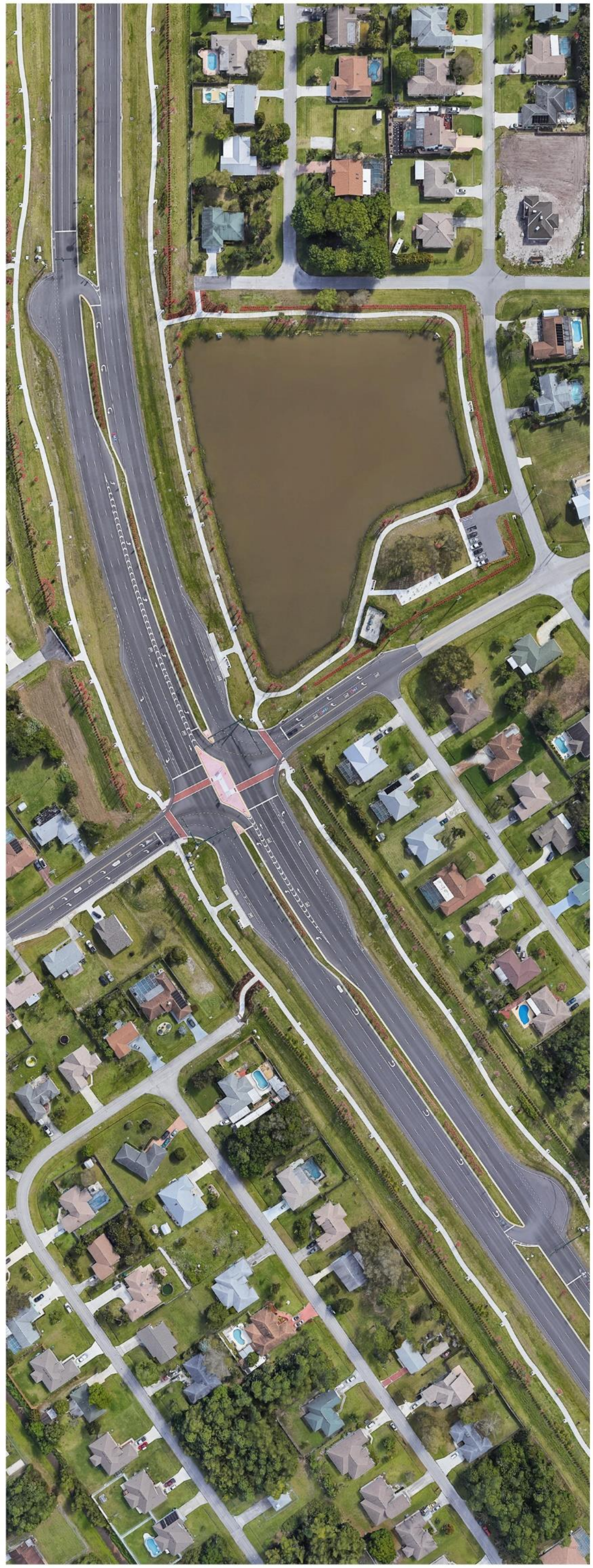

Multimodal Access Management Guidebook

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FDOT

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Chapter 1: Introduction

1.1 Purpose

The *Florida Department of Transportation's (FDOT) Systems Management Division of the Systems Implementation Office* has developed this guidebook as a way for state and local transportation officials to better understand access management principles and FDOT standards. New materials such as revised Florida Administrative Code (F.A.C) Rule Chapters *14-96* and *14-97*, the *FDOT's Context Classification System*, *FDOT Design Manual (FDM)*, *FDOT Manual on Intersection Control Evaluation (ICE)* and *FDOT Traffic Engineering Manual (TEM)* were used to develop this revised guidebook from the previous *2019 Access Management Guidebook*.

This revised guidebook explains the FDOT rules and standards developed in various FDOT documents and manuals related to access management which are to be followed in developing and designing access to state transportation facilities. This guidebook also provides background by defining access management, how it is applied on Florida's transportation facilities, and some best practices.

1.2 Background

The mission of the FDOT is to "provide a safe statewide transportation system that ensures the mobility of people and goods, enhances economic prosperity, and preserves the quality of our environment and communities." Per *Florida Statutes (F.S.) 334.044*, FDOT has the responsibility for "coordinating the planning of a safe, viable, and balanced state transportation system serving all regions of the state, and to assure the compatibility of all components, including multimodal facilities."

There are two main functions of transportation facilities: to provide mobility and to provide access. Mobility is best defined as the ability for people and goods to be moved in an efficient manner while access allows people and goods the ability to enter or exit the system or property. For motorized traffic, these are competing functions that must be balanced depending on the highest need or desired result. Effectively balancing one's mobility with access is a high priority of roadway and land use planning. Highways are an example of a roadway where vehicular access has been limited to ensure greater mobility for vehicles. A street in an urban downtown area with vehicular access to many of the adjacent properties would limit mobility for vehicles due to reduced speeds while increasing exposure to conflicts with bicyclists and pedestrians.

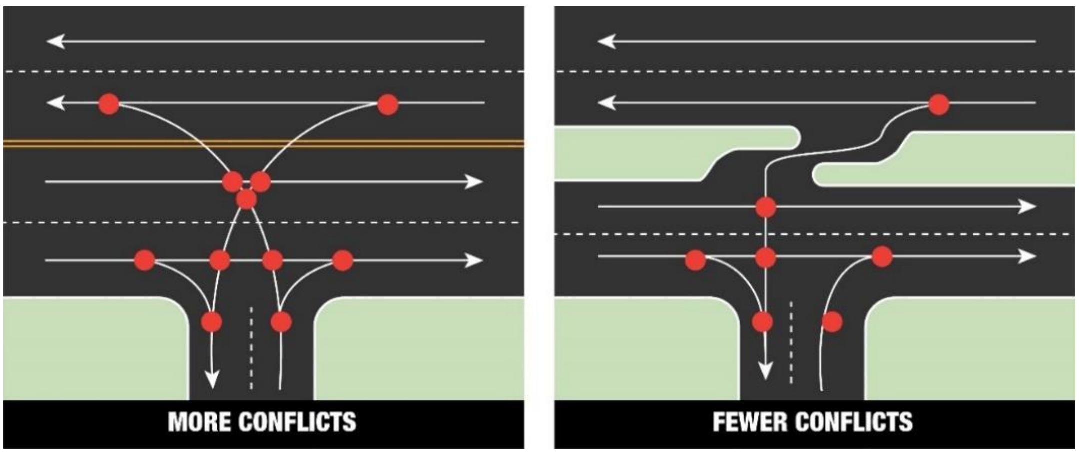
While access and mobility are competing factors for vehicles, they are synergetic and complimentary for bicyclists and pedestrians. Increased pedestrian and bicycle access along a facility improves pedestrian and bicycle mobility by providing more opportunities for convenient and direct paths to adjacent properties with fewer conflict points with motor vehicle traffic. Limited pedestrian and bicycle access can create longer walking and biking distances, and result in unsafe conditions with increased conflict points and unintentionally promoting the use of undesignated paths. As roadways change and serve increasingly more vehicles and a wider variety of road users, balancing access and mobility is more important than ever.

1.2.1 What is Access Management?

Access management is the coordinated planning, regulation, and design of access between transportation facilities and land development. It promotes the efficient and safe movement of people and goods by reducing conflicts on the roadway system and at its interface with other modes of travel.

Conflict points are defined as points along a roadway where travelers' paths can legally cross one another. Some examples of conflict points within a roadway are vehicles changing lanes, a pedestrian crossing a driveway using a sidewalk, or a vehicle making a right or left turn. The goal of access management is to manage conflicts between users of the transportation network. For example, access management may be applied on a roadway to improve safety performance by implementing a restrictive median to reduce overall conflicts (See ***Figure 1***). In this example, the installation of a median and directional median opening restricts vehicular movements, resulting in fewer conflicts overall (shown as red dots). Access was limited by the installation of the median opening, but mobility was increased, as well as improved safety performance for users.

Figure 1 | Access Management Example



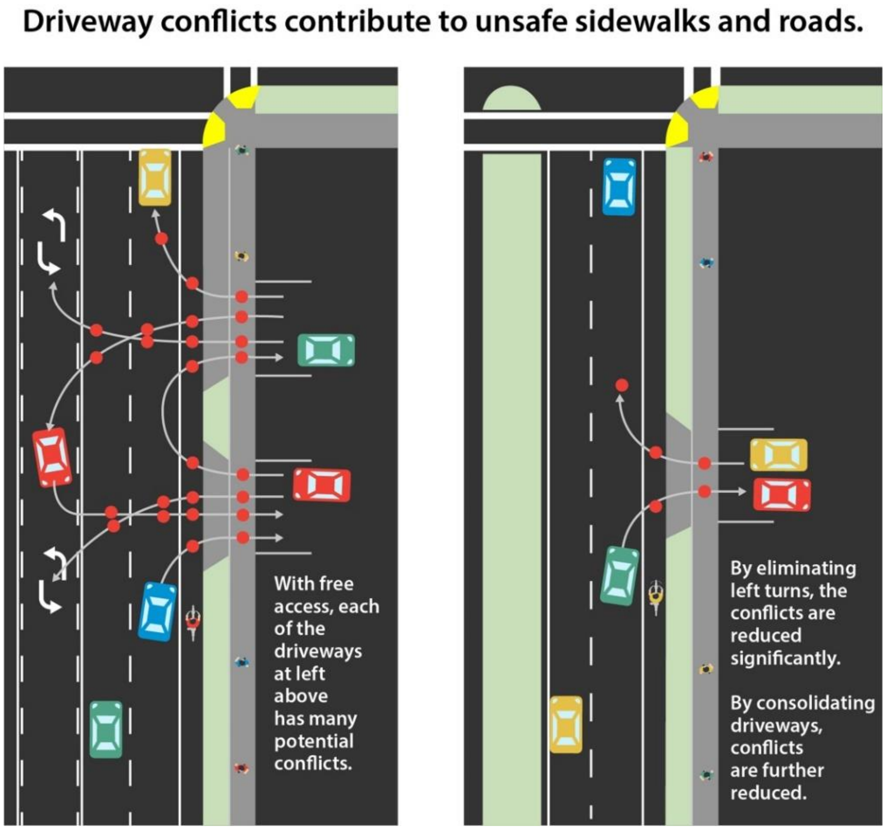
Source: FDOT

In another example, focused on non-motorized travelers, ***Figure 2*** shows how eliminating left turns and combining two driveways can significantly reduce the number of conflict points from 25 to five between vehicles (See ***Figure 2***). Further discussion on medians and median openings is provided in ***Chapter 3: Designs of Medians & Median Openings***.

In addition to providing vehicular access, transportation facilities should provide access for bicyclists and pedestrians where non-motorized users are present, planned, or promoted. Per *F.S 334.044*, it is the responsibility of FDOT to establish and maintain pedestrian and bicycle ways and to encourage and promote multimodal transportation alternatives on all FDOT SHS facilities. Pedestrian and bicycle access management should provide convenient paths for users with minimized walking distances, minimized conflicts with other modes, appropriate design and traffic control compliant with the Americans with Disabilities Act (ADA).

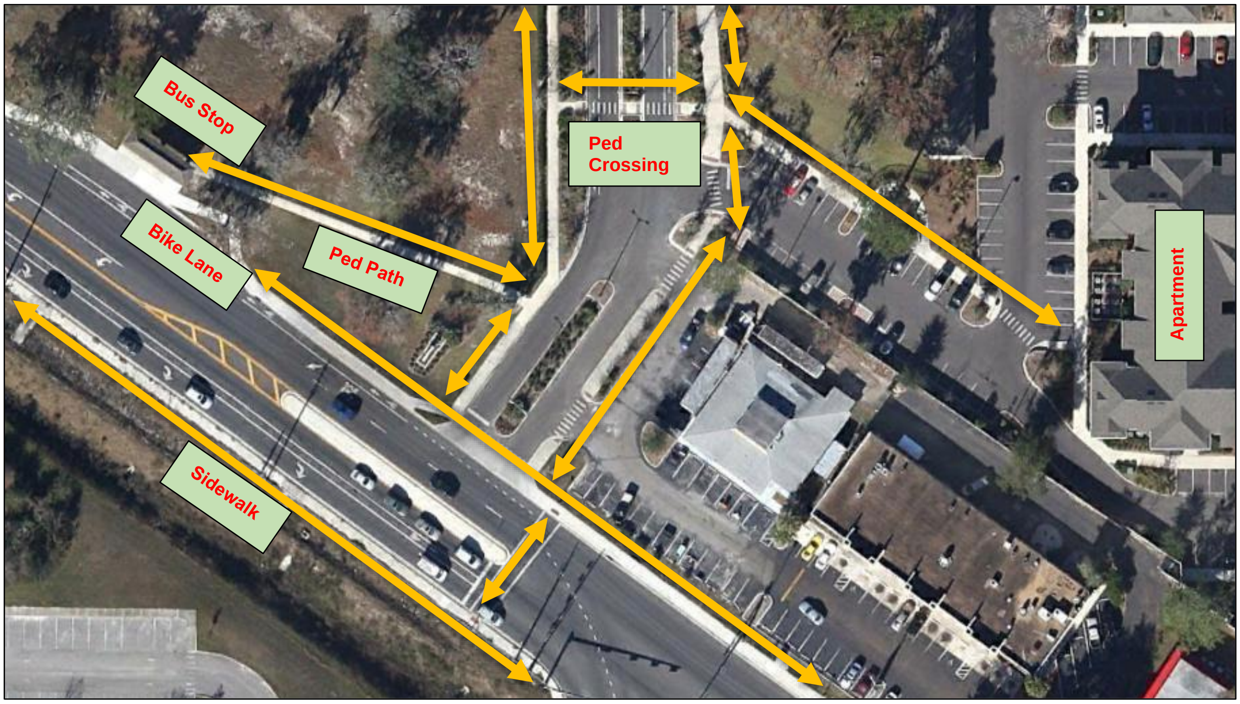
Figure 3 shows an existing mixed-use development site that provides access for pedestrians and bicyclists extending from the internal sidewalk network to the surrounding roadway network facilities, which includes transit facilities.

Figure 2 | Conflict Points and Non-Motorized Users



Source: Adapted from Oregon Department of Transportation

Figure 3 | Pedestrian Access and Circulation



Source: Gainesville, FL - Google Earth

1.3 Benefits of Access Management

The *Access Management Manual 2nd Edition* published by Transportation Research Board (TRB) illustrates the importance of roadway access management. Without proper access management, the function and character of major roadways can deteriorate significantly. An effective access management program can reduce crashes, increase roadway capacity, and reduce travel time and delay. A comprehensive access management program supports safe and efficient operations for all modes of transportation. In addition to motorized and non-motorized roadway users, access management will benefit business owners, transit agencies, freight industries, government agencies and communities as described in ***Table 1***. Safety, traffic operational, and business/economic benefits of roadway access management are discussed in the subsequent sections.

Table 1 | User/Stakeholder Benefits of Access Management

User/Stakeholder	Benefits
Motorists	• Fewer traffic conflicts • Simplified traffic task • Increased safety • Reduced travel time and traffic delays
Bicyclists	• Increased safety on roadways with medians and fewer driveways • Reduced conflicts and crashes with turning vehicles • More predictable motorist travel patterns
Pedestrians	• Fewer and less frequent conflict points from motorists entering and exiting a roadway • Medians can be used as a refuge in crossing lanes of traffic • Improved direct and safe access to destinations • Improved neighborhood walkability
Transit Rider/Transit Agency	• Reduced delay and reduced travel times • Safer pedestrian (walking environment), and bicycle access and connectivity to transit stops • Convenient access to transit stops with improved connectivity of streets and sidewalks • Improved reliability of transit service on corridors with effective access management
Business Owner	• Efficient roadway system that captures a broader market area or a greater share of vehicles (customers) • Improved pedestrian and bicycle safety • Improved pedestrian and bicycle customer access • Stable or increasing property values • Predictable and consistent development environment
Freight Industry	• Reduced delay and increased safety will lower transportation costs and shorten delivery times • Improved site design to accommodate trucks
Government Agencies	• Reduced cost of delivering an efficient and safe transportation system • Accomplish regional transportation objectives
Communities	• Enhanced business environment • Stabilize or increase property values • Safer and more sustainable transportation system for all modes of travel • Less need for road widening, which causes displacement of businesses, homes, and communities • More livable roadway corridors and activity centers • Help protect and preserve their investment in transportation facilities • Reduced capital improvement costs for new or reconstructed roadways

Source: Adapted from TRB Access Management Manual 2nd Edition, Section 1.1.2

1.3.1 Safety Benefits of Vehicular Access Management

Various research has concluded that many crashes could have been prevented through vehicular access management. Safety benefits can be achieved by effective access management such as improved access design and fewer traffic conflict locations. Common access management techniques and their associated safety and operational effects are provided in the *TRB Access Management Manual 2nd Edition* based on the access management literature (***Table 2***).

Table 2 | Effects of Access Management Techniques

Treatment	Effect
Add Non-traversable Median	• 55% reduction in total crashes • 30% decrease in delay • 30% increase in capacity
Replace TWLTL with Non-traversable Median	• 15% to 57% reduction in crashes on four-lane roads • 25% to 50% reduction in crashes on six-lane roads
Add Left-turn Bay	• 25% to 50% reduction in crashes on four-lane roads • Up to 75% reduction in total crashes at unsignalized access • 25% increase in capacity
Type of Left-turn Improvement Painted	• 32% reduction in total crashes
Separator or Raised Divider	• 67% reduction in total crashes
Add Right-turn Bay	• 20% reduction in total crashes • Limit right-turn interference with platooned flow, increased capacity
Increase Driveway Speed from 5 to 10 miles per hour (mph)	• 50% reduction in delay per maneuver; less exposure time to following vehicles
Visual Cue at Driveways Driveway Illumination	• 42% reduction in crashes
Prohibition of On-street Parking	• 30% increase in traffic flow • 20% to 40% reduction in crashes
Long Signal Spacing with Limited Access	• 42% reduction in total vehicle hours of travel • 59% reduction in delay • 57,500 gal of fuel saved per mile per year

Source: Adapted from TRB Access Management Manual 2nd Edition, Exhibit 2-10

Highway Safety Manual (HSM) and Safety Performance Functions (SPFs)

The *Highway Safety Manual (HSM)* published by AASHTO is a scientifically based guide that provides analytical tools to predict the average crash frequency of a highway system using the predictive method in Part C. The studies included in the *HSM* predictive method statistically prove that various access management techniques improve roadway safety. The *HSM* conclusively demonstrates the safety benefits of access management, especially the provision of restrictive medians for urban and suburban arterials. It also provides a method for safety impact projections which quantify the safety impact of installing restrictive medians. In addition, it provides crash prediction methods for driveway related crashes. The *HSM Part C (Chapters 10-12)* contains the information and methodology for these computations. It is based on the equations in the *HSM* called Safety Performance Functions (SPFs). These equations are used to estimate the expected average crash frequency as a function of traffic volume and roadway characteristics (such as AADT, number of lanes, median width, intersection control, etc.).

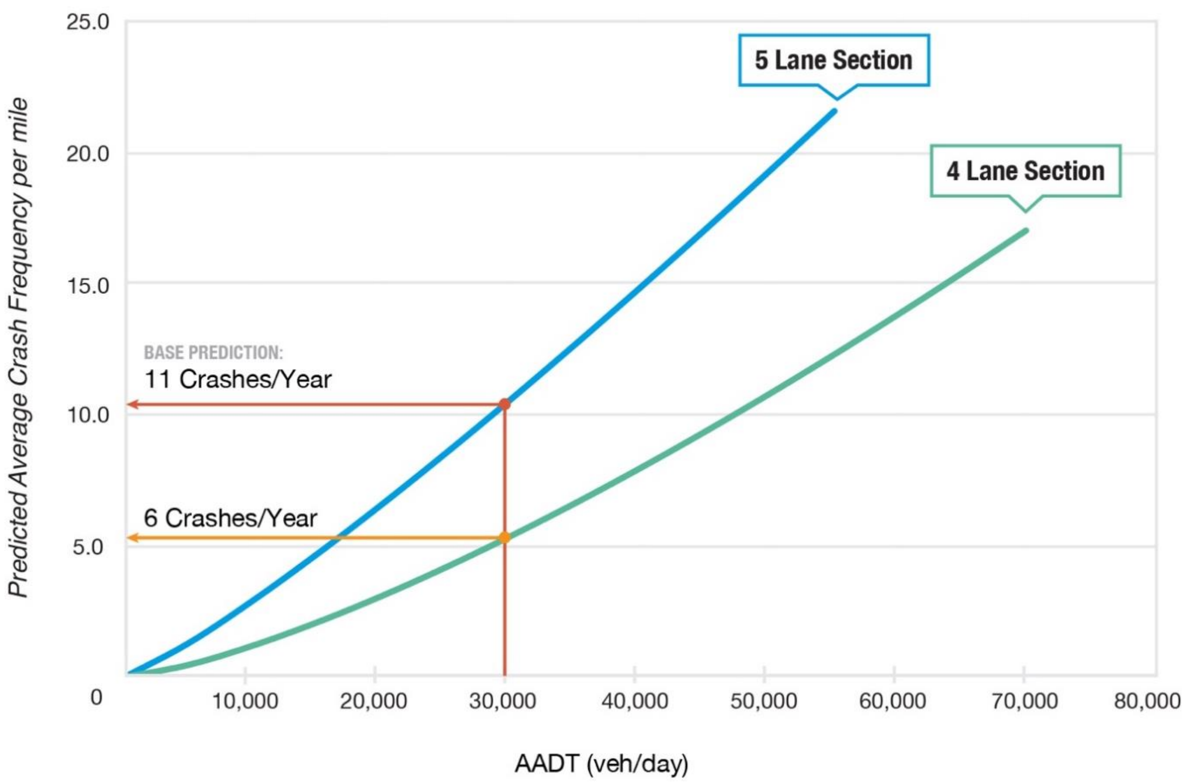
Median Example Using Safety Performance Functions (SPFs)

Using the information in Chapter 12 of the *HSM*, the following example demonstrates how SPFs could be applied to predict the safety benefits of placing a raised median:

> *Example: Evaluate the safety benefits for converting a 5-lane section consisting of two lanes in each direction with a center two-way left-turn lane (TWLTL) into a 4-lane facility with a restrictive median. The example corridor is one (1) mile in length and has annual average daily traffic (AADT) volume of 30,000 vehicles.*

Figure 4 graphs the relationship between the predicted average crash frequency per mile and the AADT of different facility types.

Figure 4 | SPF Comparison of Urban 4-lane Divided and 5-lane with Center TWLTL Roadway Segments



Source: Adapted from HSM, Figure 12-3, (from Equation 12-10 and Table 12-3)

Using the above method, adding a restrictive median is expected to reduce crashes by five per year (11 - 6 = 5). Most corridor reconstruction safety project analyses are performed on a multi-year basis. Therefore, an examination of the cumulative safety benefits is used because the roadway improvement may serve the public for 15 to 20 years.

A detailed analysis example of using the *HSM* for predicting crash reduction can be found in ***Appendix A***.

Benefit/Cost Analysis

A benefit-cost analysis calculates the ratio of the estimated annual reduction in crash costs to the estimated annual increase in combined construction and maintenance costs. The annualized conversion will show whether the projected expenditure of funds for the crash benefit will exceed the direct cost for the improvement. This example illustrates how the crash prediction methods in the *HSM* are employed in benefit/cost analysis studies. The *HSM* provides methods to predict only crashes and does NOT provide cost benefit dollar estimates as these values may vary with jurisdiction. FDOT provides average crash costs by facility type in the *FDM* which are used to estimate benefit/cost ratios. An example of a benefit/cost estimate for a project that involves access management is provided below.

Benefit/Cost Analysis Example

The following Benefit/Cost analysis example, (*HSM Case Study 3*), illustrates the comparison of two alternatives. The FDOT District 7 Office (greater Tampa area) performed a benefit/cost analysis on a resurfacing proposal. To improve the existing conditions, the District found that they would need to spend $2,200,000 for Right of Way (ROW) to improve to a 4-lane roadway (shown in ***Table 4***) with restrictive medians compared to a projected cost of $600,000 for a 5-lane roadway with TWLTL.

Table 3 provides the estimated crash costs associated with the two alternatives. These costs were estimated by multiplying the *HSM (Chapter 7)* estimated crash costs by severity and the predicted average crash rates for each crash type, as illustrated in the *HSM Case Study 3*.

- The cost = ROW acquisition, construction of proposed facility etc.
- The benefits = Monetary value of crashes reduced (The *HSM* provides the number of crashes that are reduced by the alternative.)

Table 3 | Estimated Crash Costs for Different Facility Types

Crash Type	4-Lane Divided	5-Lane with Center TWLTL
Multi-Vehicle	$1,492,000	$2,856,000
Single Vehicle	$155,000	$235,000
Driveways	$561,000	$3,337,000
Total	$2,208,000	$6,428,000

The Benefit/Cost Ratio is found by calculating the difference between the benefits and costs of each alternative. In this example, the difference in crash costs divided by the extra ROW costs, indicates the benefit/cost ratio to be 2.64 (shown in ***Table 4***). This shows that the expenditure of the extra funds for ROW is justified by the savings in crash costs over the 20-year period.

Table 4 | Benefit/Cost Ratio: 4-lane Divided to 5 lane Center Turn Lane

Cost Type	Cost	Cost Difference
4-Lane Crash Costs	$2,208,397	$4,219,132
5-Lane Crash Costs	$6,427,529	
4-Lane ROW Costs	$2,200,000	$1,600,000
5-Lane ROW Costs	$600,000	
	B/C =	2.64

$$\mathbf{B/C} = \frac{\boldsymbol{Societal\ Benefit}}{\boldsymbol{Additional\ Cost\ to\ Build}} = \frac{\mathbf{\$4,219,132}}{\mathbf{\$1,600,000}} = \mathbf{2.64}$$

Crash Modification Factors (CMF)

Another important element for predicting crashes are variables called *Crash Modification Factors (CMFs)*. CMFs represent the relative change in crash frequency after implementing a countermeasure to improve safety on a road or intersection.

The *HSM* and *FHWA's CMF Clearinghouse* provide numerous CMFs for practitioners to apply when analyzing access management treatments. Increasing the width of a median, installing a raised median, or installing or removing a driveway, are examples of the numerous CMFs that could affect the number of crashes along a roadway. The *CMF Clearinghouse* is updated regularly and is an excellent source to refer to when doing these calculations. ***Table 5*** below is based on *HSM* CMF's and illustrates the relative difference in crash reduction that can be achieved by consolidating driveway openings on a roadway. The roadway setting is for urban and suburban arterials.

Table 5 | HSM Access Management: Effects of Driveway Density

Urban and Suburban Arterials • Focus on Driveway Density; Reducing Driveways Reduces Crashes

Treatment	Setting (Road Type)	Traffic Volume	Crash Type (Severity)	% Reduction in Crashes
Reduce driveways from 48 to 26-48 per mile	Urban and suburban (Arterial)	Unspecified	All types (Injury)	29%
Reduce driveways from 26-48 to 10-24 per mile				31%
Reduce driveways from 10-24 to less than 10 per mile				25%

Note: Initial driveway density per mile based on values in this table (48, 26-48, and 10-24 per mile).

Source: Adapted from HSM Chapter 13.14: Access Management - Table 13-58

Median Safety Benefits to Pedestrians (Proven Safety Countermeasures)

Although medians have significant benefits for vehicular operations, they are also beneficial for pedestrians. Pedestrians are permitted to travel along all non-limited access facilities. Therefore, considerations for pedestrian safety and mobility should be included in median design decisions. Pedestrians are a "High" modal priority in context classifications C6, C5, C4 and C2T.

Two-Stage Crossing

For pedestrians to safely cross a roadway, they must estimate vehicle speeds, adjust their walking speed, determine gaps in traffic, and predict vehicle paths. Installing raised medians or pedestrian crossing islands can help improve safety by simplifying these tasks and allowing pedestrians to cross one direction of traffic at a time known as a two-stage crossing. The benefits from two-stage crossing are greater for elderly and less mobile pedestrians.

Nighttime Conditions

Under nighttime conditions, the crossing task is even more complex for pedestrians. Pedestrians are watching car headlights and it is more difficult to correctly judge the speed of, and distance to, approaching motor vehicles when only headlights are visible. Valuable cues used by pedestrians to judge speed, e.g., change in the observed shape of the approaching car and relative location with respect to roadside objects, are more difficult to observe at night. Variations in motor vehicle travel speeds add to the complexity of judging adequate gaps in traffic. Raised medians and refuge islands provide a space to install improved lighting at pedestrian crossing locations. Improved lighting has been shown to reduce the nighttime pedestrian fatalities at crossings by 78%.[1]

Delay Reduction

Raised medians and refuge islands also reduce the amount of delay incurred by pedestrians waiting for a gap in traffic to cross. Shorter delays translate into fewer pedestrians taking risks by crossing through "holes" in the traffic stream. On a four-lane roadway with 5,000 ADT, medians can reduce pedestrians' delay waiting for a gap by 79% (from 41 seconds to 9 seconds).[2]

1.3.2 Traffic Operational Benefits of Vehicular Access Management

The *TRB Access Management Manual* summarizes various studies related to the effects of vehicular access management on roadway traffic operation. These studies have assessed the influence of driveway spacing on travel time using a variety of analysis techniques. All the studies indicate that access management helps to increase capacity, maintain desired free-flow speed, and reduce delays. The studies conclude that vehicular access management preserves roadway efficiency.

Increasing the number of vehicle access points and signals along a roadway results in increased vehicular delay, and reduction in free-flow speed. Minimizing the number of traffic signals and promoting uniform signal spacing significantly improve travel times.

As illustrated in the *Highway Capacity Manual (HCM)* the free-flow speed (FFS) of a roadway is reduced as the vehicle access point density increases. Studies indicate that for each vehicle access point per mile, the estimated FFS decreases by approximately 0.25 mph, regardless of the type of median. The expected FFS reductions of multilane highway segments with the increase in vehicle access point density are shown in ***Table 6***.

Table 6 | Adjustment to FFS for Vehicle Access Point Density for Multilane Highways

Access Point Density (Access points/mile)	Reduction in Free Flow Speed (FFS) (mph)
0	0.0
10	2.5
20	5.0
30	7.5
>40	10

Source: HCM 7th Edition, Exhibit 12-24

1.3.3 Business/Economic Impacts of Access Management

Vehicular access management preserves the functional integrity of the state roadways which is essential for economic activity and economic development. A summary of research on the economic effects of vehicular access management is provided in the *TRB Access Management Manual*. The studies indicated that median projects generally have little overall adverse impact on

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[1] FHWA, Desktop Reference for Crash Reduction Factors, FHWA, Washington, DC, September 2007.

[2] NCHRP Report 616, Multimodal Level of Service Analysis for Urban Streets, TRB, Washington DC, 2008.

business activity. Business owner perceptions of potential impacts of changes in access tend to be much worse than the actual impacts.

In 2010, the North Carolina DOT published a study, *Economic Effects of Access Management Techniques in North Carolina*, that was conducted in response to business owner opposition to access management and a perception that access management applications would negatively affect profits. The study found no significant difference in revenue between comparison sites and treatment sites. Access management treatments, particularly the installation of medians, did not affect businesses as much as initially perceived. After completion of the project, the general perception by the business owners conceiving use of the medians was more favorable than before construction of the medians.

The *NCHRP Report 420, Impacts of Access Management Techniques*, reached the following conclusions regarding economic impacts:

> *The economic impacts of various median alternatives depend on the extent that access is improved, restricted, or denied. The impacts to specific establishments also depend on the type of activity involved and on background economic conditions.*
>
> *Where direct left tums are prohibited, some motorists will change their driving or shopping patterns to continue patronizing specific establishments. Some repetitive pass-by traffic will use well designed or conveniently located U-turn facilities. Impacts also will be reduced at locations where direct left-turn access is available. In some cases, retail sales may increase as overall mobility improves.*
>
> *The results of studies to date generally indicate that median projects have minimal adverse impact on business activity. Some businesses report increases in sales, some report no change, and others report decreases. Most of the businesses report no change in business activity after a median project.*
>
> *Destination type businesses, such as certain restaurants and specialty stores, appear to be less sensitive to access changes than businesses that rely primarily on pass-by traffic, such as gasoline stations or convenience stores. The likelihood of left turns into a business is known to decline as opposing traffic volumes increase; therefore, medians will have relatively little effect on the number of customers making left turns into a business on high-volume roadways or during peak travel periods.*

The *FDOT Access Management Brochure, Access Management Answers to your Business Questions*, states:

> *Access management does not impact the demand for goods and services. But, if access management is not implemented, businesses can be hurt by congested, high collision roadways near their entrances.*
>
> *Most businesses see no loss in business due to access management improvements. Customers favor access managed highways 4 to 1. Business owners report that the actual impacts to their properties were much less than they anticipated.*

U-turns are a safe alternative to direct left turns, and a study in Orlando shows customers do not find U-turns an inconvenience to access businesses.

In general, studies have found that access management modifications do not negatively impact businesses.

Multimodal access management considerations such as pedestrian and bicycle facilities to access business sites conveniently and safely will also increase customer base for the businesses. Especially, providing pedestrian and bicycle access to businesses such as restaurants, coffee shops, etc. from nearby residential areas and office buildings would significantly attract people to visit the businesses. People would be willing to visit the nearby businesses if they can walk or bike to the site easily without using their vehicles.

1.4 Context Classification and Access Management

The *FDOT Context Classification Guide* was first published in 2017 and updated in 2022 to provide guidance on determining context classifications along state highways. In ***Figure 5*** the spectrum of context land use zones is shown; they range from C1-Natural to C6-Urban Core. The user types and intensities expected in each context classification is illustrated in ***Figure 6***. These classifications are meant to provide planners and engineers with additional tools and criteria for designing roadways that function for all users. The roadway context classification is incorporated throughout the *FDM* and *FDM 200 - Context Based Design* provides details on the context classification system.

One of the measures used to determine context classification is the spacing of cross-street intersections. In general, higher context classifications like C2T, C4, C5, and C6 may require less restrictive access management. In these context classifications, frequent intersections, smaller blocks, and a higher degree of connectivity and access support the multimodal needs and character of the area. More restrictive median and connection spacing is typically found in C1, C2, C3C, C3R, and in some cases, C2T. The context land use classifications have been integrated into the current access management guidance.

Throughout *FDM 210 - Arterials and Collectors* there is guidance on how dimensions for medians and median openings are affected by the context classification. Low speed C5 or C6 roadways require different median treatments than high speed C2 or C3 arterials. ***Table 7*** illustrates the correlation of context classification and median location and design. *FDM 214 - Driveways* provides guidance on how driveway design is affected by the context classification. Low speed C4 or C5 roadways require different driveway designs than high speed C2 or C3 arterials. ***Table 8*** illustrates the correlation of context classification and driveway design.

These tables include proposed levels of “Modal Emphasis” (High, Medium, or Low) for each context classification for Car, Bicycle, Walking, Transit, and Truck modes.

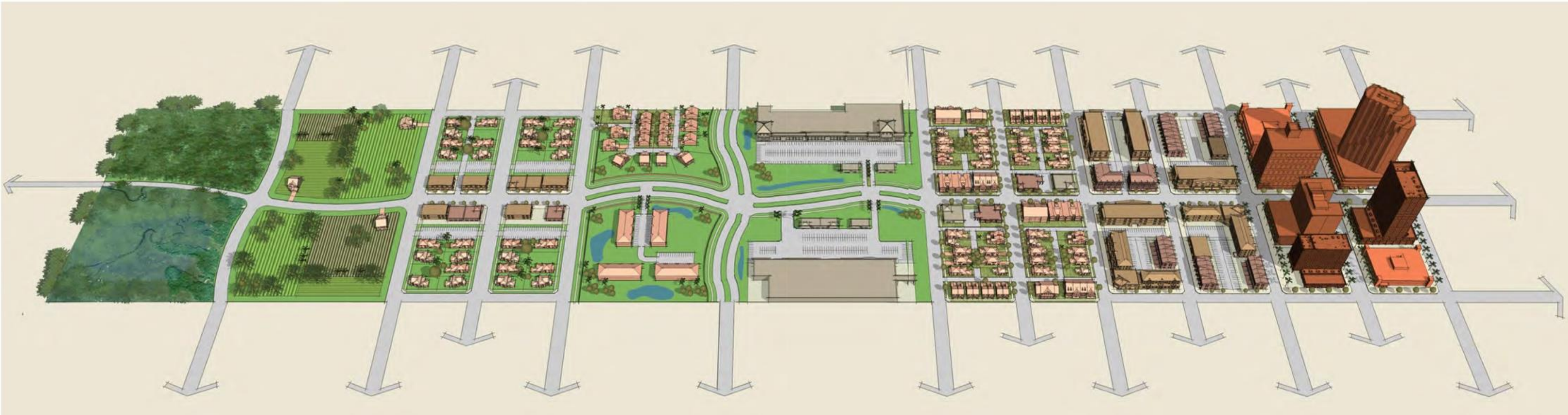
A "High" emphasis means this mode should be a primary consideration when designing access management interventions. The access management tools used should optimize for this mode first while continuing to support the other modes. For example, in a C5 downtown location, pedestrians are a "High" emphasis, so pedestrian crossing times and distances should be minimized, and pedestrian crossing opportunities should be maximized. Conversely, in a C2 Rural highway condition, the pedestrian mode is a "Low" emphasis and decisions are made to favor the movement of the Car and Truck modes, which are "High" emphasis in the C2 context classification.

A "Medium" emphasis means this mode should be expected and incorporated into the access management interventions as a matter of course. Special provisions for this mode should not be needed in normal operation.

A "Low" emphasis means that while this mode will be provided for and considered during the selection and implementation of the access management intervention, this mode may receive only the most general and basic provisions. The design and operation of the intervention will not necessarily be optimized for this mode and may entail lower speeds, longer crossing times, or similar trade-offs in favor of "High" or "Medium" priority modes.

Furthermore, other prevailing factors should be considered for roadways when determining modal emphasis. Such factors could include roadways located in industrial areas where high volumes of heavy vehicles are anticipated, or demographic and socioeconomic characteristics where there are higher volumes of walking and biking. Other overriding considerations could include high volumes of non-motorized users, a high number of crashes involving non-motorized users, the presence of existing or planned high-capacity transit, or specific higher demand facilities, such as an adjacent shared-use path or separated bike lanes.

Figure 5 | FDOT Context Classifications



C1-Natural
Lands preserved in a natural or wilderness condition, including lands unsuitable for settlement due to natural conditions.

C2-Rural
Sparsely settled lands; may include agricultural land, grassland, woodland, and wetlands.

C2T-Rural Town
Small concentrations of developed areas immediately surrounded by rural and natural areas; includes many historic towns.

C3R-Suburban Residential
Mostly residential uses within large blocks and a disconnected or sparse roadway network.

C3C-Suburban Commercial
Mostly non-residential uses with large building footprints and large parking lots within large blocks and a disconnected or sparse roadway network.

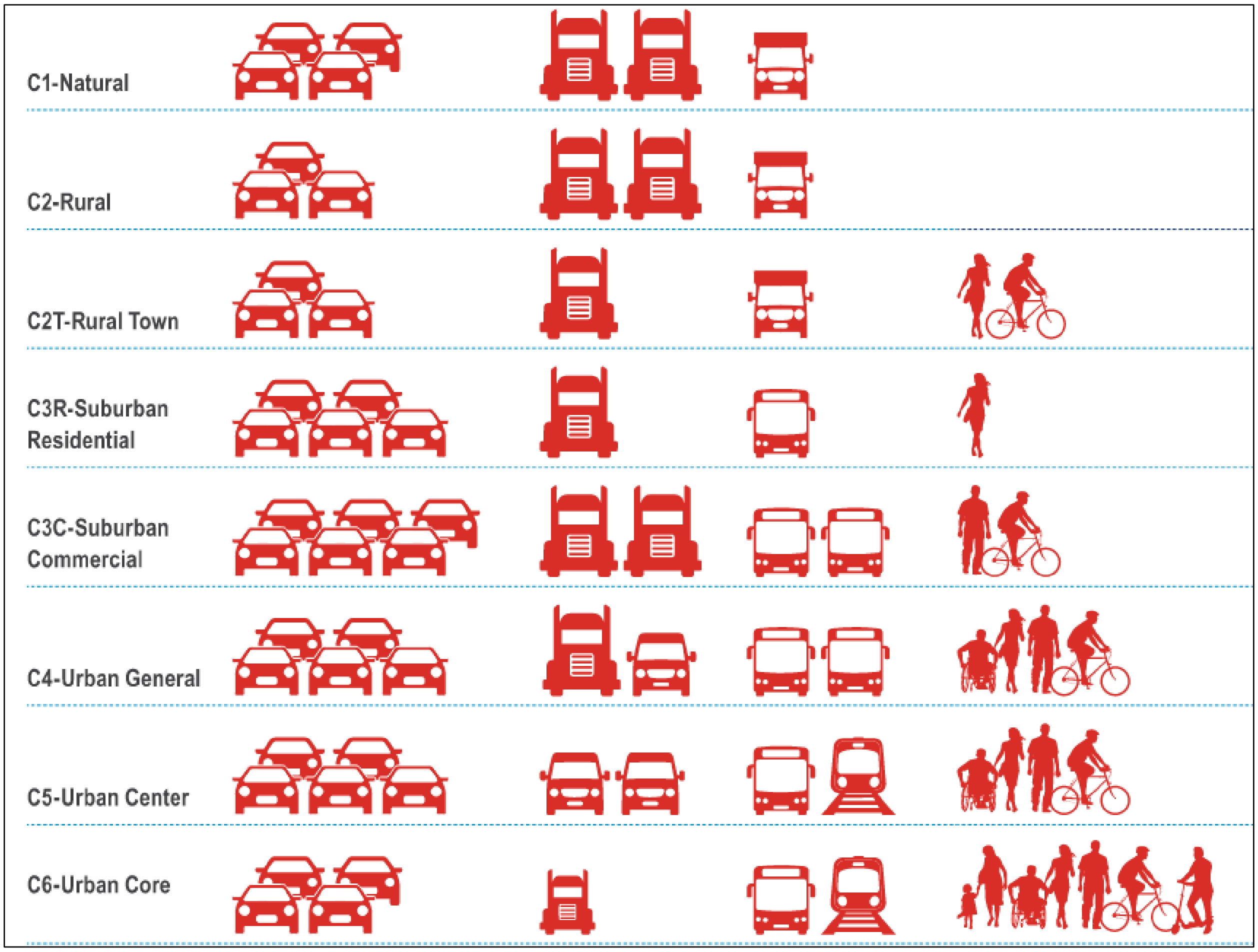
C4-Urban General
Mix of uses set within small blocks with a well-connected roadway network. May extend long distances. The roadway network usually connects to residential neighborhoods immediately along the corridor or behind the uses fronting the roadway.

C5-Urban Center
Mix of uses set within small blocks with a well-connected roadway network. Typically concentrated around a few blocks and identified as part of a civic or economic center of a community, town, or city.

C6-Urban Core
Areas with the highest densities and building heights, and within FDOT classified Large Urbanized Areas (population >1,000,000). Many are regional centers and destinations. Buildings have mixed uses, are built up to the roadway, and are within a well-connected roadway network.

Source: FDOT Context Classification Guide, Figure 5

Figure 6 | Expected User Types in Different Context Classifications



Source: FDOT Context Classification Guide, Figure 6

Table 7 | Context Classifications, Medians and Median Openings, and Modal Emphasis

Class	Characteristics By Mode	Relative Median Modal Emphasis By Context Classification					General Median Considerations
		CAR	BICYCLE	WALKING	TRANSIT	TRUCKS	
C1 Natural Access Class 2,3	Motor vehicles predominant, Occasional bicycle and pedestrian activity, occasional public transportation	High	Low	Low	Low	High	• Install medians on all major four-lane highways. • Provide turn lanes at all median openings • Retrofit continuous two-way left-turn lanes into restrictive medians
C2 Rural Access Class 2,3	Motor vehicles predominant, Occasional bicycle and pedestrian activity, occasional public transportation	High	Low	Low	Low	High	• Install medians on all major four-lane highways. • Provide turn lanes at all median openings • Retrofit continuous two-way left-turn lanes into restrictive medians
C2T Rural Town Access Class 4,5,6,7	Sidewalk paved from utility strip or in some cases the curb edge to face of building, shorter block sizes, higher pedestrian volumes, often on street parking	High to medium	Medium	High	Medium	Medium	• Install medians on all major four-lane highways leading into the rural town. • Provide left-turn lanes at all median openings • Based on expected traffic and speed, consider 3-lane section through the rural town with pedestrian refuge areas and other enhancements to the pedestrian environment to ensure visibility of pedestrians • Minimize extra driveways • Maintain sidewalks across driveway openings • Improve left turn conditions to side streets, especially parking and rear delivery entrances. • Assure safe, visible, and accessible midblock pedestrian crossings where warranted and signal spacing is greater than 660 feet • Preserve the existing street network and intersection spacing based on existing block sizes
C3R Suburban Residential Access Class 3	Bicycles and pedestrians present. Bus transit transportation is usually present. Entrances into subdivisions usually local street design	High	Medium	Medium	Medium	Medium	• Install medians on all major multi-lane highways. • Provide turn lanes at all median openings • Retrofit continuous two way left-turn lane sections into restrictive medians • Assure safe, visible, and accessible midblock pedestrian crossings where warranted and signal spacing is greater than 660 feet

Class	Characteristics By Mode	Relative Median Modal Emphasis By Context Classification					General Median Considerations
		CAR	BICYCLE	WALKING	TRANSIT	TRUCKS	
C3C Suburban Commercial Access Class 3	May include activity centers Bicycles and pedestrians present. Bus transit usually present	High	Medium	Medium	Medium	Medium to High	• Install medians on all major multi highways. • Provide turn lanes at all median openings • Retrofit continuous two way left-turn lane sections into restrictive medians. • Assure sufficient turning radii where large vehicles are frequent • Assure safe, visible, and accessible midblock pedestrian crossings where warranted and signal spacing is greater than 660 feet
C4 General Urban Access Class 4,5,6,7	Mix of uses within small blocks, well- connected roadway network, some blocks may extend long distances, Road network usually connects to residential neighborhoods along the corridor or behind	High	Medium	Medium to high	Medium to high	Medium to High	• Install medians on all major multi highways. • Provide left-turn lanes at all median openings • Retrofit continuous two way left-turn lane sections into restrictive medians with pedestrian refuge areas. • Assure sufficient turning radii at median openings where large vehicles are frequent • Assure safe, visible, and accessible midblock pedestrian crossings where signal spacing is greater than 660 feet • Preserve the existing street network and intersection spacing based on existing block sizes
C5 Urban Center Access Class 4,5,6,7	Connected buildings, sidewalk paved from curb to building face, shorter blocks, high pedestrian volumes, high bicycle volumes and bike-share possible, high bus volumes, possible rail or BRT, motor vehicle traffic congested during peak hours	Medium to low	Medium to high	High	High	Medium	• Block sizes in these sections should be sufficiently short to not require separate midblock pedestrian crossings. • Assure safe, visible, and accessible midblock pedestrian crossings where warranted and signal spacing is greater than 660 feet • Preserve the existing street network and intersection spacing based on existing block sizes
C6 Urban Core Access Class 4,5,6,7	Connected buildings, sidewalk paved from curb to building face, shorter blocks, high pedestrian volumes, high bicycle volumes and bike-share possible, high bus volumes, possible rail or BRT, motor vehicle traffic congested during peak hours	Medium to low	Medium to high	High	High	Medium	• Block sizes in these sections should be sufficiently short to not require separate midblock pedestrian crossings. • Assure safe, visible, and accessible midblock pedestrian crossings where warranted and signal spacing is greater than 660 feet • Preserve the existing street network and intersection spacing based on existing block sizes

Source: FDOT

Table 8 | Context Classifications, Driveways, and Modal Emphasis

Class	Characteristics By Mode	Relative Driveway Modal Emphasis By Context Classification					General Driveway Considerations
		CAR	BICYCLE	WALKING	TRANSIT	TRUCKS	
C1 Natural Access Class 2,3	Motor vehicles predominant, occasional bicycle and pedestrian activity, occasional public transportation	High	Low	Low	Low	High	• Wide turning radius and width necessary for multi-unit tractor trailer when present. Extra width needed to accommodate single direction only
C2 Rural	Motor vehicles predominant, occasional bicycle and pedestrian activity, occasional public transportation	High	Low	Low	Low	High	• Wide turning radius and width necessary for the design vehicle only in one direction
C2T Rural Town	Sidewalk paved from utility strip or in some cases the curb edge to face of building, shorter block sizes, higher pedestrian volumes, often on-street parking	Medium	Medium	High	Low	Medium	• Minimize the number of driveways to create a consistent pedestrian environment. • When driveways are built, the first principle is to keep the sidewalk level across the driveway space. The second is that the flare or apron not cross the sidewalk zone. This establishes that the driver is now entering a pedestrian environment. Other driveway design elements should consider bicycle and pedestrian use such as turning radii, driveway width, angle, separators, islands, and length. • Vehicular access should be through the side and back. • FDOT should reinforce local network connectivity for access/ accessibility (e.g., blocks and local streets). • Reduce the number of driveways through shared or consolidated driveways and cross-access between properties.
C3R Suburban Residential	Bicycles and pedestrians present. Bus service common. Entrances into subdivisions usually of local street design	High	Medium	Medium	Medium	Medium	• Medium turning radii in neighborhoods with attention paid to the pedestrian environment through the use well marked crosswalks. • Consider the use of small sized radii, and the use of a reinforced textured raised surface to allow off-tracking of typical multi-unit tractor trailers when present.
C3C Suburban Commercial Access Class 3	May also include activity centers. Bicycles and pedestrians present. Bus service common.	High	Medium	Medium	Medium	Medium to High	• Wide turning radius and width necessary for multi-unit tractor trailers when present. Extra width maybe needed to accommodate two movements exiting and entering at the same time, especially in industrial areas. • Consider the use of small sized radii, and the use of a reinforced textured raised surface to allow off-tracking of typical multi-unit tractor trailers when present.
C4 General Urban	Mix of uses within small blocks. Well- connected roadway network. Some blocks may extend long distances. Road	Medium	Medium	High	Medium to High	Medium	• Small to medium-sized radii on driveways. • Consider the use of small sized radii, and the use of a raised reinforced textured surface to allow off-tracking to the typical multiunit tractor trailer. • When driveways are built, the first principle is to keep the

Class	Characteristics By Mode	Relative Driveway Modal Emphasis By Context Classification					General Driveway Considerations
		CAR	BICYCLE	WALKING	TRANSIT	TRUCKS	
	network usually connects to residential neighborhoods along the corridor or behind.						sidewalk level across the driveway space. The second is that the flare or apron not cross the sidewalk zone. This establishes that the driver is now entering a pedestrian environment. Other driveway design elements should consider bicycle and pedestrian use such as turning radii, driveway width, angle, separators, islands, and length. • FDOT should reinforce local network connectivity for access/ accessibility to support rear or side entrances and exits (e.g. blocks and local streets). • Reduce the number of driveways through shared or consolidated driveways and cross-access between properties.
C5 Urban Center	Connected buildings, sidewalk paved from curb to building face, shorter blocks, high pedestrian volumes, high bicycle volumes and bike-share possible, high bus volumes, possible rail or BRT, motor vehicle traffic congested during peak hours	Medium to Low	Medium to High	High	High	Medium	• Minimize the number of driveways to create a consistent pedestrian environment. • When driveways are built, the first principle is to keep the sidewalk level across the driveway space. The second is that the flare or apron not cross the sidewalk zone. This establishes that the driver is now entering a pedestrian environment. Other driveway design elements should consider bicycle and pedestrian use such as turning radii, driveway width, angle, separators, islands, and length. • Vehicular access should be through the side and back of developments. • FDOT should reinforce local network connectivity for access/ accessibility to support rear or side entrances and exits (e.g. blocks and local streets). • Reduce the number of driveways through shared or consolidated driveways and cross-access between properties.
C6 Urban Core	Connected buildings, sidewalk paved from curb to building face, shorter blocks, high pedestrian volumes, high bicycle volumes and bike-share possible, high bus volumes, possible rail or BRT, motor vehicle traffic congested during peak hr.	Medium to Low	Medium to High	High	High	Medium	• Minimize the number of driveways to create a consistent pedestrian environment. • When driveways are built, the first principle is to keep the sidewalk level across the driveway space. The second is that the flare or apron not cross the sidewalk zone. This establishes that the driver is now entering a pedestrian environment. Other driveway design elements should consider bicycle and pedestrian use such as turning radii, driveway width, angle, separators, islands, and length. • As much as possible, large vehicle access should be through the side and back of developments. FDOT should reinforce local network connectivity for access/ accessibility (blocks, local streets) • Reduce the number of driveways through shared or consolidated driveways and cross-access between properties.

Source: FDOT

Chapter 2: Roadway Openings

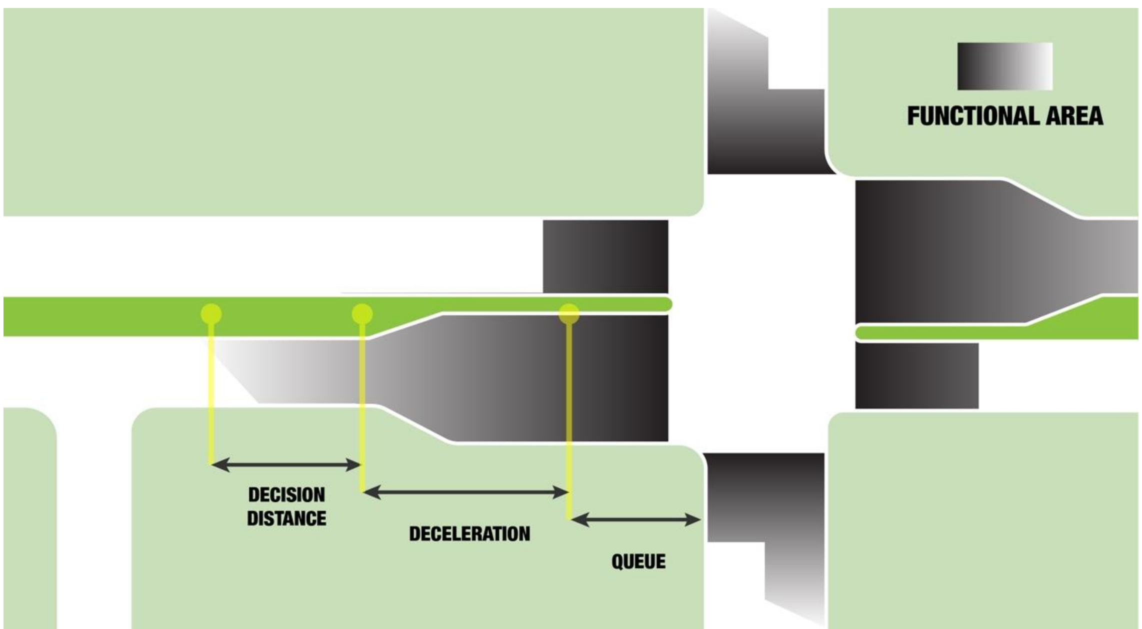
2.1 Overview

This chapter focuses on the various roadway design elements of access management such as driveways and median openings. Understanding these roadway design elements is imperative for designing safe and efficient roadway system per FDOT policies.

To properly discuss the impacts of medians and driveways on roadway traffic, reference is made to the functional area of an intersection. The functional area can be described simply as the area beyond two intersecting roadways where vehicle movements are affected by the intersection.

To prevent conflicts, vehicular traffic from roadway openings should not interact with the functional area of an intersection (See ***Figure 7***).

Figure 7 | Functional Area of an Intersection



Source: FDOT

2.2 Driveways

As defined by the American Association of State Highway and Transportation Officials (AASHTO), and the FDM;

> *"A driveway is an access constructed within a public ROW connecting a public road with adjacent property."*

It is also important to note that within other FDOT manuals, handbooks, and guides, driveways are at times referred to as "connection(s)" or "turnouts."

Driveways provide a physical transition between a property and the abutting roadway and thus are one of the most common roadway design elements. They should be located and designed to minimize impacts on roadway traffic while providing safe access to and from developments. The location and design of the connection must consider characteristics of the roadway, the geographic site, context classification, and the potential users. More information on these considerations will be discussed in later chapters.

2.2.1 Driveway Categories and Designs

The following sections describe how FDOT categorizes driveway design, which is influenced by roadway type such as "Urban," where shoulders are constructed with a curb and gutter design, or "Rural," where a flush shoulder design is used.

Categories

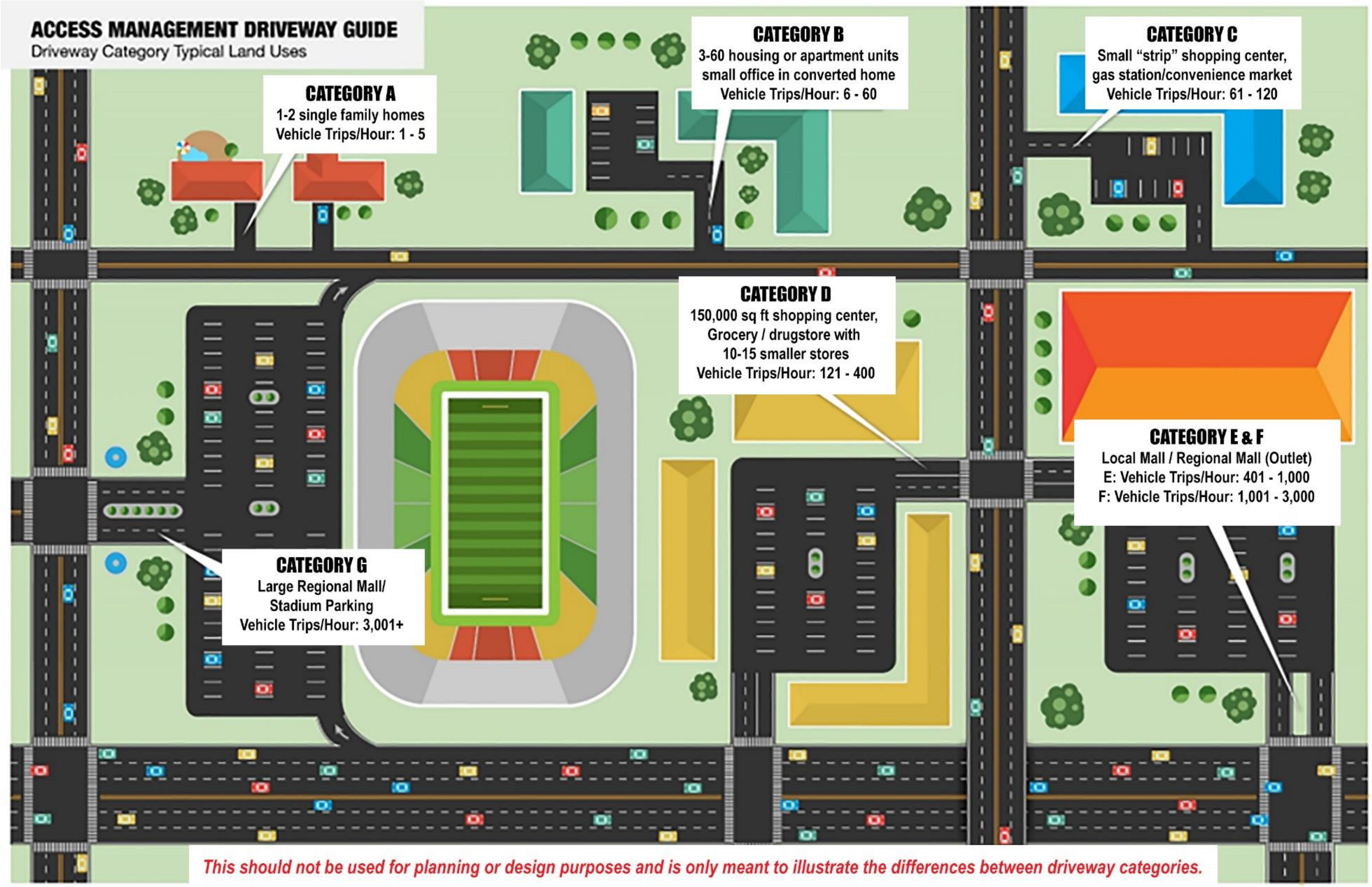
The FDOT defines driveways into seven main categories; A, B, C, D, E, F, and G. These categories are based upon the number of vehicle trips per day (vpd) or vehicle trips per hour (vph) that they are meant to serve (See ***Table 9***). This ultimately leads to differences in the width and number of lanes that these driveways typically require (See ***Figure 8***). *FDM 214 – Driveways* includes considerations and requirements for the design of driveways defined as connection categories A, B, C, or D. Connection categories E, F, and G are designed as intersections in accordance with *FDM 212 – Intersections*.

Table 9 | Connection (Driveway) Category Criteria

Driveway Category	Vehicle Trips per Day (vpd)	Vehicle Trips per Hour (vph)	Typical Land Uses
A	1 – 20	1 – 5	1 or 2 single family homes
B	21 – 600	6 – 60	3 to 60 housing or apartment units. Small office in converted home.
C	601 – 1,200	61 – 120	Small "Strip" shopping center (20-75,000 square feet)
D	1,201 – 4,000	121 – 400	150,000 square feet shopping center Grocery/drugstore with 10-15 smaller stores
E	4,001 – 10,000	401 – 1,000	Local Mall Wholesale Club
F	10,001 – 30,000	1,001 – 3,000	Regional Mall (Outlet)
G	30,001+	3,001	Large Regional Mall

Source: FDOT

Figure 8 | Driveway Categories



Source: FDOT

Category A Driveways

This category includes driveways that serve a low amount of vehicular traffic and is generally associated with land uses such as single-family home or small businesses. (See ***Table 9***.) Typically, there are 1 – 20 vpd or 1 – 5 vph in a driveway for this category and only the minimum requirements are necessary for designing this type.

Category B Driveways

This category includes driveways that serve a moderate amount of vehicular traffic and is generally associated with land uses such as apartment complexes and small office buildings or commercial properties. Typically, there are 21 – 600 vpd or 6 – 60 vph in a driveway for this category. Design standards will vary for these driveways and may require larger radial returns or turn lanes depending on the site and context classification.

Category C Driveways

This category is reserved for driveways that serve a moderate to significant amount of vehicular traffic for land uses such as small strip shopping centers and convenience stores. Typically, there are 601 – 1,200 vpd or 61 – 120 vph in a driveway for this category. An example of this would be a small to medium sized shopping center, or a strip mall. Design standards will vary for these driveways and may require larger radial returns or turn lanes depending on the site and context classification.

Category D Driveways

This category includes driveways that serve a significant amount of vehicular traffic. These types of driveways should be designed as if they are an intersecting side street and should meet all local government requirements for streets as well. Typically, there are 1,201 – 4,000 vpd or 121 – 400 vph in a driveway for this category with land uses that are similar to a large commercial property with multiple smaller properties utilizing the same driveway. An example of this would be a larger grocery store with other retail or commercial stores next to it.

Category E Driveways

Category E driveways that serve a greater amount of vehicular traffic than Category D and are designed similarly but typically accommodate 4,001 – 10,000 vpd or 401 – 1,000 vph. Land uses are similar to a large commercial property with multiple smaller properties utilizing the same driveway such as a larger grocery store with other retail or commercial stores next to it.

Category F Driveways

Category F driveways that serve a greater amount of vehicular traffic than Category E and are designed similarly but typically accommodate 10,001 – 30,000 vpd or 1,001 – 3,000 vph.

Category G Driveways

Category G driveways that serve a greater amount of vehicular traffic than Category F and are designed similarly but typically accommodate over 30,000 vpd or over 3,000 vph. An example land use of this category would be a large sports stadium or a larger regional mall.

2.2.2 Driveway/Connection Permit

A driveway permit is required for new driveways or existing driveways with a significant change in the use or expansion of the property. "Significant change" means a change in the use of the property, including land, structures or facilities, or an expansion of the size of the structures or facilities causing an increase in the trip generation of the property exceeding 25% more trip generation (either peak hour or daily) and exceeding 100 vehicles per day more than the existing use according to the *Significant Change F.S. 335.182(3)(b)*. This is an important point of the rule that assists the Department in bringing access connections into compliance.

The driveway permit application shall be submitted electronically at One Stop Permitting: *https://osp.fdot.gov*, or be mailed or delivered to the Department's District Permits Office or to the Department's District Maintenance and Field Offices.

FDOT reviews of connection permits should be consistent with *F.S. 334.044* and *F.S. 335.181-188*.

Table 10 | Key Florida Statutes Governing Connection Permits

Statute / Rule	Title	Description
F.S. 334.044	Transportation Administration	Powers and duties of the department
F.S. 335.181	State Highway System (SHS)	Regulation of access to SHS; legislative findings, policy and purpose
F.S. 335.182		Regulation of connections to roads on SHS; definitions
F.S. 335.1825		Access permit required; authority to close unpermitted connections
F.S. 335.183		Permit application fee
F.S. 335.184		Access permit review process by the department; permit denial; justification; administrative review
F.S. 335.185		Permit conditions; expiration
F.S. 335.187		Unpermitted connections; existing access permit; nonconforming permits; modification & revocation of permits
F.S. 335.188		Access management standards; access control classification system; criteria

Key statements and provisions from the Florida Statutes:

> *"The department shall have the following general powers and duties: … (14) To establish, control, and prohibit points of ingress to, and egress from, the State Highway System, the turnpike, and other transportation facilities under the department's jurisdiction as necessary to ensure the safe, efficient, and effective maintenance and operation of such facilities." [F.S. 334.044]*
>
> *"Regulation of access to the State Highway System is necessary in order to protect the public health, safety, and welfare, to preserve the functional integrity*

of the State Highway System, and to promote the safe and efficient movement of people and goods within the state.” [F.S. 335.181(1)(a)]

“Every owner of property which abuts a road on the State Highway System has a right to reasonable access to the abutting state highway but does not have the right of unregulated access to such highway. The operational capabilities of an access connection may be restricted by the department. However, a means of reasonable access to an abutting state highway may not be denied by the department, except on the basis of safety or operational concerns as provided in F.S 335.184.” [F.S. 335.181(2)(a)]

“The access rights of an owner of property abutting the State Highway System are subject to reasonable regulation to ensure the public’s right and interest in a safe and efficient highway system. This paragraph does not authorize the department to deny a means of reasonable access to an abutting state highway, except on the basis of safety or operational concerns as provided in F.S. 335.184. Property owners are encouraged to implement the use of joint access where legally available.” [F.S. 335.181(2)(b)]

“Any person seeking an access permit shall file an application with the department in the district in which the property for which the permit being requested is located. The department, by rule, shall establish application form and content requirements. The fee as required by F.S. 335.183, must accompany the application.” [F.S. 335.184(1)]

“A property owner shall be granted a permit for an access connection to the abutting state highway, unless the permitting of such access connection would jeopardize the safety of the public or have a negative impact upon the operational characteristics of the highway. Such access connection and permitted turning movements shall be based upon standards and criteria adopted, by rule, by the department.

In making the determination of whether to deny access to an abutting property owner, the department may consider, but is not limited to considering:

- *The number or severity of traffic accidents occurring on the segment of the highway to which access is sought, and the impact thereon from providing such access;*
- *The operational speed on the segment of the highway to which such access is sought and the level and amount of deceleration which such access would cause;*
- *The geographic location of the segment of the highway to which such access is sought;*
- *The operational characteristics of the segment of the highway to which such access is sought and the impact thereon from providing such access; or*
- *The level of service of the segment of the highway to which such access is sought and the impact thereon from providing such access.” [F.S. 335.184(3)]*

> *"The department may issue a nonconforming access permit after finding that to deny an access permit would leave the property without a reasonable means of access to the State Highway System. The department may specify limits on the maximum vehicular use of the connection and may be conditioned on the availability of future alternative means of access for which access permits can be obtained." [F.S. 335.187(3)]*

There are several rules within the *F.A.C.* which influence how driveways and median openings are designed, regulated, and enforced on the Florida State Highway System. All new driveways associated with a new or expanded development must be permitted in accordance with *Rule Chapter 14-96 F.A.C. (State Highways System Connection Permits)*. Permit applications must also be consistent with *Rule Chapter 14-97 F.A.C. (State Highways System Access Control Classification System and Access Management Standards)*.

Per *Rule Chapter: 14-96.003 F.A.C.*, it states that:

> *Connection permits authorize the initiation of construction of connections within Department right of way and the maintenance of connection(s) according to the permit provisions and adopted department standards. It is the responsibility of the applicant or permittee to obtain any other local permits or other agency approvals that may be required before the initiation of the connection construction. No person may construct, relocate, or alter a connection temporarily or permanently without first obtaining a connection permit from the Department, as provided in this rule chapter, regardless of governmental entity permits and approvals.*

Per *Rule Chapter: 14-97.003(3)(e) F.A.C.*, it states that:

> *Adjacent properties under common ownership shall be considered one parcel for purposes of this rule. Persons requesting connections for one or more adjacent properties under common ownership may, however, as a part of the Rule Chapter 14-96, F.A.C., permit process, request that the properties be considered individually for connection permitting purposes. Such requests shall be included as part of the permit application and shall provide specific analyses and justification of potential safety and operational hazards associated with the compatibility of the volume, type or characteristics of the traffic using the connection.*

Pre-Application Meeting

A driveway permit pre-application meeting is essential to establish a clear understanding of the site development project and develop the traffic impact study requirements and methodology as part of the permit application. The meeting also helps to identify the potential roadway, intersection, and multimodal improvements that should be evaluated associated with the site development.

Per *Rule Chapter: 14-96.005 F.A.C.*, it states that:

> *Prior to submitting an application for a Category C, D, E, F, or G connection permit the Applicant is required to request a pre-application meeting with the Department to review the site plan, establish the connection category, and identify required documentation and traffic study requirements. Upon request,*

the Department will meet with the Applicant, on-site and/or in-office, to discuss the project, projected impacts to the State Highway System, and the suggested methodology for the analysis of traffic impacts.

Traffic Control Features and Devices in the State Right of Way

The existing traffic control features and devices, such as traffic signals, median openings, turn lanes, etc., along the roadway should not be used as part of site development or driveway permit application for providing development site access without FDOT review and approval.

Per *Rule Chapter: 14-96.003 F.A.C.*, it states that:

> *Traffic Control Features and Devices in the right of way, such as traffic signals, medians, median openings, and turn lanes are operational and safety characteristics of the State Highway System and are not means of access.*
>
> *The Department may install, remove, or modify any present or future traffic control feature or device in the right of way to promote traffic safety in the right of way or promote efficient traffic operations on the highway.*
>
> *A connection permit is only issued for connections and not for any present or future traffic control features or devices at or near the permitted connections.*

Driveway Intersections

The Intersection Control Evaluation (ICE) process evaluates different intersection control scenarios using metrics such as safety, operations, cost, and social, environmental, and economic impacts. This "performance-based" approach allows for a transparent and consistent evaluation of alternatives, resulting in selecting the best-performing option. An Intersection Control Evaluation (ICE) *Form 750-010-30* is required for a Category E, F, or G Connections/Driveways or when an applicant proposes a connection permit with:

(a) New intersection signalization except for signalization at a midblock crosswalk.

(b) Major reconstruction of an existing signalized intersection (e.g., adding a left-turn lane for any approach, adding an intersection leg).

(c) Changing a directional or bi-directional median opening to a full median opening.

(d) District Design Engineer (DDE) and/or District Traffic Operations Engineer (DTOE) consider an ICE a good fit for the project.

The *FDOT Manual on Intersection Control Evaluation (FDOT ICE Manual)* must be used when designing driveways in these categories. Further discussion on FDOT ICE process is provided in ***Chapter 8: Intersection Control Evaluation (ICE) and Alternative Intersections***.

Local Government Partnerships

The connection permitting process is more efficient and streamlined when the local government partner understands and can enforce site requirements, even before the permitting stage. For example, a traffic impact analysis that was completed, as required by the local government for local government review, or during a previous Comprehensive Plan Amendment (CPA), may not satisfy the Department's criteria for a connection permit. For that reason, early coordination on potential site development projects with local governments and developers is important to avoid the need for multiple studies. FDOT can help guide the site planning process and requirements more effectively when information is provided early in the development planning stage. An example of this type of partnership is some local governments will not issue a Development Order (DO) without having current buy-in and approval from FDOT, including driveway connection permit approval(s). FDOT can help guide the site planning process, and inform developers of requirements more effectively when information is provided early in the development planning stage. For example, some local governments will not issue a Development Order (DO) without having current buy-in and approval from FDOT, including driveway connection permit approval(s).

Developer Incentives

There are many incentives for developers associated with early coordination. With early coordination, a developer will ideally understand study requirements and potential access, traffic operations, and safety concerns early on, such as during the CPA phase or earlier, when a better site plan that will best attract and serve customers can be achieved, which optimizes access and maximizes safety performance. Early coordination will provide ample time and opportunity to make any required changes to a site plan earlier than later during the permitting process, when changes can be more difficult and costly to make. Finally, this early coordination allows the developer to understand, plan for, mitigate, or even avoid potential impacts on the transportation system.

2.2.3 Driveway Design and Roadway Types

There are two types of driveways used when connecting to the State Highway System (SHS); the radial return design and the flared design. The type of design is based upon whether the roadway is curbed or has a flush shoulder, as well as the driveway category itself (See ***Figure 9***, ***Figure 10***, and ***Figure 11*** for examples of a curbed or flush shoulder).

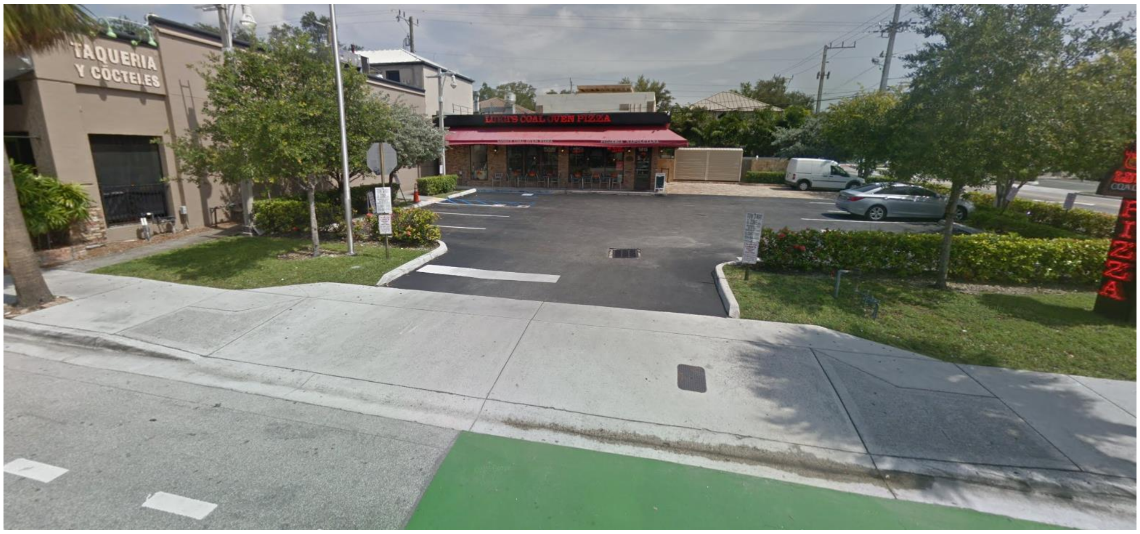
Figure 9 | Flush Shoulder Roadway (Radial Return)

Source: Brandon, FL – Google Earth

Figure 10 | Curbed Roadway (Radial Return)

Source: Pompano Beach, FL - Google Earth

Figure 11 | Curbed Roadway (Flared Return)



Source: Fort Lauderdale, FL – Google Earth

Typically, on curbed roadways, a flared driveway is used when the driveway traffic volume does not exceed 600 vpd. This is applicable for driveway categories A and B. For driveways that exceed 600 vpd, (category C and D) a radial return radius design is more appropriate (See ***Table 11*** for further details). For roadways with a flush shoulder, a radial return is the most appropriate driveway design.

Table 11 | Driveway Type Guidance

Element Description	Connection Category		
	A	B 2-Way	C and D 2-Way
Curbed Roadways	Flared	Flared	Radius
Flush Shoulder Roadways	Radius	Radius	Radius

Notes:

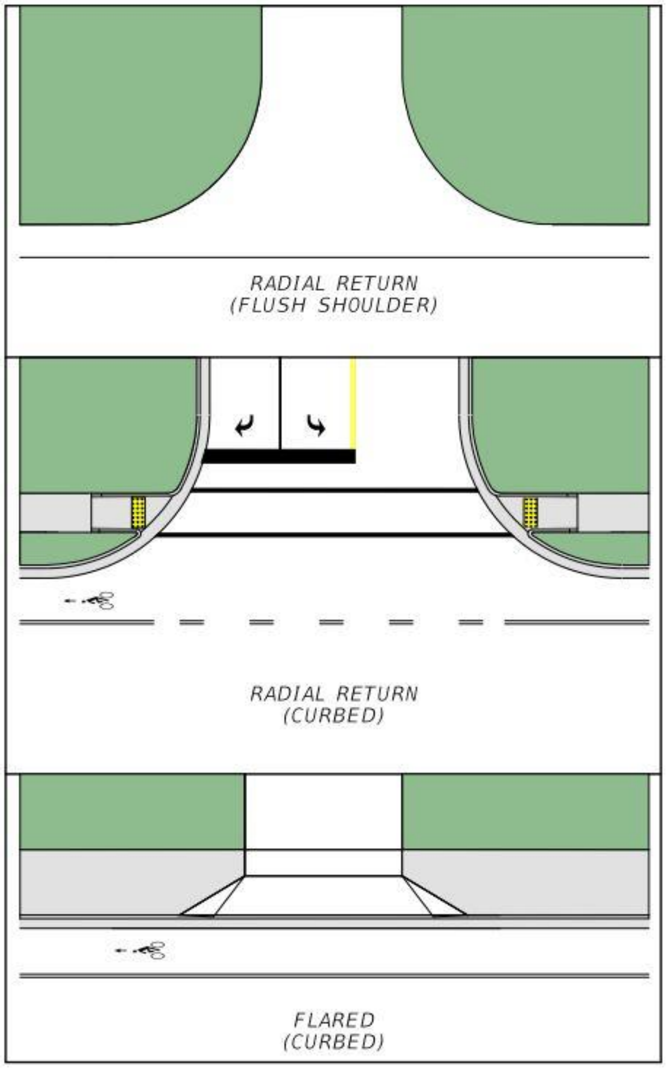
1. Connection Categories A, B, C, and D are defined in *FDM 214.1.1.*
2. Small radii may be used in lieu of flares for curbed roadways with Category B Connections when approved by the Department.

Source: FDM 214 – Driveways (Table 214.2.1)

A comparison of the driveway and shoulder types can be found in the *FDM 214 – Driveways* (See ***Figure 12***). These designs impact vehicles entering and exiting sites, with larger radial return type allowing for higher speeds. Other considerations for driveway design are:

- Design speed of roadway
- Driveway traffic volume
- Entry and exit movements (e.g., one-way, two-way, right-in/right-out)
- Available ROW
- Design vehicle
- Non-motorized users
- Context classification

Figure 12 | Comparison of Driveway Types



Source: FDM 214 – Driveways (Figure 214.2.1)

Additional information on design specifics is discussed in ***Chapter 4: Driveway Dimensions*** of this guidebook.

2.3 Medians and Median Openings

A Median is a traffic control feature or device that is the portion of a highway separating vehicular traffic travelling in opposite directions. A Restrictive Median is the portion of a divided highway physically separating vehicular traffic travelling in opposite directions. A Non-Restrictive Median is a median or painted centerline which does not provide a physical barrier between center traffic turning lanes or traffic lanes travelling in opposite directions.

Restrictive medians and well-designed median openings are a key component of access management. Raised or restrictive medians can be paved or landscaped areas that separate vehicular traffic. The documented benefits of raised medians are so significant that FDOT requires a raised or restrictive median on divided roadways with a design speed of 45 mph or greater, per

FDM 210 – Arterials and Collectors. Medians should be installed whenever possible on multilane arterial roadways.

By reducing conflicts, medians allow vehicular traffic to move more freely on a roadway. Additional conflict points that exist when a roadway has no median can lead to potential safety issues (Refer back to ***Figure 1***). Medians provide safety benefits to those traveling on the roadway, as well as non-motorized users and can improve the overall aesthetics of an area. The design and placement of median openings is essential in managing access and minimizing conflicts.

