Access Management Guidelines
for the Urbanized Area

April 2013
Table of Contents

EXECUTIVE SUMMARY ............................................................................................................. 6

SECTION 1: INTRODUCTION TO ACCESS MANAGEMENT ....................................................... 7
1.1 What is Access Management? .......................................................................................... 7
1.2 Relationships between Land Use and Transportation ....................................................... 7
1.3 Principles of Access Management ..................................................................................... 8
1.4 Benefits of Access Management ....................................................................................... 9
1.5 Effect of Access Management on Local Economy.............................................................. 10

SECTION 2: DEVELOPING REGIONAL ACCESS MANAGEMENT GUIDELINES ......................... 11
2.1 Purpose of Regional Access Management Guidelines ....................................................... 11
2.2 Roadway Functional Classification/Access Management Categories ................................ 11
2.3 Implementation of Access Management Guidelines .......................................................... 13

SECTION 3: ACCESS SPACING STANDARDS .......................................................................... 14
3.1 Intersection Functional Area ........................................................................................... 14
3.1.1 Concerns .............................................................................................................. 15
3.1.2 Benefits ................................................................................................................. 15
3.1.3 Guidelines............................................................................................................. 15

Example .................................................................................................................................. 17
3.2 Signalized Access Spacing ............................................................................................. 19
3.2.1 Concerns .............................................................................................................. 20
3.2.2 Benefits ................................................................................................................. 20
3.2.3 Guidelines............................................................................................................. 20

Example .................................................................................................................................. 22
3.3 Unsignalized Access Spacing ......................................................................................... 23
3.3.1 Concerns .............................................................................................................. 23
3.3.2 Benefits ................................................................................................................. 24
3.3.3 Guidelines............................................................................................................. 24

Example .................................................................................................................................. 25
3.4 Driveway Corner Clearance ........................................................................................... 26
3.4.1 Concerns .............................................................................................................. 27
3.4.2 Benefits ................................................................................................................. 27
5.2 TIA Elements................................................................................................................ 57
5.3 Other Road Users......................................................................................................... 60
SECTION 6: REFERENCES...................................................................................................... 62
LIST OF FIGURES

Figure 1: Relation between Land Use and Transportation ................................................................. 8
Figure 2: Relation between Land Access and Mobility ................................................................. 12
Figure 3: Physical Area versus Functional Area .............................................................................. 14
Figure 4: Upstream Minimum Functional Length ............................................................................. 16
Figure 5: Driveways within the Functional Area of the Intersection Race Street/Main Street ......... 19
Figure 6: Intersection Spacing ....................................................................................................... 19
Figure 7: Prospect Avenue Corridor from Marketview Drive to Town Center Boulevard ............... 23
Figure 8: Florida Avenue Corridor between Vine Street and Race Street ....................................... 26
Figure 9: Driveway Corner Clearance .......................................................................................... 27
Figure 10: Driveway Spacing ......................................................................................................... 28
Figure 11: Directional Median ........................................................................................................ 30
Figure 12: Full median .................................................................................................................. 30
Figure 13: Approach Sight Triangles ............................................................................................ 34
Figure 14: Departure Sight Triangles ............................................................................................ 35
Figure 15: ISD Example Illustration - Left sight triangle for the single-unit truck ......................... 42
Figure 16: Driveway Throat Length ............................................................................................. 45
Figure 17: Two-Way Left-Turn Lane ............................................................................................. 46
Figure 18: Raised median with pedestrian refuge on Philo Road in Urbana ................................. 47
Figure 19: Left Turn Lane Guideline for Two-Lane Road <= 40 mph ........................................... 51
Figure 20: Left Turn Lane Guideline for Two-Lane Road at unsignalized intersections - 45 mph ... 51
Figure 21: Left Turn Lane Guideline for Two-Lane Road at unsignalized intersection - 50 mph ...... 52
Figure 22: Left Turn Lane Guideline for Two-Lane Road at unsignalized intersection - 55 mph ...... 52
Figure 23: Left Turn Lane Guideline for Two-Lane Road - 60 mph .............................................. 53
Figure 24: Right Turn Lane Guideline for Two-Lane Roadway .................................................... 53
Figure 25: A left turn lane example illustration using Figure 19 .................................................... 54
LIST OF TABLES

Table 1: Perception-Reaction Distance ($d_1$) and Maneuver Distance ($d_2$) ........................................ 16
Table 2: Recommended Upstream and Downstream Functional Distance ........................................ 17
Table 3: Stopping Sight Distance (SSD) .............................................................................................. 17
Table 4: Correlation between cycle lengths, signal spacing and progression speed ............................ 20
Table 5: Criterion for Deviations from an Adopted Uniform Signalized Intersection Spacing .......... 21
Table 6: Guidelines for unsignalized access spacing on suburban roads ........................................... 25
Table 7: Median opening spacing guidelines ...................................................................................... 31
Table 8: Summary Table for CUUATS Recommended Access Spacing Standards ............................ 32
Table 9: Length of Sight Triangle Leg for Uncontrolled Intersections ............................................. 36
Table 10: Time Gap for Stop Controlled Intersections ....................................................................... 36
Table 11: Intersection Sight Distance for Stop-Controlled Intersections ....................................... 37
Table 12: Time Gap for Yield Controlled Intersections ...................................................................... 38
Table 13: Intersection Sight Distance for Yield-Controlled Intersections ........................................ 38
Table 14: Time Gap for Yield Controlled Intersections ...................................................................... 39
Table 15: Intersection Sight Distance for Left Turn from Major Road ............................................. 40
Table 16: Adjustment Factors for Sight Distance Based on Approach Grade ...................................... 40
Table 17: Combination of Driveway Throat Width and Turning Radii .............................................. 44
Table 18: Minimum Driveway Throat Length at Signalized Access Driveways ................................. 45
Table 19: Application of TWLTL vs. Non-Traversable Medians ..................................................... 48
Table 20: Recommended Median Width for Non-Traversable Median .............................................. 48
Table 21: Recommended Median Width for Two-Way Left Turn Lanes (TWLTL) ............................. 49
EXECUTIVE SUMMARY

This objective of this document is to provide access management guidelines for the Champaign-Urbana urbanized area. The purpose of the regional access management guidelines is to provide techniques that CUUATS member agencies can use to control access between the roadways and the adjacent land uses in the Champaign-Urbana urbanized area, while preserving the functional integrity of the local roadway system in terms of safety, capacity, and speed.

Access management standards present regulatory and design guidelines to ensure proper balance between land use access and mobility based on roadway function. The majority of streets in the Champaign-Urbana community provide for conflicting functions by offering through movement of traffic and access to property abutting those streets. Those conflicts between access and through movement become most evident on streets intended to primarily serve the needs of through traffic. This document provides concepts of access management important to balance land use access and mobility. Furthermore, spacing and design recommendations along with guidelines to conduct traffic impact analyses are provided.

The techniques described in this document are a synthesis of design considerations that have been used by a variety of transportation engineers and planners in different parts of the United States. While some of them have resulted from specialized studies, others evolved over time from the experiences of several transportation agencies. Together, they provide a conceptual understanding of access control problems. However, they should not be taken as acceptable design standards for all locations and on all streets. Local policies and regulatory standards must be examined by each CUUATS member agency in conjunction with any design or concepts proposed in this document.

The information provided in the document, including the figures and examples, should be used as guidelines by CUUATS member agencies to ensure proper access spacing and design in the urbanized area. The recommended guidelines may not be suitable for every situation. The responsible agencies should review each project on a case by case basis considering specific (if any) site limitations and by applying sound engineering judgment.
SECTION 1: INTRODUCTION TO ACCESS MANAGEMENT

1.1 What is Access Management?

Access management is a governmental function that provides or ensures proper and safe access to land development while simultaneously preserving the flow of traffic on the surrounding road systems in terms of safety, capacity needs, and speed. It is a systematic mean of balancing the access and mobility requirements of streets and roads. It involves the coordination between land use and transportation development practices to manage the location, design, and operation of driveways, median openings, and street connections to roadways.¹

1.2 Relationships between Land Use and Transportation

Access design and location recognize that access control elements, just like traditional geometric elements, must progress in a logical manner that leads to improved travel capacity, safety, and maintenance of travel speeds. Modern access management requires that land use planning and development be coordinated with transportation. It is how to maintain and transform roadside environments into safe, accessible, and viable areas in the years ahead.

The relationship between transportation and land use is sometimes described in terms of a continuous cycle of obsolescence. The construction or reconstruction of a roadway provides increased accessibility to an area, which tends to raise land values and spurs development or redevelopment. As development occurs, traffic continues to mount. Increased business and strip development along the roadway brings more driveways, more conflicts, and more congestion reaching intolerable proportions and the roadway loses functionality. Eventually traffic service levels drop so low that further roadway improvements or completely new facilities are required, and the cycle starts again². Figure 1 shows the relation between land use and transportation. This phenomenon occurs gradually, “almost naturally,” and is caused by a large number of separate decisions in the private and public sectors with little comprehensive guidance. The objective of access management techniques is to prevent this cycle from occurring so rapidly.

¹ NCHRP Report 348
² Bishop, K., 1989
1.3 Principles of Access Management

Access management standards present regulatory and design guidelines to ensure proper balance between land use access and mobility based on roadway function. Implementing access management guidelines helps provide a safe and efficient transportation system. The principles of access management are to:

- Promote intersection hierarchy.
- Reduce the number of conflict points by limiting the number of driveways and median openings.
- Provide adequate spacing between street connections, (e.g. intersections, driveways).
- Decrease interruption in traffic flow by reducing the interference of turning and through traffic.
- Provide median treatments to increase safety and roadway capacity and manage access along those medians.
- Reduce conflicts between motorized and non-motorized traffic (bicycles and pedestrians).
- Maintain progressive speeds along arterials.

3 FHWA-HOP-12-006, April 2012
• Provide adequate property access while maintaining roadway Level of Service (LOS).
• Provide proper on-site circulation to reduce the number of driveways and manage driveway design.

1.4 Benefits of Access Management

An effective access management plan plays an important role in maintaining the functionality of the regional roadway network by providing efficient land use access and promoting faster and safer travel.

An important benefit of access management is a coordinated approach towards transportation and land use planning. The following benefits can be realized by implementing appropriate access management policies in the community:

• **Improving Roadway Safety:** Studies have shown a strong correlation between an increase in crashes and the increase in the number of commercial establishments when expressed by the total number of driveways per mile. Roadway safety can be related to improved access design and fewer conflict locations. The location of access points along a roadway also has a significant impact on the safety and efficiency of pedestrian movements. Poor planning can create areas of pedestrian and vehicular conflict where driveways meet sidewalks.

Implementing proper access spacing and design standards help reduce crash potential.

• **Improved Traffic Operations:** Inappropriate intersection spacing, median openings, and driveway design add to congestion and delay along major urban corridors; contributing to operational delays. Several case studies show that providing appropriate access spacing and design standards help maintain the functionality of the roadway (desired capacity) and increase safety.

