

All elements expand on the existing urban/rural dichotomy to refine further the land use context definition. While some states have chosen merely to define an additional third class of suburban, others expand this practice by including up to 13 different land use contexts. The key to the success of the existing system has been in its simplicity, even though that simplicity still causes confusion regarding the context and function definition of the roadway. Therefore, care must be taken in establishing another system to balance simplicity with the wide range of land uses that are present in the built and natural environment. One must consider not only the various contexts, but also the implied design parameters that may exist completely outside of the normal range of design flexibility. As the review of literature and state practices revealed, a minimum set of contexts for design may be considered as:

1. Rural;
2. Rural Main Street;
3. Suburban;
4. Urban; and
5. Urban Core.
Ease of Use
Of all the objectives, ease of use was only met by one alternative, the Pennsylvania/New Jersey system. While the total number of new context definitions is significant (7) it was not identified by the WAG as overly burdensome. In addition, the primary driver of its ease of use is its heavy reliance on pictures to relate context and land use/built form environment. While WAG members from various states saw some elements that did not match their landscape, there was a consensus that each picture was successful in defining their specified elements. It will be imperative to provide this level of clarity graphically and descriptively for whichever choice is made.

Direct Relation to FHWA Functional Classification System
While this was the WAG’s lowest-rated objective, it also had the most split and consternation in determining the way forward. The consensus was that providing a direct link to the roadway classifications of arterial, collector, and local street function either by maintaining the existing nomenclature or by providing a direct relationship between the new and old system would facilitate the implementation and acceptance of the system. However, other members argued that maintaining this relationship would also provide a justification for engineers and planners wanting to preserve the status quo design philosophy associated with the FCS. Thus, when considering implementation, the desired timeframe for adoption should be considered in light of the amount of support that can be garnered from FHWA, AASHTO, and others in affirming this direct link to the existing nomenclature.
CHAPTER 5
PROPOSED FUNCTIONAL CLASSIFICATION SYSTEM

This chapter summarizes the various concepts and issues of the proposed functional classification system (referred to as Expanded FCS) and its development. A full discussion of the proposed system and demonstration of its application is provided in the accompanying Expanded FCS guide (NCHRP Research Report 855). The goal for the proposed FCS is to provide a flexible framework that replaces the existing functional classification scheme; this will facilitate optimal geometric design solutions that consider context, user needs, and road functions. In this document, the term roadway is considered to include all facilities intended for travel in the right-of-way (e.g., travel lanes, shoulders, bicycle lanes, sidewalks).

ALTERNATIVE CLASSIFICATION SYSTEM DEVELOPMENT

The literature review, the evaluation of current alternative systems, and the findings from the WAG workshop pointed toward the development of a system that provides better definitions of context, which transcend the urban/rural dichotomy, and fully considers modal priorities. Moreover, correlating the proposed scheme with the current FCS was considered a key to integration of the proposed system.

As noted in Chapter 4, the primary objectives of the proposed classification system are context definition and modal priority considerations, while the top secondary objective was ease of use. The recommended classification scheme should: 1) strive to readily define the context as easily as possible with the available data, 2) provide for modal balancing and consideration, and 3) not require overly burdensome data collection.

The Expanded FCS provides a flexible framework, which can replace the existing functional classification scheme in order to facilitate optimal geometric design solutions that take into account context, road functions, and user needs. The Expanded FCS is designed to improve information for the planner/designer so that balanced designs can be achieved through documented prioritization of roadway users. The Expanded FCS delivers enhanced information better to inform the design decision process. This is achieved by providing increased resolution of the roadway’s design context to understand the role the roadway plays within the community; identifying the role of the roadway within the local, city, and regional transportation network; and identifying the multiple roadway user groups and their network needs within the design corridor. By providing this information within the expanded framework of the FCS, practitioners have a practical tool for determining appropriate design options and elements to understand better impacts of the trade-offs necessary to balance user needs, safety, and address other community
issues. The Expanded FCS framework determines user needs and orders user levels on a given roadway. It assumes the planner/designer can develop alternative system/network strategies for meeting all user needs (Figure 40). Once the content and roadway type are defined, the users can be identified, which in turn allows for the identification of possible design element options. The presence of any additional overlays (such as transit and freight) completes the required input and refines the purpose and need document, thus establishing the framework for the design to be developed. In the end, the final balancing of facilities to accommodate user needs becomes part of the process of following project development principles for achieving CSS.

Figure 40 Expanded FCS framework
EXPANDED FCS COMPONENTS

Context

Five distinct contexts are identified in the Expanded FCS that have been determined to represent not only unique land use environments. It is recognized that a more diverse set of contexts may be identified within the built and natural environments. The five categories proposed provide general guidance so that they are applicable to a wide variety of states and agencies and they identify distinctions that require wholly different geometric design practices in terms of desired operating speeds, mobility/access demands, and user groups (Figure 41). The primary factors considered within each category are

- Density (existence of structures and structure types);
- Land uses (primarily residential, commercial, industrial, and/or agricultural); and
- Building setbacks (distance of structures to adjacent roadways).

These factors are easy to identify by observing the landscape adjacent to an existing or planned roadway. There are some other features that can generally suggest points on the development continuum such as topography and soil type, land value, population density, and building square footage. All of these are relative to context, but the Expanded FCS does not rely on these features.

The context categories are as follows:

1. **RURAL**: areas with lowest density, few houses or structures (widely dispersed or no residential, commercial, and industrial uses) and usually large setbacks.
2. **RURAL TOWN**: areas with low to medium density but diverse land uses with commercial main street character, potential for on-street parking and sidewalks, and small setbacks.
3. **SUBURBAN**: areas with low to medium density, mixed land uses within and among structures (including mixed-use town centers, commercial corridors, and residential areas) and with varied setbacks.
4. **URBAN**: areas with high density, mixed land uses and prominent destinations, potential for some on-street parking and sidewalks, and mixed setbacks.
5. **URBAN CORE**: areas with highest density and mixed land uses within and among predominately high-rise structures, and with small setbacks.
The continuum is not perfectly gradual for the determining factors among the five categories and therefore some degree of situational analysis, experience, and professional judgment is required. Furthermore, in real-world situations, discontinuities will exist even when the overall assessment is clear. The Expanded FCS context assessment does not rely on a quantitative analysis (neither persons per square mile nor building square footage) and can be used in states with broad comparative development differences between urban cores or rural areas. These differences are largely a matter of scale and intensity (the activity patterns vary...
significantly). The Expanded FCS does not provide quantitative guidance for transitional areas between categories. However, this remains an important design consideration affecting safety, function, and design detail. This is an issue that needs to be addressed at the project level and associated treatments need to be considered at that level. The context category decision becomes a possible starting point that leads to geometric design choices, as they will be influenced by the road type. These two choices—context and road type—will define the modes to be considered and their interactions. A robust CSS process (involving all stakeholders) can assist the project team in understanding the various project issues and modal needs in order to develop a contextually appropriate design.

The five Expanded FCS categories and their primary factors are shown in Table 36.

### Table 36 Expanded FCS context categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Density</th>
<th>Land Use</th>
<th>Setback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>Lowest (few houses or other structures)</td>
<td>Agricultural natural resource preservation and outdoor recreation uses with some isolated residential and commercial</td>
<td>Usually large setbacks</td>
</tr>
<tr>
<td>Rural Town</td>
<td>Low to medium (single family houses and other single purpose structures)</td>
<td>Primarily commercial uses along a main street (some adjacent single family residential)</td>
<td>On-street parking and sidewalks with predominately small setbacks</td>
</tr>
<tr>
<td>Suburban</td>
<td>Low to medium (single and multi-family structures and multi-story commercial)</td>
<td>Mixed residential neighborhood and commercial clusters (includes town centers, commercial corridors, big box commercial and light industrial)</td>
<td>Varied setbacks with some sidewalks and mostly off-street parking</td>
</tr>
<tr>
<td>Urban</td>
<td>High (multi-story, low rise structures with designated off-street parking)</td>
<td>Mixed residential and commercial uses, with some intuitional and industrial and prominent destinations</td>
<td>On-street parking and sidewalks with mixed setbacks</td>
</tr>
<tr>
<td>Urban Core</td>
<td>Highest (multi-story and high rise structures)</td>
<td>Mixed commercial, residential and institutional uses within and among predominately high rise structures</td>
<td>Small setbacks with sidewalks and pedestrian plazas</td>
</tr>
</tbody>
</table>

Additional discussion and photographic examples for each category are presented in the Expanded FCS Guide (NCHRP Research Report 855).

The roadway planning and design process should take into account anticipated future context conditions that are often defined through state, regional, and local planning documents. At the state level, there are usually long-range transportation plans that include not only vehicle transportation but also have separate plans that address the future needs of other users. Some districts may develop transportation or land use studies that address future corridors, and urban areas may have street design guidelines, all of which may influence future roadway context. It
should be emphasized here that some areas grow faster than projected/planned while others decline faster than expected/planned. This assessment takes some reality testing with stakeholders/officials/professionals to determine the likelihood of future context change.

Roadway Types

Functional classification has, for decades, relied on three general thoroughfare types for classification: arterials, collectors, and locals (more recently, arterials have been further subdivided into principal and minor, resulting in four classification types currently being used). Decades of familiarity with these terms, and many Federal funding mechanisms being based in whole or in part on these four classifications, has resulted in continued use of the same labels.

The roadway types used in Expanded FCS are based on their network function and the connectivity they provide among various centers of activity. Network function is defined based on the regional and local importance of the roadway as it pertains to vehicle movement. Connectivity identifies the types of activity centers and locales that are connected with the particular roadway. The proposed roadway types are as follows:

1. **INTERSTATES/FREeways/EXPRESSWAYS**: Corridors of national importance connecting large centers of activity over long distances.
2. **PRINCIPAL ARTERIALS**: Corridors of regional importance connecting large centers of activity.
3. **MINOR ARTERIALS**: Corridors of regional or local importance connecting centers of activity.
4. **COLLECTORS**: Roadways of lower local importance providing connections between arterials and local roads.
5. **LOCALS**: Roads with no regional or local importance; for local circulation and access only.

It should be noted that the Expanded FCS will not address context types for Interstates, Freeways, and Expressways, since designs for these facilities are based on federally developed standards with little flexibility.

It is noted that the primary difference between the Expanded FCS and the existing functional classification system is the absence of differentiation between minor and major collectors. These roadway types were combined due to the inability to distinguish sufficiently design, operating, and modal characteristics of the two classes. Therefore, existing classifications
may be transferred readily from one system to the other, though special attention may be needed in addressing minor collectors. In some cases, it may be applicable to define these roadways as local roads as opposed to collector facilities. It is also noted that the major/minor collector definition currently serves as the dividing line between eligible and non-eligible roadways within rural areas for Federal-aid. Adoption of the proposed Expanded FCS will have to address this issue when providing a new definition for Federal-aid and non-Federal-aid eligible roadways.

In addition to connectivity, other factors utilized in determining the roadway type may include:

**Efficiency of Travel.** Travelers in a private vehicle will typically seek out roadways that allow them to travel to their destinations with as little delay as possible in the shortest amount of time. Therefore, higher order driver facilities should be planned within a network to connect major centers of activity.

**Route Spacing.** Directly related to network definition is the concept of distance (or spacing) between routes. For a variety of reasons, it is not feasible to provide high-speed facilities to travel every possible trip in the most direct manner possible or in the shortest amount of time. Ideally, regular and logical spacing between routes of different classifications exists. High separation routes should be spaced at greater intervals than medium level routes, which are spaced at much greater intervals than low/no separation routes. Spacing varies considerably for different areas. In densely populated urban areas, spacing of all route types is smaller and more consistent than spacing in sparsely developed rural areas. Geographic barriers greatly influence the layout and spacing of routes.

**Vehicle Volumes.** The amount of vehicle traffic and current and design year volumes is another indicator of the type of facility and its functional classification. The amount of vehicle traffic affects several factors, including roadway vehicular capacity, vehicular delays, and most importantly, the number of lanes required to accommodate the traffic. It is important to note that the roadway project will serve users throughout its entire design life and beyond. However, many of the design choices required to accommodate traffic under a future scenario, e.g., more lanes, may be detrimental to year of opening conditions, i.e., encouraging higher speeds and longer pedestrian crossing distances. Therefore, design recommendations should be developed with both opening year, future year, and intermediate operations in mind, while also understanding impacts on peak and off-peak operating conditions to develop the “best” or phased approach scenario for all users throughout the entire design life and not just the on peak conditions.
Other Networks

Bicycle Networks

In addition to the automobile-oriented definitions of roadway type, classifications for bicycles are also proposed to confer structure and priority for bicycle networks. Similar to automobile roadway type classifications, these facilities are categorized based on the network connectivity a facility provides. However, the network scale is modified to reflect shorter travel ranges.

Three classifications of bicycle facilities are proposed. These are:

- **Citywide Connector (CC)**—providing citywide connections, connections to major activity centers, or regional bike routes that stretch over several miles and attract a high volume of use as they serve a primary commute or recreational purpose.
- **Neighborhood Connector (NC)**—providing neighborhood or sub-area connection, which establishes connections to higher order facilities or local activity centers such as neighborhood CCs.
- **Local Connector (LC)**—providing local connections of short lengths, internal connections to neighborhoods, or to higher order facilities.

In addition to connectivity, other factors may be used in planning a bicycle network. Each of these factors is identified and discussed below.

**Efficiency of Travel.** Trip makers will typically seek out roadways that allow them to travel to their destinations with as little delay as possible and in the shortest amount of time. Therefore, higher order bicycle facilities should be planned within a network to connect major centers of activity by considering recreational, work/commuting, and other trip types.

**Mode Range.** Range should also be considered, as the National Survey of Pedestrian and Bicyclist Attitudes and Behaviors Report identified an average trip length of 65 minutes, which translates to 15-20 miles (NHTSA, 2002). In establishing a bicycle network, trip lengths longer than this should factor in integration with transit facilities.