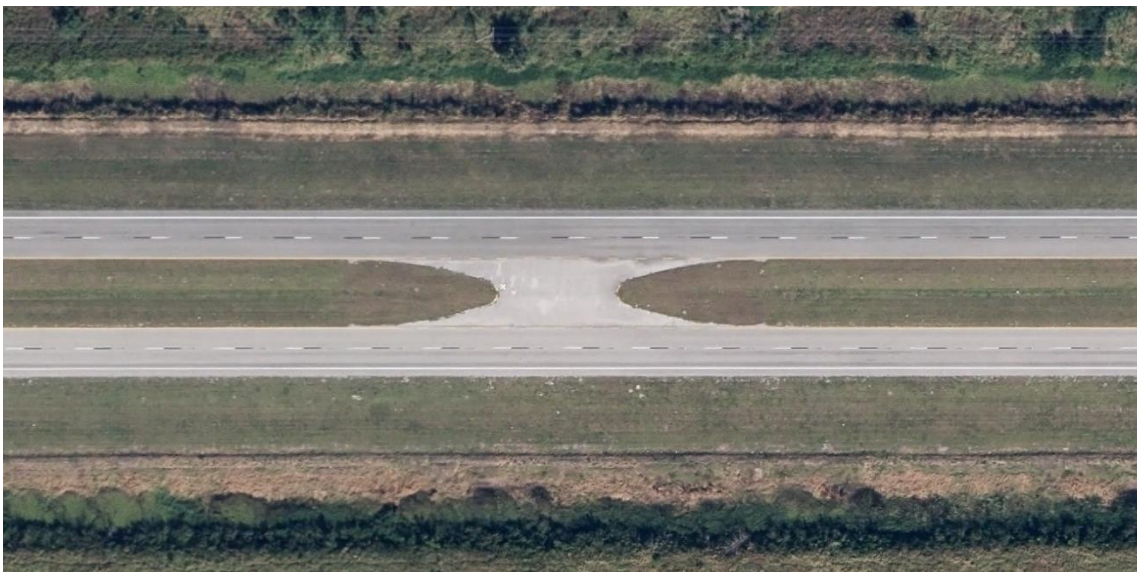
2.3.1 Median Opening Types

There are two main types of restrictive median openings; full and directional (See ***Figure 13*** and ***Figure 14***, respectively). Both provide specific benefits but should be installed depending on the local roadway conditions.

Full Median Openings

Full median openings provide fewer restrictions for vehicles and allow for a range of vehicular movements to occur (See ***Figure 13)***.

Figure 13 | Example of a Full Median Opening



Source: Moore Haven, FL – FDOT APLUS

Vehicles can make several movements when a full median opening is installed. Vehicles from the travel lanes can enter from either direction to make left turns onto other streets or driveways or make a U-turn (depending on the local conditions). Vehicles from driveways may also enter them to complete a left turn. Full median openings are usually located at:

- Signalized intersections or those expected to be signalized
- Intersections that conform to the adopted median opening spacing interval or are separated from neighboring median openings, to avoid interfering with the deceleration, queuing, or sight distance of the full opening
- Divided roadways where the traffic patterns allow left turns and crossing maneuvers from the intersecting access connection to be made with little delay

- Locations with adequate sight distance for:
  - Drivers to observe activity at the median opening and to proceed without decelerating if the median opening is unoccupied
  - A driver to complete a left turn into the roadway without interference with traffic on the roadway

Directional Median Openings

Directional median openings are designed to restrict certain traffic movements. The main characteristic of a directional median opening is that vehicular traffic from the cross streets cannot conduct left turns or cross the arterial. The only movements allowed are right turns onto the arterials (See ***Figure 14***).

Figure 14 | Example of a Dual Directional Median Opening

Source: Clearwater, FL – FDOT APLUS

2.4 Locating Roadway Openings

This section focuses on the Florida Administrative Code standards and FDOT regulating procedures for locating the roadway openings which were identified within this chapter. Driveways and median openings have specific geometric requirements, which are based upon the number of trips expected per hour and/or day.

2.4.1 Functional Area

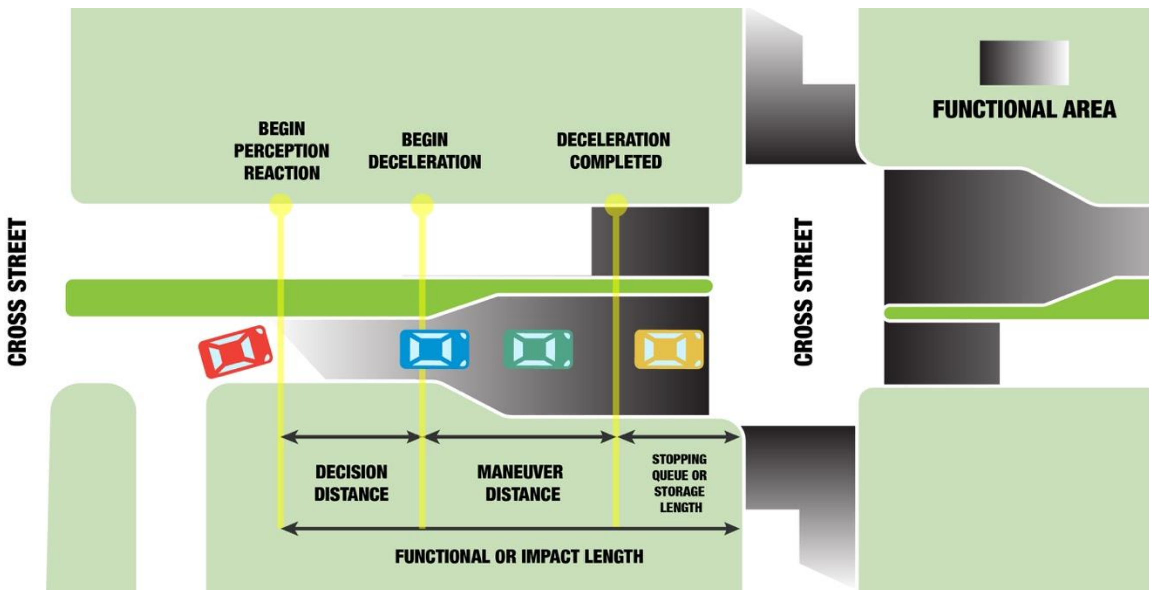
To properly discuss the impacts of medians and driveways on the transportation system, the following background information on the functional area of an intersection is provided below. The functional area can be described simply as the area beyond two intersecting roadways where vehicle movements are affected by the intersection (See ***Figure 15***). This area is further broken down into three basic elements where drivers prepare to enter the intersection.

Connection spacing standards and corner clearance standards are the tools used to protect this functional area from median openings and driveway traffic.

The intersection functional area consists of three basic elements:

- Distance traveled during decision time
- Maneuver-deceleration distance
- Queue-storage distance

Figure 15 | Functional Area Diagram



Source: FDOT

2.5 Driveway and Median Opening Spacing Standards

The context-based standards for driveway and median spacing are found in *Rule Chapter: 14-97.003 F.A.C. (Access Control Classification System and Access Management Standards)*. These standards are also included in *FDM 201 – Design Controls* and are based on the roadway access management class (See ***Table 12***). Access Class is a classification category assigned to a roadway reflecting the intended type of movement, mix of modes, and roadway network support provided by the roadway. It defines the allowable median type, median opening spacing, driveway spacing, and signal spacing.

Access Class 1 consists of limited access facilities; these are roadways that do not provide direct property connections. These roadways provide for high speed and high-volume traffic movements serving interstate, interregional, and intercity, and, to a lesser degree, intracity, travel needs. Interstate highways and Florida's Turnpike are typical of this class. The interchange spacing standards, based on the Area Type the highway is passing through, are for the through lanes or main line of the facility. New interchanges to Access Class 1 facilities shall be based on an engineering analysis of the operation and safety of the system. These interchanges can only be approved through the interchange justification process. Approval by the Department and FHWA is required before any new interchange is constructed.

Access Classes 2 through 7 consist of controlled access facilities and are arranged from the most restrictive (Access Class 2) to the least restrictive (Access Class 7) class based on development patterns as generally described through Context Classification. The context classification system describes the general characteristics of the land use, development patterns, and roadway connectivity along a roadway, providing cues as to the types of uses and user groups that will likely utilize the roadway. Context classification is based, in part, on the characteristics and spacing of cross-street intersections. In general, higher intensities of use, including context classifications C2T, C4, C5, and C6 may require less restrictive access management. In these context classifications, frequent intersections, smaller blocks, and a higher degree of connectivity and access support the multimodal needs of the area. More restrictive median and connection spacing is typically found in context classifications C1, C2, C3C, C3R, and in some cases C2T. More information about context classification is provided in ***1.4 Context Classification and Access Management***.

Generally, the roadways serving areas without existing extensive development are classified in the upper portion of the range (Access Class 2, 3 and 4). Those roadways serving areas with existing moderate to extensive development are generally classified in the lower portion of the range (Access Class 5, 6 and 7). The access management standards for each access class are further determined by the posted speed limit. These Access Classes can also be described based on movement type, multimodal mix and network density.

- Movement Type: Describes the expected transportation role of the roadway in terms of providing primarily local access, somewhat longer cross-town access, or regional access (which includes statewide access.). In general, more urban roadways will serve more local access. Still, in many cases, especially in large urban areas, it may be necessary to provide for longer-distance movement even within urban conditions.
- Multimodal Mix: Describes the extent to which the roadway is expected to serve a variety of transportation modes in addition to automobile and truck traffic. More urban roadways generally accommodate a higher number of available transportation modes, and the more rural roads have little to no mix of modes.
- Network Density: Describes the extent to which a roadway supports, and is supported by, a surrounding transportation network. In general, the more urban roads support a more extensive network of roadways and require greater connectivity and lower speeds; the more rural roads support a smaller network of roadways and have more limited connectivity to other facilities and higher speed limits.

Access Class 2 roadways are highly controlled access facilities distinguished by the ability to serve high speed and high-volume traffic over long distances in a safe and efficient manner. This access class is further distinguished by a highly controlled limited number of connections, median openings, and infrequent traffic signals. Segments of the SHS having this classification usually have access restrictions supported by local ordinances and agreements with the Department and are generally supported by existing or planned service roads. These roads are generally associated with Context Classifications C1 and C2.

Access Class 3 roadways are controlled access facilities where direct access to abutting land is controlled to maximize the operation of the through traffic movement. The land adjacent to these roadways is generally not extensively developed and/or the probability of significant land use change exists. These roadways are distinguished by existing or planned restrictive medians. These roads are generally associated with Context Classifications C1 and C2 but may sometimes be associated with Context Classification C3.

Access Class 4 roadways are controlled access facilities where direct access to abutting land is controlled to maximize the safety and operation of all modes while supporting higher volumes and speeds of through traffic movement. The land adjacent to these roadways is generally not extensively developed and/or the probability of significant land use change exists. These roadways are distinguished by existing or planned non-restrictive median treatments and will usually have very limited supporting roadway network. These roadways are typically associated with Context Classification C3.

Access Class 5 roadways are controlled access facilities where adjacent land has been extensively developed and where the probability of major land use change is not high. These roadways are distinguished by existing or planned restrictive medians. These roadways may serve a regional function within a larger urban area with a high level of multimodal activity and supporting roadway network. These roadways may exist as edge conditions or as part of larger urban landscapes with Context Classifications C3 and C4.

Access Class 6 roadways are controlled access facilities where adjacent land has been extensively developed, and the probability of major land use change is not high. These roadways are distinguished by existing or planned non-restrictive medians or centerlines. These roadways may still serve a cross-town transportation movement with high levels of multimodal activity, supported by extensive roadway network. These roadways are typically associated with Context Classifications C4, C5, and C6.

Access Class 7 roadways are controlled access facilities where adjacent land is generally developed to the maximum feasible intensity and roadway widening potential is limited. This classification is assigned to roadway segments where there is little intent or opportunity to provide high speed travel. These roadways will have the most significant component of all the Access Classes' local access needs, the highest levels of multimodal activity, and the most extensive supporting roadway network. Exceptions to access management standards in this access class may be allowed if the landowner substantially reduces the number of connections compared to existing conditions. These roadways can have either restrictive or non-restrictive medians. These are typically the most urban roadways associated with Context Classifications C4, C5, and C6. Still, Context Classification C2T, Rural Town, also falls under this Access Class due to a Rural Town's limited and historical nature.

Table 12 | Access Management Standards for Controlled Access Facilities

Roadway Access Class	FDOT Context Classification	Movement Type	Multimodal Mix	Network Density	Median Type	Connection/Driveway Spacing (feet)		Median Opening Spacing (feet)		Minimum Signal Spacing (feet)***
						≤45mph Posted	>45mph Posted	Directional	Full	
Limited Access (LA) Right of Way Facilities						Refer to Right of Way (ROW) Maps				
2	C1 Natural, C2 Rural	Regional	Low	Low	Restrictive w/Service Roads	660	1320	1,320	2,640	2,640
3	C1 Natural, C2 Rural, C2T Rural Town, C3R Suburban Residential, C3C Suburban Commercial	Regional	Low	Low	Restrictive	440	660	1,320	2,640	2,640
4	C3R Suburban Residential, C3C Suburban Commercial	Regional	Moderate	Low	Non-Restrictive**	440	660			2,640
5	C3R Suburban Residential, C3C Suburban Commercial, C4 Urban General	Regional	High	High	Restrictive	245	440	660/330*	2,640/ 1,320*/660*	2,640/ 1,320*
6	C4 Urban General, C5 Urban Center, C6 Urban Core	Cross-town	High	High	Both Median Types**	245	440	Match Network Block Size	660	1,320
7	C2T Rural Town, C4 Urban General, C5 Urban Center, C6 Urban Core	Local	High	High	Both Median Types**	125		Match Network Block Size	Match Network Block Size	1,320

**Full Median Opening Spacing 1,320 and 660 feet when roadway speed limit is 40-45 mph and 35 mph or below respectively.*
**Directional Median Opening Spacing 330 feet when roadway speed limit is 35 mph or below.*

***It is recommended that additional safety/operational analysis is completed for non-restrictive medians*

****Traffic signals, proposed at intervals closer than the access management standard for the designated access class, will only be approved where the need for such signal(s) is clearly demonstrated for the safety and operation of the roadway through the signal warrant process. (F.A.C. Rule Chapter: 14-97.003) Applicants requesting or requiring the addition, removal, or modification of a traffic signal for Category E, F, and G connections, must submit an Intersection Control Evaluation Form, Form 750-010-30 (F.A.C. Rule Chapter: 14-96.003). This language is in the draft version of rule 14-96.*

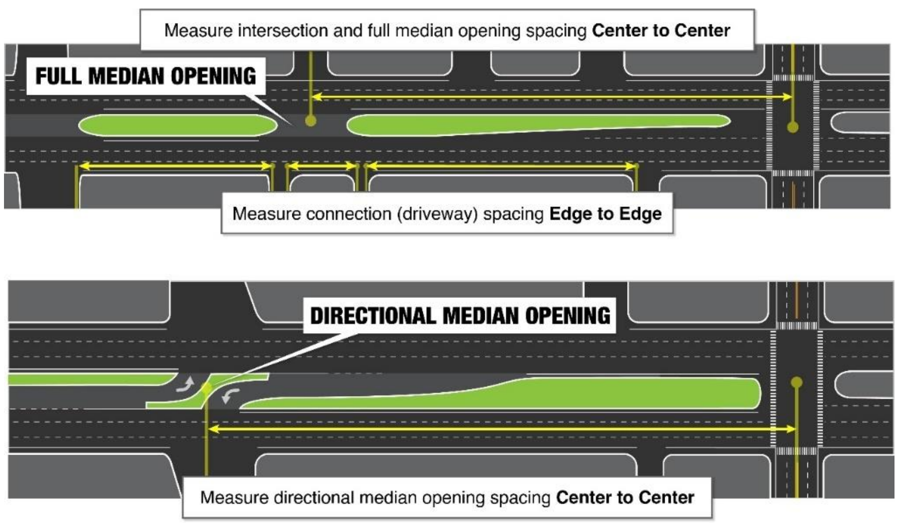
Source: Adapted from FDM 201 - Design Controls and FDOT Context Classification

It is critical to know the roadway access classification and the posted speed limit of the highway/road segment to determine what roadway features and access connection modifications are appropriate to adhere to the access management process.

The Access Management Classification can be found in the *FDOT Roadway Characteristics Inventory (RCI)* under feature 146. This information is also available within the *Access Management Classification KMZ File*, which can be downloaded from the *Systems Implementation Office website*. The file includes traffic information, the access classification and roadway speed limit. A legend for the Access Management Classification File is included here.[3]

While the spacing standards from ***Table 12*** are important for correctly designing a roadway, it is equally important to understand how to conduct the measurements. Full median openings are measured from the center of the median opening to the center of the next full median opening (or intersection). For driveways, measure from either edge of a driveway to the nearest edge of the next driveway. Where a pair of directional median openings is used, the distance is typically measured from the center of a full median opening to the center of the pair of openings (See ***Figure 16*** for examples of these situations). These measurements are specified in *Rule 14-97 F.A.C.* (See also ***Table 12***).

Figure 16 | Measuring Spacing Between Openings



Source: FDOT

[3] *Legend for KMZ File*

2.6 Driveway Spacing Considerations

A driveway constructed too closely to another connection could negatively impact roadway safety and traffic flow. As discussed previously, the standards for determining the spacing requirements for driveways are set by *Rule Chapter: 14-97.003 F.A.C*. These spacing standards and the distances from other connections based upon the roadway speed limit and roadway access classification are provided in ***Table 12***.

While it is important to design driveways correctly, it is also critical to locate them in areas where they will not interfere with other elements. Some examples of areas where driveways should be restricted are at signalized intersections, limited access interchange ramps, other driveways and median openings, and roundabouts. Placing a driveway too close to these elements may create an unsafe roadway environment.

Driveways and median openings close to a major intersection create conflicts for drivers making decisions in an area that has been designed to manage large volumes of traffic. This situation can lead to poor safety and operational conditions. Proper driveway placement can help alleviate this problem. Proper driveway placement can also help the business operators because traffic queues can become so long that traffic exiting driveways may be blocked for long periods of time. According to the AASHTO publication, *A Policy on Geometric Design of Highways and Streets*, also known as the AASHTO Green Book (Chapter 9, 2011*)*, "Driveways should not be situated within the functional area of at-grade intersections."

For example, in ***Figure 17*** and ***Figure 18***, a building site was modified so that one of the driveways could be closed. Before the driveway was closed, there were four connections in an area which may have created conflicts with the vehicles entering and exiting the site, as well as conflicts with pedestrians on the sidewalk. After the site was re-developed (see ***Figure 18***), the second driveway was closed, which reduced conflicts and increased the overall safety performance in this section of the roadway.

Figure 17 | Before Driveway Closure

Source: Miami, FL – FDOT APLUS

Figure 18 | After Driveway Closure

Source: Miami, FL – FDOT APLUS

The distance between connections (e.g., distance between a driveway and a side street or intersection) is measured from the two closest edges of the connection (or its projected edge line at the edge of travel way) as shown in ***Figure 18*** (*Rule Chapter: 14-97 F.A.C.*). More information on connection spacing, and the other driveway terms are discussed in ***Chapter 4: Driveway Dimensions***.

To minimize the number of connections to the SHS and facilitate the associated operational and benefits. Several ideas can be considered including:

- Frontage and Backage Roads – Construct frontage and/or backage roads to encourage overall circulation within similar types of land uses.
- Stub-outs – Provide stub-outs to the property lines for non-residential development to allow future traffic circulation to adjacent properties.
- Local Roadway Connections – Provide connections to the local roadway system when developments are adjacent to these facilities, as opposed to the SHS.
- Shared Connections – Work with adjacent landowners to provide a connection that serves more than one property.

2.6.1 Driveways Near Freeway Interchanges

Access Management on a crossroad at an interchange is critical for the efficient operation of an interchange. *FDM 214 – Driveways* requires, to provide adequate connection spacing along the crossroad at an interchange for the following:

- To minimize spillback on the ramp and crossroad approaches to the ramp terminal
- Provide adequate distance for crossroad weaving
- Provide space for merging maneuvers
- Provide space for storage of turning vehicles at access connections on the crossroad

Rule Chapter: 14-97 F.A.C., requires that driveways/connections and median openings on a controlled access facility located up to 1/4 mile from an interchange area or up to the first intersection with an arterial road, whichever distance is less, shall be more stringently regulated to protect safety and operational efficiency of the SHS, as set forth below:

1. The 1/4-mile distance shall be measured from the end of the taper of the ramp furthest from the interchange.
2. For Access Class 2 facilities with posted speed limits over 45 mph, the distance to the first connection shall be at least 1,320 feet.
3. For all access classifications except Access Class 2 facilities with posted speed limits over 45 mph, the distance from the interchange ramp(s) to the first connection shall be at least 660 feet where the posted speed limit is greater than 45 mph, or at least 440 feet where the posted speed limit is 45 mph or less.
4. This distance will be measured from the end of the taper for that particular quadrant of the interchange on the controlled access facility.

The driveway spacing length with and without interchange ramp taper are illustrated in ***Figure 19*** and ***Figure 20***, respectively.

Figure 19 | Driveway Spacing with Ramp Taper

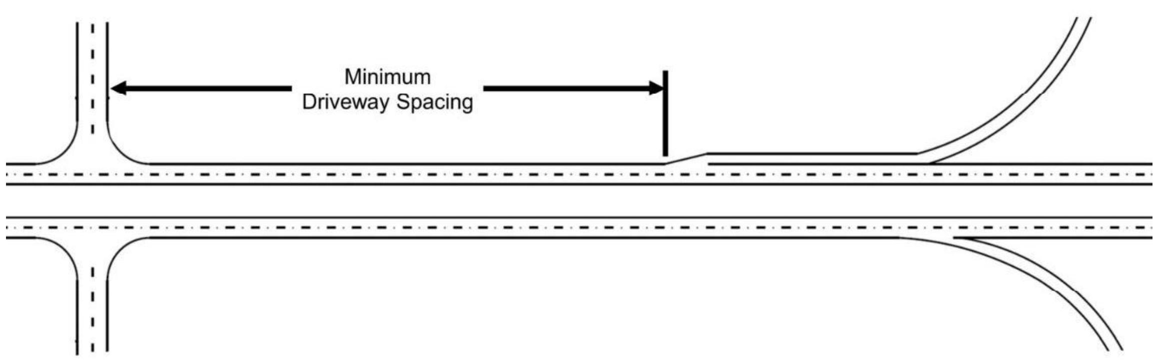
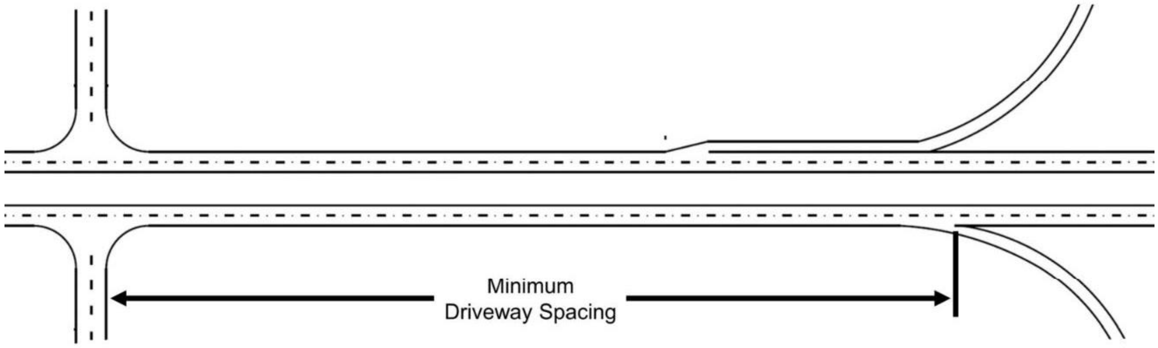


Figure 20 | Driveway Spacing without Ramp Taper



2.6.2 Driveway Spacing Deviations

Per *Rule Chapter: 14-96.003 F.A.C.*, it states that:

> *If the requirements of Rule Chapter 14-97, F.A.C., or other adopted Department access management standards, cannot be reasonably complied with, or if the standards can be met but the applicant desires to submit an alternative plan, the applicant may submit alternative access plans which will be subject to review and will require approval or denial by the Department's District Office Access Management Review Committee (AMRC).*
>
> *The acceptance of any alternative access plans shall be contingent upon maximum achievement of the purpose of Rule Chapter 14-97, F.A.C., and Sections 335.18-.188, F.S.*
>
> *For the Department to consider an alternative access plan proposed under this section, the Applicant shall provide documentation in the form of a traffic study signed and sealed by a Professional Engineer licensed in the State of Florida describing how the plan serves the driving public and not just the applicant or its clients or customers.*
>
> *Prior to the approval or denial of any alternative plan, The Department will also consider the transportation conditions stated in Section 335.184(3)(a), F.S. See also, Rule 14-96.007(4)(a)2. and Rule 14-96.009, F.A.C.*

Per *Rule Chapter: 14-97.003 F.A.C.*, it states that:

> *A property that cannot meet the access management standards for a connection, as set forth herein, is eligible to be permitted by the Department for a single connection pursuant to Rule Chapter 14-96, F.A.C., where there is no other reasonable access to the State Highway System and the connection will not create a safety or operational hazard.*

Non-conforming Connection Permits

Per Rule Chapter: 14-96.009 F.A.C., it states that:

> *The Department may issue a permit for a connection not meeting Department location and spacing criteria standards in Rule Chapter 14-97, F.A.C., if the Department determines that a conforming connection is not attainable at the time of the permit application submittal, that denial would leave the property without access to the public road system, and that the connection would not jeopardize the safety of the public or have a negative impact upon the operation of the highway. The Department also shall issue a connection permit requiring a legally enforceable cross-access connection when determined to be in the best interest of the State for restoring or maintaining the operational efficiency and safety of the State Highway System. Non-conforming connection permits shall specify conditions or limits including:*
>
> *(1) The maximum vehicular type and volume of the connection.*
>
> *(2) The construction of a conforming connection when future alternate means can be obtained with removal of the non-conforming connection.*
>
> *(3) The properties to be served by the connection.*
>
> *(4) When an adjoining property owner consents to cross access or joint access, the agreement between the parties will be recorded in the public records.*

2.6.3 Grandfathered and Unpermitted Connections

Per Rule Chapter: 14-96.011 F.A.C., it states that:

> *"Grandfathered" connections are those connections in existence prior to July 1, 1988, use of which have never been discontinued as described in subparagraph 14-96.005(2)(c)3., F.A.C., which shall not require the issuance of a permit and may continue to provide connection to the State Highway System unless modified or closed as provided in subsection (4) and are subject to the notification process in subsection (5).*
>
> *Unpermitted Connections are those in existence prior to July 1, 1988, and may continue to provide connection to the State Highway System unless modified or closed as provided in subsection (4) and are subject to the notification process in subsection (5).*
>
> *The Department will require that a permit be obtained in accordance with subsection 14-96.005(2), F.A.C., pursuant to the provisions of Section 335.187(1), F.S., if significant changes have occurred.*
>
> *The Department will modify or close an unpermitted connection if such modification or closure is determined to be necessary because the connection would jeopardize the safety of the public or have a negative impact on the operational characteristics of the state highway.*

2.7 Shared Connections/Driveways and Cross Parcel Access

A shared driveway is when two or more adjacent properties use the same driveway for ingress and/or egress. There are numerous benefits for providing cross property access and shared driveways, including the following:

- Fewer driveways reduce the number of conflict points for vehicles, pedestrians, and bicyclists, and creates a safety benefit for all modes.
- Fewer driveways also help reduce congestion caused by frequent stops, reduce the number of trips on major roads, and improve traffic flow on the major road.
- Cross access and shared driveways can replace multiple unsignalized driveways with one signalized driveway, which may help to mitigate existing crash issues at unsignalized locations, increase property value, and provide enhanced pedestrian connectivity.
- Providing cross access between properties broadens the access choices for the driver.
- Cross access particularly benefits small corner properties and outparcels because left-turn access is often a problem as they would conflict with the functional area of the adjacent intersection.
- Fewer driveways may provide the ability to provide a turn lane or longer turn lane, shift an existing median opening, or provide an additional median opening.

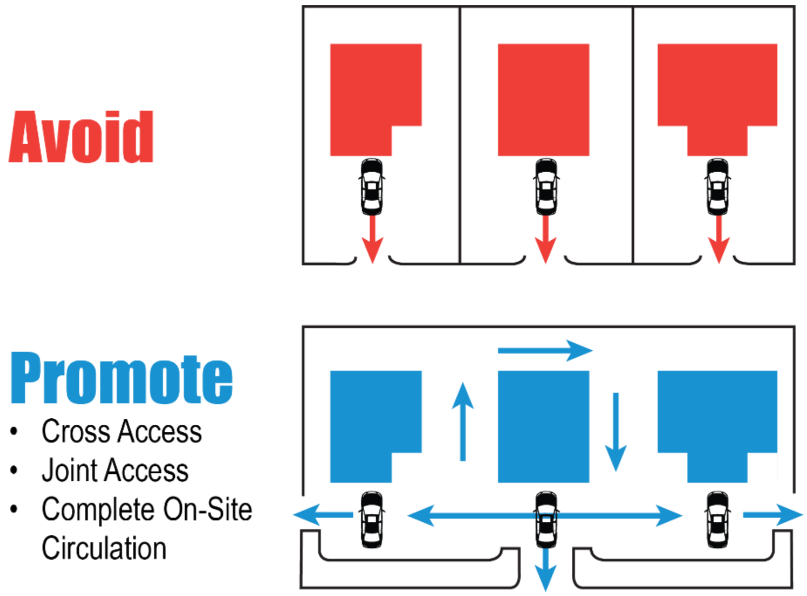
The number of driveways can be reduced by:

- Providing consolidated or shared driveways with cross-access between properties
- Providing a unified internal access to outparcels
- Enhancing roadway networks with balanced driveway connections to the main road and side streets
- Replacing multiple unsignalized driveways with one signalized driveway
- Eliminating unused or abandoned driveways

Joint and cross access are formal, legal methods of ensuring that adjacent properties can share driveways. In the case of joint access, two adjacent property owners share a driveway along their common property line. In the case of cross access, one property owner has the legal right to access and use a driveway that is on the adjacent property owner's land. Joint and cross access can be built into private real estate titles through easements. They can also be encouraged or required in local planning or design standards or in municipal and county ordinances.

If a group of smaller developments share access, a driver needing to turn left across heavy volumes can usually find an access that is signalized, allowing for use of a protected left turn movement (See ***Figure 21***). Having good cross parcel access also maximizes the number of well-designed unsignalized driveways. Drivers will have improved visibility and will be able to take advantage of sufficient gaps in traffic from a nearby signal. Joint driveways and cross access especially help small corner lots and outparcels. On small corner parcels, left-turn access is a problem because left turns would conflict with the functional area of the intersection.

Figure 21 | Driveway Consolidation



Source: "Managing Corridor Development, A Municipal Handbook", Center for Urban Transportation Research, University of South Florida, October 1996. Williams, Kristine M. and Marshall, Margaret A.

Interconnected developments give customers and delivery trucks more options, especially for completing protected left turns at signalized intersections. It is easier to provide cross and joint access if it is planned at the beginning of a development process. At that time, there will be the ability to lay out access systems and allow for good separation between these access points. Many local governments have already addressed these issues in their land development regulations by providing requirements for joint and cross access with large neighboring developments and small corner outparcels. Sample land development regulations which include these features can be found in the CUTR report for FDOT *"Model Access Management Policies and Regulations for Florida Cities and Counties: 2nd Edition."*

While FDOT cannot require cross access and shared driveways, they can and should be encouraged to the extent possible, particularly as mitigation for non-conforming connection permit applications. To reserve future cross access to adjacent undeveloped parcels, cross access should be requested to be deeded into property for future connection. Sidewalk and roadway stub-outs can be provided to adjacent properties so future connections can be established. Local government land development codes are often written to require connection to existing stub-outs.

Rule 14-96 F.A.C. contains provisions for encouraging and establishing cross access, including the following:

> *Rule 14-96.007 (8) F.A.C. states that "The Department may require permits to be recorded in the public records with the legal description of the property when cross or joint access exists, when permit conditions requiring future performance by the permittee exist such as installation of traffic control features or devices, or when other conditions warrant recording."*
>
> *In reference to non-conforming connection permits and specific conditions or limits, Rule 14-96.009 F.A.C. states "When an adjoining property owner consents*

> *to cross access or join access, the agreement between the parties will be recorded in the public records."*

In the case of a new development that requests a non-conforming access to the SHS, there is a recommended course of action if there is an adjacent property with an existing driveway access that would ideally be used as a shared driveway:

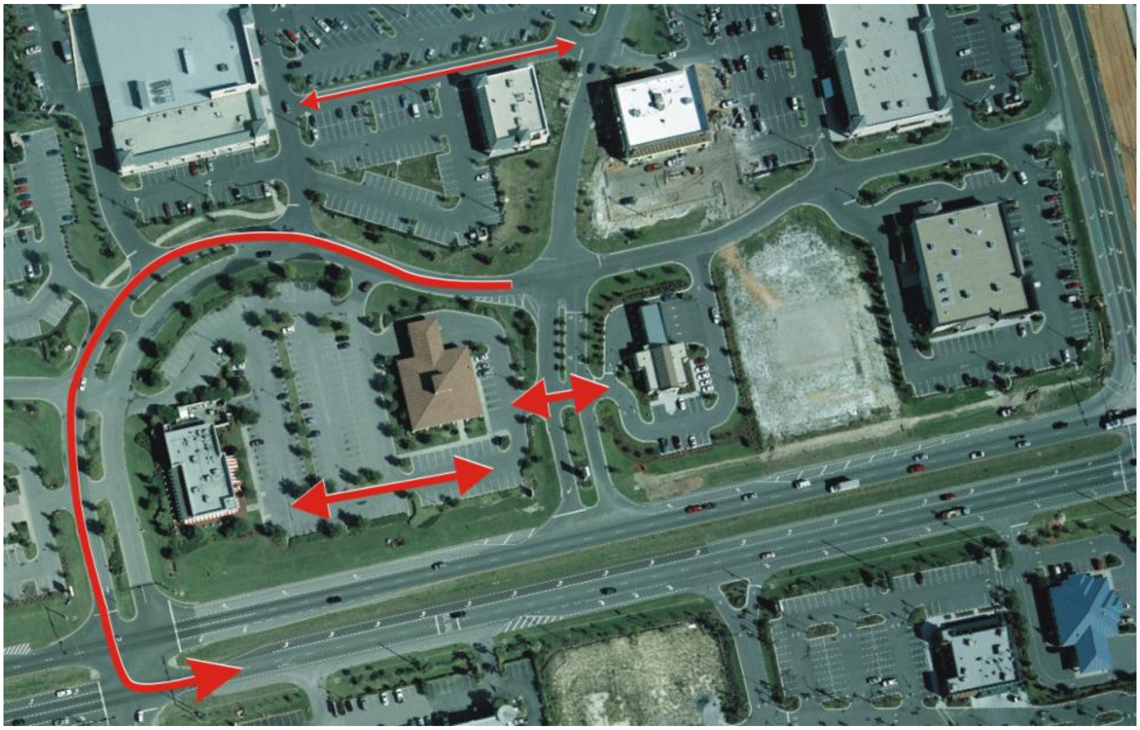
- First, have the new development (in this example, Parcel A) request a cross access agreement with the adjacent property (in this example, Parcel B).
- FDOT does not have a legal mechanism to mandate that the existing adjacent property (Parcel B) owner accept the cross access or make the connection to the new development (Parcel A). If the cross access cannot be achieved, FDOT should issue a non-conforming access permit to the new development (Parcel A) and require a cross access agreement and stub-out constructed to the adjacent property line for future use. This cross access agreement, which should be recorded, is a "one-way" agreement only.
- If and when the adjacent property (Parcel B) comes in for redevelopment or meets the threshold for a significant change, FDOT can require that parcel to connect to the neighboring property (Parcel A) that previously was approved for a non-conforming access. The driveway to that neighboring property that was permitted as a non-conforming driveway (Parcel A) should then be removed in most cases.
- There may be limited circumstances when retaining the driveway to Parcel A is preferred, for example, if an existing driveway to Parcel B is non-conforming with the next driveway in the other direction (to Parcel C) but where the distance between driveways to Parcels A and C would conform to driveway spacing standards for the specific roadway's access class.

Since standards vary depending on the specific local government, coordination is needed to provide an overall consistent approach within each entity. To provide the necessary balance between mobility and access, a collaborative approach with the property owner, local government, and FDOT is needed. Coordinate with both internal and external stakeholders to discuss shared connections and cross parcel access, the advantages, and best practices. With property owners subjected to both state and local government reviews, it becomes increasingly difficult at times for the property owner to receive consistent feedback. Consider holding joint meetings with the local governments to provide consistent reviews and to understand everyone's overall goal for access.

Shared connections and cross parcel access must be considered in the early stages of the development process and the guidance must facilitate their use from both state and local perspectives to be effectively implemented. The Department should also consider requiring cross access connection for non-conforming connection permits, when legally enforceable.

There are some challenges associated with joint and cross access in retrofit situations. These situations usually deal with groups of small shallow land parcels where joint access has never been considered in the past (See ***Figure 22***). A major problem associated with producing new joint and cross access is that cross-access points are often too close to the driveway entrances. This proximity may prevent having adequate driveway depth (See ***4.2.10: Driveway Length***). In retrofit situations, consider the volume of traffic using these driveway entrances and exits and the volume of adjacent cross access traffic to determine whether the shallow driveway depth will cause an internal traffic circulation difficulty. Signing and landscaping may also help in these tighter situations on cross access in retrofit situations.

Figure 22 | Joint and Cross Access Example



Source: FDOT

FDM and FDOT Standard Plans

While *Rule Chapter 14-96 F.A.C.* and *Rule 14-97 F.A.C.* regulate the process for approving and locating driveways, FDOT Standard Plans, Index *522-003* and 330-001, and *FDM 214 – Driveways*, dictate driveway type and design criteria based on multiple criteria, such as radius, width, angle, and setback. These specific dimensions are discussed in ***Chapter 4: Driveway Dimensions***. For additional guidance, always refer to the FDM or the Standard Plans.

2.8 Emergency Only Access Connections

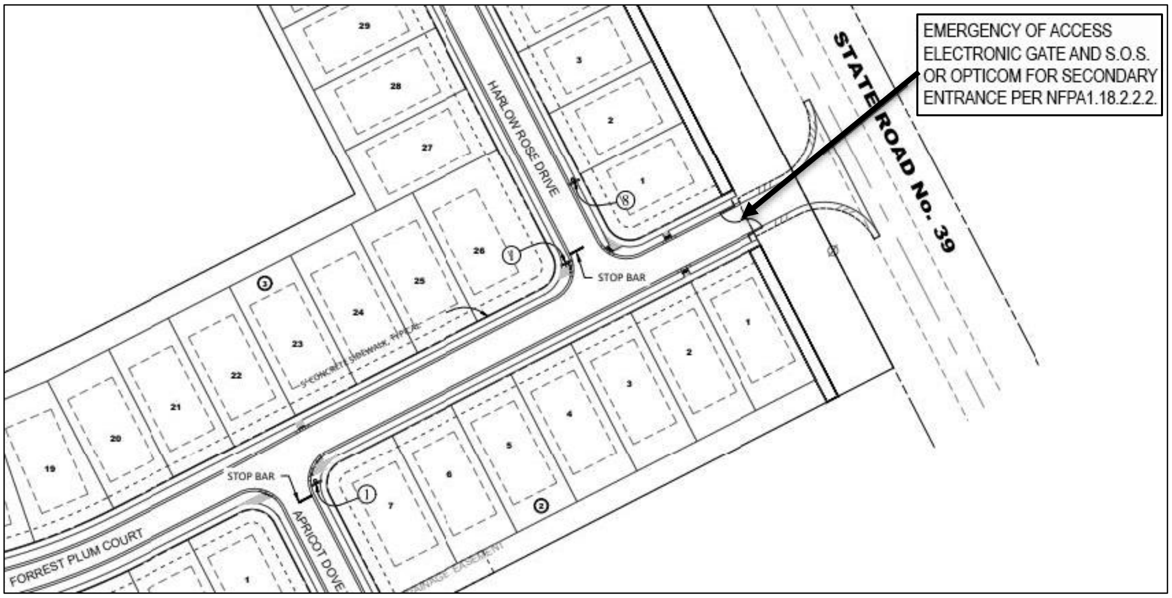
The Florida Fire Prevention Code (Rule 69A-60 F.A.C.) is adopted by the State Fire Marshal by rule based on *F.S. 633.202*. As noted in *F.S. 633.208*, the Florida Fire Prevention Code is the minimum fire safety code required for each local government, although they have the option to adopt more stringent fire safety standards. The Florida Fire Prevention Code has a general recommendation for additional emergency vehicle access, and often local governments adopt specific access requirements in their Land Development Code (LDC). In some cases, a secondary emergency-only access may be requested by the local government to address the following issues:

- To reduce response times to emergencies, particularly for areas of a larger development that are located far away from the main entrance/exit of the development, or would require emergency vehicles to travel an extended distance to reach portions of the development.
- To provide a secondary means of evacuation for the development if the main entrance/exit is blocked.
- To provide an entrance or exit for emergency vehicles that are unable to turn around within the site, i.e., if the site does not provide a turnaround such as a hammerhead or cul-de-sac.

Emergency access is a topic that should be discussed with the local government at a pre-development meeting or the driveway connection permit pre-application meeting. Confirmation of a request for an additional emergency access should be obtained from the local government or Fire Chief/Inspector in the form of written documentation.

An example plan for an emergency access is shown in ***Figure 23***.

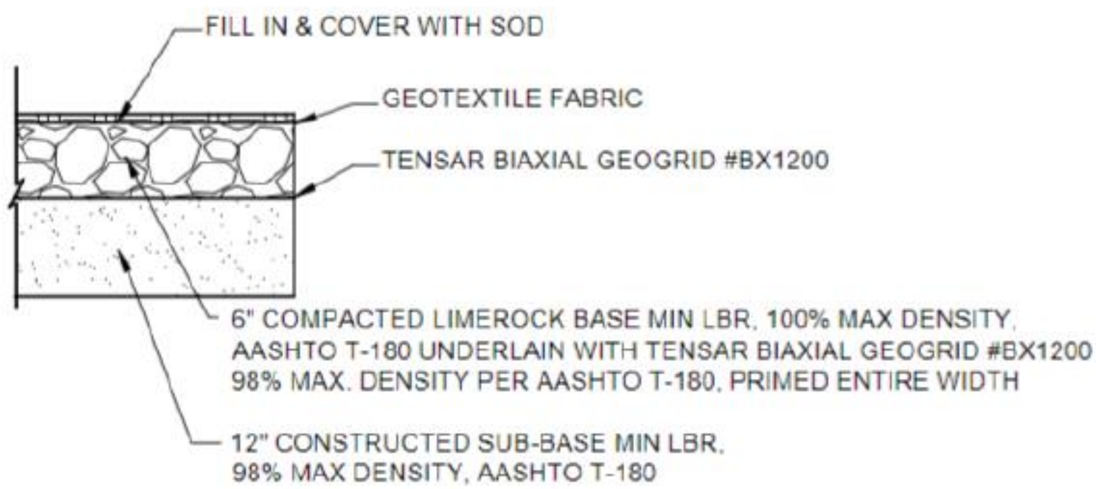
Figure 23 | Example Emergency Access Driveway Plan, SR 39, Pasco County



Since a secondary emergency-only access on the SHS would not be used by vehicles outside of emergency vehicles, it does not have to meet the access spacing requirements of Rule 14-97, F.A.C. However, to limit its use to only emergency vehicles, the following best practices should be followed:

- Access connection should be gated and locked with access only available via a "Knox Box", Opticom, Siren Operated Sensor (S.O.S.), or similar system to ensure that only emergency vehicles can open the gate.
- The design should accommodate the turning movements of the largest expected emergency vehicle.
- It is preferable to have the access driveway be sodded/grassed versus gravel or paved. Typically, a driveway as narrow as 20 feet provides sufficient width. Minimizing width and having the driveway unpaved (along with the gate and locking device) also discourages potential driver confusion and attempted use by non-emergency vehicles.
- Stabilizing the unpaved driveway, using grass pavers or other means, is recommended. See example of stabilization in ***Figure 24***.
- Require that the local government record the access in the development order as "Emergency Access only" to assist in preventing improper use in the future.

Figure 24 | Example Emergency Access Driveway Stabilization Detail



2.9 Median Opening Spacing Considerations

The location of median openings has a direct relationship to safety, operational efficiency and traffic progression along a roadway. To support safe and efficient traffic operations, full median openings should only be at locations which are thoughtfully placed along the corridor. Properly spaced median openings will facilitate signalized traffic to flow at efficient and uniform operating speeds. The *Rule Chapter: 14-97.003 F.A.C.* regulates median opening spacing and provides recommended distances. The median types and spacing standards for each roadway access classification are provided in ***Table 12***.

2.9.1 Median Openings Near Freeway Interchanges

Good access management practices are needed in the area surrounding freeway interchanges as these are areas where high speed traffic transitions to arterial speeds. In addition, congestion on the arterial can cause freeway exit ramp traffic to back up onto the mainline, creating a serious high-speed crash risk.

Rule Chapter: 14-97 F.A.C., the main rule on access management standards, considers interchange areas differently than other portions of a corridor. These areas may require spacing of median openings at greater distances than required by the individual access management class of the arterial.

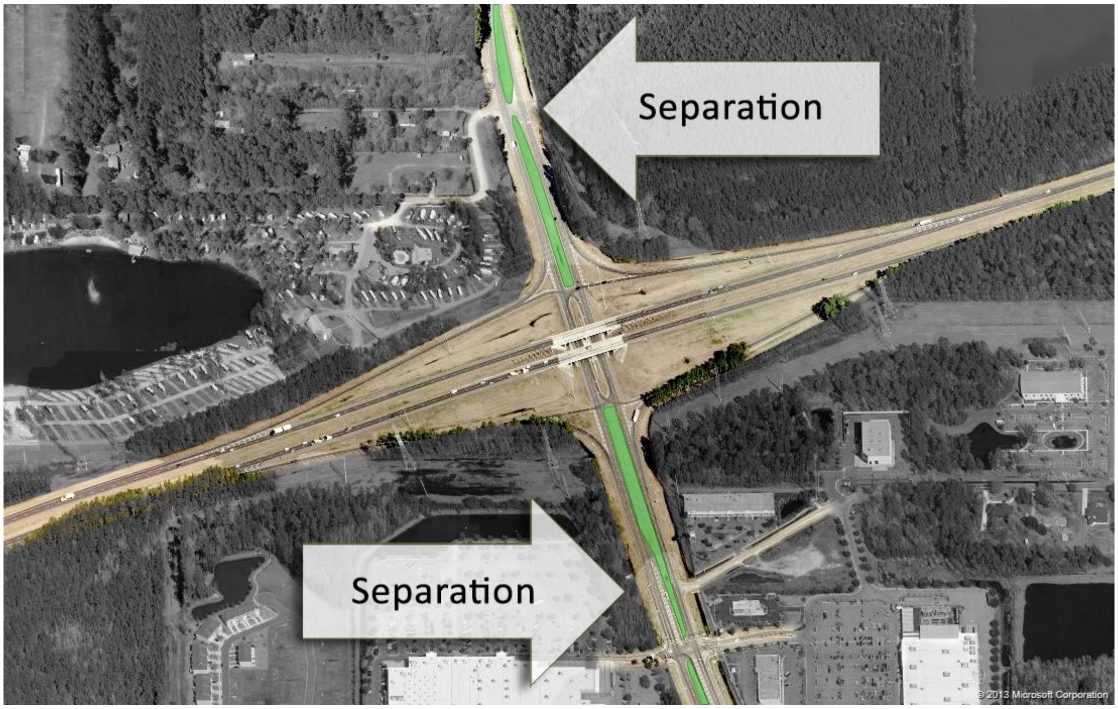
Interchange Areas *Rule 14-97.003 3. (h) 3 F.A.C.*:

> *The standard distance to the first full median opening shall be at least 2,640 feet as measured from the end of the taper of the off ramp.*

The directional median opening spacing requirement near interchanges is not specified in the current rule 14-97, however it is suggested to apply at least 1,320 feet as measured from the end of the taper of the off ramp as the standard distance to the first directional median opening.

Figure 25 illustrates the greater spacing needs in the vicinity of a freeway interchange.

Figure 25 | Median Openings Near Freeway Interchanges



Source: FDOT

The standards in *Rule Chapter: 14-97 F.A.C.* are difficult to achieve in many cases. Therefore, FDOT relies upon generally accepted professional practice to analyze and design the separation of median openings.

Transportation analysis techniques and operational models are added and changed frequently. Other generally accepted professional practice, including transportation simulation models and the *Highway Capacity Manual*, may also be used.

Figure 25 illustrates the rationale behind the 2640' distance between the off-ramp and the first signalized intersection.

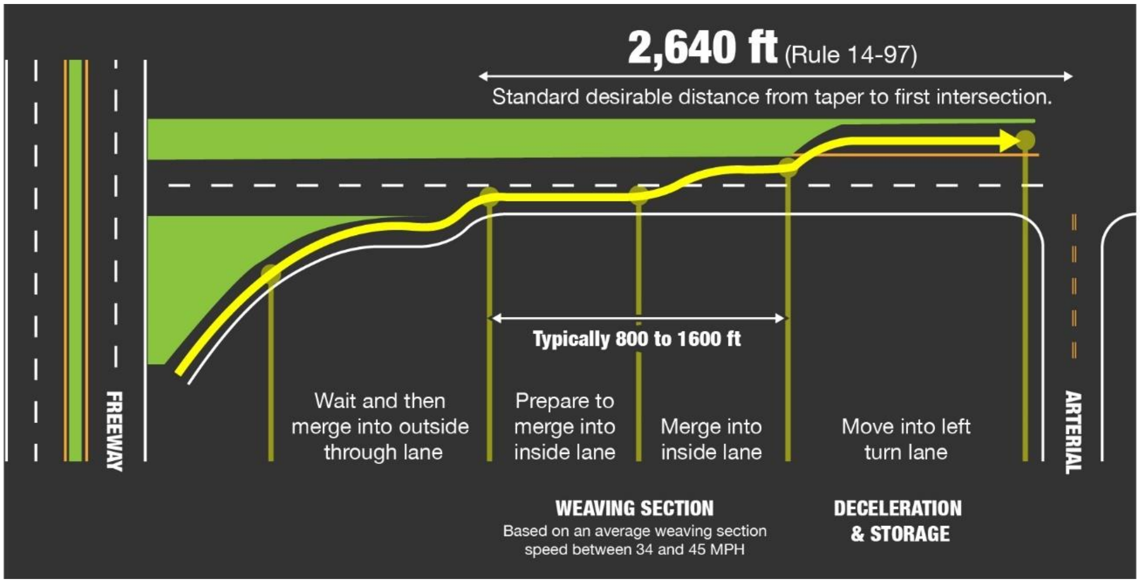
All proposed access locations within the influence area of the interchange and/or ramps are also required to be reviewed and approved by the Federal Highway Administration (FHWA). The FHWA will review the proposed location and design to ensure there are no adverse impacts to the proper function of the interstate ramps per Federal Policy. The FHWA is required to be involved in the process from the driveway access pre-application phase.

Unsignalized On and Off-Ramps

Drivers may make erratic maneuvers in areas where there is a limited separation between the off-ramp and the median opening. Desirable conditions would permit a driver to accelerate, merge into the outside traffic lane, select an acceptable gap in order to merge into the inside lane, move laterally into the left-turn lane, and come to a stop as shown in ***Figure 26*** The desired distance needed between an unsignalized freeway off-ramp and median opening at first signalized intersection is 2,640 feet.

Research[4] [5] shows that most urban situations fall within 800 feet to 1,600 feet of conflicting weaving movements within the arterial weaving section, during the peak hour. If a lower average speed such as 35 mph through that section can be achieved, the weave section may be as low as 400 feet.

Figure 26 | Distance Between Off-Ramp and First Signalized Intersection



Source: FDOT

Signalized On/Off-Ramps

If the ramp is signalized, this weaving distance will need to be determined by a signal spacing analysis or other methods and standards.

For additional information on median and roadway opening spacing in the vicinity of interchanges, please see the following resources:

- *TRB Access Management Manual 2nd Edition*
- *NCHRP Report 420, Impacts of Access Management Techniques*
- NCHRP Report 977 *Volume 1* and *Volume 2*, Access Management in the Vicinity of Interchanges
- *NCHRP 15-66, Operational Performance and Safety Effects of Arterial Weaving Sections*

2.9.2 FDOT Procedure Topic No.: 625-010-021

District Access Management Review Committee

Section 2 of the *Procedure 625-010-021* states that the FDOT District Access Management Review Committee (AMRC) will review proposed deviations from access management and median opening spacing standards. At a minimum access management, driveway, and median opening issues not resolved during the Districts Staff level review must go to the AMRC review. AMRC is used to resolve all access management issues and is not limited to median spacing challenges.

[4] *Jack Leisch – Procedure for Analysis and Design of Weaving Sections 1985*

[5] *Robert Layton - Interchange Access Management Background Paper 4 - 2012*

Review of Deviations from Median Opening Standards

One of the impacts of these median opening spacing standards is the concentration of more left turns and more U-turns. This requires careful planning of well-designed, well-placed median openings to avoid issues with left turns and U-turns. In response to this, FDOT created the following Procedure: *Topic Number 625-010-021 (Median Opening and Access Management Procedure)*.

The procedure provides guidance on applying the standards in *Rule Chapter 14-97.003 F.A.C.* to promote consistent application of access management practices throughout FDOT. It addresses the median review process, application of the standards, public comment, and considerations for review of deviations from standards.

Adhering to the median opening spacing standards of *Rule Chapter 14-97 F.A.C.* may not be achievable for various reasons. Therefore, FDOT developed a process to analyze deviation from the standards found in the Rule. The process allows project managers/permits staff a 10% deviation from the standards for full median openings and gives complete flexibility decisions involving directional median openings provided they meet minimum traffic engineering standards for storage, deceleration, sight distance, and maneuverability.

Each District has a multi-disciplinary team of Department heads, called the Access Management Review Committee (AMRC) to consider deviations from *Rule Chapter 14-97 F.A.C.* standards. The team meets on a fixed schedule of publicly noticed meetings. All deviations greater than 10% for full median openings must go to the AMRC for further study and recommendation. The AMRC will review certain proposed deviations from access management and median opening spacing standards. The factors evaluated are the project's effect on:

- Motorized and Non-motorized Traffic Safety
- Motorized and Non-motorized Traffic Efficiency
- Functional Integrity
- Context classification of the surrounding development or use

For minor deviations, decisions can be made by a responsible engineer with a 10% deviation for "full" openings allowed. Directional openings are decided on a "case-by-case" basis.

It is important to note that even deviations of less than 10% might be problematic and create operational issues. Districts can follow a stricter decision-making policy and process.

Requests for deviation from median opening standards must be fully documented and signed by a Professional Engineer knowledgeable in traffic engineering. Section 5.3 of the *Procedure 625-010-021* also cautions that deviations should not be approved in situations that would jeopardize safety or degrade the efficiency of the system.

Recommended Minimum Left-Turn Lane Queue Storage Length

Section 5.4 of the *Procedure 625-010-021* provides guidance on minimum left-turn lane queue storage lengths and identifies median opening designs that should be avoided.

A critical measure for adequate median opening design is left-turn lane queue storage. Site or project specific projections of queue storage should be used at all critical intersections. Due to the variable nature of left-turn demand, actual volumes should be collected and reviewed. Designs should also include a factor of safety to account for any uncertainty in demand.

Where left-turn volume is unknown and expected to be minor, adhere to the recommended minimums below:

- Urban/suburban minimum = 4 cars or 100 feet
- Rural/small town minimum = 2 cars or 50 feet

For more information on queue storage length, please review ***Queue Storage*** in ***Chapter 3: Designs of Medians & Median Openings***.

Design Prohibitions and Cautions

Section 5.5 of the *Procedure 625-010-021* illustrates why median openings that allow vehicular traffic to cross left or right turn lanes should not be approved. These illustrations are explained in greater detail in the ***Median Opening Placement Principles*** section of this Chapter. These principles are also explained in greater detail in ***Chapter 3: Designs of Medians & Median Openings***.

2.9.3 Signal Spacing Deviations

Per *Rule Chapter: 14-97.003 F.A.C. (3) (i)*, it states that:

> *Traffic signals, which are proposed at intervals closer than the access management standard for the designated access class, will only be approved where the need for such signal(s) is clearly demonstrated for the safety and operation of the roadway and approved through the signal warrant process.*

In addition to rule 14-97, the installation of the traffic signal has been evaluated through the Department's Intersection Control Evaluation (ICE) process. Some of ICE's alternative intersections will have signal spacing as close as 400 feet to facilitate U-turn movements. For intersection forms such as a Restricted Crossing U-Turn (RCUT), Median U-Turn (MUT), Partial Median U-Turn (PMUT) and Displaced Left Turn (DLT) the signal spacing is based upon intersections operations analysis where it is desired to provide proper queue storage while minimizing out of direction travel. The access management standards defined in rule 14-97 will not apply between the main intersection and the U-turn/crossover locations for these intersection forms.

Pedestrian midblock crossing opportunities may also be provided as needed and will not affect or be affected by the access management class unless vehicular traffic signal is also proposed.

2.9.4 Other Important Considerations

Median Opening Placement Principles

The basic concept used in median opening location and design is avoidance of unnecessary conflicts which result in crashes.

The unsignalized median opening is essentially an intersection. Properly designed, it will have an auxiliary lane allowing the left-turning vehicles to decelerate without interfering with the through movements of the leftmost through lane. The potential of high-speed crashes is the greatest in the through lanes. Before median opening placement is determined, it is important to know what speed, maneuvering distances, and storage length the project requires.

- Follow the spacing criteria in *Rule Chapter: 14-97 F.A.C.*
- Median openings should not encroach on the functional area of another median opening or intersection

Avoid Openings Within Exclusive Turn Lanes

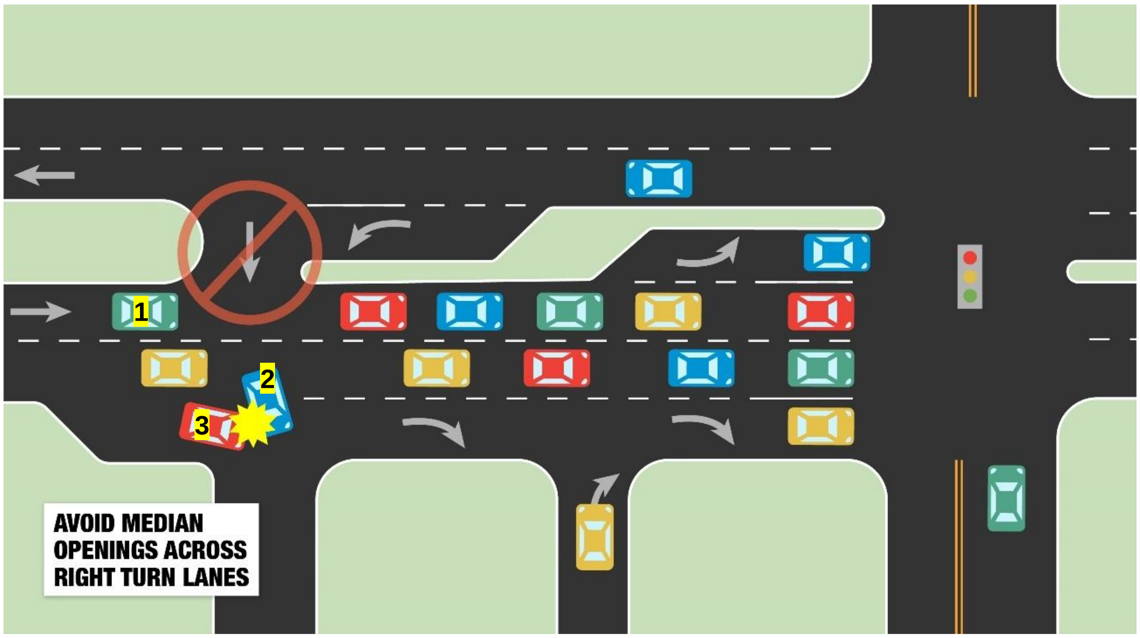
Median openings can cause significant traffic issues if they are improperly placed. For example, placing a median opening across a turn lane could introduce additional conflict points, which could result in vehicular crashes.

Exclusive right-turn lanes are most appropriate under the following conditions:

- No median openings interfere
- The right-turn lane does not continue across intersections
- No closely spaced high volume driveways

In ***Figure 27***, driver 1 (**green car**) in the through-lane decides to allow the driver 2 (**blue car**) to make a left-turn into the driveway, which results in a crash with driver 3 (**red car**) in the right-turn lane. Driver 3 (**red car**) in the right turn lane was unable to see driver 2 (**blue car**) because of the queued traffic in the through lanes. In this example, while the intentions of driver 1 (**green car**) were good, it unfortunately led to a crash.

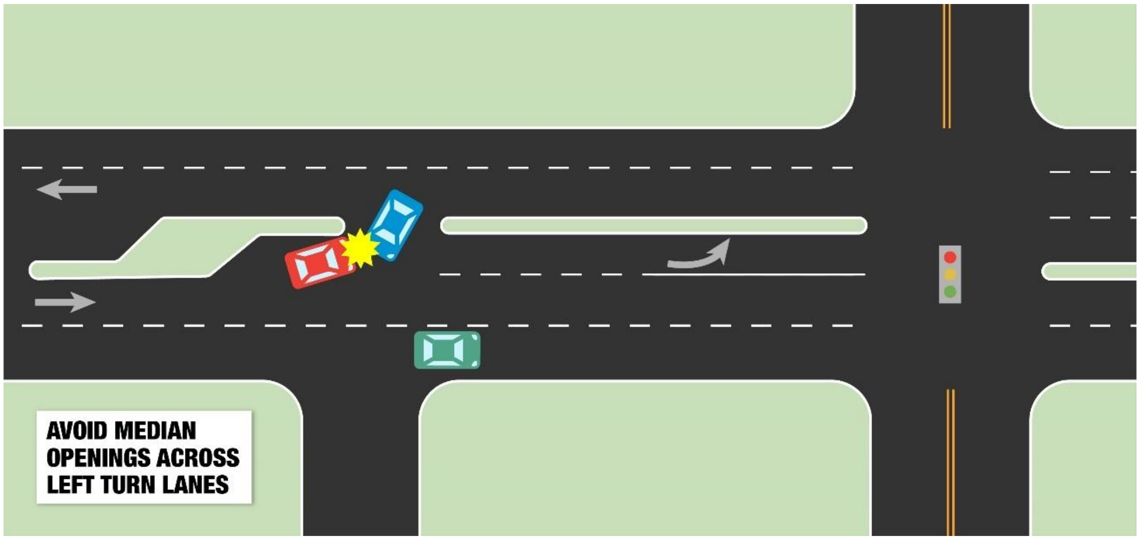
Figure 27 | Improper Median Opening



Source: FDOT

Another example of an improper median opening is one located on a left-turn lane, as shown in ***Figure 28***. The vehicle entering the left-turn lane is involved in a crash with an opposing vehicle turning left in the median opening.

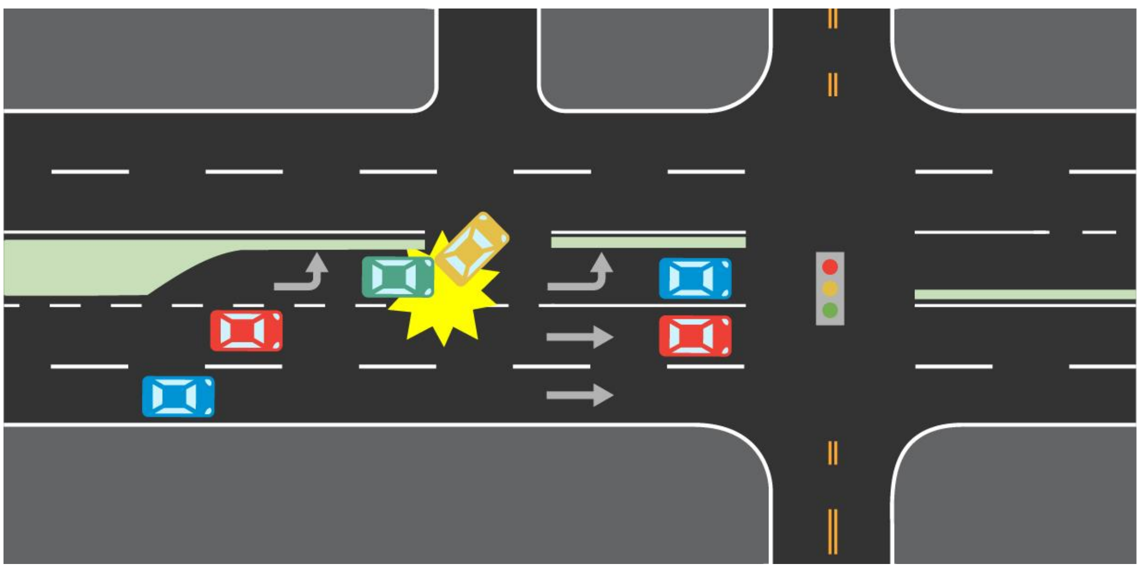
Figure 28 | Improper Median Opening



Source: FDOT

In ***Figure 29*** a rear-end collision occurs with the vehicle attempting a left turn through the opening prior to the intersection. Both examples violate driver expectancy.

Figure 29 | Improper Median Opening Violates Driver Expectancy



Source: FDOT

Additional guidance on turn lanes, median openings and driveways can be found later in this chapter, as well as in ***Chapter 4: Driveway Dimensions***, ***Chapter 5: Sight Distances***, and ***Chapter 6: Turn Lanes and U-Turns***.

Chapter 3: Designs of Medians & Median Openings

3.1 Overview

Factors such as width and median taper play a critical role when designing median openings in how they affect access management along a roadway. A critical function of many medians is to protect vehicles turning left. Medians can also serve as a pedestrian refuge for either marked crosswalks or informal crossing opportunities. These design criteria are influenced by similar factors as driveways. The speed limit of the roadway, design of the roadway shoulders (flushed vs. curbed), and context classification all influence the various design criteria for medians and median openings. These criteria are discussed in the following sections.

3.1.1 Width

One of the major design criteria for medians and median openings is the width of the median. Per *FDM 210.3.1*, "Median width is expressed as the dimension between the inside edges of traveled way."

Table 13 describes the various recommended median widths based on numerous factors. For example, a curbed or flushed shoulder roadway with a design speed of 25-35 mph in a C2T-Rural Town context classification has a minimum width specified as 15.5 feet.

Table 13 | Median Widths

Context Classification	Curbed Roadways and Flush Shoulder Roadways (feet)		High Speed Curbed Roadways (feet)	Flush Shoulder Roadways (feet)
	Design Speed (mph)			
	25-35	40-45	50-55	≥ 50
C1 Natural	N/A	N/A	30	40
C2 Rural	N/A	N/A	30	40
C2T Rural Town	15.5	22	N/A	N/A
C3 Suburban	22	22	30	40
C4 Urban General	15.5	22	N/A	N/A
C5 Urban Center	15.5	N/A	N/A	N/A
C6 Urban Core	15.5	N/A	N/A	N/A

Notes:

1. On reconstruction projects where existing curb locations are fixed due to severe right of way constraints, the minimum median width may be reduced to 19.5 feet for design speeds = 45 mph, and to 15.5 feet for designs speeds ≤ 40 mph.
2. A minimum 6-foot median may be used within C5 and C6 context classifications only where left-turn lanes are not expected.
3. N/A indicates this combination of design speed and context classification is outside the intended design range and should be avoided. See ***FDM Table 201.5.1*** for context classifications and design speed ranges.

Source: *FDM 210 – Arterials and Collectors (Table 210.3.1)*

The appropriate median width should be determined by the specific function the median is designed to serve. Considerations which affect median width on roadways having at-grade intersections include the following:

- Separate opposing traffic streams
- Pedestrian refuge
- Left-turns into side streets
- Left-turns out of side streets
- Crossing vehicle movements
- U-turns
- Aesthetics and maintenance

There are situations when additional median width may be necessary. For example, if there are trees, bushes or other similar features within the median, it may need to be enlarged. Also, if there are dual or triple left lanes or a need to offset turn lanes, then the median width will need to be larger. Finally, if there is a directional median opening, then the median width should be larger.

Determining the width of a median opening is dependent on whether it is a full or directional median opening. According to the *FDM 212.9.1*, full median opening width is descried as:

> *"…the same width as the intersecting road (including shoulders) which is sufficient to accommodate the swept path of left-turning vehicles."*

The minimum widths shown in ***Table 13*** represent a balance between mobility, safety and context classification. Median width will be discussed in further detail in ***Chapter 5: Sight Distances*** and ***Chapter 6: Turn Lanes and U-Turns***.

Important Considerations

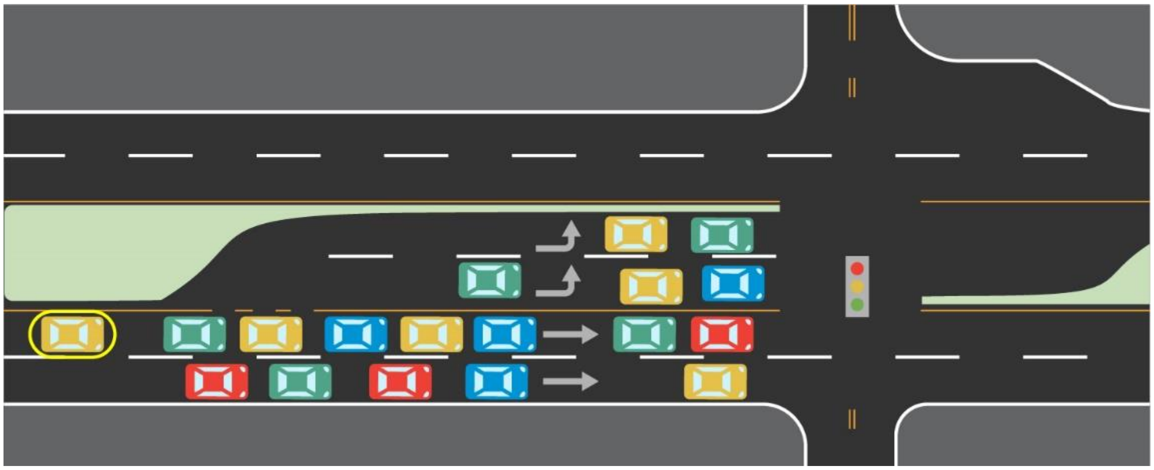
FDM 210 – Arterials and Collectors provides the following direction: Two-way left-turn lane widths (flush median) may be used on 3-lane and 5-lane typical sections with design speeds ≤ 40 mph. On new construction projects, flush medians are to include sections of raised or restrictive median to enhance vehicular, bicycle, and pedestrian safety, improve traffic efficiency, and attain the standards of the Access Management Classification of that highway system. Sections of raised or restrictive medians are recommended on RRR projects.

3.1.2 Median Opening Failures

Median opening failure can occur when critical components of the opening are not designed appropriately. This is usually due to the inadequate space for left-turn storage. This can result in excessive deceleration in the through lane, because vehicles are queued in the area of the left-turn lane needed for deceleration. Additionally, an inadequate left-turn lane length can lead to vehicle queues extending into the through lane creating a more hazardous situation.

When the queue in the through traffic lane spills past the left-turn lane, turning vehicles are trapped in the queue (See highlighted vehicle in ***Figure 30***).The left-turning vehicles are not able to move into the turn bay until the queue advances and often miss the left-turn signal phase which negatively impacts intersection efficiency. Dual left-turn lanes may be more prone to this problem.

Figure 30 | Through-Lane Queue Blocks Entry into the Left-Turn Bay

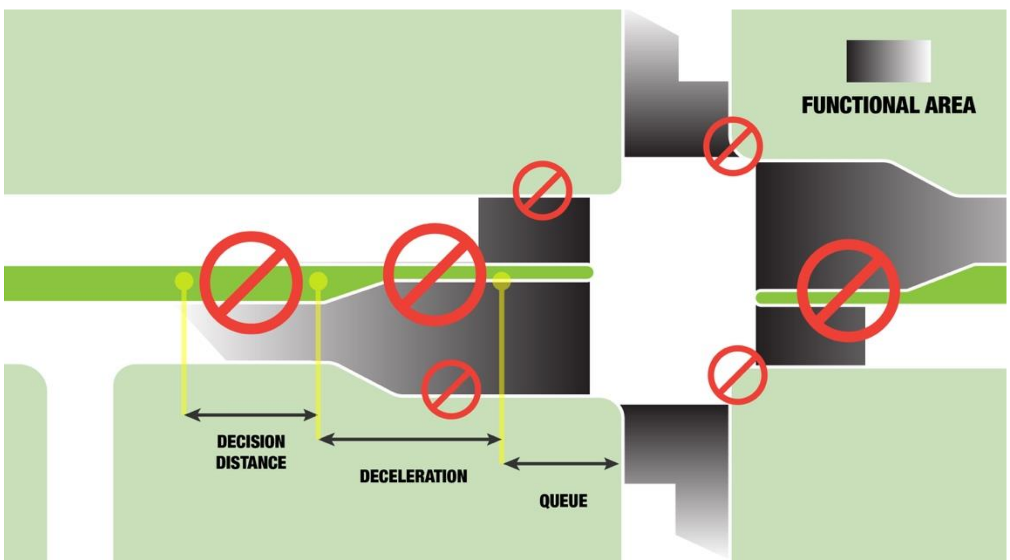


Source: FDOT

Exclusive Left-Turn Lane Length

This section will discuss exclusive left-turn lane length. To determine adequate storage lengths, the roadway designer should know the decision distance, deceleration distance and queue length as shown in *Figure 31*. In this figure, the areas that are marked out with a "do not" symbol are places where you would not want to install a median opening or driveway as it would negatively impact the roadway safety and operation.

Figure 31 | Functional Area and Medians



Source: FDOT

Decision Distance

The decision distance (also referred to as the perception-reaction distance) is the distance traveled while a driver recognizes an upcoming turn lane and prepares for the left turn maneuver. The AASHTO Green Book states:

> *The distance increases with perception-reaction time and speed. The perception-reaction time varies with the driver's familiarity with the roadway segment and state of alertness; for example, an alert driver who is familiar with the roadway and traffic conditions has a smaller perception-reaction time than an unfamiliar driver. Traffic conditions on urban and suburban roadways could result in drivers having a higher level of alertness than those on highways in rural areas. Therefore, a value of 1.5 s is often used as the perception-reaction time for suburban, urban, urban core, and rural town contexts, and 2.5 s is often used for rural contexts.*

Table 14 shows typical decision distances at varying design speeds based on the typical perception-reaction times in different area types/contexts.

Table 14 | Typical Decision Distances based on Design Speed

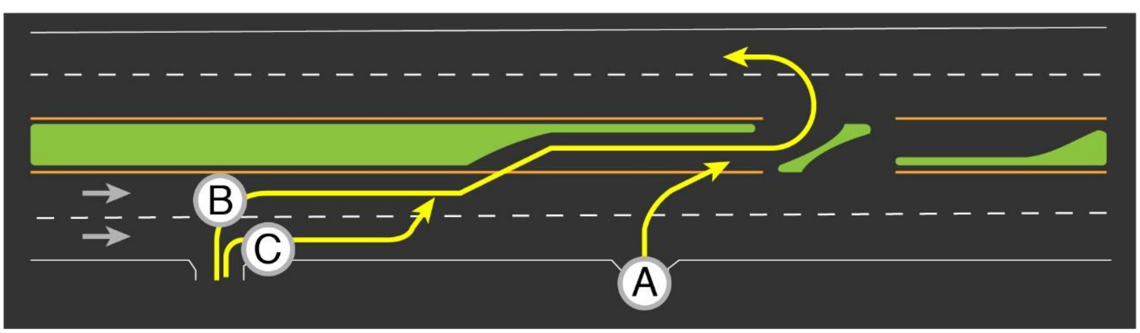
Area Type / Context	Typical Perception-Reaction Time (sec)	35 mph	45 mph	55 mph
Rural	2.5	130 feet	165 feet	200 feet
Urban, Urban Core, Suburban, Rural Town	1.5	75 feet	100 feet	120 feet

Source: based on information in AASHTO Green Book Section 9.7.2.1 Perception-Reaction Distance.

Right-Turn Weaving Distance (Right-Turn Weave Offset)

Vehicles turning right from a upstream driveway will need distance to weave if they are turning left at the next opening. **Figure 32** shows the potential weaving patterns if there is a driveway in close proximity to a median opening.

Figure 32 | Weaving Patterns



Source: FDOT

A Short Separation:

Drivers select a suitable simultaneous gap in all traffic lanes and then make a direct entry into the left-turn/U-turn lane. Short separation should be discouraged, especially in high volume and/or high-speed roads.

B Long Separation, Low-Volume approaching from the left:

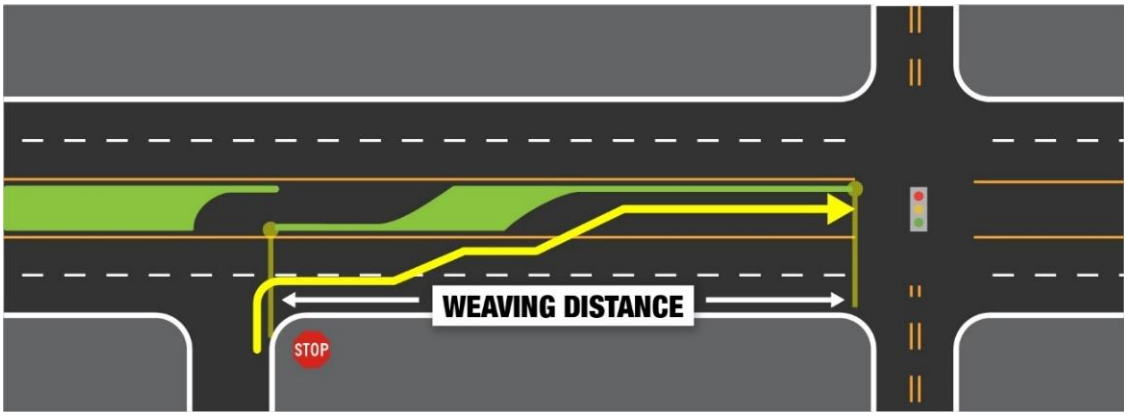
Drivers select a simultaneous gap in all traffic lanes, turn right, and make a direct entry maneuver into the left through lane.

C Long separation, high volume or low volume and high-speed traffic from the left:

Drivers wait for suitable gap, turn right, accelerate and make a lane change maneuver, then decelerate as they enter the left-turn lane.[6]

A study by the University of South Florida gives some guidance for the weaving distances needed (See ***Table 15***). ***Figure 33*** shows the "weaving distance."[7]

Figure 33 | Weaving Distance Between Driveway and U-Turn



Source: FDOT

Although the study focused on the weaving made by vehicles positioning for a U-turn, the recommended distances are the same as weaving distance for left-turn and U-turns. The research highlights that the more through lanes a facility has, the longer the weaving distances are from the driveway to the median opening. This information can be used to help optimize the location of a new driveway that will require right turns followed by left turns or U-turns downstream at the next median opening or signalized intersection.

Table 15 | Guidance on Weaving Distances

Turn Location	Number of Lanes	Weaving Distance (feet)
Median Opening	4	400
	6 or More	500
Signalized Intersections	4	550
	6 or More	750

Source: University of South Florida. (2005). Determination of the Offset Distance between Driveway Exits and Downstream U-turn locations for Vehicles making Right Turns Followed by U-turns

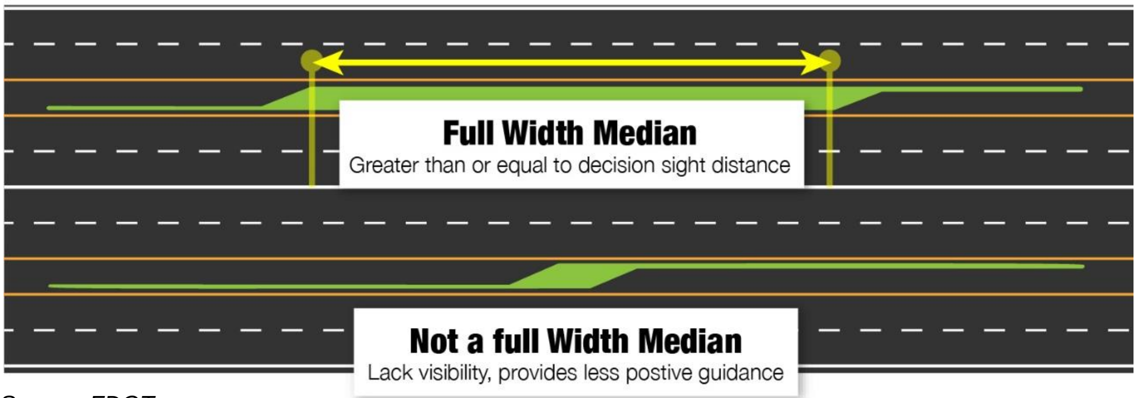
[6] *NCHRP 420 Impacts of Access Management Techniques - 1999*

[7] *Determination of the Offset Distance between Driveway Exits and Downstream U-turn Locations for Vehicles making Right Turns Followed by U-turns –University of South Florida, November 2005 - Jian John Lu, Pan Liu, and Fatih Pirinccioglu*

Full Width Median

The length of the full width median should be as long as possible so the median will be more visible to the driver (***Figure 34***). This also gives more space for traffic signs and landscaping. The full width median should be greater than or equal to the decision distance. (See *AASHTO Greenbook Chapter 3* for more information).