• **Long-term Integrity of Arterial Functions:** As the traffic volume increases due to future developments, the congestion along arterial roadways may increase due to delay and crashes. Each new driveway along an urban arterial affects traffic operation and increases conflict points. Access control ensures that an arterial roadway will continue to have high traffic movement capability; therefore, preserving its long-term carrying capacity saving future investment costs. If left uncontrolled, the carrying capacity and safety of the roadway can be degraded to the extent that people will avoid using the roadway, possibly shifting into residential streets. These both defeat the traffic movement function of arterial streets and affect businesses along the corridor.

• **Preserve Transportation Infrastructure Investment:** Once roadway safety and operational conditions deteriorate, the functionality of the roadway is lost. Rerouting traffic may result in loss of investment on the roadway and affect businesses along the corridor. Improvements to existing infrastructure can be expensive. By implementing access management standards, the

---

4 TRB Circular No. 456, 1996
local agencies benefit from low roadway maintenance, and potentially delaying and preventing costly improvements.

- **Economic Growth along the Corridor:** Well-designed access connections and driveway standards provide property owners and customers with a safe and efficient access to businesses along the corridor. Landscaping and quality access also have a positive impact on local businesses. Even though business owners are concerned about the impact of access management policies on their properties, studies show that providing appropriate access management does not have a negative impact on business activity\(^5\).

- **Cost savings, through reduced number of crashes and energy consumption:** The potential for vehicular and other modal conflicts or crashes is significantly reduced with the careful application of access management techniques. These improvements in highway safety can yield substantial cost savings of personal injuries, lost wages and productivity, insurance, litigation, and property damage. Access management also helps preserve the efficiency of roadways by reducing the public investments needed for expensive remedial measures such as traffic controls.

Vehicle speed and changes in speed are two important factors in fuel consumption. Access control can have a positive impact on changes in speed and indirectly on through traffic vehicle speeds. In addition to speed, access management also has a significant impact on capacity of a roadway and air quality.

### 1.5 Effect of Access Management on Local Economy

Ensuring that customers reach the site safely, easily and without much delay is important for the growth, expansion and prosperity of business centers. Customers are more likely to avoid a business center with limited parking spots and/or if the access road is known to be congested and/or unsafe. Improper driveway design and on-site circulation may also discourage customers from patronizing the business. It is beneficial for a business to have access from local and collector roads rather than minor and major arterials. Several “before and after” studies show that the vast majority of businesses do better after access management projects are completed. The Federal Highway Administration (FHWA) published a document titled “Safe Access is Good for Business” detailing the impacts of various access management elements on businesses\(^6\).

---

\(^5\) FHWA 2003, FHWA-OP-03-066  
\(^6\) FHWA 2006, FHWA-HOP-06-107
SECTION 2: DEVELOPING REGIONAL ACCESS MANAGEMENT GUIDELINES

2.1 Purpose of Regional Access Management Guidelines

The purpose of the regional access management guidelines is to provide techniques that CUUATS member agencies can use to control access between the roadways and the adjacent land uses in the Champaign-Urbana urbanized area, while preserving the functional integrity of the local roadway system in terms of safety, capacity, and speed. The techniques described in this document are a synthesis of design considerations that have been used by a variety of transportation engineers and planners in different parts of the United States. Some of the techniques and guidelines have resulted from specialized studies. Others evolved over time from the experiences of several transportation agencies. Together, they provide a conceptual understanding of access control problems. However, they should not be taken as acceptable design standards for all locations and on all streets. Local policies and regulatory standards must be examined by each CUUATS member agency in conjunction with any design or concepts proposed in this document. This document is intended to provide recommended guidelines for access management to be implemented by the CUUATS member agencies. The recommended guidelines set forth criteria to be considered for managing access related issues of developing the physical and functional aspects of the roadway.

2.2 Roadway Functional Classification/Access Management Categories

The roadway functional classification is an important element of access management. Regional roadways are categorized based on their function in the local roadway system. The roadway system is classified into freeways/interstates, arterials, collectors, and local roadways. Figure 2 shows the relation between land access and mobility for the different roadway categories. Maintaining proper connection between roadways is an important access management element. Ideally, driveways should connect to local roads and collectors and not to arterial roadways. Land access should be provided across low speed, low volume roads rather than high speed corridors.
The urban roadways in Champaign-Urbana are divided according to the following functional classification:

**Major Arterials**: Major arterials are the most important roadways in the regional system. They carry high volumes of traffic and provide long distance, high speed travel. Major arterials provide limited accessibility and the highest level of mobility. They feed the regional traffic to interstates/freeways. Direct property access from major arterials is not recommended. The average daily traffic (ADT) for major arterials in Champaign-Urbana is equal or greater than 12,000.

**Minor Arterial**: Minor arterials are similar to the major arterials but are used to serve comparatively lower traffic for shorter distances. They have limited access to adjacent land uses. The ADT range in Champaign-Urbana for this type of roadway is from 6,000 – 12,000.

**Collectors**: Collectors are used to serve moderate connecting traffic movements between arterials and local streets and have a higher degree of access than the minor arterials. Collectors tend to provide an equal level of mobility and access. The ADT for collector streets in Champaign-Urbana usually ranges from 2,500 – 6,000.

**Local Streets**: Local streets accommodate traffic from residential neighborhoods and local businesses and provide a connection to the collector roadways. They are characterized for having low volumes, low speeds, and being used for short distance travel. They have the highest degree of land use access and limited mobility. The ADT for local roads in Champaign-Urbana is usually less than 2,500.

---

7 Federal Highway Administration, Access Management Principles Presentation, 2011
8 Champaign County Regional Planning Commission, Long Range Transportation Plan 2035, 2009
2.3 Implementation of Access Management Guidelines

Access management is commonly overlooked in favor of more expensive alternatives. Access management requires coordination between land use and transportation, as well as within and across government agencies that share jurisdiction over a corridor. Regional corridor planning initiatives, intergovernmental agreements, access management plans, public involvement, combined review committees, and joint policy resolutions are among the methods that should be applied to improve coordination on access management issues. The FHWA Office of Operations’ “Access Management Program Plan” suggests the following planning, regulatory, and design strategies to implement access management:

- Policies, directives, and guidelines issued by state and local agencies having permit authority on development and roadway infrastructure improvements.
- Regulations, codes, and guidelines that are enforceable.
- Acquisition of access rights by states and local jurisdictions that serve to protect transportation interests and enable sufficient infrastructure to be built.
- Land development regulations by state and local jurisdictions that address property access and related issues.
- Development review and impact assessments by state and local jurisdictions.
- Good geometric design of transportation facilities.
- Understanding of access implications by businesses and property owners.

Although access management techniques are recognized to enhance traffic conditions in the transportation network, property owners may be apprehensive about access management implementation in their neighborhood. Therefore, it is important to involve the general public in the planning process and explain to them the benefits of access management. It is also crucial to clearly identify the conditions and location under which these techniques ought to be deemed.

Some variance may be acceptable when implementing access management standards. Each situation should be studied on a case by case basis by the appropriate local agencies before allowing alterations to the recommended access management standards.
SECTION 3: ACCESS SPACING STANDARDS

The increase in the number of access points along a roadway corridor introduces additional conflict points, causing friction in traffic flow, higher potential of traffic crashes, and additional congestion and delay. The location and spacing of street connections, driveways, and median openings are important access management techniques contributing to the overall safety and functional integrity of the roadway system. Excessive and closely spaced accesses can cause safety, operational and capacity issues; while on the other hand, too few may raise land access concerns. Ideally, the roadways with higher mobility (arterials) have larger access connection spacing compared to roadways providing land access (local roads or collectors).

3.1 Intersection Functional Area

Intersections are comprised of physical and functional areas, as shown in Figure 3 below. The physical extent of an intersection is the area bound by the intersection legs. The functional area extends upstream and downstream of the intersection, and includes the roadway length required for vehicle storage and maneuvering. The upstream functional area of an intersection depends on the vehicle queuing (storage length), driver perception-reaction time, and the distance required for decelerating or stopping. The downstream functional area of an intersection is the distance required by the driver to clear the intersection, and be able to perceive and react to a conflict downstream of the intersection.

Access connections are not recommended in the intersection functional area. Driveways or median openings within the functional area create conflict points, which the driver approaching or exiting an intersection may not be able to negotiate safely. The functional area of an intersection should be considered when evaluating potential driveway locations. Ideally, the functional areas of adjacent intersections should not overlap. The integrity of the intersection functional area is maintained by intersection spacing, median spacing, driveway spacing, and corner clearance.

Figure 3: Physical Area versus Functional Area

---

9 FHWA-HRT-04-091, August 2004
3.1.1 Concerns

Although it is highly recommended to avoid access in the functional area of an intersection, it is difficult to implement this recommendation in urban areas with short street spacing and small property frontages. Driveways and median openings should be limited within the intersections’ functional areas as much as possible. Providing access openings within the functional area could lead to the following issues:\(^{10}\):

- Increase the number of conflict points and the crash rates.
- Inconvenience the users (drivers).
- Delay vehicles both accessing the property served by the driveway and using the intersection.

3.1.2 Benefits

Limiting or eliminating (if possible) any direct driveway access within an intersection functional area would improve the efficiency of the intersection by:

- Allowing traffic to move smoothly without interference.
- Avoiding any delay that may result from those interferences.
- Reducing the number of decisions to be made by the driver while traveling\(^ {11}\).
- Eliminating turning movement conflicts.
- Improving safety along the roadway corridor.

Existing driveways within the functional area can be retrofitted by consolidating the number of driveways through improved internal site access, providing alternate access to the site, or by installing raised medians to avoid left turns to and from the site.

3.1.3 Guidelines

The minimum upstream and downstream functional area of an intersection can be calculated using the following guidelines.

**Upstream Functional Area**

The upstream functional area of an intersection is based on the stopping sight distance and the queuing requirements. The upstream functional area includes the following three components. Figure 4 illustrates the elements used to estimate the minimum upstream functional area.

- **Perception-Reaction Distance** (\(d_1\)): This is the distance travelled by the driver during the perception-reaction time, based on the vehicle speed. Table 1 shows the distance travelled during the perception-reaction time of 1.5 seconds in urban areas.

\(^{10}\) Transportation Research Board, Access Management Manual, 2003

\(^{11}\) FHWA-SA-10-002, February 2010
• **Maneuver Distance** \( (d_2) \): This is the distance required by a vehicle to travel from the through lane to the turn lane and come to a complete stop. The maneuver distance can be separated into the distance traveled while braking and moving laterally into a turn bay and the distance traveled to come to a complete stop at the end of the storage queue.

• **Queue Storage Length** \( (d_3) \): This is the length required to have the turn lane to store vehicles waiting to make the turn. Section 4.4: Auxiliary Lanes details the procedures to identify the need of a turn bay. The turn bay length and design should be calculated based on the procedure presented in Chapter 9 of AASHTO’s “Policy on Geometric Design of Highways and Streets”.

