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MAYOR AND COUNCIL
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UPDATE TO ORDINANCE 9823
TRANSPORTATION
Access Management Guidelines

for the *City of Tucson, Arizona*

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1.0 INTRODUCTION

Access management refers to the regulation of the design, spacing, and operation of intersections, driveways and median openings to a roadway. Its objectives are to enable access to land uses while maintaining roadway safety and mobility through controlling access location, design, spacing and operation. This is particularly important for major roadways intended to provide efficient service to through-traffic movements.

Transportation Access Management Guidelines for the City of Tucson was prepared from a compilation of multiple sources. The Guidelines describe the overall concept of access management, review current practice, and set forth basic policy, planning, and design guidelines. The Guidelines provide consistent and effective access management policies for the City of Tucson. The guidelines presented are consistent with those established by the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), the Transportation Research Board (TRB), and the Institute of Transportation Engineers (ITE).

For purposes of this report, "access" means the direct physical connection of adjoining land to a roadway via a street or driveway. These guidelines have been adopted as ordinance and are applicable to all public and private developments within the City of Tucson rights-of-way.

2.0 PRINCIPLES OF ACCESS MANAGEMENT

Fundamental to recognizing the need for access management is to understand that *movement of traffic and direct access to property are in mutual conflict*. No facility can move traffic effectively and also provide unlimited access at the same time. Extreme examples of this concept are the freeway and the cul-de-sac: freeways move traffic very well with few opportunities for access, while cul-de-sacs provide unlimited opportunities for access, but don't move traffic very well.

Crashes and congestion are frequent outcomes of attempting to simultaneously provide both mobility and access on the same street. Poor planning and inadequate control of access can quickly lead to an unnecessarily high number of direct accesses along roadways. The movements that occur on and off roadways at driveway locations, when those driveways are too closely spaced, can make it very difficult for through traffic to flow smoothly at desired speeds and levels of safety. AASHTO states that "the number of crashes is disproportionately higher at driveways than at other intersections; thus their design and location merit special consideration."[1] Additionally, research documented in the 6th *Edition ITE Traffic Engineering Handbook* confirms a direct relationship between crash and driveway frequency, driveway activity, and median access.

[1] AASHTO, "A Policy on Geometric Design of Highways and Streets," 2004

Fewer direct access points, greater separation between driveways, and better driveway design and location are the basic elements of access management. When these techniques are implemented uniformly and comprehensively, there is less occasion for through traffic to slow down and change lanes in order to avoid turning traffic.

Consequently, with good access management, the flow of traffic will be smoother and average travel times will be shorter. There will also be less potential for crashes. According to the FHWA, before and after analyses show that those routes with well managed access can experience 50% fewer crashes[2] than comparable facilities with no access controls.

Figure 2-1 shows the relationship between mobility, access, and the functional classification of streets.

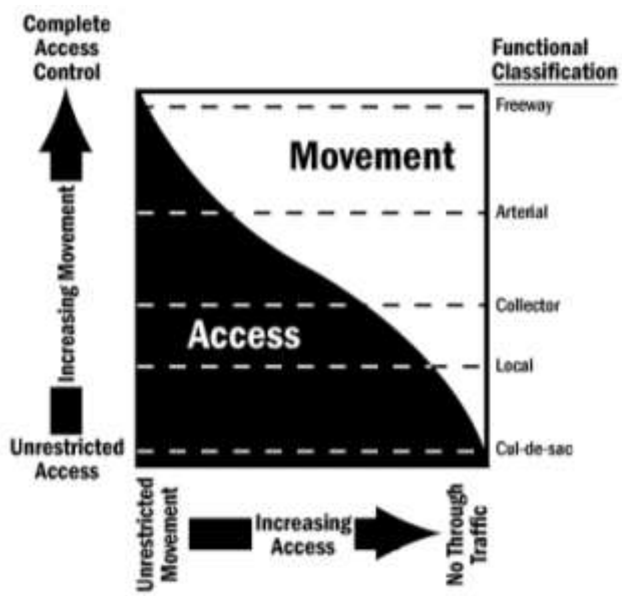


Figure 2-1 – Movement vs. Access[3]

A "vicious cycle" of traffic congestion found in many areas of the country is shown in **Figure 2-2**. An effective access management program ends a cycle of road improvements followed by increased access, increased congestion, and the need for more road improvements.