Figure 34 | Length of Full Width Median



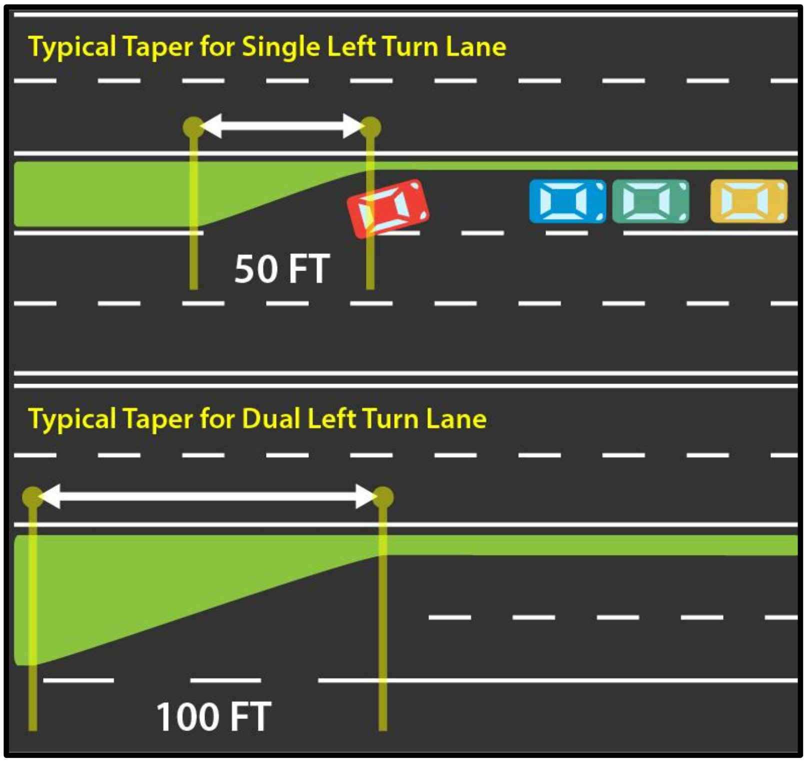
Source: FDOT

Maneuver/Deceleration Distance

The Maneuver-Deceleration Distance consists of two components; taper and deceleration. Taper is the portion of the median opening that begins the transition to the turn lane. *FDM 212 - Intersections* contains the standards for this feature.

Design standards for left-turn lanes are available from several sources, most of which determine their rate of taper length from the approach speed; the faster the speed, the longer the taper. FDOT does offer standards for the design of left-turn lanes. *FDM 212* dictates the use of a 4:1 ratio, or 50 feet, for turn bay tapers on all multilane divided facilities regardless of speed. This may appear to be an abrupt transition area for free-flow conditions; however, most urban areas will benefit from a longer storage area for queued vehicles. It also provides a better visual cue to the driver for the turn lane. Typically, 50 feet. (or 100 feet. for dual-left-turn lane tapers). ***Figure 35*** is an example of taper distances depending on the roadway and number of lanes.

Figure 35 | Taper Distances



- More Storage
- Less change of a vehicle blocking through lane

Source: Adapted from FDM 212 – Intersections

Additional Taper Designs can be found in the *AASHTO Green Book*.

Total Deceleration

Minimum standards for the distance needed to properly slow a vehicle down and bring the vehicle to the storage portion of the median opening, or deceleration distance, is found in *FDM 212*. This distance is measured from the beginning of the taper to the end of the queue storage portion.

The standards found in *FDM 212*, however, should be considered a minimum because research has shown reactions vary considerably with drivers. In many cases, more space may be needed. A table summarizing these values is provided in ***Table 16***.

The turn bay should be designed so that a turning vehicle will develop a speed differential ("through vehicle" speed minus the entry speed of the "turning vehicle") of 10 mph or less at the point it clears the through traffic lane and enters the turn lane. The length of the turn lane should allow the vehicle to come to a comfortable stop prior to reaching the end of the expected queue in the turn lane. It is important to note that class 4 - 13 vehicles can be 40 feet – 75 feet long and may require additional length to meet this requirement.

Design Speed

The design speed is the speed used to make critical decisions on the roadway design features. The *AASHTO Green Book* defines the design speed as:

> *"Design speed is a selected speed used to determine the various geometric design features of the roadway… In selection of design speed, every effort should be made to attain a desired combination of safety, mobility, and efficiency within the constraints of environmental quality, economics, aesthetics, and social or political impacts."*
>
> *"Once selected, all of the pertinent features of the highway should be related to the design speed to obtain a balanced design. Above-minimum design values should be used where practical, particularly on high speed facilities."*

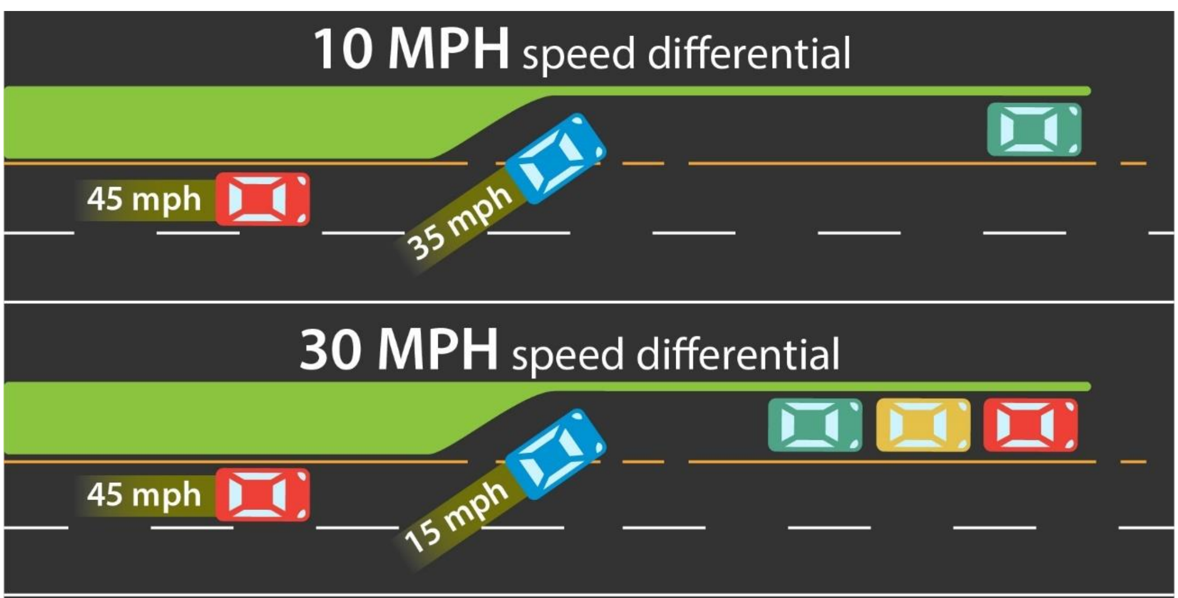
Entry Speed

When considering medians and median openings, the greatest use of design speed is for determining the length of right- and left-turn lanes. *FDM 212* identifies that design speed and the related entry speed are the basis for determining the minimum length of the turn lane for deceleration and stopping behind the turn lane queue.

If the turn lane is too short, or queued vehicles take up too much of the deceleration portion of the turn lane, excessive deceleration will occur in the through lane. This creates a high crash potential (***Figure 36***).

Non-Peak hour speeds are also important considerations since around 80% of the daily traffic takes place outside of the peak hours at that time, usually at higher speeds. Turning volumes are lower at those times which will make queuing requirements smaller.

Figure 36 | Excessive Deceleration



Source: FDOT

Table 16 | Deceleration Distances

Design Speed (mph)	Entry Speed (mph)	Total Deceleration (feet)
35	25	145
40	30	155
45	35	185
50 Urban	40	240
50 Rural	44	290
55 Rural	48	350
60 Rural	52	405
65 Rural	55	460

Source: FDM 212 – Intersections (Exhibit 212-1)

For more information on speed definitions:

- *FDM 201.5* Design Speed
- Design Speed, Operating Speed, and Posted Speed Practices, *NCHRP Report 504, 2003*
- *AASHTO Green Book*

Queue Storage

Turn lanes must include adequate length for the storage of traffic waiting to perform a turn. This is also called turn lane queue length.

The queue length provided should be based on a traffic study. *FDM 232.2* states:

> *"Storage lanes for left turns can affect the capacity and safety of intersections. The storage length of a left turn lane is a critical design element. The queue of left turn vehicles in a storage lane of inadequate length may extend into the through lanes. The result is loss of capacity for the through lanes. The queue of through vehicles may also extend beyond the entrance of a short left-turn storage lane, blocking access to the storage lane. Either case results in a less efficient operation of the intersection and may cause last minute lane changes, thereby increasing the possibility of conflicts."*

In low-volume situations, *FDM 212.14.2* states:

> *"For low volume intersections where a traffic study is not justified, a minimum 50-foot queue length (2 vehicles) should be provided for C1, C2, and C3R context classifications. A minimum 100-foot queue length (4 vehicles) should be provided in C2T, C3C, C4, C5, and C6 context classifications. Locations with over 10% truck traffic should accommodate at least one car and one truck."*

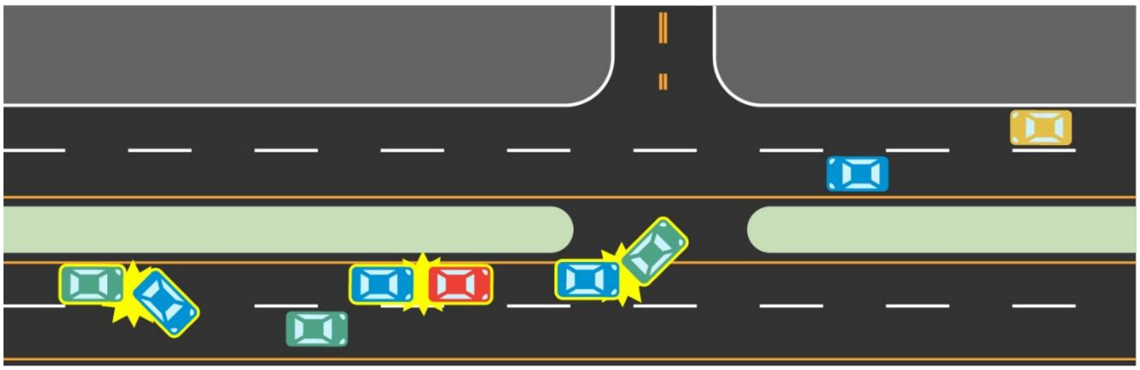
For queue lengths at signalized intersections, refer to *FDM 232*.

3.1.3 Median End Treatments

The median end design for an urban arterial should be designed for a passenger vehicle while assuring it can accommodate a larger design vehicle. Alternative median end designs include: semicircular, symmetrical bullet nose, asymmetrical bullet nose, and the half-bullet nose.

The "bullet nose" median opening requires a vehicle to make a left turn from a through lane interfering with the through traffic. This will result in a situation with a high potential for rear-end crashes as shown in ***Figure 37***.

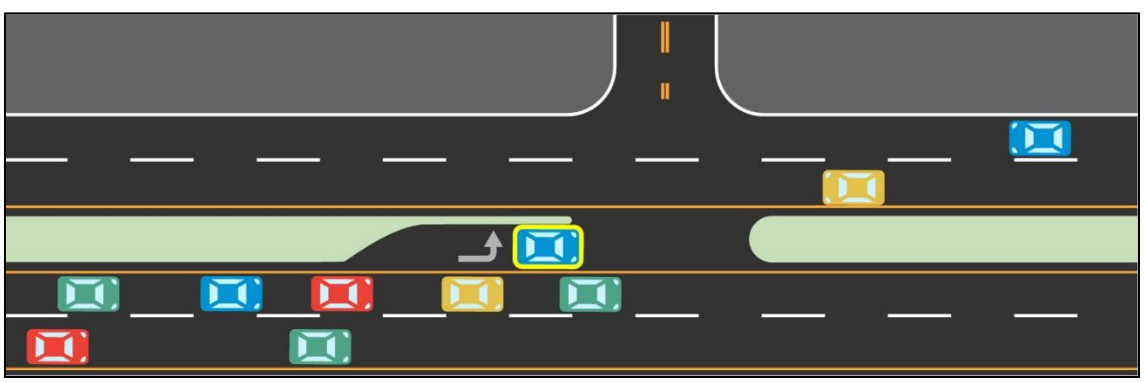
Figure 37 | Potential Crash Problems When Left Turns are Made from the Through Traffic Lane



Source: FDOT

The most common method in which left-turning vehicles can be removed from a through traffic lane is to install a left-turn lane as shown in ***Figure 38***. The lane should be of sufficient length to allow for adequate maneuvering distance plus queue storage as discussed earlier in ***Section 3.1.2*: *Median Opening Failures***. The total deceleration length, including the taper, should be sufficient to allow the turning vehicle to decelerate from the speed of through traffic to a stop, plus queue storage. Per the FDOT Median Opening and Access Management Procedure, "Existing bullet nose median openings should be replaced with an adequate left-turn lane."

Figure 38 | Left-Turn Lane to Remove Left-Turn Vehicles from the Through Traffic Lanes

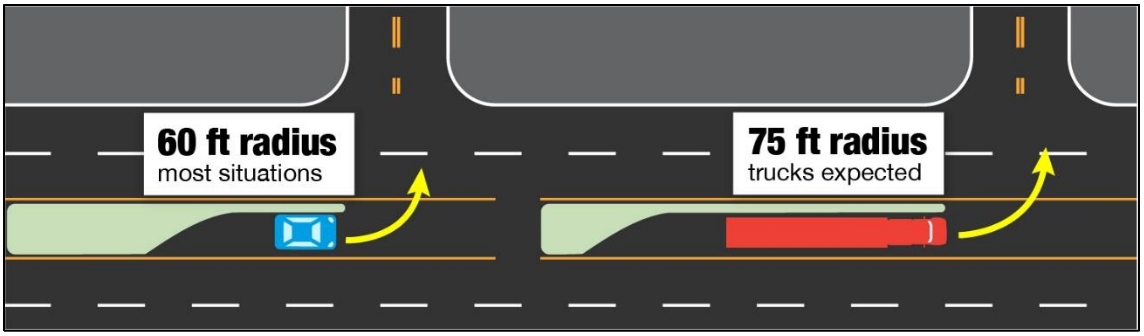


Source: FDOT

3.1.4 Median Opening Left-Turn Radius

FDOT has historically used 60 feet for most situations and 75 feet when significant truck volumes are expected for left-turn or control radii (***Figure 39***).

Figure 39 | Typical Radius for Left-Turn Movements



Source: FDOT

The *FDM 212.9* provides guidance on median openings and provides control radii for minimum speed turns. The control radius refers to a radius that must be considered in establishing the location of median or traffic separator ends on divided highways and the stop bar on undivided highways. It directs the designer to provide the radius for minimum speed (10-15 mph) left-turn movements when appropriate for establishing the location of median ends. ***Table 17*** provides the desired control radius by design vehicle.

Table 17 | Control Radii for Minimum Speed Turns

Design Vehicles Accommodated	Control Radius (feet)			
	50 (40 min)	60 (50 min)	75	130
Predominant	P	SU-30	SU-40, WB-40	WB-62FL
Occasional	SU-30	SU-40, WB-40	WB-62	WB-67

Source: FDM 212 – Intersections (Table 212.9.2)

For more detailed information on design vehicle control radius, see the *FDM 212.9 - Median Openings*.

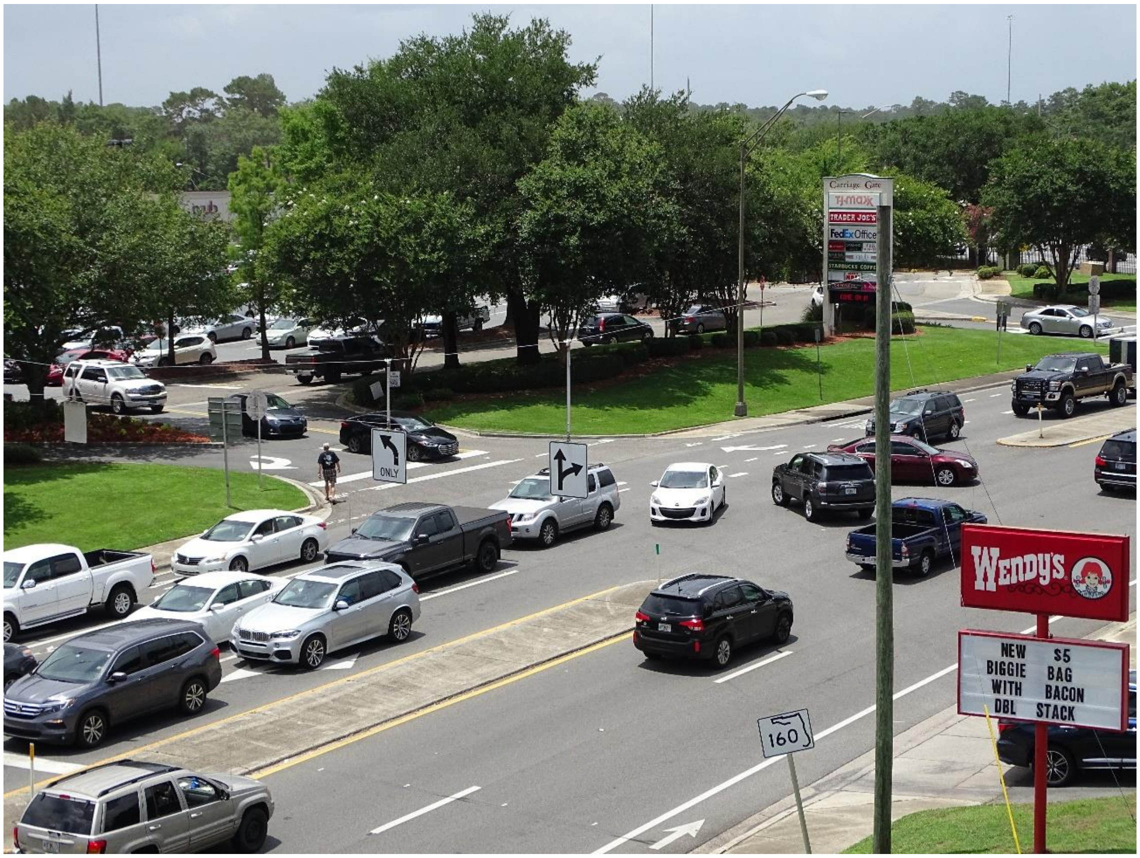
3.1.5 Median Opening Length

Median opening length is governed by the:

- Turning or control radii
- Side street geometrics
- Median (traffic separator) width
- Intersection skews
- Intersection legs

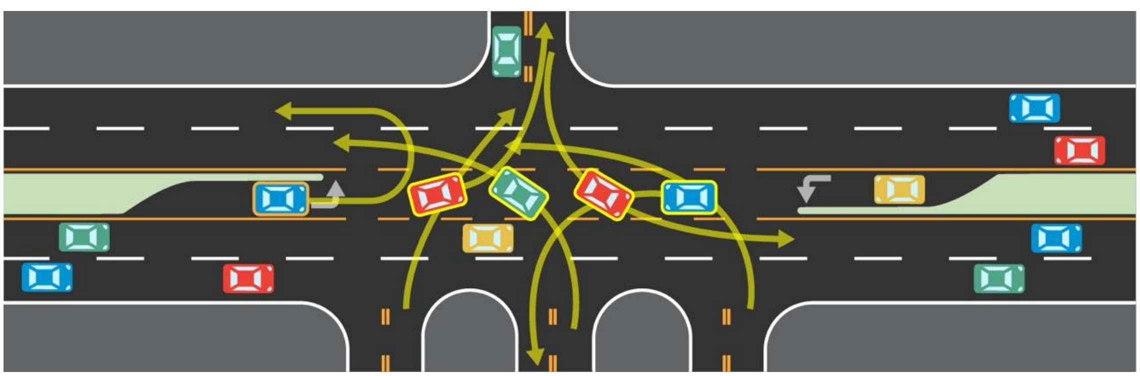
An excessively wide median opening will store multiple vehicles in an unsignalized full median opening while they are waiting to complete a maneuver. Excessively wide openings result in multiple conflicts for both the turning vehicles and through traffic. The situations illustrated in ***Figure 40*** and ***Figure 41*** are common occurrences at wide full median openings on high-volume roads during peak periods. This often occurs in areas that experienced significant development and growth in traffic volumes since the median opening was originally constructed.

Figure 40 | Vehicles Stopped in Excessively Wide Median Opening



Source: CDM Smith

Figure 41 | Vehicles Stopped in Excessively Wide Median Opening



Source: FDOT

The presence of several vehicles in the median opening results in impaired sight distance, especially when one or more of the vehicles is a pickup, van, or RV. Signalization should be considered only if the median opening meets the criteria of a signal warrant analysis.

Alternative solutions to the problem are:

- Reconstruct the unsignalized full opening as a more restrictive median opening
- Close the median opening
- Directionalize the median opening

The solution selected, as well as the design of the restrictive movement (if used) will depend on several factors including; the proximity to other median openings, alternative routes, traffic volumes, and the crash history of the roadway.

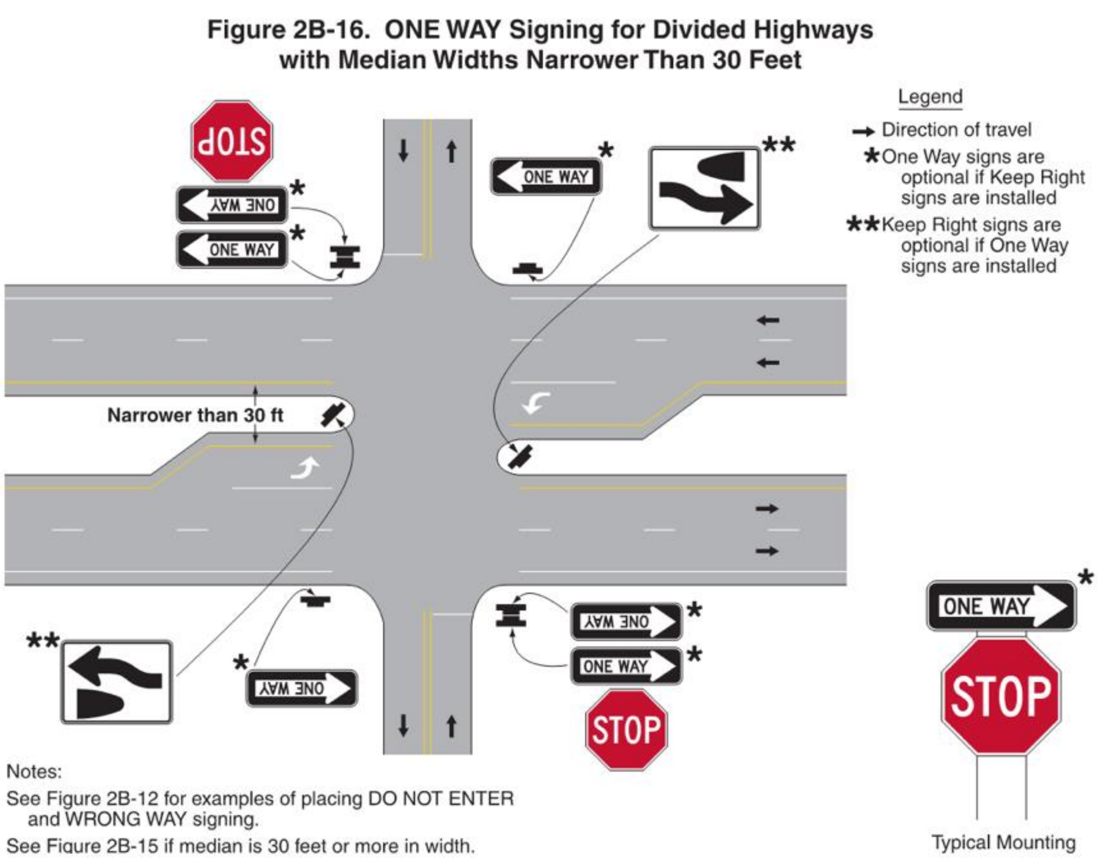
The *FDM 212.9*, provides additional guidance below on median opening length:

> *"The overall length of a full median opening is typically the same width as the intersecting road (including shoulders) which is sufficient to accommodate the swept path of left turning vehicles…For un-signalized intersections, median openings should not be longer than the required length to avoid multiple vehicles attempting to stop within the opening."*

3.1.6 Pavement Markings and Signing

The *Manual on Uniform Traffic Devices (MUTCD)* contains guidance on the type and placement of signs and traffic control devices at median opening areas (See ***Figure 42***). FDOT also provides guidance for signing and pavement markings in the *FDOT Standard Plans, Index 711-001*.

Figure 42 | MUTCD Figure 2B-16



Source: *MUTCD*

3.2 Retrofit Considerations

When resurfacing or altering a segment of a roadway within the SHS, it is recommended that all medians, median openings, and driveways be assessed to determine if it is appropriate to retrofit any of the median characteristics.

3.2.1 Assessing a Median Opening

The following assessment guidance is adapted from Guidelines for Median Opening Placement and Treatment Type from FDOT District 5 published in 1996. This practice is still employed by District 5 and considered relevant guidance today.

For the initial assessment of the existing median opening, the design requires data collection and analysis. A four-step process described below should provide adequate information for decision making on whether to close, alter, or maintain an existing median opening.

1. **Determination of "Major" Cross Streets and "Major" Driveway Locations**
   Cross streets and driveways can be determined as "Major" cross streets or "Major" driveways based on the following criteria:
   - Cross streets classified as Arterials or collectors
   - Signalized cross streets and driveways
   - Unsignalized driveways with significant peak hour or daily traffic volumes, equivalent to a Class C or higher driveway with more than 600 vehicle trips per day or more than 60 vehicle trips per hour
2. **Data Collection**
   - Identification of all existing signalized intersections, as well as those locations scheduled for signalization in the near future
   - Elimination of intersections from consideration for signalization (based on proximity to other signalized intersections)
   - 24-hour bi-directional approach counts on each leg of each intersection
   - Pedestrian and bicycle counts on each leg of the intersection, 4-12 hour depending on proposed intersection control
   - Other pertinent traffic data includes:
     - Traffic count locations for vehicle classification and volume to develop traffic characteristics
     - Planned development in the corridor
     - Locations of schools, school crossings, and school zones
     - Locations of facilities/design characteristics that serve emergency vehicles
     - Locations of land uses which have special access requirements (bus terminals, truck stops, fire stations)
     - Existing pedestrian crossings, parks, or other pedestrian generators
     - Existing and proposed bicycle facilities
     - Recent crash data (3 years minimum, 5 years preferred), especially individual crash reports
3. **Analysis**
   - Preliminary signal warrant analysis using existing volumes
   - Determine if (proposed) signal spacing is adequate using progression analysis
   - Verify that existing signals still meet the warrants
   - Intersection and arterial capacity analyses based on anticipated roadway improvements to determine overall corridor level of service (using projected design-year data)
   - Perform Intersection Control Evaluation (ICE) analysis

4. Recommendations

- Provide a list of existing signalized intersections which are expected to continue to meet the warrants for signalization
- Develop a list of intersections which are candidates for future signalization that will still provide adequate spacing between signalized intersections
- Provide roadway segments where median openings are not recommended (site specific reasoning), as well as noting all existing median openings being closed or modified
- Provide recommendations for median opening locations and treatment type
- Based on the results of the ICE analysis, verify the median type recommended based on all factors including bicyclists and pedestrians

Once the recommendation has been made to close, alter, or maintain an existing median opening, the following sections of this handbook provide guidance on how to proceed with that decision. Note that Florida Statute, *F.S. 335.199*, governs how FDOT works with the public regarding median changes. More information about required public involvement for access management can be found in ***Chapter 11: Public Involvement and Stakeholder Engagement in Access Management***.

Closing a Median Opening

The following criteria provides guidance on a recommendation to close an existing median opening:

- Narrow median width (<14 feet or less than length of design vehicle) where left-turning vehicles cannot be protected during a two-stage left-turn (move to median and then proceed left when the appropriate gap becomes available for the left-turning vehicle
- A combination of high volume left-turn-out movements coupled with high through and left-turn-in movements, significantly reducing making the availability of available gaps
- High volume of left-out movements onto the major roadway (AADT >27,000 AADT or dictated by existing crash data)
- Disproportionate share of angled crashes involving the left-out turning movement
- Provision of an appropriate place for the displaced left-turn to make U-turns
- High volume of bicycles or pedestrians crossing the cross street or driveway and/or in locations with a history of pedestrian/bicycle crashes – in this case, it may be appropriate to close the median opening to vehicular traffic but it is recommended to evaluate a formal midblock pedestrian crossing with appropriate traffic control such as a midblock pedestrian signal or pedestrian hybrid beacon

Driveway consolidation and median opening alterations that would improve traffic conditions as a result of a plan that includes median closure(s).

Altering a Median Opening

Additional guidance on the alteration of an existing median opening based on median width:

- Narrow Median (12 – 14 feet)
    - Replace a full median opening with a directional opening for left turns from one direction only
- Median (>14 feet)
    - Replace a full median opening with a directional opening for left turns from both directions

3.2.2 Constructing a Raised Median on an Existing Roadway

A common roadway retrofit for an existing 5-lane or 7-lane roadway with center turn lane to improve access management and address crash issues is to consider constructing a raised median or median islands. Evaluating a median or median islands retrofit should follow the process as defined in ***Chapter 10: Corridor Access Management Plans***. Additional considerations for this type of retrofit include the following:

- Replace the center turn lane with a raised median to restrict movements to right-in/right-out only.
- Install a raised median with a directional median opening. Where the center-turn lane width is 14 feet or more, the directional opening may be designed for left turns from both directions on the roadway. Where the center turn lane is less than 14 feet wide, the directional opening should be designed for left turns from one direction only. Consideration as to the choice as to which connection will have left-turn in movements and which will not include:
  - Alternative access - The directional median opening given to the property not having alternative access, or the less extensive alternative.
  - Traffic generation - The directional opening going to the property generating the most traffic.
- Consider traffic shifts that will result in U-turn maneuvers due to the placement of the median or median islands. On 5-lane roadways converted to 4-lane divided roadways, U-turns can be challenging maneuvers to make without additional geometric changes at the median openings. ***Chapter 6: Turn Lanes and U-Turns*** provides more information about U-turns.

For more information on this topic, see *Access Connections on Opposite Sides of Roadway, CUTR (2008)*.

3.2.3 Considerations for Resurfacing, Restoration, and Rehabilitation (3R) Projects

FDM 114 – Resurfacing, Restoration, and Rehabilitation (RRR) provides direction for 3R projects.

When a 3R project is planned for a corridor, many features of the facility are analyzed. Some of the most important considerations involve access management. These may include:

- Radius improvements at side road driveways due to evidence of off-tracking
- Close abandoned driveway in urban/curb & gutter section to improve ADA accessibility/sidewalk
- Correct driveways that do not meet design standards (i.e. slopes too steep, documented dragging or damaged driveway and/or asphalt on roadway)
- Construct new transit/bus amenities (bus bays, pads for bus shelters, bus stop pads)
- Construct new turn lanes to meet projected need
- Lengthen/revise existing turn lanes at signalized intersections due to documented operational issues
  - Any intersection could be revised as needed based on verified crash history and safety assessment [8] [9]

[8] To remain in resurfacing projects at the engineer's discretion

[9] *FDM 114.3.2.2 - Safety Assessment*

Also, while new driveways on a roadway located on the SHS must go through the full permitting process, driveways that are modified by FDOT due to roadway improvements do not need to go through the full process.

TWLTLs

FDM 210 – Arterials and Collectors provides the following direction:

> *"Two-way left-turn lane widths (flush median) may be used on 3-lane and 5-lane typical sections with design speeds ≤ 40 mph. On new construction projects, flush medians are to include sections of raised or restrictive median to enhance vehicular, bicycle, and pedestrian safety, improve traffic efficiency, and attain the standards of the Access Management Classification of that highway system. Sections of raised or restrictive medians are recommended on 3R projects."*

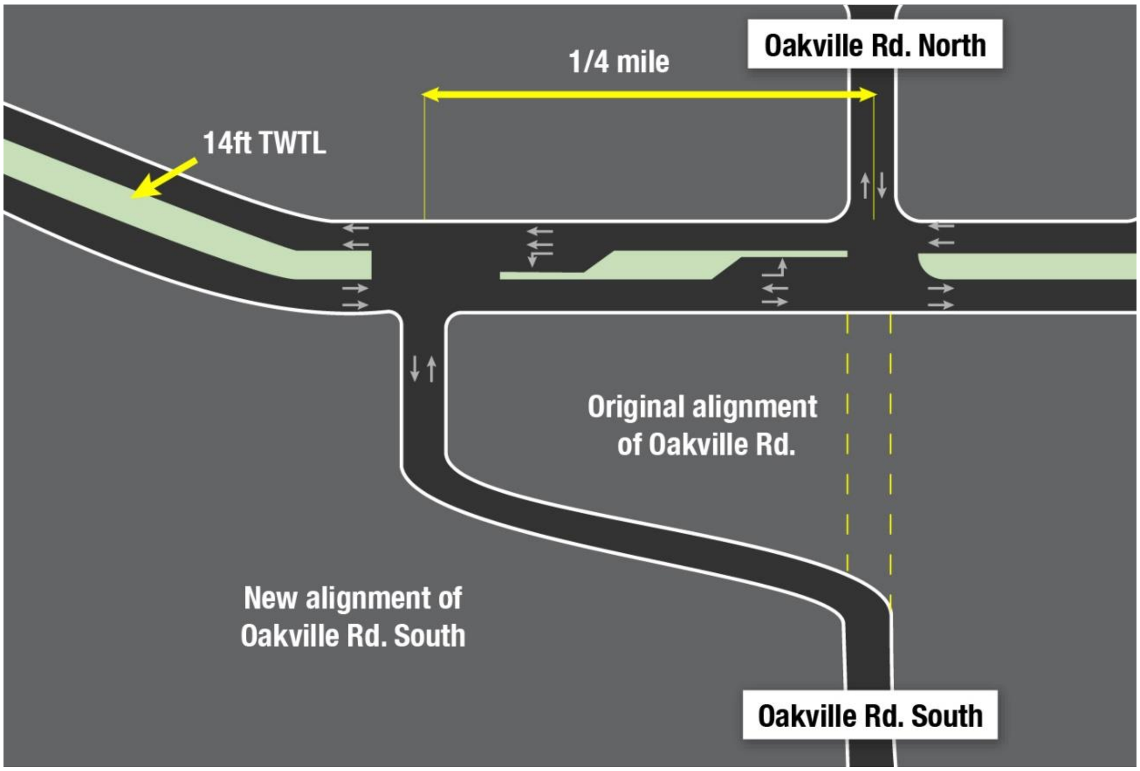
3.3 Rural Median Opening Considerations

Unsignalized intersections in rural areas can often lead to some of the most dangerous points of conflict due to generally higher speeds and reduced enforcement of proper driver behavior. Crash data in rural areas has shown a higher proportion of right-angle crashes and injury rates compared to more urbanized areas. It is in the best interest of the travelling public to limit the number of through movements across major roadways from minor roadways. The following sections provide suggestions to improve safety performance on rural facilities on the SHS.

3.3.1 Re-Aligning Minor Roadway Intersections

Where an unsignalized intersection in a rural area experiences a high crash rate, due to a minor roadway crossing a major roadway, it is recommended (when sufficient ROW exists) that one of the access points to/from the minor roadway be re-aligned so that a four-way intersection is modified to create two three-way intersections, ideally spaced approximately ¼ mile apart or more (See ***Figure 43***). This technique can reduce the number of conflict points from 32 to 24 and reduce serious injury crashes. Specific guidance and case studies for this technique can be found in *NCHRP Report 650 Median Intersection Design for Rural High-Speed Divided Highways*.

Figure 43 | Realigning Roadway to Create Two 3-Way Intersections



Source: New Jersey Department of Transportation

3.4 Special Rural Highway Treatments

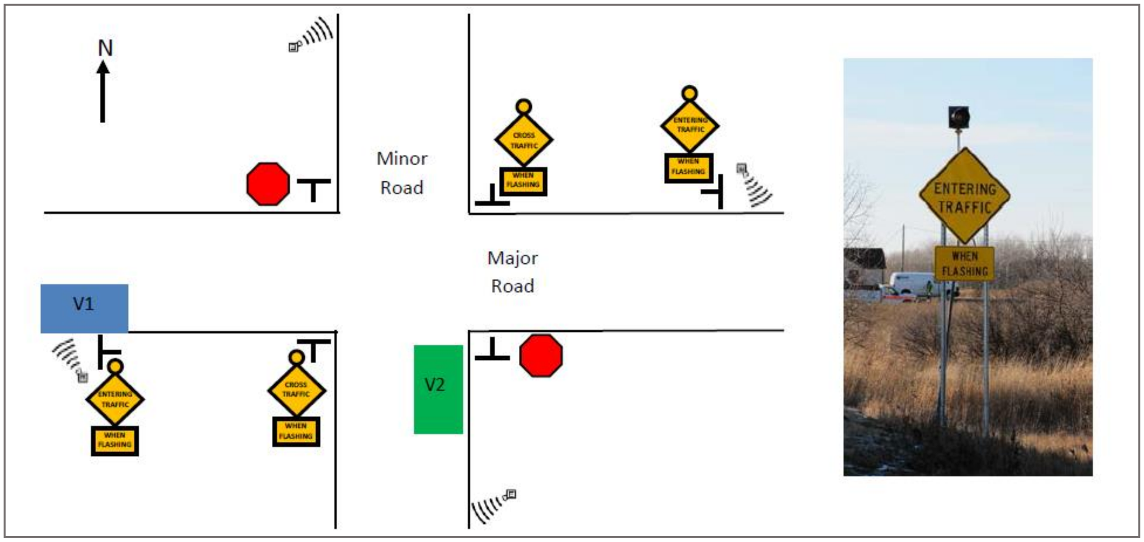
3.4.1 Advance Warning of Oncoming Vehicles on Rural Highways

Innovative treatments of problematic intersections in rural settings have proven to be beneficial in reducing the number of accidents that result in injuries and fatalities. Even though an intersection meets all FDOT guidelines and design standards, certain situations could result in higher than expected conflicts. All geometrics and hazards should be considered when attempting to improve the safety performance of an intersection and no one method may offer the desired results. It is recommended that FDOT staff should consider innovative treatments if all other design options have been exhausted.

3.4.2 Rural Intersection Conflict Warning System

Another innovative idea designed to alleviate traffic crashes has been developed by the Minnesota Department of Transportation (MnDOT) and employed elsewhere as well. This is illustrated in ***Figure 44***. The system warns motorists if a vehicle is approaching the intersection from either direction. As a vehicle on the minor roadway approaches the major roadway, a red flashing beacon will warn the motorist if vehicles on the major roadway are approaching the intersection. Alternately, as a vehicle on the major roadway approaches the minor roadway, a yellow flashing beacon will warn the motorist if there are vehicles approaching the intersection. This system requires loop sensors in advance of the intersection from each direction.

Figure 44 | Intersection Conflict Warning System (ICWS) Concept



Source: *Rural Intersection Conflict Warning Systems Deployment – Concept of Operations (2012) Minnesota DOT*

For more information on ICWS refer to the following sites/reports:

- FHWA Enterprise Pooled Fund Multi-state Study webpage: https://enterprise.prog.org/archive/itswarrants/icws.html
- USDOT Research and Development page: *https://highways.dot.gov/research-programs/safety/safety-rd-overview*
- *FHWA Intersection Conflict Warning System Human Factors: Final Report, 2016*.

Chapter 4: Driveway Dimensions

4.1 Overview

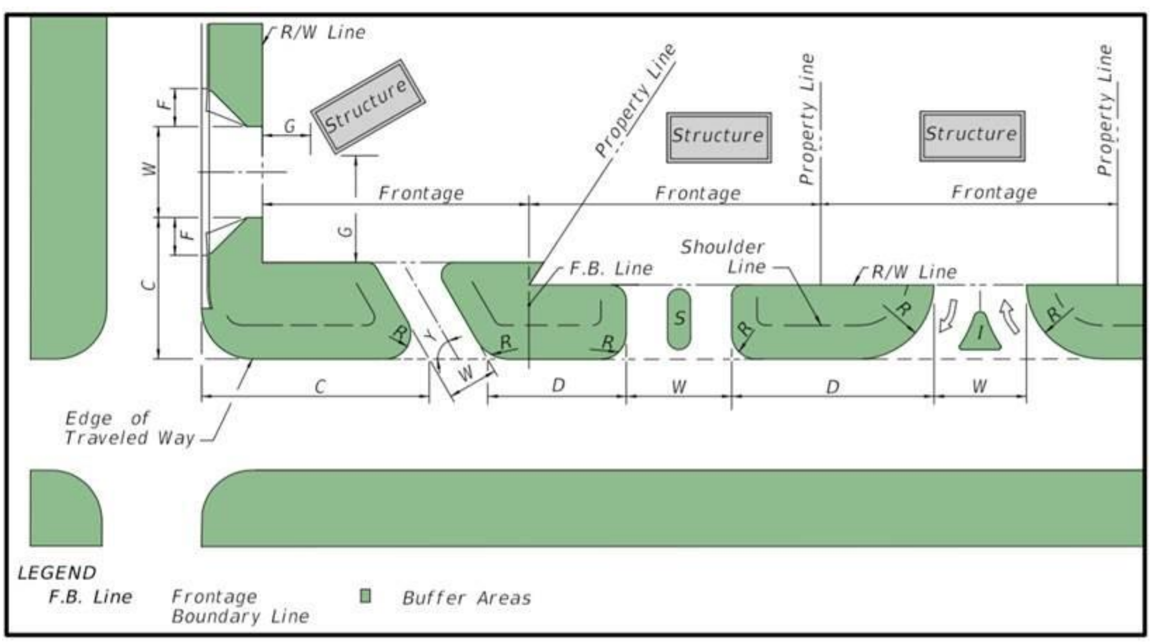
The design of driveways is influenced by numerous elements. The design speed of the roadway, the number of vehicles per day that utilize them, the roadway class and FDOT context classification all influence the various geometries of the final design. For example, a higher roadway design speed may require a driveway to have a larger radius. A significant increase in number of vehicles that enter a driveway due to new development may dictate installing a traffic separator. The following section, Driveway Geometries, will discuss the design criteria governing driveways and provide examples of how they affect operations of both the driveway and abutting roadways.

FDM 214 – Driveways, includes considerations and requirements for the design of driveways defined as connection categories A, B, C, or D. Connection categories E, F, and G are designed as intersections in accordance with *FDM 212 – Intersections*.

4.2 Driveway Geometries

The design elements and other requirements for driveways are discussed within *FDM 214 - Driveways*, with construction details detailed in *Standard Plans, Index 522-003 and 330-001*. This information enables planners and engineers to determine the best designs for driveways based on roadway conditions, the context classification, and other conditions. The various design criteria of a driveway are illustrated in ***Figure 45,*** which is from *FDM 214 - Driveways*. Each of these elements play an integral role in driveway design.

Figure 45 | Driveway Terminology



Source: *FDM 214 - Driveways (Figure 214.1.1)*

As described in *FDM Chapter 214.1.1*, the text below describes the various design elements and driveway terminologies that are standard terms or variables that provide the various typical driveway types that are required to develop driveway designs.

- **Radius (R)** – The radial dimension of curved driveway entry or exit.
- **Flare (F)** – The total length of angled approach/exit at the edge of roadway for a flared driveway.
- **(W)** – Effective width of the driveway, measured between the left edge and the right edge of driveway.
- **Driveway Connection Spacing (D)** – Spacing between driveways from the projected edge line of each driveway (see connection spacing in the FDM Tables 201.4.2 and 201.4.3).
- **Corner Clearance (C)** – Distance from an intersection, measured from the projected closest edge line of the intersecting roadway to a driveway projected edge line (see connection spacing in Tables 201.4.2 and 201.4.3).
- **(Y)** – Angle of the driveway between the driveway centerline and the roadway edge of traveled way.
- **Setback (G**) – Distance from the ROW line to the closest permanent structure.
- **Driveway Location** – Position of driveway in relation to other traffic features such as intersections, neighboring driveways, median openings, and interchanges.
- **Driveway Length** – Distance needed into the site to transition vehicles to the internal circulation system of the site.
- **Driveway Traffic Separators (S)** – Linear islands or raised medians used to separate traffic movements on the driveway.
- **Channelizing Islands (I)** – Used to facilitate right turns and discourage left-turn movements on the driveway.

As discussed in the previous chapters, there are seven different driveway categories (A – G). This chapter focuses on the first four (A – D). The various driveway design elements which are listed above are influenced by the driveway category, roadway type (Curbed vs. Flush shoulder), and context classification. These three areas affect the recommended dimensions (See ***Table 18***).

4.2.1 Radius (R)

The radius of a driveway (also called radial return) affects the turning movements of vehicles. Smaller radii, such as the 15 feet and 25 feet minimums in ***Table 18***, force drivers to slow down when turning. Larger radii, such as 50 feet and 75 feet, allow vehicles to turn more quickly, but increases the crossing distance for pedestrians and bicycles. Lower turning speeds are preferable in higher context classifications, and C2T, as well as other locations where speed management is desired.

Effective Radius

It is sometimes possible to accommodate both non-motorized users and large vehicles by utilizing an effective radius approach as illustrated in ***Figure 46***. This shortens pedestrian crossing distance and can reduce ROW requirements. The presence of a bike lane or parking lane creates an "effective radius" that allows a smaller curb radius to be constructed than otherwise would be required for some motor vehicles because these lanes occasionally can provide turning vehicles extra maneuvering space.

Table 18 | Driveway Dimensions (Curbed Roadways)

Element	Description	Connection Category		
		A	B Two-Way	C & D Two-Way
Curbed Roadways				
W	Connection Width	12' Min 24' Max	24' Min 36' Max	24' Min 36' Max
F	Flare (Drop Curb)	10' Min	10' Min	N/A
R	Radial Returns (Radius)	N/A	See Note 3	25' Min 50' Std 75' Max
Y	Angle of Driveway	60°- 90°	60°- 90°	60°- 90°
S	Driveway Traffic Separator or Median	N/A	4'-22' Wide	4'-22' Wide
G	Setback	12' Min., All categories.		
C & D	Corner Clearance and Connection Spacing	See connection spacing in ***FDM Tables 201.4.2*** and ***201.4.3***		
Flush Shoulder Roadways				
W	Connection Width	12' Min 24' Max	24' Min 36' Max	24' Min 36' Max
F	Flare (Drop Curb)	NA	NA	NA
R	Radial Returns (Radius)	15' Min 25' Std 50' Max	25' Min 50' Std 75' Max	25' Min 50' Std (Or 3-Centered Curves)
Y	Angle of Driveway	60°- 90°	60°- 90°	60°- 90°
S	Driveway Traffic Separator or Median	N/A	4'-22' Wide	4'-22' Wide
G	Setback	12' Min., All categories.		
C & D	Corner Clearance and Connection Spacing	See connection spacing in ***FDM Tables 201.4.2*** and ***201.4.3***		

Notes:

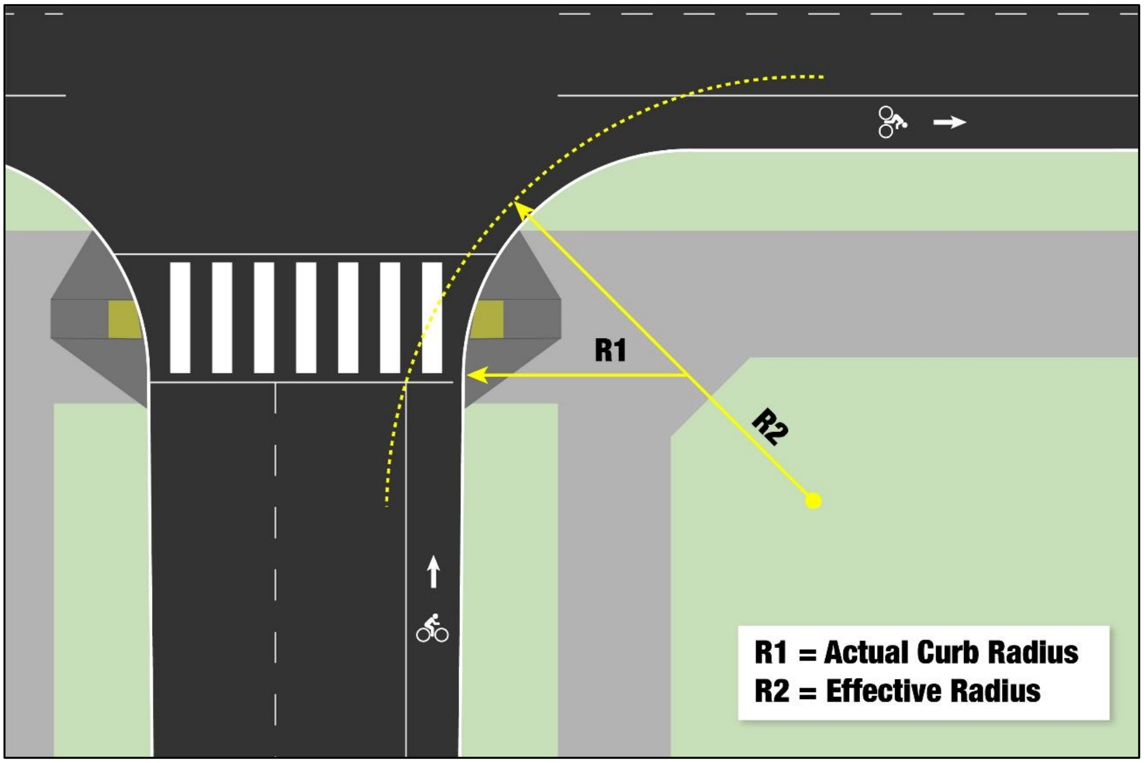
(1) Connection Categories A, B, C, and D are defined in ***FDM 214.1.1***.
(2) 2-Way refers to one entry movement and one exit movement, i.e., not exclusive left or right turn lanes on the connection.
(3) Small radii may be used in lieu of flares for curbed roadways in Connection Category B when approved by the Department.
(4) The Angle of Driveway for Connection Category A may be reduced with approval by the local Operations/Maintenance Engineer.
(5) Design criteria for channelization islands (I) is found in ***FDM 210.3***.

Radial Returns (Radius):

(6) Provide the minimum radius for low-speed roadways with driveway design vehicle of a passenger car.
(7) Provide the standard radius for high-speed roadways or driveway with large design vehicles (e.g., SU-30).
(8) Consider providing the maximum radius or compound curve for high-speed roadways or driveway with large design vehicle (e.g., WB-62).

Source: FDM 214 – Driveways (Table 214.3.1)

Figure 46 | Actual and Effective Curb Radius



Source: FDOT

Large Vehicular Movements

It is important to design roadways using a context sensitive design, to ensure large vehicles can be accommodated while safely providing for non-motorized users. For a driveway that serves multiple larger vehicles every hour, it is recommended that the final design provide assistance to these types of vehicles to minimize any potential operational or safety issues arising from conflicts with other users.

Care should be taken to balance large vehicle needs and pedestrian needs in context classifications C2T, C4-6, particularly in areas where high volumes of bicyclists or pedestrians are expected or along roadways with a dedicated separated bikeway (either a shared-use path or separate bikeway). This can be accomplished by using reinforced, raised, textured aprons (example shown in ***Figure 47)*** to accommodate the turns of larger vehicles but also help limit the speed of other smaller turning vehicles.

Figure 47 | Truck Apron

Source: SR 582 / Fowler Avenue, Tampa, FL – Google Earth

Table 19 below provides some general guidance on driveway design to be used along with ***Table 18***.

Table 19 | Recommended Driveway Design Criteria Based on Large Vehicle Use

Number of Trucks or Buses Per Hour	Operation to Design for:	Design Vehicle
Commercial and Office Uses		
≤ 2	Simultaneous 2-way	P-Vehicle or a Standard Passenger Vehicle*
≥ 3	Simultaneous 2-way**	Single Unit vehicle (typical FedEx or UPS Truck)
Industrial Uses		
	Simultaneous 2-way	Typical multi-unit tractor trailer
Other Uses		
Truck stop	Simultaneous 2-way***	Largest Vehicle****
Transit Center/ Bus Terminals	Simultaneous 2-way	Largest Bus
Recreational with RVs and trailers	Simultaneous 2-way	Motor Home w/ Trailer
** A standard passenger car (P vehicle) can enter while another standard passenger car (P vehicle) is waiting to exit.*		
*** A standard delivery Single Unit truck (SU vehicle) can enter when a standard passenger car (P vehicle) is waiting to exit.*		
**** Designed so that larger vehicles can off-track through the driveway*		
***** Interstate semi-trailer and turnpike double trailer will be the design vehicle in many states, especially in the vicinity of freeway interchanges.*		
Source: Adapted from Transportation and Land Development, 2002, Stover (pages 7-12)		

4.2.2 Flare (F)

As mentioned previously in ***Chapter 2: Roadway Openings***, there are two main types of driveways; flared and radial return. The flare design criterion is applicable towards flared driveway designs for driveway categories A and B. A flared driveway is intended for areas where there are low vehicular volumes and low speeds for vehicles entering or exiting, and where a curb and gutter exists.

Flare is described as the total distance between the beginning of the angled approach at the edge of the roadway. Per ***Table 18*** the minimum requirement for driveway flare is 10 feet. There are some instances where a small radial return design can be used in lieu of a flared driveway on curbed roadways on category B driveways, but this must be approved by the Department. An example that shows the flare at a flared driveway can be seen in ***Figure 48***.

Figure 48 | Flared Driveway Example

Source: Tallahassee, FL – Google Earth

Important Considerations

While a driveway may meet the requirements to design a flared driveway (curbed roadway and driveway category A/B), it may not be appropriate to design this driveway type depending on the circumstances. It is important to review these factors thoroughly:

- Speed of traffic on roadway
- Amount of traffic expected on the driveway (especially the chances of a vehicle in the driveway attempting to exit as another vehicle enters)
- Amount of available ROW, since the radial return may require more land
- Vehicle type (Design Vehicle) typically present
- Volume of non-motorized users

There are also certain instances when a radial return driveway is appropriate in comparison to a flared driveway. For a roadway with a flush shoulder, a radial return driveway design is most appropriate.

4.2.3 Driveway Connection Width (W)

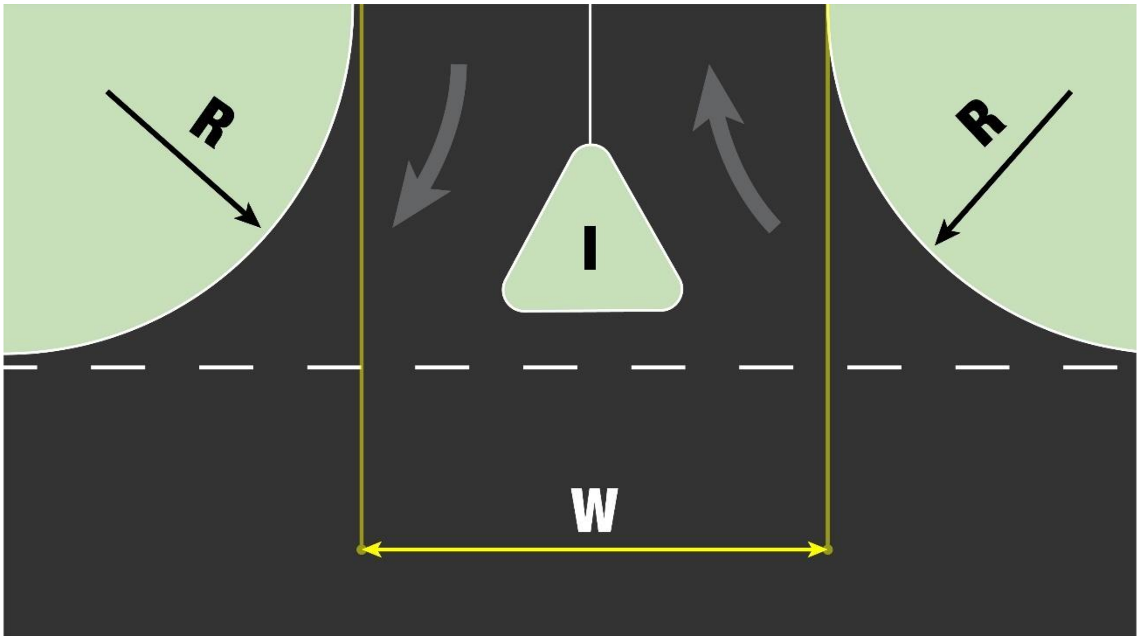
The width of the driveway is an integral part in the driveway design because it affects how quickly or easily a vehicle can enter and exit. One of the goals of good driveway design is to serve the entry and exit movements separately so the movements do not encroach on each other. This allows a vehicle to enter the driveway without encroaching on the area needed for a vehicle to exit the driveway.

A larger width also allows for vehicles to enter at a higher speed, potentially reducing roadway congestion and crashes as vehicles following the turning vehicle do not have to decelerate suddenly. A driveway with too small of a width could force vehicles to slow more than the following driver expects, thus leading to a collision. It is important to correctly design driveway width to minimize these types of collisions and situations. Context classification provides useful information about where higher-speed driveways may be appropriate. As shown in ***Table 8***, context classifications C1, C2, and C3C have a "High" or "Medium to High" modal priority for trucks, so higher speed design may be more appropriate in these locations.

Alternatively, while designing driveways with large widths would decrease the burden for persons driving, it would likely increase it for pedestrians, bicyclists and other non-vehicular users. For pedestrians walking on a sidewalk or bicyclists riding on a shared-use path or separated bike lane and crossing a driveway entrance, the width is critical because it greatly increases their exposure to traffic. Context classification provides useful information about where higher-speed driveways may be appropriate. As shown in ***Table 8***, context classifications C2T, C3R, C4, C5 and C6 have a "Medium" or "Medium to Low" modal priority for trucks, so lower speed design is more appropriate in these locations.

The width of the driveway and how it is measured is dictated by several factors. One is the angle of the driveway itself, which will be discussed later in this chapter. An example of how to appropriately determine the width of various driveways can be seen in ***Figure 49***. The correct method for measuring a driveway is to begin from the left edge and end at the right edge. Traffic separators and channelizing islands should be included within this measurement as well, as can be seen in the figure below.

Figure 49 | Driveway Width



Source: Adapted from FDM 214 - Driveways (Figure 214.1.1)

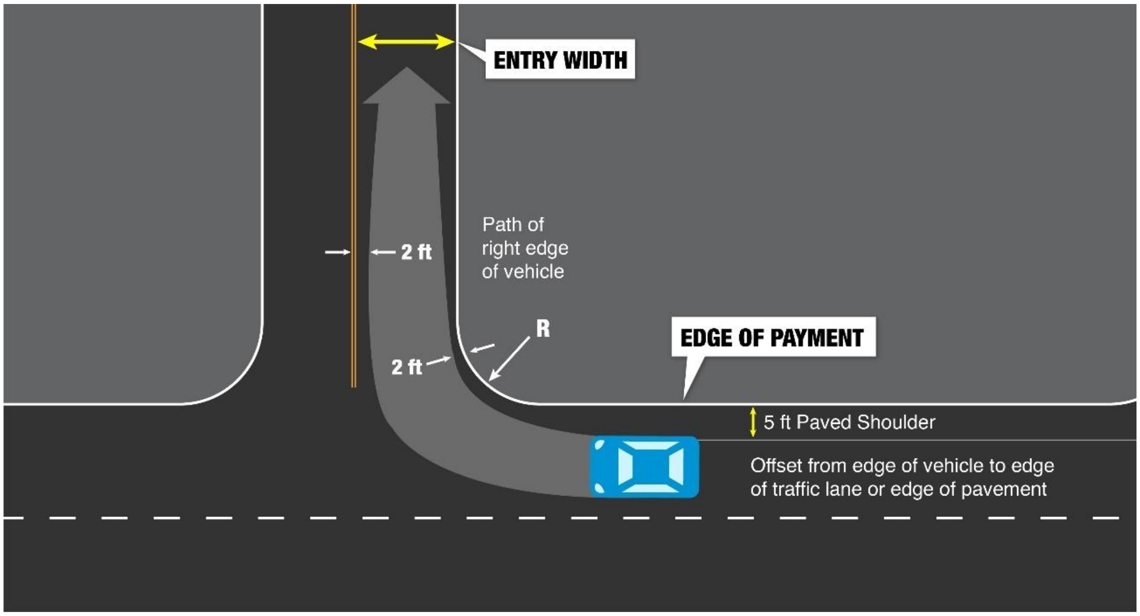
Driveway width and radius can be used in combination to create good driveway operation. Generally, a wide driveway can be used in combination with a small radius or flare to achieve similar operations. ***Figure 50*** shows the relationship between width and radius that provide for the entering passenger vehicle at approximately 10 mph to enter without encroaching on an outbound driveway vehicle.

For driveways with expected volumes of less than 20 vpd (a single home or duplex), it may not be necessary to design for "the no encroachment standard" with an outbound vehicle. For driveways above an expected volume of 20 vpd, the proper implementation of a radius is needed.

Excessive width of a driveway can create problems for both drivers and pedestrians. If the driveway is over 36 feet wide, pavement markings or channelization are generally needed to help guide the driver to the appropriate portion of the driveway. Pedestrian crosswalks are also encouraged to increase visibility to drivers entering and exiting the driveway as the width of a driveway increases.

Without the guidance of markings, drivers exiting a driveway tend to position themselves left of the driveway center. Double yellow paint lines help in guiding exiting drivers to the proper exit position. This helps ensure that the intended driveway width is available to drivers making an entry maneuver.

Figure 50 | Driveway Width and Radius



Source: FDOT

NCHRP Report 659 provides detailed guidance on the interaction of driveway width and radius. The driveway width and the curb radius can perform in concert, so to some degree one can increase as the other decreases. In other words, a wide driveway can be used together with a small radius or flare to achieve similar operations to a narrower driveway with a larger radius or flare. When only one vehicle is expected to be using the driveway at any given time, such as a residential driveway serving a two-car garage, the smaller radii are suitable with the greater widths.

Table 20 offers guidelines for driveway width and radius. These dimensions do not consider the presence of an offset between the outer edge of the traveled way and the end of the driveway, i.e., the driveway threshold.

Table 20 | Driveway Width and Curb Radius Guidelines

Category	Description of Common Applications	Driveway Width	Driveway Curb Radius (feet)		
			Higher Speed Road	Moderate Speed Road	Lower Speed Road
Standard Driveways					
Very high intensity	Urban activity center, with almost constant driveway use during hours of operation.	Many justify two lanes in, two to three lanes out. Refer to street design guides.	30–50	25–40	NA
Higher Intensity	Medium-size office or retail (e.g., community shopping center) with frequent driveway use during hours of operation.	One entry lane, 12–13 feet wide Two exit lanes, 11–13 feet wide.	25–40	20–35	NA
Medium intensity	Smaller office or retail, with occasional driveway use during hours of operation. Seldom more than one exiting vehicle at any time.	Two lanes, 24–26 feet total width	20–35	15–30	NA
Lower intensity	Single-family or duplex residential, other types with low use, on lower speed/volume roadways. May not apply to rural residential.	May be related to the width of the garage, or driveway parking. Single lane: 9–12 feet Double: 16–20 feet	15–25	10–15	5–10
Special Situation Driveways					
Central Business District	Building faces are close to the street	Varies greatly, depending on use	NA	20–25	10–15
Farm or Ranch; Field	A mix of design vehicles; some may be very low volume	Min. 16 feet, desirable 20 feet Affected by widths of field machinery	30–40	20–30	NA
Industrial	Driveways are often used by large vehicles	Minimum 26 feet	50–75	40–60	40–60

NOTES:
1. These widths do not include space for a median or a parallel bike lane or sidewalk.
2. Additional width may be needed if the driveway has a curved horizontal alignment.
3. For a flare/taper design, use the radius as the dimension of the triangular legs.
4. For industrial or other driveways frequented by heavy vehicles, consider either a simple curve with a taper or a 3-centered curve design.
5. For connection angles greatly different than 90 degrees, check the radius design with turning templates. For connection corners at which a turn is prohibited, a very small radius is appropriate.
6. Driveways crossing an open ditch should have a minimum 2 feet shoulder on each side.
7. (Source: Statewide Urban Design and Specifications, Iowa State U., Ames, IA (October 21, 2008) p. 4.)
8. If the roadway has a usable shoulder, a somewhat smaller radius may perform acceptably.
9. In areas of higher context classification (C2T or C4 - C6), as well as other contexts with existing or expected high volumes of pedestrians and/or bicyclists or locations with dedicated separated bikeways (shared-use path or separated bike lanes), the use of reinforced, raised, textured aprons should be considered where needed to accommodate larger vehicles encouraging slower speed turns by smaller vehicles.

Source: NCHRP Report 659 Exhibit 5-24 Driveway width and curb radius guidelines

One-Way Driveway Widths

While most driveways allow for vehicles in both directions, there are times when a one-way only direction is warranted. NCHRP Report 659 provides some information and guidance on these types of driveways:

*Only a small fraction of driveways operate in a one-way mode. Information on which to base guidance for the design of one-way driveways is limited and, as **Table 21** shows, current agencies' standards differ considerably. Structured studies of one-way driveway design elements would be helpful.*

Table 21 | One-way driveway widths from selected states.

Agency	Source	Category	Width for one-way
Missouri	940.16 (5/13/09)	Driveway	20–30 feet
New Jersey	C-11 (6/20/07)	Driveway	20–23 feet
New York	608-03 (1/8/09)	Minor Commercial	12–24 feet; 16 feet normal
Utah	12.1.1601.10	Driveway	12–32 feet

Source: Adapted from NCHRP Report 659

4.2.4 Driveway Connection Spacing (D)

The distance between connections is a key component when determining the location of a driveway. Placing a driveway too close to another could potentially cause traffic congestion and operations issues between vehicles. The appropriate method for measuring the distance between driveway connections is to begin at the near edge of one driveway and the near end at the edge of another. ***Figure 45*** provides examples of how driveway connection spacing is measured.

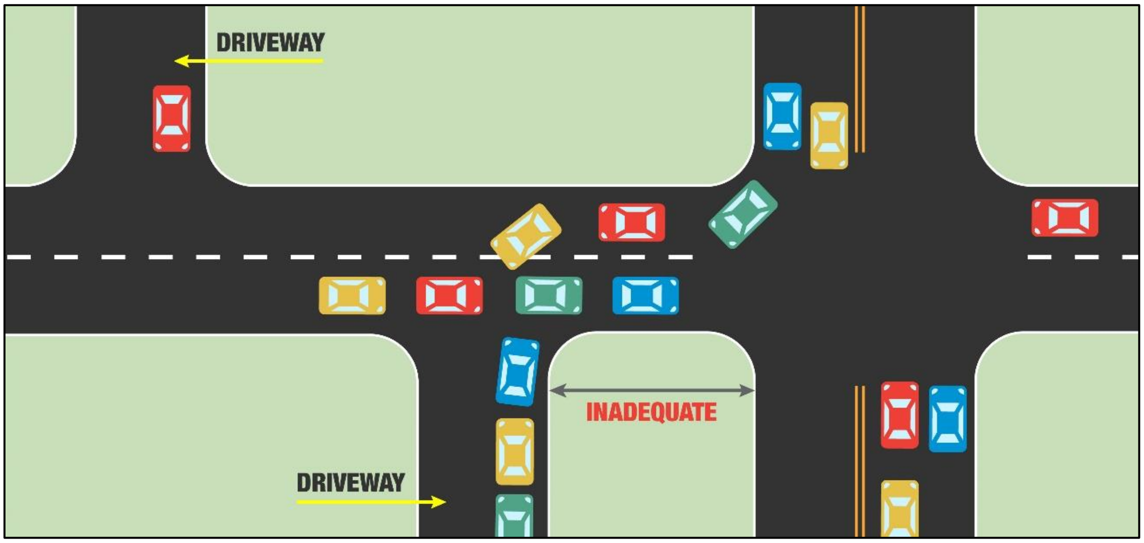
To alleviate any potential issues, there are spacing standards for driveways based on posted speeds and roadway access classification. More information on these standards can be found in ***Table 12***.

4.2.5 Corner Clearance (C)

Corner clearance design criterion is described as the distance from one connection to an intersection. Guidance governing the distance between a driveway and intersection is based on roadway access classification (1-7) and the speed limit. ***Table 12*** describes the connection spacing standards for driveways and intersections. For example, a roadway with access classification 6 has a recommended corner clearance of 440 feet when the speed limit is over 45 mph and 245 feet when 45 mph or lower. The appropriate way to measure corner clearance is from the beginning of the connection to the nearest edge of the intersection. ***Figure 51*** shows examples of corner clearance.

Driveways located too close to an intersection may have potential safety or operational issues, as shown in ***Figure 51***. This is because vehicles attempting to exit the driveway may need to queue for significant periods of time due to being blocked by vehicles in the roadway near the intersection. Also, congestion could occur if a vehicle attempted to cross the lane and turn into the driveway from the opposite direction. These are just two of the situations that could occur from a driveway being too close to an intersection.

Figure 51 | Corner Clearance and Driveways



Source: FDOT

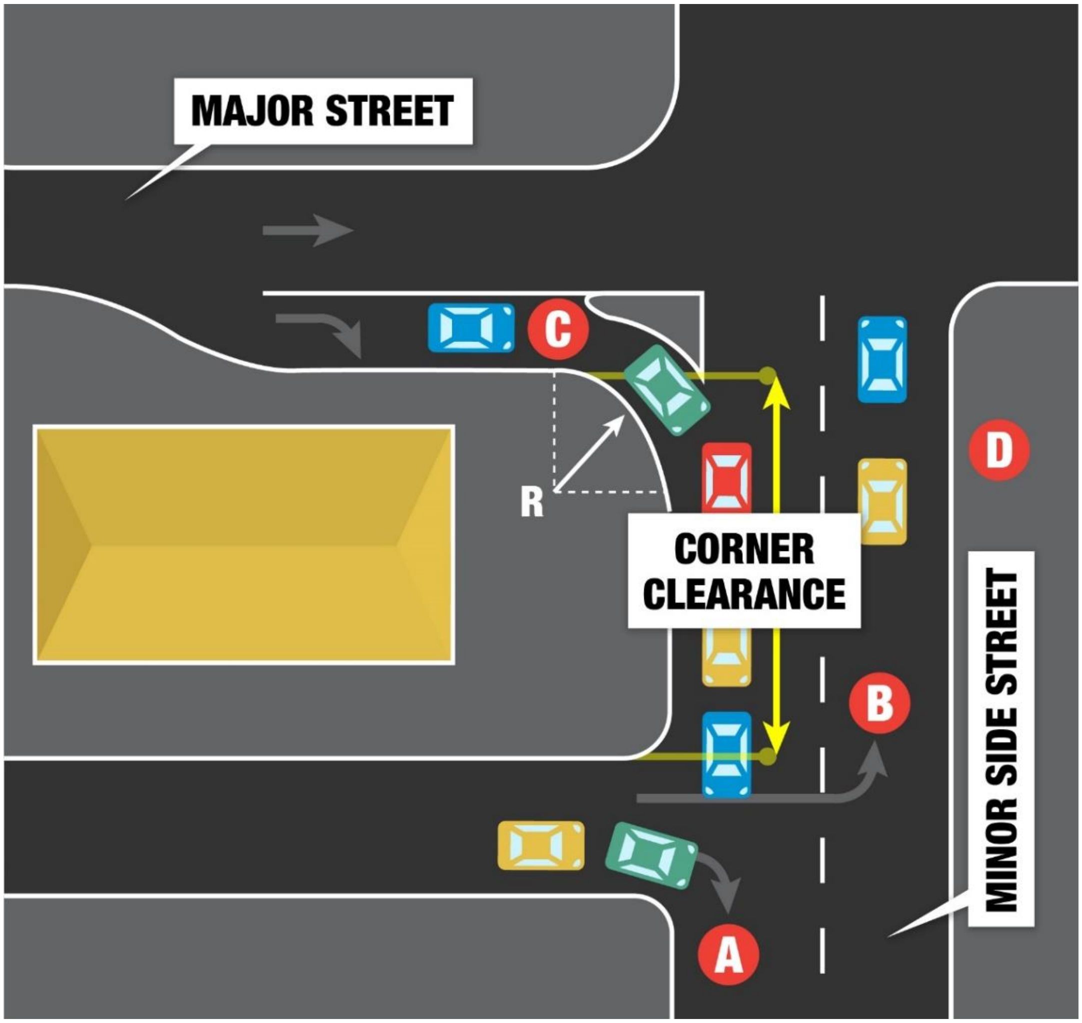
The minimum corner clearance guidance can be found within *Rule Chapter: 14-97.003(1) F.A.C.* When this cannot be met due to specific site conditions, guidance offered by the CUTR report for FDOT *Model Access Management Policies and Regulations for Florida Cities and Counties: 2nd Edition* suggests that reviewing agencies consider the following regulatory strategies:

- Require that the access connection be located as far from the intersection as possible
- Limit driveway movements to right-in/right-out only and require construction of a non-traversable median or flexible pylon as conditions of the permit, if necessary, to limit the movements
- Limit the maximum driveway volume (vehicles per hour and vehicles per day) as a condition of the permit

Important Considerations

Corner clearance is important for traffic flow upstream from an intersection, but in certain circumstances, it also is important for downstream traffic. For example, there must be enough corner clearance with a driveway that is constructed on a small side street to a major roadway. Vehicles that are exiting the major roadway may be traveling at a high speed. An example of this can be seen in ***Figure 52*** below; if the vehicle in the driveway is attempting to make a right turn (A), then vehicles coming from the main roadway (C) may be turning at a high speed and may not have enough time to stop and avoid a collision with the vehicle making a right turn from the driveway. Vehicles that are queuing (D) to exit onto the major roadway may prevent vehicles making a left turn (B). In both situations, a driveway that is too close to the major roadway could lead to safety or operational issues. Suggested guidance for minimum downstream corner clearance to side streets is provided in ***Table 22***.

Figure 52 | Downstream Traffic & Corner Clearance Issues



Source: FDOT

Table 22 | Downstream Corner Clearance for Side Street

Radius (feet)	Minimum Suggested Corner Clearance (feet)
50’ - No Channelization	120’
50’ - Channelization	200’
75’ - Channelization	230’
100’ - Channelization	275’

Source: Vergil Stover – Transportation and Land Development – ITE, 2002

4.2.6 Angle (Y)

The angle which a driveway connects to the roadway is one of the factors that influences the speed drivers will need to slow to complete their turning movement. For all driveway categories and types, the appropriate angle for driveways is from 60-degrees to 90-degrees. Typically, a driveway should be designed with a 90-degree angle as that is the angle that drivers expect. Driveways that deviate from this expectation could cause safety issues, especially on high-volume driveways. Driveways with large angles also increase the distance and exposure risk for pedestrians, bicyclists and other users that may need to cross it.

The method for measuring the driveway angle is to begin at the centerline of the driveway and end at the edge of the traveled way of the roadway (See ***Figure 45***). It should be noted that per *FDM Table 214.3.1*:

> *"The Angle of Driveway for Connection Category A may be reduced with approval by the local Operations/Maintenance Engineer."*

4.2.7 Setback (G)

The distance from the ROW line to the nearest structure is called the "setback" distance (See ***Figure 45***). For any driveway design or type, the minimum distance is 12' (See ***Table 18***). While this is the minimum, some situations may require different setback distances depending on the context classification and local conditions.

When there is not enough "setback" distance from the structures on the site, there could be potential safety issues with the driveways on that site due to vehicles traveling too close to the structures. ***Figure 17*** and ***Figure 18*** demonstrate how a structure's setback was changed and potentially enhanced the safety performance of the site and roadway. By increasing the setback, the traffic flow of the site was able to be modified and one of the driveways could be closed. This reduced the number of connections from four to three, thereby also reducing the number of conflict points along this portion of roadway.

4.2.8 Driveway Traffic Separators (S)

Per the *FDM 214.11 - Driveway Terminology*, this design criterion is defined as, "Linear islands or raised medians used to separate traffic movements on the driveway." (See ***Figure 45***). Per the driveway dimensions shown in ***Table 18*** the width for a traffic separator within a driveway for categories B - D is 4 feet to 22 feet depending on the conditions; traffic separators are not required for category A driveways.

Important Considerations

While traffic separators can assist with separating entering and exiting driveway traffic flow, thus reducing potential safety issues for vehicles, they can also lead to potential safety issues for pedestrians and bicyclists. If a 6 feet – 22 feet traffic separator is used as a pedestrian refuge, then curb cuts and sidewalks should also be installed to accommodate wheelchairs, strollers and those with mobility impairments.

Larger vehicles, such as buses or semi-trailers, may also cause potential safety issues for bicyclists or pedestrians. These vehicles may encroach onto the traffic separator due to their large turning radius, or their mirrors or other portions of the vehicle could potentially impact the area where a pedestrian or bicyclist is located.

4.2.9 Channelizing Islands (I)

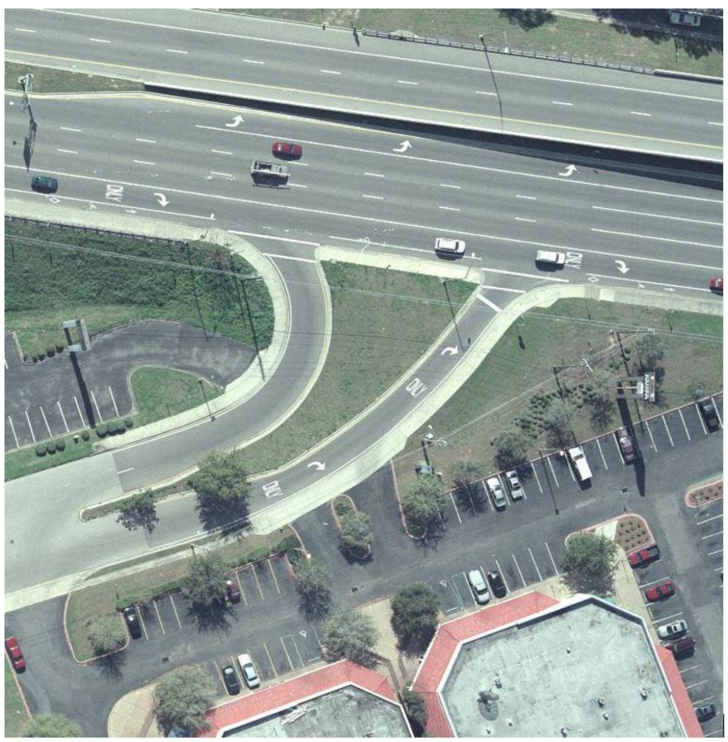
A channelizing island (divisional island) is another design criterion, similar to a traffic separator. These islands serve the same purpose in directing traffic at a driveway to ensure traffic separation and flow but are typically reserved for a significant amount of traffic. The following situations are where a channelizing island may be considered:

- A large pavement area which may confuse drivers
- Right-in/right-out driveways where movements may be unclear
- The driveway is expected to have a signal in the future
- The driveway has two or more entrance lanes

Important Considerations

The context classification of the area and the typical vehicles that use it must be considered when designing channelizing islands. For example, if there are numerous trucks which use the driveway, a larger channelizing island will likely be required. An example of this can be seen below in ***Figure 53***.