![Figure 4: Upstream Minimum Functional Length](image)

Table 1: Perception-Reaction Distance \( (d_1) \) and Maneuver Distance \( (d_2) \)^10,12

<table>
<thead>
<tr>
<th>Speed (mph)</th>
<th>Perception Reaction-Dist. ( (d_1) ) (ft.)</th>
<th>Maneuver Distance ( (d_2) ) (ft.)</th>
<th>Total ( (d_1 + d_2) ) (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>55</td>
<td>110</td>
<td>165</td>
</tr>
<tr>
<td>30</td>
<td>65</td>
<td>160</td>
<td>225</td>
</tr>
<tr>
<td>35</td>
<td>75</td>
<td>215</td>
<td>290</td>
</tr>
<tr>
<td>40</td>
<td>90</td>
<td>275</td>
<td>365</td>
</tr>
<tr>
<td>45</td>
<td>100</td>
<td>345</td>
<td>445</td>
</tr>
<tr>
<td>50</td>
<td>110</td>
<td>425</td>
<td>535</td>
</tr>
<tr>
<td>55</td>
<td>120</td>
<td>510</td>
<td>630</td>
</tr>
<tr>
<td>60</td>
<td>132</td>
<td>605</td>
<td>737</td>
</tr>
</tbody>
</table>

**Downstream Functional Area**

After exiting the intersection, the driver requires adequate distance to safely negotiate any potential conflict. The downstream functional area depends on several criteria such as stopping sight distance, influence distance, perception-reaction time, and the right-turn conflict overlap.
The following tables show the recommended minimum upstream and downstream functional area based on roadway functional classification and roadway ADT.

Table 2: Recommended Upstream and Downstream Functional Distance

<table>
<thead>
<tr>
<th>Roadway Classification</th>
<th>Average Daily Traffic (ADT)</th>
<th>Upstream Functional Distance (ft.)</th>
<th>Downstream Functional distance (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Desirable</td>
<td>Limiting</td>
</tr>
<tr>
<td>Major Arterials</td>
<td>&gt; 12,000</td>
<td>1,320</td>
<td>d₁+d₂+d₃¹</td>
</tr>
<tr>
<td>Minor Arterials</td>
<td>6,000 – 12,000</td>
<td>660</td>
<td>d₁+d₂+d₃¹</td>
</tr>
<tr>
<td>Collectors</td>
<td>2,500 – 6,000</td>
<td>330</td>
<td>SSD²</td>
</tr>
<tr>
<td>Local Streets</td>
<td>2,500 or less</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

Note: 1. Perception-reaction distance (d₁) + maneuver distance (d₂) + queue storage length (d₃)
2. Stopping sight distance based on speed limit, presented in Table 3

Table 3: Stopping Sight Distance (SSD)

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Stopping Sight Distance (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>155</td>
</tr>
<tr>
<td>30</td>
<td>200</td>
</tr>
<tr>
<td>35</td>
<td>250</td>
</tr>
<tr>
<td>40</td>
<td>305</td>
</tr>
<tr>
<td>45</td>
<td>360</td>
</tr>
<tr>
<td>50</td>
<td>425</td>
</tr>
<tr>
<td>55</td>
<td>495</td>
</tr>
<tr>
<td>60</td>
<td>570</td>
</tr>
</tbody>
</table>

Example

Problem
What is the functional area for the intersection of Main Street and Race Street in the City of Urbana? Main Street is classified as a minor arterial with a 30 mph speed limit and Race Street as a collector with a 30 mph speed limit. Direct measurements on a GIS based map give the following values for queue storage available at this intersection:
- Race Street Northbound Left turn: 94 ft.
- Race Street Southbound Left turn: 106 ft.
- Main Street Eastbound Right turn: 62 ft.

12 AASHTO, 2001
Solution

According to Table 2 above, the desirable and limiting values for the upstream and downstream functional distances should be:

a. On Main Street (minor arterial):
   - **Desirable values**
     - Upstream functional distance = 660 ft.
     - Downstream functional distance = 660 ft.
   - **Limiting values**
     - Upstream functional distance = $d_1 + d_2 + d_3$
       Based on Table 1, $d_1 + d_2 = 225$ ft.
       $d_3 = 62$ ft.
       Limiting Upstream functional distance = 287 ft.
     - Downstream functional distance = SSD = 200 ft. (Table 3).

b. On Race Street (collector):
   - **Desirable values**
     - Upstream functional distance = 330 ft.
     - Downstream functional distance = 330 ft.
   - **Limiting values**
     - Upstream functional distance = SSD = 200 ft.
     - Downstream functional distance = SSD = 200 ft.

The example above found desirable and limiting minimum values for the upstream and downstream functional distance for the intersection of Main Street and Race Street in Urbana. Those values define the functional area of the intersection and there should be no access within such area.

Figure 5 shows the existing intersection of Main Street and Race Street. Two driveway openings can be seen at a very close distance to the intersection: one on Main Street about 20 ft. from the intersection, and the other one on Race Street 116 ft. from the intersection.
Based on the results above, those openings fall within the functional area of the intersection. Therefore, such accesses are not in compliance with the proposed access recommendations regarding minimum upstream and downstream functional area based on roadway functional classification and roadway ADT.

### 3.2 Signalized Access Spacing

Signal spacing is defined as the distance between two successive at-grade signalized intersections, measured between the closer curb/edge of the intersection. Optimum spacing of the intersections has a significant impact on safety, traffic operations, and level of service of the corridor. Each additional traffic signal reduces travel speed while increasing travel time/delay. The optimal spacing of signals depends on the cycle length and the posted speed limits. Long cycle lengths and high speeds usually require longer distances between signals. Shorter cycle lengths and lower speeds enable closer spacing between signals.
3.2.1 Concerns

Closely and irregularly spaced signalized intersections cause frequent stopping which tends to:

- Increase congestion and delay.
- Increase the fuel consumption and vehicular emissions.
- Increase the crash potential.
- Potentially increase red light running.
- Force drivers to use alternate roadways to avoid congestion.

3.2.2 Benefits

Appropriate signal spacing is critical for traffic progression on urban roadways and is directly related to roadway efficiency. Large and regular signal spacing inclines to:

- Maximize capacity and improve safety.
- Provide efficient traffic progression on major urban arterials.
- Prevent overlapping of functional areas of adjacent intersections.
- Reduce “stop and go” traffic; thereby, increase safety and minimize vehicle emissions, fuel consumption and delay.

Adequate signalized intersection spacing maybe difficult to implement in developed urban areas; however, closing, relocating, and consolidating driveways/street connections should be considered as needed to provide adequate spacing of signalized intersections. Effort should be made to retrofit the signal spacing standard on existing corridors whenever possible.

3.2.3 Guidelines

Uniform, or near uniform spacing of signals enables through bands to be equal to the green time. Cycle length, speed and signal spacing should be balanced to produce the maximum bandwidths progression. Choice of appropriate cycle length depends on critical intersection capacity, pedestrian crossing needs, and signal coordination consideration. The following table shows the recommended signal spacing for various cycle lengths and speed limits:

<table>
<thead>
<tr>
<th>Cycle length (s)</th>
<th>Speed (mph)</th>
<th>Signal Spacing (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>1,100</td>
<td>1,320</td>
</tr>
<tr>
<td>70</td>
<td>1,280</td>
<td>1,540</td>
</tr>
<tr>
<td>80</td>
<td>1,470</td>
<td>1,760</td>
</tr>
<tr>
<td>90</td>
<td>1,630</td>
<td>1,980</td>
</tr>
<tr>
<td>120</td>
<td>2,200</td>
<td>2,640</td>
</tr>
</tbody>
</table>

Table 4: Correlation between cycle lengths, signal spacing and progression speed

The values under the red line are undesirable long values of signal spacing and should be avoided.

The following signal spacing is recommended for the Champaign Urbana Urbanized Area (CUUATS):

- A minimum of ¼ mile (1,320 ft.) spacing should be maintained for minor arterials (ADT<12,000) assuming a 60 second cycle length and considering a speed limit of 30 mph.

- A minimum signal spacing of ½ mile (2,640 ft.) should be used for major arterials (ADT>12,000) where cycle lengths usually fall between 80 and 120 seconds and speed between 35 and 45 mph. As the traffic volume increases along arterials, longer cycle length can be used to minimize lost time\textsuperscript{10}.

Sometimes the signal location is already established or the spacing is restricted due to natural barriers, street location, or land ownership constraints. When deviation from ideal signal spacing is required, the minimum bandwidth criterion for through traffic (Table 5) can be used to determine the alternate signal spacing.

### Table 5: Criterion for Deviations from an Adopted Uniform Signalized Intersection Spacing\textsuperscript{10}

<table>
<thead>
<tr>
<th>Functional Roadway Classification</th>
<th>Average Daily Traffic (ADT)</th>
<th>Ideal Signalized Intersection Spacing (ft.)</th>
<th>Minimum Bandwidth Criteria For Deviation from the Ideal Spacing\textsuperscript{a,b}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Arterial</td>
<td>&gt; 12,000</td>
<td>2,640</td>
<td>Peak Hour: 50% Off-Peak Hour: 45%</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>6,000 – 12,000</td>
<td>2,640 ± 300\textsuperscript{c}</td>
<td>Peak Hour: 40% Off-Peak Hour: 30%</td>
</tr>
<tr>
<td>Collector</td>
<td>2,500 – 6,000</td>
<td>Variable</td>
<td>Progression generally not a criterion</td>
</tr>
</tbody>
</table>

Note: \textsuperscript{a} In addition to minimum bandwidth, the following conditions are also important to specify for the evaluation of a deviation request: the cycle length and progression speed for the peak hour and off-peak periods, the segment of roadway to be used in the analysis, the methodology/model to be used, and any relevant local conditions.

\textsuperscript{b} Where signalization already exists and the progression bandwidth as a percent of cycle length is less than what is shown in the table, an additional signal may be permitted if it does not result in a reduction of progression bandwidth.

\textsuperscript{c} A signalized intersection located within 300 ft. of the ideal location is generally acceptable without detailed analysis. It is important that signal locations are based on traffic projections for a 5-year (or other appropriate number of years) period, after development is occupied, and is coordinated with public street signal needs.
Example

Problem
What should the minimum spacing be between two consecutive signalized intersections in a corridor along Prospect Avenue (minor arterial)?

Solution
According to Table 5 above, the ideal minimum distance between two signalized intersections on a minor arterial should be 2,640 ft. The signalized intersection can be located within 300 ft. of the ideal location without a need of a detailed analysis. Such ideal minimum distance can be altered by 40% based on the bandwidth criteria.

The figure below shows a segment of Prospect Avenue from Marketview Drive to Town Center Boulevard.

There are 4 signalized intersections within a 0.27 mile corridor (1,446 ft.).

- Prospect Avenue and Marketview Drive (Intersection 1)
- Prospect Avenue and a driveway (Intersection 2)
- Prospect Avenue and Baytowne Drive (Intersection 3)
- Prospect Avenue and Town Center Boulevard (Intersection 4)

This segment of Prospect Avenue is classified as a minor arterial. Referring to the Table above, the ideal signal spacing should be 2,640 feet. However, the figure above shows that the spacing between the signalized intersections are not only less than the ideal value but also less than the value obtained after alteration due to bandwidth criterion (40% of ideal spacing). These situations should be evaluated for possible mitigation along existing corridors, whenever possible.
3.3 Unsignalized Access Spacing

Unsignalized intersections are more common than signalized intersections. Unsignalized intersections usually occur between low volume arterials, collectors, local roads and driveways. They include stop-controlled, yield-controlled and uncontrolled intersections.