**Bicyclist Safety.** Another issue is the vulnerability of bicyclists. Safe bicycling facilities and options should be considered. This may often require greater separation between bicyclists and traffic in order to reduce safety concerns, especially in facilities with high speeds.

**Route Spacing.** Directly related to network definition is the concept of distance (or spacing) between routes. For a variety of reasons, it is not feasible to provide high order facilities to accommodate every possible trip in the most direct manner possible or in the shortest
amount of time. Ideally, regular and logical spacing between routes of different classifications exists. High separation routes should be spaced for intervals greater than medium level, which are spaced at much larger intervals than low/no separation routes. This spacing varies considerably for different areas. In densely populated urban areas, spacing of all routes types is smaller and generally more consistent than the spacing in sparsely developed rural areas. Geographic barriers greatly influence the layout and spacing of routes.

**Bicycle Volumes.** Estimating the amount of anticipated bicycle traffic is another indicator of the type of facility and its functional classification. Future community plans to address bicycle mobility issues and options should be considered when determining the type of facility and its functional classification. The amount of bicycle traffic affects several factors, including bicycle capacity, vehicular delays, and most importantly, the level of risk associated within the bicycle and auto traffic mix. Three basic categories of bicycle volume are considered for categorization purposes: 1) low volume, including rare or occasional bicycle traffic; 2) medium volume, which sees some bicycle trips measured in bicycles per day; and 3) high volumes. Volume is measured in bicycles per hour. Each of these volumes will require a different treatment based on the context–roadway interaction. Higher order bicycle facilities with higher volumes are considered primarily for relatively dense areas for the purpose of intermodal connection, and reasonably short trips to work or shop in or between urban core, urban, and suburban areas, though rural towns may have such networks within a smaller concentration. While rural areas do not exhibit the density typically associated with successful bicycle networks, these may occur in certain circumstances. In addition, recreational users may favor longer trips and lower interruptions provided by rural roadways, and higher volumes of recreational cyclists may be found in rural areas along popular routes or near other recreational areas that attract cyclists such as rural parks.

**Pedestrian Networks**

While other modes readily lend themselves to a network planning strategy for incorporated areas, pedestrian activity accommodations may be defined by the individual context of the area. This is in part due to the relatively short range of typical pedestrian activity. Moreover, pedestrian facilities may be even more localized, such as at a storefront or at a surrounding a bus stop, and not extend throughout the entire context area.

However, in denser urban areas, pedestrian activity may also cross contexts or land use boundaries, requiring the routing of pedestrian traffic through a context area to another major area.
of activity. For example, a corridor connecting a university campus with a downtown area may require enhanced sidewalks even if the immediate context may not demand such treatment. In addition, for larger context zones, such as suburban areas, pedestrian facilities may be focused on connecting areas of potential or anticipated pedestrian activity, such as connecting a residential subdivision to another subdivision or a nearby shopping center to a transit stop. As such, it may not be necessary to continue the sidewalk or path for the entire length of the roadway but have the potential to make more meaningful connections between compatible land uses. For example, a corridor with a suburban context may not require continuous pedestrian facilities if the centers of activity with potential pedestrian traffic are discontinuous. However, where evidence of pedestrians exists or where pedestrian travel is likely expected a minimum sidewalk width should be a priority to provide improved safety for pedestrian movements outside of the high-speed traffic area.

In addition to connectivity, other factors may be utilized to plan a pedestrian network including:

**Efficiency of Travel.** Pedestrians typically seek out roadways (pathways) that let them travel to their destinations along routes they perceive as safe and interesting. Distinct from other modes, pedestrians also consider, but are less directed by, the route with the shortest travel time. Therefore, higher order pedestrian facilities should be planned within a network to connect major centers of activity and consider recreational, work/commuting, and other trip types.

**Mode Range.** Range should also be taken into account. A typical pedestrian range of 0.25-0.50 miles is often used as an acceptable walking distance in the U.S., however, this length may increase in urban areas where walking is the preferred method of transport (NHTSA, 2002). In establishing a pedestrian network, trip lengths longer than this should factor in integration with transit and enhanced pedestrian facilities. Due to the relatively short range of pedestrian travel, the level of pedestrian activity can often be directly associated with the area’s context and land use.

**Pedestrian Safety.** Another issue is the vulnerability of pedestrians. Safe pedestrian facilities and options should be evaluated. Providing a separation between the pedestrian facility and the traffic or expanding available sidewalk width are methods to improve safety and pedestrian comfort by reducing potential conflicts and exposure for pedestrians. This may be especially important for roadways with medium or high speeds.
**Block Length.** The length of blocks affects pedestrian travel demand. In general, desirable block lengths range between 200 to 400 feet and should not exceed 600 feet (ITE, 2010). Long blocks tend to discourage pedestrians.

**Pedestrian Volumes.** Estimating the amount of pedestrian traffic will help determine the type of facility and its functional classification. The amount of pedestrian traffic affects several factors, including pedestrian facility capacity, vehicular delays at signalized intersections, and most importantly, the level of risk associated from jaywalking pedestrians. Four basic categories of pedestrian volume are used for classification purposes: 1) rare or occasional volume; 2) low volume, which sees a few pedestrians measured in pedestrians per day; 3) medium volume, which sees several pedestrians, measured in pedestrians per hour; and 4) high volumes measures of pedestrians per hour and over a short time period. Each of these volumes will require a different facility based on the context-roadway interaction.

**Expanded FCS Matrix**

The correlation of context, roadway types and users results in the Expanded FCS matrix (Figure 42). This allows for the development of a multimodal, context-based design with some degree of flexibility. Each matrix cell defines the various users (drivers, bicyclists, and pedestrians) and identifies which characteristics are to be balanced.

![Figure 42 Expanded FCS framework user matrix](image-url)
The classification of the roadway types for the driver and bicycles are considered across the entire network and their combination will provide the required coverage to address and balance their needs, based on the roadway context. Pedestrian needs are also defined based on the roadway context but there is no specific network classification for facilities to accommodate their needs. It should be noted also that a corridor may transition into different contexts over its length and this will be reflected in the design considerations and cross sections.

**Overlays**

While the corridor planning/design team often directly addresses the inclusion of auto, bicycle, and pedestrian users, other users may exist. These users, such as transit and freight, are established to meet the unique needs of the system and the network in which they operate. These users may then be applied to the corridor as overlays that add to the understanding of the total users for the roadway. When considering balancing needs of overlays, information regarding the frequency, use, and importance of the individual routes within the overlay network is essential, as discussed below.

**Transit Networks**

Transit routes are typically fixed and well defined by the local transit agency to meet the demands of transit ridership. Additional resources are available to determine the best network and routing plans for transit facilities as well as guides to aid in the design of transit facilities (AASHTO, 2014). It is imperative to incorporate transit facilities into the overall transportation network so that they can be considered in the context of the overall transportation network and not be viewed separately.

Increased recent ridership trends may require a closer examination of such overlays and their potential impacts on design. A closer coordination with transit agencies, which typically are independent from DOTs, is essential to define properly transit overlays for roadways where transit either exists or is anticipated to be located.

**Freight Networks**

Freight networks typically describe where large trucks that require high-type accommodation may be concentrated on the roadway network. Studying land use to identify industrial centers, multimodal ports, manufacturing, and commercial areas may determine freight networks. Once freight-generating land uses are identified, preferred supply and delivery routes can be identified that connect the centers where activity originates with expected destinations. Heavy freight is routed typically to larger, higher classification roadways, such as major and minor arterials, where
increased mobility is preferred. However, in addition to evaluating the roadway types to serve freight corridors, sensitive context zones, such as urban and urban core areas, should be avoided to minimize interactions between freight and vulnerable road users.

Freight networks should be characterized based upon the frequency and size of expected freight traffic. Lower classification roadways may accommodate occasional through freight vehicles, while certain roadway and land use contexts may preclude large freight traffic. On heavy freight routes, the roadway, adjacent facilities, and intersections should be designed to move traffic safely and efficiently. Moderate or occasional use facilities may marginally accommodate larger freight vehicles while being designed to provide lower speeds and shorter crossing distances for other users. Within these roadway/context combinations, impacts to operational efficiencies may be experienced as freight traffic traverses the corridor.

*Network Overlay Application*

Each modal network can be assembled to determine good network layouts for each user. Once complete, these networks may be overlaid on top of one another to develop a representation of the comprehensive transportation network and users (Figure 43). This is critical for identifying conflicts between users groups so that revisions may be made to best accommodate all users—not necessarily on all roadways but within the entire transportation network.
Figure 43 Networks overlay
Incompatibilities between user groups will likely arise throughout the network planning and project development process. When these conflicts occur, the application of an alternate network strategy can be used to identify parallel routes that meet transportation needs for other user groups on routes with more compatible uses. For example, while it may be desirable to accommodate bicyclists on an arterial, heavy vehicle volumes may present a challenging trade-off decision when considering how to accommodate significant bicycle demand. In this case, parallel roads can be used to divert the bicycle traffic and establish the required separation. While it is understood easily that all users must be accommodated within the transportation system, not all roads can be all things to all people. However, all users can be supported fully by the total network. It is therefore imperative that a designer evaluates the needs of all users, as well as understands the priority of users within the route and each of their modal networks. In establishing modal networks, the primary consideration will be identifying the generators for each mode and then providing connection between major points of trip attraction or generation. For instance, a roadway in the urban core with heavy pedestrian use in retail areas should place a high priority on pedestrian movement as it serves as the point of attraction. Roadways connecting the activity center with either residential or transit centers may also need to prioritize pedestrian movements, but may also lower priority if an alternative is identified which better accommodates the mix of users, such as establishing a pedestrian only corridor closed to automobile traffic. At a minimum, the design should accommodate intended users on the road of concern or be moved to a parallel route. Where possible, enhancements should be made beginning with the highest priority user.

This application of the Expanded FCS requires expansion of the documented public transportation system to include pedestrian and bicycle networks as well as to identify future connections within these networks. Transportation agencies routinely establish roadway networks and clearly understand the role of these networks. On the other hand, bicyclist and pedestrian networks are not used widely and this may pose an initial issue for the Expanded FCS implementation. Due to the relatively limited range of pedestrian activity, it may not be necessary to identify a comprehensive pedestrian network, but rather the individual context of the area may be used to determine the level of pedestrian activity, with individual projects identifying special connections to transit and adjacent contexts. The longer range of bicycle travel, however, has the tendency to pass routinely through several context zones, increasing the need for an extended network determination of bicycle facilities. A process to identify these could be undertaken through initial consultation with the appropriate stakeholders and existing facilities can be identified at this stage. For example, cities with an inventory of sidewalks and bicycle groups often have bicycling maps developed for their members. Using such resources as a starting process will provide the
basis for additional discussions with these stakeholders aiming to identify the relative importance for each facility within the respective network. This process can be relied on CSS principles to define modal priorities and hence establish the network classifications for bicyclist and pedestrian facilities.

An agency can follow these CSS-based approaches to establish these networks:

- Identify appropriate stakeholders.
- Identify centers of activity that could attract and/or generate pedestrian and bicyclist activity.
- Solicit stakeholder input on route choices and priorities and collect existing maps and other data.
- Develop preliminary network classifications and solicit stakeholder input.
- Finalize and publish pedestrian and bicyclist networks.

It is noted also that the absence of a comprehensive network does not render the application of the Expanded FCS useless. As opposed to utilizing a preexisting network, a project team in conjunction with project stakeholders and public input may identify the priority of bicycle and pedestrian facilities for a roadway. This determination is dependent upon the existing and anticipated bicycle/pedestrian volumes, adjacent facilities, traffic generators and attractions both within and outside the project area or along the route in question. Addressing bicycle and pedestrian routes in this manner will allow for advancement of modal equality, however, full network planning will be required to provide a truly cohesive system.

**EXPANDED FCS MODAL ACCOMMODATIONS**

The Expanded FCS identifies user groups, which include drivers, pedestrians, and bicyclists. It should be noted that the term “driver” refers to automobile drivers, since drivers for transit and freight are handled as an overlay. Fundamental design accommodation elements for each mode are identified also, and design ranges for each are provided based on the overall roadway network type. Various user needs should be identified from the outset and considered when balancing and making the necessary trade-offs among design elements in order to develop contextually appropriate multimodal solutions.
Driver Accommodation

The metrics used to define the context-roadway interaction for drivers are the target operating speed and the balance between mobility and access.

Target Operating Speed

Target operating speed is grouped into three categories: Low (<30 mph), Medium (30-45), and High (>45 mph). These definitions coincide, in general, with the existing high and low design speed concepts in the Policy for Geometric Design of Highways and Streets, or Green Book (AASHTO, 2011) and can form the basis for initial designs. Speed, in general, decreases along the context continuum (from rural to urban core) as well as along the roadway type (from Principal Arterials to Locals).

The speed used in the Expanded FCS is the target operating speed of the roadway. The rationale for selecting operating speed in the Expanded FCS is the need to recognize the influence of driver desire and expectations. Moreover, the goal is to develop a facility where the operating speed is close to the design speed, resulting in an environment with smaller speed differences among drivers. Smaller speed differentials could improve safety, since they will eliminate discrepancies between design speed and operating speeds, creating a more uniform speed profile among drivers. These speeds need to be considered with both existing and future volumes and contexts.