Figure 53 | Large Driveway Channelizing Island



Source: Tallahassee, FL – Google Earth

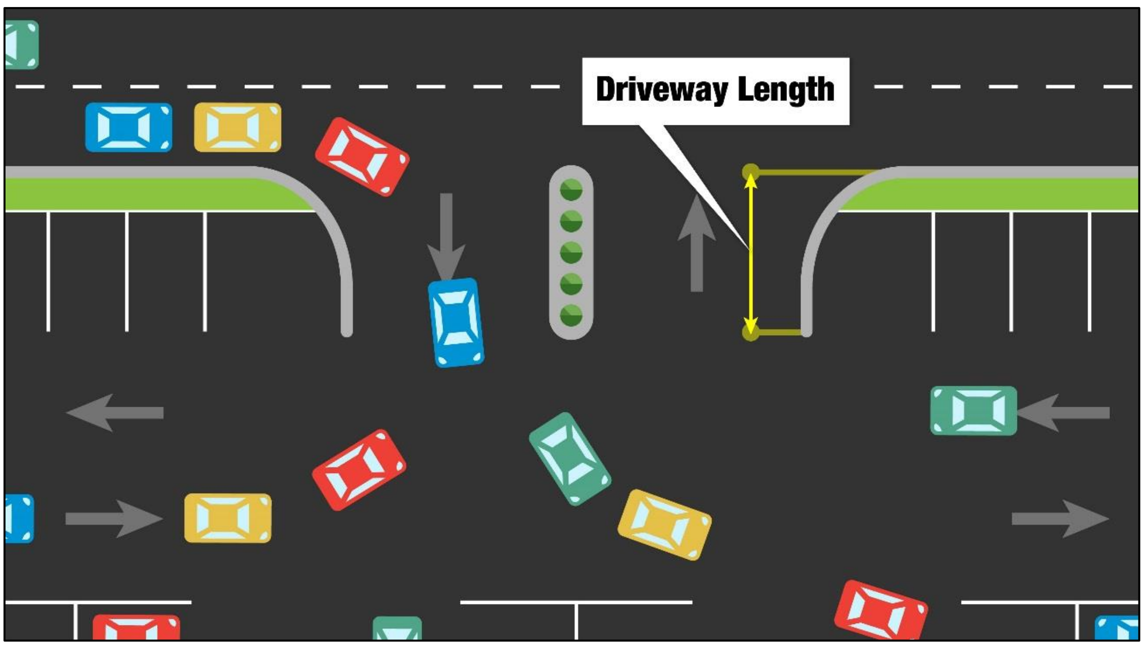
While larger islands may help with traffic, thought must be given to pedestrians and bicyclists who must cross these areas. These larger islands ultimately increase the crossing distance for non-motorized users and could decrease overall safety performance and increase the overall risk. Channelizing islands that are too small may not be seen well by drivers when entering or exiting the driveway.

4.2.10 Driveway Length

Sufficient driveway length helps make the driveway operate more efficiently. As vehicles enter a site, they should be able move quickly enough so that they don't interfere with traffic within the site nor interrupt traffic that is moving along the roadway. A driveway that is too short could delay vehicles exiting the roadway, as the driveway is filled with vehicles entering. This can lead to rear end collisions. Similarly, if there are multiple conflict points near the driveway, this could cause delays for people entering the site, and similar issues. An uninterrupted area (driveway length) before the first conflict point on site is an important tool to prevent these scenarios. The greater the volume using the driveway, the more the driveway should be designed like a roadway intersection.

The appropriate method for measuring a driveway's length is to begin from the edge of the traveled way to the first "conflict point." Below is an example of a driveway that is not long enough (See ***Figure 54***). As vehicles attempt to enter the site, they are blocked by others who are attempting to exit or park. Not only is this driveway not long enough, but a traffic separator or channelizing island (as shown below) is needed to improve the operation and traffic flow of this driveway.

Figure 54 | Improper Driveway Length



Source: FDOT

Major driveways to large developments should be designed as roadway intersections and not just a simple driveway. This type of access will have multiple lanes and sufficient positive guidance to the driver. As noted in ***3.2.1 Assessing a Median Opening***, a major driveway has with significant peak hour or daily traffic volumes, equivalent to a Class C or higher driveway with more than 600 vehicle trips per day or more than 60 vehicle trips per hour.

For driveways that may be signalized, driveway length should be determined by a traffic study of expected future traffic and queues. An important measurement in determining the driveway length is the outbound queue. The estimates in ***Table 23*** can be used for unsignalized driveways or for a first estimate of driveway length. The distance required should be maintained or increased so as to avoid interference with the mainline traffic flow for large sites with high volumes, heavy truck traffic, and on high volume roadways. If no other design alternatives exist and interior drives are proposed which do not meet minimum spacing, the left-turning movement should be restricted with a raised barrier.

Table 23 | Recommended Minimum Driveway Length for Major Entrances

Land Use	Driveway Length (feet)
Any major entrance to a development with 4 or more total lanes in the driveway. (Typically, malls and "Big Box Centers")	300 or greater, based on traffic study
Regional Shopping Centers (over 150,000 square feet)	250
Community Shopping Center (100-150,000 square feet) (supermarket, drugstore, etc.)	150
Small Strip Shopping Center	50
Smaller Commercial Developments	30
Note: for large developments (such as regional malls, big box centers, or regional office centers), the total recommended length is not necessary for all entrances, only the major ones.	

Source: Adapted from Vergil Stover unpublished course notes

Additional discussion on driveway length can be found in NCHRP Report 659. **Table 24** from this report presents simplified guidance on driveway length (also referred to as throat length) based on number of lanes and type of control.

Table 24 | Minimum Driveway (Throat) Length Based on the Type of Control and Number of Lanes

Type of Control	Number of Exit Lanes Present			
	1 Exit Lane	2 Exit Lanes	3 Exit Lanes	4 Exit Lanes
Stop Sign	30 to 50 feet	50 feet (2 cars)	--	--
Signal	N/A	75 feet	200 feet	300 feet

Note: N/A indicates no value given

Sources: NCHRP Report 659 Exhibit 5-55, Transportation and Land Development, 2nd ed. (2002), p. 7-28 (5-13) and TRB Access Management Manual (2014), p. 31-316

Important Considerations

For corridor improvements (not during the driveway permit process), the ability to design adequate driveway length may depend on existing development and available ROW. Where the land use along the corridor is dense, driveway length might be restricted at individual locations. Working with the property owner for a better design on their property will benefit the business as well as the driver. Coordination with the local government might be needed where landscaping or parking spaces are impacted.

Drive-through Queues

When determining site design, including driveway length, knowledge of the expected queue of drive-through traffic is important. These queues should be stored away from the area of the driveway used for driveway length. This is especially important in areas that are classified as the C3C – Suburban Commercial context classification. C3C areas typically have a disconnected roadway network (non-grid pattern) and thus roadways that are arterials have a higher likelihood of high vehicle speeds. Land-use types that produce a significant number of vehicle trips that also include a drive-through should be studied carefully to not impact the vehicles which are not visiting these sites.

Larger site sizes for modern service stations, convenience markets and the stand-alone drugstores with drive-through prescription service have helped assure that these distances are provided for newer development.

School Driveway Queues

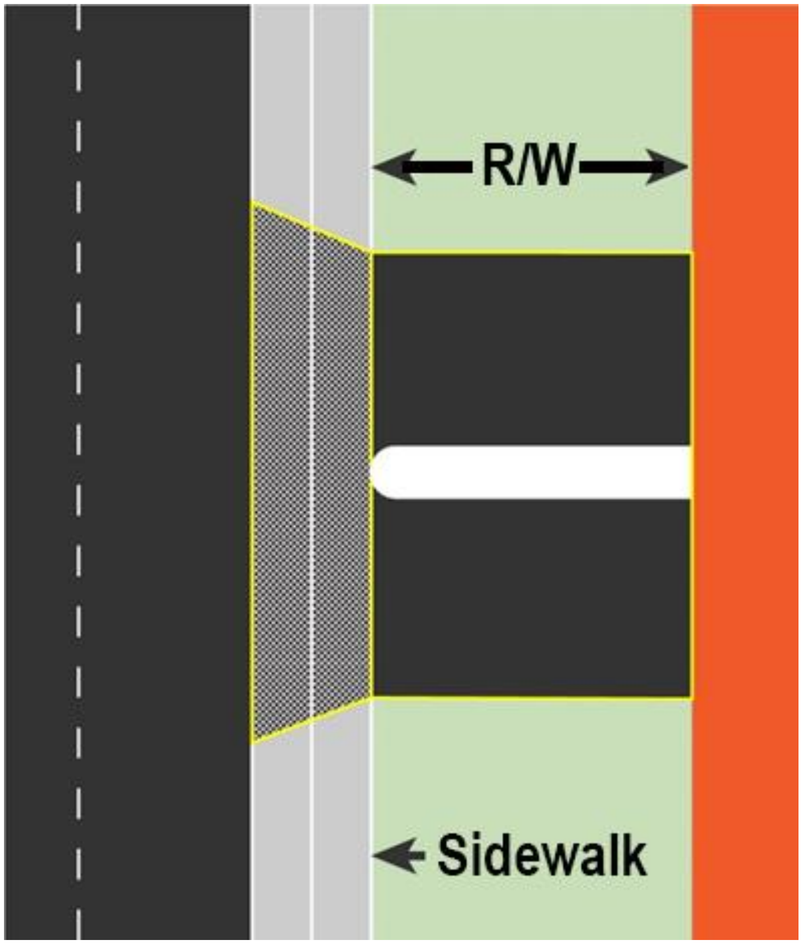
Schools served by school buses pose a challenge as well. Driveways should be designed with sufficient queue areas so that waiting vehicles don't conflict with movements on the highway system. The size of school buses together with the peaking characteristics from people picking up children can make designing sufficient queue areas a significant challenge. A queuing study might be necessary in order to assure that back-ups on the SHS are avoided. It is recommended to include school officials in the planning process.

For any schools that are within areas that are C3R and C3C, sufficient queue lengths are especially important due to the typical volumes and vehicles speeds on these roadways. Any waiting vehicles could cause significant safety concerns, as well as operational issues along the main roadway. It is also important to consider the placement of sidewalks and to ensure they do not interfere with the driveway(s) of the school.

Maintenance

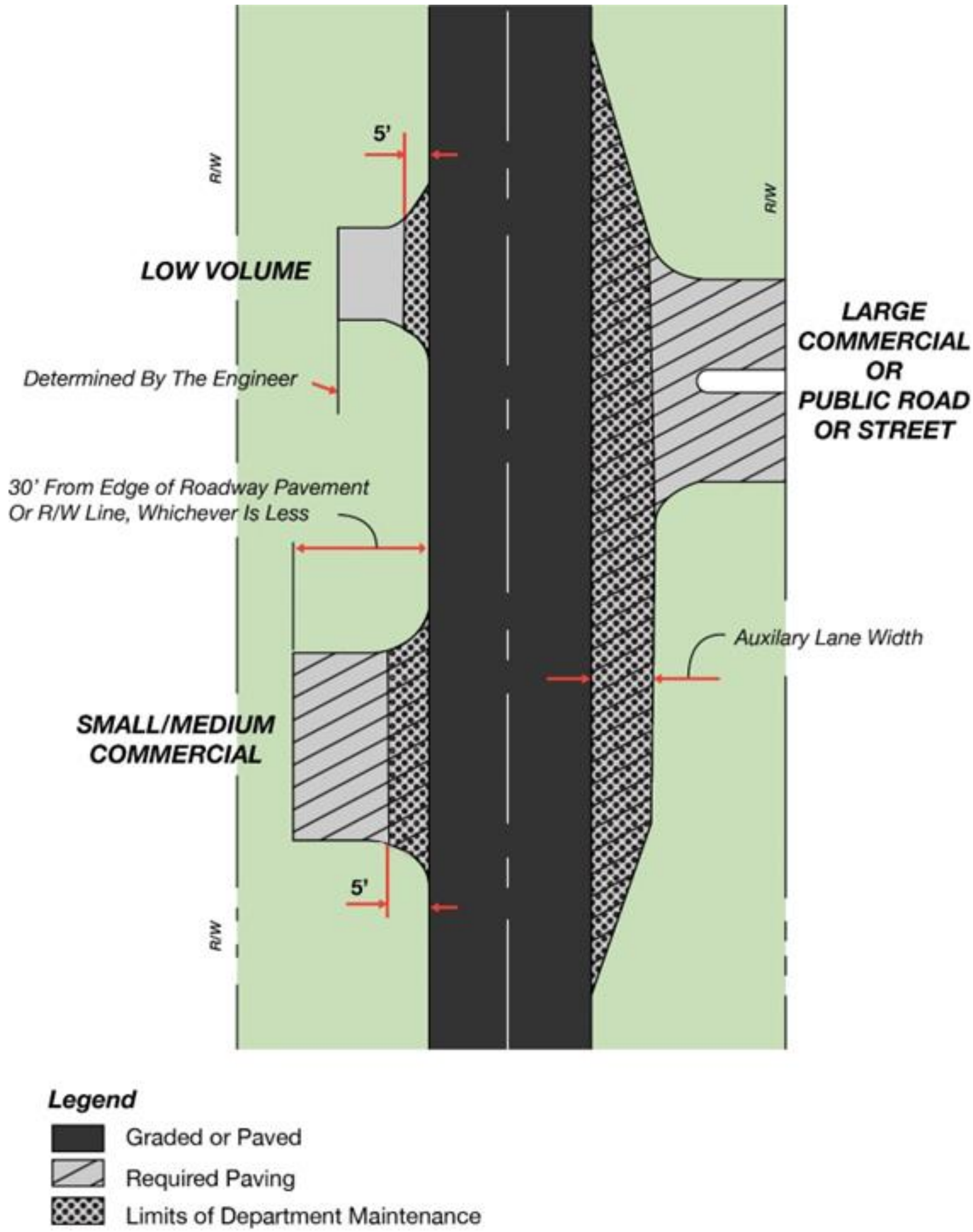
Per *Rule Chapter: 14-96.016 F.A.C.*, it states that FDOT will be responsible for driveway maintenance in urban (curb and gutter) sections from the roadway to the existing or maintained right of way line or to the back of the sidewalk, whichever distance is less. For driveways on non-curbed or rural sections, FDOT maintenance will extend five feet beyond the edge of the roadway pavement, including auxiliary lanes, or to the limits of the paved shoulder (See ***Figure 55*** and ***Figure 56***).

Figure 55 | Limits of Construction and Maintenance for Flush Shoulder "Rural" Section Connections



Source: *Rule Chapter: 14-96.016 F.A.C.*

Figure 56 | Limits of Construction and Maintenance for Flush Shoulder "Rural" Section Connections



Source: [Rule Chapter: 14-96.016 F.A.C.]

4.2.11 Driveway Grade

Driveway grade is important because turning vehicles must slow down to enter a driveway. The steeper the driveway, the greater the reduction in speed required to prevent hitting the bottom of the vehicle against the pavement.

Vehicles entering and leaving driveways that have abrupt changes in grade must travel at extremely low speeds. For those entering the driveway, the possibility of rear-end collisions on the roadway is increased because following traffic must slow down for right-turn vehicles. Exiting vehicles and those turning left into the driveway must wait for larger gaps in traffic.

Reducing driveway grade is an important consideration along roadways that carry considerable through traffic volumes. Steep driveways might be more acceptable on local streets and reconstruction/resurfacing projects. Steeper grades are also more acceptable at locations with low driveway traffic volumes where only a few trucks are expected to use the driveway.

Grades

Requirements for the driveway grades are included in *FDM 214 – Driveways* and *Standard Plans, Index 522-003*. Maximum grades are 10% for commercial driveways and 28% for residential driveways and details for each application are included in Standard Plans, Index 522-003. FDM 214.4 provides direction and information for various applications on flared driveways. FDM 214.4 provides guidance on flush shoulder driveways. An important note, it also states that in reconstruction projects, the 10% or less grade for commercial can be exceeded with the approval of the District Design Engineer where operational and safety impacts are acceptable. If regular scheduled passenger buses will be using the driveway, the maximum grade should not exceed 12% with a preferred maximum design grade of about 8%.[10]

While these may be the maximum practical grades, it is much better to use smaller grades. Research has shown that grades less than 14% for low-volume driveways and grades less than 5% for higher volume driveways are more desirable (See ***Figure 57*** for an example of a commercial driveway grade).

Consideration for the expected volume and class of traffic on driveways is important. Though the FDM uses the terms “Commercial” and “Residential,” there is great variability within these terms. The amount and type of traffic for a barbershop (commercial) is very different than a one million square foot mall (also commercial) or a 300-unit apartment complex (residential). The barbershop, of course, would not need the design standards of either the mall or the apartment complex.

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[10] Adapted from the *Design Guide for Transit Facilities on Highways and Streets. AASHTO Phase I*

Figure 57 | Commercial Driveway - Grade

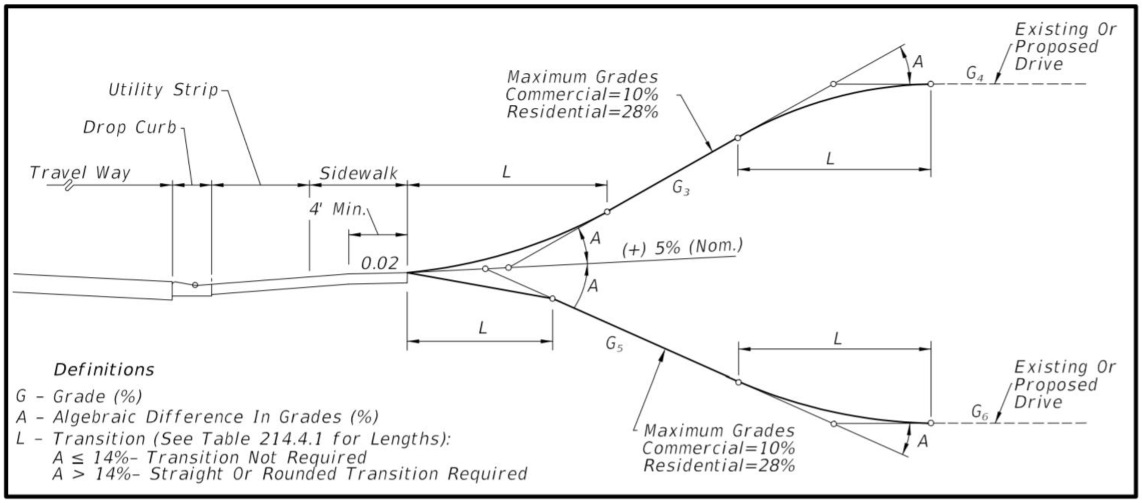
Source: CDM Smith

Important Considerations

Driveway Grade Differences

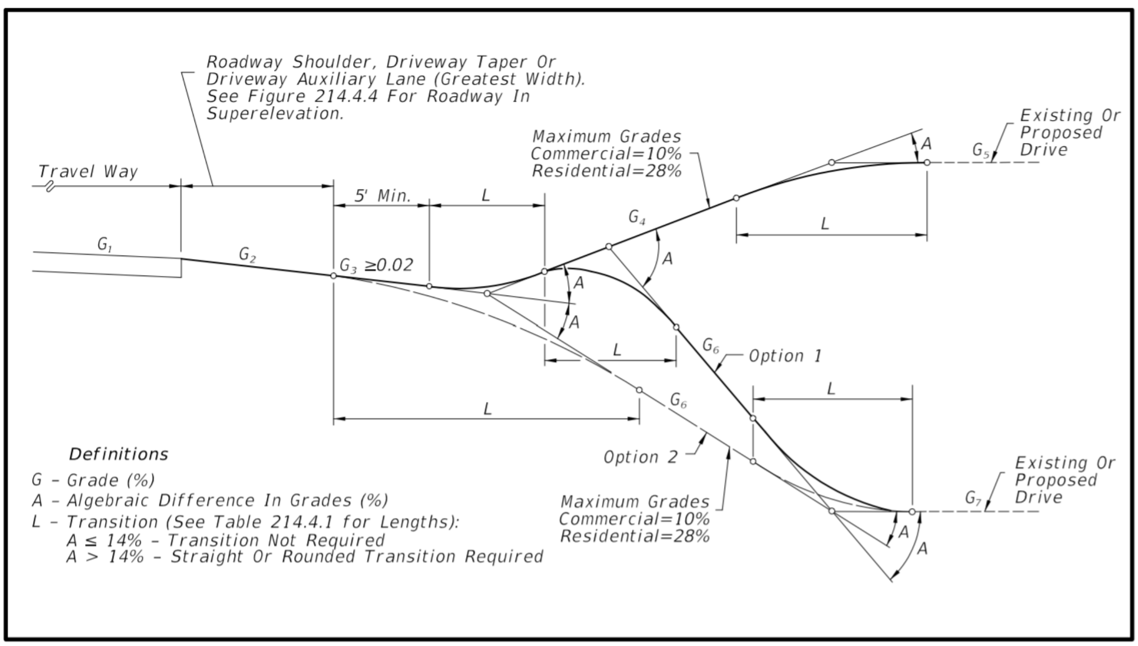
The maximum practical difference in grade is 12%. Above these grades, vehicles will routinely "bottom out" and potentially cause damage to their vehicles and/or the roadway itself. This is called "A" or "Algebraic Difference in Grade" (See ***Figure 58*** and ***Figure 59***).

Figure 58 | Curbed Roadway Driveway Profiles



Source: FDM 214 – Driveways (Figure 214.4.2)

Figure 59 | Flush Shoulder Roadway Driveway Profiles



Source: FDM 214 – Driveways (Figure 214.4.3)

For areas and driveways with a significant number of large vehicles or trucks, special attention should be paid to the driveway grades as these vehicles will have a different profile than passenger vehicles and may encounter operational issues. Larger class vehicles (Class 9 – 10) may require lower grades than what is typical.

Superelevation and Driveway Visibility

Another concern in driveway grade is the visibility of the driveway. A driveway that slopes downward and connects with a roadway on a horizontal curve that has superelevation, has sight distance problems. Guidance for this concern is also found in *FDM 214* driveway profile grades adjacent to super-elevated roadways (See G2 in Figure 214.4.3) with the slopes and break-overs shown in *FDM Figure 214.4.4*.

Guidance for Driveway Design in the Standard Plans and in the FDOT Design Manual (Curb Sections)

FDM 214 and *Standard Plans, Index 522-003* provides criteria and guidance for design of flared driveways for curbed roadways.

Some guidance for curbed roadway driveway design is also shown in the *FDM 113 - Right of Way*. The manual states the following:

> *"On projects with sidewalks and driveway connections, the design elements can be accurately established only if proper survey data has been obtained for the designer's use. Profile elevations along the proposed ROW line and back of sidewalk and half-sections or profiles at each driveway location should be obtained as a minimum standard practice."*

4.2.12 Sight Distances

Driveways must be built to provide sufficient sight distance so that drivers can safely operate their vehicles. More information on sight distances can be found in ***Chapter 5: Sight Distances***.

4.2.13 Driveway Location

Determining the correct placement for driveways along a roadway is important because they affect the traffic patterns and overall flow of traffic. For more information on properly locating driveways, review ***Chapter 2: Roadway Openings***. Important design criteria that affect the driveway location are the connection spacing requirements and corner clearance.

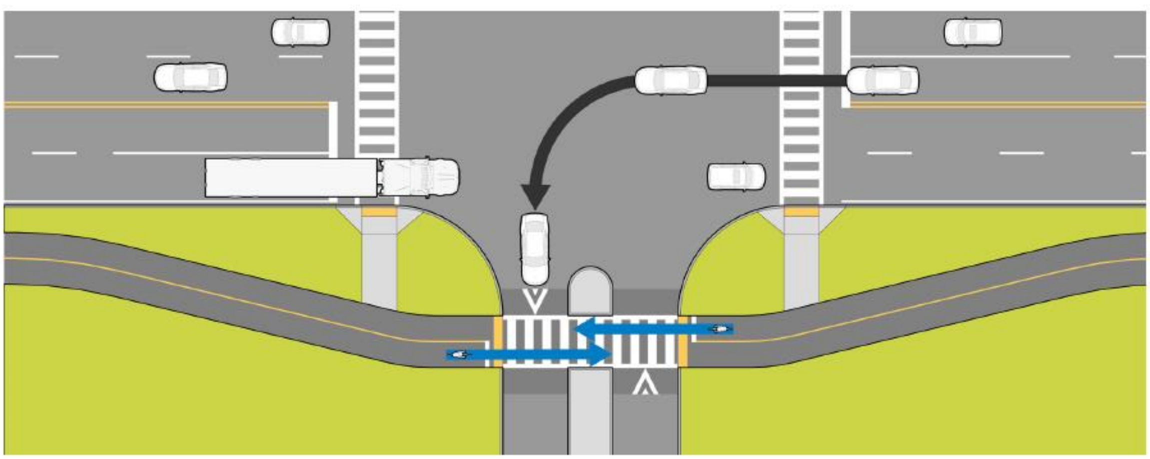
4.2.14 Raised Crosswalks at Driveways and Minor Cross Streets

Raised crosswalks (See ***Figure 60*** for an example of a raised crosswalk) can be considered at driveways and minor street crossings, particularly at locations with high pedestrian volumes or in locations with either a shared use path or sidewalk-level separated bike lanes. Raised crosswalks can reduce vehicle speeds and enhance the crossing environment. Consideration should be given to the volume and speed of the roadway and the potential to create conflicts with vehicles slowing to negotiate the raised crosswalk, particularly for left turns entering the driveway or minor street crossing. This can be mitigated by using a "bend out" style design for a separated bike lane, shared use path, or sidewalk with a recessed crossing point, which provides space for a driver to yield to users at the crossing without blocking through traffic on the major street. A recessed, raised crossing also allows turning vehicles to traverse the raised crossing at 90 degrees rather than as they are completing their turn. *FDM 202.3.8* states that raised crosswalks are not allowed at intersections within the turning path of the design vehicle. The "bend-out" design with raised crossing is illustrated in ***Figure 61***. In some cases, it may be preferred to limit raised crosswalks to driveway locations with right-in, right-out only, on multilane roadways.

Figure 60 | Raised Sidewalk Crossing

Source: Cambridge, MA – HDR Photo

Figure 61 | Recessed Raised Crossing at Shared Use Path Intersection



Source: MassDOT Separated Bike Lane Planning & Design Guide

4.2.15 Continuous Sidewalk at Driveways

Continuous sidewalks (See ***Figure 62*** for an example of a continuous sidewalk) maintain the sidewalk treatment (color/pavement) across the driveway to raise awareness of pedestrians. In most cases, the sidewalk is maintained at a constant level across through the driveway (i.e., the driveway ramps up to sidewalk level), but the continuous sidewalk may not always be raised.

Figure 62 | Continuous Sidewalk

Source: Metral Drive, British Columbia – Google Earth

Chapter 5: Sight Distances

5.1 Overview

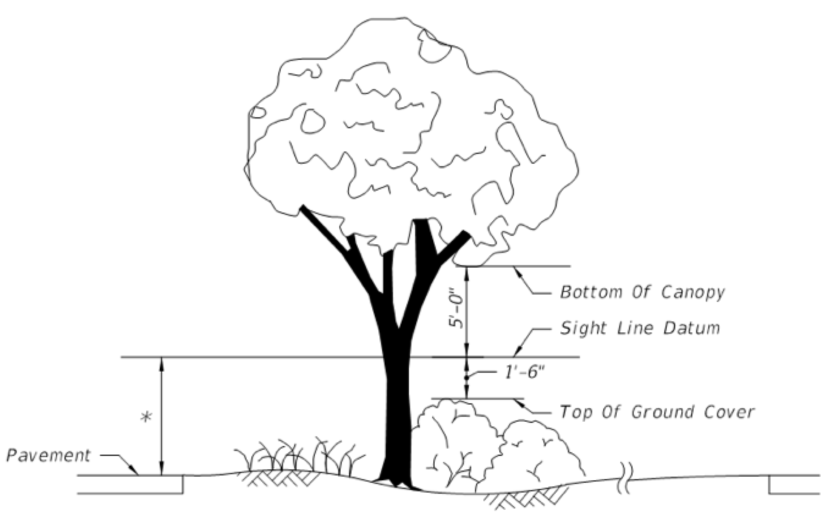
The focus of this chapter is to review the role of sight distance for unsignalized driveways and median openings. Specifically, the concepts of stopping sight distances and intersection sight distances will be discussed. Much of the current literature on sight distances stems from the *AASHTO Green Book*. It discusses sight distances in detail and is the basis for much of the standards for Florida. Passing sight distances are not discussed within this chapter as they are typically not involved in these types of roadway designs. For more information on passing sight distances, please refer to *FDM 210 - Arterials and Collectors*.

5.1.1 Sight Distance Factors

There are multiple types of sight distances, each of which are affected by several factors. Some of these factors which affect the sight distances for a person driving are: height of the eye, height of the object, driver eye setback, vehicle area, time, and visibility.

The height of the eye pertains to the person who is passing or moving through the intersection, typically the driver. This measure is significant as it assumes people to be able to see a above a certain height and could affect the design of the driveway or median, as well as any landscaping. *FDM 210* defines this height as 3.5 feet (3'6"). It is also referred to as the sight line datum (See ***Figure 63***).

Figure 63 | Sight Distance Parameters



**Since observations are made in both directions, the line of sight datum between roadways is 3.5 feet above both pavements.*

Source: FDM 212 – Intersections (Figure 212.11.3)

The object height is similar to the previous measure, with various heights being determined based on roadway environment. For stopping sight distances, the object height is determined to be 0.5 feet (6") above the road surface. This is meant to allow drivers to see oncoming vehicles when traveling through the intersection.

Another factor that influences sight distance is the distance of a driver's eye from the roadway itself, which is called the driver eye setback. For intersections and driveways, the minimum distance is 14.5 feet (14'6") from the edge of traveled roadway (See ***5.3 Intersection Sight Distance (ISD)***).

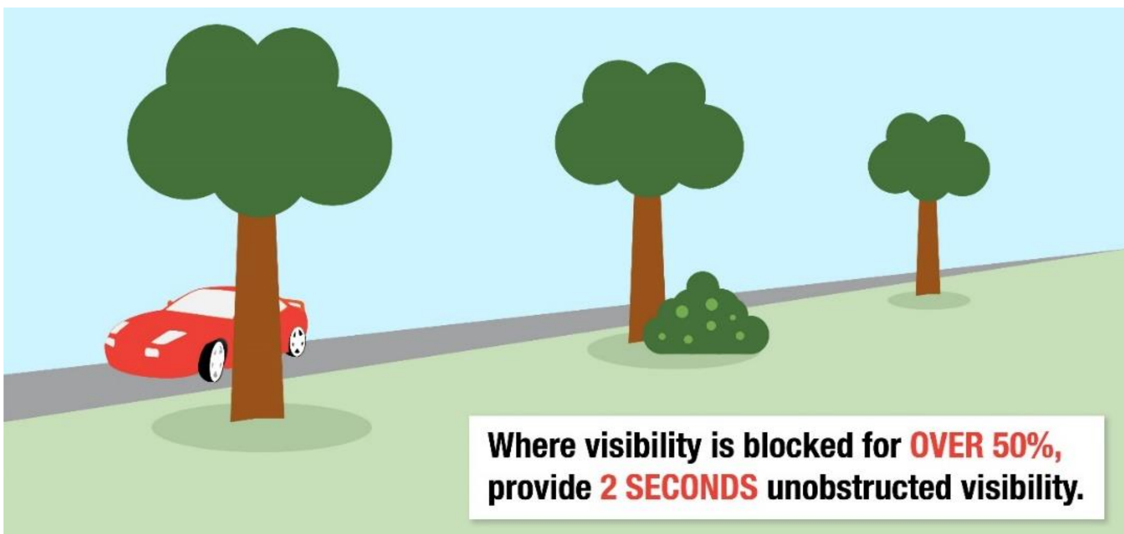
Vehicle area size is used to determine whether a vehicle is considered visible or not. Landscaping or other objects along the roadway can obscure a person's sight, reducing their overall sight distance. The Department states that if a driver can see 50% of the visual area of another vehicle, then it is considered to have 50% "shadow," but still considered visible (See ***Figure 64***).

Figure 64 | Vehicle Area Size

Source: FDOT

One of the last factors that influences sight distance is amount of time that something is obstructed (See ***Figure 64***). According to the *FDM 212.11.2*, allow for two seconds of unobstructed visibility when the area is blocked 50% (See ***Figure 65***).

Figure 65 | Time and Visibility



Source: FDOT

5.2 Stopping Sight Distance (SSD)

Per *FDM 210 – Arterials and Collectors*, stopping sight distance can be defined as:

> *"…the distance needed for drivers to see an object on the roadway ahead and bring their vehicles to a safe stop before colliding with the object. The distances are derived for various design speeds based on assumptions for driver reaction time, the braking ability of most vehicles under wet pavement conditions, and the friction provided by most pavement surfaces."*

Stopping sight distance plays an important role for both driveways and median openings. The various factors that affect stopping sight distance are the grade of the roadway and design speed which in turn determine the SSD for the roadway (See ***Table 25***). See *FDM 210 – Arterials and Collectors,* for the complete Minimum Stopping Sight Distance (SSD) table.

Table 25 | Minimum Stopping Sight Distance

Grade (%)	Minimum Stopping Sight Distance (feet)									
	Design Speed (mph)									
	25	30	35	40	45	50	55	60	65	70
Downgrade/Upgrade (≤2%)	155	200	250	305	360	425	495	570	645	730

Source: Adapted from FDM 210 - Arterials and Collectors (Table 210.11.1)

There may be instances when the minimum stopping sight distances shown in ***Table 25*** may not be adequate. In these situations, when drivers require additional time to make decisions, larger distances may be necessary. The *AASHTO Green Book* states that:

> *"…greater distances may be needed where drivers must make complex or instantaneous decisions, when information is difficult to perceive, or when unexpected or unusual maneuvers are needed."*

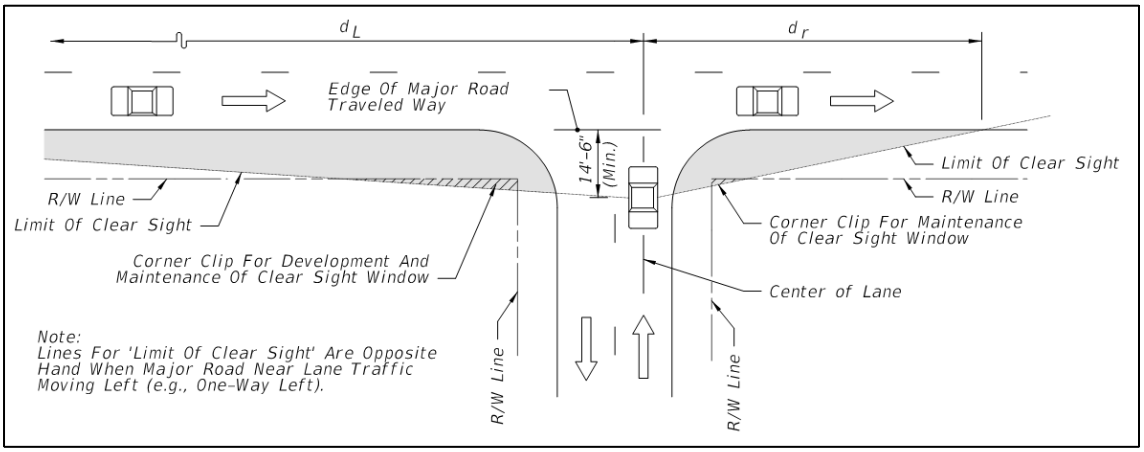
5.3 Intersection Sight Distance (ISD)

Per *FDM 210 – Arterials and Collectors*, intersection sight distance can be defined as:

> *"Sight distances needed by a motorist to see approaching vehicles before their line of sight is blocked by an obstruction near the intersection."*

Intersection sight distances are important for medians and median openings, but more importantly for driveways, since they are treated as intersections. An overview of intersection sight distance can be seen in ***Figure 66***. For vehicles at the driveway, the driver must be 14.5 feet (14'6") away from the edge of the traveled way (driver eye-setback), or alternatively be far enough back from the edge of the traveled way with their vehicle appropriately positioned behind the stop line which should be located a minimum of 4 feet behind a dedicated sidewalk or separated bikeway, and must have clear sight to their left and right, which are called clear sight triangles.[11]

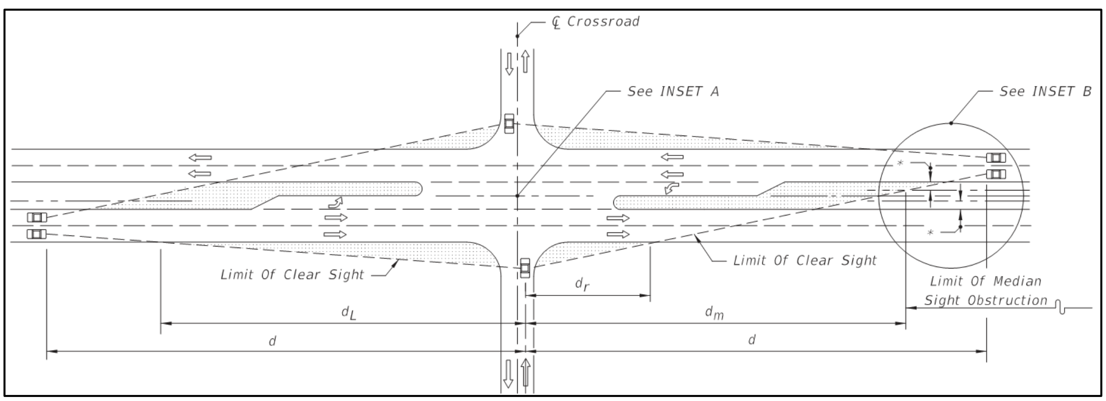
Figure 66 | Clear Sight Triangles



Source: FDM 212 - Intersections (Figure 212.11.1)

An example of intersection sight distance for a 4-lane divided roadway can be seen in ***Figure 67***, along with the corresponding sight distances in ***Table 26***.

Figure 67 | Intersection Sight Distance (4-Lane Divided Roadway)



Source: FDM 212 - Intersections (Exhibit 212-6)

[11] Per the FDM 212.11.1, "The minimum driver-eye setback of 14.5 feet from the edge of the traveled way may be adjusted on any intersection leg only when justified by a documented, site-specific field study of vehicle stopping position and driver-eye position."

Table 26 | Sight Distances

Design Speed (mph)	Sight Distance at Intersection (in feet) Passenger Vehicle (P) (feet)	Sight Distance at Intersection (in feet) Single Unit Vehicle (SU) Common Delivery Truck (feet)
30	395	540
35	460	630
40	525	720
45	590	810
50	655	900
55	720	990
60	785	1,080
65	850	1170

Source: FDM 212 - Intersections (Exhibit 212-6)

For more information on intersection sight distances for combination trucks other types of roadways, please refer to FDM 212.

FDM Exhibits 212-4 through 212-7 provide intersection sight distances for stop-controlled intersections. The tables in the exhibits provide sight distance values for Passenger vehicles, Single Unit (SU) Trucks, and Combination vehicles for design speeds ranging from 30 mph to 65 mph. Intersection sight distance based on Passenger vehicles is suitable for most intersections; however, consider the values for SU Vehicles or Combination vehicles for intersections with high truck volumes.

Similar to other standards, if sufficient intersection sight distance cannot be achieved, and there are no other driveway location alternatives, stopping sight distance can be used on roadways that have a design speed of 35 mph or less. This distance will allow the through traffic driver to avoid a hazard at the driveway (See FDM 210 and 214 for further requirements).

5.3.1 The Crossing Maneuver as a Two-Step Process

Also, if full intersection sight distance cannot be achieved on a driveway connecting to a multilane highway, and the median is sufficiently wide (minimum 25’ for a passenger vehicle), the maneuver may be performed as two operations. The stopped vehicle must first have adequate sight distance to depart from a stopped position and cross traffic approaching from the left. The crossing vehicle may then stop in the median prior to performing the second operation. The second move requires the necessary sight distance for vehicles to depart from the median opening, to turn left into the crossroad, and to accelerate without being overtaken by vehicles approaching from the right. For further information illustrating the shorter distance criteria for these movements, refer to FDM Exhibit 212-6 (Intersection Sight Distance, 4-Lane Divided) and FDM Exhibit 212-7 (Intersection Sight Distance, 6-Lane Divided).

5.4 Important Considerations

While sight distances play an integral role in the development of driveways and median openings, there are specific considerations that must be made. The landscaping near a driveway or along a median can affect the sight distances for drivers, and there are certain designs that are needed for left turns and U-turns for median openings and driveways. See *FDM 212.11.6* for criteria.

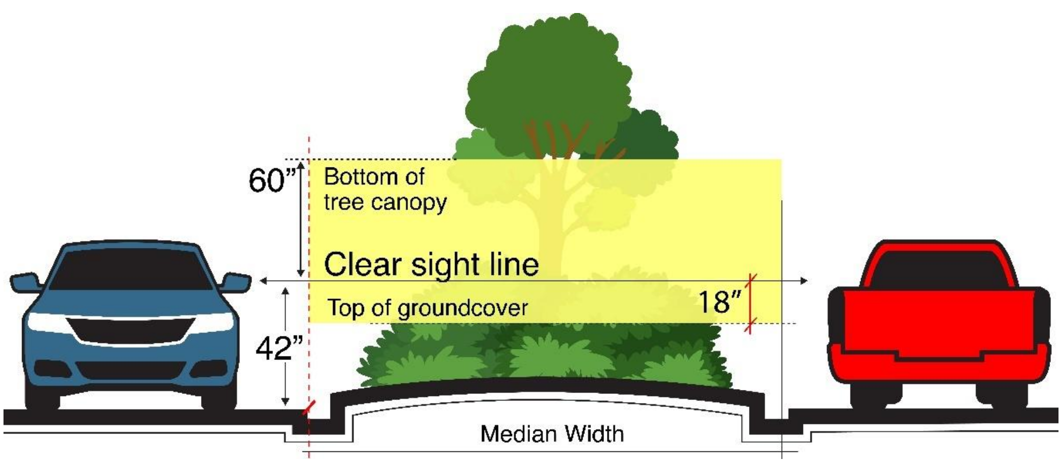
5.4.1 Landscaping

As mentioned earlier in this chapter, there are several factors that influence sight distances for drivers; eye height, object height, the vehicle area size and visibility. Another set of factors that impact the sight distance for vehicles is landscaping that surrounds or is near a median or driveway. Driveways and medians can be treated like intersections when evaluating the correct landscaping procedures. Per *FDM 212.11.6.1*, the "…clear sight window concept may provide opportunities for vegetation within the limits of intersection sight triangle." (See ***Figure 68***). The chapter states that this detail provides:

> *"…the required vertical clear sight limits with respect to the sight line datum. The horizontal limits of the window are defined by clear sight triangles. Within the limits of clear sight triangles, the tree canopy must be at least 5 feet above the sight line datum and the top of the ground cover must be at least 1.5 feet below the sight line datum. See FDM 228.2(2)(a) for additional information about plant selection and placement."*

Please consult with the Project/District Landscape Architect on proper vegetation choices to maintain clear sight triangles.

Figure 68 | Landscaping and Sight Distances



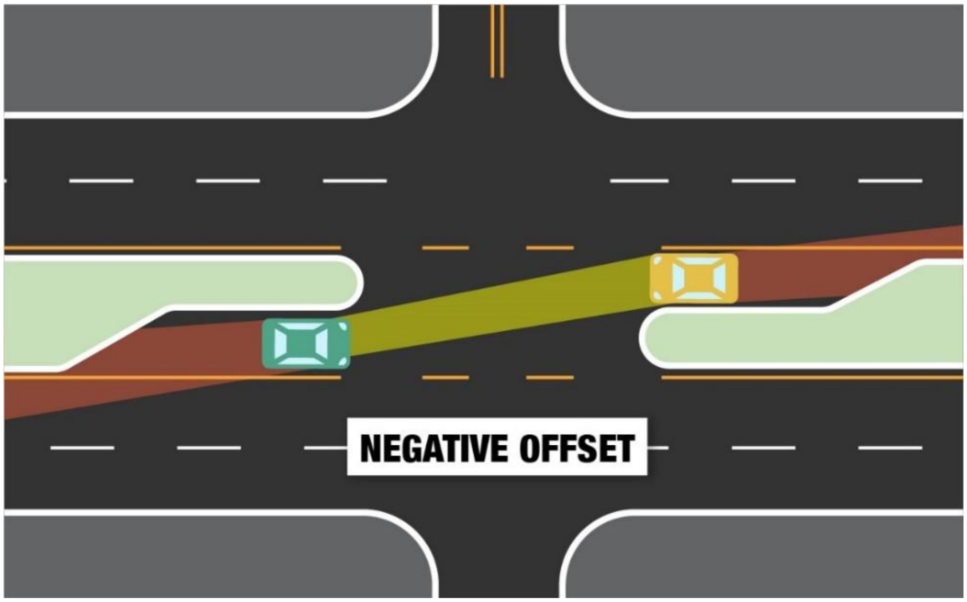
Source: FDOT

Spacing between vegetation located in medians of a roadway and or in the vicinity of driveways fall in the limits of clear sight triangles. To maintain minimum spacing and diameter requirements for vegetation, please refer to *FDM 212.11.6*.

5.4.2 Lateral Offset for Left-Turn Lanes

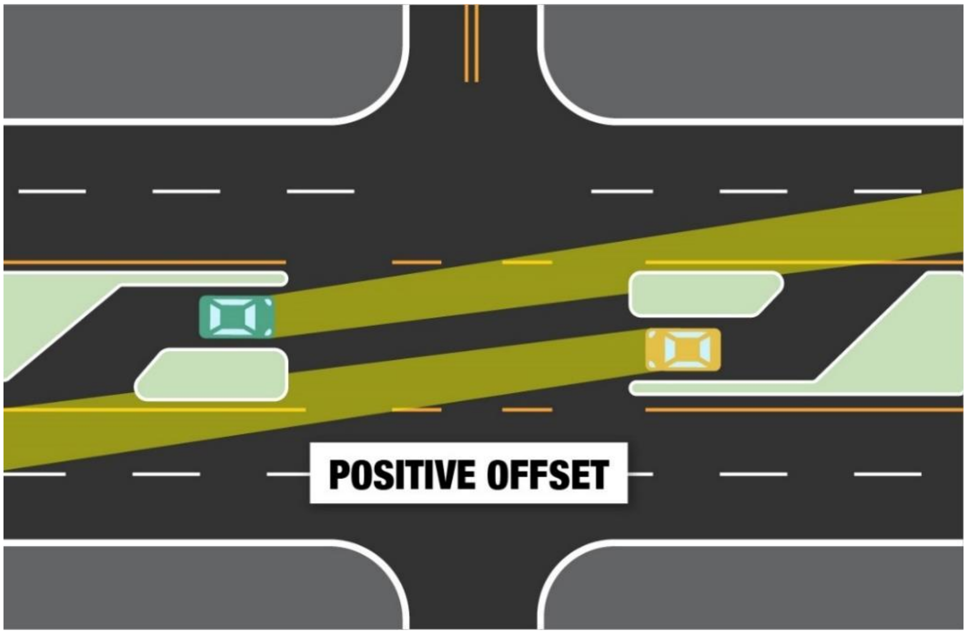
Offset is defined as the lateral distance between the left edge of a left-turn lane and the right edge of the opposing left turn. Vehicles turning left from opposing left-turn lanes may restrict sight distance with a negative offset (See *Figure 69*). Creating a positive offset in the roadway design allows for improved sight distance for each vehicle (See *Figure 70*). However, a positive offset provides less lateral space for U-turn maneuvers and may make them more challenging to execute.

Figure 69 | Negative Offset between Opposing Left-Turn Lanes



Source: FDOT

Figure 70 | Positive Offset between Opposing Left-Turn Lanes



Source: FDOT

Desirable offsets should be positive with a recommended minimum offset of 2 feet when the opposing left-turn vehicle is a passenger car and a minimum offset of 4 feet when it is a large vehicle. In both cases, the left-turn vehicle is assumed to be a passenger car.

In an urban setting, context classifications C4-C6 (or other areas with curbed roadways), offset left-turn lanes are recommended with median widths greater than 18 feet. A 4 feet wide traffic separator should be used, when possible, to channelize the left-turn movement and provide separation from opposing traffic. It is recommended to use offset left-turn lanes at rural intersections with a high volume of vehicular turning movements.

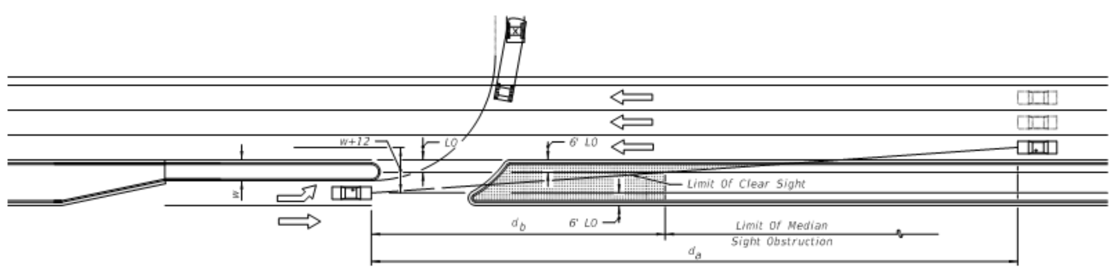
On median widths 30 feet or less, an offset left-turn lane parallel to the through lane is recommended. In addition, the area between the left-turn lane and the through lane where vehicles are moving in the same direction should be channelized with pavement markings. On medians greater than 30 feet, a tapered offset should be considered.

See *FDM 212 - Intersections* for more information on Offset Design.

5.4.3 Left-Turn onto Side Street

FDM 212 provides sight distance guidance for left turns from a divided highway. ***Figure 71*** provides guidance for different design vehicles: passenger cars (P), single unit trucks (SU), and combination trucks (Comb.). Further guidance is available in the *AASHTO Green Book, Chapter 9*.

Figure 71 | Sight Distance for Left Turn from Highway



Design Speed (mph)	d_a (feet)								
	1 Lane Crossed			2 Lane Crossed			3 Lane Crossed		
	P	SU	Comb.	P	SU	Comb.	P	SU	Comb.
25-30	245	290	330	265	320	365	290	350	395
35	285	335	385	310	370	425	335	410	460
40	325	385	440	355	425	485	385	465	525
45	365	430	495	400	475	545	430	525	590

Notes:

(1) Provide a lateral offset (LO) of 6' as shown in the diagram above. d_b may be determined by the equation $d_b = d_a (w/(w+12))$. For roadways with non-restricted conditions, d_a and d_b should be based on the geometry for the left turn storage and on clear zone widths.

(2) For wide medians where the turning vehicle can approach the through lane at or near 90°, use d values from tables in ***Exhibits 212-6*** and ***212-7***. (The clear sight line origin is assumed to be 14.5 feet from the edge of the near travel lane.

Source: FDM 212 – Intersections (Table 212.11.1)

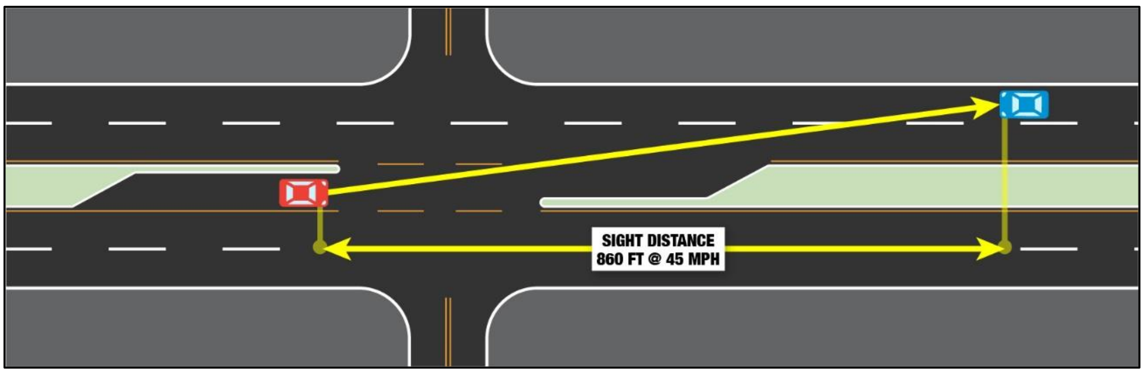
5.4.4 U-Turns

U-turns are more complicated than simple turning or crossing maneuvers. Sight distances for U-turns, shown in ***Figure 72***, were calculated for automobiles with the following assumptions:

- "P" vehicle (Passenger vehicle)
- 2.5 seconds reaction time
- Additional time required to perform the U-turn maneuver
- Begin acceleration from 0 mph only at the end of the U-turn movement (this is conservative)
- Use of speed/distance/and acceleration figures from *AASHTO Green Book*
- 50 feet clearance factor

For information on these calculations, please reference ***Appendix C***.

Figure 72 | U-Turn Sight Distance



Source: FDOT

In addition, sight distances are also impacted by speed, as shown in ***Table 27***. As the speed of the vehicles in the opposite lanes increases, more sight distance is required. For vehicular speeds of 45 mph, there is a required sight distance of 860 feet for vehicles to safely complete a U-turn at an unsignalized median opening.

Table 27 | Sight Distance for U-Turn at Unsignalized Median Opening

Speed (mph)	Sight Distance (feet)
35	540
40	670
45	860
50	1,075
55	1,290
60	1,585

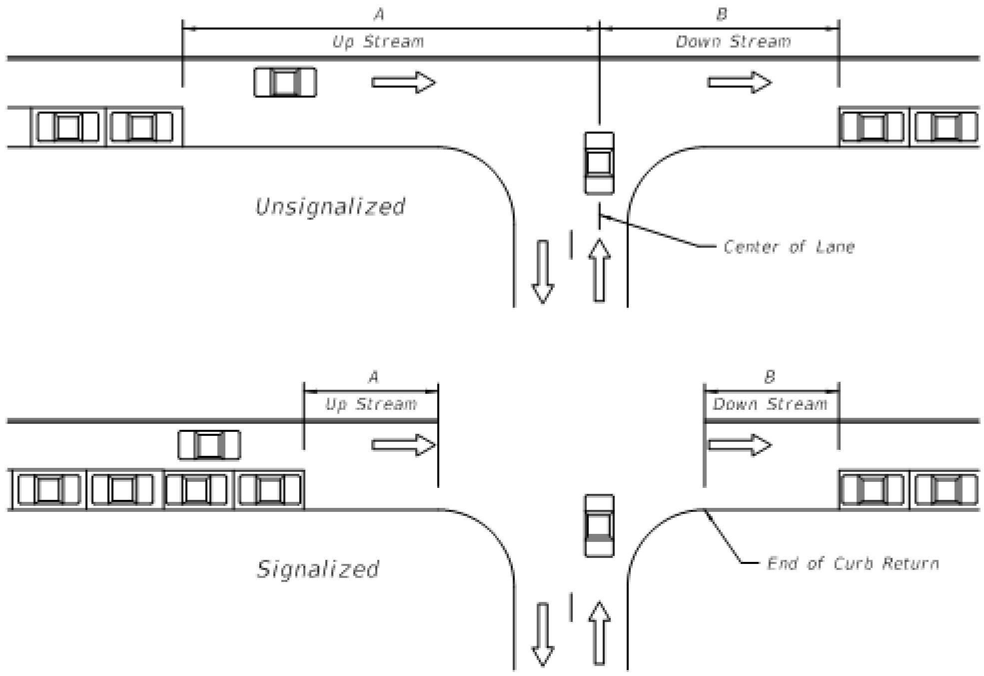
Source: Adapted from the course material notes of Virgil Stover

5.4.5 On-Street Parking

The location of a driveway close to on-street parking can seriously impact visibility. In FDM 212.11.5, there is additional guidance on the placement of driveways in relation to on-street parking (See **Table 28**).

Table 28 | Parking Restrictions for Driveways and Intersections

Control Type	Posted Speed (mph)	A – Up Stream (feet)	B-Down Stream (feet)	
			2-Lane	4-Lane
Unsignalized	<35	90	60	45
	35	105	70	50
Signalized	< 35	30	30	30
	35	50	50	50



Notes:

(1) For entrances to one-way streets, the downstream restriction (B) may be reduced to 20 feet.

(2) Do not place parking within 20 feet of a marked crosswalk.

Source: FDM 212 – Intersections (Table 212.11.2)

5.4.6 *Sight Distance and Construction*

Barriers erected during construction work on roadways or buildings can interfere with clear sight distances for driveways or intersections. It is important to coordinate with the local government overseeing this work to ensure that clear sight distances are maintained throughout the construction period.

5.4.7 *Sight Distance Concerns at Driveways*

When designing or reviewing site plans that include driveways, it is important to ensure that adequate sight distances are maintained so that drivers exiting the driveway have a clear view of pedestrians and bicyclists utilizing sidewalks or separated bikeways. This principle applies to travel in both directions on the sidewalks adjacent to and entering the business. ***Figure 73*** shows how a brick fence column (highlighted in yellow) or a tall vehicle parked in the handicap parking space could contribute to a pedestrian or bicycle crash with a vehicle exiting the driveway.

Figure 73 | Sight Distance Concerns at Driveways

Source: Oakland, CA – Google Earth

Chapter 6: Turn Lanes and U-Turns

6.1 Overview

For driveways, medians, and median openings, the placement and design of turn lanes and U-turns are critical to avoid potential traffic safety issues. For example, a median opening placed across a left-turn lane at an intersection could create conditions leading to a vehicular crash (See ***Figure 27*** or ***Figure 28***). Locating these roadway openings is discussed in greater detail in ***Chapter 2: Roadway Openings***. This chapter will instead focus on where to locate and design turn lanes and U-turns and how they relate to driveways, medians, and median openings.

6.2 Exclusive Right-Turn Lanes

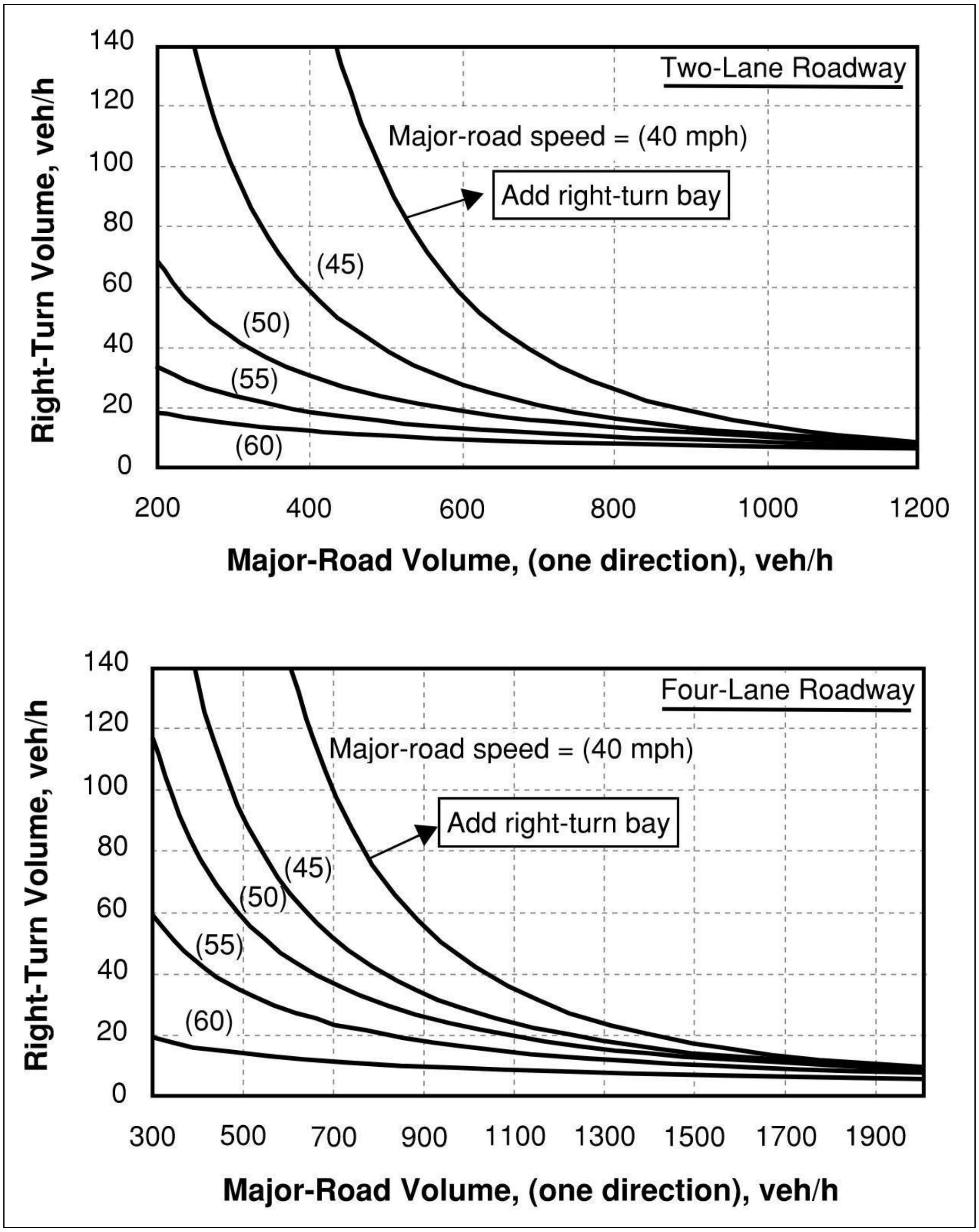
At driveways and intersections, an exclusive right-turn lane separates vehicles that are slowing or stopped to turn from the major road through traffic lanes. This separation minimizes turn-related collisions and eliminates unnecessary delay to through vehicles. Exclusive right-turn lanes are useful where a combination of high roadway speeds, and high right-turn volumes into a driveway are expected. Congestion on the roadway may also be a good reason to use an exclusive right-turn lane. If properly built, they remove the turning vehicle from the through lanes, thereby decreasing the operational and safety impact of right turning vehicles on the through traffic.

It is also important to consider potential pedestrian conflicts since the addition of a right-turn lane increases the crossing distance, time, and exposure for pedestrians. A well-designed right-turn lane can help to reduce pedestrian conflicts by slowing vehicle speeds, increasing pedestrian visibility, and reducing pedestrian exposure with a pedestrian refuge area.

6.2.1 When to Consider Exclusive Right-Turn Lanes

There are instances when adding an exclusive right-turn lane for unsignalized driveways and intersections is beneficial to traffic operations and safety. ***Figure 74*** provides guidance for two-lane and four-lane roadways based on the speed limit of the major roadway, major roadway approach volume, and how many right turns occur per hour. These recommendations are based primarily on the research done in *NCHRP Report 457, Evaluating Intersection Improvements: An Engineering Study Guide, Chapter 2 – Add a Right-Turn Bay on the Major Road*.

Figure 74 | Recommended Guidelines for Exclusive Right-Turn Lanes to Unsignalized Driveway/Intersection



Source: NCHRP Report 457, TDOT Highway System Access Manual

Here are some additional situations when adding an exclusive right-turn lane may be required:

- Facilities having a high volume of buses, trucks, or trailers (2 or 3 per hour), including:
    - Trucking facilities (or other locations that have a high volume of large vehicle traffic such as water ports, train stations, etc.)
    - Recreational facilities attracting boats, trailers, and other large recreation vehicles
    - Transit facilities
    - School driveways to drop-off and pick-up areas
- Poor internal site design of a driveway facility causing potential backups in the through lanes
- Heavier than normal peak flows on the main roadway
- Very high operating speeds (such as 55 mph or above) and in rural locations where turns are not expected by through drivers
- Highways with curves or hills where sight distance is impacted
- Gated entrances
- Crash experience, especially rear end collisions
- Intersections or driveways just after signalized intersections where acceleration or driver expectancy would make a separate right-turn lane desirable
- Severe skewed angle of intersection requiring right-turn vehicle to slow greatly

6.2.2 When Not to Consider Exclusive Right-Turn Lanes

- Dense or built-out corridors with limited space
- Right-turn lane that would negatively impact pedestrians or bicyclists
- Vehicular movements from driveways or median openings that cross the right-turn lane resulting in multiple threat crashes
- Context classifications C2T, C4, C5, or C6

6.2.3 Exclusive Right-Turn Lane Design

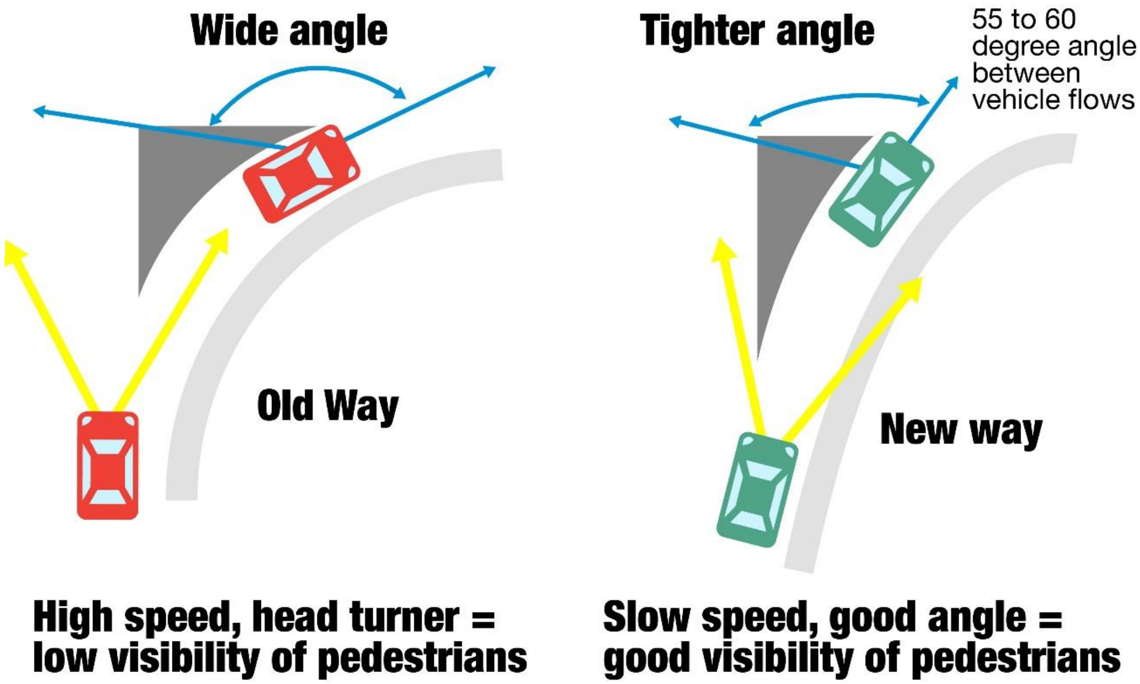
For information on exclusive right-turn lane design, refer to *FDM 212 - Intersections* and *Standard Plans, Index 711-001*. The FDM states that “Right-turn lane tapers and lengths are identical to left-turn lanes under stop control conditions. Right-turn lane tapers and lengths are site-specific for free-flow or yield conditions.” Sheet 11 of Standard Plans, Index 711-001 provides requirements for clearance distance, brake to stop distance and deceleration distance by design speed for both curbed and uncurbed roadways. ***Section 3.1.2: Median Opening Failures*** provides discussion on the various parameters used in turn lane design such as decision distance, stopping distance, etc.

6.2.4 Important Considerations

Right-Turn Channelization

Where right-turn exiting channelization is used, be careful to provide a traffic entry angle that is easy for the exiting driver to negotiate while trying to enter traffic. ***Figure 75*** illustrates how driver head turn angles between 120°-125° (Tighter Angle) are more comfortable than the 145°-150° (Wide Angle) associated with more traditional designs. The tighter angle also encourages drivers to slow down, which provides more time for a thorough scan for conflicts.

Figure 75 | Right-Turn Channelization



Source: NCHRP No. 279 (Intersection Channelization Design Guide) and Chapter 9 of the AASHTO Green Book

Proper right-turn channelization at intersections can also improve safety performance for bicyclists and pedestrians by improving visibility to turning motorists. The "old way" for channelized right-turn lanes with a 30-40° angle-of-entry (Wide Angle) entering the roadway decreases driver's view of pedestrians and increases pedestrian crossing distance. The driver's head must turn further to merge successfully and can easily miss a crossing pedestrian or bicyclist.

Research performed by Schattler and Hanson showed a 44% overall reduction in intersection crashes and a CMF of 0.56 when the angle-of-entry of channelized right turns was reduced. This resulted in a reduction of the angle drivers had to turn their heads to scan for traffic and pedestrians. This "new way" improves the line-of-sight of right-turning passenger vehicles by reducing the angle-of-entry, while at the same time continuing to accommodate large semi-tractor trailer trucks to make right turns without encroachment.[12] This countermeasure is included in the CMF Clearinghouse as "Improve angle of channelized right turn lane."[13]

Right-Turn Lane Design for Pedestrians

Right-turn lanes can create potential hazards for pedestrians since they increase their crossing distance and exposure at the intersection. Right-turn lanes can be designed to enhance pedestrian safety by improving pedestrian visibility, decreasing vehicle speeds, and reducing crossing distance with the following features:

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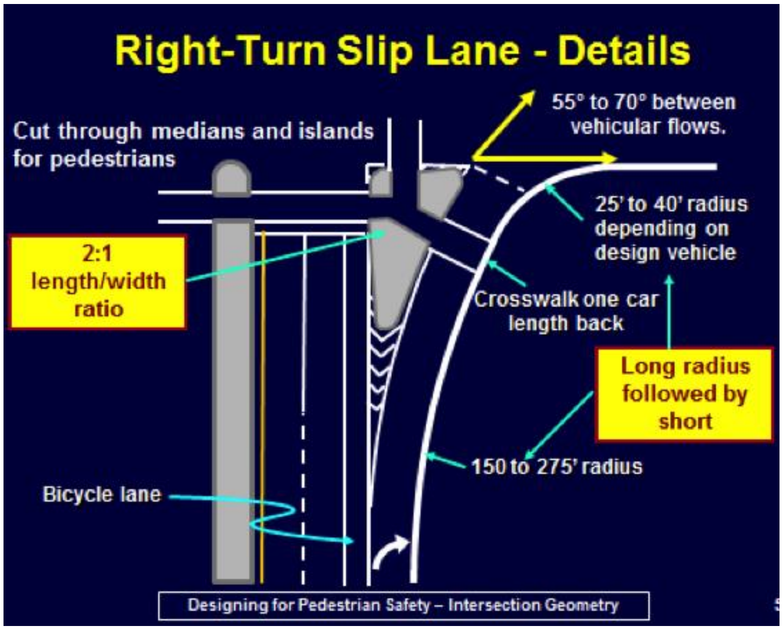
[12] Schattler, K. and T. Hanson. "Safety Impacts of a Modified Right Turn Lane Design at Intersections". Presented at the 95th Annual Meeting of the Transportation Research Board, Paper No. 16-0790, Washington, D.C., (2016).

[13] *https://apps.ict.illinois.edu/projects/getfile.asp?id=4949*

- Reduce corner radius to slow vehicle speeds and to reduce the crossing distance for pedestrians
- Consider channelization in order to provide an island large enough to accommodate pedestrians to serve as a refuge with accessibility features
- Reduce right-turn lane width to encourage slower vehicle speeds
- Optimize sight lines between vehicles and pedestrians
- Orient the crosswalk at a 90-degree angle to the right-turn lane (***Figure 76***)
- Upon entering the right-turn lane, provide enough distance for a vehicle to come to a complete stop if needed
- Use high-visibility pavement markings and signage to increase pedestrian visibility
- Consider other enhancements, such as raised crosswalks (***Figure 77***), where appropriate
- Provide accessibility features such as rumble strips
- To encourage slower speeds, do not provide for an uncontrolled, free flow right-turn movement, which includes providing an acceleration lane for right-turning vehicles
- If channelized, position the crosswalk one car length away from the cross street to allow a vehicle to wait for a gap to complete their right turn without blocking the crosswalk (***Figure 76***)
- If channelized, use a tighter angle of entry for the vehicles (***Figure 76***), as previously discussed in ***Right-Turn Channelization***

These features should be considered for contexts C2T, C4, C5, C6, and in locations with anticipated pedestrians.

Figure 76 | Recommended Pedestrian Design Elements for Right-Turn Channelization



Source: PEDSAFE – Pedestrian Safety Guide and Countermeasure Selection System

Figure 77 | Raised Crosswalk at Channelized Right Turn

Source: City of Los Angeles Supplemental Street Design Guide

6.3 Exclusive Left-Turn Lanes

While some principles for right-turn lanes apply to left-turn lanes, there are inherent differences between them.

6.3.1 When Exclusive Left-Turn Lanes are Beneficial

There are several situations when a left-turn lane should be built on the roadway. For example, if on a multilane roadway and there is a median opening that is serving a driveway, there should be a left-turn lane to allow for vehicles to move safely out the way of the through traffic. Exclusive left-turn lanes should be considered at any location serving the public, especially on curves and where speeds are in excess of 45 mph. The *AASHTO Green Book* contains guidance on this issue. However, the guidelines were developed based on delay rather than crash avoidance. Safety is the main reason behind exclusive left-turn lanes.

6.3.2 When to Consider Exclusive Left-Turn Lanes at Unsignalized Intersections and Driveways

Left-turn lane warrants at unsignalized intersections and driveways were included in *NCHRP Report 745, Left-Turn Accommodations at Unsignalized Intersections*. The recommended left-turn lane warrants are provided for the following roadway facilities.

- Rural, two-lane highways (***Figure 78***)
- Rural, four-lane highways (***Figure 79***)
- Urban and suburban roadways (***Figure 80***)

Alternatively, the left-turn warrants based on *NCHRP Report 457*, (See ***Figure 81***) can be used if it is found to be more appropriate and reasonable for a local condition. Engineering judgment should be used when deciding between the NCHRP 745, and NCHRP 457 guidelines.

Figure 78 | Left-Turn Lane Warrants for Two-Lane Rural Roadways (Unsignalized)

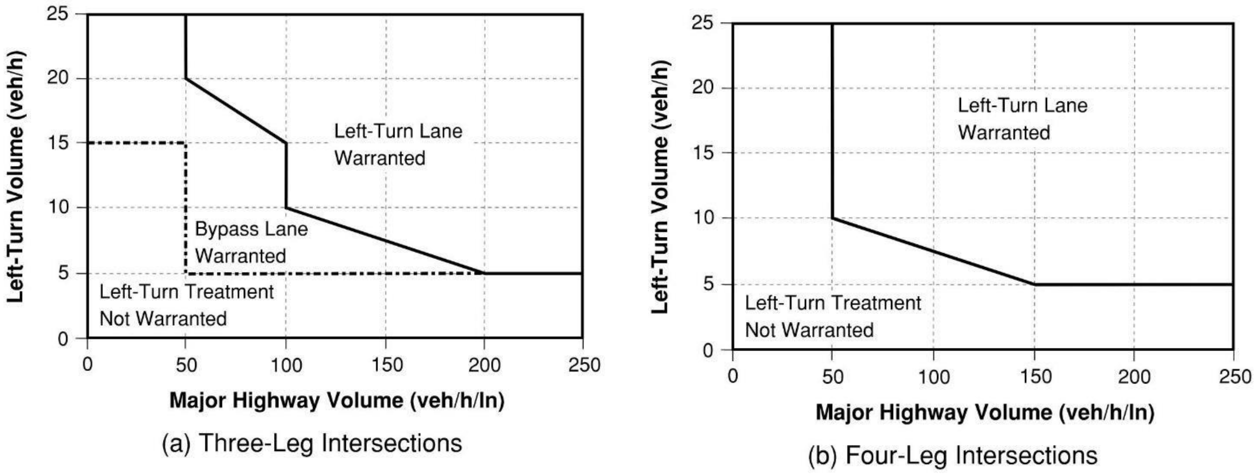


Figure 79 | Left-Turn Lane Warrants for Four-Lane Rural Roadways (Unsignalized)

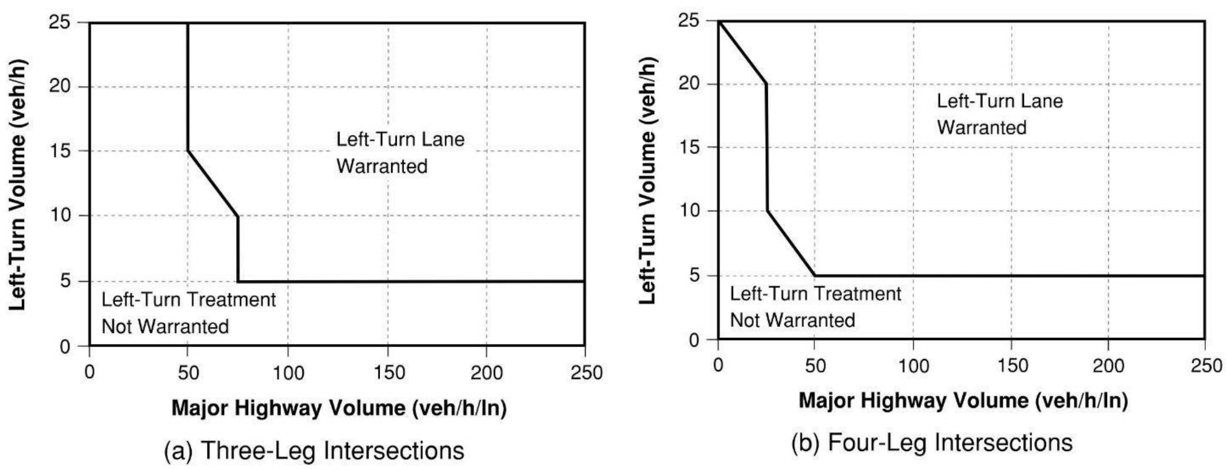
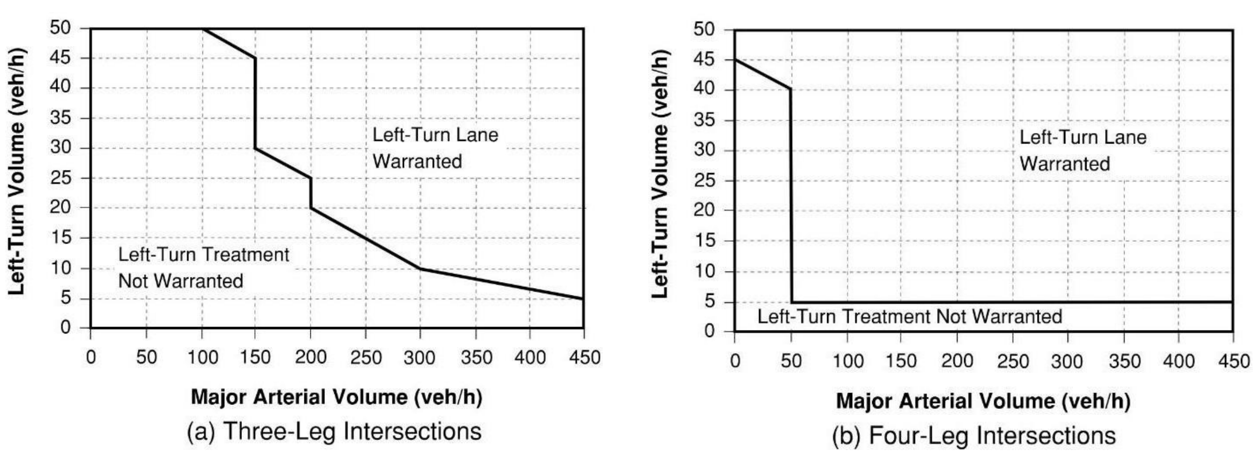
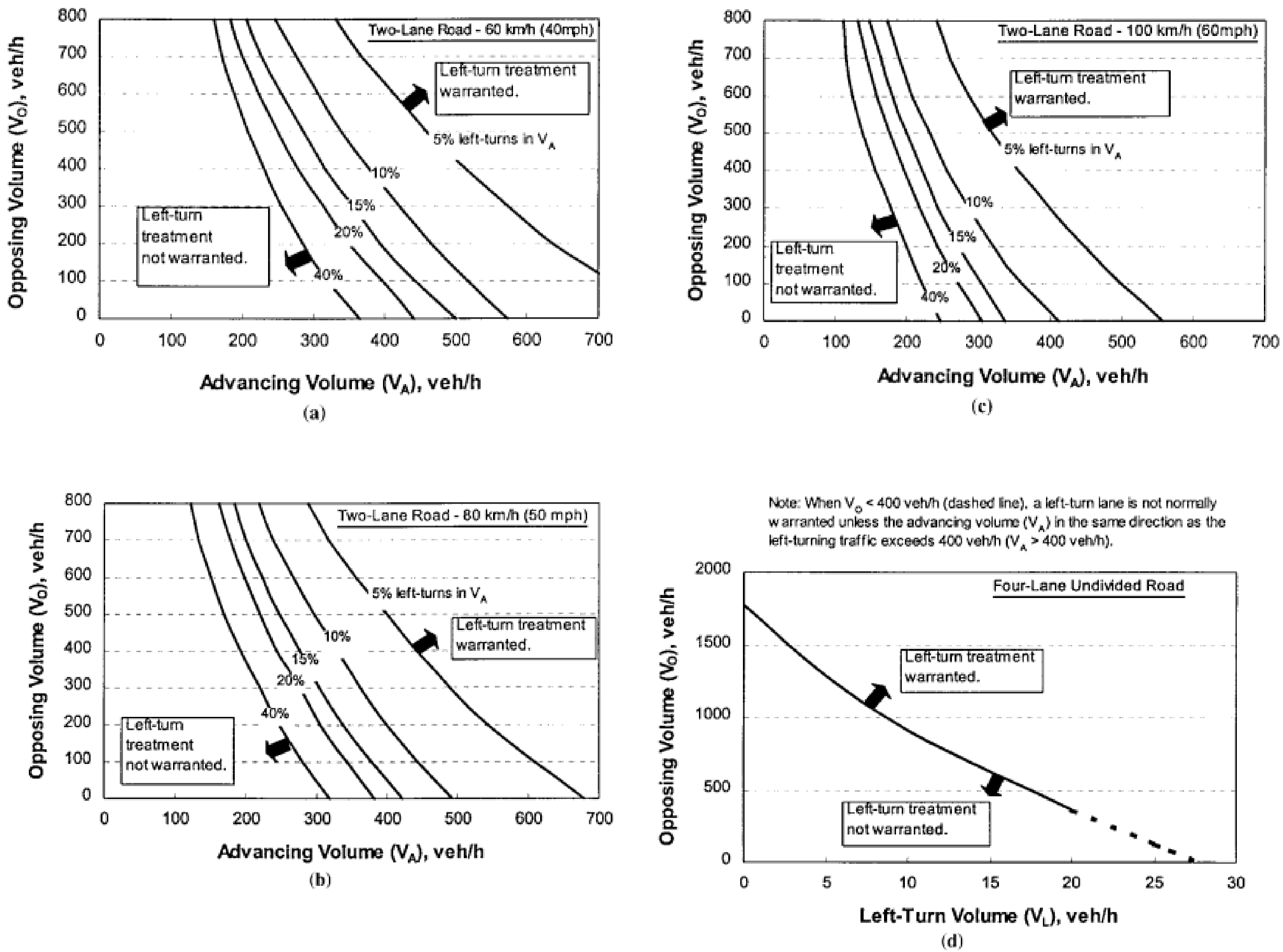


Figure 80 | Left-Turn Lane Warrants for Urban and Suburban Arterials



Source: NCHRP Report 745

Figure 81 | Left-Turn Lane Warrants (Unsignalized Intersections) – Alternate Method



Source: [NCHRP Report 457]

6.3.3 Designing Exclusive Left-Turn Lanes

Left-turn movements at unsignalized intersections and driveways that are made from through traffic lanes cause delay and adversely impact safety. Left-turn lanes can reduce the potential for collisions and improve capacity by removing stopped vehicles from the main travel lane.