3.3.1 Concerns

Closely spaced and irregularly spaced intersections could lead to the following problems:

- Increased number of conflict points resulting in excessive congestion and delay and potentially higher crash rates.
- Potential induced friction in the flow of traffic due to frequent turn movements.
On the other hand, excessively large unsignalized access spacing may not provide the desired access to local businesses.

### 3.3.2 Benefits

Some of the advantages of regulating unsignalized access include:

- Increased capacity and reduced delay.
- Reduced conflict points, and thereby reduced crash potential.
- Improved site design.

### 3.3.3 Guidelines

The optimal intersection spacing depends on the following criteria:

- **Access Density**: It is the number of unsignalized intersections per mile. The relative crash rates increase as the number of unsignalized access per mile increases.

- **Stopping Sight Distance (SSD)**: It is the distance needed by the driver to react to a conflict and come to a complete stop. The stopping sight distance depends on the vehicle speed and is discussed in the AASHTO “Policy on Geometric Design of Highways and Streets”.

- **Intersection Sight Distance (ISD)**: It is the sight distance required by a vehicle waiting at the intersection to safely enter and cross the intersection. The intersection sight distance is discussed in detail in section 4.1.

- **Intersection Functional Area**: The intersection functional area defines the conflict area upstream and downstream of the intersection (See Figure 3).

- **Right-Turn Conflict Overlap**: The right turn conflict overlap occurs when a driver has to keep an eye on more than one intersection/access at a time when traveling through on a road. Such conflict which increases the driver’s workload is directly related to access spacing.

- **Influence Distance**: The influence distance includes two elements: the impact distance and the perception-reaction time. The impact distance is defined as the distance between an access (driveway) and the upstream location where the brake lights of the following vehicle are activated.

- **Egress Capacity**: The term “Egress Capacity” refers to the ability of a car to enter a roadway when exiting a property. Closely spaced intersections can restrict the number of cars entering the roadway from the unsignalized intersections. A minimum access spacing is recommended to maximize egress capacity.
The following unsignalized access spacing guidelines are recommended for the Champaign-Urbana urbanized area:

<table>
<thead>
<tr>
<th>Roadway Functional Classification</th>
<th>Average daily Traffic (ADT)</th>
<th>Undivided Roadway (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Arterial</td>
<td>&gt; 12,000</td>
<td>2,640</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>6,000 – 12,000</td>
<td>660</td>
</tr>
<tr>
<td>Collector</td>
<td>2,500 – 6,000</td>
<td>330</td>
</tr>
<tr>
<td>Local Roads</td>
<td>&lt; 2,500</td>
<td>100</td>
</tr>
</tbody>
</table>

The minimum acceptable spacing can be affected by surrounding land uses. Access spacing should be addressed on a case by case basis. When the unsignalized intersection is expected to be signalized in the future, signal access spacing should be followed. The proposed unsignalized intersection should satisfy the intersection sight distance criterion (Section 4.1) and in the case of a driveway, the driveway design guidelines (Section 4.2)

**Example**

**Problem**
What should be the spacing between unsignalized accesses along a minor arterial corridor?

**Solution**
Table 6 above indicates that the spacing between two consecutive unsignalized accesses along a minor arterial should be at least 660 ft.

The following figure shows a segment on Florida Avenue between Race Street and Vine Street. Florida Avenue is classified as a minor arterial.
The GIS aerial map of the corridor was used to estimate the unsignalized spacings between streets along the corridor as shown in the figure above. As it can be seen, all the spacings are less than the minimum recommendation (660 ft.).

The intersection of Pleasant Street and Florida Avenue is about 412 ft. away from the intersection of Florida Avenue and Vine Street (distance from A to B), and there are three driveways in between. Such situation should be avoided in order to maintain a safe environment for the neighborhood’s residents as much as the drivers.

### 3.4 Driveway Corner Clearance

Corner clearance is defined as the minimum distance between an intersection and a driveway. Placing driveways too close to the intersection raises issues regarding traffic operations, capacity, and safety. Corner clearance criterion helps remove the driveway from the intersection functional area.
3.4.1 Concerns

Failure to provide proper spacing between driveways and intersections creates the following concerns:

- Complicates driving activity near the intersection.
- Increases the number of conflict points near the intersection.
- Blocks driveway movements by vehicles queued at the intersection approaches, leading to driver frustration and delays.
- Blocks traffic by vehicles waiting to turn into the driveway.

3.4.2 Benefits

Sufficient corner clearance can be achieved by moving the driveway away from the intersection. Providing adequate corner clearance will create the following benefits:

- Less delay from queueing vehicles.
- Fewer conflict points.
- Additional time and space for vehicles to turn or merge safely across lanes.
- Adequate sight distance.
3.4.3 Guidelines

The corner clearance criterion is the same as the intersection functional area. A driveway should not be located within the functional area of an intersection. The criterion selected for intersection functional area in section 3.1 is recommended to be used for corner clearance.

Exceptions to the above guidelines may be considered in the following situations:

- No other reasonable access to the property is available. In such cases, directional driveways (i.e. right in/out, right in only, or right out only) may be required.
- Site specific study of the proposed driveway (prepared by an engineer licensed in Illinois and submitted by the applicant) determines that the proposed connection does not create a safety or operational problem.

In cases where exceptions to the guidelines are required, trip generation and judgment of a local agency engineer should be considered.

3.5 Driveway Spacing

Driveway spacing is the distance between two adjacent driveways, and is measured from the nearest edge of one driveway to the nearest edge of the next driveway (inclusive of the radii), as shown in Figure 10. Driveways should be spaced so the drivers can perceive and react to each access in succession. Driveway spacing is longer on collectors and arterials compared to local roadways.

Figure 10: Driveway Spacing

3.5.1 Concerns

Driveway spacing is difficult to implement in developed urban areas. Increased driveway density can cause:
• Congestion.
• Decreased egress capacity.
• Decreased travel speed along the corridor.
• Increased traffic crash potential.

3.5.2 Benefits

Sufficient driveway spacing can be achieved by mandating a minimum separation between driveways. Providing adequate driveway spacing will create the following benefits:

• Minimize conflicts from adjacent driveway movements and from through traffic on the adjacent street system.
• Maintain efficient traffic flow.
• Reduce the potential for conflict as vehicles enter and exit the roadway.
• Provide adequate sight distance.

3.5.3 Guidelines

Driveways should be located to minimize interruption with the through traffic flow. Driveways’ design guidelines should be satisfied before allowing a driveway. Volumes used for minimum driveway spacing requirements should be based on 25 year projected average daily traffic (ADT) volumes. The following guidelines can be used to determine the driveway spacing in the Champaign-Urbana urbanized area:

• All roadways with ADT volumes greater than 12,000 or major arterials: No driveway access allowed, public street access only. Right in/out driveways can be provided on major arterials spaced at least 1,320 feet apart.

• Residential roadways with ADT volumes between 2,500 and 12,000 (collectors and minor arterials): Driveway spacing will be governed by applicable municipal zoning ordinance.

• Commercial roadways with ADT volumes between 2,500 and 12,000 (collectors and minor arterials): The unsignalized access spacing criterion should be followed, unless:
  ✓ Traffic Impact Analysis determines otherwise.
  ✓ Restricted by lot width.
  ✓ Engineering judgment states otherwise.

• Right in/out driveways can be provided on a minor arterial (6,000 – 12,000 ADT) at 330 feet spacing.

• All roadways with ADT volumes less than 2,500 (local roads): Driveway spacing will be governed by applicable municipal zoning ordinance.
Whenever possible, the driveway access should be provided from local roads. Driveway access should be avoided on minor and major arterials. Driveways on arterials can be limited or eliminated by providing frontage and backage roads or shared driveways.

3.6 Median Opening Spacing

Raised medians are introduced to mitigate crash potential by providing refuge to pedestrians and by removing turning traffic from through movements. Median openings are provided at all signalized intersections and at unsignalized intersections of major urban roadways. Such opening can allow all turning movements (full median openings) or just left-turns and U-turns from the main roadway only (directional median openings). The following figures show directional and full median openings.

3.6.1 Concerns

Closely spaced median openings result in:

- Increased congestion.
- Excessive delay.

---

14 Georgia Department of Transportation, October 2009
15 Virginia Department of Transportation, December 2011
• Potential high crash rate.
Therefore, it is important to choose the appropriate median spacing in the planning stage.

3.6.2 Benefits

Providing adequate median spacing helps to:
• Improve traffic operation and overall highway safety.
• Reduce delay and the number of conflict points at the intersection.
• Reduce vehicular emissions and increase fuel economy.

3.6.3 Comparison between Full and Directional Medians

Both types of openings are known to allow left turns without disturbing through traffic. However, while full median openings are recommended at all signalized intersections; the directional median openings are emerging as more safe and efficient at unsignalized intersections between signals. The benefits of directional median openings over full median openings include:

• Less crashes than full median openings.
• Reduced number of conflict points compared to full median openings.
• More likely to be accepted by stakeholder groups.
• Reduced delay at downstream signalized intersections.\(^\text{16}\)

3.6.4 Guidelines

The following table shows the recommended median opening spacing for the Champaign-Urbana urbanized area.

Table 7: Median opening spacing guidelines\(^{10}\)

<table>
<thead>
<tr>
<th>Roadway Functional Classification</th>
<th>Average daily Traffic (ADT)</th>
<th>Median Opening Spacing (ft.)</th>
<th>Full Median Opening</th>
<th>Directional Median Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major Arterial</td>
<td>&gt; 12,000</td>
<td>2,640</td>
<td>1,320</td>
<td></td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>6,000 – 12,000</td>
<td>1,320</td>
<td>660</td>
<td></td>
</tr>
<tr>
<td>Collector</td>
<td>2,500 – 6,000</td>
<td>Not Applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Roads</td>
<td>&lt; 2,500</td>
<td>Median generally not used</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{16}\) Florida Department of Transportation, February 2006.
Median openings should be prohibited under the following situations:\textsuperscript{15}:

- Within the functional area of an intersection between two public roads.
- At locations that have high crash rates.
- Where an opening would be unsafe because of inadequate sight distance.

Median openings should be closed when the traffic volume warrants a signal, but where the signal spacing is inappropriate. Median openings with left turn bays should be spaced adequately to allow sufficiently storage for left turning vehicles.

3.7 Summary of Access Spacing

Table 8 summarizes the access spacing guidelines recommended for the Champaign-Urbana urbanized area.

<table>
<thead>
<tr>
<th>Roadway Functional Classification</th>
<th>Average Daily Volume (ADT)</th>
<th>Intersection Functional Area (ft.)</th>
<th>Signalized Access Spacing (ft.)</th>
<th>Unsignalized Access Spacing (ft.)</th>
<th>Driveway Spacing</th>
<th>Median Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Full Opening</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(ft.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Directional</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(ft.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Full Opening</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(ft.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Directional</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(ft.)</td>
<td></td>
</tr>
<tr>
<td>Major Arterial</td>
<td>&gt;12,000</td>
<td>1,320</td>
<td>2,640</td>
<td>2,640</td>
<td>N/A</td>
<td>1,320</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,320</td>
<td>2,640</td>
</tr>
<tr>
<td>Minor Arterial</td>
<td>6,000-12,000</td>
<td>660</td>
<td>1,320</td>
<td>660</td>
<td>660</td>
<td>330</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>330</td>
<td>660</td>
</tr>
<tr>
<td>Collector</td>
<td>2,500 – 6,000</td>
<td>330</td>
<td>1,320</td>
<td>330</td>
<td>330</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Local Street</td>
<td>&lt; 2,500</td>
<td>100</td>
<td>N/A</td>
<td>100</td>
<td>MZO\textsuperscript{1}</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note: \textsuperscript{1} Municipal Zoning Ordinance
SECTION 4: ACCESS DESIGN STANDARDS

Access design criteria are also to be considered in access management in the Champaign-Urbana Area. Because of their effects on conflicts and interference between through and turning vehicles at intersections, elements such as intersection sight distance, driveways geometrics, median design, auxiliary lanes and frontage/backage roads are the main elements detailed in this section.