The limits for each category are based on established practices and extensive research. The speed of 25 mph was considered the limit for the low-speed environments based on current trends of several urban areas to facilitate a speed limit of 25 mph. Indeed, 20 mph is considered the survivability speed for pedestrians and bicyclists in the event of a collision with a vehicle. Such collisions typically result in injuries, and non-drivers have a high chance of surviving when speeds remain at or below 20 mph. As such, speeds of 20 mph or less should be considered in areas of higher pedestrian activity in the urban and urban core environments. Target speeds for urban and rural towns have been designated as Low / Medium because of the competing issues within these contexts and the varied pedestrian and roadside environment. The designer should examine the available speed range to select the operating speed most appropriate for all users given the facilities and context. The upper limit for high speeds is based on the Green Book definition of high-speed roads, which are those with speeds of 50 mph and above.
Access and Mobility

The typical trade-off between access and mobility presented in the existing classification system is improved in the Expanded FCS to reflect the influence of roadway and context as it changes across the various matrix categories. Access is defined as the frequency of driveways or intersections and is grouped in three categories based on distance between access points: Low (>0.75 mile), Medium (0.75-0.25 mile), and High (<0.25 mile). Mobility is defined-qualitatively-as a function congestion level. There are three categories: Low (congested conditions), Medium (some congestion), and High (no congestion; free flow). It should be noted that volumes referred to here are taken to be during the peak period.

The values for the access are based on current understanding of access management concepts and principles. While it is desirable for access density to decrease on higher mobility roadways, within certain contexts this rule does not hold true, as the roadway serves as the primary means of access. Mobility levels are based on generalized concepts of the level of service (LOS) for a facility and correspond to broad values of all roadways.

Expanded FCS Matrix Approach

For the driver, the interaction of access and mobility varies along the context spectrum where mobility decreases from rural to urban core and access increases from rural to urban core.

Figure 44 shows the interactions and relationships for the drivers. The matrix indicates how driver metrics change based on the interactions of different combinations of context and roadway. For example, when focusing on Principal Arterials, one can observe that in a rural setting, the mobility is expected to be high with low congestion levels, while access may be low with few driveways or intersections along the corridor. As the context settings change with increased density and smaller building setbacks as well as increased pedestrian volumes and proximity to the traffic stream, mobility declines (i.e., more congestion is anticipated) and access increases, which provides more opportunities to access land uses (which also change from rural character to a more developed environment). The target operating speed also changes along the context continuum, with higher speeds anticipated in rural settings. This reflects the higher mobility in these locations. Reductions in operating speed are anticipated as the context transitions to developed and urban settings. Similar changes are also noted along the roadway type categories. Mobility decreases along the spectrum of roadway type categories (from principal arterials to locals), while access increases along the same direction. Mobility increases as the roadway type rises in category, reflecting the anticipated higher mobility levels of arterials compared to local roads. In a reverse manner, access levels increase as the roadway categories decrease, reflecting
the greater need for access of local roads. The target speed also changes among the categories, with an increasing trend from local to arterial roads. This reflects the mobility trends noted above. The changes along both axes of the matrix enable a three-dimensional interpretation of the typical access-mobility graph used in the existing FCS.

Design Considerations
The primary design consideration for drivers is mobility. Roadways regularly have diverse modal traffic. In order to address their needs, the level and type of separation provided for the other users from vehicles may require attention. These considerations should be based on the volume of motorized, pedestrian, and bicycle traffic. Increased separation may be needed between high volumes of other users and motorized traffic. This can be achieved using either barriers or with separate facilities. Additional discussion on this is provided with the other modes.

Another issue to be mindful of is the fact that not all routes are conducive to bicyclists and pedestrians (i.e., high speed principal arterials). In these cases, alternative routes should be identified that could satisfy the mobility needs of these users and accommodate them as needed. However, in some restricted cases speeds must be reduced or varied to accommodate specific users more safely.
For principal and minor arterials in rural town and urban contexts, designers can select from a wider range of speed choices (low through medium) for motorized traffic which will help accommodate pedestrians and bicyclists and provide for a safe design for all users.

**Bicyclist Accommodation**

The primary design consideration for a bicycle facility is the level of separation between motorized and bicycle traffic. Other factors that can help determine the proper treatment of bicyclists are discussed as well.

**Separation**

Bicycle facilities generally can be categorized based on the amount of separation they provide from motorized traffic. For the purposes of the Expanded FCS, they are categorized as:

- **High separation** — provides physical separation from traffic in the form of physical barrier or lateral buffer.
- **Medium separation** — provides a dedicated space adjacent to motorized traffic.
- **Low/No separation** — provides shared use facilities for motorized and non-motorized traffic.

The amount of separation necessary for a facility is dependent mostly on:

- The amount of bicycle traffic on the facility.
- The speed of motorized traffic on the adjacent roadway.
- The amount of motorized traffic on the adjacent roadway.

The need for variances in separation may be demonstrated by examining two extreme examples. First, consider a high-speed urban arterial that also serves as a regional bicycle connection; it has heavy volumes of bicycle traffic. In this instance, a cycle track or even independent multi-use paths may be appropriate to serve the bicycle traffic. Providing a separate facility reduces the number of conflicts between the two modes of traffic, which may be frequent considering the high traffic volumes of both modes and the potential severity due to high speeds of the motorized facility. Conversely, at a low-speed neighborhood street serving only local riders, bicycles and vehicles may share the same space due to the low probability of conflict and low speed differential between the two modes.
The proposed functional classification matrix identifies a proposed level of separation that may be considered for each bicycle facility category according to roadway type and context. The following section identifies potential treatments that may be included within each of these separation levels.

**Low/No Separation Treatments**
- No specific treatment, for cases with rare or occasional bicycle traffic.
- Sharrows — for cases when a bicycle lane is not feasible and they can be used either with narrow lanes, ensuring that a driver can only pass a cyclist very slowly.

**Medium Separation Treatments**
- Bike lanes — for separating bicycles from vehicular traffic.

**High Separation Treatments**
- Buffered bike lane/cycle track — for cases with high bicycle volume.
- Multi-use path — for cases with high bicycle and pedestrian traffic.

**Expanded FCS Matrix Approach**
The level of separation provided should be based on speed of traffic, context and roadway type, and is defined for all three levels of bicycle traffic. The separation changes along the context continuum to reflect the effects of target operating speed (Figure 45). For example, higher speeds on Principal Arterials require some balancing of the separation based on the amount of anticipated bicycle traffic and context. For Rural and Suburban contexts, high bicycle volumes require a high separation and the designer should determine the type to be used based on the discussion provided in the next section. In all other contexts with lower speeds, a Medium separation is recommended for high volume traffic. Similarly, there are interactions between bicycle separation and roadway type. For example, on local roads, the slow-moving traffic does not require any special separation for bicyclists, and for all contexts, Low separation is recommended. It should be noted here that all options are provided in order to allow the designer to determine the appropriate facility required to accommodate bicycle traffic based on the bicycle classifications that may exist. The matrix presents the minimum accommodation that should be expected form travelers for all modes. However, these levels of accommodation may be increased to address local priorities and where sufficient space exists to provide enhancements.
**Design Considerations**

Sharrows with *narrow* lanes may be used when the narrow lane would not cause safety concerns or exceptionally delay traffic flow, including:

- Small speed differential between bicycles and vehicles.
- Low volume of vehicular or bicycle traffic.
- Short length bicycle facilities (<.25 miles).

Narrow lanes are no more than 10 feet wide and traffic speeds are low (less than 20 mph). Conversely, sharrows with wider lanes typically provide a wide travel lane of 13–14 feet with supplemental striping and/or signing. The wider lane allows for vehicular traffic to pass cautiously slower bike traffic. It may be a solution for constrained roadways with minimal speed differentials between bicycle and vehicular traffic (<30 mph).

Bike lanes, while providing space exclusive from travel lanes, do not provide physical separation. Bicycle/vehicular conflicts at intersections with turning traffic and from “dooring”
incidents with parked vehicles are not eliminated. Narrower bike lanes (~4 foot) should only be used when right-of-way is constrained and not in the presence of on-street parking, unless an additional buffer is provided. Additionally, bike lanes should not be used for high-speed facilities and/or facilities with a combination of high vehicular and bike traffic. In the presence of higher speed traffic or high traffic volumes, wider bike lanes are warranted to create additional separation between facilities.

Off-street paths (and trails) are cycle routes that are not part of the regular street network. An ancillary consideration is the separation of bicycle users from pedestrian activities. Both of these considerations should be based on the volume of autos/pedestrian traffic and bicycle traffic as well as the anticipated speed of cyclists and autos. Vehicular speed should be targeted based on the functional classification and context of the roadway. In addition, bicycle speed may fluctuate based on the FHWA designated “Design Bicyclist” Group A, B, or C (Advanced, Basic and Children Bicyclists, respectively) (FWHA, 1992).

Bicycle separation is highly contingent on the speed differential between bicycles and motorized traffic. As speeds go up, as indicated in Figure 45, separation should also increase. However, if lower volumes of bicycle traffic are anticipated and more bicycle commuting traffic is anticipated, higher bicycle speeds (and possibly increased comfort riding in traffic) may be assumed, allowing reduced separation. If conflicts arise and vehicular or bicycle traffic cannot be accommodated on parallel routes, consideration should be given to lower targeted speeds and designing the roadway (e.g., narrower lanes, lowered mobility) to achieve that, in lieu of increased separation.

While bicycle facilities are aligned to fit well with the overall vehicular functional classification, it is important to remember that bicycle facilities should be considered in terms of the overall bicycle network. The overall bicycle network should be planned to allow connections to recreational cycling areas for casual users (Group B or C) and provide commuting and general transportation opportunities for Group A users. While it would be beneficial to develop a formal area-wide bicycle network that can be overlaid with vehicular, pedestrian, and transit uses, it is not necessary as long as network connectivity is considered on a project-by-project basis.

Bicycle facilities can be considered longitudinal treatments along the length of the roadway, and limited intersection elements may be required. However, considerations for turns for primary junctions within the bicycle network should be incorporated into the plan such as the use of bike boxes etc.

Access density is also a consideration with bikes, especially with cycle tracks and buffered bike lanes. In areas of high access density, the separation of bicycle traffic should be avoided because it increases the number of crossing conflicts for ingress and egress traffic.

Rural bicycle facilities also necessitate additional consideration in the design process. As noted previously, bicycle networks are more prevalent within urbanized areas due to the increased density allowing the shorter range of cycling to be a more effective transportation solution. However, rural areas may experience high volumes in special circumstances, often arising from high demands from recreational riders. Understanding the unique and varying needs of recreational cyclists is important in understanding the final design of the facility. For instance, routes, which experience high usage, related to bicycle club ridership may be used by experienced riders comfortable riding next to or sharing lanes with higher speed traffic, while recreational facilities surrounding parks or other attractions may attract users of all abilities and necessitate higher separation facilities due to high vehicular speeds.

Pedestrian Accommodation
The primary design consideration of a pedestrian facility is its width. Other factors that can help determine the proper treatment of pedestrians are also discussed.

Facility Width
Pedestrian facilities can be generally categorized by the width of the facility to be provided. For the purposes of this document, they are categorized as:

- * — facilities require site specific consideration.
- Minimum width — provides for the minimum required width based on American with Disabilities Act (ADA) requirements.
- Wide width — provides for wider than minimally required width for a pedestrian facility.
- Enhanced width — provides for additional space than the wider width to accommodate congregating groups of pedestrians and street furniture.

The first category (noted with a *) indicates that for occasional pedestrians site specific considerations are required in order to determine whether facilities may be placed based on the
local conditions and consistency with future plans for the area or alternative accommodations such as providing shoulders for pedestrian/bicycle usage may be considered.

Separation
In addition to the facility width, separation of the pedestrian facility from the travel way is also an important consideration. However, this design element is primarily dependent on the speed of the automobile facility rather than on the level of pedestrian activity on the facility. Typically, medium and high-speed facilities will require separation from the travel way whether this is in the form of a landscaped buffer, bicycle lanes, or parking areas. For low-speed facilities, the sidewalk may be attached to the curb, directly adjacent to the travel way without a need for a buffer area.

The width necessary for a facility depends on many factors, but most notably:

- The amount of pedestrian traffic adjacent to the facility.
- The speed of motorized traffic on the adjacent roadway and required separation.
- The amount of motorized traffic on the adjacent roadway.

It is noted also that the absence of physical separation of a sidewalk may reduce the available functional width of the sidewalk in areas of high speed and high volume traffic causing pedestrians to shy away from the edge of the roadway. As such, the final design of the facility should ensure both proper width and separation to meet the anticipated needs of pedestrians within a corridor.

The need for variances in width may be demonstrated by examining two extreme examples. First, consider a high-speed urban arterial that also serves as a connector between large centers of activity (e.g., a university campus and the downtown area) that has heavy volumes of pedestrian traffic. In this instance, a wide or enhanced width detached facility may be appropriate to serve the pedestrian traffic. Providing a separation improves pedestrians’ comfort levels and could reduce the number of conflicts between the two modes, which may be frequent given the high traffic volumes of both facilities, and the potential severity of conflicts due to the high speeds of the motorized facility. Conversely, on a low-speed local street serving only local pedestrians, a minimum or wide width attached facility may be appropriate depending on the pedestrian volumes, thus decreasing the probability of conflicts.

The proposed functional classification matrix identifies a level of facility width that may be considered for each pedestrian facility category according to roadway type and context.
Expanded FCS Matrix Approach

The width of the pedestrian facility and separation from the travel way provided must account for the speed of the motorized traffic and is defined for the anticipated or potential levels of pedestrian traffic for each context and roadway type. The width changes along the context continuum to reflect the traffic volumes anticipated for the facility (Figure 46). For example, when designing Principal Arterials in high-speed environments there is a need to consider the pedestrian traffic volumes in order to determine the appropriate width. In this case, for Rural and Suburban contexts, high pedestrian volumes require Enhanced width (which here can be viewed as a separate facility) to establish a safe pedestrian environment, while in cases where pedestrians are present rarely or occasionally, adding pedestrian facilities requires additional consideration and appropriate facilities need to be included commensurate with pedestrian volumes. Similar considerations are developed for the other contexts with lower speeds where the anticipated pedestrian volumes would indicate the width to be provided. For the roadway type, there is no interaction between pedestrian facilities and roadway, since the designed facility width will depend on the level of pedestrian traffic. However, as noted above, medium and high speed facilities do require increased separation of pedestrian ways and the traveled way of the road. The matrix presents the minimum accommodation that should be expected from travelers for all modes. However, these levels of accommodation may be increased to address local priorities and where sufficient space exists to provide enhancements.
**Design Considerations**

The primary design consideration of pedestrian facilities is the width of the sidewalk or pathway that can comfortably accommodate the demand in a given context. Pedestrian facility widths are defined as minimum per ADA requirements. This width has the ability to accommodate a high demand of pedestrians, allowing for passing single file two-way traffic. In higher density areas, pedestrians may walk several across or in larger queues, which requires wider sidewalks to accommodate high volumes of pedestrian traffic. In the most active pedestrian centers, sidewalks can serve not only as walking routes, but also as places where people congregate. In these contexts, enhanced and wider sidewalks are necessary for pedestrian groups, but also provide for activity areas and street furniture, such as waiting areas, benches, or even outdoor seating, depending upon the adjacent land use.