[2] Transportation Research Board, "Access Management Manual," 2004.
[3] Adopted from: NCHRP Report 348 "Access Management Policies and Guidelines for Activity Centers." Metro Trans Group, TRB Washington DC, 1992.

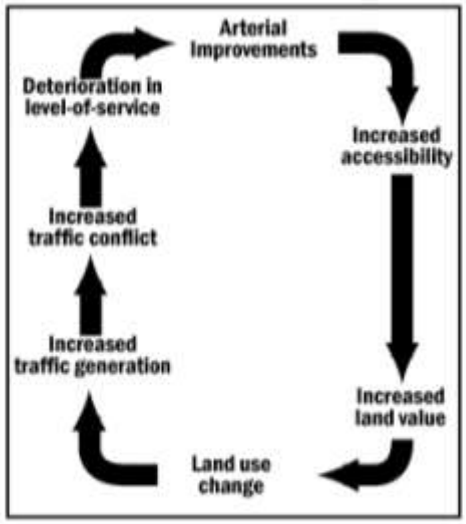


Figure 2-2 – Cycle of Traffic Congestion[4]

An effective access management program accomplishes the following:

1) ***Limits the number of conflict points at driveway locations.*** Conflict points are indicators of the potential for crashes. The more conflict points that occur at an intersection, the higher the potential for crashes. The number of conflict points is significantly reduced when left turns and cross street through movements are restricted.
2) ***Separate conflict areas.*** Intersections created by streets and driveways represent basic conflict areas. Adequate spacing between intersections allows drivers to react to one intersection at a time, and reduces the potential for conflicts.
3) ***Reduces interference to through traffic.*** Through traffic often needs to slow down for vehicles exiting, entering, or turning across the roadway. Providing turning lanes, designing driveways with appropriate and adequate turning radii, and restricting turning movements in and out of driveways allows turning traffic to get out of the way of through traffic.
4) ***Provides sufficient spacing for at-grade, signalized intersections.*** Good spacing of signalized intersections reduces conflict areas and increases the potential for smooth traffic progression.
5) ***Provides adequate on-site circulation and storage.*** The design of good internal vehicle circulation in parking areas and on local streets reduces the number of driveways that businesses need for access to the major roadway.

[4] Adapted from: Vergil G. Stover and Frank J. Koepke, "Transportation and Land Development, Institute of Transportation Engineers, 1988.

3.0 ROADWAY FUNCTIONAL CLASSIFICATION

Access and mobility are competing functions. This recognition is fundamental to the design of roadway systems that preserve public investments, contribute to traffic safety, reduce fuel consumption and vehicle emissions, and do not become functionally obsolete. Suitable functional design of the roadway system also preserves the private investment in residential and commercial development.

The 2004 *AASHTO Policy on Geometric Design of Highways and Streets* ("Green Book") recognizes that a functionally designed circulation system provides for distinct travel stages, that each stage should be handled by a separate facility and that "the failure to recognize and accommodate by suitable design each of the different stages of the movement hierarchy is a prominent cause of roadway obsolescence."[5] The AASHTO policy also indicates that the same principles of design should be applied to access drives and comparable street intersections.

A typical trip on an urban street system can be described as occurring in identifiable steps or stages as illustrated in **Figure 3-1** and **Figure 3-2**. These stages can be sorted into a definite hierarchy with respect to how the competing functions of mobility and access are satisfied. At the low end of the hierarchy are roadway facilities that provide good access to abutting properties, but provide limited opportunity for through movement. Vehicles entering or exiting a roadway typically perform the ingress or egress maneuver at a very low speed, momentarily blocking through traffic and impeding the movement of traffic on the roadway. At the high end of the hierarchy are facilities that provide good mobility by limiting and controlling access to the roadway, thereby reducing conflicts that slow the flow of through traffic.