Concerns

Implementing access design standards helps preserve the public investment by limiting the conflict points and the interference between through and turning vehicles. Therefore, improper access design elements can greatly and negatively impact the traffic flow at intersections. Studies have shown that improper access design greatly disrupts the traffic flow at intersections by:

- Creating an unsafe environment for a vehicle to enter or cross the intersection (obstruction in intersection sight triangle).
- Increasing the crash potential (high frequency of driveway access along a main road, inadequate turning radius, improper median geometrics, etc.).
- Resulting in bad operations at the intersection (backage/frontage roads are provided too close to the main intersection, etc.).

Benefits

Providing proper access design helps:

- Improve safety by providing adequate sight distance at intersections.
- Reduce the speed difference between through and turning vehicles.
- Minimize the number of conflict points at an intersection.
- Provide adequate storage of turning vehicles.
- Facilitate the entry and exit of vehicles at a driveway.

The following section discusses the various design elements and standards applicable in the Champaign-Urbana urbanized area.

4.1 Intersection Sight Distance

The intersection sight distance is the distance required by a vehicle to safely enter (turning right, turning left or cross) an intersection. The intersection sight distance is an important safety/design component and a controlled factor while providing an access connection. There needs to be an unobstructed triangular view, called a sight triangle, between the approaching and departing vehicles at an intersection. Obstructions in a sight triangle create an unsafe environment for a vehicle to enter or cross the intersection; increasing crash potential. Two types of sight triangles are considered: approach sight triangle and departure sight triangle.
Approach Sight Triangle: Approach sight triangle provides the vehicle approaching the intersection an unobstructed view of the vehicle approaching in the conflicting direction. The sight distance should be enough for the vehicle to safely stop before entering the intersection. The approach sight triangle is used when vehicles are required to yield but not stop at an intersection.

Departure Sight Triangle: Departure sight triangle provides the vehicle waiting at an intersection a clear path to turn onto or cross the major roadway. This sight triangle is appropriate when the vehicle is required stop at the intersection. The departure sight triangle is measured from at least 15 feet from the edge of the major roadway. The distance along the minor road from the major road, “a”, is the distance between the decision point and the center of the nearest traffic lane on the left for vehicles approaching on the left on the major road or on the right for vehicles approaching on the right on the major road.
4.1.1 Guidelines

The sight distance is calculated assuming the driver’s eye is 3.5 feet above the roadway’s surface and that the object to be seen is 3.5 feet above the surface of the intersecting road. Any object obstructing the driver’s view in the sight triangle should be removed (e.g. parking, landscaping, structures etc.).

The intersection sight distance depends on the type of control at the intersection and the design speed of the major roadway. The following sections present the recommended intersection sight distance for various intersection control types:

a) **Intersections with no control**: The vehicles are not required to stop at an uncontrolled intersection. When approaching an uncontrolled intersection, the drivers from both directions should be able to see the conflicting vehicle and have enough time to either stop or slow down to avoid a crash. The sight distance along the minor and major approach is estimated based on the distance travelled during the perception-reaction time and braking time. The vehicles are assumed to slow to 50% of their mid-block speed while approaching an uncontrolled intersection. Table 9 shows the length of sight triangle leg for each approach based on roadway design speed.
Table 9: Length of Sight Triangle Leg for Uncontrolled Intersections

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Length of Leg (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>70</td>
</tr>
<tr>
<td>20</td>
<td>90</td>
</tr>
<tr>
<td>25</td>
<td>115</td>
</tr>
<tr>
<td>30</td>
<td>140</td>
</tr>
<tr>
<td>35</td>
<td>165</td>
</tr>
<tr>
<td>40</td>
<td>195</td>
</tr>
<tr>
<td>45</td>
<td>220</td>
</tr>
<tr>
<td>50</td>
<td>245</td>
</tr>
<tr>
<td>55</td>
<td>285</td>
</tr>
<tr>
<td>60</td>
<td>325</td>
</tr>
</tbody>
</table>

Note: For approach grade of 3% or less.

b) Intersections with stop control on minor approach(s): The vehicles on the minor approach are required to stop at a stop-controlled intersection. The vehicle waiting at the intersection should have sufficient sight distance to safely complete the turning or crossing maneuver without affecting the speed of the conflicting vehicle. The Intersection Sight Distance (ISD) is calculated using the following formula:

\[
\text{ISD} = 1.47 \times V_{\text{major}} \times t_g
\]

Where:
- ISD = intersection sight distance in feet
- \(V_{\text{major}}\) = design speed of major road in mph
- \(t_g\) = time gap for vehicle in minor road to enter the major road

Table 10 shows the acceptable time gap for vehicles waiting at the minor approach. The time gap changes based on the number of lanes to be crossed and the grade of the minor approach. The time gap can be decreased by 1 second for right turn maneuvers without undue interference with the major road traffic.

Table 10: Time Gap for Stop Controlled Intersections

<table>
<thead>
<tr>
<th>Design Vehicle</th>
<th>Time Gap(s) at Major Road Design Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Car</td>
<td>7.5</td>
</tr>
<tr>
<td>Single-unit Truck</td>
<td>9.5</td>
</tr>
<tr>
<td>Combination Truck</td>
<td>11.5</td>
</tr>
</tbody>
</table>

Note: 1. Multilane Highways: For left turns onto two-way highways with more than two lanes, add 0.5 seconds for passenger cars or 0.7 seconds for trucks for each additional lane, from
the left, in excess of one, to be crossed by the turning vehicle.

2. Minor Road Approach Grades: If the approach grade is an upgrade that exceeds 3 percent, add 0.2 seconds for each percent grade for left turns.

Table 11 shows the intersection sight distance required for a stopped vehicle to safely turn onto or cross the intersection.

### Table 11: Intersection Sight Distance for Stop-Controlled Intersections

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Intersection Sight Distance (ft.) (Stop Controlled)</th>
<th>Right Turn²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left Turn and Crossing Maneuver¹</td>
<td>1 Lane</td>
</tr>
<tr>
<td>15</td>
<td>170</td>
<td>180</td>
</tr>
<tr>
<td>20</td>
<td>225</td>
<td>240</td>
</tr>
<tr>
<td>25</td>
<td>280</td>
<td>295</td>
</tr>
<tr>
<td>30</td>
<td>335</td>
<td>355</td>
</tr>
<tr>
<td>35</td>
<td>390</td>
<td>415</td>
</tr>
<tr>
<td>40</td>
<td>445</td>
<td>475</td>
</tr>
<tr>
<td>45</td>
<td>500</td>
<td>530</td>
</tr>
<tr>
<td>50</td>
<td>555</td>
<td>590</td>
</tr>
<tr>
<td>55</td>
<td>610</td>
<td>650</td>
</tr>
<tr>
<td>60</td>
<td>665</td>
<td>710</td>
</tr>
</tbody>
</table>

Note: Intersection sight distance for a passenger vehicle crossing an undivided two lane roadway with approach grade of 3% or less.
¹ Number of lanes to be crossed to make a left turn.
² The time gap for right turn was decreased by 1 second.

### c) Intersection with yield control on minor approach(s):

The vehicles on the minor approaches are required to yield but not stop at a yield controlled intersection. The intersection sight distance should be sufficient for the vehicle on the minor approach to travel from the decision point to the intersection and clear the intersection. The length of the approach sight triangle along the minor leg should be 85 feet, assuming the vehicles will slow down when approaching a yield-controlled intersection.

The time gap required by drivers at a yield-controlled intersection is higher than the stop-controlled intersection. At a yield controlled intersection, the driver on the minor approach is assumed to need additional 3.5 seconds to travel from the decision point to the intersection, but requires about 3 seconds less to turn and accelerate to the major road speed. Table 12 shows the acceptable time gap for the vehicle approaching a yield-controlled intersection on the minor approach.
Table 12: Time Gap for Yield Controlled Intersections\textsuperscript{12}

<table>
<thead>
<tr>
<th>Design Vehicle</th>
<th>Time Gap(s) at Major Road Design Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Car</td>
<td>8.0</td>
</tr>
<tr>
<td>Single-unit Truck</td>
<td>10.0</td>
</tr>
<tr>
<td>Combination Truck</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Note: \textit{Multilane Highways:} For left turns onto two-way highways with than two lanes, add 0.5 seconds for passenger cars or 0.7 seconds for trucks for each additional lane, from the left, in excess of one, to be crossed by the turning vehicle.

\textit{Minor Road Approach Grades:} If the approach grade is an upgrade that exceeds 3 percent, add 0.2 seconds for each percent grade for left turns.

Table 13 presents the length of a sight distance leg along the major roadway.

Table 13: Intersection Sight Distance for Yield-Controlled Intersections\textsuperscript{12}

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Intersection Sight Distance (ft.) (Yield Controlled)</th>
<th>Left Turn and Crossing Maneuver</th>
<th>Right Turn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 Lane</td>
<td>2 Lanes</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>180</td>
<td>190</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>240</td>
<td>250</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>295</td>
<td>315</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>355</td>
<td>375</td>
</tr>
<tr>
<td>35</td>
<td></td>
<td>415</td>
<td>440</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>475</td>
<td>500</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>530</td>
<td>565</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>590</td>
<td>625</td>
</tr>
<tr>
<td>55</td>
<td></td>
<td>650</td>
<td>690</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td>710</td>
<td>750</td>
</tr>
</tbody>
</table>

Note: Intersection sight distance for a passenger vehicle crossing an undivided two lane roadway with approach grade of 3% or less.

The intersection sight distance presented in Table 13 should be adequate for vehicles turning right, turning left, or crossing the yield-controlled intersection.

d) \textit{Intersection with traffic signal control:} At a signalized intersection, the following sight distance conditions should be satisfied:

1. The vehicle stopped at the intersection should be able to view the first vehicle stopped at every other approach.
2. Left turning vehicles should have enough sight distance to select a gap in the oncoming traffic.

3. If right turn on red is allowed at the intersection, the departure sight triangle to the left should be the same as for stop controlled intersections.

4. If the signalized intersection is placed under two-way flashing operation, the sight distance condition for case “b” (Intersections with stop control on minor approach(s)) should be satisfied.

e) **Intersection with all-way stop control:** The vehicle stopped at the intersection should be able to view the first vehicle stopped at every other approach. This intersection control is commonly provided when the sight distance for other intersection controls cannot be met.

f) **Left turns from major road:** Adequate sight distance should be provided for left turning vehicles to safely turn across the opposing traffic. If stopping sight distance is satisfied along the major corridor and sight distance conditions along the minor road (case “b” & case “c”) are satisfied, no additional sight distance checks are required.