Similar to right-turn lanes, information on how to design left-turn lanes can be found in *FDM 212 Intersections* and *Standard Plans, Index 711-001*. Sheet 11 of Standard Plans, Index 711-001 provides requirements for clearance distance, brake to stop distance, and deceleration distance by design speed for both curbed and uncurbed medians. ***Section 6.3.4: Important Considerations*** below provides further guidance on left-turn lanes and driveways. ***Section 3.1.2: Median Opening Failures*** provides discussion on the various parameters used in turn lane design, such as decision distance, stopping distance, and other factors.

6.3.4 Important Considerations

Left Turns and Driveways

One area where left turns may need to be discouraged is when the driveway is located near an intersection. In these instances, a driveway may need to be channelized (See ***Section 4.2.9: Channelizing Islands (I)*** for more information) to restrict unsafe vehicular movements. These are also known as “Divisional Islands.”[14]

Divisional Islands can provide guidance to drivers on roadways with medians for right-in, right-out movements. However, they are not sufficient to prohibit left turns in or out. The divisional island design might also be useful on an undivided roadway where the driveway is so close to an intersection that the left-turn would be unsafe at any time due to vehicle queuing and visibility restrictions. The most effective way to prohibit left turns is to install restrictive medians. Where space for a median is not available, the traffic engineer can use flexible traffic delineator posts or hardened centerline (see *FDM 210.3.3*) in the main road to discourage left turns.

Separate Left-Turn Exit Lanes for Driveways

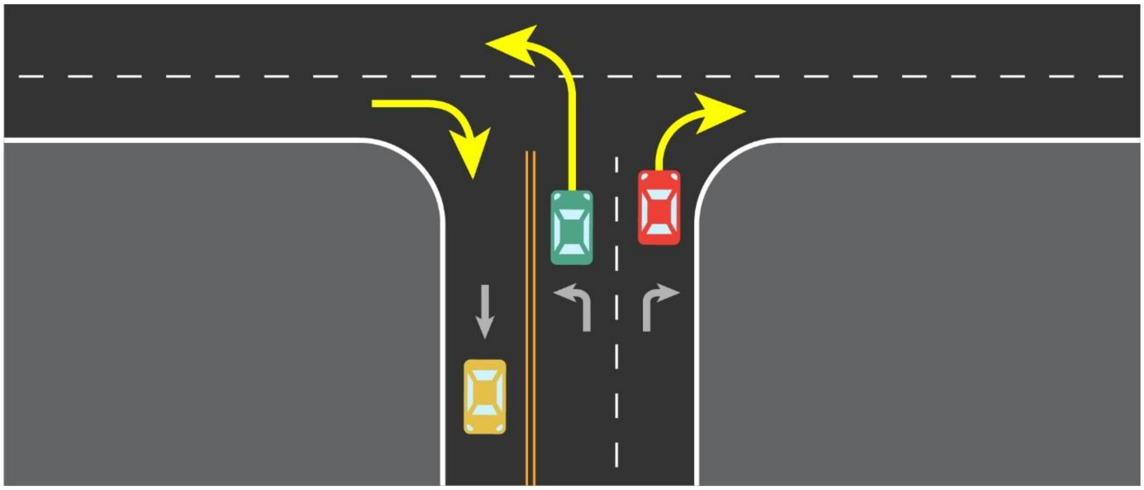
Separate left- and right-turn lanes should be provided on major commercial driveways (Class C or higher driveways with volumes of 600 vpd or more, or 60 vph or more) where both left turns and right turns are permitted to exit. Even a small number of left turns may cause a substantial delay to right turns out of the driveway with a single exit-lane. Separate left- and right-turn lanes may also be considered at driveways with lower volumes based on the expected exiting left turn volume, delay, and area context.

However, it should be noted that separate left- and right-turn lanes are disadvantageous to bicyclists and pedestrians since additional lanes increase crossing distance, time, and exposure. Furthermore, separate left- and right-turn lanes can introduce multiple-threat pedestrian crashes for pedestrians/bicyclists crossing the driveway. Multiple-threat crashes occur when a pedestrian begins crossing in front of a slowed or stopped vehicle and then encounters a second same-direction vehicle in the adjacent lane which does not stop. The view of the pedestrian, and the

[14] These are colloquially called “Pork Chops”.

pedestrian's view of the second vehicle, is obstructed by the first vehicle. This disadvantage should be considered in contexts C2T, C4, C5, C6, and in locations with anticipated bicyclists/pedestrians.

Figure 82 | Three Lane Driveway[15]



Source: Adapted from Vergil Stover

Left-Turn Lanes Serving Driveways on Multilane and Two-Lane Roadways

Multilane Roadway with A Median

Whenever a driveway is served by a median opening, a left-turn lane should be available. This provides for the safest left turns into the driveway.

Two-Lane Roadway

The *AASHTO Green Book* contains guidance on left turns. However, the guidelines were developed based on delay rather than crash avoidance. Safety is the main reason behind exclusive left-turn lanes.

6.4 Center Two-Way Left-Turn Lanes (TWLTL)

TWLTLs (also referred to as flush medians) allow for multiple turning vehicular movements but can cause operational and safety issues depending on the application. ***Section 1.3.1: Safety Benefits of Vehicular Access Management***, demonstrates the reduced safety performance of TWLTLs compared with raised medians. Per FDM 210.3, a raised or restrictive median should be provided on divided roadways that have a design speed of 45 mph or greater. TWLTLs (flush median) may be used on 3-lane and 5-lane typical sections with design speeds ≤ 40 mph.

Design criteria for lane widths and pavement slopes are given by lane type, design speed, and context classification. Minimum travel, auxiliary, and two-way left-turn lane widths are provided in *FDM 210*. On new construction projects, flush medians are to include sections of raised or restrictive median to enhance vehicular, bicycle, and pedestrian safety, improve traffic efficiency,

[15] When driveway volumes exceed 600 vpd, a three-lane cross-section should be considered. Consider channelization if traffic is over 4,000 vpd.

and attain the standards of the Access Management Classification of that highway system. Sections of raised or restrictive medians are recommended on RRR projects.

Per *NCHRP Report 659*, on roadways that are undivided or have TWLTLs, the alignment of driveways on opposite sides of the road needs to be considered. Driveways on opposite sides of a lower-volume roadway may be aligned across from each other. Alternatively, they should be spaced so that those drivers desiring to travel between the driveways on opposing sides of the roadway need to make a distinct right turn followed by a left turn (or a left followed by a right). A much longer separation is needed on a higher-speed, higher-volume roadway.

6.5 U-Turns

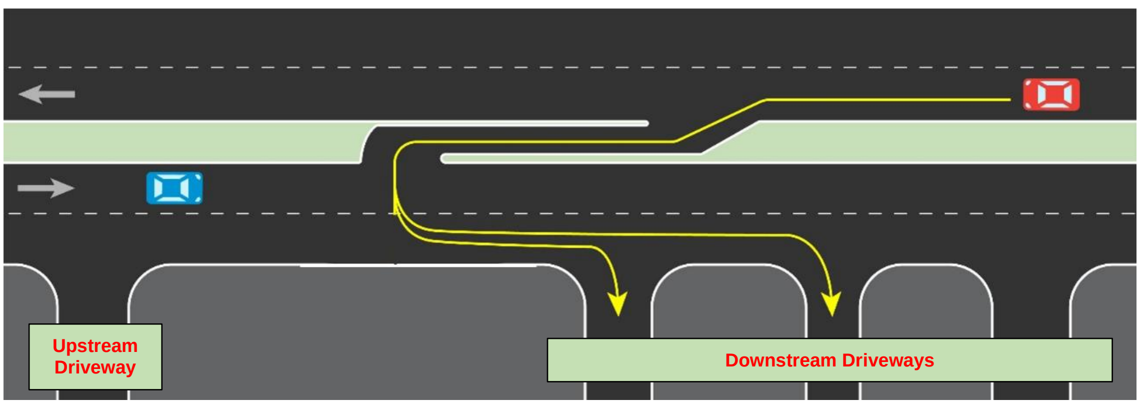
Vehicles attempting to make U-turns from a median opening onto the roadway, into a driveway, or from a left-turn lane may require specific considerations to avoid potential safety issues.

6.5.1 Important Considerations

Driveways and U-Turn Movements

Driveways should be located directly opposite, or downstream, from a median opening. Where a driveway cannot be directly across with a median opening, the closest upstream driveway access should be located more than 100 feet from the median opening to prevent wrong-way maneuvers (See ***Figure 83***).

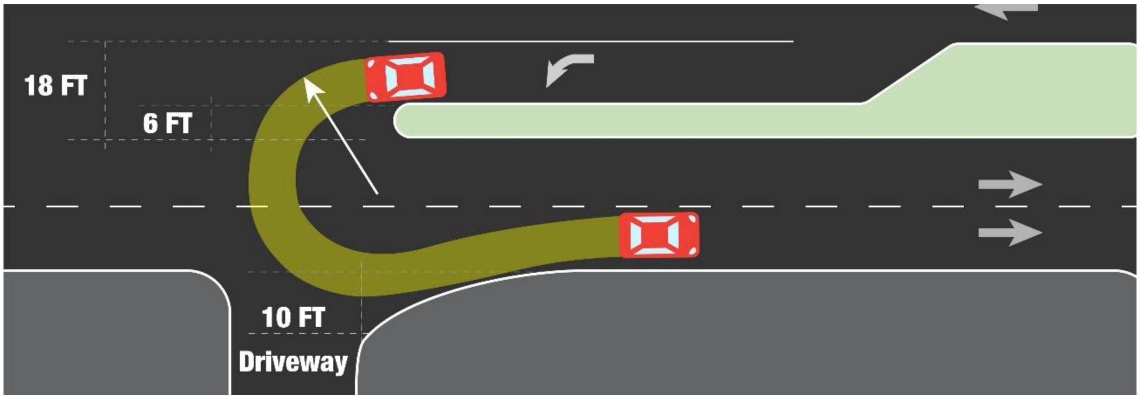
Figure 83 | Entry Maneuvers from a U-Turn



Source: FDOT

It is sometimes necessary to widen the driveway apron to allow easier U-turns at a median opening. This is typically the case on four-lane roadways with driveways across from the median opening. A design like the one shown in ***Figure 84*** can allow the ease of this movement. Paved shoulders can also provide the extra space needed to facilitate U-turns for class 4-9 vehicles with more than two axles.

Figure 84 | U-Turns and Driveways[16]



Source: Adapted from 2011 AASHTO Greenbook

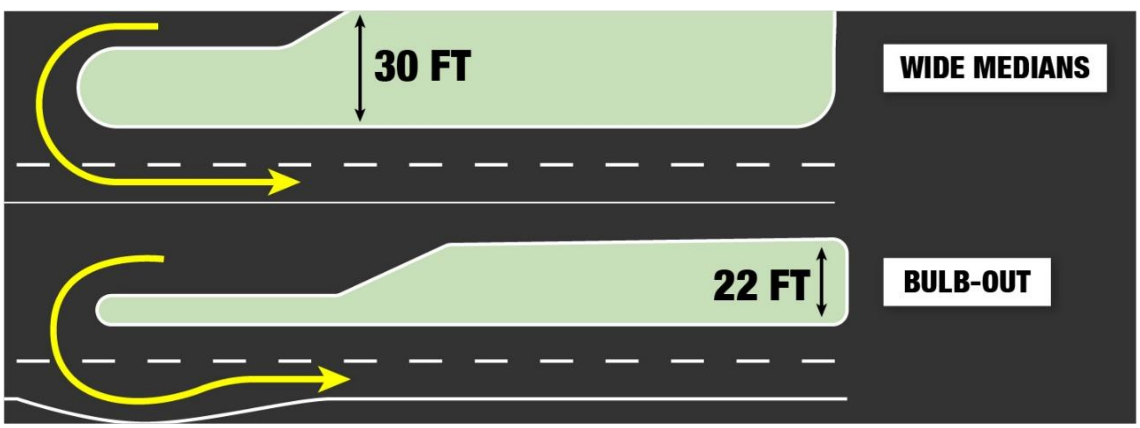
Medians, Median Openings and U-Turns

U-turns should not be permitted from the through traffic lane due to the potential for high-speed, rear-end crashes and serious impact on traffic operations. All left-turns and U-turns should be made from a left-turn/U-turn lane.

Designing Medians for U-Turns

To accommodate U-turns, either a wide median can be designed or a bulb-out can be placed onto the side of the roadway. This principle is illustrated in ***Figure 85*** which shows the typical turning width required by a large passenger car or SUV on a suburban 4-lane arterial roadway. The type of traffic, land uses, and terrain surrounding the area will determine whether these designs are viable. For specific information on median widths, refer to ***Table 13*** in ***Chapter 3: Designs of Medians & Median Openings*** where guidance is provided based on design speed and context classification.

Figure 85 | Example U-Turn Options on a 4-Lane Arterial



Source: FDOT

[16] Providing extra driveway pavement across from median openings can help U-turn movements. This would typically be done on 4-lane roads.

U-Turn Locations

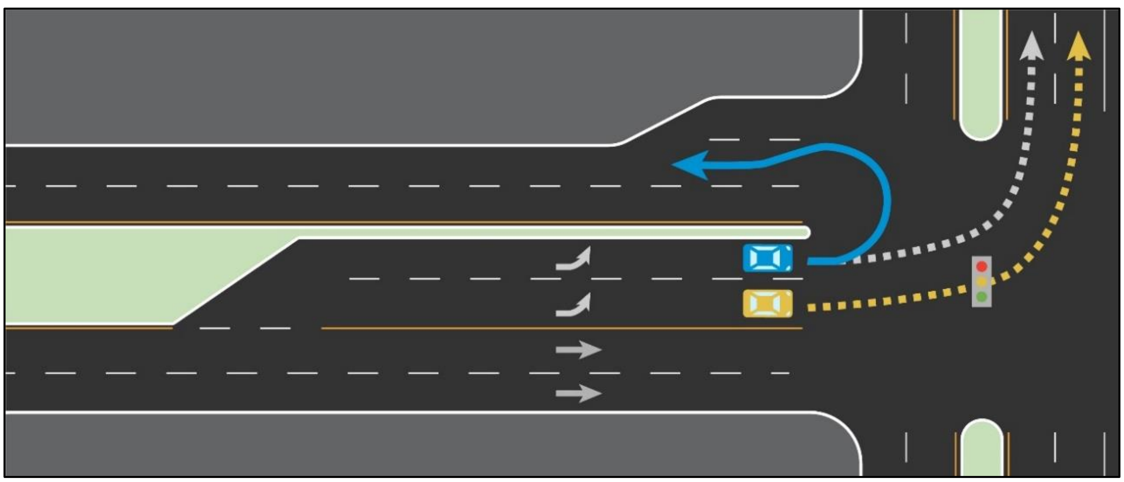
The locating and allowing of a U-turn movement must be reviewed thoroughly to avoid causing issues with other aspects of the transportation network. This is especially important when there are multiple signalized intersections and driveways on the roadway.

For U-turn movements that are meant to be completed at a signalized intersection, there must be sufficient median width to avoid encroachment onto the sidewalks. There should also be a low combined left-turn plus U-turn volume at signalized single left-turn lanes at the intersection. The reason for this is that vehicles making U-turn movements take longer to complete in comparison to left turns. Caution should be taken when there are side streets without "right-on-red" restrictions or for signal operation that includes right-turn overlaps.

Where medians are of sufficient width to accommodate dual left-turn lanes, an option is to allow U-turns from the inside (left-most) left-turn bay as illustrated in ***Figure 86***. However, this option may increase the crossing distances for bicyclists and pedestrians.

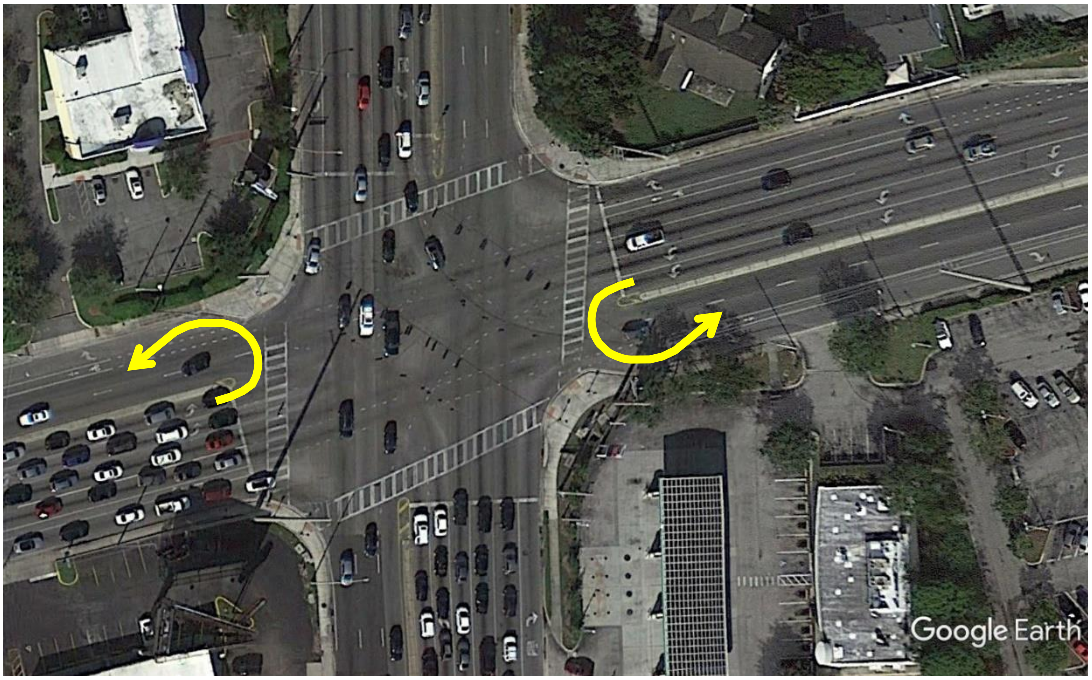
Another alternative is to pull the end of the median back to allow the U-turn to occur behind the corner of the intersection. As depicted in ***Figure 87***, this effectively configures the corner with a bulb out and curb extension to provide the necessary U-turn space, but also maintains a shorter pedestrian crossing.

Figure 86 | Dual Left-Turn Lanes and U-Turns



Source: FDOT

Figure 87 | Decreasing Pedestrian Crossing Distance and U-Turns



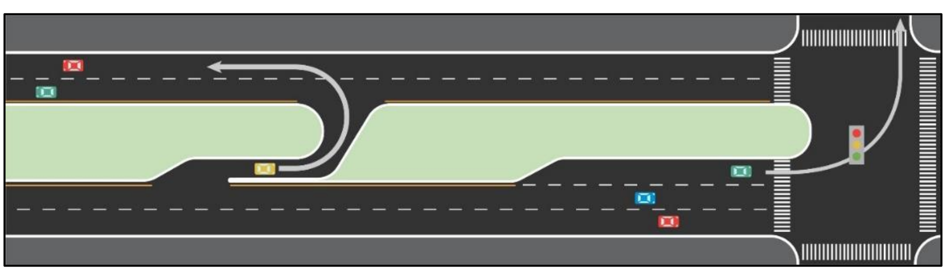
Source: SR 436 / Semoran Boulevard at SR 426 / Aloma Avenue, Winter Park, FL – Google Earth

U-Turns Before or After Intersections

A U-turn in advance of a signalized intersection will result in two successive left-turn lanes as illustrated in ***Figure 88***. However, unless there is a substantial length of full median width, drivers may mistakenly enter the U-turn lane when desiring to perform a left-turn at the downstream signalized intersection. Motorists may perform abrupt re-entry maneuvers into the through traffic lane to escape the U-turn lane. Over 100 feet of full median width between the median opening and the intersection helps to alleviate this problem. If 100 feet is not possible, signage or other pavement markings can be used to help guide the motorist. Indications that you should consider a U-turn opening before a signalized intersection are:

- High volume of U-turns currently at signalized intersection
- Numerous conflicting right turns
- A gap of oncoming vehicles would be available at a separate U-turn opening
- Where there is sufficient space to separate the signalized intersection and U-turn opening

Figure 88 | U-Turn (Median U-Turn) Before a Signalized Intersection



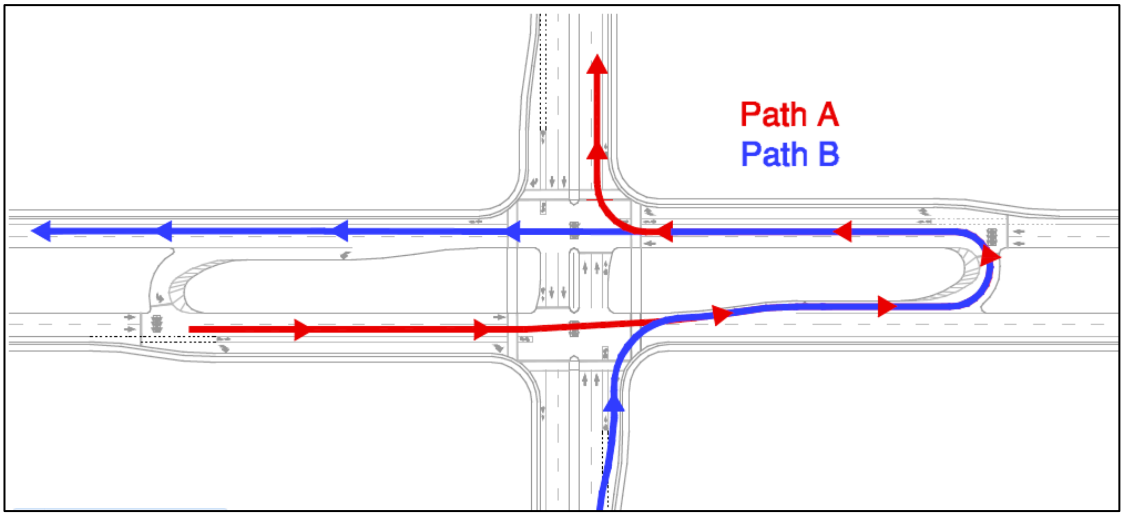
Source: Safety and Operational Evaluation of Right Turns Followed by U-turns as an Alternative to Direct Left Turns, University of South Florida

For U-turns that are to be made after a traffic signal (See ***Figure 89***), it is recommended that a "Median U-Turn" is used to allow for these types of movements (previously called "Michigan U-Turns"). See the *FDOT ICE Manual* and the *FHWA Median U-Turn Information Guide* for guidance on median U-turn intersections.

The Median U-Turn (MUT) and other alternative intersection designs such as the Restricted Crossing U-Turn Intersection (RCUT) are techniques that reduce the number of signal phases at intersections which in turn can reduce delay and increase intersection efficiency for multiple modes. By providing carefully designed U-turning paths, direct left-turns are eliminated.

As shown in Path A in ***Figure 89***, Drivers desiring to turn left from the major road onto an intersecting cross street must first travel through the at-grade, signal-controlled intersection and then execute a U-turn at the median opening downstream of the intersection. These drivers then can turn right at the cross street. As shown in Path B in the same figure, drivers on the side street desiring to turn left onto the major road must first turn right at the signal-controlled intersection and then execute a U-turn at the downstream median opening and proceed back through the signalized intersection.

Figure 89 | Median U-Turn Intersection Vehicle Paths



Source: FHWA Median U-Turn Intersection Information Guide

The MUT can be implemented with and without signal control at the median openings on the major road. There are many variations of the MUT which are covered in the FHWA guidance. These include U-turn crossovers before and after the intersection. Any installation of an alternative intersection should be done following the guidance in the *ICE Manual* and in conjunction with the FDOT Roadway Design Office.

There are similar operational issues for vehicles when the U-turn is before the signal, but the implementation of this roadway design is said to increase capacity by 20-50%. According to FHWA, while there are no absolute traffic volume requirements for the use of this design, they have traditionally been implemented on state roads with average traffic volumes of at least 10,000 vpd.

Overall, it has been found that there are reduced average delays for left-turning vehicles and through-traffic with this design. They have also been found to be safer for pedestrians who are crossing the roadway and improve vehicular safety by decreasing the number of crashes.

Large Vehicles and U-Turns

The extremely wide median that is required for buses and trucks to make a U-turn makes it impractical to design for these vehicles except in special cases. An example of a truck U-turn can be seen in ***Figure 90***. The need for U-turns by large vehicles can generally be avoided in the following ways:

- Bus and truck delivery routes can be planned to eliminate the need for U-turns on a major roadway
- Driveways can be adjusted, and on-site circulation designed to eliminate the need for U-turns by trucks

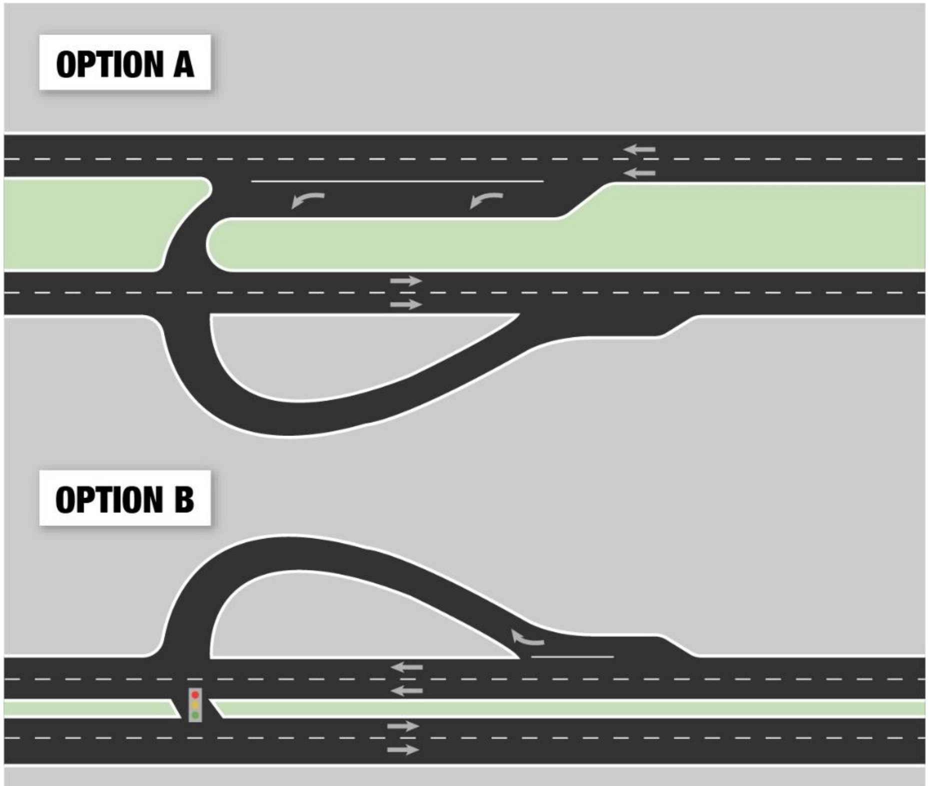
Local governments can avoid the need for U-turns by large vehicles through their subdivision and site development ordinances. Sample land development regulations which include these features can be found in the CUTR report for FDOT: *Model Access Management Policies and Regulations for Florida Cities and Counties: 2nd Edition*.

Figure 90 | Truck U-Turn in Williston, FL

Source: Williston, FL – Google Earth

There are various roadway designs though that can be used to allow trucks or other large vehicles to make U-turn movements. These alternatives are sometimes called “Jughandles” and permit the vehicle to complete the U-turn without encroaching into lanes (See ***Figure 91***). By creating a large, sweeping design on the side of the roadway, these vehicles can more safely make U-turns.

Figure 91 | U-Turn Alternatives for Large Vehicles



Source: FDOT

Both Option A and B are useful, but there are differences in these two designs. Option A has the following desirable operational features:

- A U-turning vehicle is stored in the median parallel to the through traffic lanes
- A suitable gap is needed in the opposing traffic stream only
- After completion of the U-turn the driver can accelerate prior to merging into the through traffic lane
- Typically, commercial drivers would prefer Option A over Option B as they will only be required to travel over one direction of traffic

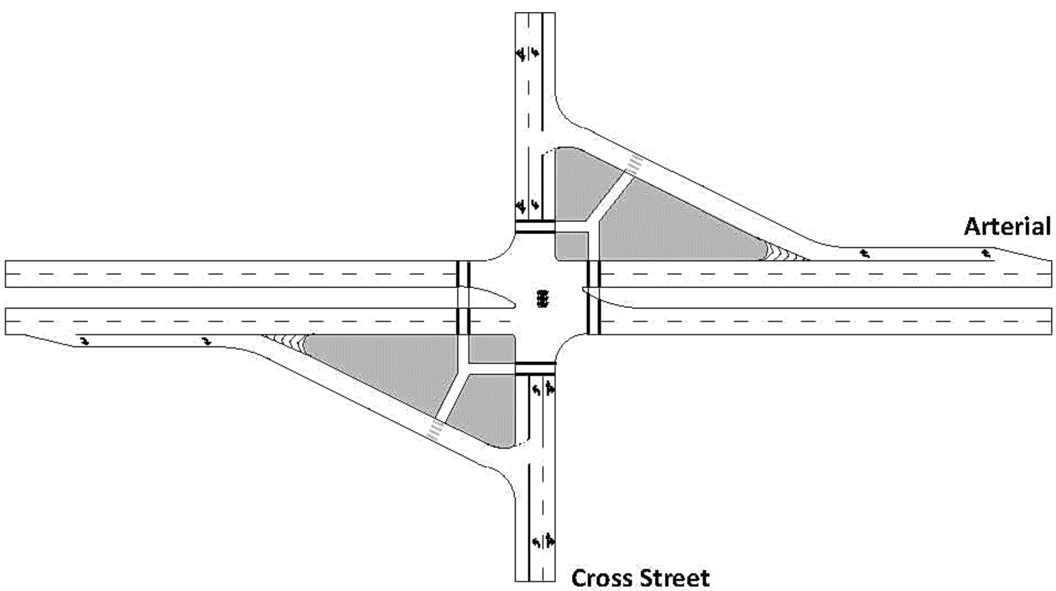
In most cases, Option B will need a signal. Both options require more ROW than most standard highway designs, but it may be more cost feasible where public land is available or in special cases. For example, a horse racetrack installed a "jughandle" design to more easily allow for movements of vehicles that had horse trailers (See ***Figure 92***).

Figure 92 | U-Turn Alternative B

Source: Miami, FL – Google Earth

When this treatment is used at an intersection it is known as a New Jersey Jughandle Intersection (NJJI). For a simplified view of the NJJI design, please refer to ***Figure 93***.

Figure 93 | NJJI Simplified View



Source: New Jersey Department of Transportation

For more information on "Jughandles", please refer to the *FDOT ICE Manual, Appendix A* or *FHWA's Techbrief on "Jughandle" intersections*.

Alternative Intersections and U-Turns

Below is a list of the various alternative intersection designs:

- Median U-Turn
- Restricted Crossing U-Turn
- Roundabout
- Displaced Left-Turn
- Quadrant Roadway

For more information on these alternative designs, please refer to the *FDOT Intersection Control Evaluation (ICE) Manual*. Alternative intersections and ICE process are also discussed in the ***Chapter 8: Intersection Control Evaluation (ICE) and Alternative Intersections*** of this guidebook.

Chapter 7: Multimodal Access Management

7.1 Overview

While access management has traditionally focused on vehicles to balance safe and efficient travel on roadways while providing access to adjacent properties, it is also critical to provide access for pedestrians, bicyclists, transit vehicles, larger vehicles, and freight for the same reasons. Often site design only accounts for vehicular access to the site and does not provide access for pedestrians and bicyclists. This can create several issues:

- Pedestrians and bicyclists attempting the access the site will create their own pathways such as through driveways, landscaping, parking lots, etc. (examples depicted in ***Figure 94***). These pathways may not only be inconvenient, but also unsafe.
- The lack of safe and convenient paths for bicyclists and pedestrians to access a site discourages non-motorized modes; driving a car may be considered an easier option. This can increase vehicle use which contributes to congestion on roadways, as well as air quality and public health issues.
- People that depend on non-vehicular modes of transportation may not able to access the site locations.

Figure 94 | Worn Footpaths between Bus Stop, Crosswalk, and Major Retail Center

Source: Google Earth

Per *F.S. 334.044*, FDOT has the authority and responsibility to establish and maintain pedestrian and bicycle ways, and to encourage and promote multimodal transportation alternatives. Where non-motorized travel exists, is anticipated, or promoted, safe and convenient access should be provided for bicyclists and pedestrians to adjacent properties along the roadway.

Per *Rule Chapter: 14-96.005 F.A.C.*, it states that:

> *Where non-motorized users (bicyclists and pedestrians) are present, planned, or promoted, safe and convenient access for non-motorized users should be provided by the site. The pedestrian/bicycle access should connect the external pedestrian and bicycle network/s (e.g., the sidewalk and/or bicycle facility along the site's frontage) to the main entrance of the site's building/s. Access should be safe and convenient with minimal conflicts with other modes and minimized travel distance with the most direct route.*

All users of the roadway benefit from improved safety performance and operations when conflict points are well managed as part of a comprehensive approach.

7.2 Site Access for Non-Motorized Users

It is important to ensure access for non-motorized users (pedestrians, bicyclists, etc.) for sites. For example, the site that was referenced in ***Figure 94*** and ***Figure 95*** showed how sidewalk access was kept when it was redeveloped. This access is important for these users because without it, they are forced to traverse the site without any specific space dedicated to them and perhaps may need to enter the site using the driveway. This could be dangerous, especially for sites that have a high number of vehicles entering/exiting (fast-food, convenience store, etc.).

Crashes can be reduced by separating modal users. To encourage people to walk, bicycle, or access transit safely, it is important to provide a connected sidewalk and bicycle facility network and to provide direct access to properties along a roadway. People on foot often travel slower, make shorter trips than automobiles, and seek direct routes. It is important that their transportation networks be permeable and offer multiple options to keep trips direct.

To provide pedestrian/bicycle access to a site, paths should:

- Connect the external pedestrian and bicycle network/s to the main entrance of the site's building/s
- Be provided between the main entrances of multiple on-site buildings, if present
- Be provided between the parking areas and building entrances
- Be convenient with minimal conflicts with other modes, and minimized travel distance with the most direct route
- Meet ADA requirements

Figure 95 shows a site that provides a direct sidewalk connection from the sidewalk along the major arterial to the site. The sidewalk path connects to high visibility textured crosswalks onsite with a stop-controlled condition for vehicles.

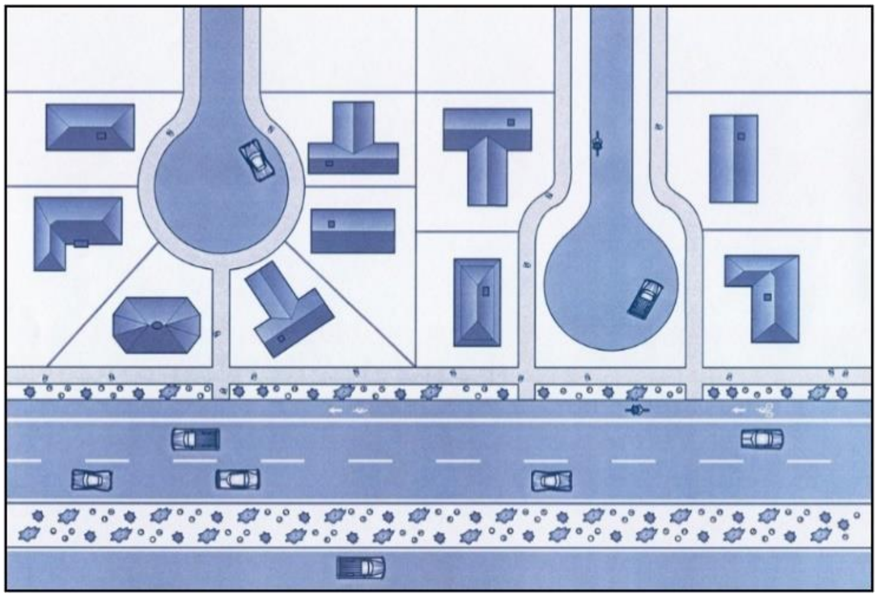
Figure 95 | Direct Sidewalk Connection from Roadway to Site with Crosswalks Onsite

Source: Google Earth

7.3 Pedestrian/Bicycle Connectivity

To minimize the travel distance for non-motorized users, sites should consider neighboring properties and providing direct pedestrian/bicycle access. As shown in ***Figure 96***, a sidewalk in a cul-de-sac is connected to the nearby sidewalks to allow for people to walk or ride their bicycle. This type of neighborhood design promotes connectivity for pedestrian and bicycle modes, while prohibiting vehicles from driving through the area. These types of connections can make it possible for non-motorized users to avoid arterial roadways and access key destinations, which greatly shortens trips. These direct and convenient paths for bicyclists and pedestrians can reduce vehicle trips and lessen the demand on roadways by encouraging walking and biking instead of driving a car.

Figure 96 | Connected Cul-de-Sac



Source: FHWA Achieving Multimodal Networks

7.3.1 Bicycle Boulevards

Sometimes a short connection between two cul-de-sacs, a path through a park, or a footbridge over a river or highway, can overcome a major barrier to connectivity and become the linchpin of a bicycle boulevard route. A bicycle boulevard, also known as a neighborhood greenway, can take advantage of low-volume streets parallel to arterials to create a designated bicycle route where bicycles have priority over other modes. This can include diverting motorized traffic off the street and allowing bicycles through movement. In ***Figure 97,*** signage indicates that vehicular traffic must turn and pavement markings and signage direct bicyclists to use a short cut-throughs to continue their travel. ***Figure 98*** shows example treatment of a bicycle boulevard on a low-volume street. These treatments are typically applied in areas with a well-connected roadway grid. Bicycle Boulevards employ a network-based strategy of traffic calming or diverting methods to keep motorized traffic volumes and speeds low. For more information on this technique, see the North American City Transportation Officials *(NACTO) Urban Bikeway Design Guide*.

Figure 97 | Bicycle Boulevard Example

Source: Tallahassee, FL - CDM Smith

Figure 98 | Bicycle Boulevard on Low-Volume Street Example

Source: Long Beach, CA - HDR Photo

7.4 Midblock Crosswalks

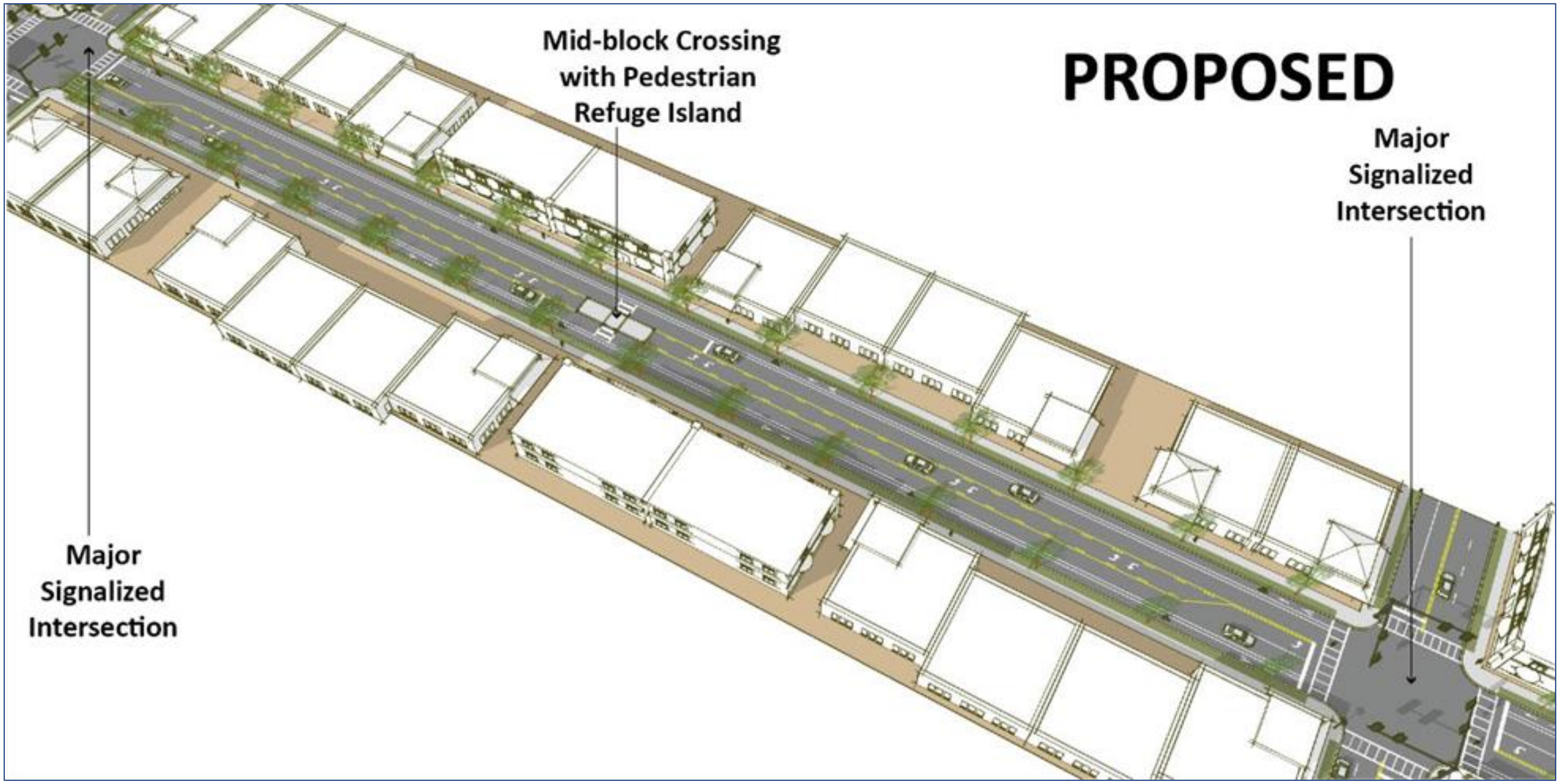
As noted previously in ***1.4 Context Classification and Access Management***, it is important to minimize pedestrian crossing times and distances and maximize pedestrian crossing opportunities in context classifications where pedestrian and/or bicycle use are a "high" emphasis, such as C4, C5, C6, and C2T. The same can be said about areas in other context classifications where localized pedestrian use may be high or concentrated based on the adjacent land uses. Pedestrians should not be expected to walk long distances out of their way to access the nearest marked crosswalk, whether at an intersection or midblock. Midblock crosswalks allow pedestrians to cross the street at midblock locations more conveniently instead of being required to walk to the nearest intersection. In addition to decreasing pedestrian walking distances, they can improve pedestrian safety performance by reducing random and unexpected pedestrian crossings and improve driver expectations, and encourage walking/biking trips instead of vehicular trips.

Marked midblock crosswalks effectively manage access across roadway corridors and to adjacent land development for non-motorized users by providing formal crossing locations where their presence is expected and planned for.

As discussed in ***1.3.1*** Safety Benefits ***of Vehicular Access Management***, medians have significant benefits for vehicular operations and safety, but also benefit non-motorized users. This is particularly true when considering midblock crossings since medians or median islands provide more opportunity for formal midblock crossings with a refuge for non-motorized users crossing the street. The median refuge allows users to make a two-stage crossing focusing on one direction of traffic at a time. The median or median island also allows for enhanced lighting and traffic control focused at the crosswalk and reduces delay for people crossing since they don't have to find as large a gap in traffic to cross a single direction compared to having to cross both directions at once. Even without formal marked crosswalks, medians or median islands also provide a refuge point that more easily allows for informal pedestrian crossing opportunities.

Per *FDM 222.2.3.2*, Midblock crosswalks are used to supplement pedestrian crossings in areas between intersections. Illumination for both new and existing midblock crosswalks should be provided in accordance with *FDM 231 - Lighting*. An engineering study following the procedure and guidelines identified in *TEM 5.2* is required for all new Midblock Crosswalks. A concept sketch of a midblock crosswalk is provided in ***Figure 99***.

Figure 99 | Midblock Crosswalk Concept



Source: FDM 202 – Speed Management (Figure 202.3)

7.4.1 Midblock Crossing Island

FHWA directs that transportation agencies should consider medians or pedestrian crossing islands in curbed sections of urban and suburban multilane roadways, particularly in areas with a significant mix of pedestrian and vehicle traffic, high volumes of traffic (more than 12,000 vpd) and intermediate or high travel speeds. Some example locations that may benefit from raised medians or pedestrian crossing islands include:

- Midblock areas
- Approaches to multilane intersections
- Areas near transit stops or other pedestrian-focused sites (schools, hospitals, senior housing, community centers, parks, trails)
- Where curb extensions may not be feasible

Vehicle travel speeds are typically higher at midblock locations, which contributes to the larger injury and fatality rate seen at these locations. A pedestrian's risk of fatality or serious injury is 85% when hit by vehicles traveling at 40 mph or faster while that risk drops to 5% when hit at 20 mph or less.[17]

Installing such raised channelization on approaches to multilane intersections has been shown to be especially effective. Medians are a particularly important pedestrian safety countermeasure in areas where pedestrians access a transit stop or other clear origins/destinations across from each other. Providing raised medians or pedestrian refuge areas at marked crosswalks has demonstrated a 46% and 56% reduction in pedestrian crashes, respectively.[18] At unmarked crosswalk locations, medians have demonstrated a 39% reduction in pedestrian crashes.

Where small median islands are placed in conjunction with midblock crosswalks, care should be taken in the placement of the islands so as to not unnecessarily impede vehicular access into or out of adjacent driveways. One exception would be if there is redundant vehicular access to the parcel via a different driveway.

7.4.2 Installation Criteria

FDOT's Traffic Engineering Manual (TEM) Section 5.2 provides installation criteria for marked midblock crosswalks and refuge islands. It states that:

> *"Placement of marked crosswalks should be based upon a strategic plan and requires an engineering study to validate the need. Marked crosswalks should not be used indiscriminately at midblock and unsignalized intersections. An engineering study (see Section 5.2.6) shall address, but not be limited to, pedestrian-vehicle crash history, proximity to significant generators and attractors, minimum levels of pedestrian demand, and minimum location characteristics.*

[17] Source: "Killing Speed and Saving Lives - The Government's Strategy for Tackling the Problems of Excess Speed on our Roads." London: Department of Transport, 1987

[18] *https://safety.fhwa.dot.gov/provencountermeasures/ped_medians/*

Any marked crosswalk or other treatment proposed for a midblock or unsignalized intersection on the SHS shall be reviewed and approved by the District Traffic Operations Engineer prior to installation."

7.4.3 Important Considerations

FHWA guidance further states that medians/refuge islands should be at least 4 feet wide (preferably 8 feet wide for accommodation of pedestrian comfort and safety) and of adequate length to allow the anticipated number of pedestrians to stand and wait for gaps in traffic before crossing the second half of the street.[19] On refuges 6 feet or wider that serve designated pedestrian crossings, detectable warning strips complying with the ADA requirements must be installed.

Other important design considerations for pedestrian refuge islands:

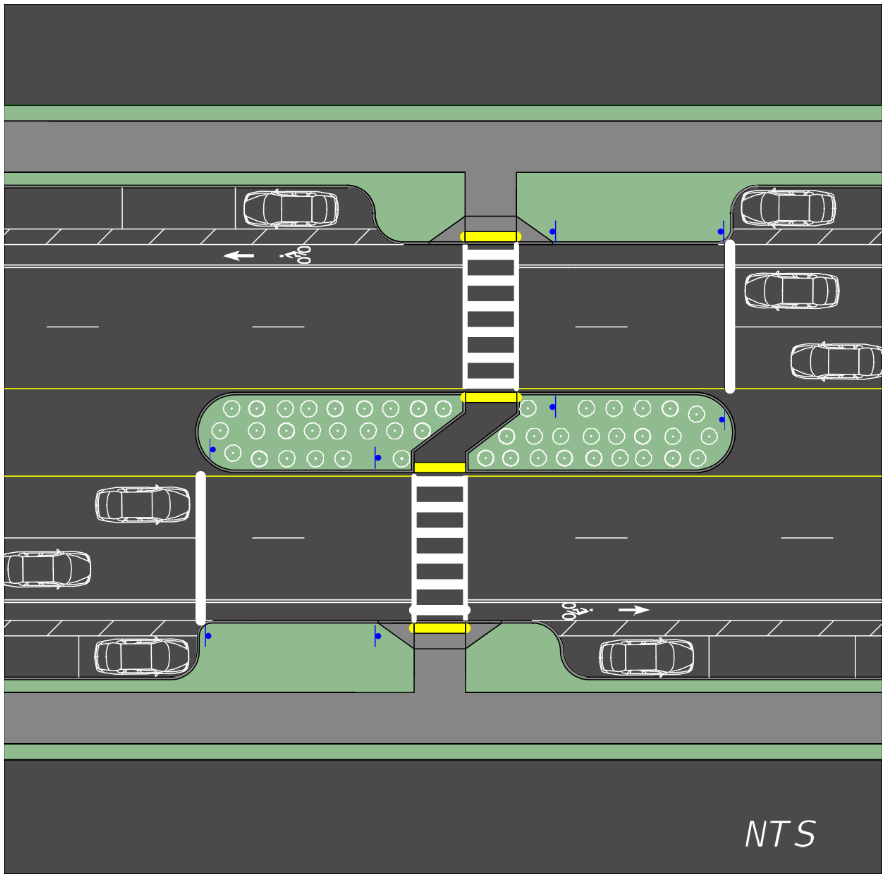
- Include a vertical element (such as landscaping, bollard, or other) on pedestrian refuges to ensure visibility to motorists
- Use the "z crossing" or angled crossing design for the pedestrian refuge to ensure that pedestrians are facing oncoming traffic (See ***Figure 100*** and ***Figure 101***)
- Include adequate lighting to ensure that crossing pedestrians are visible on the refuge and through the crosswalk (See ***Table 29***)

Figure 100* | *Angled Pedestrian Refuge Crossing

Source: FHWA Median Brochure

[19] https://safety.fhwa.dot.gov/legislationandpolicy/policy/memo071008/#ped_refuge

Figure 101 | Midblock Refuge Island Concept



Source: *FDM 210 – Arterials and Collectors (Figure 210.3.4)*

7.4.4 Supplemental Traffic Control Treatments

The *TEM* also provides standards for the appropriate supplemental traffic control treatments for marked midblock crossings. The determination of the appropriate treatments is generally based upon pedestrian volumes, vehicular volumes, posted speed limit, number of lanes, distances to adjacent traffic signals, presence of shared use path crossings, etc. The *TEM* outlines three primary treatment options for midblock crossings beyond an appropriately signed and marked crosswalk:

1. Traffic Signal – A conventional full traffic signal installed at a midblock location. Consideration for traffic signal warrant and spacing criteria must be addressed as part of this option.

2. Pedestrian Hybrid Beacon (PHB) – This treatment is also referred to as a High-intensity Activated crossWalK (HAWK). This treatment provides for signalized, protected pedestrian crossings while minimizing disruption to vehicular traffic flow. PHBs must meet specific warrant criteria for installation as outlined in the *TEM*. This is an option for locations where a full traffic signal is not warranted by pedestrian volumes, yet demand justifies a more intense warning and traffic control treatment. *TEM* Section 5.2 provides more information on location placement of PHBs and other considerations.

3. Supplemental Beacons – The *TEM* provides two options for supplemental beacons: flashing yellow warning beacons and rectangular rapid flashing beacons (RRFBs). Note that the *TEM*

requires that these beacons be activated by a pedestrian to increase the effectiveness of the treatment. Conventional flashing yellow warning beacons are installed as part of regulatory or warning signs and provide additional emphasis on the crossing location. FHWA considers RRFBs to be highly successful for marked crosswalks at uncontrolled approaches. RRFB's are also pedestrian actuated and quickly flash alternating warning lights in a "wig-wag" pattern. Signs and audible messages at crossings with RRFBs are required to provide information to pedestrians that vehicles may not stop and to cross with caution. *TEM* Section 5.2 provides more information such as limitations of use of flashing beacons and supplemental treatments.

In addition to these treatments, other enhancement tools are available to the roadway designer to further enhance midblock crossings. These enhancements include, but are not limited to:

- Supplemental and advanced pavement markings/signage
- In-street warning lights
- Curb extensions can be considered for midblock locations to reduce crossing distance, provide traffic calming, provide space for lighting/landscaping/other curb elements, and improve pedestrian visibility
- Raised crosswalks
- Speed reduction treatments
- Overhead lighting
- Passive pedestrian/bicycle detection
- Transverse rumble strips

Note that all marked midblock crossings must meet the ADA standards. The *TEM* provides guidance for the application of these supplemental enhancements.

In addition to the TEM, FHWA has developed the *Safe Transportation for Every Pedestrian (STEP)* program. The *Guide for Improving Pedestrian Safety at Unsignalized Locations* includes two matrices for determining the appropriate countermeasure(s) to use based on roadway geometry, traffic, crossing distances, etc. ***Appendix A*** contains the table with crash reduction and modification factors for each of the recommended countermeasures.

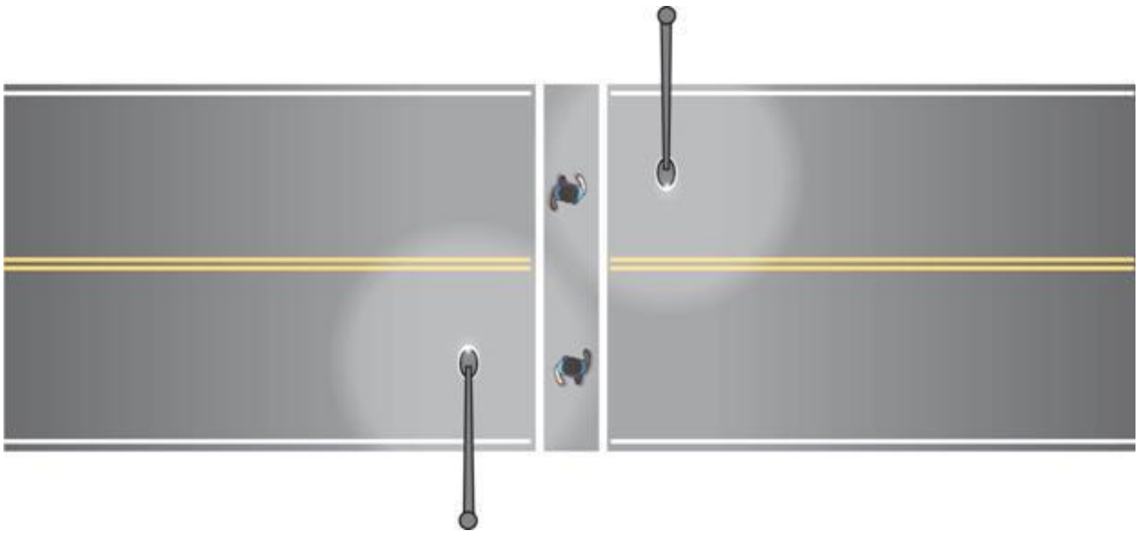
Lighting information for midblock crosswalks is provided in *FDM 231 - Lighting*. A simplified version of *FDM Table 231.2.1* is provided in ***Table 29***. This also contains lighting levels for sidewalks and shared use paths. Studies have found lighting at midblock crosswalks to be most effective when placed in advance of the crosswalk, as shown in ***Figure 102***, instead of centered directly over the crosswalk.

Table 29 | Midblock Crossing Lighting Standards - FDM

Roadway Classification	Illumination Level Average Initial Foot Candle		Illumination Uniformity Ratios	
Or Project Type	Horizontal (H.F.C.)	Vertical (V.F.C.)	Avg./Min.	Max./Min.
Midblock Crosswalk Lighting				
Low Ambient Luminance	N/A	1.5	N/A	N/A
Medium & High Ambient Luminance		2.3		
Sidewalks and Shared Use Paths				
Facilities Separated from the Roadway	2.5	N/A	4:1 or Less	10:1 or Less

Source: Adapted from FDM 231 – Lighting (Table 231.2.1)

Figure 102 | Midblock Lighting Placement



Source: FHWA Informational Report on Lighting Design for Midblock Crosswalks

7.5 Transit Vehicle Considerations

7.5.1 Driveways near Bus Stops and Transit Facilities

Bus stop locations can have a major impact on the operation and visibility of driveways. This is even more important in locations where buses may “layover,” since the sight distance may be blocked for a large amount of time. If a poorly positioned driveway cannot be moved, work with the local transit authority to possibly move the bus stop to avoid any potential safety concerns.

Interaction Between Modes

When transit is present, improving safety by minimizing conflicts between transit, transit passengers, and other modes must be a primary consideration. The first step, in locating a driveway near a bus stop, is to consider the interaction of the bus with other vehicles and pedestrians. It is important to identify and analyze any potential hazards and vulnerabilities that could lead to a crash. For example:

- The bus operator must be able to see the vehicles entering and exiting the driveway
- The bus operator and those entering and exiting the driveway should be able to see transit patrons
- The people using the driveway should have sufficient sight distance to see oncoming buses and traffic

The landscape and facility design for entrances and exits to lots which are used by both vehicles and buses should not obstruct clear lines of sight. All landscaping should adhere to current FDOT standards along FDOT-designated highways.

The *FDOT Accessing Transit Design Handbook* recommends that whenever possible, bus stops should be located beyond driveways to minimize conflicts (See ***Figure 103***). Transit stops should be located a minimum of 200 feet away from any existing driveway when at all possible.

Figure 103 | Acceptable Bus Stop Placement Near Driveway

Source: FDOT Accessing Transit Design Handbook 2013 (Figure 4.2.4)

The handbook recommends that if blocking a driveway cannot be prevented, at least one entrance and exit to a property should remain open while a bus is loading or unloading. In the worst-case circumstances where a bus stop location requires passengers to board or alight in a driveway, the slope cannot exceed ADA Standards.

Transit Stops in Medians

If an exclusive transit way is a median transit way, bus stops may be in the median itself. However, bus shelters on the median are prohibited in Florida except when maintained by bus rapid transit providers using an inside lane for passenger transport per *Rule Chapter: 14-20.003 F.A.C.*

Sight Distances for Buses

For each driveway exit, the local street and roadway standards will determine the required sight distance for the critical design vehicle using the driveway. For driveways used primarily by transit, the transit vehicle should be held as the critical design vehicle due to its slower acceleration capabilities. Additional information on the modal interactions and driveways can be found in ***Table 8***.

7.6 Large Vehicle and Freight Considerations

It is equally important to incorporate different roadway designs for non-motorized users, just as it is important to consider freight and large vehicular movements on a roadway. Just as non-motorized users have specific needs on a roadway, freight and other vehicles can require specific needs when designing a roadway. General guidance on design and control vehicles is provided in *FDM 201 - Design Controls*. A chart showing the FHWA vehicle classification scheme is included in ***Appendix B***. Techniques, guidance, and criteria to support freight movement are included throughout this document.

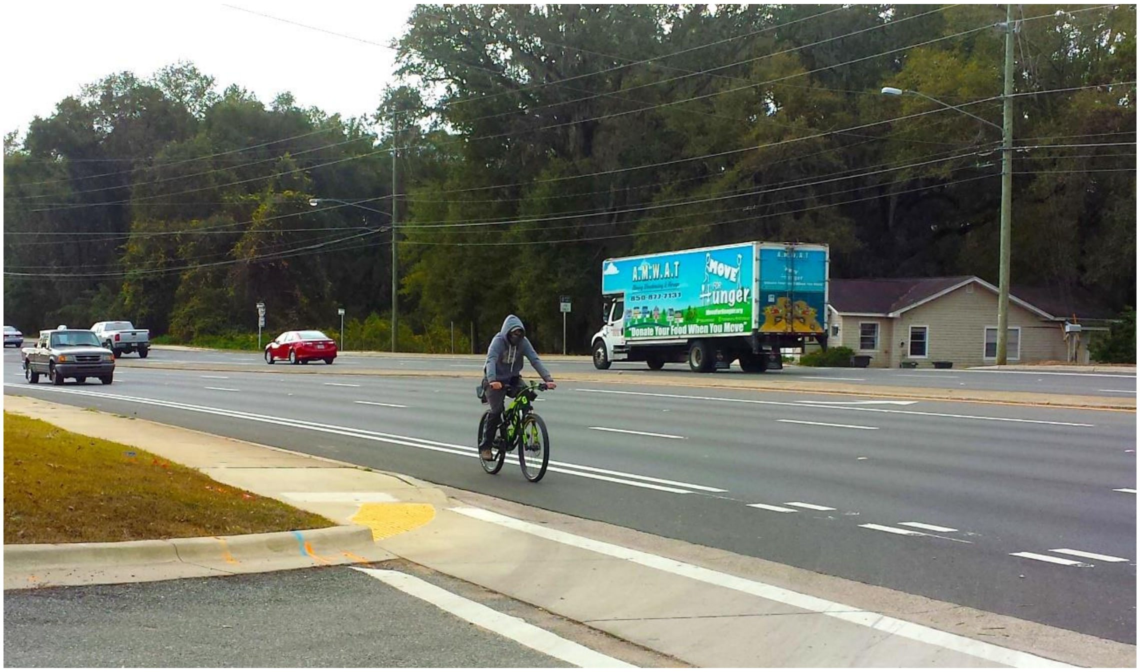
7.6.1 Access Management and Freight Deliveries

Trucks need to be able to park and unload their goods in a safe and efficient fashion. The context classification and surrounding roadways can influence the types of delivery areas that are available to freight traffic. It may be appropriate to have the deliveries and truck parking be placed behind the facilities if there is a significant amount of non-motorized traffic, to minimize conflicts. Similarly, another option is to place truck parking in specific areas and/or allow for deliveries during certain periods of the day. This topic is covered in detail in the ***Chapter 9: Curbside Management*** of this guidebook, and *ITE Curbside Management Practitioners Guide*. The guide provides methods to organize curb space and prioritize modal users.

Non-Motorized Users, Freight and Access Management

Another possible consideration for freight traffic would be freight/industrial areas where there are also bicycle lanes. There is value in considering the interaction of access management techniques with other modes and how they may interact with one another. For instance, it may be appropriate to either redirect trucks off these roadways or move the bike lanes to a different facility. Another option would be to utilize buffered or separated bike lanes to separate the traffic from one another (See ***Figure 104***). Large trucks can create hazards for bicyclists when traveling on the roadway due to the wind blast trucks create when passing or the mirrors extending into the bicyclists' space. Buffered bike lanes or separated bicycle facilities can negate or lessen these effects.

Figure 104 | Buffered Bike Lanes in Freight/Industrial Areas



Source: FDOT

Driveways and Freight

It's important to understand and consider the roadway and land use of an area, particularly if special considerations need to be made for freight movements. Driveways are a piece of the roadway design which require special attention due to the typical size and profile of freight vehicles. For areas where there is a significant amount of freight vehicles entering a property, the driveway would need to be designed to be wider than normal to allow for them to turn inside safely. Alternatively, if there was a significant amount of other types of non-motorized traffic then other considerations may need to be made to account for all modes of traffic in the area.

Another example of this type of design is in ***Figure 105*** which was built in Hartford, CT. The radius of the turn was reduced for vehicles so they would enter the turn at a slower speed, while still allowing for large vehicles to enter with less operational issues. It also integrates a sidewalk into the design to still provide appropriate pedestrian accommodation.

Figure 105 | Truck Apron and Driveways

Source: Hartford, CT – Google Earth

Three Centered or Compound Curves for Handling Trucks Instead of Large Radii

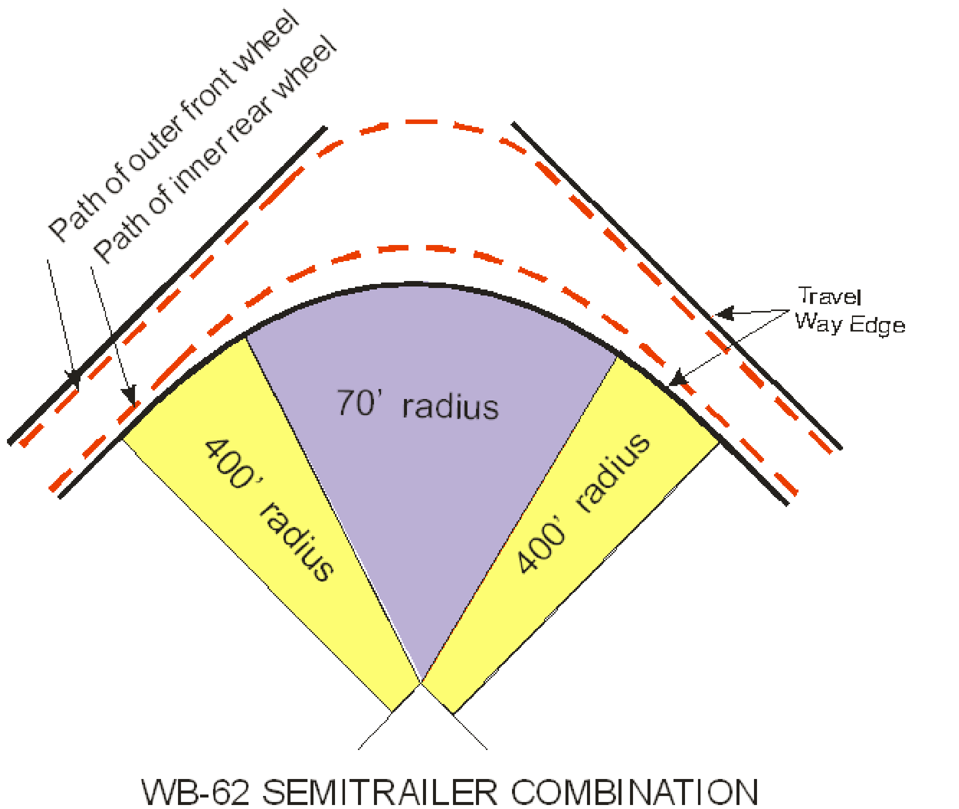
To have the best design for trucks, the use of compound curves rather than a simple radial return has many advantages (See ***Figure 106***), including the following:

- The total driveway width is reduced
- Where the driveway is designed primarily for vehicles, the occasional truck can be better accommodated
- When the driveway is designed for trucks, the narrower exit lane width and geometrics of the connection provide better positive guidance to vehicular drivers

Using a compound curve rather than a simple radial return of 30 feet will permit the driver of a passenger car to exit a driveway without encroaching on the through lanes.

The *AASHTO Green Book* also gives guidance on the use of compound curves. ***Figure 106*** is an example for the design of a WB-62 using compound curves for a 90-degree turn.

Figure 106 | Equivalent Compound Curves Geometrics for Departure Radii



Source: AASHTO Turning Template

Exclusive Right Turn Lanes for Trucks and Buses

To turn into a driveway, trucks and other large vehicles need to slow down considerably, which can cause considerable disruption for the through movement traffic. If there is a site that has large vehicles turning into it at a higher than average proportion, then this roadway design may be helpful. See ***Chapter 6: Turn Lanes and U-Turns*** for more information on exclusive right-turn lanes and how to design for them.

Chapter 8: Intersection Control Evaluation (ICE) and Alternative Intersections

8.1 Overview

Traffic control and the permitted movements at intersections are key elements of a corridor's access management. According to the FHWA *Primer on Intersection Control Evaluation (ICE)*:

> *ICE is a data-driven, performance-based framework and approach used to objectively screen alternatives and identify an optimal geometric and control solution for an intersection.*
>
> *On corridor improvement projects, results from ICE may serve as the basis of not only the major intersection type and control decisions but the nature of access management along the entire corridor.*

This chapter focuses on tools to improve the efficiency and safety of all users. It discusses selection of ICE techniques and when to use the *FDOT Manual on Intersection Control Evaluation* process to select and document the best alternative. Traffic operations, safety, multimodal access, land access, and place-making are examples of potential project needs for which an ICE analysis may be initiated. Various alternative intersections are evaluated in the ICE process to identify the intersection design configuration.

8.2 Intersection Control

Intersection control design is discussed in detail in the *FDM 212* and the *FDOT Traffic Engineering Manual (TEM)*. To ensure that the best intersection control strategy is implemented, the FDOT Traffic Engineering and Operations Office has developed the *ICE Manual*. This was published in November 2017 and provides direction to transportation professionals when building a new intersection or modifying an existing one.

8.2.1 Intersection Control Evaluation (ICE) Process

With the implementation of *FDOT's Complete Streets Policy*, increased emphasis has been placed on the safety of all road users in intersection design. Per *FDM 212.1.2*, ICE is a process to determine the most effective intersection configuration for a specified project. Through ICE, multiple alternative and conventional intersection configurations are compared to one another based on safety, operations, cost, and environmental impacts. The ICE procedure provides a transparent and consistent approach to intersection alternatives selection and provides documentation to support decisions made. ICE policy and procedure is published in the *FDOT ICE Manual*.

The ICE process quantitatively evaluates several intersection control scenarios (alternatives) and ranks these alternatives based upon their operational and safety performance. Implementing a "performance-based" procedure such as ICE creates a transparent and consistent approach to consider intersection alternatives based on metrics such as safety, operations, cost, and social, environmental, and economic impacts.

Specific guidance on when an ICE process is required is provided below:

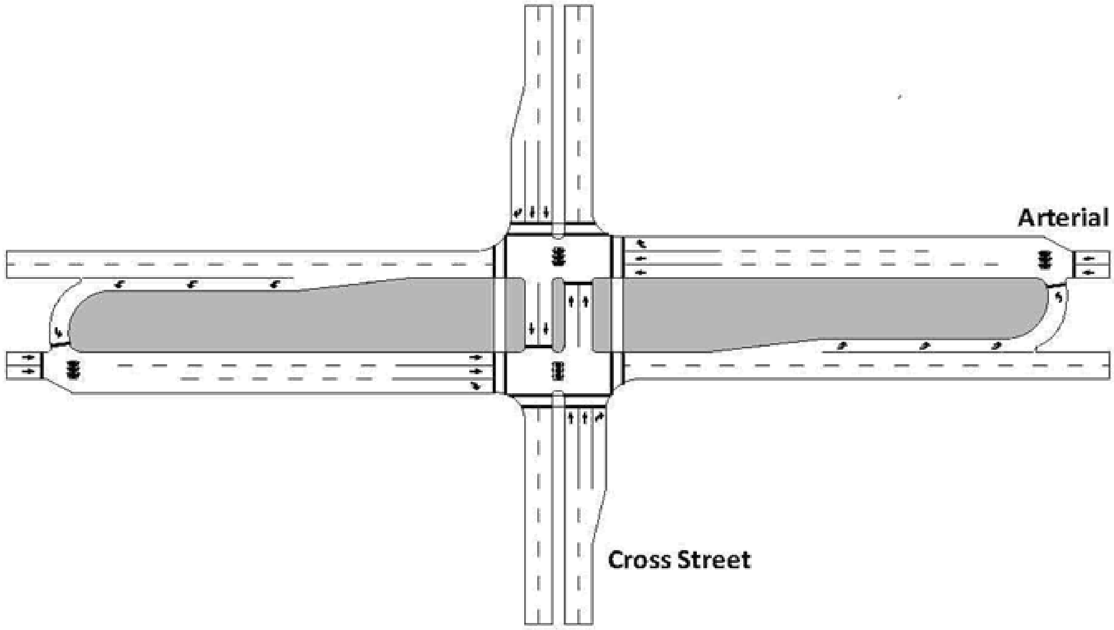
> *Applicability (1) An ICE is required when: (a) New signalization is proposed; (b) Major reconstruction of an existing signalized intersection is proposed (e.g., adding a left-turn lane for any approach; adding an intersection leg); (c) Changing a directional or bi-directional median opening to a full median opening; (d) Driveway Connection permit applications for Category E, F, and G standard connection categories (defined by average daily trips thresholds in Rule 14-96.004, F.A.C.) add, remove, or modify a traffic signal; or (e) District Design Engineer (DDE) and District Traffic Operations Engineer (DTOE) consider an ICE a good fit for the project. (2) An ICE is not required for intersection projects if any of the following apply: (a) Work involved does not include any substantive proposed changes to an intersection (e.g., a project limited to only "mill and resurface" pavement with no change to intersection geometry or control; converting a 2-way stop intersection to a 4-way stop intersection; changing a full median opening to a directional median opening). (b) Minor intersection operational improvements (such as adding right-turn lanes or changing signal phasing) or signal replacement projects where the primary purpose is to upgrade deficient equipment and installations. (3) FDOT encourages local agencies and counties to perform an ICE for projects they lead on locally maintained roadways, but ultimately it is the choice of the local jurisdiction.*

8.3 Alternative intersections

Traditionally, the most common solutions to intersection challenges involved stop-controlled, conventional signalization scenarios, or interchanges and focused on the movement of vehicles through the intersection. In recent years, several new alternative intersection designs have been introduced across the United States. These "alternative" intersection control types are enhancing safety and improving operations, along with varying degrees of other benefits.

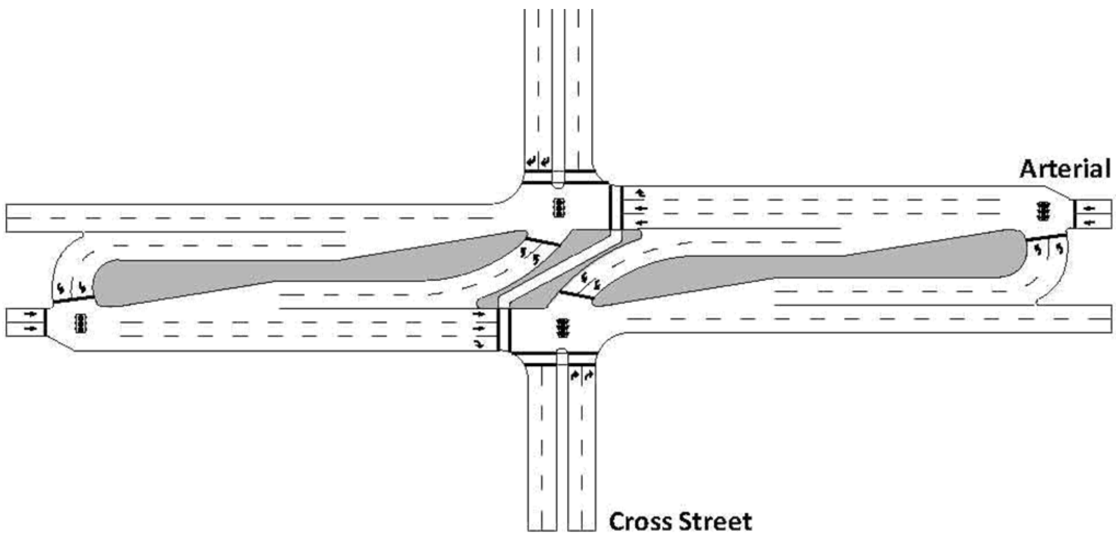
Per *FDM 212.1.1*, Alternative intersection design is a key component of upgrading our transportation facilities and improving the mobility and safety of all road users. These innovative designs are becoming more common as increasing traffic demand exceeds the limitations of traditional intersection solutions. Alternative intersections offer the potential to improve safety and reduce delay at lower cost and with fewer impacts than traditional solutions such as adding lanes or grade separation. Alternative intersections (including roundabouts, cross-over-based designs, and U-turn-based designs) often consider community needs, transportation needs, and control strategies to achieve multiple objectives. The Median U-Turn (MUT), Signalized Restricted Crossing U-Turn (RCUT), and Displaced Left-Turn (DLT) are shown in ***Figure 107***, ***Figure 108*** and ***Figure 109***. Roundabouts are discussed in greater detail in ***Section 8.4***.

Figure 107 | Median U-Turn (MUT)



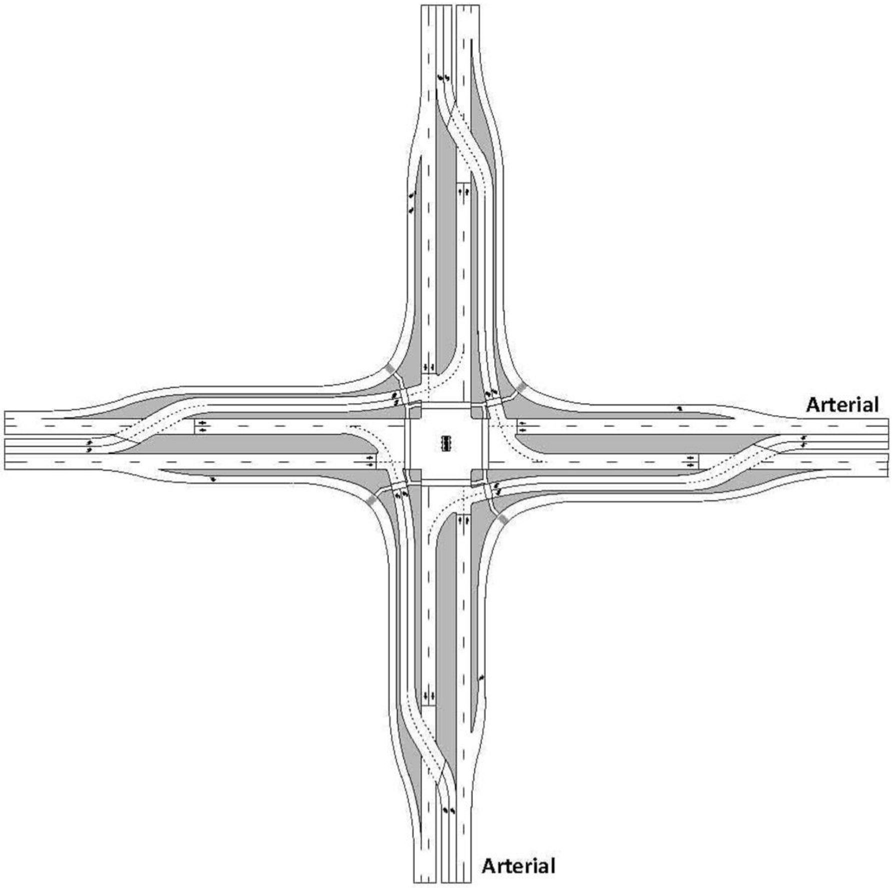
Source: FDOT ICE Manual

Figure 108 | Signalized Restricted Crossing U-Turn (RCUT), or Superstreet



Source: FDOT ICE Manual

Figure 109 | Displaced Left-Turn (DLT)



Source: FDOT ICE Manual

The FHWA has published comprehensive informational guides for alternative intersections which include guidance on how to plan, design, construct, and operate them. The following link provides access to these guides: *FHWA Alternative Designs*. Using these types of alternate intersection designs should be coordinated with the *Central Office Roadway Design Office*. The method to evaluate and compare these intersection types is part of the *ICE Manual*. In addition, forms, templates and software to assist in this process are located on the *FDOT Intersection Operations and Safety* webpage and in the *ICE Manual*. Appendix A of the *ICE Manual* details all the intersection control strategies.

8.3.1 Pedestrian and Bicycle Accommodation at Alternative Intersections

Because there is more limited experience in evaluating, designing, and implementing many types of alternatives intersections, *NCHRP Report 948, Guide for Pedestrian and Bicyclist Safety at Alternative and Other Intersections and Interchanges*, presents a guide for pedestrian and bicycle accommodation at alternative intersections. The following sections provide best practices for appropriately accommodating pedestrians and bicyclists at different types of alternative intersections.

MUT Intersection

Pedestrians can cross at the main MUT intersection and at each of the U-turn crossover locations as depicted on ***Figure 110***. Without left-turn lanes at the main intersection, the lengths of crossings for pedestrians are less compared to a conventional intersection. U-turn crossover intersections create additional opportunities for midblock pedestrian crossings using a traffic signal or pedestrian hybrid beacon (PHB).