An ancillary design consideration for pedestrian ways is deciding whether to increase separation from motorized (and bike) traffic when medium or high speeds or volumes could
expose pedestrians to risk or deter them from walking because they may feel uncomfortable or unsafe. In these instances, a buffer between the traffic and the pedestrians is desirable. Buffer widths vary depending on the land uses and different types can be used to create an inviting pedestrian environment. On-street parking or bicycle lanes can also act as buffer. Desirable widths vary from 2-4 feet for local and collector roadways to 5-6 feet for arterials (AASHTO, 2004b). Increased tree lawns, shielding or physical separations could be used as buffers, and in extreme cases, off-roadway pathways may provide the best pedestrian experience. In this case, one needs to be mindful of the reductions of the effective facility width due to presence of separation (e.g. trees, shrubs or grass) based on the approach and values outlined in the *Highway Capacity Manual* when determining the pedestrian LOS (TRB, 2010).

Intersections are of particular concern to pedestrians. As such, nodal treatments and provision of appropriate pedestrian crossing treatments is critical. Where possible, for high pedestrian movements narrow crossing widths should be used. These treatments may conflict with vehicular demands, which prioritize mobility (i.e., need more lanes) or transit and freight routes, which may require wider turning radii. Consideration may be given to alternate guidance for auxiliary turning lanes, in the presence of bicycle and pedestrian traffic. Design should take into account the increased exposure and risk of other modes when auxiliary lanes, which increase crossing distance and encourage bike conflicts in light of any decrease in safety provided by the exclusion of auxiliary turn lanes. It is imperative that the designer evaluate the needs of all users, as well as understand the priority of users within the route and each of their modal networks.

*Transit Rider Accommodation as an Overlay*

Transit routes are typically fixed and well defined by the local transit agency to meet the demands of the transit ridership. As such, there are no specific considerations to be provided as in the other modes. Close coordination and cooperation with local agencies is imperative in establishing the transit overlays in order to ensure proper accommodation of transit needs.

*Design Considerations*

Transit routes may not require significant additional facilities beyond those provided for vehicular traffic, if mobility and speeds of the vehicular routes align with transit goals. However, curbside lanes should be designed to accommodate the width of the design transit vehicle — typically lane widths of 11–12 feet. Additional width may be necessary if bicycles share the curb lane with on-street low separation facilities. Nodal treatment considerations should ensure wide turning radii to accommodate transit vehicles. While low-order transit routes and infrequent turns may not require
special accommodation, higher priority routes for transit should have smooth turning radii to minimize unnecessary delays at turns. In addition, for high priority or express routes special controlled lanes should be considered for either bus rapid transit or light rail to designate lanes and/or areas for transit service within the right-of-way. Moreover, special operational parameters such as bus transit priority at signals may be contemplated, recognizing that this may affect the delay and travel time of other modes. Cooperation with local transit agencies will allow identifying future transit facilities and routes in order to define future needs and land uses.

On bike, priority routes, which call for lower vehicle speeds, wider lanes used to accommodate transit may encourage higher speeds. When this occurs, increased separation of bike facilities may be an option to mitigate this increase in speed as well as to improve potential safety concerns due to the vulnerability of bicyclists.

Nodal considerations include bus stop locations and potential bus pullouts. Pullout locations should be placed and designed based on an examination of the safe operation and specific needs of the transit provider and its users. As noted above with respect to pedestrian treatments, enhanced pedestrian facilities and connections to adjacent activity centers (such as shopping/business, transit stops or even parking in park and ride areas) should be provided. In addition, some separation of the pedestrian facilities form the roadway may be considered in order to address possible safety concerns.

*Freight Accommodation as an Overlay*

Freight routes may not require significant additional facilities beyond those provided for vehicular traffic, if mobility and speeds of vehicular routes are consistent with freight movement. However, curbside lanes should be designed to accommodate the width of the design freight vehicle — typically lane widths of 11–12 feet. Additional width may be necessary if bicycles share the curb lane with on-street low separation facilities. Nodal treatments should ensure wide turning radii to accommodate trucks. While low-order freight routes and infrequent turns may not require special accommodation, higher priority routes for freight should have smooth turning radii to minimize unnecessary delays and possibility of crashes at turns.

On bike priority routes, which call for lower speeds of vehicular traffic, wider lanes used to accommodate freight may encourage higher speeds. When this occurs, increased separation of bike facilities may be imperative to avoid conflict and improve bicyclist safety.
EXPANDED FCS MATRIX

The preceding sections identified the specific user-related issues and design considerations that need to be addressed when balancing their needs to deliver a contextually appropriate multimodal design. Figure 47 shows the complete Expanded FCS matrix, which presents the treatment options for each user (driver, bicyclist, and pedestrian) and identifies the interactions along the context and roadway type continuums.

<table>
<thead>
<tr>
<th>Context</th>
<th>Rural</th>
<th>Rural Town</th>
<th>Suburban</th>
<th>Urban</th>
<th>Urban Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Principal Arterial</td>
<td>H speed</td>
<td>L/M speed</td>
<td>M/Hi speed</td>
<td>L/M speed</td>
<td>L speed</td>
</tr>
<tr>
<td></td>
<td>LC: L separation; NC: M separation; CC: H separation</td>
<td>LC: L separation; NC: CC: M separation</td>
<td>LC: L separation; NC: M/Hi separation; CC: H separation</td>
<td>LC: L separation; NC: M/Hi separation; NC: CC: M separation</td>
<td>LC: L separation; NC: CC: M separation</td>
</tr>
<tr>
<td></td>
<td>P1: *; P2: Min; P3, P4: Wide</td>
<td>P2: Min; P3: Wide; P4: Enhanced</td>
<td>P1: *; P2: Min; P3: Wide; P4: Wide</td>
<td>P2: Min; P3: Wide; P4: Enhanced</td>
<td>P3: Wide; P4: Enhanced</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>H speed</td>
<td>L/M speed</td>
<td>M/Hi speed</td>
<td>L/M speed</td>
<td>L speed</td>
</tr>
<tr>
<td></td>
<td>LC: L separation; NC: M separation; CC: H separation</td>
<td>LC: L separation; NC: CC: M separation</td>
<td>LC: L separation; NC: M/Hi separation; CC: H separation</td>
<td>LC: L separation; NC: M/Hi separation; NC: CC: M separation</td>
<td>LC: L separation; NC: CC: M separation</td>
</tr>
<tr>
<td></td>
<td>P1, P2: Min; P3, P4: Wide</td>
<td>P2: Min; P3: Wide; P4: Enhanced</td>
<td>P1: *; P2: Min; P3: Wide; P4: Wide</td>
<td>P2: Min; P3: Wide; P4: Enhanced</td>
<td>P3: Wide; P4: Enhanced</td>
</tr>
<tr>
<td>Collector</td>
<td>M speed</td>
<td>L speed</td>
<td>M/Hi speed</td>
<td>L speed</td>
<td>L speed</td>
</tr>
<tr>
<td></td>
<td>P1, P2: Min; P3, P4: Wide</td>
<td>P2: Min; P3: Wide; P4: Enhanced</td>
<td>P1: *; P2: Min; P3: Wide; P4: Wide</td>
<td>P2: Min; P3: Wide; P4: Enhanced</td>
<td>P3: Wide; P4: Enhanced</td>
</tr>
<tr>
<td>Local</td>
<td>M speed</td>
<td>L speed</td>
<td>L/Hi speed</td>
<td>L speed</td>
<td>L speed</td>
</tr>
<tr>
<td></td>
<td>LC: NC; CC: L separation</td>
<td>LC: NC; CC: L separation</td>
<td>LC: NC; CC: L separation</td>
<td>LC: NC; CC: L separation</td>
<td>LC: NC; CC: L separation</td>
</tr>
<tr>
<td></td>
<td>P1, P2: Min; P3, P4: Wide</td>
<td>P2: Min; P3: Wide; P4: Enhanced</td>
<td>P1: *; P2: Min; P3: Wide; P4: Wide</td>
<td>P2: Min; P3: Wide; P4: Enhanced</td>
<td>P3: Wide; P4: Enhanced</td>
</tr>
</tbody>
</table>

Speed, Mobility, Accessibility and Separation levels: H: High; M: Medium; L: Low
Bicycle Connectors: LC: Local; NC: Neighborhood; CC: Citywide
Pedestrian traffic levels: P1: rare/occasional; P2: low; P3: medium; P4: high
Pedestrian facility width: *: site specific considerations; Min: minimum; Wide: greater than minimum; Enhanced: wide for large congregating pedestrian groups
Pedestrian facility separation should be considered in conjunction with driver target speeds

Figure 47 Expanded FCS multimodal matrix by context and roadway type

Proper contextual roadway designs require an understanding of how the roadway functions in its context and the needs of the potential roadway users. The Expanded FCS matrix
can be used to identify preliminary requirements that should be given due consideration when assessing current and future roadway context and user needs. In a general project development approach, this process can assist with providing input and refining the purpose and need document, which establishes the framework for the design to be developed.

EXPANDED FCS APPLICATION

When approaching a corridor design, the design team can utilize the Expanded FCS to understand the role the roadway will play in both the environment in which it will be constructed and the role it plays within the network. Various user groups that must be accommodated within the roadway, often with competing needs or spatial demands, are identified. To assist in prioritizing and balancing these needs, the importance of the project within the individual network of each road user is also highlighted. A concept that needs to be clarified from the outset is that accommodating all the users at all the times on all roadways is impossible.

This approach assumes that the Expanded FCS will be initially applied to all state-maintained roadways and replace the existing functional classification system. It is anticipated that periodic reviews and revisions will be conducted (consistent with current practices) that will review the context and roadway types for each roadway and adjust them as needed to accommodate change. It is also possible that a transportation agency will elect to implement Expanded FCS in a staged approach where the changes are considered at a project level. Once a project is started, the professional will have to review the context and roadway type designations and determine whether these are applicable or require any adjustments. Once this determination is made, the team can proceed with validating each component of the classification process, including context, roadway type, and users and proceed in developing a contextual design utilizing CSS to balance project needs and community values. This process encourages the project team to be diligent in determining the complexities of the context, both current and future, as well as all other subtleties associated with the social and natural environment surrounding the project. This implies that once the appropriate matrix cell that addresses the context–roadway environment is defined, the project team could start developing the preliminary designs, considering community comprehensive plans including the future land use plan, and any other pertinent information (including zoning ordinances) in order to develop an evolving design that could address potential changes in the roadway context. The need for a robust CSS process (involving all stakeholders) is integral to the successful implementation of the Expanded FCS and development of contextually appropriate designs.
Each matrix cell provides a range of design options based on defined context zone and roadway type (Figure 47). Once the roadway type/context cell is identified, the modal needs and volumes need to be considered to narrow further the range of design options. During this step, the needs of the driver, bicyclist, and pedestrian, should be determined and examined. Lists with potential accommodations based on the concepts defined for each user in the previous section should be developed. Any special overlays that need to be considered, such as transit or freight routes, should be identified next. Once individual user needs are defined, they should be synthesized to identify what design trade-offs will be necessary to best accommodate all users. Alternative designs should be developed and evaluated in order to deliver context-appropriate design. However, the project may extend beyond a single context, which should be addressed through the use of transition zones. NCHRP Report 737 (Torbic et al., 2012) provides additional guidance on proper transition considerations and design. Special attention needs to be paid when speeds transition from high to low and when considering context with changes to modal accommodations. The project team needs to also consider potential future changes in the context of contemplating community needs and goals, land use plans, and other items that could have an impact on the design.

Once all these individual components are selected, the cross section may be assembled and the designer needs to determine how each component can be best fitted within the available right-of-way. Available tools for evaluating different options can be used to determine the advantages and disadvantages of each alternative. For example, Highway Capacity Manual (TRB, 2010) and Highway Safety Manual (AASHTO, 2010) procedures can be employed to determine the operation and safety effects of each choice, simulation can be used to determine the impacts of integration of vehicle and bicycle facilities, Highway Capacity Manual procedures can be used to determine the operational efficiency of pedestrian and bicycle facilities. Performance Based Design concepts and principles can be implemented to evaluate safety and operational performance of alternatives. The designer needs to establish the metrics to use for these comparisons and develop a systematic process to evaluate each alternative and compare their impacts as they relate to the purpose and need goals and specific objectives.

The accompanying guide developed for the Expanded FCS provides detail on how to determine:

1. Appropriate context category;
2. Appropriate roadway type;
3. Levels of accommodation needed for different modal users (priority and balance);
4. Use of network overlays such as transit and freight; and
5. Design considerations that may assist in balancing design needs and accommodation of competing needs on a corridor.

Examples of such guidance are provided here and the reader is encouraged to review the NCHRP Research Report 855 for additional examples. The guide also presents two case studies that demonstrate the application of the Expanded FCS matrix in projects and provides guidance for the identification of possible design options to address the competing needs of the drivers, bicyclist, pedestrians, transit users, and freight. A summary of each case is also included in the following.