At a three legged minor road or driveway intersection located on or near a horizontal curve or crest vertical curve on the major road, the adequate sight distance for left turning vehicles should be checked. Tables 14 and 15 show the time gap and the intersection sight distance required for left turns from a major road.

Table 14: Time Gap for Yield Controlled Intersections

<table>
<thead>
<tr>
<th>Design Vehicle</th>
<th>Time Gap(s) at Major Road Design Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Car</td>
<td>8.0</td>
</tr>
<tr>
<td>Single-unit Truck</td>
<td>10.0</td>
</tr>
<tr>
<td>Combination Truck</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Note: For left turns onto two-way highways with more than two lanes, add 0.5 seconds for passenger cars or 0.7 seconds for trucks for each additional lane, from the left, in excess of one, to be crossed by the turning vehicle.
Table 15: Intersection Sight Distance for Left Turn from Major Road$^{12}$

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>Intersection Sight Distance (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>125</td>
</tr>
<tr>
<td>20</td>
<td>165</td>
</tr>
<tr>
<td>25</td>
<td>205</td>
</tr>
<tr>
<td>30</td>
<td>245</td>
</tr>
<tr>
<td>35</td>
<td>285</td>
</tr>
<tr>
<td>40</td>
<td>325</td>
</tr>
<tr>
<td>45</td>
<td>365</td>
</tr>
<tr>
<td>50</td>
<td>405</td>
</tr>
<tr>
<td>55</td>
<td>445</td>
</tr>
<tr>
<td>60</td>
<td>490</td>
</tr>
</tbody>
</table>

Note: Passenger car crossing an undivided two-lane highway with approach grade of 3% or less.

The intersection sight distance needs to be adjusted for the following conditions:

- **Approach Grade**: For approach grades greater than 3%, the sight distance should be adjusted using the factors presented in Table 16.

Table 16: Adjustment Factors for Sight Distance Based on Approach Grade$^{12}$

<table>
<thead>
<tr>
<th>Approach Grade (%)</th>
<th>Design Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15</td>
</tr>
<tr>
<td>-6</td>
<td>1.1</td>
</tr>
<tr>
<td>-5</td>
<td>1.0</td>
</tr>
<tr>
<td>-4</td>
<td>1.0</td>
</tr>
<tr>
<td>-3 to +3</td>
<td>1.0</td>
</tr>
<tr>
<td>4</td>
<td>1.0</td>
</tr>
<tr>
<td>5</td>
<td>1.0</td>
</tr>
<tr>
<td>6</td>
<td>1.0</td>
</tr>
</tbody>
</table>

- **Medians**: If the median is wide enough to accommodate the design vehicle with approximately 3 feet clearance on both ends of the vehicle, no separate analysis for sight distance triangles is required. The departure sight triangle for right turn will provide adequate sight distance for the vehicle to travel to the median. A sight triangle to the right for the left turns will allow the vehicle to turn left from the median to the major roadway.
If the median is not wide enough to accommodate the design vehicle, the median width should be converted into equivalent lanes and considered in determining the number of lanes to be crossed.

**Example**

**Problem**
What should be the provided sight distance for a single-unit truck turning left onto a major road at an intersection with the following characteristics?

- Stop signs on the minor road
- Left turns allowed from the minor road cross two (2) lanes on the major road
- Minor approach is located at a 4% grade
- A 40 mph design speed on the major road
- A 24 ft. wide median separates opposite traffic on the major road

**Solution**
The Intersection Sight Distance is given by the ISD formula above:

\[
\text{ISD} = 1.47 \times V_{\text{major}} \times t_g
\]

Where:

- \( \text{ISD} \) = intersection sight distance in feet
- \( V_{\text{major}} \) = design speed of major road in mph
- \( t_g \) = time gap for vehicle in minor road to enter the major road

- The time gap for single-unit trucks is 9.5 seconds (Table 10). However, since there is a 24 ft. median separating traffic on the major road, this width needs to be converted to an equivalent lane (12 ft. = 1 lane) which brings the number of lanes to be crossed when turning left to a total of 4 (2 lanes for 24 ft. median + 2 lanes on major road).

- Table 10 above recommends adding: 0.7 seconds for trucks per additional lane from the left, in excess of one, to be crossed by the turning vehicle and 0.2 seconds for each grade percent when the approach grade for the minor road exceeds 3%.
  In this example, there are 3 additional lanes in excess of one to be crossed and the minor road approach grade is 4%. The time gap becomes:

\[
9.5 + (3 \times 0.7) + (4 \times 0.2) = 12.4 \text{ seconds.}
\]
- Referring to Table 16 above, a 0.9 adjustment factor should be applied to the design speed for an approach grade of 4% and a 40 mph speed.

The ISD is finally obtained as followed:

\[ \text{ISD} = 1.47 \times 40 \times 0.9 \times 12.4 = 656.2 \text{ ft.} \approx 656 \text{ ft.} \]

The following figure shows the sight distance that should be provided on the left of the single-unit truck. The same distance should also be provided on the right.

Figure 15: ISD Example Illustration - Left sight triangle for the single-unit truck

4.2 Driveway Geometrics

Proper driveway design is an important access management technique to improve flow and safety at a driveway access. The vehicles turning into driveways create a speed differential between through and turning vehicles. Larger speed differentials can be related to increased crashes and poor operations. Driveway design helps maintain the traffic turning into and out of driveways. It also improves the safe ingress and egress of vehicles from the development and minimizes the impact on the through traffic.

4.2.1 Driveway Alignment

The driveways on either side of the road should be aligned opposite to each other whenever possible. When it is not possible to align driveways directly opposite to each other, it is advisable to follow the driveway spacing criterion to provide enough space for safe left turn movements.

Closely spaced driveways on either sides of the road tend to create a conflict between left turners from opposite directions. In case of no median or Two-Way Left Turn Lane (TWLTL), the driveway spacing should be considered for consecutive driveways irrespective of which side of the road they are on. If a raised median exists, the driveway spacing applies to driveways on the same side of the roadway.

Ideally, the roadways should intersect at a 90 degree angle. The minimum acceptable angle for a two-way driveway is 60 degrees.
4.2.2 Driveway Throat Width

Narrow driveways can cause larger speed difference between through and turning vehicles. Driveways that are too wide may cause confusion and pose a safety risk for pedestrians. Commercial driveways are usually wider than residential driveways to accommodate larger traffic volume at higher speeds. In some cases, additional driveway width may be required to compensate for smaller driveway turn radii. The driveway should be designed to provide the shortest possible path for safe pedestrian access. When four lane driveways are planned, a median with pedestrian refuge should be considered.

- **Commercial Driveway:** A minimum width of 14 feet is recommended for one-way driveways. In case of a two-way driveway, the driveway should be at least 24 feet wide and marked for two-way traffic. Each additional lane should be 12 feet wide. A raised median should be considered if the driveway is more than 44 feet wide. The driveway at a signalized intersection should have at least two outbound lanes for through/right turns and left turns.

- **Residential Driveway:** Residential driveways should be, based on the design vehicle, at least 12 feet wide, 14 feet being the desirable value.

4.2.3 Turning Radius

An adequate driveway turning radius should be provided to allow safe entrance and exit of vehicles at a reasonable speed. This allows maintaining lower speed differential between through and turning vehicles. The edge of a driveway should be rounded to allow easy access of turning vehicles in and out of the driveway. Providing an appropriate turning radius prevents turning vehicles from encroaching onto the adjacent lane or the oncoming traffic when turning into the driveway. The driveway turning radii should be designed considering the largest design vehicle expected to access the property.

- **Commercial:** A minimum turning radius of 15 feet, with a desirable range of 30 to 40 feet, is recommended in urban areas for passenger vehicles. A turning radius of at least 30 feet is recommended for larger design vehicles such as single-unit trucks. Longer turning radii may be required at driveways with dual turning lanes.

- **Residential:** Shorter radii ranging from 10-15 feet is acceptable at residential driveways from local roadways.

The driveway throat width and turning radii are interrelated and should be selected together to provide for a safe and efficient driveway operation. Various combinations of throat length and turning radii provide similar driveway operations. The presence of bike lanes affects the design turning radii and subsequently the driveway width. The following table provides a common combination of the two driveway design elements.
Table 17: Combination of Driveway Throat Width and Turning Radii

<table>
<thead>
<tr>
<th>Design Condition</th>
<th>Turning Radii (ft.)</th>
<th>Driveway Width (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No Bike Lane</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-lane exit, entering passenger car must wait until an exiting vehicle clears the driveway</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Simultaneous entry and exit by passenger cars</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>Simultaneous exit by passenger car and entry by single unit-truck</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>Separate left-turn and right-turn exit lanes for passenger cars and simultaneous entry by passenger car</td>
<td>20</td>
<td>43</td>
</tr>
<tr>
<td>Simultaneous entry and exit by single-unit trucks</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td><strong>With Bike Lane</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entering passenger car must wait until exiting vehicle clears the driveway</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Simultaneous exit and entry by passenger cars</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>Simultaneous exit by passenger car and entry by single-unit truck</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>Separate left-turn and right-turn exit lanes for passenger cars and simultaneous entry by passenger car</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>Simultaneous entry and exit by single-unit trucks</td>
<td>25</td>
<td>40</td>
</tr>
</tbody>
</table>

4.2.4 Throat Length

The driveway throat length is the distance between the street and the property (business/residence) the driveway is serving. Providing sufficient throat length helps keep traffic conflicts to a minimum and promotes efficient operations on the site. It should allow the vehicle to clear the intersection/driveway before running into the on-site circulation. Insufficient throat length can cause unsafe conditions and results in vehicles backing in the major roadway.
Throat Length

The driveway throat length depends on the site traffic, design vehicle and expected queues. The throat length and the number of lanes (ingress/egress) should be based on a detailed site circulation study and traffic impact analysis.

- **Residential**: For low volume driveways (< 100 peak hour vehicles), minimum roadway throat length of 20 ft. should be used. For residential driveways with higher traffic, the throat length should be based on queue length determined from the traffic impact study.

- **Commercial**: A minimum throat length of 40 feet is recommended for low volume commercial driveways (< 100 peak hour vehicles). The throat length for a major commercial development depends on the traffic generated by the site and should be ideally greater than 200 ft.

For high volume signalized driveways, Table 18 provides the recommended throat length.

<table>
<thead>
<tr>
<th>Number of Egress Lanes</th>
<th>Minimum Throat Length (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>75</td>
</tr>
<tr>
<td>3</td>
<td>200</td>
</tr>
<tr>
<td>4</td>
<td>300</td>
</tr>
</tbody>
</table>

If left turns out of the driveway are allowed, a marked left turn lane should be provided when possible to reduce delay and congestion on the driveway.
4.3 Median Design

Medians are used to separate the traffic in opposite directions, thereby reducing conflicts, improving safety and enhancing the traffic operation along the arterial. More than two-thirds of access related collisions involve left-turning vehicles\(^1\). The following sections discuss the median type and the median design elements.