As discussed in the *NCHRP Report 948*, right-turning traffic volumes are higher at an MUT intersection than at the equivalent conventional intersection. This could create operational or safety challenges for both pedestrians and motor vehicles. Restricting right-turns on red (RTOR), providing pedestrian lead interval signal timing, and positioning stop bar for through vehicles to be farther from the crosswalk than the stop bar for right-turning vehicles (increases visibility between right-turning motorists and pedestrians) are treatments that can be implemented to manage the conflict between pedestrians and right-turning motor vehicles.

Various safety challenges and concerns for pedestrians and bicyclists at MUT intersections, are discussed in the *NCHRP Report 948*. Three MUT design concepts are presented in the *NCHRP Report 948* to illustrate the techniques to improve the pedestrian and bicyclist safety and operational performance of MUTs. The designs include the following:

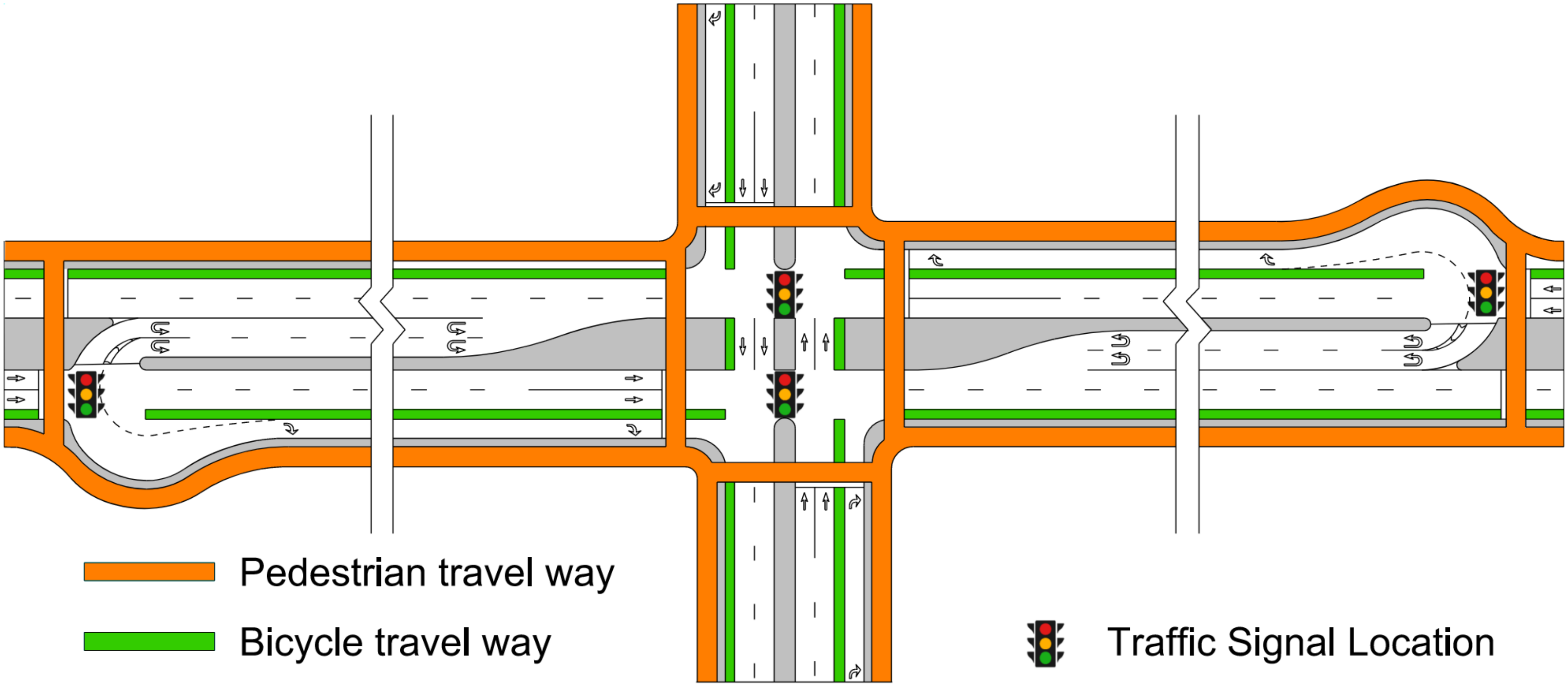
- MUT On-Street Bikeway Concept
- MUT Protected Intersection Concept
- MUT Shared-Use Path Concept

MUT On-Street Bikeway Concept

As stated in the *NCHRP Report 948*, the MUT on-street bikeway concept (***Figure 110***) would be appropriate for a low speed and/or low volume context and provides an example for carrying existing bike lanes through an MUT. As described in the *NCHRP Report 948*, the design addresses these key elements regarding safety and comfort:

- Corner refuge islands tighten right-turn radii and extend physical protection for crossing pedestrians. This turn radius may ultimately need to be modified based on the intended design vehicle path, but the design would control speeds of right-turning vehicles.
- For bicyclists, the design includes on-street bike lanes with two-stage turn boxes at the intersection to facilitate left-turns. This feature has the benefit of providing an intuitive left-turn movement for all bicyclists and mitigates the indirect path. The two-stage turn boxes also prevent bicyclists from the need to cross over vehicle travel lanes at speed, eliminating the lane change across motor vehicle travel lanes.
- For pedestrians, the midblock (at the U-turn) crossings provide more potential for route directness by allowing pedestrians to cross upstream or downstream of the intersection.
- For pedestrians, the design includes a separate sidewalk system with exclusively signal controlled crossings, including supplemental crossings at the U-turn locations. A refuge is provided for every pedestrian crossing to allow for two-stage crossings.
- All pedestrian crossings would be signal controlled.
- The design includes a narrowed median with loons (localized widening) to accommodate U-turns.
- The concept features a relatively compact main intersection footprint among MUT concepts. This brings potential ROW acquisition or construction cost benefits, and residual benefits related to the pedestrian and bicyclist experiences (e.g., shorter crossings generally).

Figure 110 | MUT Intersection Pedestrian Crossing Locations and On-Street Bikeway Concept



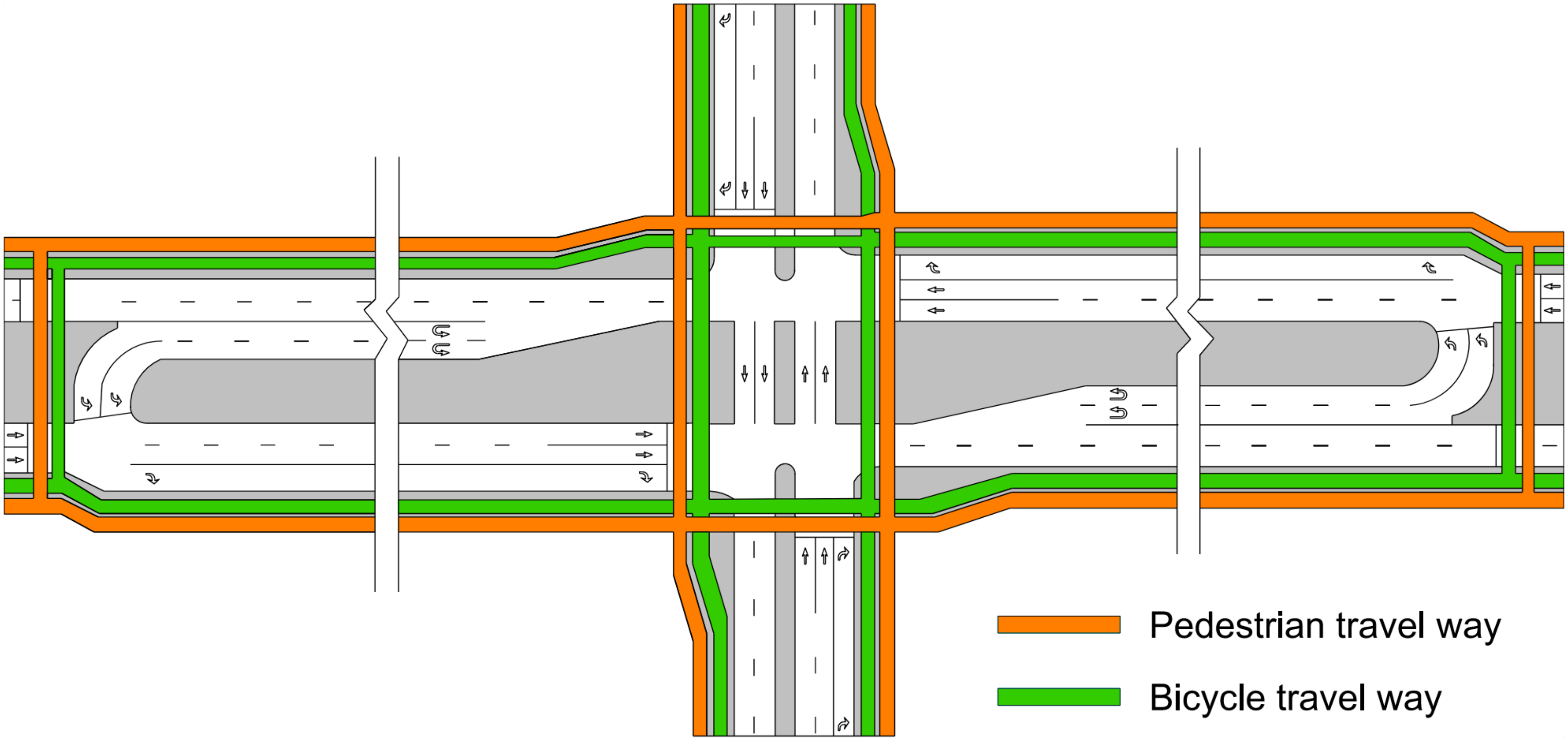
Source: Adapted from [NCHRP Report 948 - Exhibit 6-3]

MUT Protected Intersection Concept

As stated in the *NCHRP Report 948*, this MUT concept (***Figure 111***) is distinguished by its implementation of a protected intersection concept with separated bike lanes. The concept would be implemented in locations with either relatively high motor vehicle volumes or high speeds. The separated bike lane and intersection treatment provide a low-stress riding environment for people biking, including less confident bicyclists. This design is most associated with an urban or suburban environment; the intersection could either match back into existing separated bike lanes or provide ramps for bicyclists to enter or exit the lane. The separated bike lane could be implemented as a shared-use path with pedestrian facilities, as shown in the next concept. As described in the *NCHRP Report 948*, the design addresses these key elements regarding safety and comfort:

- The design includes the protected intersection concept with corner refuge islands that tighten turn radii and extend physical protection for crossing pedestrians. The turn radius would need to be refined based on the intended design vehicle path but would control right-turning vehicle speeds. Crossing pedestrians are pulled back to enhance their visibility.
- For bicyclists, the design includes separated street bike lanes with the ability to complete left-turns in two stages using the bike lane. This has the benefit of providing a more intuitive left-turn movement for all bicyclists and mitigates the indirect paths.
- For pedestrians, the midblock (at the U-turn) crossings provide more potential for route directness by allowing pedestrians to cross the major street upstream or downstream of the intersection.
- All pedestrian crossings would be signal controlled, providing safe crossing opportunities.
- Crossings for pedestrians and bicyclists are defined with this design; particularly for bicyclists, the separated bike lane gives positive guidance and wayfinding benefits throughout the intersection.
- This concept moves all riding away from mixed traffic with physical (horizontal and vertical) separation. Bicyclists would cross motor vehicle paths using marked crossings.

Figure 111 | MUT Protected Intersection Concept



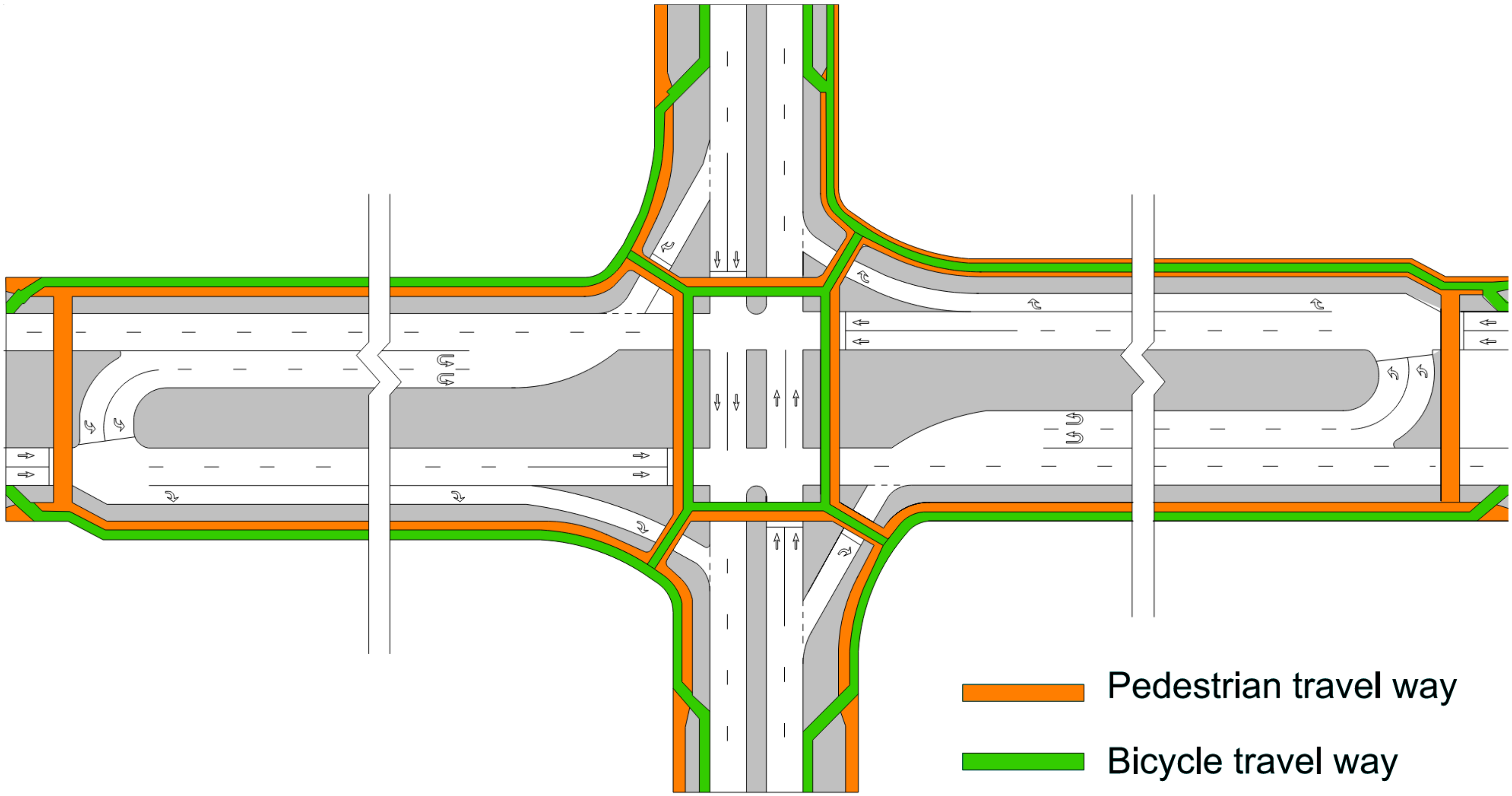
Source: Adapted from [NCHRP Report 948 - Exhibit 6-16]

MUT Shared-Use Path Concept

As stated in the *NCHRP Report 948*, this MUT concept (***Figure 112***) is distinguished by its implementation of a shared use path. The concept would be implemented in locations with either relatively high motor vehicle volumes or high speeds such that physical separation is advisable for bicycle facilities. The shared use path would be appropriate where a relatively low mix of walking and biking would be expected; with high expected volumes, separate facilities would be recommended. The shared use path treatment provides a low stress riding environment for people biking, including less confident bicyclists. This design may be appropriate where a MUT intersection was tying into an existing roadway without bicycle facilities through bicycle ramps before and after the intersection. The path, which expands in width when it transitions to include bicycles, would be appropriate in the presence of heavy right-turns or trucks by allowing bicyclists to avoid these conflicts. As described in the *NCHRP Report 948*, the design addresses these key elements regarding safety and comfort:

- The design includes channelized right-turns with signal control. The right-turn vehicle conflict with pedestrians would be separated and controlled.
- The provision of channelized right-turn lanes on all approaches ensures that no single pedestrian crossing is over two lanes wide, eliminating the need for pedestrians to cross more than two lanes at one time.
- For bicyclists, the design includes separated street bike lanes with the ability to complete left turns in two stages using the bike lane. This has the benefit of providing a more intuitive left-turn movement for all bicyclists and mitigates the indirect paths.
- For pedestrians, the midblock (at the U-turn) crossings provide more potential for route directness by allowing pedestrians to cross the major street upstream or downstream of the intersection.
- All pedestrian crossings would be signal controlled, providing safe crossing opportunities.
- Crossings for pedestrians and bicyclists are defined with this design; particularly for bicyclists, the separated bike lane gives positive guidance and wayfinding benefits throughout the intersection.
- This concept moves riding away from mixed traffic at the intersection with ramps to transition bicyclists off-street. Bicyclists would cross motor vehicle paths using marked crossings.
- Although the design provides channelized right-turn lanes, the shared use path and the ramps leading to the path allow for right-turning cyclists to bypass this conflict point.
- Channelized turn lanes for motorist right-turns with loons to keep intersection as close to perpendicular as possible. The channelized turns also separate the conflict between right- turning vehicles and crossing pedestrians and provide visibility at these conflict points. These channelized crossings would be signalized.

Figure 112 | MUT Shared Use Path Concept



Source: Adapted from [NCHRP Report 948 - Exhibit 6-18]

RCUT Intersection

As discussed in the *NCHRP Report 948*, one of the common means of serving pedestrians at an RCUT intersection is a "Z" crossing treatment, as shown in ***Figure 113***. Various safety challenges and concerns for pedestrians and bicyclists at RCUT intersections, are discussed in the *NCHRP Report 948*. Four RCUT design concepts are presented in the *NCHRP Report 948* to present options for improving pedestrian and bicycle safety and operational performance at RCUT intersections. The designs include the following:

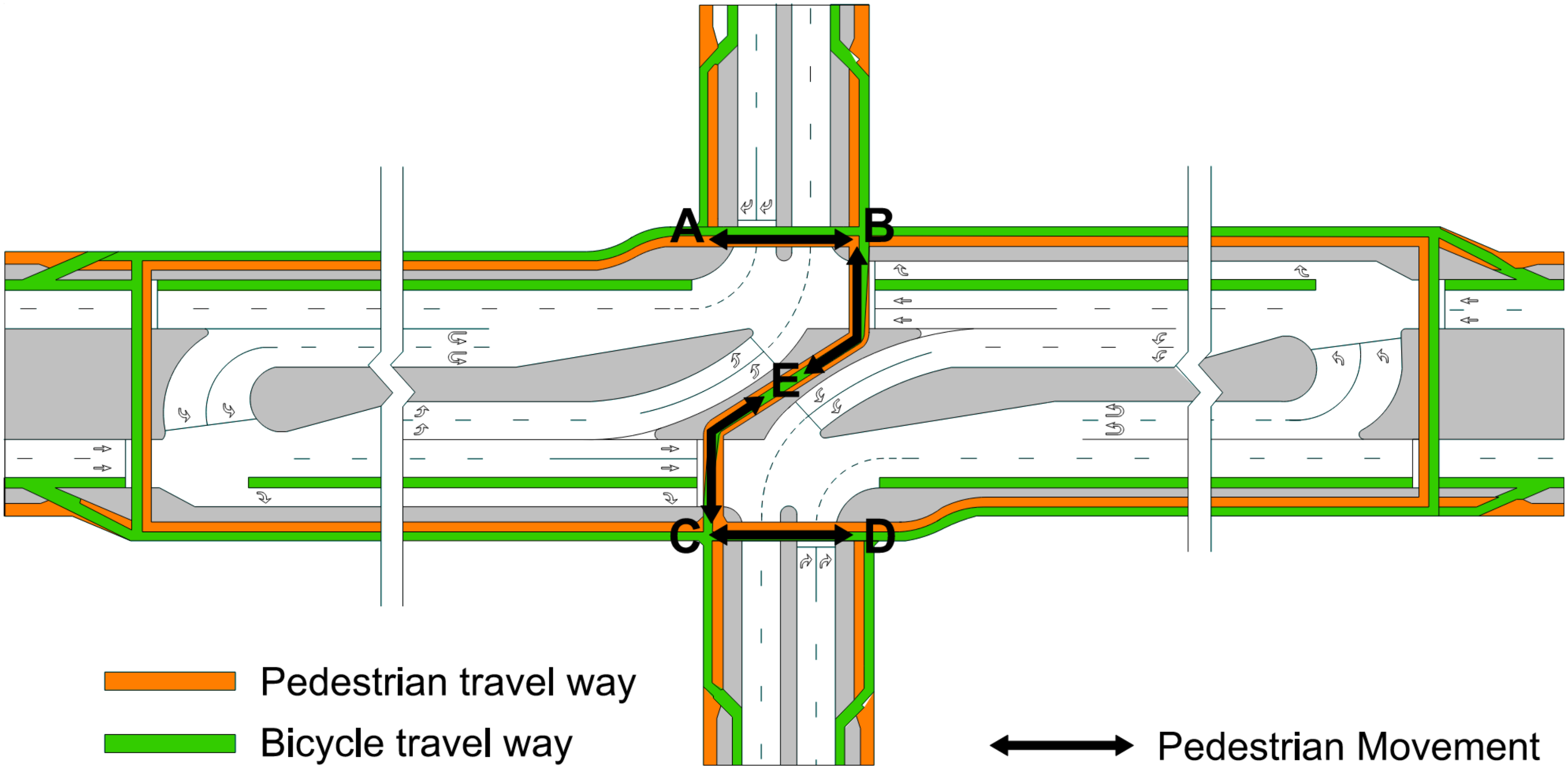
- RCUT Bike Lane and Path Concept
- RCUT Shared-Use Path Concept
- RCUT Separated Bike Lane Concept
- Rural RCUT with Biking on Shoulder Concept

RCUT Bike Lane and Path Concept

As stated in the *NCHRP Report 948*, this RCUT concept (***Figure 113)*** is distinguished by its provision of on-street bike lanes along with a shared-use path. The concept would be appropriate for a low-speed and/or low volume context and provides an example for carrying existing bike lanes through an RCUT. As described in the *NCHRP Report 948*, the design addresses these key elements regarding safety and comfort:

- Where pedestrian crossings exist, corner refuge islands tighten right-turn radii and extend physical protection for crossing pedestrians.
- For bicyclists, the design includes on-street bike lanes with ramps to shared use paths. This feature has the benefit of providing an off-street left-turn or minor street through movement for all bicyclists (through the "Z") and mitigates the indirect path.
- For pedestrians, the ability to cross all four legs of the intersection (as well as the supplemental crossings at the U-turn) promotes accessibility and eliminates circuitous paths.
- All pedestrian crossings would be signal controlled, providing safe crossing opportunities.
- For bicyclists who use the available ramps, this concept moves their riding away from mixed traffic with physical separation. Bicyclists would cross motor vehicle paths using marked crossings.
- Shared use path system in the Z-crossing configuration for pedestrians and bicyclists with all signalized crossings.
- Two-stage pedestrian crossings across the major roadway with wide median refuge.

Figure 113 | RCUT Pedestrian Movements and Bike Lane and Path Concept



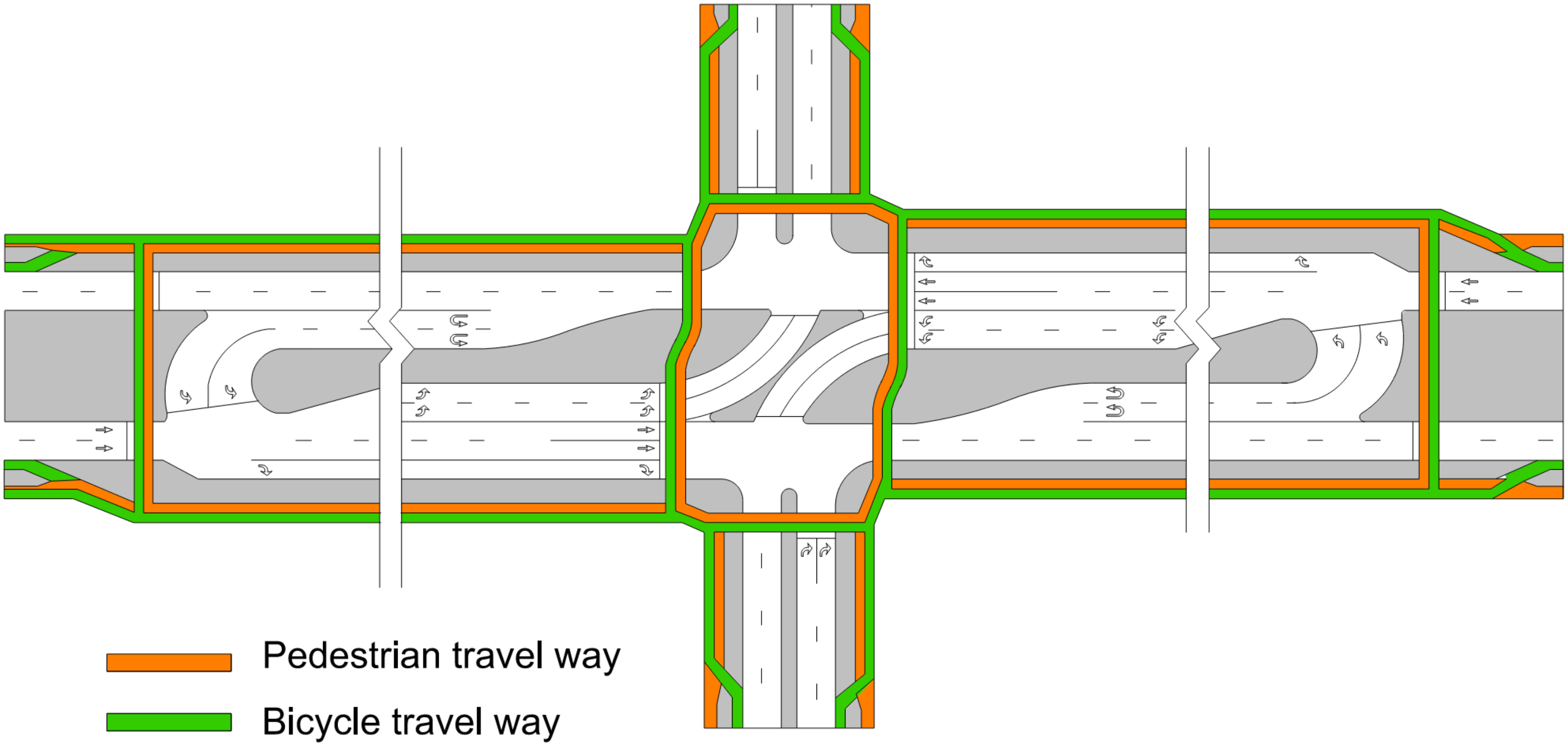
Source: Adapted from [NCHRP Report 948 - Exhibit 7-4]

RCUT Shared-Use Path Concept

As stated in the *NCHRP Report 948*, this RCUT shared-use path concept (***Figure 114***) is distinguished by its implementation of a shared-use path through the intersection. The design concept also features crossings on all four intersection approach legs. The concept is intended to be implemented in locations with either relatively high motor vehicle volumes or high speeds. The separated path provides a low stress riding environment for people biking, including less confident bicyclists. The path would be appropriate for a relatively low combined expected volume of bicyclists and pedestrians. With higher volumes of both, separate facilities for each mode would be appropriate. As described in the *NCHRP Report 948*, the design addresses these key elements regarding safety and comfort:

- The design includes corner refuge islands that tighten turn radii and extend physical protection for crossing pedestrians. The turn radius would need to be refined based on the intended design vehicle path but would control right-turning vehicle speeds. Crossing pedestrians are pulled back to enhance their visibility.
- For bicyclists, the design includes separated paths that enable riders to complete left-turns in two stages and to complete a minor street through movement without a U-turn. This provides more intuitive movements for all bicyclists and mitigates the indirect path.
- For pedestrians, the midblock (at the U-turn) crossings and the four approach legs being striped provide more potential for route directness by allowing pedestrians to cross in some locations.
- All pedestrian crossings would be signal controlled, providing safe crossing opportunities.
- Crossings for pedestrians and bicyclists are defined with this design: particularly for bicyclists, the path gives positive guidance and wayfinding benefits throughout the intersection.
- This concept moves all riding through the intersection away from mixed traffic with physical (horizontal and vertical) separation and ramps to and from the shared-use paths. Bicyclists would cross motor vehicle paths using marked crossings.
- An exclusive pedestrian phase would allow the possibility of a complete pedestrian crossing in one stage. Additionally, the pedestrian crossings could be coordinated to minimize the delay between stages, with minimal to no disruption to vehicle signal progression. Both options would require the major street signals to be coordinated, reducing the vehicular operational benefit of the RCUT. Introducing a third phase at the RCUT would result in less efficient vehicle operations, compared to the standard operation with two critical phases.

Figure 114 | RCUT Shared Use Path Concept



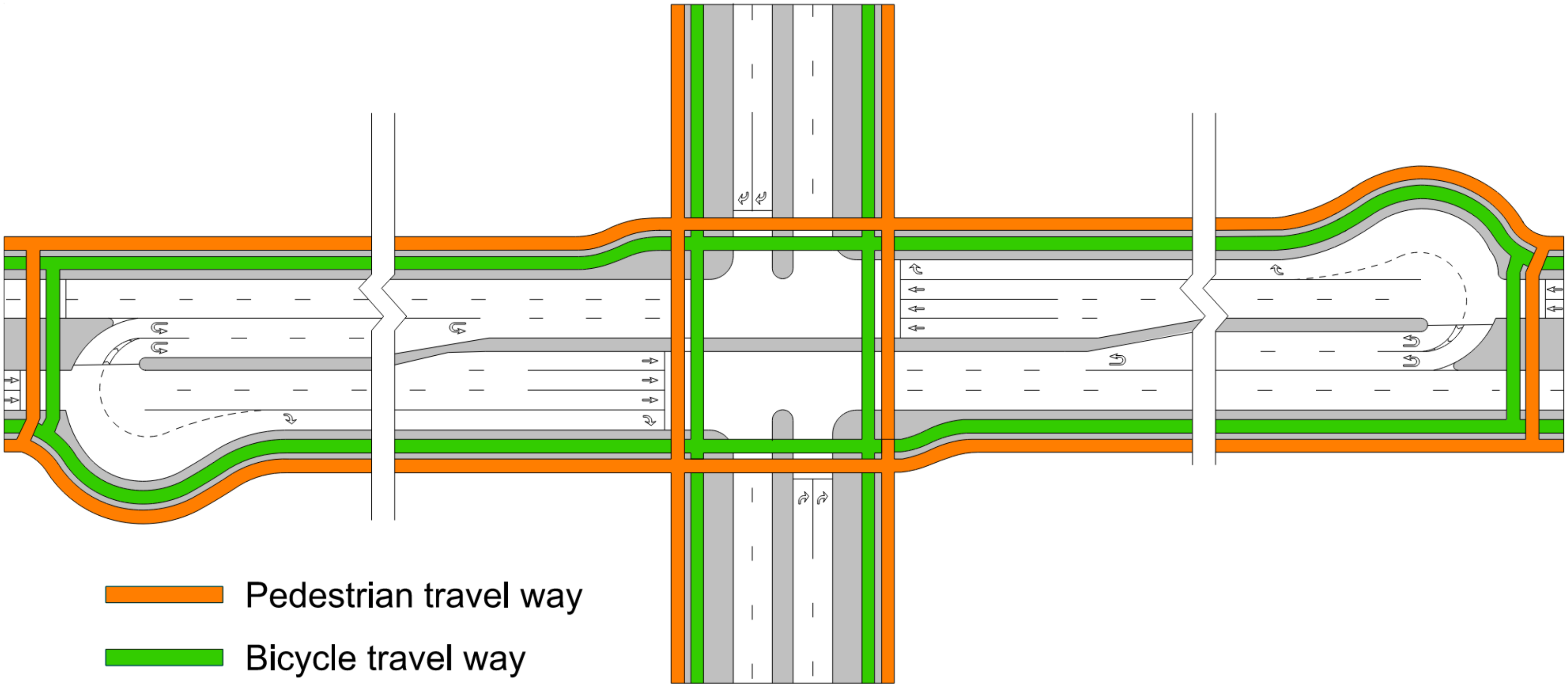
Source: Adapted from [NCHRP Report 948 - Exhibit 7-13]

RCUT Separated Bike Lane Concept

As stated in the *NCHRP Report 948*, the RCUT separated bike lane concept (***Figure 115***) is distinguished by the separated bike lane and the removal of the major street left turns. The design concept also features crossings on all four intersection approach legs. The concept is intended to be implemented in locations with either relatively high motor vehicle volumes or high speeds; the separated bike lane provides a low-stress riding environment for people biking and separates bicyclists from pedestrians. The removal of the major street left-turn movement would either make this design feasible only with low volumes of left-turns or with left-turn operations as an explicit tradeoff of the design. The bike lanes would either be matched to the existing roadway or could be developed through a ramp from the approach lanes. As described in the *NCHRP Report 948*, the design addresses these key elements regarding safety and comfort:

- The design includes the protected intersection concept with corner refuge islands that tighten turn radii and extend physical protection for crossing pedestrians. The turn radius would need to be refined based on the intended design vehicle path but would control right-turning vehicle speeds. Crossing pedestrians are pulled back to enhance their visibility. All right-turn movement volumes are increased with this design, given the elimination of all left-turn vehicle movements. Providing an exclusive pedestrian phase would provide time separation of the minor street right turns and the major street pedestrian and bicycle movement.
- For bicyclists, the design includes separated bike lanes enabling bicyclists to complete left turns in two stages. This provides a more intuitive left-turn movement for all bicyclists and mitigates the indirect path.
- For pedestrians, the mid-block (at the U-turn) crossings provide more potential for route directness by allowing pedestrians to cross the major street upstream or downstream of the intersection. All four main intersection legs include pedestrian crossings, allowing for direct walking routes.
- The concept eliminates all vehicle left turns at the intersection. This elimination of the movement also increases signal design flexibility, which may provide other benefits for pedestrians.
- All pedestrian crossings would be signal-controlled, providing safe crossing opportunities.
- Crossings for pedestrians and bicyclists are defined with this design; particularly for bicyclists, the separated bike lane gives positive guidance and wayfinding benefits throughout the intersection.
- This concept moves all riding away from mixed traffic with physical (horizontal and vertical) separation.

Figure 115 | RCUT Separated Bike Lane Concept



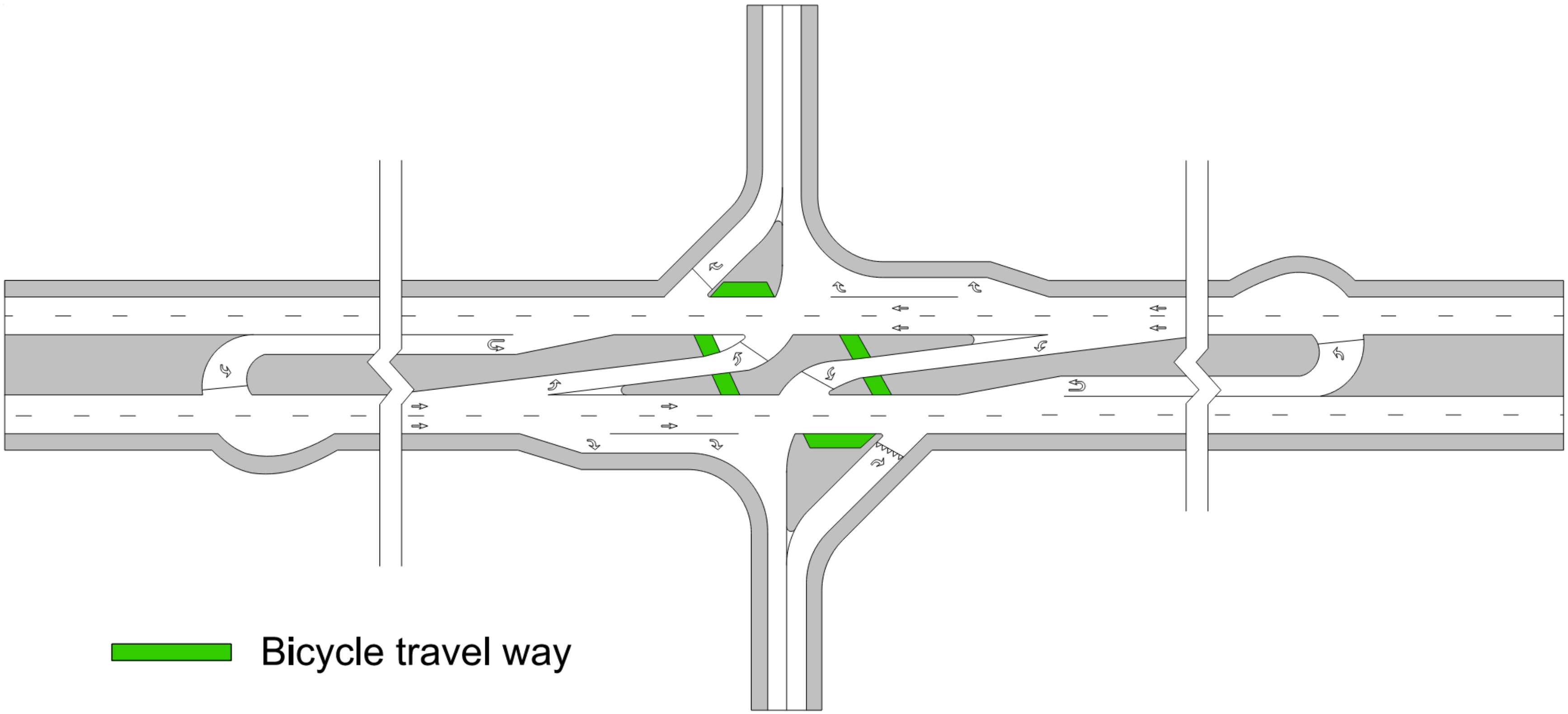
Source: Adapted from NCHRP Report 948 - Exhibit 7-15

Rural RCUT Concept with Biking on Shoulder Concept

As stated in the *NCHRP Report 948*, the rural RCUT concept (***Figure 116***) is presented with a distinctly different lane configuration and context from the other three concepts. The context for this design is along a rural corridor with a two-lane cross street. This design would be expected to be installed in a location with biking on the shoulder along the major street and limited or no existing pedestrian facilities. The concept offers a "cut-through" bike path across a single-lane U-turn and a bicycle refuge. Bicyclists on the minor street would proceed through the channelized turn lane and then cross the median. Bicyclists on the major street could pull into the refuge area to cross the major street traffic at a perpendicular angle instead of crossing lanes at speed to enter the channelized left-turn lane. As described in the *NCHRP Report 948*, the design addresses these key elements regarding safety and comfort:

- The concept has the benefit of retaining a relatively small footprint compared to other RCUT concepts discussed in this chapter. The compact footprint would help with costs and could have residual benefits for pedestrians and bicyclists (e.g., shorter crossings and walking distances).
- The concept reduces required out-of-direction travel for bicyclists at an RCUT by providing the cut-through lanes for minor street crossings. Bicyclists would not need to cross over for a U-turn to make a minor street through or major street left-turn movement.
- The concept retains the ability to be retrofitted to include a pedestrian Z-crossing between the major street left-turns.

Figure 116 | Rural RCUT Concept with Biking on Shoulder Concept



Source: Adapted from [NCHRP Report 948 - Exhibit 7-17]

DLT Intersection

As discussed in the *NCHRP Report 948*, pedestrian crossings at DLT intersections differ from those at conventional intersections. The main reason for this difference is the position of left-turn lanes between opposing through lanes and right-turn lanes, which presents pedestrians with an unfamiliar crossing scenario (i.e., motor vehicle traffic approaching from a nonintuitive direction). Additionally, the geometry of the crossover may create a wide median that adds length to the mainline pedestrian crossing.

There are two primary design approaches (locations) for providing pedestrian crossings: an outside crossing (***Figure 117***) or an inside crossing (***Figure 118***). In the "outside crossing" option, the mainline pedestrian crossings are located outside of the displaced left-turns. In the "inside crossing" option, the mainline pedestrian crossings are inside the displaced left-turns. These crossing options affect the experience of pedestrians and operations for all users.

Safety challenges and concerns for pedestrians and bicyclists at DLT intersections, are discussed in the *NCHRP Report 948*. Four RCUT design concepts are presented in the *NCHRP Report 948* to present options for improving pedestrian and bicycle safety and operational performance at DLT intersections. The designs include the following:

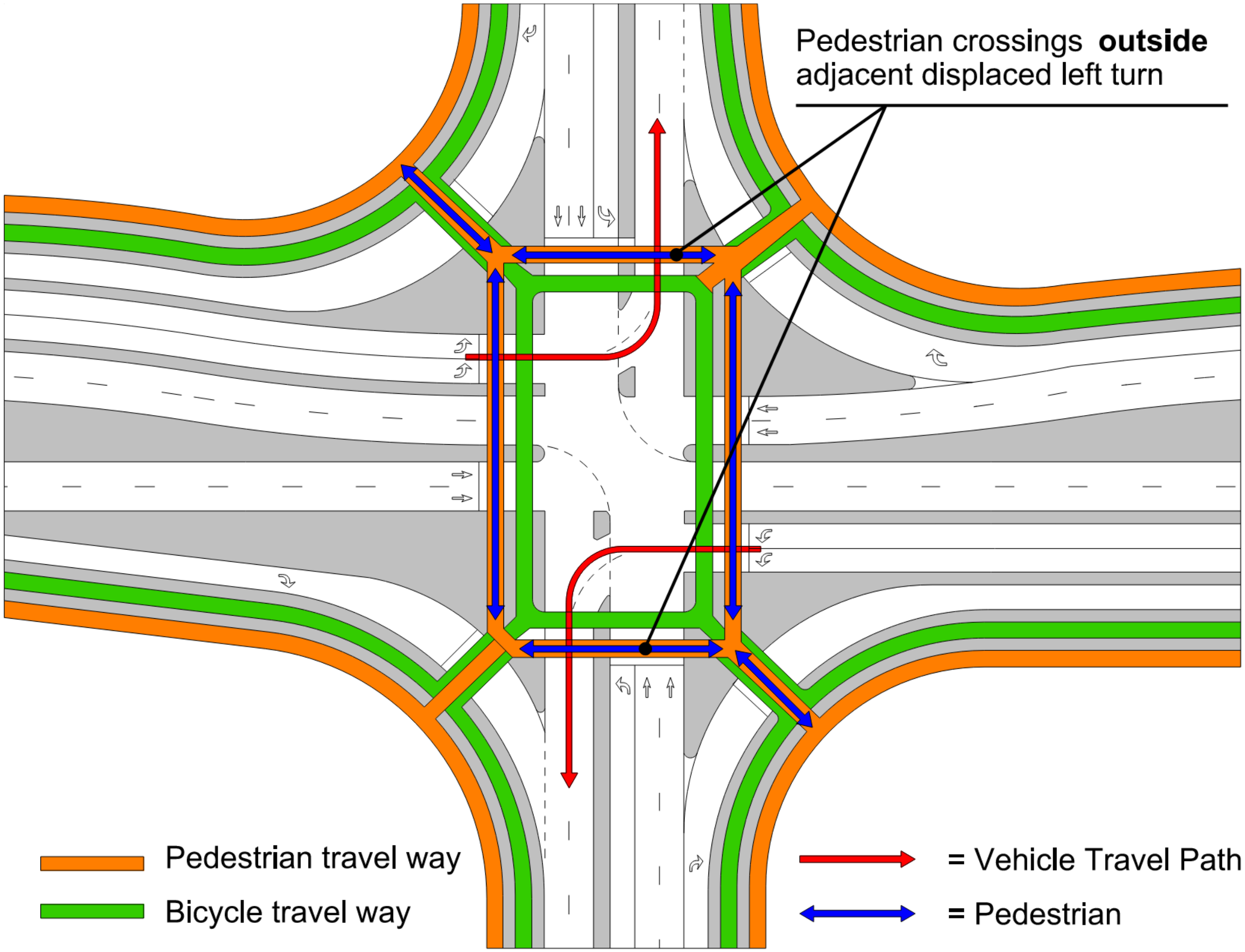
- DLT Bike Lane and Path Concept
- DLT Protected Intersection Concept
- DLT Pedestrian Walkway Between Vehicle Lefts and Throughs Concept

DLT Bike Lane and Path Concept

As stated in the *NCHRP Report 948*, this partial DLT intersection concept (***Figure 119***) is distinguished by its provision of on-street bike lanes along with a shared use path for right-turning bicyclists. The concept would be appropriate for a context of low motor vehicle speeds, low motor vehicle volumes, or both; the concept also provides an example for carrying existing bike lanes through a DLT intersection. As described in the *NCHRP Report 948*, the design addresses these key elements regarding safety and comfort:

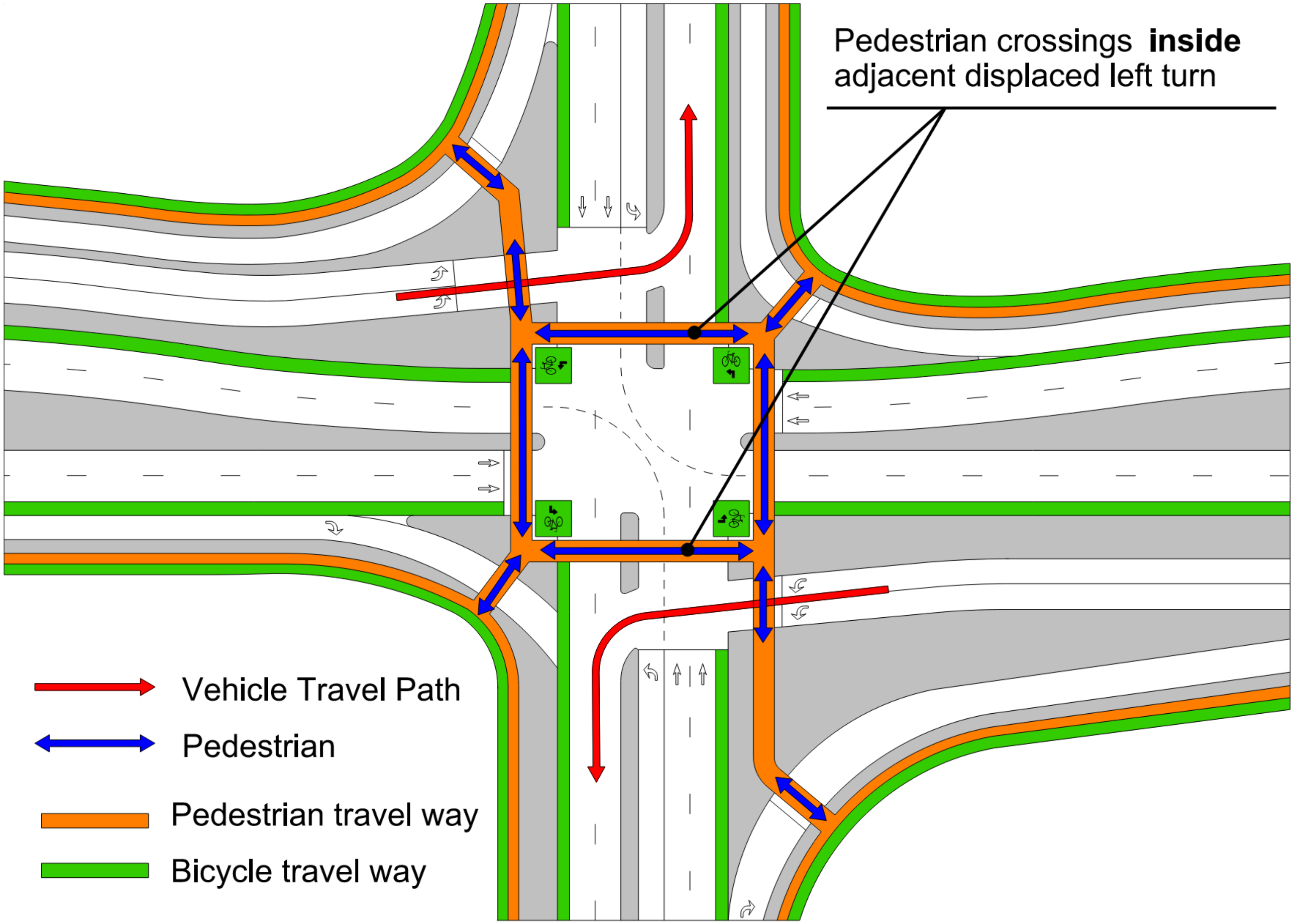
- All pedestrian crossings are controlled in this concept.
- An inside crossing pedestrian mainline crossing minimizes crossing distance and exposure to vehicular traffic. A tapered median also allows for a relatively narrow median at the mainline crossing, to shorten the crossing distance.
- The provision of the on-street bike lane and the shared use path allows users to select their desired riding position, providing for more highly confident bicyclists and those who would not use on-street facilities in this context.
- For left-turning bicyclists, using a two-stage turn queue box removes the need to cross over vehicle travel paths and travel in a channelized left-turn lane on the major street approach. Similarly, for right-turning bicyclists, the ramp to a shared use path allows bypass of the channelized right-turn lane with a downstream ramp to return to an on-street bike lane.
- The right-turn bypass lane includes (along the major street) a signalized reentry to control the bicycle-vehicle conflict for through bicyclists at this location.

Figure 117 | Partial DLT Intersection with Outside Crossing Option



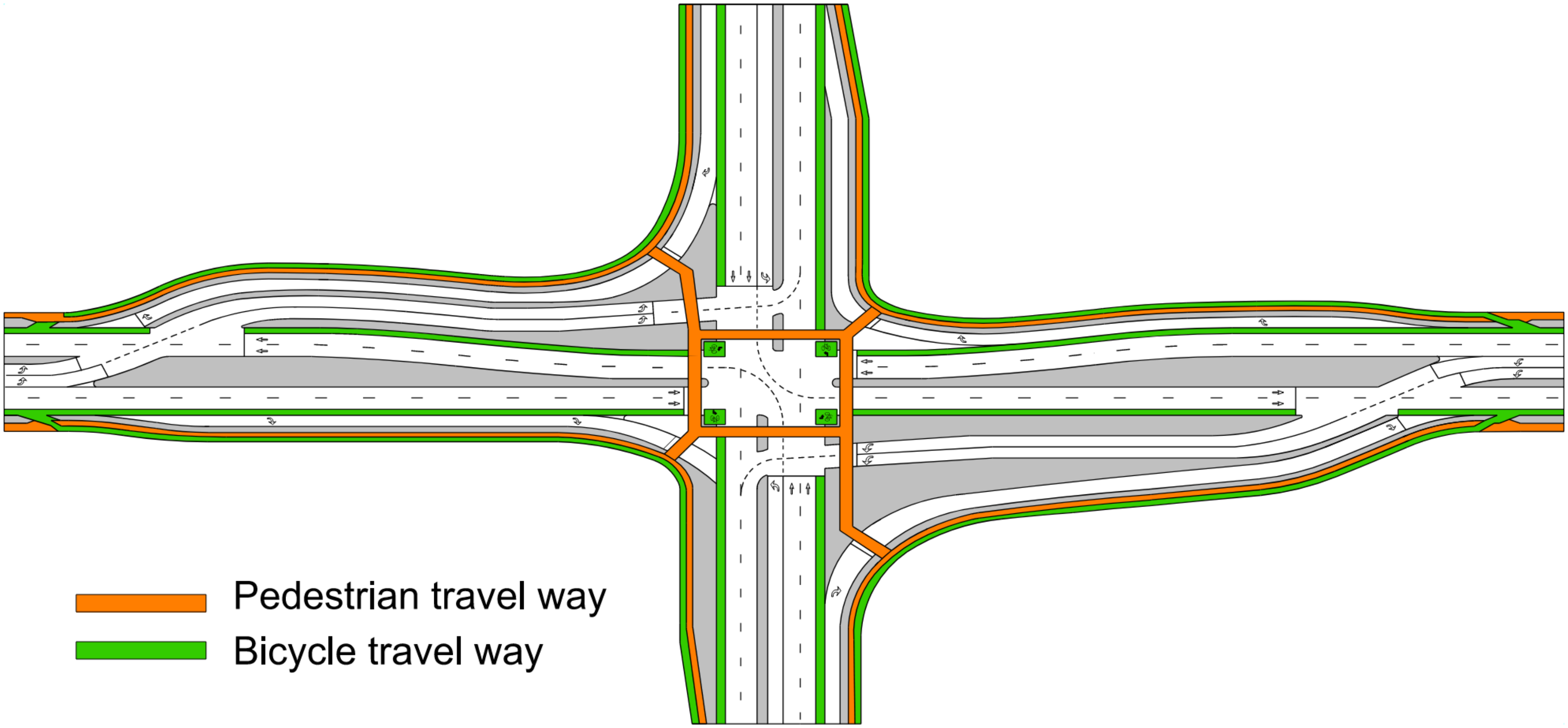
Source: Adapted from NCHRP Report 948 - Exhibit 8-4

Figure 118 | Partial DLT Intersection with Inside Crossing Option



Source: Adapted from [*NCHRP Report 948 - Exhibit 8-5*]

Figure 119 | DLT Bike Lane and Path Concept



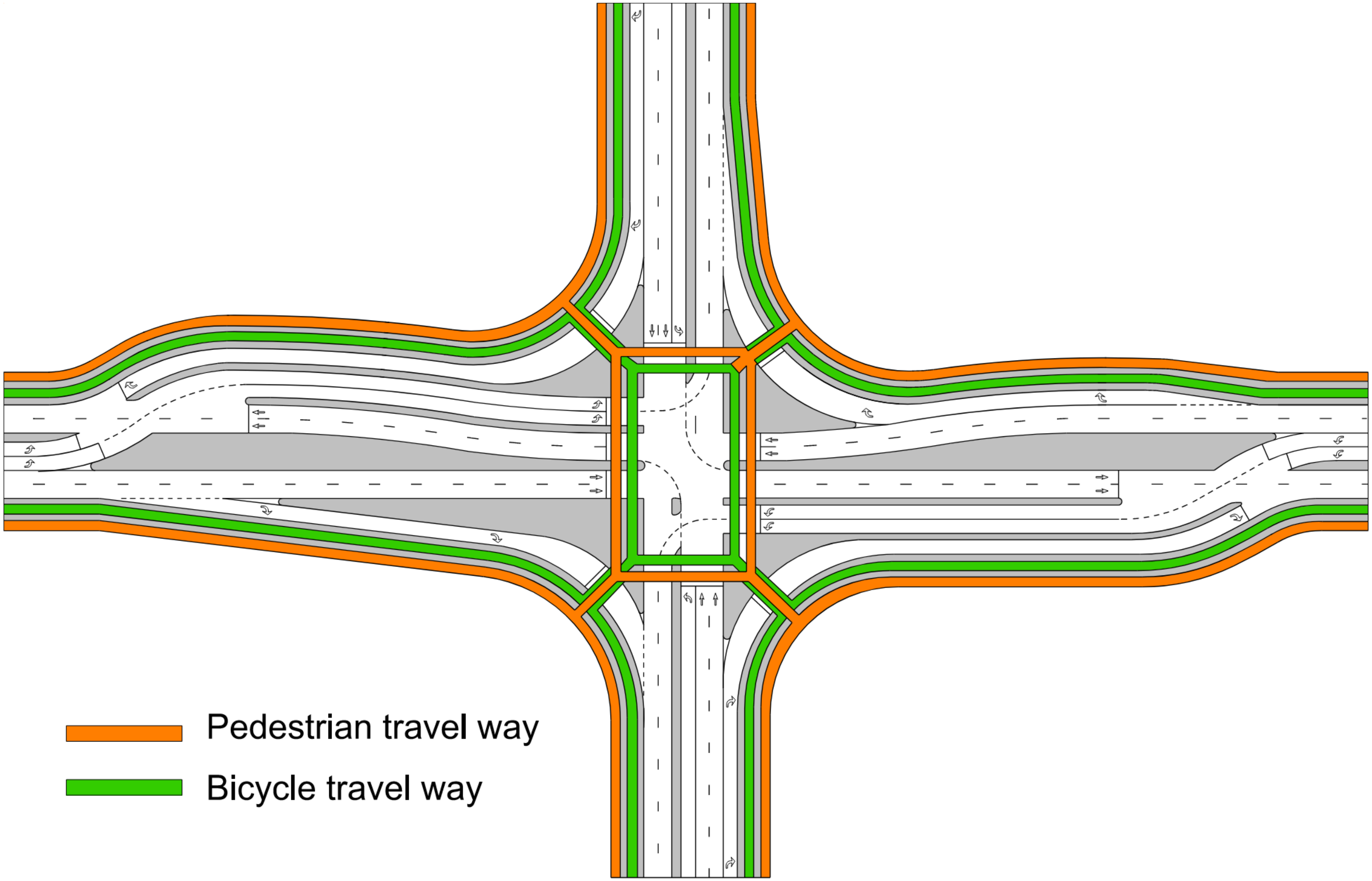
Source: Adapted from NCHRP Report 948 - Exhibit 8-15

DLT Protected Intersection Concept

As stated in the *NCHRP Report 948*, this DLT intersection concept (***Figure 120***) is characterized by the separated bike lane on all approaches and the shared crossings over channelized right-turn lanes. The separated bike lane would be an appropriate design technique for locations with relatively high motor vehicle volumes, speeds, or both. The separated bike lane would provide a low-stress riding environment and encourage use by less confident bicyclists. Depending on the surrounding facilities, the separated lane could match back into existing separated bike lanes or provide ramps back to on-street facilities. Using a separated bike lane versus a shared-use path would depend on the number of pedestrians and bicyclists expected to use the facility. As described in the *NCHRP Report 948*, the design addresses these key elements regarding safety and comfort:

- The design includes the protected intersection concept with corner refuge islands that tighten turn radii and extend physical protection for crossing pedestrians. The turn radius would need to be refined based on the intended design vehicle path but would control right-turning vehicle speeds. Crossing pedestrians are pulled back to enhance their visibility.
- All pedestrian crossings would be signal controlled, providing safe crossing opportunities.
- This concept moves all riding away from mixed traffic with physical (horizontal and vertical) separation. Bicyclists would cross motor vehicle paths using marked crossings. The separated bicycle lane removes the bicycle and motor vehicle crossover conflict points throughout the intersection, relocating conflict to a controlled crossing of right-turn channelized turn lanes. The channelized lane crossings would be bidirectional for pedestrians and bicyclists, with sufficient width and marking to provide for these movements.
- The major street pedestrian crossing would be made in a single stage, eliminating the extra delay that could be incurred waiting between two-stage crossings.

Figure 120 | DLT Protected Intersection Concept



Source: Adapted from [NCHRP Report 948 - Exhibit 8-17]

DLT Pedestrian Walkway Between Vehicle Lefts and Throughs Concept

As stated in *the NCHRP Report 948, this* DLT intersection concept (***Figure 121***) is distinguishable by the provision of the walking path between the displaced left-turn and through lanes, as well as the absence of bicycle facilities along the major street. Based on the bicycle facilities, this concept would be expected to be implemented where a bicycle route of importance suitable for on-street facilities (the minor street) crosses a major arterial route that is not a critical piece of a planned bike network.

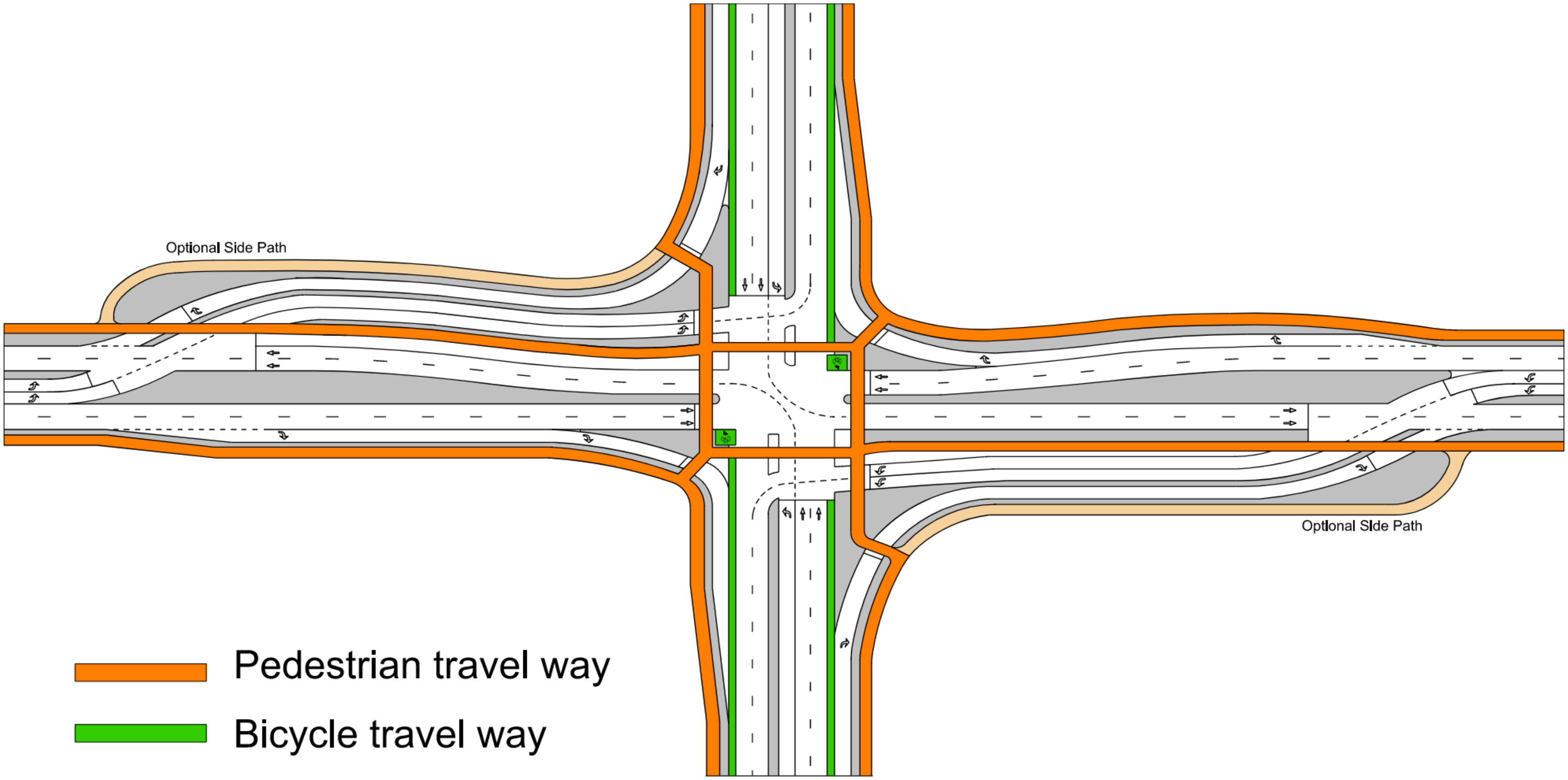
This includes the addition of a pedestrian facility between the DLT and the opposing through movement that travels away from the main intersection toward the crossover and bypass right lane end. This design places pedestrians in the median refuge island toward the crossover to cross the DLT there. The design, which functions similarly to the inside crossing option, creates a crossing opportunity across the DLT lanes at the crossover intersection because of the median positioning.

This concept allows the channelized right-turn and DLT crossings to operate on the same signal phase, minimizing the number of signal phases needed to cross quadrants at the intersection. Provided the two stages can be made within the provided clearance phase, the reduction in stages would reduce pedestrian delay at the main intersection.

As described in the *NCHRP Report 948*, the design addresses these key elements regarding safety and comfort:

- An inside crossing pedestrian mainline crossing minimizes crossing distance and exposure to vehicular traffic. A tapered median also allows for a relatively narrow median at the mainline crossing, to shorten the crossing distance. The median walk concept also provides opportunities for pedestrians to avoid delay while crossing.
- All pedestrian crossings would be signal controlled, providing safe crossing opportunities.
- If pedestrians are crossing the intersection from west to east or east to west and are strictly using the median walk, they may avoid crossing over the displaced left turns entirely.
- The presence of the median walk would allow for the placement of a transit stop between the main and crossover intersections. The other DLT intersection designs would not allow for this because of the placement of the displaced left-turns between the through lane and walking paths.

Figure 121 | DLT Pedestrian Walkway Between Vehicle Lefts and Throughs Concept

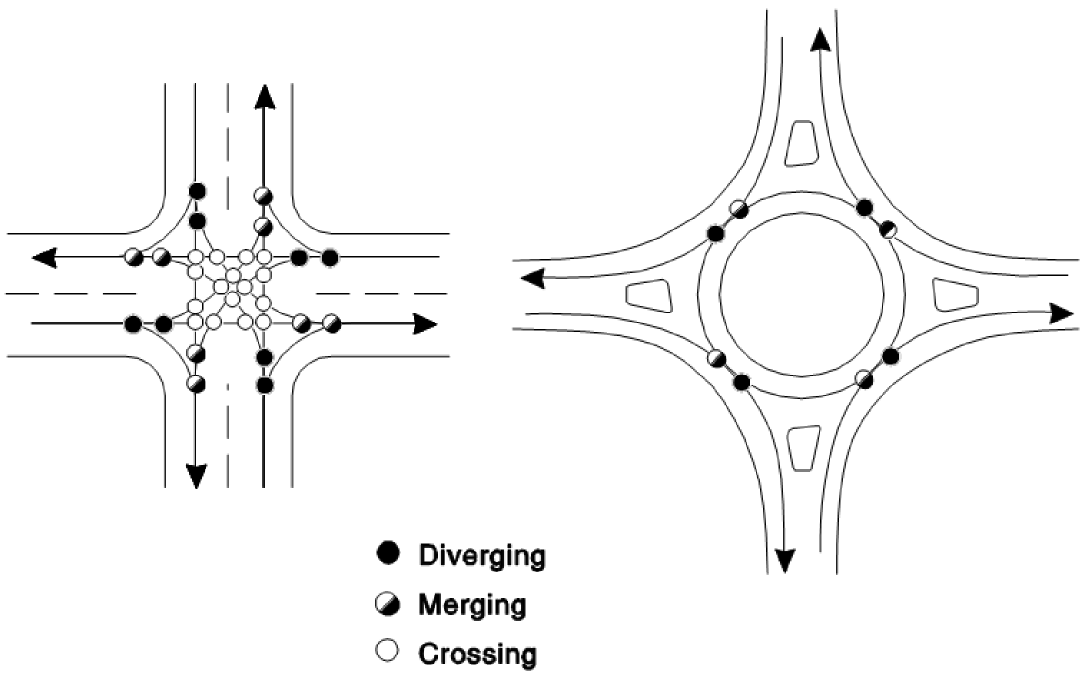


Source: Adapted from [NCHRP Report 948 - Exhibit 8-19]

8.4 Roundabouts

Roundabouts are frequently selected in this process and are often encouraged as an access management and intersection control strategy. Roundabouts provide significant benefits for roadway users by reducing the number of conflict points that can occur when compared to a signalized or unsignalized intersection. ***Figure 122*** demonstrates how vehicular conflict points are reduced from thirty-two to eight while eliminating crossing conflicts, which are the main cause of serious injuries and fatalities. According to the *Highway Safety Manual (HSM)*, this has been found to increase overall safety performance for roadway users by reducing the number of serious injuries and fatalities by 79% when compared to a signalized intersection.[20] Although the number of conflicts increases at multilane roundabouts when compared to single-lane roundabouts, the overall severity (and often number) of conflicts is typically less than other intersection alternatives. In addition to reducing conflict points for vehicles, they are similarly reduced for non-motorized users as well.[21] *NCHRP 672* and *FDM 213 – Modern Roundabouts* provide greater detail in non-motorized users safety benefits. Typically, these benefits are higher with single lane roundabouts.

Figure 122 | Intersection vs. Roundabout Conflict Points



Source: NCHRP Report 672 (Figure 5-2)

For planning purposes, a roundabout will typically provide better operational performance than a signal in terms of stops, delay, vehicle queues, fuel consumption, safety, and pollution emissions. According to *NCHRP 672*, a roundabout that operates within its capacity will generally produce lower delays than a signalized intersection operating with the same traffic volumes and ROW limitations.[21]

[20] *http://www.cmfclearinghouse.org/detail.cfm?facid=4184*

[21] *NCHRP Report 672 - Roundabouts: An Informational Guide – Second Edition*

A detailed methodology for section of roundabouts is provided in the *ICE Manual*. In addition, *NCHRP 672* provides a detailed methodology for comparing potential roundabout performance with a comparable signalized intersection. A simplified version of this is summarized in ***Table 30*** below. Several other benefits of roundabouts include providing simpler U-turn movement opportunities for users, as well as potentially creating a system that can move vehicular traffic more efficiently in a city when multiple roundabouts are built in a network.

Table 30 | Guidance on Roundabout Category Comparisons

Factor	Single lane	Multi-lane
Total Entering Traffic Volumes	Up to 25,000	Up to 45,000
Entry Speed	20 - 25 mph	25 - 30 mph
Typical Inscribed Circle Diameter	90 - 180 feet	150 - 300 feet

Source: Adapted from NCHRP 672

Roundabouts should be able to accommodate most large vehicles easily through them, such as; school buses, moving vans, garbage trucks, fire trucks, and other emergency vehicles should be able to utilize a roundabout with no significant operational issues. The inclusion of a truck apron around the circular island allows for larger trucks to safely make all turning movements. Appropriate pavement markings are key to guide where the steering axle and wheels are needed to minimize off-tracking.

8.4.1 Geometric Considerations

When properly designed, the geometric design of roundabouts reduces the speed of vehicles approaching, using, and exiting the roundabout. Reducing vehicle speed benefits all users.

Traffic flow through a roundabout is especially sensitive to small geometric changes. Some considerations that must be addressed for successful implementation are:

- Good deflection at the entry of a roundabout
- Truck movements
- Public acceptance/awareness

Roundabouts can handle higher volumes of traffic than equivalent signalized intersections. ***Table 30*** provides guidance for comparing single and double-lane roundabouts.

Peer review of all designs is highly recommended because many minor crashes can be avoided by a careful review of initial designs. Roundabouts are one of the *FHWA Proven Safety Countermeasures*. The *FDOT Central Office's Roadway Design Office* will also review roundabout designs if requested.

FDM 213 Modern Roundabouts provides specific FDOT criteria on roundabout design. These criteria are supported by *NCHRP Report 672, Roundabouts: An Informational Guide* which covers certain aspects of roundabout design in more detail.

This section provides some general guidance on roundabouts in conjunction with access management strategies.

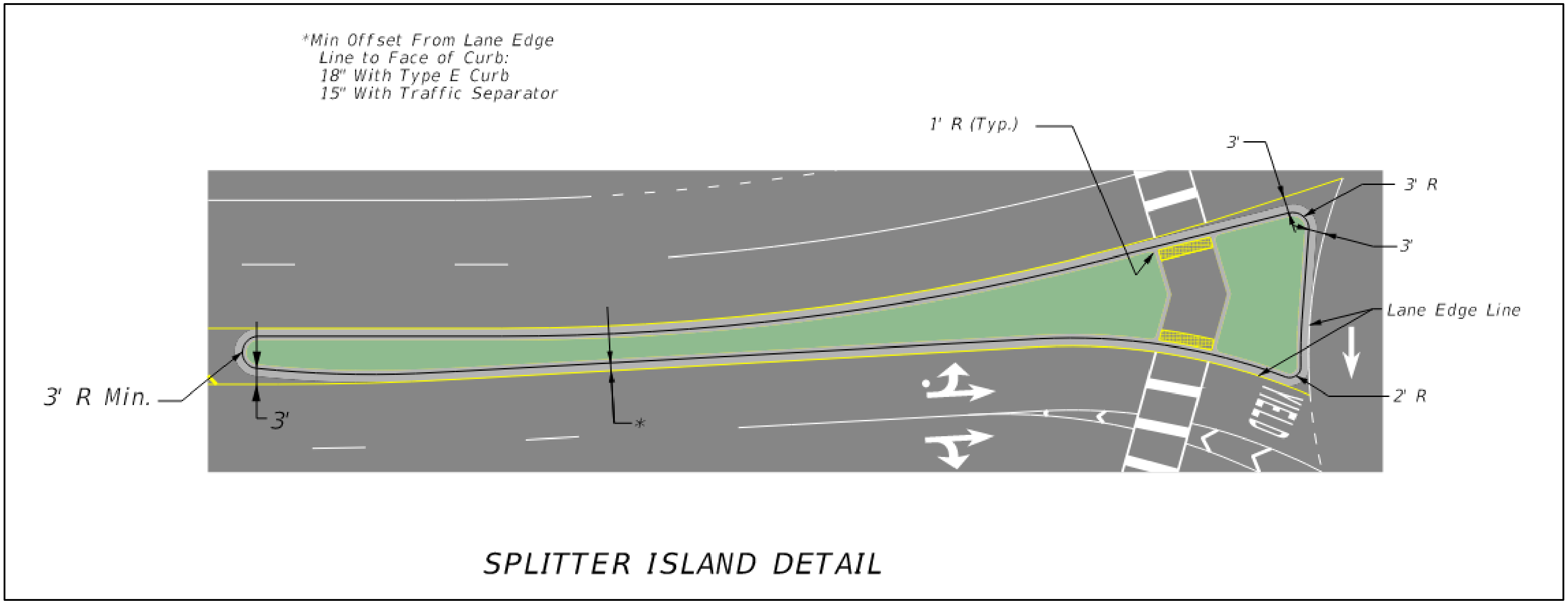
8.4.2 Pedestrian and Bicycle Accommodation at Roundabouts

Pedestrian and bicycle accommodation at roundabouts are illustrated in this section (See ***Figure 123***, ***Figure 124,*** or ***Figure 125***). Pedestrians are accommodated by crossings around the perimeter of the roundabout. By providing space to pause on the splitter island, pedestrians can consider one direction of conflicting traffic at a time, which simplifies the task of crossing the street. The roundabout should be designed to discourage pedestrians from crossing to the central island, e.g., with landscape buffers on the corners.

Bicyclists may be offered two paths upon approach to the roundabout. An existing or planned bicycle lane on an approach roadway must end in advance of a 2-lane roundabout with “bicycle ramps” providing access to the sidewalk. Bicycle ramps are optional for single-lane roundabouts. Bicycle ramps near roundabouts may be confusing to pedestrians with visual impairments. Directional Indicators are intended to minimize confusion by redirecting pedestrians with visual impairments away from bicycle ramps and guide them to stay on the sidewalk. Directional Indicators are designed to be detectable by cane, underfoot, and visual contrast with surrounding pavement (*Refer to FDOT Roadway Design Bulletin 19-5 for more information*). *FDM 213 – Modern Roundabouts* provides overall FDOT guidance on roundabout design.

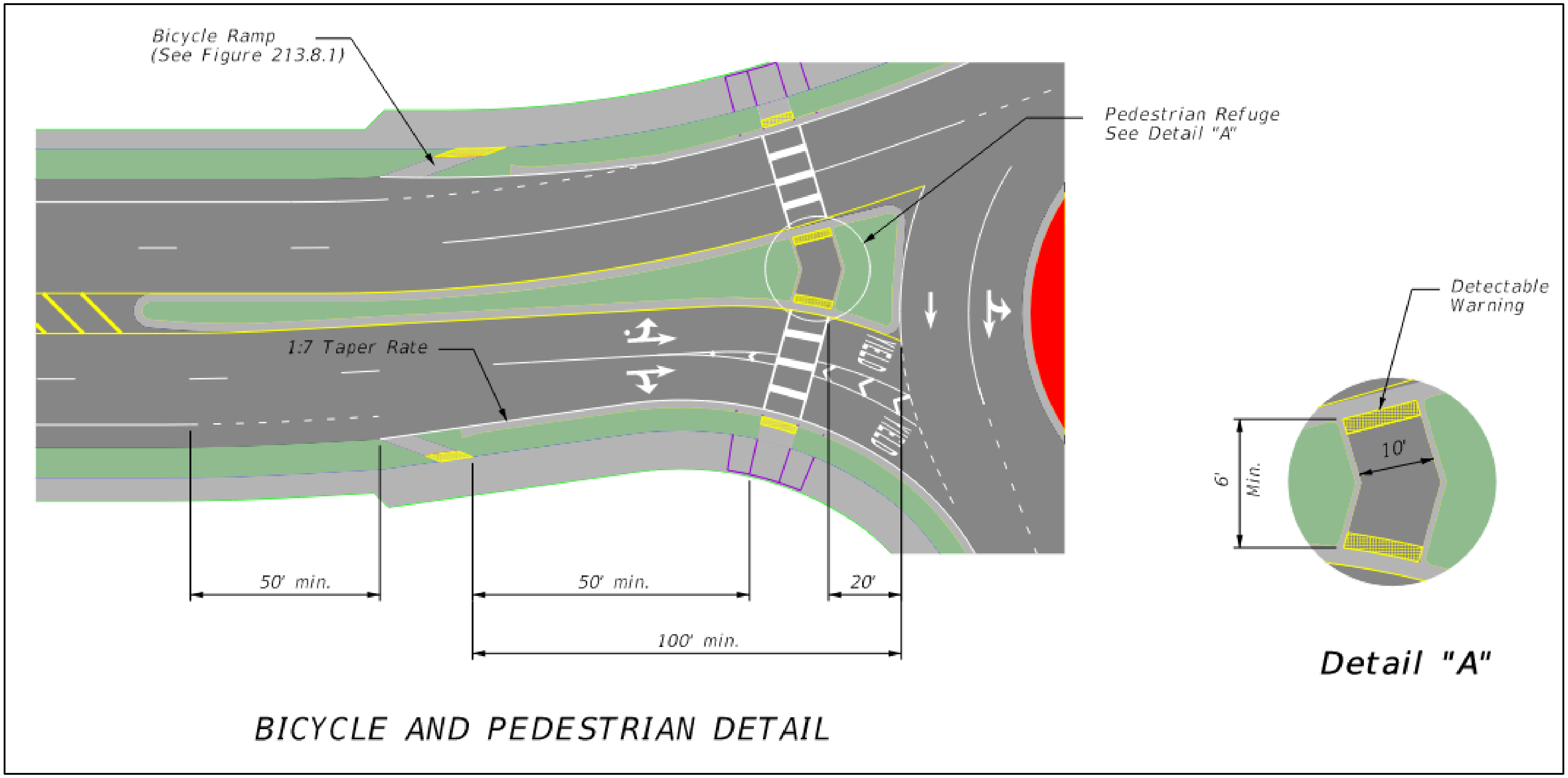
At the end of the bicycle lane, the bicyclist may either “control the lane” and navigate the roundabout as a vehicle or divert onto the sidewalk/shared-use-path and cross at pedestrian crossings. The typical motor vehicle operating speed within the roundabout is in the range of 15 to 25 mph, which is similar to that of a bicycle. No bicycle lane markings are to be placed within the circulatory roadway.