Application Examples

Single Context Example: Suburban Minor Arterial
This cell defines the suburban context for a principal arterial. In this case, a roadway provides for medium speed for the driver, translating into medium mobility and medium levels of access. The appropriate facility to be provided for the bicyclists is based upon the type of bicycle facility and its use. The facility for pedestrians is based on the amount of anticipated traffic. Finally, design considerations for transit and freight will be based on the existing overlays and their presence will have an impact on the selection of design element values.

In a typical suburban minor arterial, pedestrian activity may be concentrated around specific locations, and there may be a need for targeted accommodation at these locations. Possibly, areas with high pedestrian traffic will exist in the vicinity of certain land uses (e.g., commercial, educational, office, etc.) that may require appropriate facility width commensurate with the level of pedestrian traffic. High traffic will require wide sidewalks and possibly street furniture to accommodate higher volumes. The pedestrian facility should be detached and appropriate buffer placed between the traffic and the pedestrians. If on-street parking is allowed or a bicycle lane is included, then the buffer could be eliminated. The bicycle network classification will also dictate the separation of the bicyclist from the traffic. As the network changes from local to citywide connector, bicycle volumes are expected to increase, establishing a need for greater
separation. For local connectors, sharrows may be appropriate due to the medium vehicular speeds. Similarly, for a neighborhood connector, a bike lane may be appropriate, and for citywide connectors a buffered lane may be considered. In the event that there is not adequate space to accommodate a bicycle citywide connector, a wide bike lane may be considered as an alternative or the target operating speed for drivers may be revisited and adjusted (e.g. 5 mph lower) for the benefit of bicycle traffic and to provide a safer facility. In this case looking at accommodating bicyclists on parallel routes could be evaluated to determine its feasibility.

The presence of any transit may require lane widths to accommodate the buses that use the facility if they are larger than the design vehicle selected. The same is needed if there is a freight overlay, requiring design consideration of the typical truck that uses the facility. The presence of trucks may also have implications for shoulder width and grades.

**Corridor Example**
There are frequently cases where roadways may traverse a variety of contexts and the Expanded FCS can assist in these cases as well for developing appropriately contextual designs (Figure 48). Additional consideration should be given to the context transitions and the various design features to be used.

![Figure 48 Corridor example Expanded FCS application](image)
An issue that also merits attention is balancing modal needs and priorities along a corridor, since these may vary along the corridor. These issues are also presented here, and they form the basis for trade-offs among the often-competing needs of each user in order to develop and deliver sound contextually appropriate multimodal solutions.

The example addresses a principal arterial transitioning from rural to a rural town to rural context. The issues of concern here extend beyond the accommodation of the users within each segment as discussed above. The additional concern is providing users with the appropriate clues about changes in the roadway context and accommodate them while moving through one context to the next.

For the rural to rural town change, the operating target speed changes from high to low and this should be communicated to the drivers in a manner that is more expansive than signage displaying speed limit changes. Attention should be paid to transition them toward lower speeds using design features that would gradually change from the rural cross section to the rural town cross section. This may involve gradual elimination or narrowing of the shoulder, narrowing of the travel lanes, use of pavement markings, addition of gateways or roundabouts or central island medians (Torbic et al., 2012).

Accommodating users in the transition zone is critical. For drivers, attention needs to be placed in providing visual clues and guidance for the required speed reduction and this should be accomplished over a transition zone with positive guidance. For bicyclists, the first step is determining whether different bicycle separation (i.e., facilities) are in place in each zone, requiring a different level of separation. In the event that there is an agreement, then the separation type could be carried forward into the transition zone and rural town context. In this case, local connectors requiring low separation could be addressed through the use of sharrows. For neighborhood and citywide connectors, a review of the separation level in the rural and rural town contexts should be undertaken to identify whether there are any differences. For example, if sharrows are used in the rural setting and bike lanes in the rural town context, transitioning to a bike lane in the transition zone is appropriate. Obviously, similar facilities in the context areas will not require additional special consideration, but they should ensure continuity in the separation level. For arterials, there is also a change in the separation level from high in the rural to medium in rural town context. This transition requires additional considerations especially when changing from a separate multi-use path to an on-street facility.

Accommodating pedestrians also follows the same considerations in the rural to rural town transition. Pedestrian facilities present in the rural town may need to be extended through the transition zone and be connected with the rural context facilities. This is more significant when the
enhanced facility in the rural context is an off-road facility, since attention should be given for the transition to a sidewalk.

Transitioning from the rural town to rural context could follow a reverse order and complement the rural to rural town transition.

Case Studies
Multi-Context Application
This case study roadway is a principal arterial (urban-rural) that extends 10.5 miles. Figure 49 presents the two ends of corridor, urban core to rural town. It traverses the five context categories of the Expanded FCS. The analysis included aerial photography, visual survey, review of the state’s functional classification, review of city transit information and review of city/county bike information. The roadway functional type is designated principal arterial (urban/rural) by the state’s highway department. The study provides an analysis of context using the Expanded FCS methodology. Design considerations are established using the appropriate cell of Expanded FCS matrix providing ranges to accommodate drivers, bicyclists, and pedestrians. Additionally, consideration is given to any transit or freight route information as an overlay. These matrix cell ranges for each context are then translated into a cross section alternative for illustration purposes.

The roadway context starts as urban core (0.0-0.7 miles) and then transitions to urban (07-2.5 miles) followed by a suburban area with mixed commercial and residential development (2.5-4.4 miles) and another suburban area with primarily residential uses (4.4-6.4 miles). The rural section (6.1-10.0 miles) is interrupted from a commercial development in the vicinity of an interchange (82.-9.1 miles). The last section of the roadway is in a rural town (10.0-10.5 miles).
For each section of the roadway, a discussion of the driver, bicyclist, pedestrian, transit user and freight is provided that leads to considerations for the designs to be developed. As an example, the discussion for the urban core section is presented here. The complete discussion for all sections is part of the guide in NCHRP Research Report 855.

**Urban Core**

This is the urban core of the second-largest city in Kentucky that is consolidated with Fayette County; the city’s 2014 population was 310,797, anchoring a metropolitan city-county area of 489,435 people and a combined two-county statistical area of 708,677 people.

This Expanded FCS matrix cell defines the design considerations for the Urban Core Principal Arterial section of the corridor. The roadway context is urban core due to the small setbacks, the mixed land use (residential, commercial and institutional), and high density of buildings. Most of the buildings are high-rise, multistory, there are enhanced sidewalks with street furniture and pedestrian accommodation facilities (benches) and plazas, and there is on-street parking along most of the section. The roadway type is a principal arterial, since it provides regional network connectivity to traffic through the town and on to access the area centers of activity. The roadway operates as a one-way pair.

**Driver Accommodation:** According to the definitions for an Urban Core Principal Arterial, the roadway should provide low operating speeds (<25 mph). Due to the Principal Arterial designation, the upper range of speeds is considered appropriate at 25 mph. This translates into medium mobility and medium levels of access.

**Bicyclist Accommodation:** The roadway is considered a Citywide Connector as it draws ridership from all areas within the city and accesses downtown Lexington. This designation requires a medium separation treatment; a 6.5-foot bicycle lane is considered appropriate in this section of the corridor due to the lower speeds, but provides additional width for interactions with transit vehicles and parking.

**Pedestrian Accommodation:** The land use indicates high pedestrian activity with several destinations in the area and therefore an enhanced width sidewalk is recommended. Street furniture and pedestrian plazas may be considered to accommodate aggregating pedestrians in this section.
Overlays: There is heavy transit demand along the corridor and the lanes need to be designed to accommodate transit buses. There is also some freight demand, mainly small delivery trucks, and this needs to be considered during the final cross section design.

Recommended Cross Section

The cross section in Figure 50 was developed using the matrix cell guidance provided by Expanded FCS. It features a 25 mph speed limit with a reduced number of narrow 10-foot lanes (an outside 11-foot lane to accommodate transit vehicles). Turn lanes are eliminated within the urban core to calm travel speeds and minimize pedestrian crossing distances. A wider 6.5-foot bike lane is used to increase separation from parking and transit. The cross section shows the typical little to no building setback of an urban core. Enhanced sidewalks with occasional “parklets” to facilitate pedestrian are in use. On-street parking is provided as well as transit stops. Other cross section alternatives may be reasonable and warranted. The one-way pairs culminating on the right are clearly visible in the aerial photograph below. The shadows are indicative of the high-rise and multi-story structures of the urban core.

Single-Context Application

This case study roadway is a principal arterial (urban) that extends 0.73 miles. It traverses a single context category of the Expanded FCS (Figure 51). The analysis included aerial photography, visual survey, review of the state’s functional classification, review of city transit information and review of city/county bike information. The roadway functional type is designated principal arterial (urban) by the state’s highway department. The study provides an analysis of context using the Expanded FCS methodology. Design considerations are established using the appropriate cell of
the Expanded FCS matrix providing ranges to accommodate drivers, bicyclists, and pedestrians. Additionally, consideration is given to any transit or freight route information as an overlay. These matrix cell ranges for each context are then translated into a cross section alternative for illustration purposes. An evaluation of alternative cross sections based on operational and safety analysis is also included.

The roadway context here is urban core with commercial, institutional and residential uses.

Urban Core
This is the urban core of the largest city in Kentucky; the city's 2014 population was 741,096, anchoring a metropolitan city-county area of 1,338,433 people.

This Expanded FCS matrix cell defines the design considerations for the Urban Core Principal Arterial section of the corridor. The roadway context is urban core due to the small setbacks, the mixed land use (residential, commercial and institutional), and high density of buildings. Most of the buildings are high-rise, multistory, there are enhanced sidewalks with street furniture and pedestrian accommodation facilities (benches) and plazas, and there is on-street parking along most of the section. The roadway type is a principal arterial, since it provides regional network connectivity to traffic through the town on to the area centers of activity.
Driver Accommodation: According to the definitions for an Urban Core Principal Arterial, the roadway should provide low operating speeds (<25 mph). Due to the Principal Arterial designation, the upper range of speeds is considered appropriate at 25 mph. This translates into medium mobility and medium levels of access.

Bicyclist Accommodation: The roadway is considered a Citywide Connector as it draws ridership from all areas within the city and accesses downtown Lexington. This designation requires a medium separation treatment; a 6.5-foot bicycle lane is considered appropriate in this section of the corridor due to the lower speeds, but provides additional width for interactions with transit vehicles and parking.

Pedestrian Accommodation: The land use indicates high pedestrian activity with several destinations in the area and therefore an enhanced width sidewalk is recommended. Street furniture and pedestrian plazas may be considered to accommodate aggregating pedestrians in this section.

Overlays: There is heavy transit demand along the corridor and the lanes need to be designed to accommodate transit buses. There is also some freight demand, including small delivery trucks and large WB-53 Trucks, and this needs to be considered during the final cross section design.

Cross Section
The existing cross section on Broadway Street has two primary drivers: 1) automobile access providing a primary east-west route across Louisville with access to the interstates (64, 65, and 264 and 2) and east west pedestrian movements as evidenced by the wide (25 foot) sidewalks. In order to serve automobile traffic, seven 10-foot travel lanes are provided, though the outside lanes provide for time of day-restricted parking. No turn lanes are present with four lanes eastbound and three lanes westbound. Broadway is also a heavily traveled transit route serving lines Express Route 23, Frequent Service Routes 2 & 31 and Local Routes 31, 49, 53, 64, 61, 66, 67, 68, & 78. The ZeroBus, a free fare downtown route, also traverses Broadway between 4th and 3rd Streets. While the 25-foot sidewalks provide ample mobility for pedestrians along the corridor, the wide street makes pedestrian crossings difficult due to longer cycle lengths required to accommodate longer pedestrian crossing times; increasing delay to drivers and pedestrians. No bike accommodations are present on the corridor.

Evaluating the operations of major intersections within this section demonstrates that all intersections maintain a high LOS (LOS A or B) with minimal vehicular delay.
Evaluating the Pedestrian Crosswalk Score as computed by the *Highway Capacity Manual* a LOS of C was rated for all approaches. This LOS is based on pedestrian compliance (a function of delay, and width of crossing).

The proposed cross section (Figure 52) will reduce the number of lanes from seven to five, including a center two-way left turn lane, allowing dedicated left turns at major intersections. Parking is removed except in localized areas that experience high drop-off/pick-up locations such as the Brown Theatre and ample off-street parking opportunities exist within the corridor. Outside lanes are proposed as 13 feet to better accommodate the needs of transit. Additionally, the outside lane is striped as a shared bike lane, to allow riders comfortable riding with traffic to use the facility. It is also proposed that parallel streets on W. Chestnut Street and Breckenridge be signed and striped as higher order bike routes with separate facilities due to lower volumes of vehicular traffic on these routes; rear access to all building fronting Broadway is available from these routes. It is also proposed that an expanded and improved tree lawn be provided along the sidewalk to increase separation from the vehicular traffic, as the existing sidewalk width is more than adequate to accommodate pedestrian demands. While the total pavement width is not reduced in this scenario, the opportunity exists to create curb extensions at major intersections or pedestrian crossing points to reduce crossing width and allow the use of shorter traffic signal cycle lengths, as shown in the figure below. Right turn lanes are not provided to eliminate bike–vehicle interactions when entering right-turn lanes.

![Figure 52 Proposed cross section](image-url)
Vehicle LOS for the proposed alternative does degrade, with increased delays leading to a LOS C/D, but all intersections are still shown to operate within capacity during the AM and PM peak hours.

Pedestrian Crosswalk LOS is improved from LOS C to LOS B due to the reduced crossing times and delays.

**Safety Evaluation**

Application of the *Highway Safety Manual* procedures is not possible as there is no base model available for prediction of crashes for 7-lane sections. However, individual design elements and their effect on Crash Modification Factors or the base crash model for other conditions may be evaluated to identify potential trade-offs in the design. These are summarized in Table 37.