4.3.1 Median Type

Medians can be classified as a Two-Way Left Turn Lane (TWLTL) or a non-traversable raised median.

Two-Way Left Turn Lane (TWLTL)

A two-way left turn lane is a continuous lane located between opposing traffic streams that provides a refuge area for vehicles to complete left turns from both directions\(^{10}\). This type of median treatment is commonly used on urban arterials with frequent access connections (side streets and driveways). The advantages of TWLTL include:

- Reduction in crash potential by about 33% (especially rear-end crashes).
- Increase in roadway capacity.
- Reduction in delay.

Even though the TWLTL improves roadway operations and safety and can be beneficial on low volume roadways and on roadways requiring snow removal, it is not as safe as non-traversable medians. The TWLTL is not recommended when busy commercial driveways are closely spaced, since it may cause left turn overlapping. It may also encourage strip development. TWLTL treatment is not ideal for pedestrians crossing the roadway.

Figure 17: Two-Way Left-Turn Lane\(^{17}\)

\(^{17}\) FHWA-HRT-08-046, McLean, VA, March 2006
Non-traversable Medians

A non-traversable median is a physical barrier in the roadway that separates traffic travelling in opposite directions\(^{10}\).

![Image](image-url)

Figure 18: Raised median with pedestrian refuge on Philo Road in Urbana

The advantages of non-traversable medians include the following:

- Reduces head-on collision.
- Allows the provision of a separate turn bay to store left turn vehicles and reduce the speed differential.
- Works better than TWLTL when access connections are closely spaced. Provides refuge for pedestrians crossing the road and avoids conflict with left-turning vehicles.

4.3.2 Selection of Median Type

The choice of median depends on several factors, including, but not limited to roadway functional class, traffic volumes, roadway speed, number of lanes, crash rates, presence of pedestrians, and left-turning volume.

Two-Way Left Turn Lanes (TWLTL) are recommended in the following conditions:

- Urban and suburban roadways with less than 24,000 ADT\(^{10}\).
- Collectors in developing residential and suburban areas with direct access to abutting properties or high access density.
- Collector streets in developed urban and suburban areas when the crash rates cannot be improved/reduced by raised medians.

Non-Traversable Medians are recommended in the following conditions:

- All new multilane urban arterial roadways.
- All urban and suburban arterials with an ADT in excess of 24,000.
- Roadways with aesthetic considerations.
• High crash locations where left turns need to be limited.
• Multilane roadways with a high volume of pedestrians.

The following table presents the scenario when a certain median type is more applicable.

Table 19: Application of TWLTL vs. Non-Traversable Medians

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Non-Traversable Median</th>
<th>TWLTL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operation Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced delay to major roadway traffic</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Enhances capacity</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Reduced delay to minor roadway left turns</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Reduced delay to major roadway left turns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Low-volume major roadway</td>
<td>Partial</td>
<td>X</td>
</tr>
<tr>
<td>b. High-volume major roadway</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Safety Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced vehicular crashes</td>
<td>X</td>
<td>Partial</td>
</tr>
<tr>
<td>Pedestrian refuge</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td><strong>Other Effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aesthetics</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>Snow removal</td>
<td>-</td>
<td>X</td>
</tr>
<tr>
<td>Construction cost</td>
<td>Partial</td>
<td>Partial</td>
</tr>
</tbody>
</table>

4.3.3 Median Width

The following table shows the minimum standard and the desirable values for non-traversable median width.

Table 20: Recommended Median Width for Non-Traversable Median

<table>
<thead>
<tr>
<th>Median Function</th>
<th>Minimum Width (ft.)</th>
<th>Desirable width (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separating opposing traffic stream</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Pedestrian refuge and room for signs</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Storage of single left-turn lane</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Storage for dual left-turn lane</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Protection for passenger vehicles crossing or turning left onto the mainline</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Design directional openings for selected ingress or egress movements only.</td>
<td>18</td>
<td>30</td>
</tr>
</tbody>
</table>
The following lane width is recommended for two-way left turn lanes.

Table 21: Recommended Median Width for Two-Way Left Turn Lanes (TWLTL)

<table>
<thead>
<tr>
<th>Design Speed (mph)</th>
<th>TWLTL width (ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Desirable</td>
</tr>
<tr>
<td>40 and up</td>
<td>12 – 14</td>
</tr>
<tr>
<td>45 - 50</td>
<td>14</td>
</tr>
<tr>
<td>&gt;50</td>
<td>16</td>
</tr>
</tbody>
</table>

4.3.4 Median Opening Length

Median opening lengths are a function of the turn radii, the side street geometrics, the median width, the intersection skews (the difference between the intersection angle and 90°) and the intersection legs. Inadequate or excessive median opening length results in additional conflicts and impaired sight distance. Appropriate median opening length should be selected based on the procedures outlined in the AASHTO “Green Book”.

4.4 Auxiliary Turn Lanes

Auxiliary acceleration and turning lanes are used to minimize the interference between through and turning vehicles. Their implementation reduces both the frequency and severity of conflicts by providing separate paths and storage areas for turning vehicles. Because acceleration lanes are not expected to be used in the Champaign-Urbana urbanized area, only the auxiliary deceleration lanes are discussed in this section. The benefits of providing auxiliary lanes include:

- Removing turning vehicles or queues from the through lanes.
- Reducing the frequency of rear-end collisions with turning traffic.
- Encouraging connections between adjacent properties due to easy access.

4.4.1 Guidelines

The decision to implement auxiliary lanes at intersections usually depends on the turning volume, roadway ADT, and posted speed limit. The following guidelines discuss the need of left-turn or right-turn auxiliary lanes.

Left Turn Deceleration Lane

An exclusive left turn-lane needs to be installed when the following conditions are met:

---

18 Texas Department of Transportation, May 2010.

19 Illinois Department of Transportation - Division of Highways, September 2010
• All intersections on divided urban highways with a median wide enough to accommodate a left turn lane, irrespective of the traffic volumes.
• At a signalized intersection where the left-turning volume is greater than 75 vehicles per hour (vph). Dual left turn lanes are recommended if the turn volume is equal to or greater than 300 vph.
• At any unsignalized intersection on a two-lane urban or rural arterial which satisfied the criterion established in Table 19 and Figures 19 to 23.
• At any intersection where a capacity analysis determines a left-turn lane is necessary to meet the level-of-service criteria.
• If other intersections have left-turn lanes, for uniformity of intersection design along the highway; to satisfy driver expectancy.
• Any intersection where crash experience, traffic operations, sight distance restrictions, or engineering judgment indicates a significant conflict related to left-turning vehicles.

Right Turn Deceleration Lane

A right turn-lane needs to be installed when the following conditions are met:
• At any unsignalized intersection on a two-lane urban or rural highway which satisfied the criterion established in Figure 24.
• At any unsignalized intersection on a high-speed, four-lane urban or rural highway which satisfies the criterion established in Figure 24.
• On expressways, at all public road intersections where the ADT on the side road is greater than 250.
• At any intersection where a capacity analysis determines a right-turn lane is necessary to reach the level-of-service criterion.
• At any signalized intersections where the right-turning volume is greater than 150 vph and where there is greater than 300 vehicles per hour per lane (vphpl) on the mainline.
• If other intersections have right-turn lanes, for uniformity of intersection design along the highway.
• At any intersection where the mainline is curved to the left and where the mainline curve requires superelevation.
• At an intersection where the crash experience, existing traffic operations, sight distance restrictions, or engineering judgment indicates a significant conflict related to right turning vehicles.

The auxiliary lane design and length should be calculated based on procedures outlined in the Section 36-3 in the IDOT Bureau of Design and Environment (BDE) Manual and/or Chapter 9 in the AASHTO “Green Book”.
Figure 19: Left Turn Lane Guideline for Two-Lane Road $\leq 40$ mph

Instructions:
1. The family of curves represent the percent of left turns in the advancing volume ($V_a$). The designer should locate the curve for the actual percentage of left turns. When this is not an even increment of five, the designer should estimate where the curve lies.
2. Read $V_a$ and $V_o$ into the chart and locate the intersection of the two volumes.
3. Note the location of the point in relation to the curve in the chart. If the point is to the right of the curve, then a left-turn lane should be considered. If the point is to the left of the curve, then a left-turn lane is not warranted based on traffic volumes.

Figure 20: Left Turn Lane Guideline for Two-Lane Road at unsignalized intersections - 45 mph

Instructions:
1. The family of curves represent the percent of left turns in the advancing volume ($V_a$). The designer should locate the curve for the actual percentage of left turns. When this is not an even increment of five, the designer should estimate where the curve lies.
2. Read $V_a$ and $V_o$ into the chart and locate the intersection of the two volumes.
3. Note the location of the point in relation to the curve in the chart. If the point is to the right of the curve, then a left-turn lane should be considered. If the point is to the left of the curve, then a left-turn lane is not warranted based on traffic volumes.
Figure 21: Left Turn Lane Guideline for Two-Lane Road at unsignalized intersection - 50 mph

Instructions:
1. The family of curves represent the percent of left turns in the advancing volume ($V_A$). The designer should locate the curve for the actual percentage of left turns. When this is not an even increment of five, the designer should estimate where the curve lies.
2. Read $V_A$ and $V_O$ into the chart and locate the intersection of the two volumes.
3. Note the location of the point in $\bullet 2$ relative to the curve in $\bullet 1$. If the point is to the right of the curve, then a left-turn lane should be considered. If the point is to the left of the curve, then a left-turn lane is not warranted based on traffic volumes.

Figure 22: Left Turn Lane Guideline for Two-Lane Road at unsignalized intersection - 55 mph

Instructions:
1. The family of curves represent the percent of left turns in the advancing volume ($V_A$). The designer should locate the curve for the actual percentage of left turns. When this is not an even increment of five, the designer should estimate where the curve lies.
2. Read $V_A$ and $V_O$ into the chart and locate the intersection of the two volumes.
3. Note the location of the point in $\bullet 2$ relative to the curve in $\bullet 1$. If the point is to the right of the curve, then a left-turn lane should be considered. If the point is to the left of the curve, then a left-turn lane is not warranted based on traffic volumes.
Figure 23: Left Turn Lane Guideline for Two-Lane Road - 60 mph

Instructions:
1. The family of curves represent the percent of left turns in the advancing volume ($V_a$). The designer should locate the curve for the actual percentage of left turns. When this is not an even increment of five, the designer should estimate where the curve lies.
2. Read $V_a$ and $V_o$ into the chart and locate the intersection of the two volumes.
3. Note the location of the point in 2 relative to the curve in 1. If the point is to the right of the curve, then a left-turn lane should be considered. If the point is to the left of the curve, then a left-turn lane is not warranted based on traffic volumes.

Figure 24: Right Turn Lane Guideline for Two-Lane Roadway
Example

Problem
Is it required to have a left turn lane at a two-lane unsignalized intersection given the following information?
- Design Speed = 40 mph
- Advancing volume = 375 vph
- Opposing volume = 290 vph
- Percentage of left turns = 10%

Solution
Using the information given above and using Figure 19 (see below), a left turn lane is not necessary. However, if the intersection is subject to high crashes rates due to left-turn conflict, a left-turn lane may be considered.