Figure 123 | Roundabout Details – Splitter Island



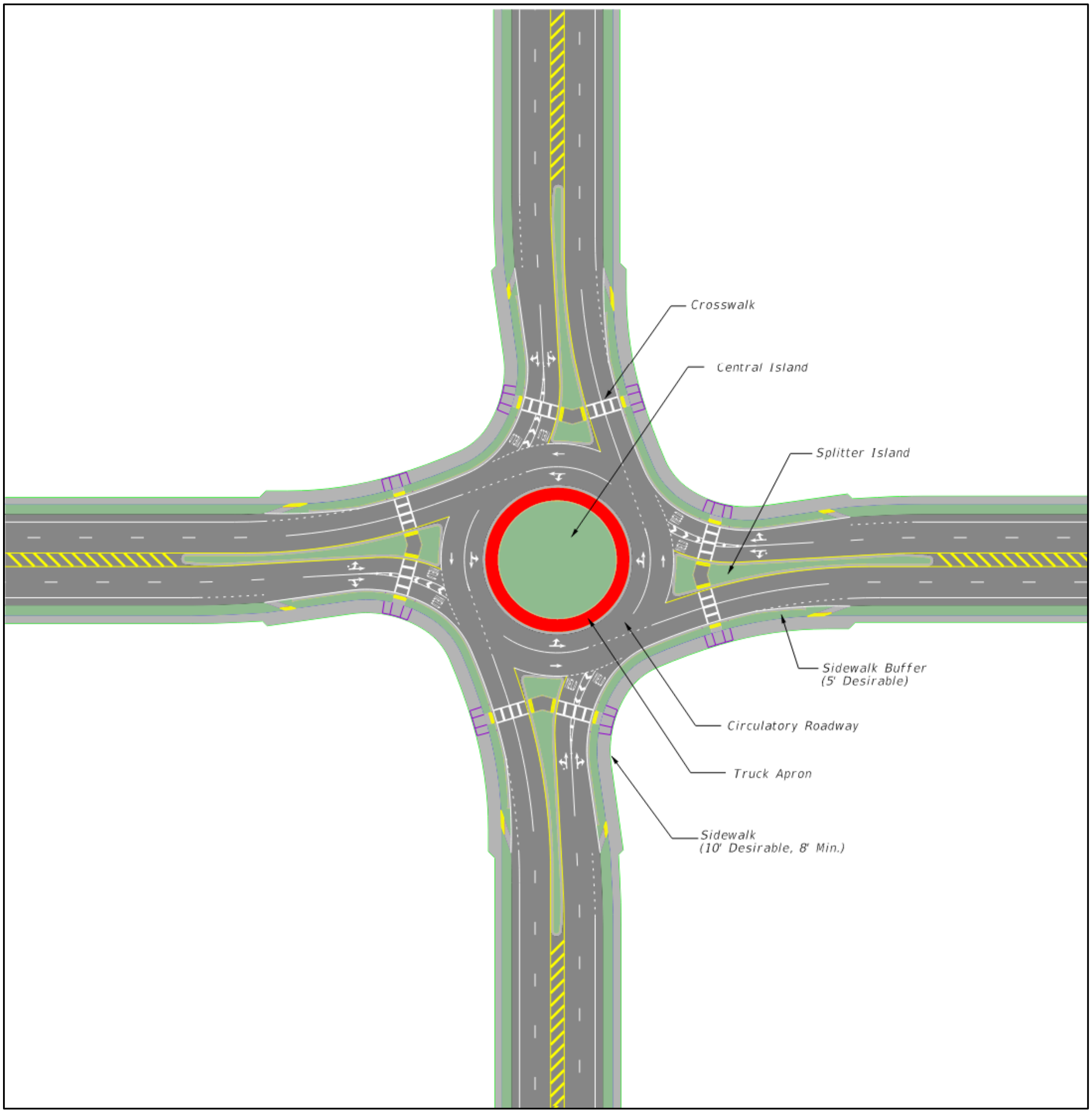
Source: FDM 213 – Modern Roundabouts (Exhibit 213-1)

Figure 124 | Roundabout Details – Non-Motorized Features



Source: FDM 213 – Modern Roundabouts (Exhibit 213-1)

Figure 125 | Roundabout Details



Source: [FDM 213 – Modern Roundabouts (Exhibit 213-1)]

8.4.3 Important Considerations

Roundabouts should always be designed for the largest vehicle that can be reasonably anticipated (the "design vehicle"). For single-lane roundabouts, this may require the use of a mountable apron around the perimeter of the central island to provide the additional width needed for tracking the trailer wheels (See ***Figure 126***). At double-lane roundabouts, large vehicles may track across the whole width of the circulatory roadway to negotiate the roundabout.

Transit considerations at a roundabout are similar to those at a conventional intersection. Buses should not be forced to use a truck apron to negotiate a roundabout. To minimize passenger discomfort, if the roundabout is on a bus route, it is preferable that scheduled buses are not required to use a truck apron if present. Bus stops should be located carefully to minimize the probability of vehicle queues spilling back into the circulatory roadway.

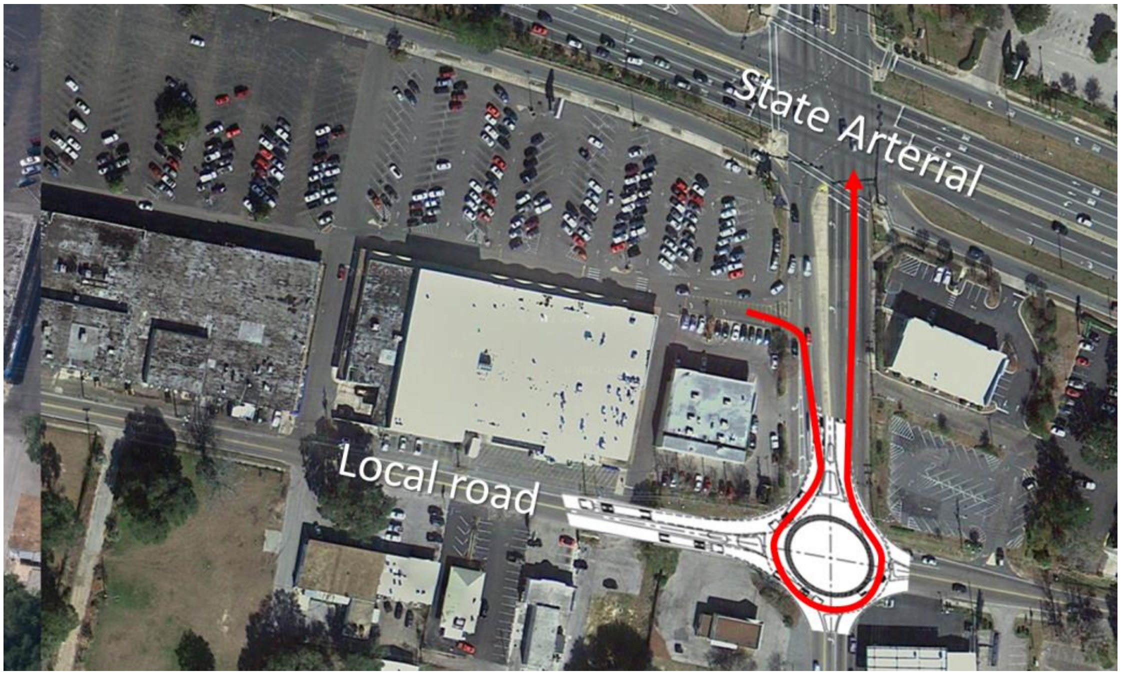
Figure 126 | Roundabout Example

Source: Aerial Innovations – Lake Wales, FL

8.4.4 U-Turns

Roundabouts allow U-turns within the normal flow of traffic, which often are not possible at other forms of intersection. Roundabouts can also change access management patterns by changing side street and driveway access spacing needs and requirements. For example, a roundabout can facilitate access from an arterial to a shopping center, where the median opening was closed (See ***Figure 127***).

Figure 127 | Example of Proposed Roundabout Near Arterial



Source: Google Earth

8.4.5 Median Openings

The operational characteristics of a roundabout are different than a conventional intersection. The slower speeds and traffic queues provide more flexible turning opportunities that would typically disrupt a signalized intersection.

Directional median openings could be considered after exiting a roundabout. The ease of making a U-turn reduces the need for median openings prior to roundabouts. Since speeds are lower before and after roundabouts, the design and location of median openings will depend on the specific location.

Chapter 9: Curbside Management

9.1 Overview

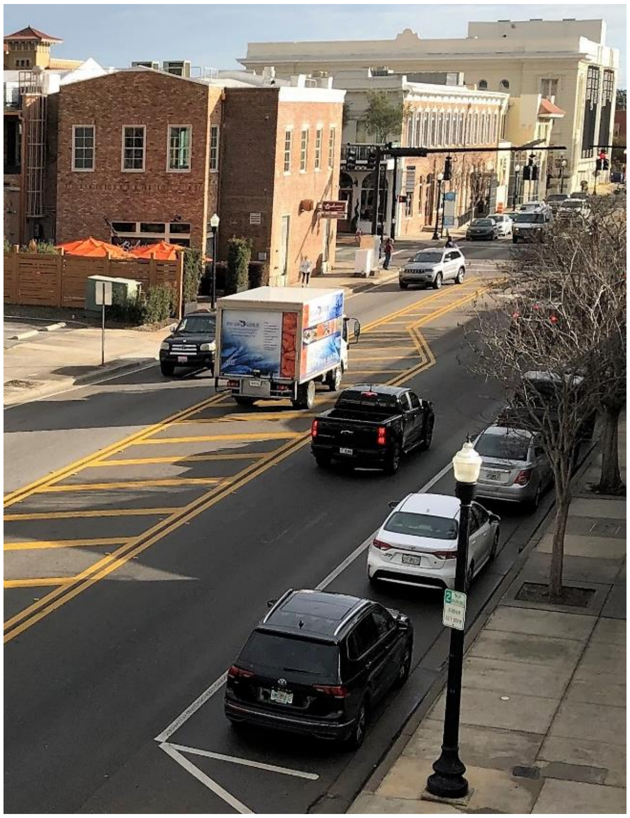
This chapter focuses on the area of curbside management and how it relates to the broader topic of access management. Good curbside management practices provide a variety of benefits to businesses, road users of all modes, local governments, and the community. This chapter includes discussion on a series of planning considerations and identifies best practice curbside management techniques to improve the safety performance and mobility of roadways.

Curbside use is generally managed and regulated at the local government level. This can be through city or county ordinances, policies, and strategic plans. FDOT has several interests in the application of effective curbside management including safety, mobility for all modes, convenience and comfort of all road users, economic growth, and enhancing the quality of life for communities. This chapter seeks to provide guidance on implementing good curbside management practices.

9.1.1 What is Curbside Management

Curb space is the interface between the access and mobility functions of a road. This is a complex and shared environment with competing demands from different road users. Curb space is in high demand along many corridors, and when unmanaged it can lead to safety and congestion issues. For example, delivery trucks may use undesirable and unsafe areas for deliveries if adequate curb space is not available (*Figure 128*).

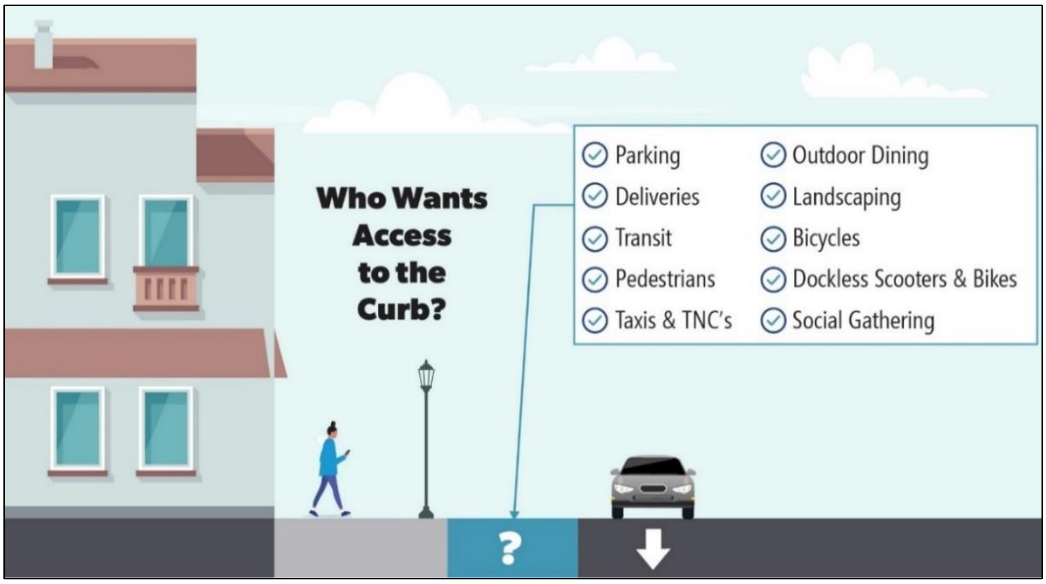
Figure 128 | Delivery Truck Using Median



Source: Pensacola, FL – HDR Photo

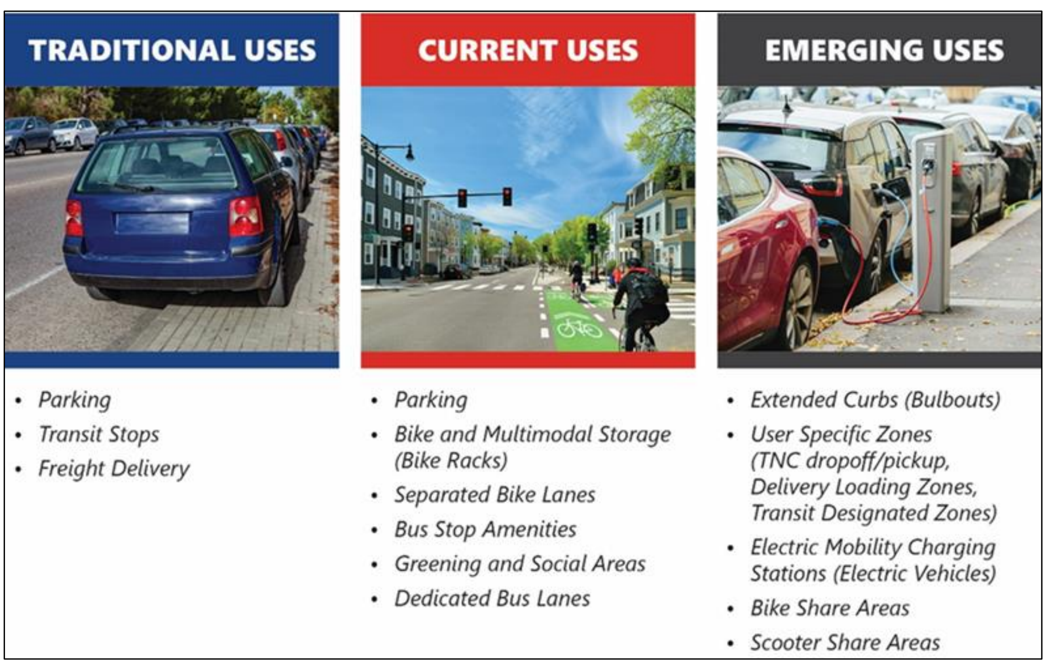
Curbside management is the process of managing and allocating use of the curb space along a roadway. Curbside management involves consideration of the various needs and demands of road users and adjacent land uses to best manage the limited curb space. Curbside users encompass a variety of transportation modes including parking, taxi, and transportation network companies (TNC), pedestrians, bicyclists, transit, micromobility, commercial deliveries, and community or small business use such as parklets, alfresco dining, and food carts (see *Figure 129*).

Figure 129 | Who Wants to Access the Curb



Traditional curbside management approaches have tended to favor providing unrestricted and untimed parking for private vehicles along the curb. While this approach may be suitable along some corridors, it can also be inefficient on other corridors and may exclude non-drivers from what is an important public space. Increasing use of e-commerce for shopping deliveries and transportation network companies such as Uber and Lyft for mobility has increased the complexity and use of the curbside and highlights the importance of having good curbside management policies and plans in place (see *Figure 130*). When planning curbside management considerations need to be given to the location of seating, signage, lighting, and utility infrastructure.

Figure 130 | Changes in Curbside Uses Over Time



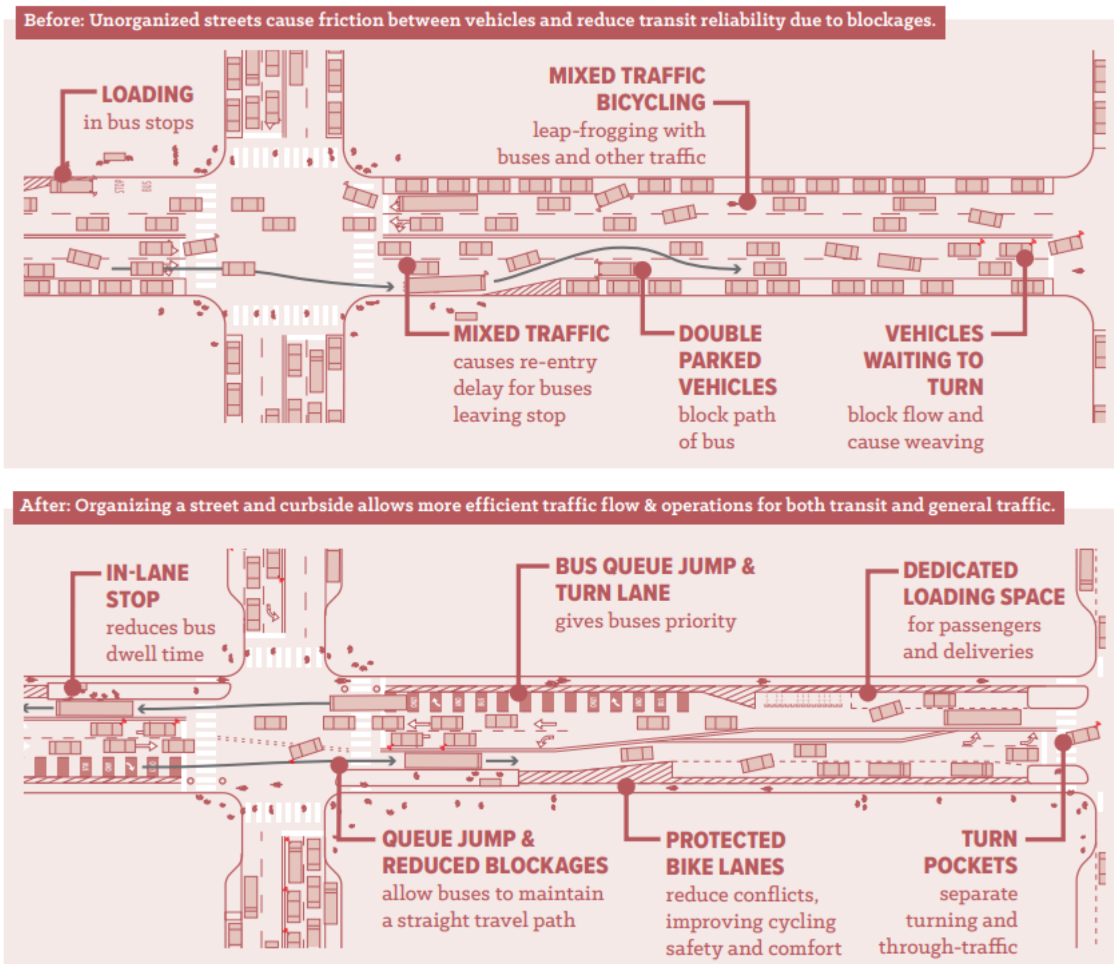
Source: Managing the Curb National Best Practices Scan, HDR Whitepaper

9.1.2 Curbside Management and Access Management

Curbside management has become an increasingly critical component of access management. Curb space can serve as a main point of access for people and goods to and from adjacent land uses. Curbside management seeks to balance curb use between various road user categories including drivers, transit passengers, bicyclists, and pedestrians as well as commercial delivery drivers, taxis, and rideshare operators while maintaining safe and efficient operations.

Poorly managed curb space can lead to the degradation of mobility, access, and safety along the road network (*Figure 131*), which undermines the goals of access management.

Figure 131 | Example of an Unmanaged Curb Versus Good Curbside Management



Source: NACTO-Curb-Appeal-Curbside-Management.pdf

9.1.3 Benefits of Good Curbside Management

There are many benefits to good curbside practices. These benefits affect a wide range of stakeholders including the local community, local businesses, drivers, transit riders, bicyclists, and pedestrians as well as local and state governments (see ***Figure 132***).

Figure 132 | Who Benefits from Curbside Management

Benefits of curbside management include improving the efficiency of curb space, providing more access, improving the safety performance of the street, reducing 'double parking,' provision of facilities for pedestrians, bicyclists, micromobility, and improved street amenity through provision of parklets (see ***Figure 133*** and ***Figure 134***).

Figure 133 | Benefits of Curbside Management

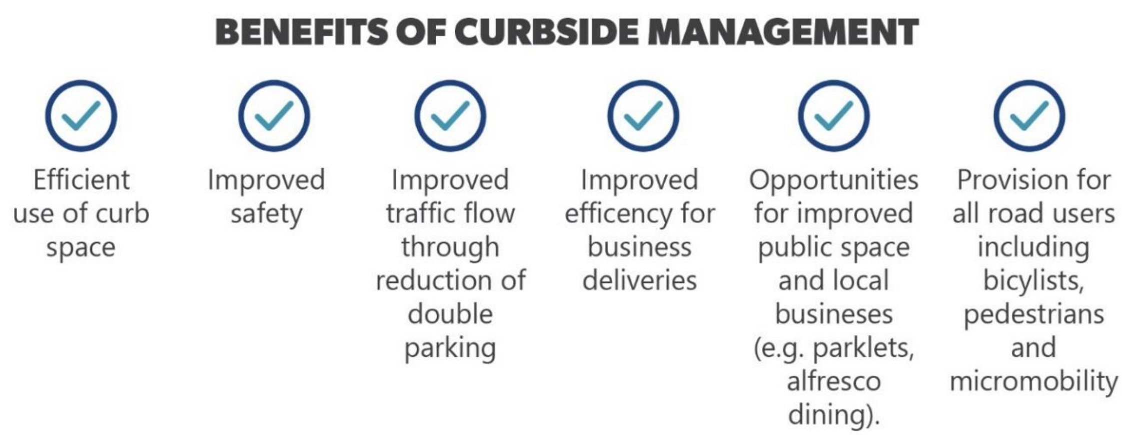
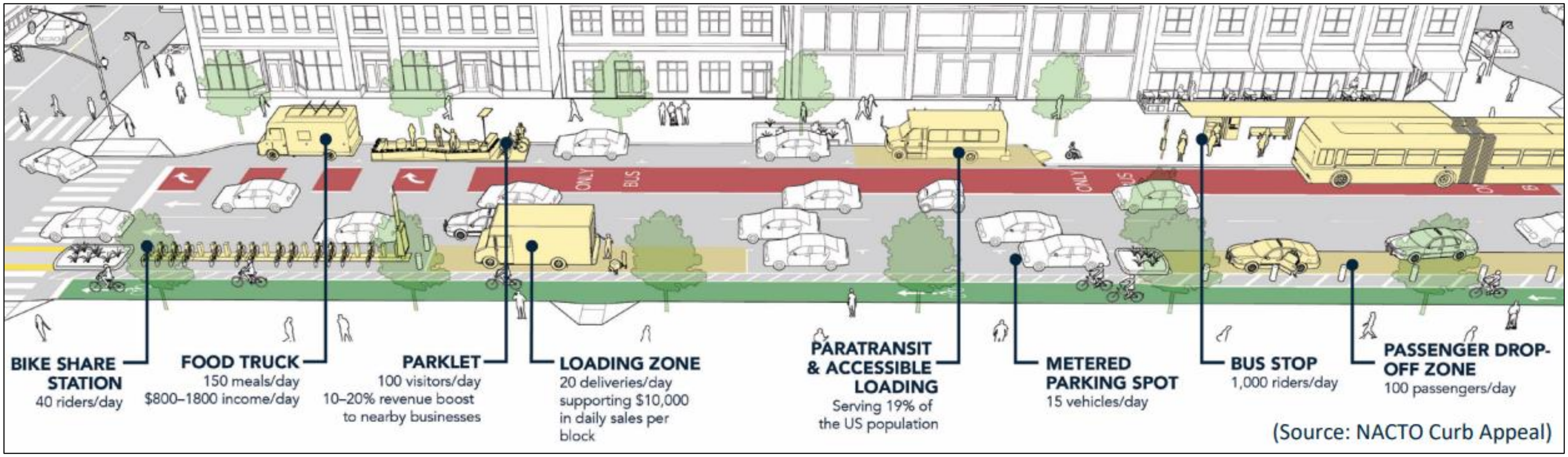


Figure 134 | Capacity by Curbside Use



Source: NACTO-Curb-Appeal-Curbside-Management.pdf

9.2 Planning Considerations

There are several planning considerations that should be explored when implementing curbside management techniques, policies, or strategies. These include the roadway's context and characteristics, demands on the curbside, and the existing corridor ROW. Each of these considerations is important in determining the curbside priorities for a locality, which can then be used to allocate curbside space and establish which techniques are appropriate for use.

9.2.1 Context Classification and Transportation Characteristics

Consideration should be given to both context classification and transportation characteristics in determining the roadway's users, the travel demand, and the access needs. Curbside management plans need to respond to the context and characteristics of the subject roadway to achieve the desired benefits and goals of the strategy.

Context varies between cities and neighborhoods and there is no one-size-fits-all approach to curbside management. Florida is home to a unique and diverse range of localities that must be understood by planners and government agencies when considering curbside management. FDOT has developed eight context classifications for the state-maintained highway network, excluding limited access facilities. These context classifications broadly identify the type of built environment along a roadway based on existing or future land use characteristics, development patterns, and the roadway connectivity of an area. The existing and future context classification should both be taken into consideration when implementing curbside management practices on the state highway network.

In addition to the context of the roadway, the roadway's transportation characteristics should be considered. Each roadway serves a role regarding the type of access it provides, the types of trips it serves, and the types of users it serves. Regional travel patterns, freight movements, transit operations, functional classifications, and SIS designations are also key transportation characteristics.

9.2.2 Curbside Demand

Demand for curb space is often high in downtown districts and along denser urban corridors. In many of these places, demand for curb space outpaces supply. This issue is further compounded by current trends in curb use which have seen the overall curbside demand increase and the types of curbside uses become more complex. Curbside demand may also fluctuate by time of day or by day of the week. Good curbside management requires consideration of the various existing and potential future demands for curb space.

When curbside demand exceeds supply, or when insufficient provisions are made for the types of curbside uses experienced along the corridor, then compliance with curbside restrictions and traffic rules may decrease. This can result in dangerous and illegal actions such as vehicles double-parking, passengers being dropped off from the travel lane, or delivery vehicles in the travel lane or median.

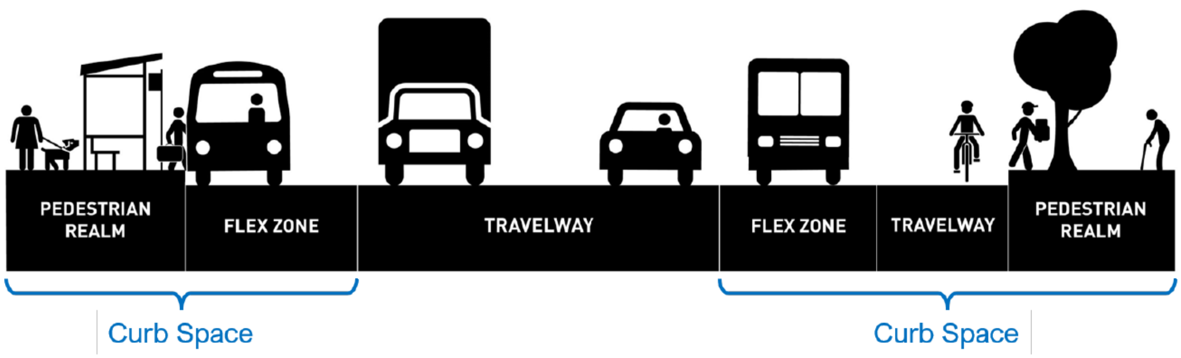
It is important that curbside uses and demands are understood prior to allocating curb space and developing curbside strategies. This ensures that the proposed curbside management techniques provide for the existing demand and potential future changes in demand. Extensive consultation with the community, local landowners, and businesses can help identify curb uses and the level of demand for each of these uses.

9.2.3 Right of Way (ROW)

The public ROW along road corridors is made up of three aspects: the travelway, the pedestrian realm, and the flexible area in between including the curb (see ***Figure 135***). The travelway is used for the mobility of vehicles and other modes of transportation; the pedestrian realm is used for the movement or gathering of people; the flexible area in between has a variety of uses and is the interaction between the travelway and the pedestrian realm. The use and demand of the three ROW components vary across context classifications and land use.

The width of a ROW corridor is usually fixed and can place limitations on the number of curbside uses that could be implemented. Lane repurposing can be considered to reduce the number of traffic lanes and hence the space required for the vehicle travelway which could then provide additional space to be utilized for curbside uses including buffered bicycle lanes and widened sidewalks. See the *FDOT Lane Repurposing Guidebook* for further information.

Figure 135 | Right of Way



Source: Future of the Commonwealth's Curb (mass.gov)

9.2.4 Curbside Priorities

A fundamental component of curbside management is developing priorities for curbside use. These priorities will vary based on context and land use. Setting curbside management priorities involves consideration of the factors discussed in ***Sections 9.2.1 - 9.2.3*** of this chapter as well as the overall transportation goals of the city or local government. ***Figure 136*** identifies questions that need to be considered when developing curbside management priorities.

To address these different priorities, it is helpful to create a curbside priority matrix such as the examples shown in ***Figure 137*** and ***Figure 138***. A curbside priority matrix is a flexible tool used to guide future decision making and discussions around implementation of curbside management policies. Development of a matrix helps the curbside management authority communicate the different curb use priorities by context setting.

9.2.5 Impacts of Parking Removal

When considering the removal of parking spaces from roadways, it is important to analyze the current utilization of those spaces, the highest priority use of the curbside space and evaluate the potential impacts of the proposed changes. There is no universal solution for managing curbside space, so decisions should be made on a case-by-case basis, taking into account local conditions, feedback, and context.

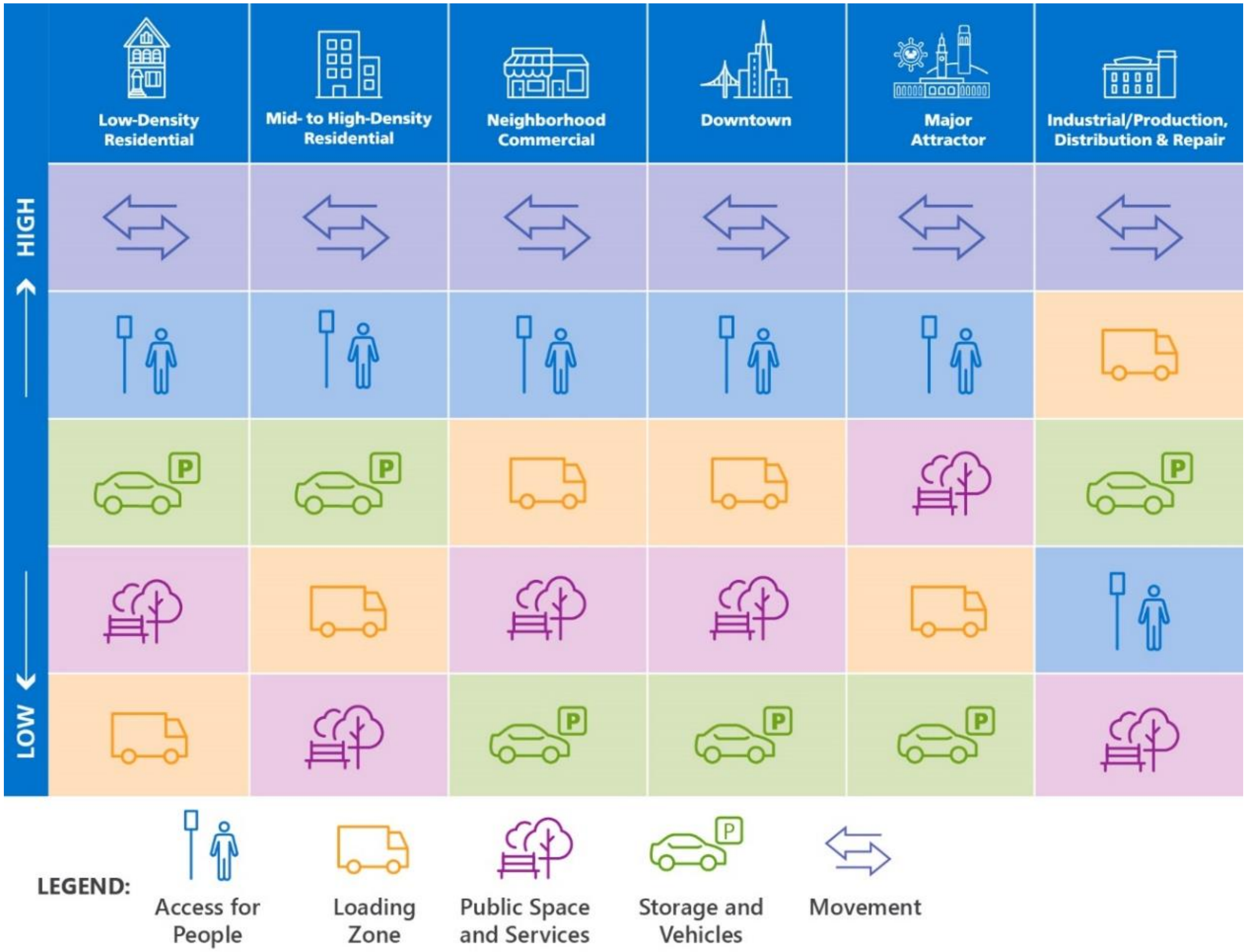
Figure 136 | Questions to Consider when Developing Curbside Priorities

QUESTIONS TO CONSIDER WHEN DEVELOPING CURBSIDE PRIORITIES

WHAT TYPES OF LAND USES ARE PRESENT?	• Commercial, retail, offices • Restaurants, bars, cafes • Mixed-Used developments
WHO ARE THE PRIMARY USER GROUPS?	• Pedestrians • Cyclists • Transit (bus or rail) • Vehicles • Delivery
WHAT ARE THE PRIMARY ACTIVITIES AT THE CURB?	• Transportation and mobility • Social gathering: street furniture, public art, parklets, street festivals, food trucks • Retail & shopping: restaurants, outdoor dining cafes, shops • Pickup/drop-off: TNCs, deliveries • Parking
WHAT ARE THE COMMUNITIES GOAL FOR THE CURB? **CONSIDER CITY-WIDE MOBILITY & PLANNING GOALS.**	• Reduce single occupancy vehicle mode share • Improve pedestrian walkability • Increase transit service • Reduce vehicle congestion • Accommodate pickup/drop-off activities • Improve safety for bike and pedestrian activity • Reduce conflicts between various modes and activities • Provide on-street parking for surrounding land uses • Reduce on-street parking • Increase turnover of on-street parking • Encourage economic development • Provide space for social gathering • Bringing order and safety

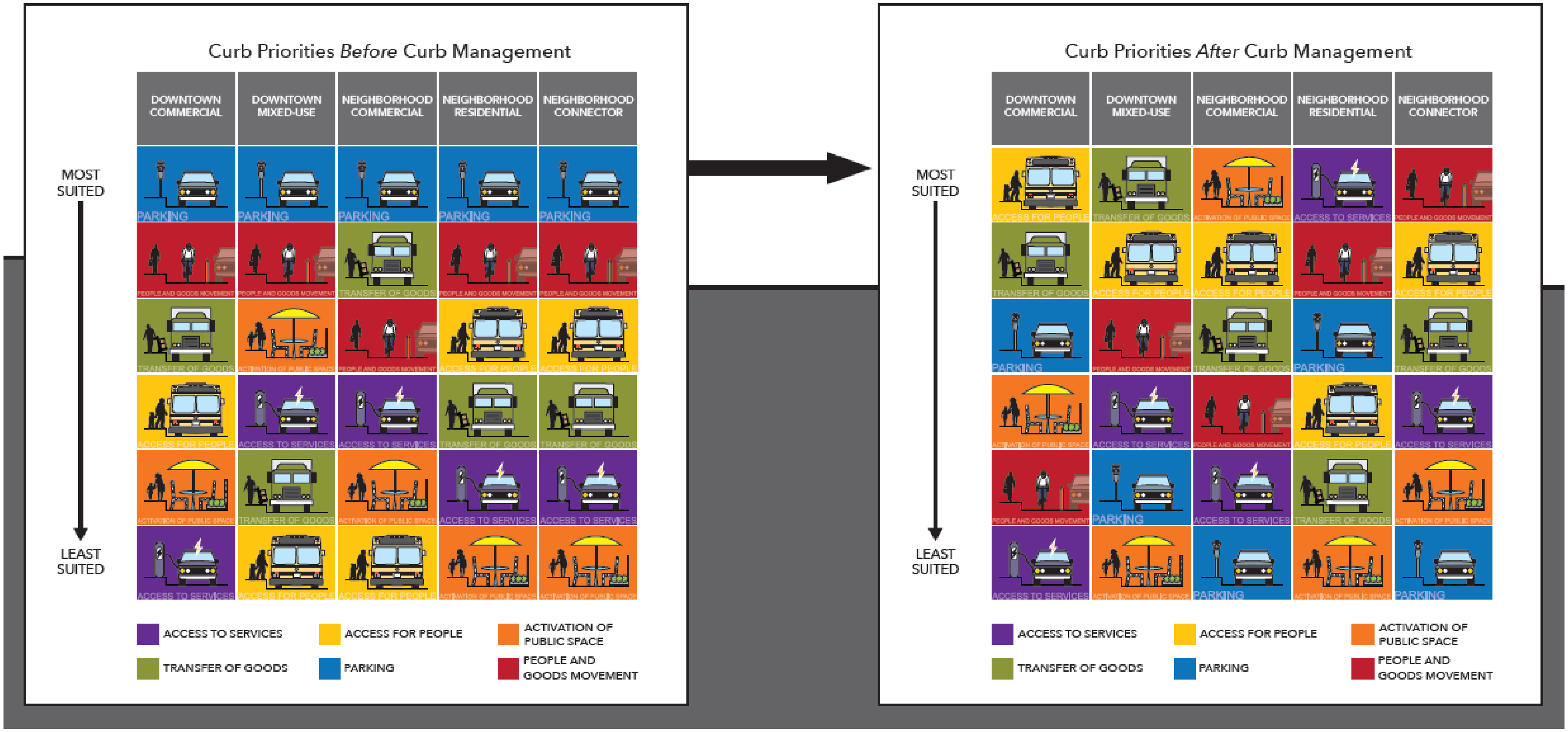
Source: Adapted from Curb Management Regional Planning Guide

Figure 137 | Curbside Priorities



Source: San Francisco Curb Management Strategy

Figure 138 | Curbside Priorities



Source: Managing Curb Space in the Boston Region

9.3 Curbside Management Techniques

This section provides an overview of best practices for curbside management techniques and strategies. Curbside management techniques should be selected based upon the specific curbside management goals and priorities for the location and consideration of the factors listed in ***Section 9.2*** of this chapter. Several curbside uses such as parking, freight deliveries, TNC pick-up and drop-off, public transit, pedestrian, bicyclists, business use, and relevant curbside management strategies are discussed in the following sections.

9.3.1 Parking

Unregulated vehicle parking is often the most common existing form of curbside treatment. In downtown areas with high demand for curbside use, unrestricted parking can result in a low turnover of private vehicles and an inefficient use of space. Vehicles that are parked for extended periods of time reduce turnover for local businesses and decrease access for other road user modes.

Curbside management techniques and strategies for parking are discussed below.

Timed Parking Restrictions

Parking time limits are suited for on-street parking in areas that require more frequent turnover of parking spaces. This includes where parking demand exceeds supply and where there is a demand for short-stay visitation. Short-term parking is most suited to central business districts and commercial areas in cities and towns of all sizes.

Timed parking restrictions can be static or may vary by time of day or day of the week to respond to changes in curbside demand. ***Figure 139*** shows an example of timed parking restrictions that varies by time of day and the day of the week.

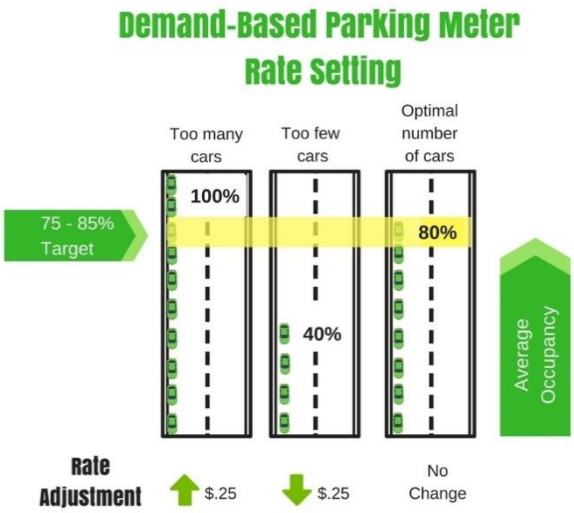
Figure 139 | Example: Timed Parking Restrictions

Source: Washington D.C. - Curbside Management Practitioners Guide

Demand-Based Pricing

Demand-based parking pricing is used to create the ideal occupancy rate along a road segment or curb. This occupancy rate should allow parking spaces to be efficiently used while still providing some spaces available for users requiring immediate access. To achieve the desired occupancy rate, parking fees may be raised or lowered periodically and may vary by neighborhood, time of the day, or day of the week. ***Figure 140*** illustrates how demand-based parking pricing works.

Figure 140 | Demand Based Parking Concept



Source: [Demand-Based Parking Meter Rate Setting | Parking Authority (baltimorecity.gov)]

An example of best practice demand responsive parking is the SFPark Project in San Francisco. SFPark is a large-scale parking management system which includes both on- and off-street parking within the commercial center of San Francisco. Parking rates are adjusted for segments monthly by a maximum of 25 cents based on whether parking occupancy for each parking zone falls within occupancy targets of 60-80%. The trial of SFPark found that the scheme resulted a reduction in average parking fees, increase in parking availability and ease in finding parking, and reductions in greenhouse gas emissions and vehicle miles traveled.

Priority Parking Programs

Priority parking programs increase access to curbside parking for designated users by reducing access for other groups. These programs are used around university campuses or in residential neighborhoods. This technique provides parking permits to residents or other designated users and enable unlimited parking in what would otherwise be restricted parking zones. For example, Florida State University has a priority parking program in place around campus for students and staff (***Figure 141***).

Figure 141 | Example: FSU Priority Parking Permit

Wayfinding Signage

Along curbsides with limited or high-demand private vehicle parking, wayfinding signage can be provided to direct drivers to other nearby locations with on- or off-street parking. This can reduce the occurrence of double or illegal parking, reduce cruise time for vehicles trying to find parking, and improve the overall efficiency of the curb and the corridor.

9.3.2 Loading Zones

Freight deliveries are an essential curbside use and are necessary for commercial businesses and functional town centers. The growth in e-commerce and food delivery providers such as Uber Eats and DoorDash, has increased the demand for loading zones and short stay parking in both commercial and residential neighborhoods. Loading zone strategies and best practices are discussed below.

Pick-up / Delivery Zone Location

Freight loading zones should be provided along commercial corridors or within downtown areas where parking is scarce and high volumes of deliveries occur. In higher density residential areas, the rise in demand for residential deliveries can also justify dedicated loading zones where short-term parking is not readily available.

Where feasible, loading zones should be consolidated at midblock locations to minimize conflicts with bicyclists and motorists near intersections. Midblock loading zones also prevent large vehicles from obscuring corner and pedestrian visibility.

Freight Zone Pricing

Charging fees to access freight loading zones can reduce the delivery vehicle dwell time at the curb and ensure that these spaces are more frequently available when needed. Loading zone fees can be static or demand responsive and can be used to help promote off-peak deliveries.

Following trials of freight zone pricing in Washington, D.C., results showed that delivery companies were willing to pay for the benefits offered by the pricing scheme including improved reliability, time savings, and reductions in parking violations.

Digital Freight Zone Management

Digital curbside management systems can be used to better allocate and manage deliveries and the use of loading zones. These systems allow delivery drivers to reserve and prebook loading zones to ensure that they are available on arrival to the destination. Successful trials have occurred in Washington, D.C., Columbus, and Omaha. The system requires that all drivers be registered with the curbside management application and can incorporate freight zone pricing. Results from the CurbFlow trial in Washington, D.C., showed a reduction in double parking by 64% during the trial of the system.

Promote Off-Peak Deliveries

Shifting demand for loading zones away from peak periods can improve traffic flow and safety performance on the transportation network. Cities may encourage use of off-peak hours for deliveries by limiting use of loading zones between set hours (as shown in ***Figure 142***) or by charging higher fees to use loading zones during peak times. It is noted that shifting delivery hours tends to be more feasible for large and chain businesses.

Successful promotion of off-peak delivery times requires local governments to work with businesses and commercial delivery services. Reduced delivery waiting times, reduced traffic congestion, and reductions in

Figure 142 | Example: Timed loading zones

Source: Curb Management Regional Planning Guide parking violations can also benefit delivery drivers who are able to conduct deliveries outside of regular hours.

Moving Loading Zone Locations

Another strategy is to relocate loading zones from main corridors to side or secondary streets. Rather than trying to serve all curbside uses along a single road frontage, relocating loading zones enables curbside uses with higher efficiency or priority (such as transit) to be located along main roads, while pick-up / deliveries are still able to occur in a nearby location.

9.3.3 Transportation Network Companies and Taxi's

The introduction of transportation network companies (TNCs) such as Uber and Lyft to the market has transformed the point-to-point transportation industry with rapid increases in ridership. If available curbside space insufficient, TNC drivers may drop off or pick up passengers from dangerous locations including from within the traffic lane or intersections. The following strategies can be considered to manage TNCs along the curb.

Pick-up Drop-off Zones (PUDO)

In areas with high demand for TNC services, passenger pick-up and drop-off (PUDO) spaces can be provided. These parking spaces typically have short time limits with 5–10-minute maximums. They can be permanent spaces or limited to time of day or day of week restrictions. PUDO parking spaces can be used by a range of users including TNCs, taxis, meal delivery drivers, and personal pick-up/drop-offs. PUDO parking in busy areas should be provided in coordination with TNCs.

PUDO zones are most suited to being located within or near public transit hubs, downtown and nightlife areas, or other dense urban areas. When allocating space for PUDO zones, considerations need to be given to the passenger demand and the physical size of the zone. Sufficient clearance space must be provided to allow vehicles to enter and depart the curb in a forward direction and not result in a hold up in traffic. If demand for PUDO zones exceeds supply, then drivers will revert to picking up and dropping off passengers in dangerous locations. PUDO spaces have been successfully trialed and installed within many cities around the country including San Francisco, Fort Lauderdale (***Figure 143***), and Washington, D.C.

Figure 143 | Example of a PUDO Space

Source: Fort Lauderdale, FL - Google Maps, 2023

PUDO Geofencing

Geofencing is the use of GPS technologies to set a virtual geographic boundary that can enable or limit the use of technologies. PUDO parking can include geofencing systems that restrict pick-ups from occurring at undesignated locations, and direct local riders and drivers to use the assigned spaces. Geofencing can improve the use of PUDO zones and reduce congestion by decreasing the distance travelled and time spent looking for a parking space.

9.3.4 Public Transit

Curbside management strategies often prioritize transit due to its ability to move large volumes of people in comparison with other transportation modes. There are several options for increasing the mobility of transit vehicles through dedicating curbside space. Several techniques are discussed below.

Transit Only Lanes

The lane adjacent to the curb can be dedicated for transit vehicles to operate as a transit only lane (an example is provided in ***Figure 144***). Transit only lanes are generally located along busy corridors or in busy downtown areas with a high demand for transit. Transit only lanes may operate as permanent lanes or can operate during peak periods based on time and day of the week. Transit only lanes improve operation of transit services by removing interference from other vehicles and curbside uses. This can result in faster and more reliable transit service.

Figure 144* | *Example of Transit Lanes

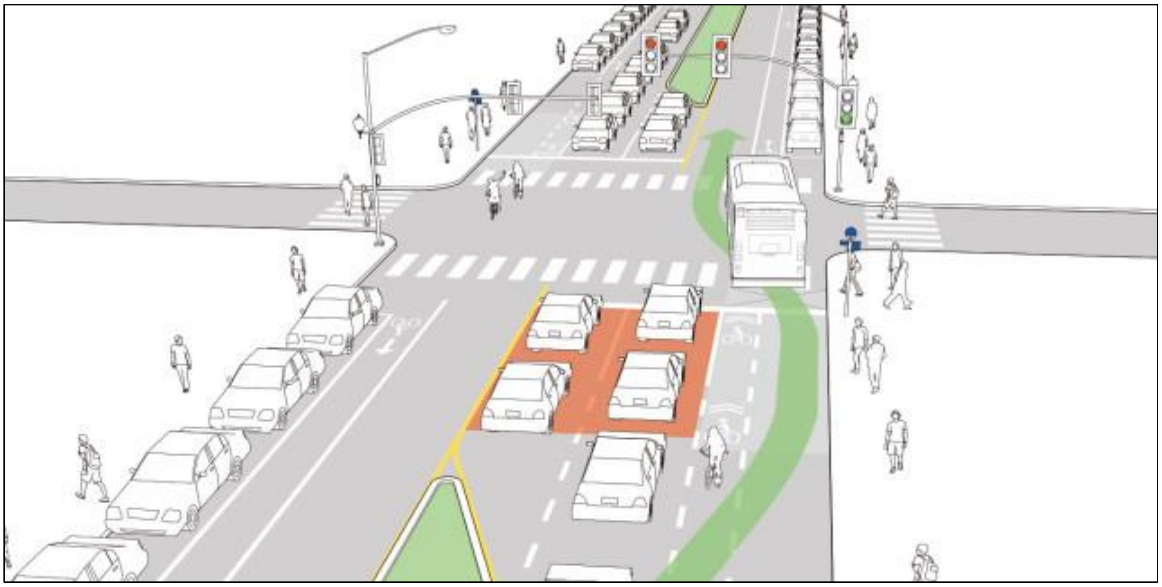
Source: *Global Street Design Guide*

Intersection Prioritization

Intersection prioritization for transit may occur in one of two ways with either bus queue jumps or right-turn pockets. Where curbside space is constrained and a transit lane can only be provided along part of the curbside, bus queue jump lanes allow buses to bypass traffic queues during red traffic signals. Queue jumps are often installed in right turn lanes and used in conjunction with leading bus interval or transit signal priority at traffic lights (see ***Figure 145***).

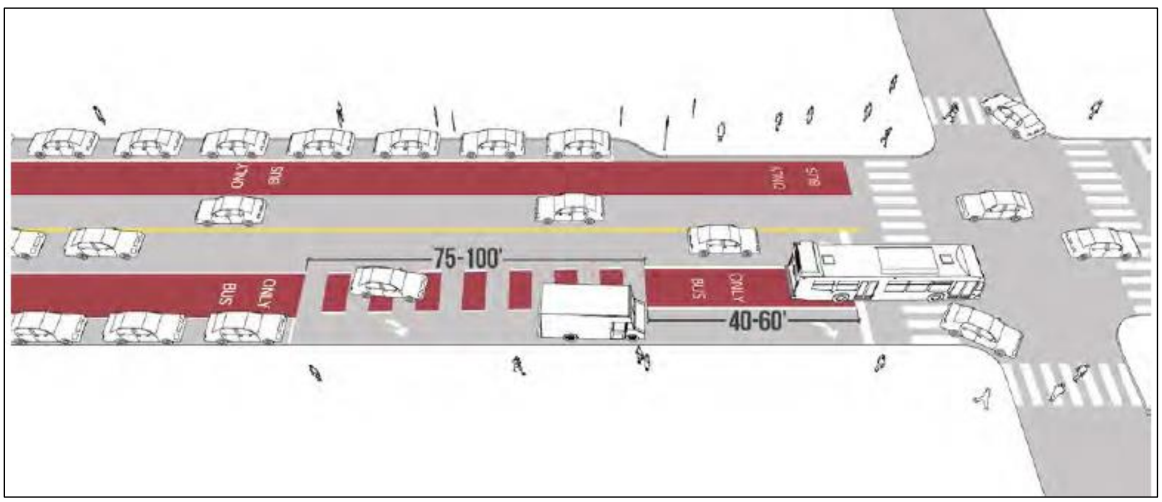
Right-turn pockets aim to reduce transit delays caused by right turning vehicles at intersections. In this technique, right turning vehicles cross the transit lane and turn right from the curbside space (see ***Figure 146***).

Figure 145 | Example of Bus Queue Jump Lanes



Source: *NACTO Transit Street Design Guide*

Figure 146 | Example: Right-Turn Pocket



Source: *NACTO Transit Street Design Guide*

Bus Bulbs

Bus bulbs are a type of curb extension, located within the curb space, allowing buses to stop without leaving the travel lane (***Figure 147*** & ***Figure 148***). This saves time and eliminates the need to merge back into traffic. The pedestrian boarding and waiting area separates waiting transit riders from the sidewalk and can allow space for raised platforms for level boarding on buses to improve mobility and reduce dwell time at stops. Bus bulbs can be integrated with bike lanes to divert bicycles between the bus stop and sidewalk rather than between the travel lane and bus stop.

Figure 147 | Graphic of a Bus Bulb

Source: NACTO Urban Streets Design Guide

Figure 148 | Example of a Bus Bulb in New York

Source: New York DOT

9.3.5 Pedestrians

Greater focus on pedestrians as a transportation mode in curbside management can increase activation of the street front and improve pedestrian safety performance. The following strategies can be considered to accommodate pedestrians along the curbside. ADA requirements should be considered when implementing curbside management strategies.

Curb Extensions

Curb extensions extend the sidewalk into the curbside lane at intersections and pedestrian crossings to reduce the pedestrian crossing distance. Curb extensions provide safety benefits for pedestrians by making them more visible to drivers, slowing turning vehicle traffic, and by reducing the crossing and exposure distance for pedestrians. Curb extensions also provide opportunities for additional landscaping, transit waiting areas, and micromobility storage.

Wider Sidewalks

Widening sidewalks increases the pedestrian accessible area on the curbside and allows for increased foot traffic. Wider sidewalks can increase activation and encourage additional pedestrian activity which benefits businesses along the road corridor. Benefits also include improved pedestrian safety performance through reductions in exposure of pedestrians to vehicle traffic.

Sidewalk Setbacks

A sidewalk setback increases the distance between the sidewalk and the roadway by adding additional space between the curb and the sidewalk. This additional space provides separation between motorized users along the road and non-motorized users utilizing the sidewalk (see ***Figure 149***).

Figure 149 | Example of Sidewalk Setbacks

Source: Global Street Design Guide

9.3.6 Bicyclists

Current trends have recognized the benefits that bicycling offers to the community and transportation network. This has resulted in an increase in demand for bicycle infrastructure and priority. Curbside management techniques and strategies for bicyclists are discussed below.

Separated Bicycle Lanes

Separated bicycle lanes are street- or sidewalk-level lanes dedicated to bicyclists. The lanes are physically separated from vehicle traffic by elevation or physical barriers such as a curb, flex posts, or on-street parking. If located adjacent to parallel vehicle parking, adequate separation is necessary to allow for opening of car doors. Separated bike lanes increase comfort for bicyclists, can reduce congestion by removing vehicle trips on roadways, and reduce the space taken by bicyclists on sidewalks thus improving pedestrian comfort and reduce conflicts with bicyclists.

Bicycle Storage

Rise in use of bicycles as a transportation mode has increased demand for bicycle parking, particularly in commercial areas. If unmanaged, lack of bicycle parking can result in bicycles being left on the sidewalk obstructing mobility of pedestrians, or in other undesired locations. Lack of bicycle parking can also act as a barrier to people using bicycle as a transportation mode. Bicycle parking may be provided in the form of sidewalk bicycle racks or on-street bicycle corrals.

9.3.7 Micromobility

Micromobility includes the use of bikeshare, e-bikeshare, and electronic scooters for transportation. Use of micromobility as a transportation mode is increasing and warrants consideration in all aspects of transportation planning, including curbside management. Micromobility services rely upon having shared bikes and scooters available on-demand from a variety of curbside locations. If unmanaged, bikes and scooters can impact negatively sidewalk mobility and introduce additional conflicts.

Figure 150 | Example of a Micromobility Parking Area

Source: Shared Micromobility Playbook

Use and Parking

Space for micromobility travel is ideally provided adjacent to or within the curbside to reduce interactions with pedestrians. Parking for micromobility typically requires only small amounts of space and can be integrated within other curbside uses including parklets, landscaping, and bicycle parking. Options also include conversion of curbside vehicle parking into micromobility zones (see ***Figure 150***).

9.3.8 Parklets

Parklets are opportunities to extend pedestrian space beyond the curb line by converting curbside space into shared community space. Parklets improve neighborhood amenities and promote activation of the street front. Parklet design can vary with some including public art and landscaping while others provide gathering areas and seating. Parklets can provide opportunities for businesses such as cafes, food trucks, and restaurants to expand and create spaces for outdoor dining without impacting the mobility of the sidewalk (see ***Figure 151***). It is noted that parklets need to be considered on a case-by-case basis and may not be desirable in all locations due to safety risks due to their proximity to vehicle travel lanes. Proposed parklet locations on the state highway network require approval by the relevant FDOT District. Clear zone requirements need to be addressed when proposing installation of parklets.

Figure 151 | Gran Forno Parklet

Source: Fort Lauderdale, FL - Google Maps, 2023

9.3.9 General Strategies

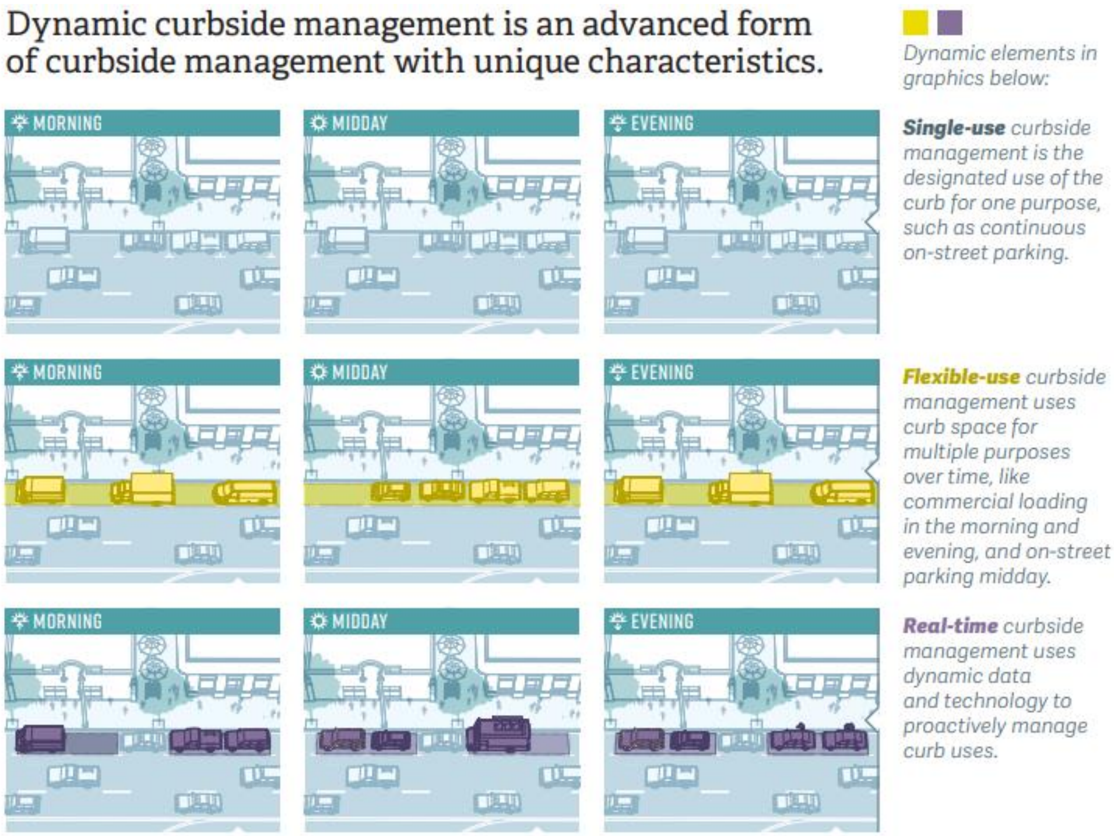
This section provides a brief overview of general curbside management techniques that can be used to manage curb use for a multiple users.

Dynamic Curbside Management or 'Flex Zones'

Rather than seeking to allocate different road segments for various curbside users, dynamic curbside management creates what are known as 'Flex Zones.' Flex zones are flexible areas that can accommodate different curbside users along the same part of the curb space. Flex zones may operate with different functions being served in the same space simultaneously, with time restrictions fluctuating between curb users over the course of the day, or with a variety of users being served simultaneously with different spaces along the road corridor (see ***Figure 152***).

Dynamic curbside management has advantages over traditional approaches as it acknowledges that the best curbside use for any section of road may change based on time of day or day of the week. This allows the use of the curbside to respond to these demand changes and ensure that the curb space is being used effectively. Dynamic curbside management also offers potential to utilize data and innovative technology to better allocate curbside space.

Figure 152 | Flexible Curbside Management

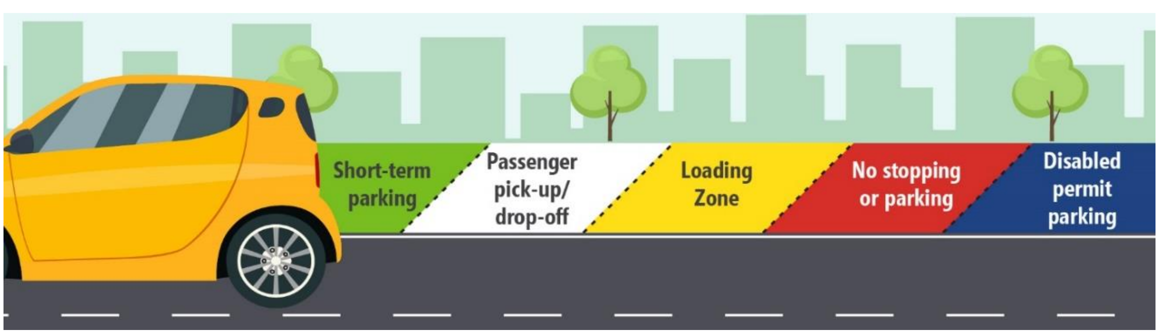


Source: NCHRP 20-102(26)

Color Curb Program

Applying a standard treatment citywide or countywide can improve compliance with curbside policies and improve the effectiveness of curbside management plans. Californian cities such as San Francisco use standardized paint color strips along curbs to denote the relevant curbside use for that space. Under the San Francisco scheme, yellow is used to represent freight loading zones, blue is used for disabled parking spaces, red for no parking zones, green for short-term parking, and white for passenger pick-up/drop-off zones.

Figure 153 | California Color Curb Program



Source: Graphic created by HDR

Digital Signage

Digital signage is an emerging technology which can simplify complex parking restrictions for drivers to improve compliance as well as the effectiveness of curb management strategies. Signage such as the example in ***Figure 154*** can be used to display the current parking restrictions and transition between various restrictions which may vary by time of day or day of the week. These signs are also able to display temporary special event parking restrictions.

Figure 154 | Example of Digital Parking Signage

Source: Transport for NSW

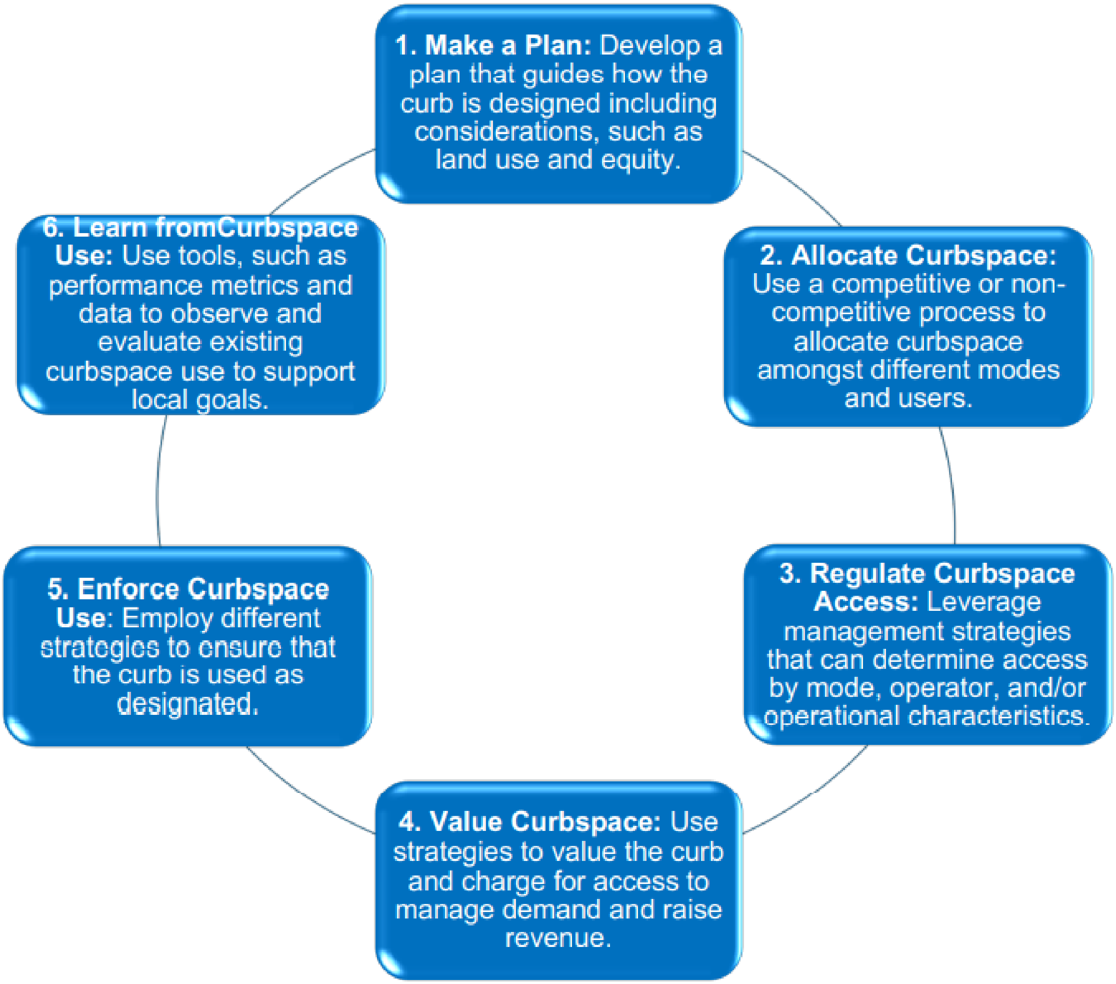
9.4 Implementation Strategies

This section identifies and discusses key elements of effective implementation of curbside management. Local governments and authorities should consider these elements when preparing curbside management plans and policies.

9.4.1 Framework

Use of a framework can assist local governments and authorities in developing best practice curbside management plans and policies. The MARVEL framework was developed by the Mineta Transportation Institute to guide local governments and transportation agencies through the process of creating and implementing curbside management plans and policies. The framework involves six steps: planning, allocating, regulating, valuing, enforcing, and evaluating curb space use (see ***Figure 155***).

Figure 155 | MARVEL Framework



Source: *Managing the Curb: Understanding the Impacts of On-Demand Mobility on Public Transit, Micromobility, and Pedestrians*

9.4.2 Coordination

A wide range of stakeholders have interests in curbside management ranging from various road user groups to residents and local businesses (***Figure 156***). Effective community engagement with these multiple stakeholders is crucial to the success of any curb management plan or policy.

Community consultation and stakeholder engagement should occur throughout the process of developing curbside management plans. Early community input in the planning process helps increase community buy-in and develops community support for the project. Engagement also provides opportunities to highlight the benefits and tradeoffs involved in curbside management and can reduce future opposition to projects. Projects without community buy-in often face greater resistance and can have challenges in achieving successful outcomes.

Coordination between internal government departments can also improve the outcomes for curbside management. Having a coordinated approach and developing inter-agency working groups enables the sharing of data and information as well as a consistent approach to managing the curbside. Creating the role of a 'curbside manager' to oversee stakeholder engagement and intra agency coordination can assist in managing the implementation of curbside management policies.

Figure 156 | Stakeholders in Curbside Management

Businesses	Comercial Delivery Drivers	Community Groups	County/City Government Departments	Bicyclists
Emergency Services	Enforcement Agencies	Florida Department of Transportation	Landowners & Residents	Major Institutions (e.g. Universities, Schools)
Micromobility Operators (e.g. Bike Share)	Motorists	Pedestrians	Transit Operators	Transportation Network Companies & Taxi's

9.4.3 Trials and Enforcement

Strategies to improve the success of curbside management plans include operating trials of proposed curbside treatments and ensuring targeted enforcement of the implemented curbside rules. Living previews and pilot projects are two ways of testing curbside management techniques, these two methods are summarized below as along with a brief discussion on targeted enforcement of curbside rules.

Living Previews

Living previews are temporary, short-term trials of curbside management techniques and treatments. Living previews allow stakeholders and the community to experience and test treatments to provide real time feedback. Staff are often present on site to interact with members of the public and conduct surveys. Living previews are a valuable tool to introduce new concepts to the community and allow members of the public to become familiar with and utilize new project types. Curbside treatments such as protected bicycle facilities, curb extensions, and parklets are ideal for living previews.

Pilot Projects

Pilot projects differ from living previews through acting as a longer-term trial of curbside management techniques and treatments. Pilot projects often involve more robust construction which can be maintained or easily converted into permanent fixtures. Pilot projects allow local governments to test curbside management techniques prior to wider roll outs of a curbside management policy or plan and allows for the collection of data to analyze the impacts of the proposed technique. Pilot projects can assist in winning political and community support for curbside management treatments and allow any issues to be addressed and resolved before the changes are made permanent.

Targeted enforcement

Curbside management plans can only achieve the targeted outcomes if curbside and road users follow the rules and policies in place. Illegally parked vehicles blocking bicycle or transit lanes can severely impact the mobility for those road users and introduce additional conflicts. Active enforcement of curbside rules is required to ensure that the desired benefits from curbside treatments can be achieved. Enforcement should be a priority as part of any curbside management implementation plan, particularly regarding the use of commercial loading zones.

Automated enforcement can be used in circumstances where manual enforcement is not possible such as for private vehicles using transit lanes, queue jumps, and bus stops. Automated enforcement typically relies upon the use of pole mounted cameras which record license plates of vehicles using transit facilities and citations are posted to the registered drivers. Automated enforcement technologies are improving and could also be utilized to monitor other curbside uses including illegal parking and time-limited restrictions in real-time.

9.4.4 Performance Measurement and Data Collection

Once implemented, curbside management strategies should be monitored for both efficiency and effectiveness compared with the project goals. Performance measurement and data collection are two essential components of monitoring the effectiveness of curbside management techniques. These two components are discussed and summarized below. Performance measurement and data collection should both be considered and planned for prior to the implementation of curbside management practices. Often performance measurement and data collection are seen as optional or not carried out. This undermines the goals and objectives of the plans put in place and can hamper future curbside management projects.

Performance Measurement

Performance measurement is important to ensure that the curbside management plan is operating as desired, and the anticipated benefits are being realized. Performance measurement can identify problems which need to be addressed or where changes are needed to the new curbside treatments following implementation. Performance measurement can also be used to demonstrate the benefits of the curbside management plan and assist in explaining the benefits for future projects.

Considerations should be given in choosing performance measures that are directly related to the goals and objectives of the curbside management plan. Selection of performance measures should also consider the requirements for data collection and analysis for each chosen performance measure. ***Figure 157*** identifies numerous performance measures that could be used for curbside management projects.

Figure 157 | Curb Side Performance Measures

Impact Category	Description	Metrics
Bikeability	Analysis of supportive biking infrastructure and potential safety risks	Number of bike parking stations Number of bicyclists on a block per hour
Curb Productivity	Measurement of how productive a segment of the curb is based on its designated use (e.g., loading zone)	Number of passengers loading on a bus at a public transit stop Number of deliveries made
Economic Vitality	Analysis of changes in economic activity in the area	Number of commercial vacancies Number of users
Equity	Identification of accessibility and equity barriers by different demographic groups	Number of accessible vehicles or devices available Number of available payment options (e.g., cash, credit card) for various modes Number of languages on signage
Parking Demand	Evaluation of the current and desired parking amount	Number of available parking spaces per day Parking requests
Parking Efficiency	Measurement of how efficiently parking in an area is used	Duration of time vehicles are parked Number of vehicles double parked
Passenger Loading Activity	Quantitative measurement of the number and type of passenger loading activities taking place at the curb	Number of passengers loading Number of passengers unloading Number of passenger vehicles per loading zone
Passenger Loading Demand	Evaluation of the number of vehicles that need curb access and the length of time the curb is needed	Curb length Number of vehicles trying to access the curb
Passenger Loading Impact	Description of how passenger loading activity impacts travel conditions or other modes	Number of cars forced to go around by a vehicle loading or unloading Number of minutes traffic flow was delayed
Public Transit Reliability	Evaluation of the impact of curb changes on public transit service	Average travel speeds Ridership rates Public transit schedule adherence
Safety	Evaluation of how design changes have impacted safety	Number of accidents reported over time Number of police citations for traffic violations

Source: [Managing the Curb: Understanding the Impacts of On-Demand Mobility on Public Transit, Micromobility, and Pedestrians]

Data Collection

Data collection should be undertaken both before and after implementation of curbside management plans and policies as well as during any pilot or trial periods. This enables data comparison to understand the impact of the new curbside treatments. Data collected prior to curbside management is also useful in analyzing existing use of the curb and can be used to help prioritize curbside space.

Most jurisdictions do not have detailed data on existing curb inventories or curbside uses, and without this data it can be difficult for public officials to make the case that changes are needed at the curbside. Creating a curbside inventory is often the first step towards developing a curbside management plan. Data collection can take the form of physical observations, video data and machine learning, radar sensing, or can be sourced from third party providers such as transportation network companies, freight carriers, or specialized data providers.

Chapter 10: Corridor Access Management Plans

10.1 Introduction

A Corridor Access Management Plan (CAMP) is defined in F.A.C. 14-97 as a *strategy defining site specific access management and traffic control features for a particular roadway segment, developed in coordination with the affected local government and adopted by the Department in cooperation with the affected local government(s)*. A CAMP typically evaluates existing and proposed future conditions for a corridor with respect to roadway geometry and access characteristics, safety, and traffic operations to develop a specific plan for future access management infrastructure improvements. It will address key access management elements such as placement of median openings, turn lanes, traffic control, and other important provisions such as service roads and supporting street networks, joint driveways and cross access connections, and multimodal facilities and connections.

These plans are often developed in response to local government requests to address forthcoming roadway improvements, new development(s), traffic operations and/or traffic safety concerns or issues, aesthetics, and the economic vitality and competitiveness of a corridor. While such plans can include parcel level detailed plans and binding agreements, they are more typically conceptual level plans that help guide future decisions related to new development or redevelopment reviews and access permitting, and roadway improvements including access points and circulation, traffic control, and roadway cross-sectional elements. A CAMP may be prepared as a stand-alone study, but more often, it is a key element of a larger corridor study.

This chapter provides a general framework for conducting a CAMP on the State Highway System (SHS), including the typical process and elements of a study.

10.1.1 CAMP Goals and Objectives

A CAMP should establish a set of overarching goals. Common goals related to CAMPs may address operations, safety, design, and sustainability, such as the following:

- Promote and improve mobility and safety performance along the corridor.
- Enhance multimodal access and safety performance for all users.
- Allow development of properties along the corridor by providing circulation and connectivity which follows adopted access management policies and standards.
- Ensure any side street access or driveway access will be carefully located and integrated into the conceptual design and/or implementation.
- Reduce traffic congestion.
- Support economic development goals.
- Preserve or enhance the efficient movement of people and goods.
- Optimize the operational performance and reliability of the corridor.
- Plan for and control future growth.
- Support corridor land uses and desired urban form.
- Align transportation and land use contexts, policies, and function.
- Enhance the aesthetics of the corridor.
- Improve community quality of life.

Typical objectives of a CAMP, as noted in the *Transportation Research Board (TRB) Access Management Manual, Second Edition, 2014* (Exhibit 10-3), include the following:

- Promote improved regional coordination of land use and transportation planning and linkages across the various agencies and institutions that have a role in advancing corridor management objectives.
- Improve or maintain the safety and operational efficiency of the primary roadway through access management.
- Expand mode choice through new or improved bicycle, pedestrian, and transit facilities and services.
- Improve operations through intelligent transportation systems, signal coordination plans, and other operational strategies.
- Encourage the establishment of an effective land use or growth management plan for the corridor.
- Prevent or minimize development within the pathway of planned transportation facilities.
- Promote development of supporting street, sidewalk, and site circulation systems where land development is desired.
- Improve intermodal connections.
- Promote economic development and revitalize older developed areas:
    - Create livable, mixed-use activity centers and connect these to high-quality transit service.
    - Provide multimodal access to corridor destinations.
    - Address site-by-site development impacts along the corridor through transportation impact assessment and developer mitigation.

10.1.2 CAMP Benefits

There are many benefits to completing a CAMP, including the following provided in *the* TRB Access *Management Manual, Second Edition, 2014 (Exhibit 10-1)*:

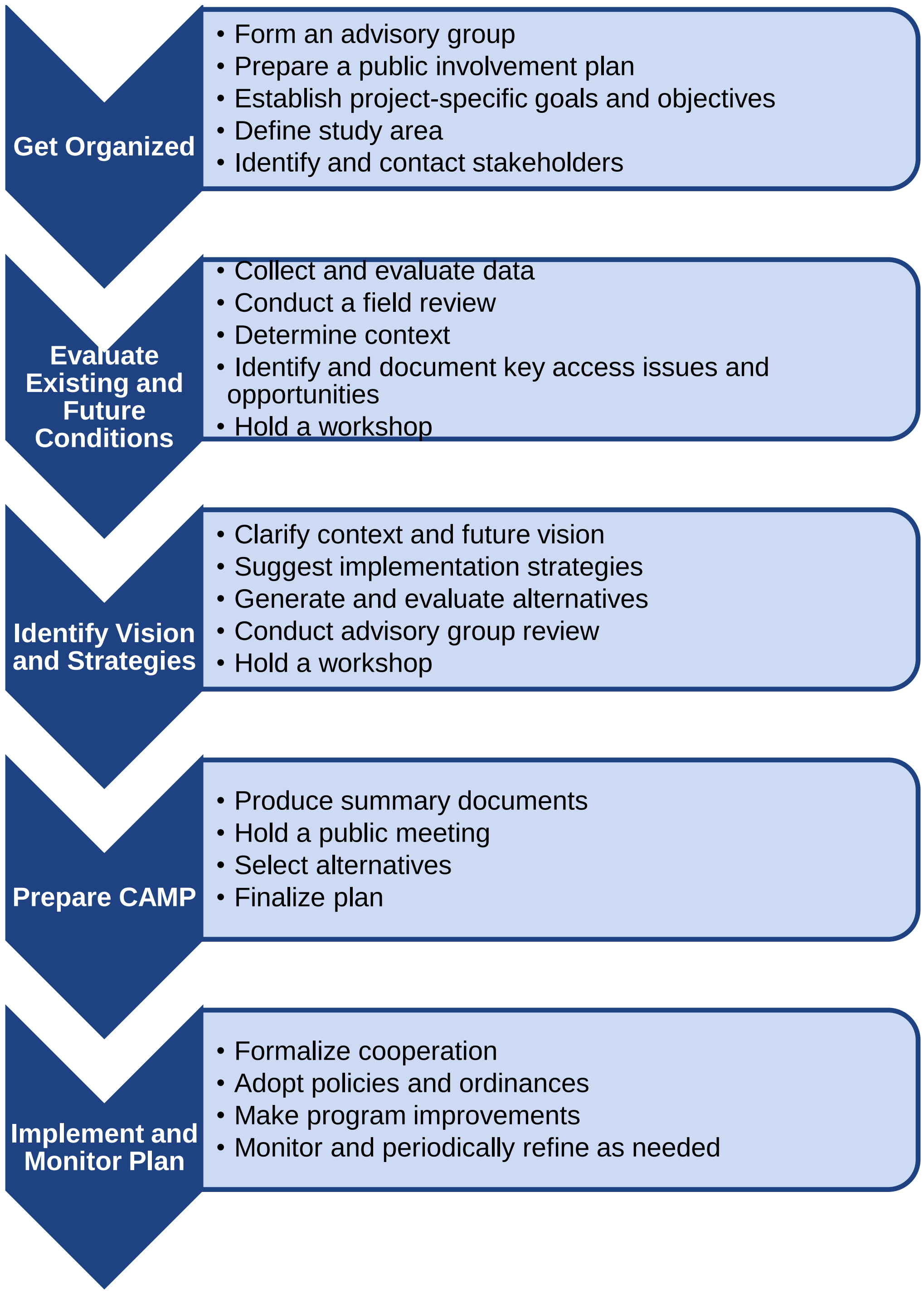
- To identify and address transportation deficiencies before they turn into critical problems that can affect quality of life and limit economic development.
- To allow for development of coordinated transportation and land use solutions along a corridor – a far more effective approach than individual piecemeal initiatives that may act at cross-purposes.
- To bring together diverse stakeholders (local, regional, and state agencies, property owners, and others) and reach agreement on mutually beneficial strategies as well as ongoing mechanisms for cooperatively pursuing these strategies.
- To save money by implementing non-capital-intensive strategies (such as operational improvements, access management, or land use policies) as an alternative to expensive transportation capital investments.
- To develop creative strategies for supporting sustainable economic development in corridor communities.
- To ensure that transportation needs are addressed in a manner that preserves and enhances the natural environment and the unique character of its communities.

10.2 Corridor Access Management Plan Process

10.2.1 Study Process and Framework

Figure 158 provides the typical steps in a five-phase planning process for completing a CAMP.

Figure 158 | Typical Corridor Access Management Plan Process



Source: TRB Access Management Manual, Second Edition, 2014 (Exhibit 10-2)

See ***Section 10.3: Corridor Access Management Plan Elements****, for more information about specific elements of a CAMP across the five recommended phases.*

10.2.2 Agency Participation

FDOT may lead the development of a CAMP, or one may be developed by any local municipality or metropolitan planning organization (MPO) in conjunction with FDOT. With FDOT responsible for establishing and implementing access along the SHS, and local governments responsible for regulating and approving land development, it is critical to have state and local coordination to achieve effective and comprehensive corridor access management solutions that integrate both transportation and land use, regardless of which agency leads the development of the CAMP.