**Table 37 Safety evaluation summary**

<table>
<thead>
<tr>
<th>Design Elements</th>
<th>Existing Cross Section</th>
<th>Existing CMF</th>
<th>Proposed Cross Section</th>
<th>Proposed CMF</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of curb length with on-street parking</td>
<td>0.8</td>
<td>1.57</td>
<td>0.25</td>
<td>1.14</td>
<td>CMF</td>
</tr>
<tr>
<td>Median Width</td>
<td>0</td>
<td>23.5</td>
<td>10</td>
<td>13.2</td>
<td>Not a direct measure of median width, but rather change in segment crashes resulting from undivided to divided</td>
</tr>
<tr>
<td>Offset to roadside fixed objects</td>
<td>3</td>
<td>1.03</td>
<td>16</td>
<td>1</td>
<td>CMF</td>
</tr>
<tr>
<td>Number of Lanes Crossed by Pedestrian</td>
<td>7</td>
<td>0.042</td>
<td>5</td>
<td>0.039</td>
<td>Impacts the base conditions for pedestrian involvement</td>
</tr>
<tr>
<td>Number of Left Turn Lanes</td>
<td>2</td>
<td>0.81</td>
<td>4</td>
<td>0.66</td>
<td>CMF</td>
</tr>
</tbody>
</table>

Each of these features can affect safety and discussions on how each can affect design alternatives are presented in the guide (NCHRP Research Report 855).
CHAPTER 6
EXPANDED FCS IMPLEMENTATION

This section discusses the potential impacts of the Expanded FCS on other areas where the existing FCS is used. The literature review and practitioner survey has identified and documented the ubiquitous applications of functional classification within and outside of the geometric design process. Functional classification is used for various applications, ranging from Federal-aid funding and project prioritization, to serving as the basis for safety performance function categorization within the Highway Safety Manual. Functional classification is a major factor in shaping many local land use and access management policies. These applications are reviewed here to determine where the impacts of functional classification warrant further scrutiny.

EXPANDED FCS IMPLEMENTATION IMPACTS
Beyond providing direction for design element selection, the FCS is used for various applications from Federal-aid funding to project prioritization and even serves as a basis for some construction and maintenance activities. These uses were identified in the survey sent to all state highway agencies. Figure 53 shows those uses where more than 50 percent of respondents stated that they use functional classifications in decision making. These applications have been reviewed to determine where functional classification consideration may be appropriate as it relates directly to the regional network functionality of the roadway, and where it may only serve as a generalized surrogate for context. The Expanded FCS largely maintains the same roadway types as the existing classification while expanding the context categories to address information to be considered in geometric design and other phases of the planning and design process.
A series of meetings and conference calls with stakeholders from state DOTs and FHWA were undertaken to identify concerns and issues that the Expanded FCS implementation may pose. This section presents the issues identified and provides considerations for possible mitigation. However, the recommendations here should be viewed as preliminary and additional work is recommended to explore fully how these could be resolved. The ultimate goal of the NCHRP 15-52 is to develop a classification system that will be ultimately accepted and adopted in the AASHTO Green Book and other documents.

The various issues identified are a result of meetings with FHWA and the WAG. These groups provided a wide range of users, from federal and state to local agencies and thus could cover the spectrum of possible concerns. It should be noted that while these issues were identified, all members expressed interest in the proposed classification approach and indicated that the system will be relatively easily incorporated into the existing project development process. It was also felt that the Expanded FCS will provide improved granularity of the transportation needs and context in which projects are proposed. This will aid in project definition and scoping, since it will require an earlier identification of the various issues and modes to be addressed and could result in a project scoped more properly and closer to its context. The proposed system has the potential to encourage and allow more discussions early in the programming and planning stage and thus enhance the final design alternatives.
Federal-aid Funding

A primary issue raised by various stakeholders was the exclusion of the rural minor collector designation. Currently, the dividing line between major and minor collectors is used to identify roadways that are and are not available for Federal-aid funding. The combination of these classifications does not allow for the differentiation of Federal-aid eligibility within the FCS itself and an additional category would need to be identified to serve this purpose. Moreover, it is believed that it would be inappropriate simply to classify minor collectors as local roads as the speed and access classifications associated with minor collectors would not be consistent with proposed design values for local roadway types. A potential solution to this issue could be the development of a Federal-aid layer for collectors in the Expanded FCS that would determine whether the roadway qualifies for Federal-aid funding.

Another issue related to Federal-aid funding was the expressed concern regarding accountability, in that there is a need for accountability of expenditures by functional classification category (e.g. urban collector). The fact that the Expanded FCS develops more categories that overlap with the existing categories could create an issue, if not formally adopted and tracked by the FHWA.

There was also concern (primarily from local agencies and MPOs) that the creation of more functional classification categories could lead to development of refined funding categories, such as creating specific funding categories for suburban contexts. It is believed that increased funding categorization could limit the funding flexibility that is currently available, thus allowing agencies to address higher priority needs first within the entire system and within segments of the system.

FHWA Policy

In order for the Expanded FCS to be widely accepted and used by all agencies, there is a need for FHWA to adopt and develop it as a national policy (i.e., similar to the current classification policy). This will allow for a wider acceptance of the classification and quicker implementation. It is envisioned that several agencies (those that are currently exploring and considering other classification systems or are on the initial stages of such efforts) could adopt the Expanded FCS. However, the development of FHWA guidelines as well as inclusion in the Green Book will allow for the wider acceptance of the classification. The lack of an FHWA policy was a concern raised by state divisions of planning, since FHWA heavily regulates planning activities.
Transition from Current FCS

A final issue raised is that much guidance that is provided to engineers is based on the existing FCS. Many data sets currently are aligned to these classifications. This includes research efforts in access management, highway safety crash prediction models and crash modification factors, and environmental guidance for issues important to rural and urban environments. While this guidance includes all of the roadways and contexts currently in place, additional guidance may be needed to assist practitioners in selecting which of the existing guidance is most pertinent to the new categories, such as suburban and rural town contexts. In the long term, the increased resolution of the context categories and documentation of that in operational databases, such as the HPMS, will allow for more refined research and guidance that addresses the specific and unique needs of the new categories being proposed.

NCHRP Project 15-47 is currently updating the geometric design process and has recommended the need for consideration of context as part of the process. The research team had developed a strawman classification system, independent of this effort, which is identical to the one proposed here. Their system was developed in order to provide a basis for their design guidance recommendations and the similarity supports the idea of extended context categories to reflect appropriate contextual design.

Conclusion

The overall conclusion from this effort is that the proposed classification system will not negatively affect any of the project development phases but on the contrary, it has the potential to facilitate them and result in a more contextually appropriate design. The proposed system has the potential to encourage and require discussions of the context at an earlier stage, thus identifying users and multimodal issues that could be addressed early on. However, some measure of sensitivity must be applied to existing regulations and guidance.

IMPLEMENTATION PLAN

The implementation plan for NCHRP 15-52 outlines the stages for developing the research project and realizing the findings. The initial problem statement was provided by the NCHRP 15-52 RFP titled, Developing a Context-Sensitive Functional Classification System for More Flexibility in Geometric Design. The proposing/performing research team presented a solution idea/concept. The research work plan and implementation plan is shown in Table 38.
The first stage encompasses the research project activity and its products as shown above. The next two stages are necessary to accomplish implementation. The activities and products are outlined above. While these stages constitute a plan, the fulfilment of the plan requires implementation activity—action steps being accomplished. It should be noted that at the completion of stage one, over 20 researchers and practitioners were involved in the development of the innovative Expanded FCS. This does not include the many professionals at local and state levels that participated in the research survey used to identify and document the uses and shortcomings of the traditional FCS.

Implementation of any innovation requires that particular roadblocks be addressed. The type of innovation involved with NCHRP 1552 and specifically, the innovative Expanded FCS framework suggests that at least the following roadblocks will present themselves and will be addressed. These roadblocks are presented in terms of the expected questions that will arise:

- Can a consensus be achieved for a new FCS?
- How easy is it to explain its use to all potential users and stakeholders?
- What are the benefits of a new FCS?
- Is it easy to understand and apply the new FCS process/framework?
- What resources are required to implement the new FCS?
- Is it being championed by potential/actual users?
- Does it work wherever applied on projects?
- Can it be applied for just selected projects?
Suffice it to say, the Expanded FCS that has been developed provides the roadway planner/designer with a framework and systematic process to achieve a more context sensitive roadway design that reasonably accommodates all modes. The process includes several roadway types and context categories and provides multimodal user design considerations that can achieve successful solutions that will be acceptable to a wider range of stakeholders. This achievement should be widely beneficial to any transportation agency and can be developed with a reasonable effort that could eliminate costly do-overs and the early development of dissatisfaction among the project’s stakeholders. The products already developed and anticipated will address the potential roadblock questions listed above.

Table 39 summarizes the updated implementation plan indicating obstacles, action steps, responsibilities, and the products/tools of each stage from the current time into the multi-year future required for implementation. If this plan is followed successfully, the implementation of the Expanded FCS can be expected within a few years. While the plan may be reasonable, it will require responsible parties to act and that the products/tools will be available.

Table 39 Implementation steps and timetable

<table>
<thead>
<tr>
<th>Staging</th>
<th>Primary Obstacles</th>
<th>Action Steps</th>
<th>Responsibilities</th>
<th>Products/Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Near Term 2014-2016</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop Concept</td>
<td>• Achieved consensus</td>
<td>• Research concepts</td>
<td>NCHRP project team Advisory groups</td>
<td>Guide Case studies Research report</td>
</tr>
<tr>
<td></td>
<td>• Communicability</td>
<td>• Prepare guide</td>
<td>NCHRP panel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Conduct case studies</td>
<td>• Conduct case studies</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Publish report</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mid-Term 2016-2017</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain and Demonstrate Process</td>
<td>• Perceived advantages</td>
<td>• TRB meetings</td>
<td>NCHRP project team</td>
<td>Presentations Webinars</td>
</tr>
<tr>
<td></td>
<td>• Perceived simplicity</td>
<td>• AASHTO meetings</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Selected group meetings</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Long Term 2017-2019</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Champions and Training</td>
<td>• Perceived credibility</td>
<td>• Selected state DOTs</td>
<td>Champions/trainers</td>
<td>Workshops Short courses</td>
</tr>
<tr>
<td></td>
<td>• Proven reliability/use</td>
<td>• Selected MPOs</td>
<td>AASHTO committees</td>
<td>Green Book</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Green Book modification</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FCS AND EXPANDED FCS RELATIONSHIP**

Special concerns regarding implementation of the Expanded FCS at the transportation agency-level center around the resources required. In a general sense, the new framework requires a
broader perspective toward the accommodation of multimodal users. It also requires seeing a greater and more discrete gradation of context. This does not mean that the traditional urban-rural assignment cannot be for other purposes such as project funding. This delineation can and should be made for those purposes as required. The relationship is shown in Table 40.

Table 40 Existing and Expanded FCS relationship

<table>
<thead>
<tr>
<th>Expanded FCS Context Categories</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>Rural Town</td>
<td>Suburban</td>
<td>Urban</td>
<td>Urban Core</td>
</tr>
<tr>
<td>Rural</td>
<td></td>
<td></td>
<td>Urban</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Roadway Type Classification</th>
<th>Existing FCS</th>
<th>Expanded FCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Arterial</td>
<td>Principal Arterial</td>
<td></td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>Minor Arterial</td>
<td></td>
</tr>
<tr>
<td>Major Collector</td>
<td>Collector</td>
<td></td>
</tr>
<tr>
<td>Minor Collector</td>
<td>Local</td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td>Local</td>
<td></td>
</tr>
</tbody>
</table>

In addition, the requirement to accommodate multimodal users presumes that a network approach is taken for user modes. That network information needs to be available or assembled for expected users: vehicular, bike, and pedestrian as well as transit and freight as appropriate. While any given roadway may not accommodate all users, the broader or surrounding network should be adapted to provide for the prescribed users. An agency may choose to have network information available for the entire jurisdiction in advance or collect/develop it on a project-by-project basis.

**PILOT IMPLEMENTATION**

A pilot implementation of the Expanded FCS was undertaken to determine the efforts required for adoption of the Expanded-FCS by a state agency and to identify, if necessary, refinements to the proposed Expanded FCS. The research team developed a one-day workshop on the Expanded FCS explaining the concepts and steps required for the implementation of the classification. The training was delivered to Pennsylvania and Washington DOTs.

The workshop evolved as a series of charrettes where each step of the process was briefly presented followed by a work session on a local corridor(s). This provided the required basic knowledge of the local conditions and allowed for addressing local complications or issues that
agencies may face when implementing the Expanded FCS. At the end of each charrette, a short
discussion was to be held to identify pros and cons of the step and issues that may require further
attention and clarification on the guide. At the end of the day, time was to be allocated for an open
discussion where the entire process was reviewed, and additional comments were solicited aiming
to improve both the guide and the workshop. The discussion was also focused on identifying what
tools are needed to ensure the implementation of the Expanded FCS throughout the agency. A
general agenda for the workshop was developed and presented to the participating DOTs in order
to provide a basis for adjusting the workshop goals and approach to fit the needs and objectives
of the agency. A sample agenda and the training material are included in Appendix B.

Overall, the participants in both workshops provided positive feedback for the Expanded
FCS and noted that this can aid in the development of a more contextually appropriate, multimodal
design. The use of the local corridors helped in the understanding of the concepts presented even
though most of the participants were not very familiar with each corridor, as participants came from
various areas of each state. Based on the experience from both DOTs, it is apparent that it is
possible for persons not familiar with the context of a corridor to use the context definitions and come
to a consensus with the other team members to determine the corridor context and functional
classification. Few of the participants had reviewed the guide and were able to consult it during the
charrette activities, and thus they were able to provide feedback on the guide specifics.