![Figure 25: A left turn lane example illustration using Figure 19](image-url)
4.5 Frontage and Backage Roads

Frontage and backage roads are generally used on properties fronting arterials to provide alternate access to property without disrupting the arterial flow. The frontage/backage roads are used to reduce turning access points on major roadways for better traffic operations and safety. While the function of the frontage road is to provide alternative access to the front of the properties, the backage roads provide such access at the rear and the back. These types of roads can be one-way or two-way and are often used for access to commercial businesses and developments²⁰.

Frontage and backage roads can significantly improve safety and operations by reducing the number and severity of crashes on the highways and by protecting the functional integrity of major roadways. These facilities are most effective on high speed, high volume arterials. However, if the frontage/backage roads are provided too close to the major roadway, it may end up being detrimental to operations and capacity and the major roadway.

4.5.1 Guidelines

The following guidelines should be considered when evaluating frontage/backage roads for arterials²¹.

- The frontage roads should ideally be one-way, especially for retrofit situations and should be implemented as merging or diverging movement for the main road.
- Signalized intersections should not be allowed between the arterial and the frontage road.
- A minimum distance of 300 ft. should be maintained between the frontage road and the arterial.

One way frontage roads are generally proven to work more efficiently and safely than two-way frontage roads. They tend to reduce vehicular and pedestrian conflicts; therefore, clearly surpass the two-way frontages in safety and operation. Two-way frontage roads may be used for partially developed areas with irregular access and suburban areas with widely spaced arterial access.

²⁰ Missouri Department of Transportation, September 2003
²¹ NCHRP Report No. 420
SECTION 5: TRAFFIC IMPACT ANALYSIS (TIA) STUDIES

Traffic Impact Analysis refers to the study of the impacts generated by a proposed new project development on the surrounding transportation network. Every development idea results in land use changes and traffic generation; therefore, traffic impact studies become essential tools in access management used for methodic planning to mitigate negative impacts on access and traffic.

TIAs can respond to a wide variety of issues ranging from preliminary site plan review, to the determination of necessary roadway improvements, and to a comprehensive study of thoroughfare, transit, pedestrian, and environmental issues. A TIA is specifically concerned with site traffic generation, the directional distribution, assignment for site traffic onto available or future roadways, public safety requirements, and the determination of transportation needs of the site and the surrounding road system.

Concerns

Failure to assess traffic impact can result in:
- A saturated transportation network since the generated traffic has not been predicted nor evaluated.
- Unpredictable changes in the budget allocated for the project.
- Discrepancies from the access management techniques described above.

Benefits

Traffic Impact Analysis helps planners, engineers and communities to:
- Predict future traffic generated by a new development.
- Determine improvements needed to accommodate the proposed project.
- Have a more efficient fund allocation.
- Relate traffic conditions to land use decision.
- Identify and evaluate needed roadway improvements such as the number, location and design of access points.
- Keep traffic data updated.

22 http://www.lic.wisc.edu/shapingdane/facilitation/all_resources/impacts/analysis_traffic.htm
23 Champaign County Regional Planning Commission, Access Management Guidelines, October 2001
5.1 Need of a Traffic Impact Analysis

A site developer shall provide the existing and new peak-hour vehicle trips on streets adjacent to the development site. New peak-hour vehicle trips shall be calculated using the ITE Trip Generation Manual. The TIA should be prepared by the site developer in the following situations:

a. Developments that can be expected to generate more than 100 new peak-hour vehicle trips on the adjacent street per the ITE Trip Generation Manual.
b. Developments of less than 100 new peak-hour trips in areas of critical concerns such as high crash locations (as defined in the most recent CUUATS Selected Crash Intersection Locations document) and congested areas.
c. Any changes in the land use or density that will increase the site traffic generation by more than 15 percent, where at least 100 new peak-hour vehicle trips are involved.
d. Any change that will cause the directional distribution of traffic to increase more than 20 percent where site traffic generation can be expected to ultimately be over 100 peak-hour vehicle trips.
e. When the original TIA is more than 2 years old, access improvements are incomplete, or changes in development have occurred in the site.
f. When an agreement between the developer and the local agency requires cost sharing contributions to major roadway improvements.
g. Any other situation where the local agency engineer believes it is important to understand the impact of traffic from the new development on its surrounding area.

Exemptions

Developments that meet the above criteria may be exempt from the traffic impact analysis requirements at the discretion of the local agency.

5.2 TIA Elements

The local agency engineer shall determine which of the principal elements should be included in the traffic impact analysis. The local agency engineer may also make the determination to extend the study to additional street segments and/or intersections. The elements below are intended to:

- Provide developers with recommendations for site selection, site transportation planning, and anticipated traffic impacts.
- Provide the local agency with information on which to base decisions about permits and approvals.

The TIA shall be performed by a professional engineer licensed in Illinois who is prequalified for traffic studies by IDOT and/or approved by the local agency. The TIA shall include the following elements:
a. Introduction and Summary
   i. Purpose of the report and the study objectives
   ii. Executive summary
b. Description of the Proposed Development
   i. Land use and intensity
   ii. Location and site plan
   iii. Zoning
   iv. Project phasing
c. Existing Conditions (including but not limited to the following)
   i. Study area of influence
   ii. Study area land uses
      • Existing land uses
      • Existing zoning
      • Future planned development
   iii. Site Accessibility
   iv. Roadway and Intersection Conditions (within study area)
      • ADT counts on roadways and peak hours turning movement counts at intersections
      • Transit service
      • Pedestrians and Bicyclists
      • Existing site traffic (if any)
      The traffic volume data should be collected on during peak hours on a typical weekday (Tuesday, Wednesday, and/or Thursday). The turning movement counts should be collected in no greater than 15-minute interval.
d. Build-out Conditions (including but not limited to the following)
   i. Site traffic (each horizon year)
      • Trip generation; using ITE trip generation manual
      • Trip distribution
      • Trip Assignment
   ii. Through Traffic (each horizon year)
      • Projected traffic along roadways and intersections in the study area
      • Method of projection
      • Non-site traffic from anticipated developments in the study area
      • Planned roadway and intersection improvements
   iii. Total traffic (each horizon year)
e. Traffic and transportation analysis (for the study area)
   i. Site access/ circulation plan
   ii. Capacity and Level of Service (LOS) analysis (for each horizon year) for study intersections and roadway segments
      • Existing conditions
      • Background conditions (existing + growth)
• Build-out conditions (existing + growth + site traffic)
  iii. Traffic safety analysis
  iv. Site circulation and parking
  v. Turn lane and signal warrants (if applicable)
  vi. Driveway design and spacing
  vii. Intersection design studies (if applicable)
  viii. Compliance with regional access management guidelines.
  ix. Pedestrian and bicycle facilities
  x. Other factors that affect traffic on and adjacent to the site

f. Improvement Analysis
  i. Improvements to accommodate existing traffic
  ii. Improvements to accommodate background traffic
  iii. Improvements to accommodate build-out traffic (background + site traffic)
  iv. Status of any planned improvements in the study area.
  v. Improvements proposed by the developer (if required)

g. Study Findings
  i. The adequacy of site access
  ii. The impact of the specific development of the surrounding area
  iii. The suitability of on-site circulation and parking
  iv. Need of any improvements

h. Recommendations

The following tables and maps are recommended to be included in the traffic impact analysis report:
  a. List of Figures
    i. Figure 1: Site Location: Map showing the location of the site.
    ii. Figure 2: Study Area: Map showing the anticipated area of influence.
    iii. Figure 3: Existing Conditions Map: Map showing the transportation system and the existing development in the study area. The map should include signal locations and any major transit, bicycle, and pedestrian routes. (It can be shown with Figure 2)
    iv. Figure 4: Existing Traffic Volumes: Peak hour turning movement traffic at intersections in the study area.
    v. Figure 5: Background Traffic Volumes: Peak hour intersection turning movement traffic for each horizon year.
    vi. Figure 6: Estimated Off-Site Development Traffic: Map showing the anticipated off-site developments and the estimated traffic generated by other anticipated developed in the study area (for each horizon year). The trip distribution along the study area roadways should also be shown.
    vii. Figure 6: Estimated Site Traffic: Estimated peak hour trips generated by the proposed development and distributed along the roadways in the study area.
    viii. Figure 8: Build-out/Total Traffic Volumes: Map showing the estimated total peak hour turning movement traffic for intersections in the study area, for each horizon year.
ix. Figure 9: Anticipated Transportation System: Map showing programmed and applicable roadway, transit, bicycle, and pedestrian improvements in the study area, effecting site access or the transportation impact of the trips generation from the site.

x. Figure 10: Projected level of service: Map(s) showing the level of service conditions for the study area intersections for existing, background (including off-site traffic), and build-out conditions (each horizon year).

xi. Figure 11: Recommended Improvements: Map showing the improvements recommended mitigating the impact of the traffic generated by the proposed development. The map should also include any proposed changes to the site access, internal circulation, and parking.

a. List of Tables
   i. Table 1: Proposed Land Uses and Project Phasing: The list of proposed land uses planned to be developed in phases.
   ii. Table 2: Trip Generation: Table(s) showing the peak hour traffic generated by the proposed development and by the anticipated new development in the study area for each horizon year.
   iii. Table 3: Projected Level of Service: Approach and overall intersection level of service for existing, background (including off-site traffic), and build-out conditions (each horizon year).
   iv. Table 4: Recommended Improvements: List of proposed improvements to help mitigate the transportation impact of the project traffic.

Addition tables and figures should be added to provide a detailed analysis, based on the extent of the study.

5.3 Other Road Users

Development in agencies that have adopted the “Greenways & Trails of Champaign County: Design Guidelines, Logos and Signage” should follow these guidelines when designing pedestrian and bicycle facilities. The TIA should take into account additional travel modes, including, but not limited to trucks, pedestrians, bicycles, and transit. The following items should be considered:

Trucks

Site driveways and internal circulation must be designed to accommodate the largest truck anticipated to serve the development. Vehicle turning paths need to be provided such that the trucks do not encroach over curbs and medians. Encroachment into opposing turning lanes should be minimized but can be consistent with the scale of development and the frequency and timing of truck movements. Truck circulation through a development site should minimize conflicts with customer
traffic, and loading docks should be configured such that parked trucks do not impede normal traffic flow\textsuperscript{24}.

\textit{Pedestrians}

The investment in sidewalks along streets or off-street paths is diminished if pedestrians cannot readily travel between public sidewalk facilities and adjacent land uses. All development plans should provide this connectivity whether it is made via proposed parking lot facilities and/or additional sidewalks or paths\textsuperscript{24}.

\textit{Bicycles}

Development plans should provide reasonable opportunities to travel between adjacent public streets or bicycle trails and the land use. This does not imply that separate facilities are needed; rather, the conditions within a development site should be comparable to conditions adjacent to and near the site. Adequate and properly placed parking facilities for bicycles are a key component to encouraging bicycle travel\textsuperscript{24}.

\textit{Transit}

Site development should account for both current and potential bus services. Transit considerations are similar to truck considerations described above due to the relatively large size of buses; however, buses need to circulate with customer traffic flow.

\footnote{City of Olathe, KS, 2003 (as cited in Champaign County Regional Planning Commission, Access Management Guidelines, April 2010)}
SECTION 6: REFERENCES