When FDOT is not leading the development of a CAMP, it is particularly important to establish the right FDOT contact for coordination purposes. In most cases, this would be the District Access Management Coordinator. Although not typically required during the development of a CAMP, it may also be desirable to have participation in the process by the District's Access Management Review Committee (AMRC).

The *Guide for Analysis of Corridor Management Policies and Practices* (Center for Urban Transportation Research, May 2007) notes that intergovernmental coordination, including roles and responsibilities and levels of commitment to implementing the plan, can best be accomplished through official adoption of the plan and an intergovernmental agreement that specifies each agency's roles and responsibilities in carrying out the plan. The *TRB Access Management Manual, Second Edition, 2014* states that it is best if the cooperation of each local government that will be involved in developing and implementing the plan are secured at the onset of the study. A Memorandum of Understanding (MOU) or resolution are common types of agreements used for this purpose, although it's important to note that neither are legally binding.

10.2.3 Public and Stakeholder Involvement

Per *Rule Chapter: 14-96.003 F.A.C.*, it states that:

> *Corridor Access Management Plans may be adopted by the Department in coordination with local governmental entities. These plans shall be based on an analysis by the Department using generally accepted professional practice standards and will provide corridor specific access management and traffic control features. Before the adoption of such plans, the Department shall notify affected local governments and abutting property owners and shall hold a public meeting, if requested. After consideration of public input, the Department shall, in cooperation with the affected local government, finalize the plan.*

Therefore, the only requirement for public involvement regarding a CAMP is to hold a public meeting, if requested, prior to the adoption of the plan. However, *FDOT's policy on Community Engagement, Topic No. 000-525-050-j* states:

> *"It is the policy of the Department to use every possible opportunity to engage with and involve the public that thereby leads to community-based decisions when planning, designing, constructing, and maintaining transportation facilities and services to meet the State's transportation needs. The participation of the*

public and community is an integral part of the transportation process and results in:

- *Early and continuous opportunities for public input*
- *Consideration of public needs and preferences*
- *Informed decisions through collaborative efforts*
- *Mutual understanding and trust between the Department and its partners*

The Department will promote community involvement, engagement opportunities and information exchange activities in all functional areas using various techniques adapted to the audience, local area conditions, and project requirements."

Based on FDOT policy, it is recommended to engage with the public and key stakeholders over the course of the CAMP study. As shown in ***Figure 158***, the typical CAMP process recommends including a minimum of two workshops during the early phases of the CAMP, so that issues, concerns, and opportunities can be voiced by stakeholders and considered during the preparation and evaluation of alternatives. These early workshops provide an opportunity to directly involve stakeholders in decision-making throughout the study process, resolve potential concerns, minimize public conflict, and build trust with the participating public agencies. If the right stakeholders are effectively engaged and heard throughout the study process, the final public meeting prior to plan adoption should provide confirmation that the proposed plan provides balanced and appropriate solutions within any overall project constraints and is supportable by many or most of the key stakeholders.

Key stakeholders may include, but are not limited to, local government and regional planning agencies, the Metropolitan Planning Organization (MPO), transit agency/provider, developers, community leaders, business and property owners, representatives of the business community, and residential developments or homeowners' associations, schools, environmental and resource management agencies, and interest or advocacy groups. Representatives from various agencies and groups can be invited to join a project advisory group, which may help to provide key insights and feedback as the project moves through its early phases. The first two workshops shown in ***Figure 158*** at the end of the Evaluate Existing and Future Conditions and Identify Vision and Strategies phases can be held with the project advisory group.

While a CAMP is typically just a plan and does not involve detailed design, if the CAMP is done in conjunction with the design phase, the requirements of *F.S. 335.199* should be followed, as discussed previously in ***Section 9.2.1*** **Context Classification and Transportation Characteristics.** To assist with understanding the public involvement and decision-making process for FDOT projects on the SHS, the *FDOT Public Involvement Handbook* should be referenced throughout the project process.

10.2.4 Plan Implementation

Once the plan has been finalized following the public meeting, the first step in implementation of a CAMP is for FDOT to adopt the plan and notify each of the affected local governments of its adoption. Effective Strategies for Comprehensive Corridor Management (Center for Urban Transportation Research, 2004) notes that "upon adoption, the plan would serve as the official set of access management standards for that section of the state highway system and would guide

District connection permitting decisions accordingly. In practice, this process is highly interactive with the FDOT, local governments and affected property owners participating.” Following adoption of the plan by FDOT, local governments and the MPO may want to incorporate or reference the plan in their relevant documents, such as the Comprehensive Plan. Implementation is then typically achieved by combining regulations and policy, interagency or public/private agreements, design standards, and road improvement projects.

Effective Strategies for Comprehensive Corridor Management (Center for Urban Transportation Research, 2004) provides numerous examples and case studies related to how local and state governments have implemented CAMPs. Examples cited in this report include the following:

- Hernando County, Florida established a “frontage road” ordinance that requires each developer of property adjacent to specified arterial highways to provide for the funding and construction of frontage roads upon demonstration of need and demand by the County.
- A smaller community in Kansas (Hays, Kansas) partnered with the Kansas Department of Transportation (KDOT) to increase the ability to create service roads along a state highway. A Corridor Master Plan developed by the city and KDOT called for the creation of alternative access for existing and future development, installation of parallel facilities and reverse access roads.
- The City of Fort Collins, Colorado promotes a supporting street network on arterials through street spacing and connectivity requirements in its land development code.
- Levy County, Florida established a requirement for its primary arterial (US 19) by tying minimum lot frontage to the FDOT access spacing requirement of 660 feet.
- The City of Tallahassee, Florida established a regulation prohibiting the creation of new lots that fail to meet adopted access spacing criteria.
- Citrus County, Florida has a requirement that properties under common ownership be treated as one property for the purpose of access review. They limit access to one per ownership unless the properties meet spacing requirements.

Potential funding opportunities include:

- Incorporation of access changes as part of larger corridor improvements such as resurfacing or widening.
- Require developers to construct off-system improvements such as frontage/backage roads or off-system connections to existing roadway network.
- If the CAMP study was completed for a SIS roadway and parallel facilities are recommended, there is now the option to apply for SIS funds to be considered for use as part of the Off-SIS Program. The intent of the program is to support projects that are projected to relieve congestion on adjacent/nearby SIS highways through traffic diversion. Specific eligibility requirements must be met, but any transportation agency within the jurisdiction of the candidate Off-SIS project may apply for funding.
- Local option gas tax
- Local government infrastructure surtax
- Ninth cent gas tax
- Transportation impact fees or mobility fees
- Developer contributions, including ROW donations

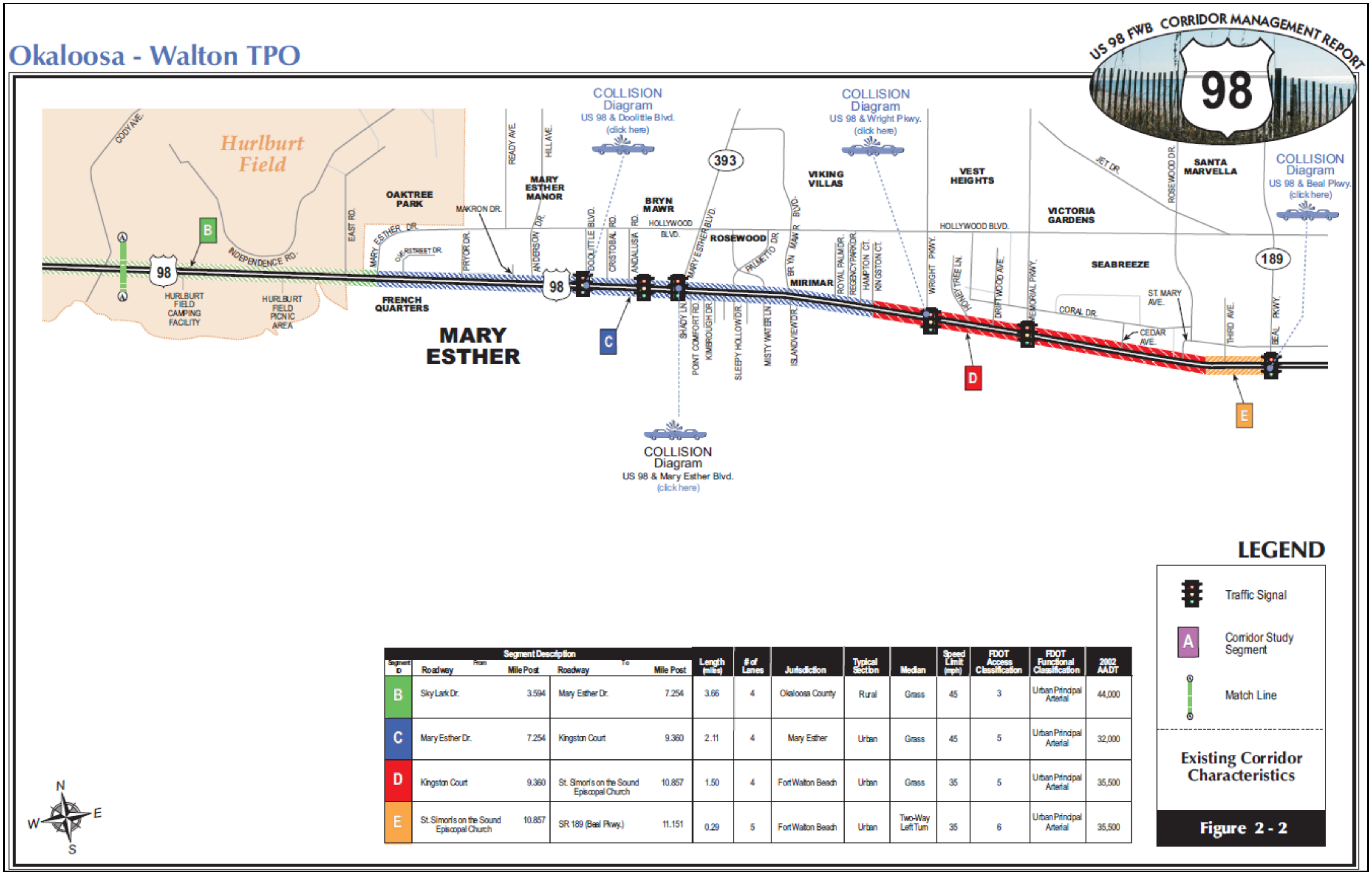
10.3 Corridor Access Management Plan Elements

This section provides more details on key elements that should be included as part of a CAMP.

10.3.1 Corridor Definition

Overall study area limits should be established during the Get Organized phase on specific transportation and access needs or concerns, as well as elements such as typical sections, traffic volumes, context and/or access classification, land use and development patterns, environmental characteristics, and social considerations. The width of the study area may be influenced by existing or potential parallel facilities and adjacent areas that may affect overall corridor circulation. The same elements can be considered to divide the corridor into discreet segments with shared characteristics. ***Figure 159*** shows an example of CAMP corridor segmentation.

Figure 159 | Corridor Segmentation Example



Segment ID	Segment Description: From Roadway	From Mile Post	To Roadway	To Mile Post	Length (miles)	# of Lanes	Jurisdiction	Typical Section	Median	Speed Limit (mph)	FDOT Access Classification	FDOT Functional Classification	2002 AADT
B	Sky Lark Dr.	3.594	Mary Esther Dr.	7.254	3.66	4	Okaloosa County	Rural	Grass	45	3	Urban Principal Arterial	44,000
C	Mary Esther Dr.	7.254	Kingston Court	9.360	2.11	4	Mary Esther	Urban	Grass	45	5	Urban Principal Arterial	32,000
D	Kingston Court	9.360	St. Simon's on the Sound Episcopal Church	10.857	1.50	4	Fort Walton Beach	Urban	Grass	35	5	Urban Principal Arterial	35,500
E	St. Simon's on the Sound Episcopal Church	10.857	SR 189 (Beal Pkwy.)	11.151	0.29	5	Fort Walton Beach	Urban	Two-Way Left Turn	35	6	Urban Principal Arterial	35,500

Source: US 98 FWB Corridor Management Report, Okaloosa-Walton TPO, June 2004

10.3.2 Data Collection

One of the key steps during the Evaluate Existing and Future Conditions phase is data collection. *Table 31* provides a list of key questions to ask and data needed to provide a comprehensive understanding of the transportation characteristics and context of the study corridor and surrounding area. The table also provides potential data sources to consider for obtaining the necessary data.

Table 31 | CAMP Data Needs and Potential Sources

KEY QUESTIONS AND DATA NEEDED	POTENTIAL DATA SOURCES
What are the existing physical conditions?	
• What is the existing ROW width? • What is the existing roadway geometry (cross section(s), number and width of lanes, median width and design, locations and widths of sidewalks and bicycle facilities, curb type and design)? • What are the existing posted speed limits? • Where are intersections located, what is their design and traffic control? • Where are median openings and access connections located? • Where are left and right turn lanes located and what is the design (width, total length, and taper length)? • What is the design speed and target speed of the roadway? • What is the condition of the roadway / sidewalk / transit facility?	• Field review • Existing survey • Local jurisdiction's Geographic Information System (GIS)-based parcel data • Existing aerials • Web-based mapping
How is site access and circulation provided at locations along the corridor?	
• How are driveways designed (widths, corner radii, throat lengths, profile)? • What is the site circulation (for motor vehicles, trucks, pedestrian, and bicyclists) and parking layout? • What is the site layout including footprint and location of buildings, drive-through windows, and truck loading areas?	• Field review • Existing aerials
How are people moving around in this area?	
• If there are challenges to mobility, what is the nature (local or regional, multi-modal)? • What is the average trip length? • Will travel patterns be similar in the future? Are there major land use or transportation changes that would cause travel patterns to shift?	• Stakeholder interviews • Transit data • Existing sub-area model or regional model • Origin-destination survey • Project-specific sub-area model
What is traffic like currently and in the future	
• What are the existing and projected traffic volumes (annual average daily traffic (AADT), peak hour intersection turning volumes)? • What has the historical traffic volume growth been along the corridor? • What component of the traffic is freight / truck traffic? • What are the congestion levels? • When and how long is the peak traffic? • What are the average travel times for typical trips along the corridor and what are the typical delays at intersections? • What locations have vehicle queuing concerns? • What are the measured speeds along the corridor (including average and 85th percentile speeds)? • What are the travel characteristics?	• Existing FDOT traffic data *Florida Traffic Online* • Project-specific traffic data, supplemented by other existing resources • Big data sources (e.g., Streetlight Data, INRIX, etc.)

<table>
<tr><th>KEY QUESTIONS AND DATA NEEDED</th><th>POTENTIAL DATA SOURCES</th></tr>
<tr><td colspan="2">What is the role of the roadway within the study area?</td></tr>
<tr><td>• What is the functional classification, context classification, and access classification of the roadway?
• Does the corridor have a major role for a specific mode (pedestrian / bicycle / freight / transit / auto)?
• What is the rest of the transportation network like?</td><td>• Stakeholder interviews
• Existing FDOT traffic and roadway data (FDOT Statistics; ConnectPed Public (arcgis.com))
• Field review
• GIS-based mapping
• Project-specific mapping</td></tr>
<tr><td colspan="2">Are there any safety concerns?</td></tr>
<tr><td>• Does the crash data indicate any specific problem areas or trends (based on historic crash data: rates, locations, severity, types, time of day, and environmental and behavioral factors)?
• Does the crash data indicate a high occurrence of pedestrian / bicycle incidents?</td><td>• Stakeholder interviews
• Existing FDOT crash database
• Field review
• Efficient Transportation Decision Making (ETDM) database</td></tr>
<tr><td colspan="2">What is the transit mobility like currently and in the future?</td></tr>
<tr><td>• What existing and proposed transit services serves the area?
• What are the current and planned operating characteristics (ridership, frequency, headways)?
• Where are the existing and proposed transit stop locations?
• Are there existing transit stop amenities?
• Are there signs that transit users' needs are not being met? (e.g., informal paths in grass)</td><td>• Stakeholder interviews
• Existing survey
• Field review
• Web-based mapping
• Transit agency database and mapping
• Transit use data (Automatic Vehicle Location (AVL) or Automatic Passenger Count (APC) data)</td></tr>
<tr><td colspan="2">What is the pedestrian / bicycle traffic and infrastructure like currently and in the future?</td></tr>
<tr><td>• What are the pedestrian and bicycling traffic volumes?
• What is the pedestrian crossing activity at intersections? Midblock? Near bus stops?
• What do the existing and proposed sidewalk network look like?
• Where are the existing and proposed bicycle facilities (routes, conventional / buffered / separated bike lanes, multi-use trails)?
• Do sidewalks and crosswalks meet ADA standards?
• Are there impediments in the sidewalks?
• Is there a buffer between the sidewalk and the street?
• Is shade / landscaping provided?</td><td>• Stakeholder interviews
• Field review
• Web-based mapping
• Transit agency database and mapping
• Transit use data (AVL or APC data)</td></tr>
<tr><td colspan="2">What type of area is being served by the corridor?</td></tr>
<tr><td>• What is the existing and planned future land use (urban, suburban, rural; transitioning or stable)?
• Are there future developments proposed along or in close proximity to the corridor?
• Is there an economic development goal for the area?
• What is the future vision for the area?</td><td>• Stakeholder interviews
• Field review
• Local plans and policy documents
• GIS-based mapping from local jurisdiction</td></tr>
</table>

KEY QUESTIONS AND DATA NEEDED	POTENTIAL DATA SOURCES
Who are the predominant users of the corridor?	
• What are the existing and future traffic generators in and around the study area? • Are there uses generating local trips? Pedestrian / bicycling trips? • What are the existing and projected population and employment? • Are there any special population groups, particularly historically marginalized populations (below poverty level, minorities, or limited English proficiency) or vulnerable users (under 18 or over 65, zero-vehicle households, or commuting by non-auto modes)?	• Stakeholder interviews • Field review • Web-based mapping • Transit agency database and mapping • Transit use data (AVL or APC data) • Census data • Comprehensive plans
Are there land uses that require special consideration?	
• Are there sensitive environmental uses or major environmental features in the area? • Are there social and economic, cultural, natural, and/or physical resources that may potentially be impacted by changes to the corridor? • Is the area part of a historic district? • Are there major community venues (schools, parks, etc.) that generate more non-motorized traffic?	• Stakeholder interviews • Field review • GIS-based mapping from local jurisdiction • Local plans and policy documents • ETDM database
What are the regional priorities related to this area?	
• What are the plans and programs in the MPO Long Range Transportation Plan (LRTP)? Transportation Improvement Plan (TIP)? Unified Planning Work Program (UPWP)? Regional Planning Council's plans? • Are there any previous studies that would impact the study corridor, e.g., site development traffic impact studies, bike/ped plans/studies, previous corridor studies, etc.? • Are there any cross-jurisdictional plans?	• Stakeholder interviews • Regional plans and programs • Previous studies
What are the local goals and priorities related to this area?	
• Do the local plans and policies address this area (comprehensive plan, land development regulations, vision plans)? • Are there major public and private land use and infrastructure investments in the horizon? • Is the area part of a special use district / taxing district (Community Redevelopment Authority (CRA), Business Improvement Districts (BID), Neighborhood Improvement District (NID), etc.)? • What are the priorities of the local neighborhood, local business owners, community groups, etc.?	• Stakeholder interviews • GIS-based mapping from local jurisdiction • Local plans and policy documents

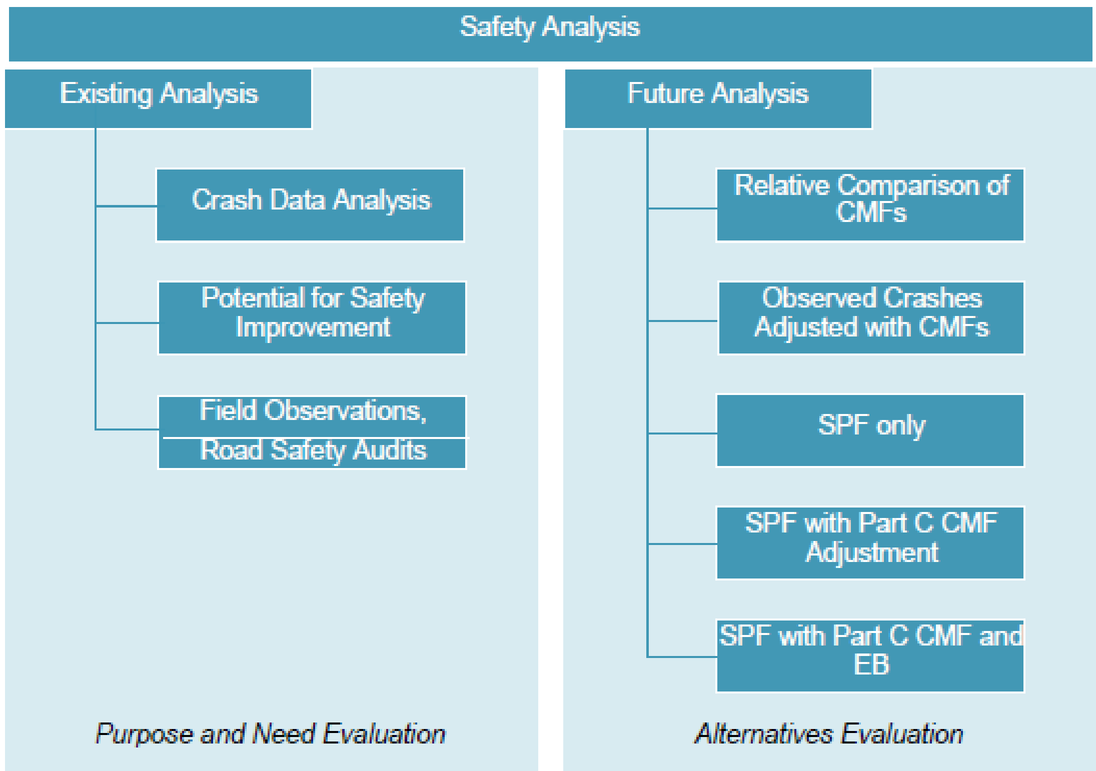
Source: Adapted from FDOT District 5 Multi-Modal Corridor Planning Guidebook, 2014

Traffic volume data is particularly important to evaluate the impacts of potential access changes along the study corridor. Peak hour turning movement counts should be collected at all significant intersections on the study corridor, including all signalized intersections, all major side streets that are located at full median openings or are otherwise not access restricted, all full median openings, and all major driveways providing access to large traffic generators. Coverage of count data should be sufficient to account for potential traffic volume and pattern changes resulting from proposed access modifications. Without sufficient coverage of count data, peak hour usage from uncounted corridor locations may have to be estimated to appropriately assess changes, for example U-turns resulting from restrictions to existing full median openings.

10.3.3 Crash and Safety Analysis

Safety is FDOT's number one priority and should be a key element of any CAMP during the Evaluate Existing and Future Conditions phase. Many access management improvements reduce the number of conflict points and are specifically intended to enhance safety performance. A CAMP should provide recommendations that seek to mitigate existing and historic crash locations and types, as well as proactively recommend countermeasures at other locations along the corridor that have similar geometric, traffic, and land use characteristics. ***Figure 160*** shows typical quantitative safety analysis methods that may be employed for both existing and future analyses.

Figure 160 | Quantitative Safety Analysis Methods



Source: FDOT Safety Analysis Guidebook for PD&E Studies, 2019

Existing Safety Analysis

Key considerations for completing an existing crash and safety analysis within a CAMP include the following:

- Historic crash data should be collected for the corridor for the most recent available five-year period, at a minimum. The preferred data platform is Signal Four Analytics (*Signal Four Analytics (ufl.edu)*), which can provide a crash database as well as individual crash reports. FDOT's Crash Analysis Reporting System (CARS) is being sunset in 2023.
- Crash data should be summarized to understand spatial, temporal, environmental, and behavioral factors associated with the crashes. These summaries will help to identify key patterns and understand existing crash problems, issues, and trends. Useful statistics include:

- Crash identifiers such as crash date, day of week, time of day
- Crash type
- Crash severity
- Sequence of events of the crashes
- Contributing causes
- Contributing circumstances
    - What modes were involved in the crash
    - Road condition
    - Lighting condition
    - Weather condition
    - Driver impairment

- It may be necessary to read the narratives and review the crash diagrams in the individual crash reports to fully understand the specific crash location, cause, and contributing factors.
- Visual assessments may be just as useful as descriptive statistics in identifying crash patterns. A crash heat map is an effective tool to help determine specific high-crash locations and locations of concern for potential access modifications. Collision diagrams showing location and crash type should be considered to graphically summarize the crash history at intersections, median openings, or other locations along the corridor.
- Calculating crash rates for segments or intersections in the project study area and then comparing them to the average crash rates for similar facilities either in the same FDOT district or statewide. The procedure for calculating crash rates can be found in the *FDOT Safety Analysis Guidebook for Project Development and Environment (PD&E) Studies*. Determine whether the project includes any identified high crash segment or intersection locations.
- Technology including high quality video and LIDAR, video processing algorithms, artificial intelligence (AI) and machine learning, and data analytics now allow for data on near misses, critical conflicts, and crash risk (both occurrence and severity) to be gathered. While not required for a CAMP analysis, this information can supplement the historic crash data and provide additional insights into locations that may be underrepresented in recorded crash data.
- Apply *Highway Safety Manual (HSM)* methods and tools to diagnose safety conditions.
    - Safety performance functions (SPFs), where available, can be used to determine whether the observed safety performance at a given location is higher or lower than the average safety performance of other locations with similar roadway characteristics and exposure. Locations with higher-than-average safety performance may have the greatest safety need or high potential for safety improvement (PSI).
    - The PSI, which can be used when observed crash data, SPFs and calibration factors are available, is the difference between the expected crash frequency (calculated using the Empirical Bayes (EB) method) and the predicted crash experience (based on the SPF) for a given traffic volume.

Observations and Issues

A field review or road safety audit (RSA) is recommended to be completed at high-crash locations (at a minimum) to observe and confirm traffic operations, typical user behaviors, and potential countermeasures to help mitigate prevalent crash types and safety concerns. Field observations may help identify specific conditions or potential risks that may otherwise not be apparent. FHWA's RSA website (*Road Safety Audits (RSA) | FHWA (dot.gov)*) provides additional guidance, information, and resources.

The *TRB Access Management Manual, Second Edition, 2014* provides the following summary of key issues to look for in a corridor access management analysis:

- Are vehicles using shoulders as right-turn lanes?
- Are auxiliary lanes needed in some locations?
- Does an existing median need to be improved, or should a non-traversable median be incorporated into the roadway design?
- Do traffic signals seem to be coordinated? Are there problems with traffic signal location and traffic progression?
- Are there any queues from turn lanes that back into the through lane, or do queues extend back from one intersection and block the upstream intersection?
- Are there intersections or segments of the corridor with unacceptable levels of congestion or delay?
- Do some intersections or segments have actual or perceived safety hazards (for motor vehicles, pedestrians, or other road users)?
- Are there geometric deficiencies that create problems for trucks and buses?
- Are there inadequate lane or shoulder widths for bicyclists?
- Are there continuous non-motorized networks connecting residential areas with key destinations and transit stops?
- Are there areas with high existing or potential pedestrian usage that lack adequate pedestrian facilities or crossings?
- Are there currently any internal access connections between properties? Are there opportunities for joint access or inter-parcel circulation?
- Is there a supporting street network and, if so, are there gaps that should be connected?
- How can the supporting street and site circulation system be modified or developed to improve corridor safety and operations?
- Are there substandard driveway design conditions, such as driveways with excessive grades or slopes, inadequate widths or radii, or inadequate throat lengths?
- Do some sites have open frontages or too many driveways?
- Are there sight impediments (e.g., signs, shrubs, fences) or visual impairments (e.g., complex sign and signal environments, glare)?
- Are there areas with abrupt transitions in speed, lane drops, or turn lanes, particularly those correlated with dense driveway environments?

High level observations and issues can be summarized on a corridor map, as shown in ***Figure 161***.

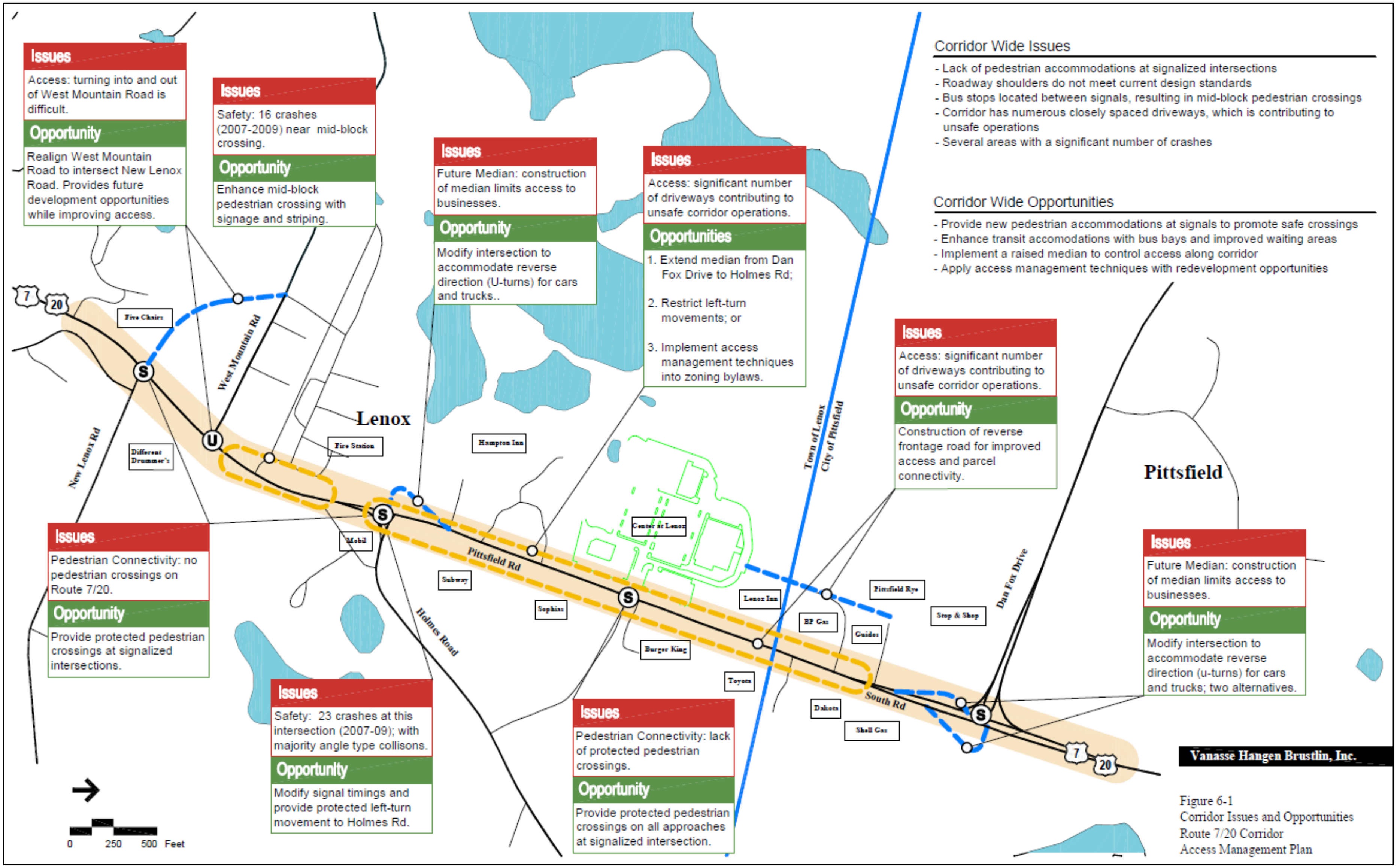
Future Safety Analysis

Completing a future safety analysis can provide information on preferred safety countermeasures to target and their anticipated impacts. If a future analysis is included in a CAMP, the following are key considerations and potential components:

- Use results from safety diagnostic analyses (*HSM* Chapter 5 through 7) to develop concepts and alternatives.
- Use crash modification factors (CMF) (*HSM* Part D and the FHWA *CMF Clearinghouse*) to estimate changes in crash frequency or severity between different design alternatives.
- Use the *HSM* predictive method (Part C) to estimate the magnitude of the changes in crash frequency or severity associated with a change in traffic volume, traffic control or roadway characteristics. The results of the HSM predictive method can be used to estimate the change in safety performance of a preferred alternative compared to a no-build alternative.

Additional guidance on the application of CMF, SPFs, and the *HSM* predictive method is provided in the *FDOT Safety Analysis Guidebook for PD&E Studies* and in the *HSM*.

Figure 161 | Corridor Issues and Opportunities Example



Source: Route 7/20 Corridor Access Management Plan, Berkshire Regional Planning Commission, December 2010

10.3.4 Traffic Operations Analysis

A traffic operations analysis is a key component of the Evaluate Existing and Future Conditions phase of a CAMP to understand existing operational concerns or issues, and the operational impacts of potential access modifications. This will allow the corridor operations to be optimized for safety performance and efficiency, while accommodating potential future growth and potential future redevelopment opportunities. The basic components that should be considered for a CAMP traffic operations analysis include existing conditions analysis, traffic forecast, future conditions, and No Build and Build analyses. Because FDOT has many documents that provide guidance on completing a traffic operations analysis, the following sections only provide key considerations as related specifically to an access management study.

FDOT traffic study reference documents include the following:

- *Traffic Analysis Handbook*
- *Project Traffic Forecasting Handbook*
- *Manual on Intersection Control Evaluation*
- *Model Calibration and Validation Standards Report*

The primary focus of the traffic operations analysis for a CAMP is typically on vehicular movements and, as such, it should document vehicular level of service (LOS), delay, and queuing associated with existing access and traffic control, as well as with potential access modification alternatives. Corridor travel times may be another performance measure to consider. It may also be important to evaluate the impact of the proposed alternatives to non-motorized users, even if done in a more qualitative manner. *FHWA's Guidebook for Developing Pedestrian and Bicycle Performance Measures* includes 30 different performance measures that can be considered. Crossing opportunities and route directness in particular may be measures to consider related to potential changes in corridor access.

Existing Conditions Analysis

It is important to establish the baseline of existing traffic operations under the existing network and conditions and document existing deficiencies and issues. As noted in ***Section 10.3: Corridor Access Management Plan Elements***, collecting appropriate existing traffic count data not only allows for this assessment, but also sets the stage for understanding the impact of potential traffic volume and pattern changes resulting from proposed access modifications. If following the Intersection Control Evaluation (ICE) process in evaluating potential modifications, the *FDOT Manual on Intersection Control Evaluation* notes that ICE analysis is to be completed for the existing year (year of data collection) in addition to the design year.

Traffic Forecast and Analysis Methodology

Using a traffic forecast will allow for an analysis of the corridor considering potential future growth and a comparison of the operations between existing (No Build) conditions and a Build alternative with proposed access and/or traffic control modifications. A traffic forecast and analysis methodology should be established at the beginning of a CAMP project to document the assumptions and approach to be used for the analysis. It may describe the proposed method(s) for forecasting future traffic, including the use of travel demand models or other alternatives, horizon/analysis years, as well as data collection needs, performance measures, and analysis tools proposed to be used. If simulation is proposed for the analysis, the methodology should describe the methods to be used for calibration and analysis. The *FDOT Traffic Analysis Handbook* includes a Traffic Analysis Methodology Content Checklist (Table 2-1) that can help guide the overall approach to the forecast and analysis. Because access modifications will affect operations at individual intersections, traffic forecasts should be completed to the intersection level.

If a travel demand model is used, it should be determined whether it can be used as-is or if further calibration will be needed to appropriately match corridor conditions and volumes. Further information on model calibration can be found in the *FDOT's Model Calibration and Validation Standards Report*, *Project Forecasting Handbook*, and *Traffic Analysis Handbook*.

For analysis horizons, it is preferable to follow the typical FDOT design year standards:

- 10 years for operation improvement projects such as signalization; resurfacing, restoration, and rehabilitation (RRR) projects; and safety or operational improvements
- 20 years for projects that add capacity with new construction or reconstruction

Projected Future No Build Traffic Volumes

Traffic projections should account for growth from planned development along the corridor, as well as anticipated changes in regional through traffic, if not accounted for by using a regional travel demand model. Available site development traffic impact analyses/studies and accumulations of committed trips from the local government(s) can be used to verify or develop corridor and intersection traffic projections. In some cases, it may be necessary to make assumptions regarding potential development of undeveloped parcels on the study corridor for which no site plan or development program is available. If using a regional travel demand model, land use along and near the corridor should be checked for accuracy, including future year model land use zonal totals for both existing developed and undeveloped parcels.

Future Conditions Analysis

The future conditions No Build analysis includes the projected design year traffic forecasts and the existing intersection and access conditions without changes. It allows for a comparison to the existing conditions analysis to determine the impact of expected traffic growth and development along the corridor, as well as to the future conditions Build alternative(s) to determine the operational impact of potential access and/or traffic control changes.

Build alternative(s) that change access and/or travel patterns should account for the appropriate shifting of traffic volumes. For example, the modification of an existing full median opening to a directional left turn opening will require side street traffic that would have turned left or traveled straight across with a full median opening to instead turn right and make a U-turn at a downstream intersection. The operational analysis of such changes may show the need for changes to turn lane storage. Access changes at one location may also support a change in traffic control at an adjacent or nearby access point. For example, closing or modifying an existing full median opening may allow an adjacent unsignalized full median opening to either be signalized or use another form of traffic control due to the resulting shift in traffic. The ICE process should be considered for any locations where a substantive change is proposed to intersection geometry or control (see ICE applicability requirements in the *FDOT Manual on Intersection Control Evaluation*).

10.3.5 Development of Access Alternatives

The Identify Vision and Strategies phase of a CAMP includes the development of access alternatives. This should be a multifaceted process based on inputs including the corridor vision, technical data, public comments, design parameters, and guidance from the advisory group.

Guiding principles or overarching elements such as safety, mobility, accessibility, and connectivity should inform the development of potential alternatives, along with the following key considerations:

- Evaluate existing median opening spacing based on *Rule Chapter 14-97 F.A.C.* and identify substandard unsignalized access connections as potential candidates for reconfiguration, relocation, or closure. In particular, full median openings that are too closely spaced or serve uses or local streets with low traffic volumes should be considered for reconfiguration (e.g., modification to a directional opening) or closure. When evaluating modifications to existing median openings, tradeoffs should be considered comparing the shorter spacing, more direct travel, fewer U-turns, but potential degraded safety and operations with longer spacing and improved safety performance and operations but less direct travel.
- Provide full median openings only at locations that are appropriate for signalization or other types of alternative traffic control such as roundabouts. It is not necessary to provide a full median opening at every side street.
- For access points or driveways that provide inadequate corner clearance, consider the following:
    - Limit corner property development intensity based on number of trips generated and access standards.
    - Coordinate with property owners to consolidate driveways to adjacent compatible-use properties.
    - Limit access of the corner property to the lower volume side street.
- Install a median barrier at the intersection so that corner property movements are restricted to right-in, right-out only.
- Evaluate existing sight distance at intersections and median openings. Where sight distance is inadequate, consider removing the obstruction, relocating the access where sight distance would be improved to acceptable levels, or reconfiguring the access point, such as changing a full median opening to a directional opening.
- Take every opportunity to limit the number of access points on the SHS by providing primary property access via side streets, consolidating to fewer access points, and providing cross access between adjacent properties. Unified and coordinated access and circulation systems off the SHS can be established through a combination of local street networks and inter-parcel connectivity.
- Consider the movement of large vehicles, trucks and freight, particularly if the study corridor is a designated truck route or part of the Strategic Intermodal System (SIS) and existing truck movements would be prohibited or require U-turns. In such cases, corridor access concepts may need to appropriately accommodate large vehicle turning / U-turning movements and swept paths, or alternative truck routes may need to be identified. It should be verified that truck access is sufficiently accommodated in the proposed alternatives, including access to loading/off-loading locations and minimizing or avoiding conflicts with pedestrian, bicycle, and auto circulation.
- Install medians in high-crash locations and in place of continuous two-way left-turn lanes.
- Work with property owners to close or consolidate redundant driveways, or reconstruct or relocate substandard driveways, particularly during RRR, sidewalk, or other corridor improvement projects. This may require offering to pay for and complete site-related construction. Note that one-on-one meetings with property owners are often more effective than public forums in identifying acceptable alternatives or outcomes.
- Define smaller driveways through low-cost provisions such as placement of planter boxes with wide driveways or along unlimited access points.

- Incorporate auxiliary and turn lanes into concept designs.
- Require consolidation of access and cross access when adjacent parcels come under common ownership.
- Eliminate closely spaced or jogged intersections.

Roundabouts

As noted in ***Section 8.4.4: U-Turns***, roundabouts allow U-turns within the normal flow of traffic, which often are not possible at other forms of intersection, including other types of alternative intersections as described in ***Chapter 8: Intersection Control Evaluation (ICE) and Alternative Intersections***. For this reason, roundabouts can be considered along a corridor to better manage access between intersections. *Effective Strategies for Comprehensive Corridor Management* (Center for Urban Transportation Research, 2004) notes that:

> *"When roundabouts are combined with raised median treatments, the safety and operational benefits can extend to an entire corridor. Because even large vehicles can safely make a U-turn at the roundabout, all access to uses along the corridor can be accommodated using safe right-in/right-out driveways. For example, a roundabout having an outside diameter of 130 feet can accommodate semi-trailer trucks with a wheelbase of up to 60 feet. The use of a roundabout rather than a signalized intersection can better accommodate the U-turns created by a median. The raised median removes the opportunity to make left -turns across travel lanes thereby eliminating severe right-angle crashes and greatly reducing the potential for head on crashes."*

The CUTR report also states:

> *"Another benefit of roundabouts is that vehicles must slow down on the approach to check for circulating vehicles. This slower speed contributes to the lower rate and severity of crashes as well as to increased pedestrian safety. The FHWA estimates up to a 90% reduction in fatalities, a 76% reduction in injury crashes, and a 30-40% reduction in pedestrian-related crashes is possible with the use of roundabouts. The slow speeds and right-turning movements are also safe and easy for drivers with slower reflexes, such as the elderly."*

In summary, multiple consecutive roundabout intersections with full access control between the roundabouts can enhance safety performance through managed access and reduction of conflict points; improve aesthetics and reduced corridor travel speeds through enhanced median landscaping and horizontal deflection at the roundabouts; and provide multimodal improvements in the form of safer crossings and more informal crossing opportunities with median refuge.

Numerous communities across the country have implemented roundabout corridors with successful results. One example of a similar corridor is South Golden Road in Golden, Colorado, which has seven roundabouts along a multilane corridor that has shopping centers, restaurants, two schools, and neighborhoods. A case study conducted for the corridor showed that not only did crashes and injuries decrease by 60% and 96%, respectively, but the stores along the corridor also reported increased sales. There is promise in implementation of roundabout corridors in Florida similar to South Golden Road for a couple of reasons. First, the curb-to-curb width of the four-lane South Golden Road is similar to a typical five-lane urban arterial in Florida. Second, the roundabouts implemented on South Golden Road worked well despite having inscribed circle

Figure 162 | US 41 Corridor

Source: US 41, Sarasota, FL - Google Earth.

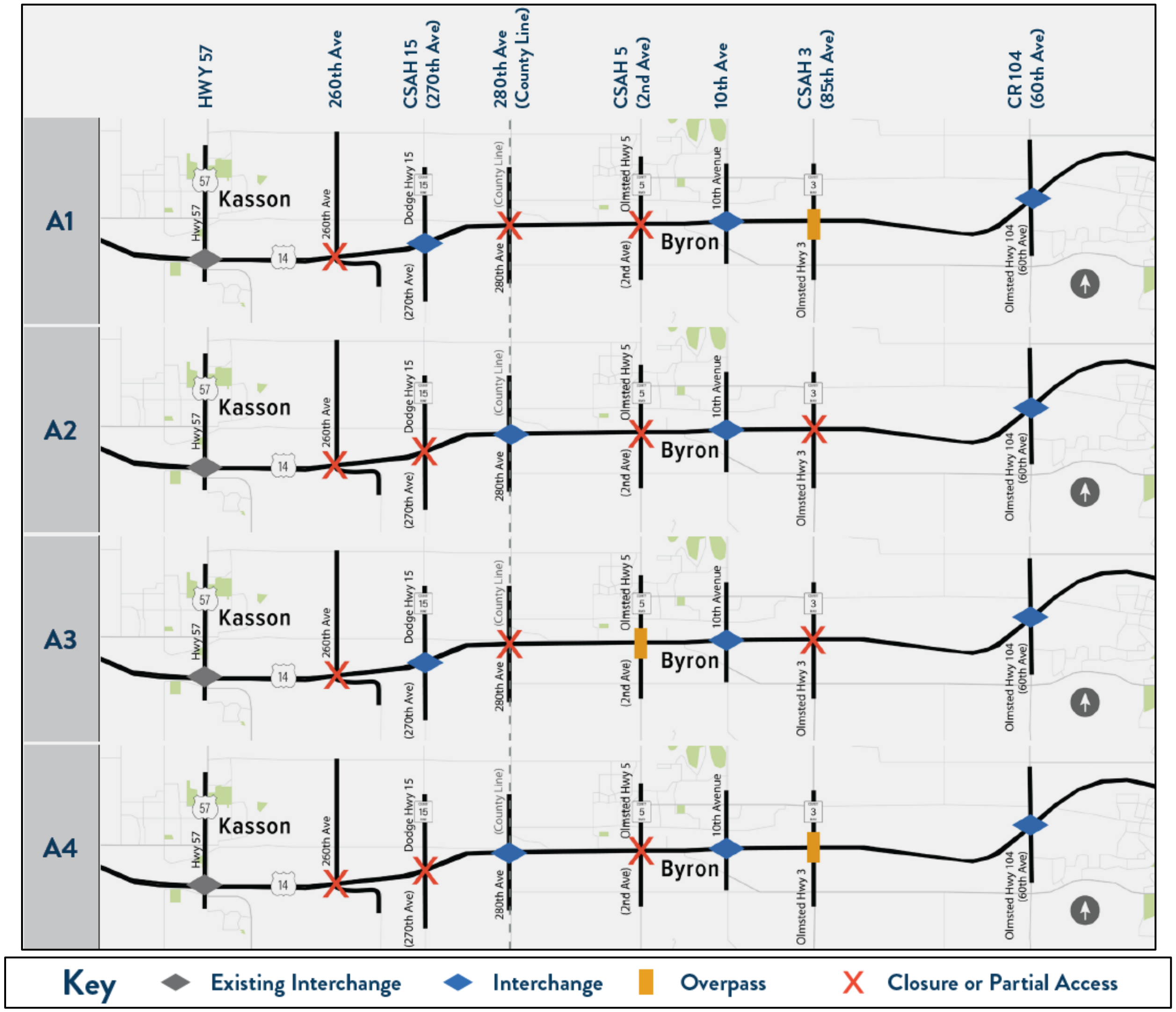
diameters varying from 105 to 155 feet, which are small compared to most typical multilane roundabouts.

An emerging roundabout corridor in Florida is US 41 in Sarasota, which as of spring 2023 had four existing multilane roundabouts within an approximate one mile stretch between 14th Street and Gulfstream Avenue (see ***Figure 162***). This corridor also has an additional four roundabouts planned, which would provide a total of eight roundabouts within a 2.5-mile section of the corridor.

Summarizing Access Alternatives

After access alternatives have been developed, a summary of the alternatives should be produced that allows for easy comparison of the proposed changes and differences between alternatives. Although more detailed to-scale plan view concepts can be developed at this stage to show specific details, what is most beneficial from an overall corridor perspective is a to-scale, corridor-wide graphical summary of the alternatives being considered, such as the example shown in ***Figure 163***.

Figure 163 | Access Alternatives Summary Example



Source: US 14 Corridor Analysis Final Report, Minnesota DOT, January 2021.

10.3.6 Evaluation of Alternatives

Completing an evaluation of the alternatives is another key step in the Identify Vision and Strategies phase of a CAMP. The initial evaluation should be presented for feedback to the advisory group, at a minimum, but can also be considered for presentation to the public as part of a public workshop as well. Feedback can help identify any concerns or disagreements over the evaluation, including criteria and scoring used. However, if guiding principles, performance measures, and evaluation criteria are established and vetted early in the CAMP process, and evaluation outcomes are data-driven versus qualitative, the results should be supportable with fewer stakeholders in disagreement.

Factors that may be considered in a multi-criteria evaluation of alternatives include:

- Multimodal safety, such as estimated safety impacts or predictive safety benefits; reduction of conflict points; potential to slow corridor traffic speeds; improved accessibility and/or accommodations and connectivity for non-motorized users
- Mobility and operational efficiency, including improvements in vehicular LOS, delay, queuing, and/or travel time compared to existing and/or future No Build conditions; improved adherence to existing access spacing standards; provision of parallel facilities and connections outside of the ROW in order to reduce the number of short distance trips on the arterial; improved mobility for non-motorized users; and maintenance of freight movements or truck access
- Potential to divert trips through a residential area
- Improved aesthetics
- Cost effectiveness and/or financial feasibility, which may be based on planning-level order of magnitude cost estimates or more detailed benefit/cost (B/C) assessment and factor in cost components such as design, ROW acquisition, construction, and ongoing operations and maintenance
- Potential social, economic, and environmental impacts
- Local accessibility to neighborhoods and commercial areas, minimizing negative property impacts
- Alignment with other plans and studies
- Public acceptance and preferences

Figure 164 provides an example of an alternatives evaluation summary based on criteria and evaluation metrics in major categories such as safety, mobility, accessibility to local communities, and regional connectivity. Evaluation of each criterion in the example is based on a scale from poor to good. Summary discussion of the alternatives in the CAMP report should include key design considerations as well as the pros and cons of each alternative and range of costs.

Figure 164 | Alternatives Evaluation Summary Example

	Safety			Mobility		Accessibility to Local Communities			Regional Connectivity		
Criteria	Implement improvements to reduce crashes at critical crash risk locations	Compliant with access spacing guidelines	Improves safety for pedestrians and bicyclists	Reduces congestion along US 14	Improves mobility for pedestrians and bicyclists	Provides reasonable access to and from local communities	Minimizes property impacts	Encourages economic development	Minimizes system connectivity disruptions	Maintain freight movement	Reduces impacts to agricultural movement
Evaluation Metric	Total conflict points	Access spacing guidelines: - Interchange spacing 2-3 miles - Overpass spacing 1.5-2 miles	Provides a grade separated crossing of US 14	Reduces congestion with the reduction in at-grade access points	Provides crossing accommodations (at-grade or grade separated) of US 14	Based on interchange location and number of interchanges	Reduces the total number of full or partial property acquisitions	Alignment with the City's Comprehensive Plan	Total mileage to be transferred or reconstructed	Connectivity of north/south County Roads (e.g. CSAH 15, CSAH 5, and CSAH 3)	Evenly spaced grade-separated north/south routes
A1	Acceptable	Moderate	Good	Acceptable	Acceptable	Acceptable	Moderate	Acceptable	Moderate	Moderate	Good
A2	Acceptable	Good	Moderate	Acceptable	Moderate	Acceptable	Acceptable	Good	Poor	Poor	Poor
A3	Acceptable	Moderate	Good	Acceptable	Good	Acceptable	Less desirable	Acceptable	Moderate	Moderate	Acceptable
A4	Acceptable	Moderate	Good	Acceptable	Acceptable	Acceptable	Moderate	Good	Poor	Less desirable	Moderate
B1	Moderate	Good	Good	Moderate	Acceptable	Good	Less desirable	Less desirable	Acceptable	Acceptable	Good
B2	Acceptable	Good	Good	Acceptable	Acceptable	Moderate	Less desirable	Poor	Moderate	Good	Good
C1	Acceptable	Good	Acceptable	Acceptable	Less desirable	Less desirable	Good	Moderate	Less desirable	Less desirable	Less desirable
C2	Acceptable	Good	Good	Acceptable	Acceptable	Less desirable	Less desirable	Moderate	Moderate	Moderate	Moderate

Good; meets criteria well — Acceptable; but relatively less than good — Moderate; no distinguishing characteristics — Less desirable; considering criteria — Poor; fails to meet criteria

Source: US 14 Corridor Analysis Final Report, Minnesota DOT, January 2021

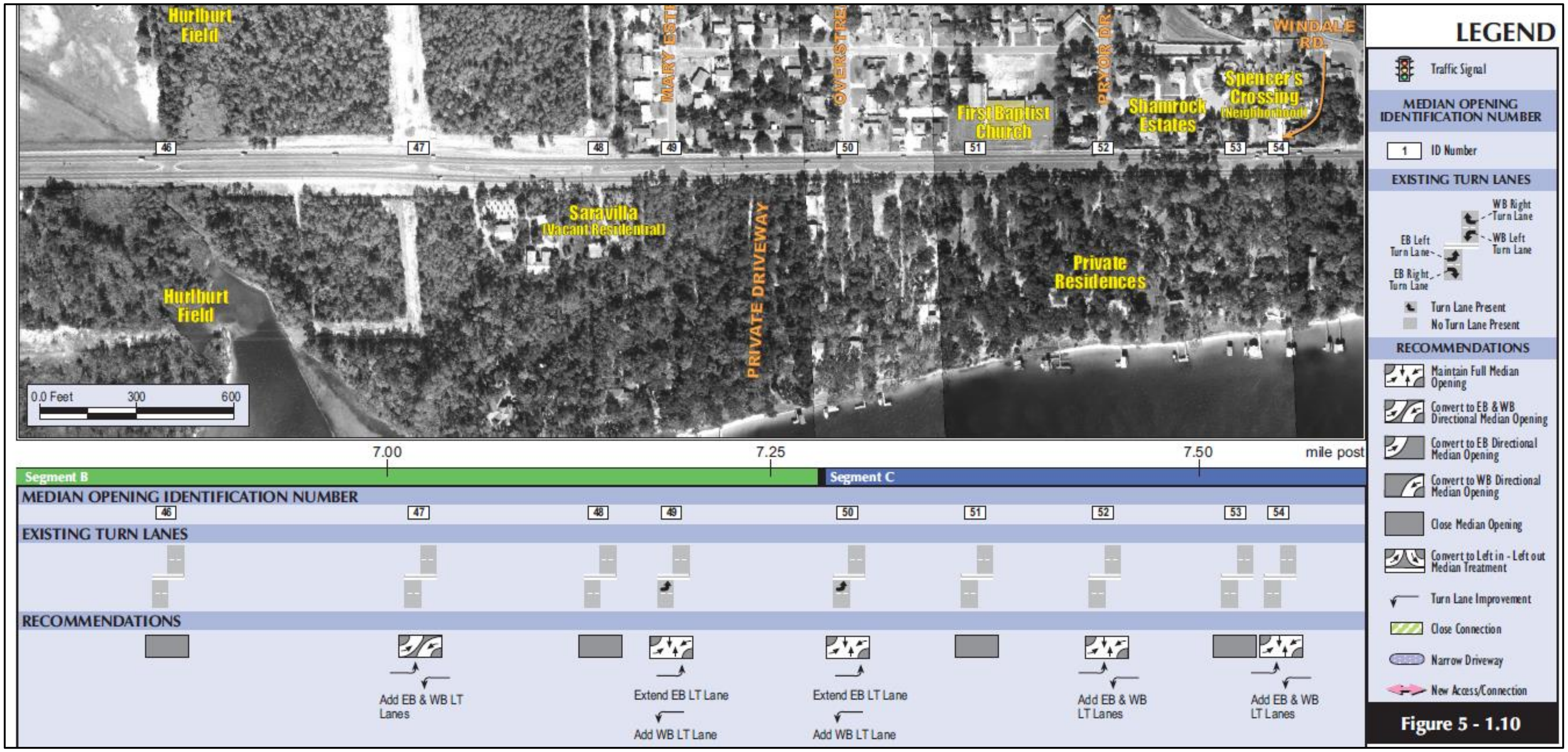
10.3.7 Recommended Corridor Access Management Plan

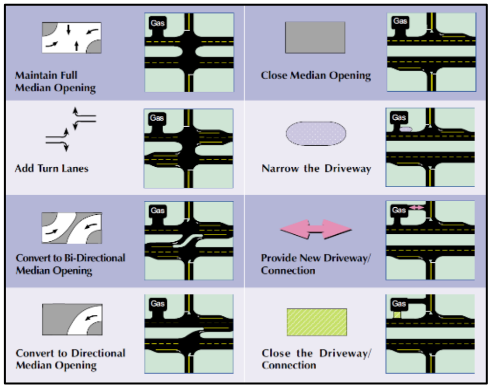
The Prepare CAMP phase of the project culminates by finalizing the recommended plan following selection of a preferred alternative. The preferred alternative is informed by feedback obtained at the required public meeting. Similar to the previous Identify Vision and Strategies phase where alternatives are developed and evaluated, summary graphics should include to-scale corridor-wide graphical summary of the recommended plan. ***Figure 165*** provides an example of a recommended CAMP showing the location and types of the improvements, along with explanation of the symbology used in the summary graphic to detail the proposed access changes. ***Figure 166*** provides an example of a more detailed, to-scale concept plan drawing of proposed access changes; these detailed concept plans can be more effective in more specifically communicating the proposed changes and are great supplements to an overall graphical corridor summary. Graphics and concepts can also communicate proposed phasing, including both short-term (requiring less time and cost) and long-term improvements.

Other recommended components of a final CAMP include:

- Phasing of improvements, particularly near- or short-term opportunities for improvements versus longer term improvements
- More detailed cost estimates
- Implementation strategies and funding plan, which may include identifying implementation responsibilities, policy recommendations, or recommending establishment of a MOU or other interagency agreement(s)

Figure 165 | Recommended Corridor Access Management Plan Example





Source: US 98 FWB Corridor Management Report, Okaloosa-Walton TPO, June 2004.

Figure 166 | Recommended Corridor Access Management Plan Detailed Plan View Example

Source: Beavercreek Road Access Management Plan, City of Oregon City, October 2005.

Chapter 11: Public Involvement and Stakeholder Engagement in Access Management

11.1 Overview

Public involvement is a key aspect of the planning process; especially in access management. It is critical and essential to get public and stakeholder involvement and participation in planning, design, construction, and operation of access management treatments along the state roadways. Public involvement is important to build public trust and support to the roadway access management plans.

Access management of state roadways affects the corridor land uses; hence, property owners have concerns about the corridor access management plans. Collaborating with the corridor property owners, site developers, public using the roadway, and other stakeholders would help to implement access management plans and strategies for the benefits of all the parties and result in the success of the roadway access management.

The *TRB Access Management Manual*, *FDM 104 – Public Involvement*, and the *FDOT Public Involvement Handbook* provide communication strategies, resources, and techniques for public involvement in access management decisions.

The *TRB Access Management Manual* states:

> *Effective public involvement helps to safeguard a program or project against arbitrary or undesirable changes.*
>
> *Circuity of access, impacts on business activity, potential for neighborhood cut-through traffic, access for delivery vehicles, and the safety of U-turns are among the issues that frequently arise.*
>
> *An effective public involvement process is one that parallels the decision-making process.*
>
> *Procedures, rather than actual decisions, appear to be the origin of most people's perception of political legitimacy.*
>
> *Open House meetings are especially effective for projects involving medians and access changes, since they provide a relaxed forum in which interested parties can examine the design and speak with project engineers one-on-one, without waiting through lengthy meetings.*

An example response for addressing public concerns related median construction is illustrated in ***Figure 167***.

Figure 167 | Addressing Public Concerns About Median Construction

EXHIBIT 5-6 Addressing Public Concerns About Medians (*16*)

Concern	Response
You are going to put me out of business.	Conduct survey of business owners and drivers on another corridor where median project was completed and review results. Explain that motorists avoid unsafe driveways. Review studies of economic effects of median projects. Emphasize that demand is not affected. Discuss difficulty of left turns into property under high traffic volumes.
What about trucks?	Talk to business owners and delivery drivers to determine nature of their concern. Drive routes yourself. Look for internal circulation problems. Be prepared to discuss specific truck issues.
U-turns are not safe.	Review safety research on median projects and explain effects of reducing traffic conflicts. Avoid problem locations, such as areas with heavy right-turn traffic, trucks, or right-turn overlaps. Review collision data on corridor. Talk to local law enforcement staff.

Source: *TRB Access Management Manual Exhibit 5-6*

11.2 FDOT Practices in Public Involvement

Florida statutes establish requirements related to public involvement in access management such as median modifications, and other project development activities. FDOT has also developed standards and guidelines with respect to public involvement activities in roadway access management projects.

11.2.1 Median Modifications

Florida statute, *F.S. 335.199*, governs how FDOT works with the public regarding median changes. It states:

(1) Whenever the Department of Transportation proposes any project on the State Highway System which will divide a state highway, erect median barriers modifying currently available vehicle turning movements, or have the effect of closing or modifying an existing access to an abutting property owner, the Department shall notify all affected property owners, municipalities, and counties at least 180 days before the design phase of the project is completed. The Department's notice shall provide a written explanation regarding the need for the project and indicate that all

affected parties will be given an opportunity to provide comments to the department regarding potential impacts of the change.

(2a) If the project is within the boundaries of a municipality, the notification shall be issued in writing to the chief elected official of the municipality. If the project is in the unincorporated area of a county, the notification shall be issued in writing to the chief elected official of the county.

(2b) The department must also consult with the applicable local government on its final design proposal if the department intends to divide a state highway, erect median barriers, or close or modify existing access to abutting commercial business properties. The local government may present the department with alternatives that relieve impacts to such business properties.

(3) The department shall hold at least one public meeting before completing the design phase of the project in the jurisdiction where the project is located and receive public input to determine how the project will affect access to businesses and the potential economic impact of the project on the local business community.

(4) The department must review all comments from the public meeting and take the comments and any alternatives presented by a local government under subsection (2) into consideration in the final design of the highway project.

Public Hearing Requirements May be Met in the ETDM/PD&E Phase

F.S. 335.199 requires at least one public hearing (advertised and recorded). Many times, the decision whether to construct a median is made during the Planning and/or Efficient Transportation Decision Making (ETDM)/Project Development & Environment (PD&E) phases of a project. During these phases, the FDOT works with a community with an emphasis on their participation in the decision-making process concerning the project's need and basic concepts. These phases involve local government representatives, public input, business interest input as well as other interested parties along the corridor and others outside the corridor. The ETDM/PD&E phases document these activities for major projects throughout.

As this phase progresses, stakeholder input is sought and may involve multiple mailings, meetings and workshops depending on the scope of the project. This process in most cases will satisfy the 180-day hearing requirement. Since only major studies like an EIS, EA, and major Type 2 Categorical Exclusions are required to have a formal hearing, a hearing during the final design phase shall be conducted when one hasn't been conducted during the ETDM/PD&E phase.

11.2.2 Other FDOT Public Involvement Activities

For on-going design projects, additional outreach to the community is provided through implementation of Community Awareness Plans, which include notification of property owners and occupants.

If a final design plan has been inactive (on-the-shelf) for a time long enough that there are major changes in roadside business ownership and occupancy, FDOT staff should work with the new owners and residents to inform them of the upcoming changes and allow for a dialogue before construction begins.

The Department provides property owners Access Management Notices with project plans and right (See *F.S. 120.525*). The Access Management Review Committees continue to meet and provide property owners the ability to voice their concerns before the Department.

Additional Public Involvement Guidance

FDM 104 – Public Involvement, which addresses public involvement in design and construction projects, provides further guidance on when additional public involvement may be required.

> *Typically, when a project reaches the design phase, many of the project commitments and community issues have already been identified. However, there are times when design alternatives need to be reevaluated to determine their community impacts. Any commitments made in previous phases are communicated to designers, who are responsible for carrying them out. If constraints arise that require design changes which affect FDOT's ability to meet commitments, then the process would require follow-up with the affected community. In such cases, additional public involvement and community impact assessment may be necessary to address public concerns.*

It lists medians or access changes as projects which may have potential community impacts which are not identified until the design phase.

In *FDM 104.3 - Community Awareness Plan (CAP)*, it points out that median openings or closures are Level 3 projects which may be controversial, significantly affect traffic flow, or significantly affect the accessibility to properties. The highest level of public involvement is Level 4 and is associated with road widening or major reconstruction, bridge widening or replacement, new interchanges, etc.

FDOT's *Project Development and Environment Manual Part 1, Chapter 11*, provides detailed guidance on public involvement activities.

The *FDOT Public Involvement Handbook*, provides techniques and methods to encourage meaningful public participation throughout the transportation decision-making process. The handbook follows FDOT public involvement policies and other legal foundations for public involvement.

11.2.3 Public Education and Outreach

As a public education and outreach material, FDOT published an *Access Management Brochure*, to the property owners and businesses explaining its responsibility to ensure that the design of each state road, properly balances access and mobility. This brochure is intended to provide with a better understanding of access management to dispel public concerns. The brochure illustrates that the standards used by FDOT are thought to provide the optimal balance between access and mobility and consider the characteristics of different types of roadways. It further discusses the benefits of proper access management.

Appendix A

Driveway-Related Collisions on a Roadway Segment

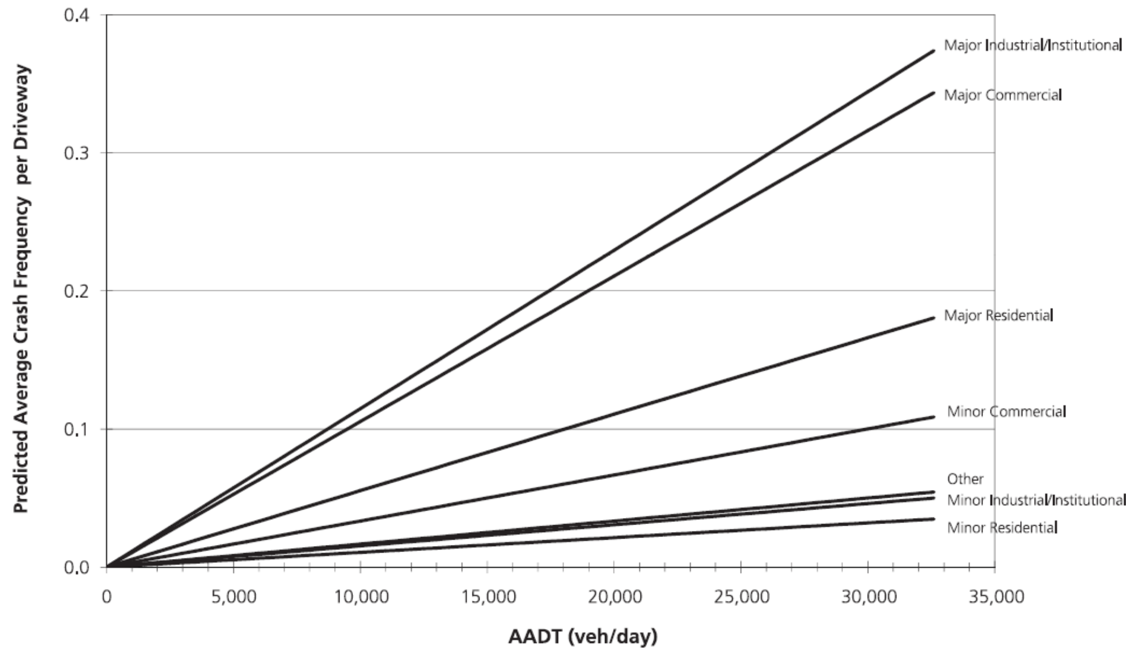
The *HSM* provides crash prediction methods for driveway related crashes. Seven types of driveways are considered:

- Major commercial driveways
- Minor commercial driveways
- Major industrial/institutional driveways
- Minor industrial/institutional driveways
- Major residential driveways
- Minor residential driveways
- Other driveways

For the *HSM*, a driveway is considered 'Major' if it serves a location with 50 or greater parking stalls. Commercial driveways access retail locations while industrial/institutional driveways serve factories, warehouses, schools, hospitals, churches, offices, public facilities, and other places of employment.

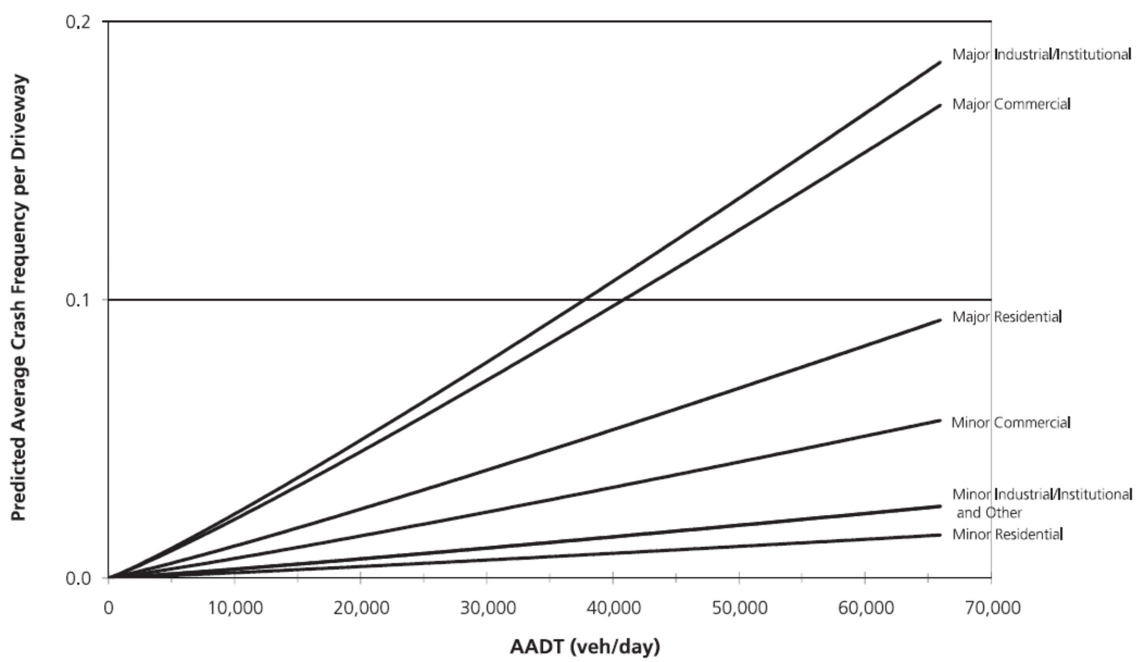
HSM prediction methods are available for the following types of roadway segments: Two-lane undivided arterials (2U), Three-lane arterials including a center two-way left-turn lane (TWLTL) (3T), Four-lane undivided arterials (4U), Four-lane divided arterials (i.e., including a raised or depressed median) (4D), and Five-lane arterials including a center TWLTL (5T). For Driveway Related Collisions for each of these facility types refer to *HSM* Figure 12-5 through Figure 12-9. ***Figure 168*** and ***Figure 169*** below illustrate the predicted crashes by individual driveway type for 2U and 4U roadways compared to AADT.

Figure 168 | Multiple Vehicle Driveway Related Collisions on Two-Lane Undivided Arterials (2U)



Source: Fig 12-5: Multiple Vehicle Driveway Related Collisions on Two-Lane Undivided Arterials (2U)

Figure 169 | Multiple Vehicle Driveway Related Collisions on Four-Lane Undivided Arterials (4U)



Source: Fig 12-7: Multiple Vehicle Driveway Related Collisions on Four-Lane Undivided Arterials (4U)

The following example illustrates how SPF coefficients are applied to each driveway type to predict the number of crashes per year.

Example:

What is the predicted Driveway Related (multiple vehicles) crashes per year for this urban arterial?

Roadway Type = Two-lane undivided arterials
Length of segment, L (mi) = 1 mile
AADT (vehicle/day) = 17,700 (Maximum Service Volume for LOS D using FDOT Generalized Urbanized Area Tables for 2 lane undivided arterials)
Number of Driveways = 30 driveways (10 minor commercial, 2 major residential, 15 minor residential, 3 minor industrial/institutional)

Solution:

Multiple-Vehicle collisions are estimated using HSM Equation 12-16 shown below.

$$N = \sum n_j \times N_j \times (\frac{AADT}{15000})^t$$

n_j= Number of driveways of driveway type j

The value of N_j and t is found from HSM Table 12-7 shown below.

Table 12-7. SPF Coefficients for Multiple-Vehicle Driveway Related Collisions

	Coefficients for Specific Roadway Types				
Driveway Type (j)	**2U**	**3T**	**4U**	**4D**	**5T**
Number of Driveway-Related Collisions per Driveway per Year (N_j)					
Major commercial	0.158	0.102	0.182	0.033	0.165
Minor commercial	0.050	0.032	0.058	0.011	0.053
Major industrial/institutional	0.172	0.110	0.198	0.036	0.181
Minor industrial/institutional	0.023	0.015	0.026	0.005	0.024
Major residential	0.083	0.053	0.096	0.018	0.087
Minor residential	0.016	0.010	0.018	0.003	0.016
Other	0.025	0.016	0.029	0.005	0.027
Regression Coefficient for AADT (t)					
All driveways	1.000	1.000	1.172	1.106	1.172
Overdispersion Parameter (k)					
All driveways	0.81	1.10	0.81	1.39	0.10
Proportion of Fatal-and-Injury Crashes (f_{dwy})					
All driveways	0.323	0.243	0.342	0.284	0.269
Proportion of Property-Damage-Only Crashes					
All driveways	0.677	0.757	0.658	0.716	0.731

Given 10 minor commercial, 2 major residential, 15 minor residential, 3 minor industrial/institutional driveways we can estimate the number of crashes as below:

Driveway Type	n_j	N_j	t	$n_j \times N_j \times (\frac{17700}{15000})^t$
Major commercial	0	0.158	1.000	0.000
Minor commercial	10	0.050	1.000	0.590
Major industrial/institutional	0	0.172	1.000	0.000
Minor industrial/institutional	3	0.023	1.000	0.081
Major residential	2	0.083	1.000	0.196
Minor residential	15	0.016	1.000	0.283
Other	0	0.025	1.000	0.000
Total				**1.151**

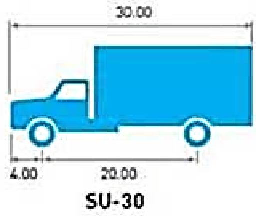
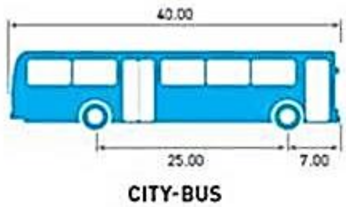
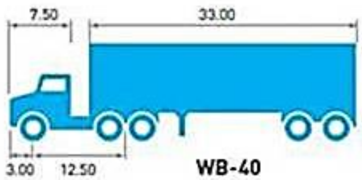
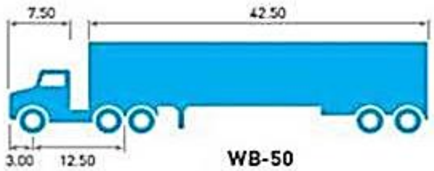
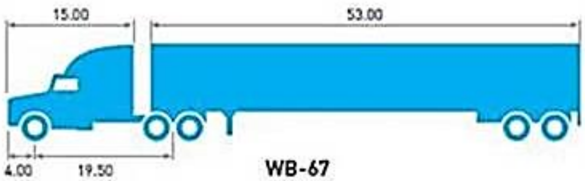
There will be 1.151 driveway related collisions per year.

Table 12-7 can be used to get a breakdown of how many of these are Fatality/Injury (FI) and Property Damage Only (PDO) crashes. In this case 32.3% is FI and remaining 67.7% are PDO.

Appendix B

In the table below, the vehicle examples refer to specific design vehicles which are mentioned in the *FDM*. The corresponding FHWA vehicle classification was determined to provide greater context in how they relate to the FDM.

Table 32 | FHWA Vehicle Classifications for FDM Freight Vehicles

Vehicle Example	FHWA Vehicle Classification
	Class 5 with only 2 axles (as shown) Class 6 with only 3 axles Class 7 with only 4 axles
	Class 4 with 2 or 3 axles
	Class 9 with 5 axles (as shown) Typically, WB-40 configuration is a Class 8 with 3 or 4 axles
	Class 9 with 5 axles
	Class 9 with 5 axles

Source: FHWA and FDM

Appendix C

U-Turn Sight Distance

Assumptions

- Passenger Car U-turn on a level road
- Perception/Reaction time (PRT) = 2.5 secs
- Driver will start to accelerate from zero mph to design speed after 180 degree turn. (Acceleration distance can be found in 2011 *AASHTO Green Book* Fig 2-24, Pg. 2-34)
- Turn radius = 15 feet (Minimum Turning Radii of Design Vehicles can be found in 2011 *AASHTO Green Book*, Table 2-2b, Pg. 2-7)
- Clearance distance = 50 feet
- π = 3.14

Table 33 | U-Turn Sight Distance for Various Seconds of PRT and Design Speed

Sight Distance (feet)				
Design Speed (mph)	Perception/Reaction Time			
	2 secs	2.5 secs	3 secs	3.5 secs
35	516	541	567	593
40	641	671	700	729
45	827	860	893	926
50	1037	1074	1110	1147
55	1252	1292	1333	1373
60	1542	1586	1630	1674

Source: Dr. Vergil Stover

Sample Calculation

- Calculate total Distance traveled:
  - Distance traveled along the circular part of U-turn = π x turn radius = 3.14 x 15 feet = 47.1 feet

According to 2011 AASHTO Green Book Fig 2-24, Pg. 2-34, going from 0 to 45 mph, the vehicle will travel 580 feet

Length of a passenger car = 19 feet (Design Vehicle Lengths can be found in 2011 AASHTO Green Book, Table 2-1b, Pg. 2-4)

Total Distance = 47.1 + 580 + 19 = 646.1 feet (say, 645 feet)

- Calculate total time spent:

Perception/Reaction time = 2.5 secs

Time to travel 645 feet @ rate of acceleration 3.77 feet/sec^2 = sqrt (645 x 2 / 3.77) = 18.5 secs. (Using the equation for starting from rest, distance = (1/2) x acceleration x time^2)

Total time = 2.5 + 18.5 = 21.0 secs

- Calculate Sight Distance:

Distance traveled by Opposing vehicle during this time = 1.47 x design speed x 21.0 secs =

1.47 x 45 x 21.0 = 1,390.1 feet (1.47 converts mph to feet/sec)

Clearance = 50 feet

Total distance = 1,390 + 50 = 1440 feet

Sight distance = Total distance – Distance traveled by vehicle to go from 0 mph to Design Speed = 1,440 – 580 = 860.1 feet (say 860 feet)

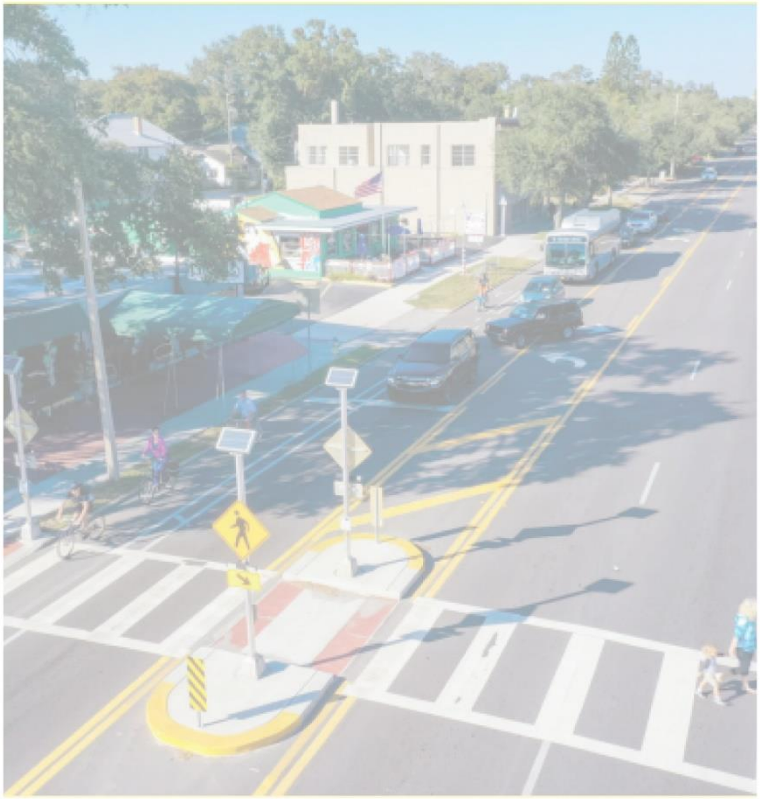
Other Notes: (Equation of Motion) Calculation of acceleration rate (= 3.77 feet /sec^2)

Calculation of acceleration rate = 3.77 feet /sec^2

$$v^2 = u^2 + 2as$$
$$v = 45mph, u = 0mph, s = 580ft$$
$$a = \frac{v^2}{2s} = 3.77$$

Also,

$$S = ut + \frac{1}{2}at^2$$
$$u = 0$$
$$t = \sqrt{2s/a} = \sqrt{2x645/3.77} = 18.5.$$



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