Several of the comments and issues identified during the workshops were similar to those
the research team has already considered while developing the guide. For example, there was
some discussion about the lack of numerical values in the context definitions (these were not
considered appropriate and thus were not used, allowing values to be relative within each area)
as well how would one define the boundaries between certain contexts (in this case between
urban and suburban). It should be noted here that the new Complete Streets Handbook that the
Florida DOT (FLDOT) recently published has also adopted the concepts of the Expanded FCS
and includes a set of more-specific values regarding some of the metrics used to identify the
specific context categories. This is a step that may be taken by each state or MPO, but may not
be practical on a national scale.

The need for additional categories within a context category is not recommended, since
this will increase the number of categories without having a specific effect on design. In this case,
local solutions should be sought in order to address the specific issues through a careful
consideration of the users and their needs to be accommodated. The FLDOT Handbook has
proposed seven categories, distinguishing between rural natural and agricultural categories and
suburban residential and commercial. However, this is to be used mainly for planning purposes and not for design, since the handbook indicates that for design purposes these are to be handled similarly with an added consideration to the needs of the various users for proper accommodation.

The open discussion at the end of both workshops also focused on how the Expanded FCS could be implemented. The research team presented the participants with two approaches to achieve this at project level, i.e., one project at a time, or districtwide. Each state decided to follow a customized approach to deal with implementation. The PennDOT was more inclined to classify roads on a project basis and implement this in a gradual manner. The WSDOT determined that the context definitions could be part of the Corridor Sketch Plan (considered to be the first step in the project development where options are considered and evaluated or a larger district wide corridor), since they have the potential to improve bicyclist and pedestrian definition of needs and accommodation. The option of assigning the Expanded FCS to the entire network is also under consideration. This would allow for developing the context-roadway combinations at the high level and then each project will identify and balance the users and their needs. A pilot is under way of this approach for the Eastern District, but it has not been completed yet.

The FLDOT approach is to classify all state-maintained roads within the next three years and provide for the context-roadway combinations for all roads. The agency is mindful of potential changes in land use, and thus context, that can occur between the classification and when a project may be designed. However, this is an issue that all agencies face currently, since previously considered rural areas have been developed and become more urbanized. Another issue that they are also considering is the practicality of the seven categories and the possibility of collapsing the two rural and two suburban categories into a single one ad thus align them with the categories in the Expanded FCS.

Another issue that is relevant to implementation is the potential of the Expanded FCS to be modified based on the state needs. The design guidance provided in the matrix is generic in nature and identifies several metrics qualitatively, e.g. high, medium and low. The FLDOT Complete Streets Handbook has developed quantitative metrics for several of the same criteria used in the Expanded FCS to reflect the Florida-specific conditions and land use. During the workshops, the qualitative nature of the metrics did not seem to pose any issues, but agencies that require a more quantitative approach could follow the example of FLDOT and develop their own specific criteria both for the classification and design elements.

Given the experience of WSDOT and FLDOT, it is recommended that a DOT should attempt to initially reclassify all state-maintained roads and develop the context–roadway combinations. This will allow for aligning all pertinent activities that currently are based on
functional classification. Moreover, further and more detailed definition can be achieved at the project level once one is defined to allow for a more accurate reflection of the current context in case this has changed from the initial classification.
CHAPTER 7
CONCLUSIONS AND FUTURE RESEARCH

CONCLUSIONS

The primary outcome of this research effort is the development of a flexible framework to replace the existing functional classification scheme. This new framework will facilitate optimal geometric design solutions that take into account context, user needs, and functions. The Expanded FCS is designed to provide improved information to the designer so that balanced designs can be achieved through documented prioritization of roadway users and community needs. The new system is simple yet dynamic so that its straightforward application will be well received by all stakeholders.

A remarkable amount of thought has already gone into possible alternatives to the FCS. This has yielded an extensive array of alternatives that address a range of perceived shortcomings. The recommended alternative Expanded FCS proposed by the research team takes advantage of the available forethought and provides a complete innovative framework that brings together context, road type, and user needs to establish multimodal design guidance and considerations to achieve context sensitive, enhanced solutions. The Expanded FCS is an advanced alternative that can fit a variety of situations and can be used for individual projects or adopted for jurisdiction use on all project development.

Over the past decades, substantial efforts were undertaken to not only modernize current practices in highway design but to also address the public’s concerns regarding potential adverse effects for the roadway designs developed. This new environment required that state DOTs reconsider how projects were developed and deliver designs that were in harmony with the surrounding context of the roadway. Major efforts were undertaken to shift the traditional project development approach to a more responsive process. This started with addressing concerns for the physical and cultural environments and continued with the encouragement of developing multidisciplinary design teams and involving all project-affected stakeholders. These concepts were expanded later to include the entire project development and delivery process from planning to operations and maintenance, providing for a comprehensive approach resulting in the practice of CSS. Recent economic constraints that several state DOTs are facing have created a new emphasis on financial issues as they relate to project development generating the concept of Practical Design. Finally, the most recent development of Performance-Based Practical Design can assist in delivering optimum solutions through flexible design approaches while alleviating fears regarding liability and safety concerns though the use of analysis tools to evaluate the ultimate operational and safety performance of a geometric design.
The existing functional classification originally was developed to provide a means for selecting roads for federal funding as well as for defining statewide systems that included roads beyond those on the nationally recognized system. Over the years, functional classification has come to assume additional significance beyond its purpose as a framework for identifying the role of a roadway in moving motor vehicles through a network of highways. Functional classification carries with it expectations about roadway design, including its speed, capacity, design controls and criteria, and relationship to existing and future land use development. Federal legislation continues to use functional classification to determine eligibility for funding under the Federal-aid program. Transportation agencies describe roadway system performance, benchmarks, and targets using functional classifications. The universal application of the FCS has enabled its integration into many facets of local operations. Uses include local access management and traffic calming eligibility, grouping for operational and safety performances, and directing built form through local land use plans and/or zoning ordinances, subdivision regulations, and site development standards. The funding component of FCS almost ensures that it will be used locally, especially in jurisdictions that lack the wherewithal to develop their own system.

An issue of concern regarding the impacts of the existing FCS on design has been its linkage to geometric design standards. Highway agencies have used this linkage as their default position, where deviations and variations from the Green Book values are often achieved though administrative waivers and design exceptions. State transportation agencies now depend on defined design guidelines as design standards as a means of avoiding agency liability because of the status given to the AASHTO Green Book and state design manuals. With these standards often closely linked to functional classification, it has fostered a degree of inflexibility in roadway design—especially in urban streets—that limits an agency’s inclination to explore flexible designs for a project that are necessitated by CSS and PBPD.

Another primary issue of concern with the FCS is the singular focus on automobile-centric travel. With recent refocusing on public spaces, including streets, as an activity center as well as the recent growth in pedestrian, bicycle, and transit usage for mobility, this limited understanding of roadways is insufficient to provide guidance to planners and designers. CSS and Complete Streets have brought up the issue of multimodal transportation facilities and it has emphasized the need for considering roadways as facilities that move more than vehicles. One notable consequence of this continued reliance on the FHWA classification system is that a large share of highway funding resources have continued to be concentrated on mobility-oriented corridors, even when planning at a metropolitan or local level. Additionally, the absence of the documented
importance of pedestrian, bicycle, or transit oriented corridors often leads to designs that identify these uses as secondary to auto oriented travel.

Two issues relative to context definition in the existing FCS are the lack of recognition of rural towns and distinctions in urban networks. The urban/rural classification is essential in assigning jurisdictional roles, operational needs, and funding allocation; however, it does not provide the perspective required to guide contextual design. Frequently, roadways pass through small towns with population less than the minimum required thresholds to be classified as urban. This results in designs that are not appropriate for the roadway context. In such cases, the surrounding land use, prevailing speeds, and transportation functions are more like urban or suburban than typical rural areas and designers need to recognize such situations and apply common sense judgments in interpreting design criteria and developing appropriate solutions or design approaches. Similarly, within urban networks one can traverse along corridors with varied user and modal needs and the current FCS does not allow for the complexity of built environments or the continuity of development from rural forests and farmlands to the urban core. While the current process may accommodate these areas through the design exception process, this effort attempts to identify harmonious design as the rule, as opposed to the exception.

The Expanded FCS was developed to address these issues and provide a framework that could assist in delivering appropriately contextual designs. The classification was based on a review of globally available classification systems and on responses from a nationwide survey of transportation agencies. These reviews identified the need for the existing system to have expanded context in order to recognize the lack of suburban and rural community (Main Street) contexts and the lack of balancing modal needs. Correcting both needs encourage generalized design solutions.

The proposed classification balances the simplicity of the dual context with the need for expanded context sensitivity by identifying five specific categories. These categories are based on density, land use, and building setbacks. The five categories are:

1. **RURAL**: areas with lowest density, few houses or structures (widely dispersed or no residential, commercial and industrial uses) and usually large setbacks.

2. **RURAL TOWN**: areas with low to medium density but diverse land uses with commercial main street character, potential for on-street parking and sidewalks, and small setbacks.
3. **SUBURBAN**: areas with low to medium density, mixed land uses within and among structures (including mixed-use town centers, commercial corridors and residential areas) and with varied setbacks.

4. **URBAN**: areas with high density, mixed land uses and prominent destinations, potential for some on-street parking and sidewalks, and mixed setbacks.

5. **URBAN CORE**: areas with highest density and mixed land uses within and among predominately high-rise structures, and with small setbacks.

The Expanded FCS defines roadway types based on their network function and the connectivity they provide among various areas. The existing names of the categories were utilized to allow for an easier transition to the proposed system as well as to retain consistency with existing funding mechanisms and other uses of the functional classification. The network function is defined based on the national, regional, and local importance of the roadway. The connectivity identifies the types of activity centers and locales that are connected with the particular roadway. The proposed roadway types are as follows:

1. **INTERSTATES/FREEWAYS/EXPRESSWAYS**: Corridors of national importance connecting large centers of activity over long distances.

2. **PRINCIPAL ARTERIALS**: Corridors of regional importance connecting large centers of activity.

3. **MINOR ARTERIALS**: Corridors of regional or local importance connecting centers of activity.

4. **COLLECTORS**: Roadways of lower local importance providing connections between arterials and local roads.

5. **LOCALS**: Roads with no regional or local importance; for local circulation and access only.

It should be noted that the Expanded FCS will not address context types for Interstates, Freeways, and Expressways, since designs for these facilities are based on federally developed standards with little flexibility.

The Expanded FCS identifies user groups, which include drivers, pedestrians, and bicyclists. Fundamental design elements for each mode also are identified, and design ranges for each are provided based on the overall roadway network type. Various user needs should be identified from the outset and considered when balancing and making the necessary trade-offs
among design elements in order to develop contextually appropriate multimodal solutions. The correlation of context, roadway types, and users results in the Expanded FCS matrix. This allows for the development of a multimodal, context-based design with some degree of flexibility. Each matrix cell defines the various users (drivers, bicyclists, and pedestrians) and identifies which characteristics are to be balanced.

Design teams can utilize the Expanded FCS to understand the role the roadway will play in both the environment in which it will be constructed and the role it plays within the network. Various user groups that must be accommodated within the roadway are also identified, so that their competing needs and spatial demands may be considered. To assist in balancing these needs, the importance of the roadway within the individual network of each road user is also identified.

Balancing modal needs is central to Expanded FCS. It is understood that there is the possibility that the designer will not be able to provide the best facilities for all the users at all times and at the same location in all roadways. There will be instances where the mobility needs for some groups require adjustments and/or consideration of alternative routes as well as the use of revised system overlays. On high-speed arterials, for example, bicycles and pedestrians may need to be accommodated on a parallel roadway with lower speeds. Likewise, a corridor with high bicycle demand and mobility needs may require the presence of bicycle facilities that would lower speeds and possibly reduce the number of available vehicle lanes if there is limited right-of-way. Design considerations of how to achieve this are presented in the guide (NCHRP Research Report 855).

Proper contextual roadway designs require an understanding of the function of the roadway within its current and expected future context and the needs of the potential roadway users. The Expanded FCS and associated design matrix can assist in identifying the preliminary requirements for proper consideration of roadway context and user needs. This approach provides the framework for determining user needs and ordering user levels on a given roadway. It assumes the planner/designer can develop alternative system/network strategies for meeting all user needs. This process can assist in providing input and refinement to the purpose and need document which establishes the framework for the design to be developed. In the end the final balancing of facilities to accommodate user needs becomes part of the process of following project development principles for achieving CSS.
FUTURE RESEARCH

The work completed here also identified areas where additional research is needed to provide answers to the questions that were posed but not addressed due to resource limitations. The following areas of future research are recommended:

1. Case studies can be undertaken where the implementation of the Expanded FCS could be applied. This would require areawide planning to identify contexts and user networks and be carried through to identify projects in their initial stages to allow for Expanded FCS influence on designs. The development of the process and establishment of additional implementation guidance would allow for a systematic evaluation of the proposed classification. This could be accomplished either at the state level or at MPO level.

2. Another effort could explore further the guidance used to define the contexts and to determine possible ranges of values for their stratification. The Expanded FCS does not provide any metrics for the quantification of the contexts and this could be addressed in the future to allow for a more complete implementation.

3. A third effort could focus on further incorporating procedures and methods of the Highway Safety Manual (AASHTO, 2010) in estimating risk and benefits of alternative modal accommodations. This would allow a more detailed evaluation of the trade-offs required when developing design options and comparing alternatives.
References


APPENDIX A

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Presenter(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-9:00</td>
<td>Introductions; meeting objectives</td>
<td>Donahue/Stamatiadis</td>
</tr>
<tr>
<td>9:00-9:30</td>
<td>NCHRP 15-52 Functional Classification Overview</td>
<td>Stamatiadis</td>
</tr>
<tr>
<td>9:30-10:15</td>
<td>Charrette: Context definition</td>
<td>Stamatiadis</td>
</tr>
<tr>
<td>10:15-10:30</td>
<td>Break</td>
<td>Stamatiadis</td>
</tr>
<tr>
<td>10:30-11:45</td>
<td>Charrette: Roadway type/User identification</td>
<td>Kirk</td>
</tr>
<tr>
<td>11:45-12:15</td>
<td>Lunch Break</td>
<td></td>
</tr>
<tr>
<td>12:15-2:00</td>
<td>Charrette: Design options</td>
<td>Kirk</td>
</tr>
<tr>
<td>2:00-4:00</td>
<td>Guidance needs discussion</td>
<td>Stamatiadis/Kirk</td>
</tr>
</tbody>
</table>
WORK SESSION 1
CONTEXT DEFINITION

Objective: Define context(s) for the corridor. Maximum time: 30 minutes

Assignment
Working as a team:
1. Review context category definitions from NCHRP 15-52.
2. Identify key characteristics that can aid the determination of context for different areas on the corridor.
3. Determine context boundaries for corridor areas and justify choices.
4. Identify elements missing from the context definition that could aid in determination of context and boundaries.
5. Prepare for a brief (5 min maximum) presentation to present the context decisions and basis for the corridor.

WORK SESSION 2
ROADWAY TYPE/USER IDENTIFICATION

Objectives: Determine roadway type(s) for the corridor; Identify users for the corridor and their level of importance. Maximum time: 60 minutes

Assignment
Working as a team:
1. Review roadway type definitions from NCHRP 15-52.
2. Identify key characteristics that can aid the determination of roadway type for the corridor.
3. Identify elements missing from the roadway type definition that could aid in determination of context and boundaries.
4. Review user accommodation definitions from NCHRP 15-52.
5. Define for each user the appropriate corridor classification based on NCHRP 15-52 categories.
6. Identify key characteristics that require consideration to aid the identification of needs and balancing of users for the corridor.
7. Determine possible user accommodation approaches for the corridor and justify choices.
8. Identify elements missing from the user accommodation concepts that could aid in determination of their accommodation and balancing needs.
9. Determine possible roadway type boundaries for corridor sections and justify choices.
10. Prepare for a brief presentation (max 5 minutes) to present the roadway type and user accommodation decisions for the corridor.
Objective: Develop conceptual design options for the corridor. Maximum time: 30 minutes

Assignment
Working as a team:
1. Review user accommodation and balancing from Work Session 2.
2. Identify roadway design elements required to accommodate users based on the Expanded Functional Classification matrix cell.
3. Develop potential cross sections for each context/roadway type cell to address user accommodation along the corridor.
4. Discuss potential conflicts between user groups and how those may be resolved.
5. Identify elements missing from the Expanded FCS that could aid in determination of the design options.
6. Prepare for a brief (5 min maximum) presentation to present the design options considered and selected for the corridor.
IMPLEMENTATION OF NCHRP 15-52
Washington DOT
Nikiforos Stamatiadis
Adam Kirk

Agenda

8:30- 9:00  Introductions; meeting objectives
9:00- 9:30  NCHRP 15-52 Functional Classification Overview
9:30-10:15  Charrette: Context definition
10:15-10:30 Break
10:30-11:30 Charrette: Roadway type/User identification
11:30-12:15 Lunch Break
12:15- 1:30  Charrette: Design options
1:30- 4:00  Guidance needs discussion
Workshop Objectives

♦ Review NCHRP 15-52
♦ Identify application needs
♦ Incorporate Expanded FCS into PA Design Guide
♦ Solicit feedback
Context Types

♦ 5 Contexts
♦ Defining elements
  ● Density
  ● Land use
  ● Building setbacks

Roadway Types

♦ Existing terms
♦ Defining element
  ● Network function
  ● Connectivity

<table>
<thead>
<tr>
<th>Expressways/Freeways*</th>
<th>Corridors of national importance providing long distance travel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Arterial</td>
<td>Corridors of regional importance connecting large centers of activity</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>Corridors of local importance connecting centers of activity</td>
</tr>
<tr>
<td>Collector</td>
<td>Roadways providing connections between arterials and local roads</td>
</tr>
<tr>
<td>Local</td>
<td>All other roads</td>
</tr>
</tbody>
</table>

*Expressways/Freeways* and *Collector* are not commonly used to describe roadway types.
User Groups

♦ Driver
♦ Bicyclist
♦ Pedestrian
♦ Overlays
  • Transit
  • Freight

Expanded-FCS Matrix
Application
Case Study 2
Louisville, KY
<table>
<thead>
<tr>
<th>Milepoint</th>
<th>Density</th>
<th>Land use</th>
<th>Setbacks</th>
<th>1552-FCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0-0.73</td>
<td>High density, multi-story and high-rise buildings; highest density within the corridor</td>
<td>Commercial, institutional (court houses and government offices), and residential uses; off-street parking and parking structures</td>
<td>Small setbacks with wide sidewalks and enhanced pedestrian facilities (benches, street furniture and pedestrian plazas)</td>
<td>Urban Core</td>
</tr>
</tbody>
</table>
CONTEXT

Context Types

- Rural
- Suburban
- Urban
- Urban Core
### Rural

<table>
<thead>
<tr>
<th>Density</th>
<th>Land use</th>
<th>Setback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest (few houses or other structures)</td>
<td>Agricultural uses with some isolated residential and commercial</td>
<td>Usually large setbacks</td>
</tr>
</tbody>
</table>

### Rural Town

<table>
<thead>
<tr>
<th>Density</th>
<th>Land use</th>
<th>Setback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low to medium (single family houses and other single purpose structures)</td>
<td>Primarily commercial uses along a main street (some adjacent single family residential)</td>
<td>On-street parking and sidewalks with predominately small setbacks</td>
</tr>
</tbody>
</table>
### Suburban

<table>
<thead>
<tr>
<th>Density</th>
<th>Land use</th>
<th>Setback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low to medium (single and multi-family structures and multi-story commercial)</td>
<td>Mixed residential neighborhood and commercial clusters (includes town centers, commercial corridors, big box commercial and light industrial)</td>
<td>Varied setbacks with some sidewalks and mostly off-street parking</td>
</tr>
</tbody>
</table>

![Suburban Image 1](image1)

![Suburban Image 2](image2)

### Urban

<table>
<thead>
<tr>
<th>Density</th>
<th>Land use</th>
<th>Setback</th>
</tr>
</thead>
<tbody>
<tr>
<td>High (multi-story, low rise structures with designated off-street parking)</td>
<td>Mixed residential and commercial uses, with some intuitional and industrial and prominent destinations</td>
<td>On-street parking and sidewalks with mixed setbacks</td>
</tr>
</tbody>
</table>

![Urban Image 1](image3)

![Urban Image 2](image4)
Urban Core

<table>
<thead>
<tr>
<th>Density</th>
<th>Land use</th>
<th>Setback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest (multi-story and high rise structures)</td>
<td>Mixed commercial, residential and institutional uses within and among predominately high rise structures</td>
<td>Small setbacks with sidewalks and pedestrian plazas</td>
</tr>
</tbody>
</table>

Work Session 1

♦ Objective
  ● Define corridor context(s)

♦ Working as a team:
  ● Review Expanded FCS contexts
  ● Identify key characteristics
  ● Define context boundaries
  ● Identify missing elements
  ● Present corridor context(s)
ROADWAY TYPES
USERS

Roadway Types

♦ Existing terms
♦ Defining element
  • Network function
  • Connectivity
**Roadway Type Considerations**

- Efficiency of Travel
- Route Spacing
- Modal Range
- Safety
- Volumes

**Roadway Types**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expressways/Freeways*</td>
<td>Corridors of national importance providing long distance travel</td>
</tr>
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</tr>
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<td>Minor Arterial</td>
<td>Corridors of local importance connecting centers of activity</td>
</tr>
<tr>
<td>Collector</td>
<td>Roadways providing connections between arterials and local roads</td>
</tr>
<tr>
<td>Local</td>
<td>All other roads</td>
</tr>
</tbody>
</table>

*Not addressed here*
Expanded-FCS Matrix

Driver Accommodation

- **Speed**
  - Low
  - Medium
  - High

- **Access levels**
  - Low
  - Medium
  - High

- **Mobility levels**
  - Low
  - Medium
  - High
### Expanded-FCS Driver Accommodation

<table>
<thead>
<tr>
<th>Context</th>
<th>Rural</th>
<th>Rural Town</th>
<th>Suburban</th>
<th>Urban</th>
<th>Urban Core</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Roadway</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Principal Arterial</td>
<td>H speed</td>
<td>L/M speed</td>
<td>M/H speed</td>
<td>L/M speed</td>
<td>L speed</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>H speed</td>
<td>M speed</td>
<td>M/H speed</td>
<td>M/H speed</td>
<td>M speed</td>
</tr>
<tr>
<td>Collector</td>
<td>M speed</td>
<td>M speed</td>
<td>M/H speed</td>
<td>M/H speed</td>
<td>M speed</td>
</tr>
<tr>
<td>Local</td>
<td>M speed</td>
<td>M speed</td>
<td>M/H speed</td>
<td>M/H speed</td>
<td>M speed</td>
</tr>
</tbody>
</table>

**Speed, Mobility and Accessibility levels:**
- H: High
- M: Medium
- L: Low

### Expanded-FCS Driver Accommodation

**Speed, Mobility and Accessibility levels:**
- H: High
- M: Medium
- L: Low
### Bicyclist Accommodation

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citywide Connector</td>
<td>Citywide/Regional connections or connections to major activity centers or</td>
</tr>
<tr>
<td></td>
<td>regional bike routes stretching over several miles attracting high bike</td>
</tr>
<tr>
<td></td>
<td>volumes</td>
</tr>
<tr>
<td>Neighborhood Connector</td>
<td>Neighborhood or sub-area connections allowing access to higher order</td>
</tr>
<tr>
<td></td>
<td>facilities or local activity centers</td>
</tr>
<tr>
<td>Local Connector</td>
<td>Local connections of short length providing internal connections to</td>
</tr>
<tr>
<td></td>
<td>neighborhoods or connect to higher order facilities</td>
</tr>
</tbody>
</table>

#### Separation
- High
- Medium
- Low

### Expanded-FCS Bicyclist Accommodation

<table>
<thead>
<tr>
<th>Context</th>
<th>Rural</th>
<th>Rural Town</th>
<th>Suburban</th>
<th>Urban</th>
<th>Urban Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Principal Arterial</td>
<td>LC: L separation</td>
<td>LC: L separation</td>
<td>LC: L separation</td>
<td>LC: L separation</td>
<td>LC: L separation</td>
</tr>
<tr>
<td></td>
<td>NC: M separation</td>
<td>NC: M separation</td>
<td>NC: M separation</td>
<td>NC: M separation</td>
<td>NC: M separation</td>
</tr>
<tr>
<td></td>
<td>CC: H separation</td>
<td>CC: H separation</td>
<td>CC: H separation</td>
<td>CC: H separation</td>
<td>CC: H separation</td>
</tr>
</tbody>
</table>

- Bicycle classification levels: CC: Citywide Connector; NC: Neighborhood Connector; LC: Local Connector
- Separation levels: L: Low, M: Medium, H: High
## Expanded-FCS Bicyclist Accommodation

<table>
<thead>
<tr>
<th>Context</th>
<th>Roadway</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principal Arterial</td>
<td>LC: L separation; MC: M separation; CC: H separation</td>
<td></td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>LC: L separation; NC: M separation; CC: H separation</td>
<td></td>
</tr>
<tr>
<td>Collector</td>
<td>LC: L separation; NC: M separation; CC: M separation</td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td>LC: L separation; NC: L separation; CC: L separation</td>
<td></td>
</tr>
</tbody>
</table>

(Bicycle class: CC: Citywide Connector; NC: Neighborhood Connector; LC: Local Connector; Separation levels: H: High; M: Medium; L: Low)

## Pedestrian Accommodation

- **Traffic**
  - P1 (Rare/Occasional)
  - P2 (Low)
  - P3 (Medium)
  - P4 (High)
- **Sidewalk width**
  - *Not Applicable, Not Recommended, Not Appropriate*
  - Minimum
  - Wide
  - Enhanced
- **Separation**
Expanded-FCS Pedestrian Accommodation

<table>
<thead>
<tr>
<th>Context</th>
<th>Rural</th>
<th>Rural Town</th>
<th>Suburban</th>
<th>Urban</th>
<th>Urban Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Principal Arterial</td>
<td>P1: *; P2: Min; P3: Wide; P4: Wide</td>
<td>P2: Min; P3: Wide; P4: Enhanced</td>
<td>P1: *; P2: Min; P3: Wide; P4: Enhanced</td>
<td>P2: Min; P3: Wide; P4: Enhanced</td>
<td>P3: Wide; P4: Enhanced</td>
</tr>
</tbody>
</table>

Pedestrian traffic levels P1: None/Occasional; P2: Low; P3: Medium; P4: High
Pedestrian facility widths: *: specific considerations; Min: minimum; Wide: greater than minimum; Enhanced: wide
For large congesting pedestrian groups,
Pedestrian facility separation should be considered in conjunction with driver target speeds.

Modal Network Planning

City of Philadelphia Bike Network
Overlays

Transit Network Overlays
Work Session 2

♦ Objectives
  ● Determine roadway types
  ● Identify corridor users

♦ Working as a team:
  ● Review Expanded FCS definitions
  ● Identify key characteristics for determination
  ● Determine user accommodation
  ● Identify missing elements
  ● Present roadway type and user accommodation
Design Considerations and Interactions

♦ Caution regarding use of paired minimum design elements
♦ Evaluate Alternate Routes
♦ Lower Target Speeds/Mobility
Work Session 3

♦ Objective
  • Develop conceptual corridor designs

♦ Working as a team
  • Review choices in Work Session 2
  • Identify design elements
  • Develop cross sections
  • Identify missing elements
  • Present selected designs