A transition occurs each time that a vehicle passes from one roadway to another and should be accommodated by a facility specifically designed to handle the movement. Even the area of transition between a driveway and a local street should be considered as an intersection and be treated accordingly. However, the design of these intersections poses few problems since speeds and volumes are low. Many urban circulation systems use the entire range of facilities in the order presented here, but it is not always necessary or desirable that they do so.

The functional classification system divides streets into three basic types: arterials, collectors, and local streets. The function of an arterial is to provide for mobility of through traffic. Access to an arterial is controlled to reduce interference and facilitate through movement. Collector streets provide a mix for the functions of mobility and access, and therefore accomplish neither well. The primary purpose of local streets is to provide direct access to adjoining property.

[5] AASHTO, "A Policy on Geometric Design of Highways and Streets," 2004

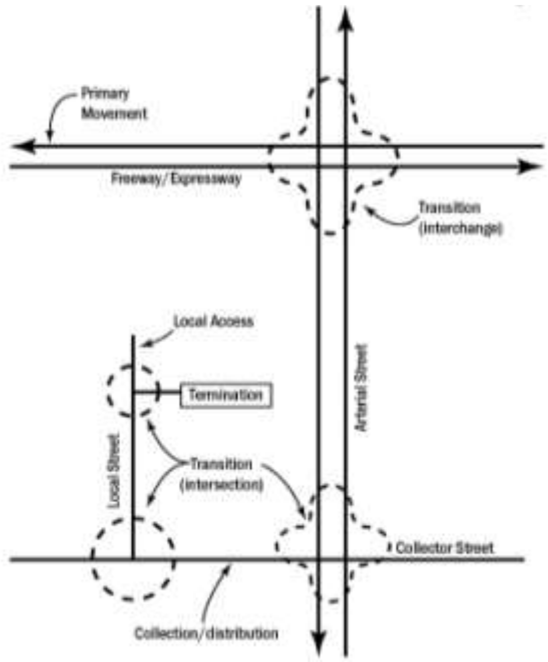


Figure 3-1 – Hierarchy of Movement in a Functional Circulation System[6]

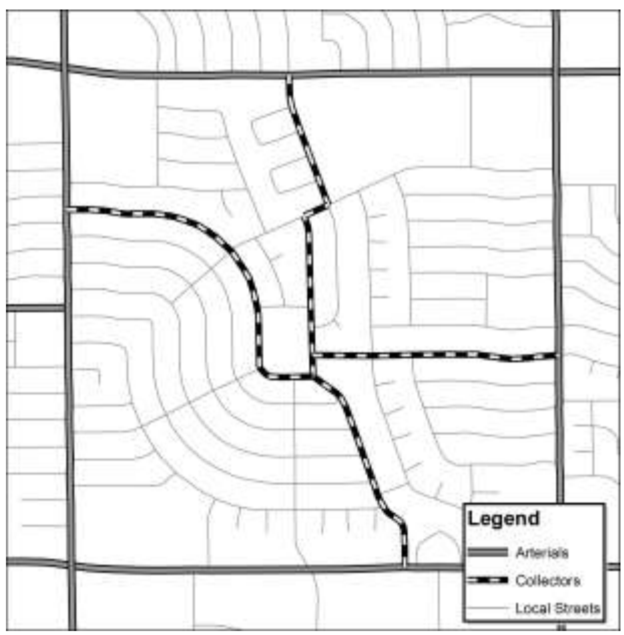


Figure 3-2 – Suburban Street Network[7]

[6] Adopted from: "A Policy on Geometric Design of Highways and Streets. Chapter 1, Washington DC, AASHTO, 2004.
[7] Adopted from: AASHTO "A Policy on Geometric Design of Highways and Streets," Exhibit 1-4. Schematic Illustration of a Portion of a Suburban Street Network (Tucson at 22nd and Wilmot), 2004.

Each class of roadway has its own geometric, traffic control, and spacing requirements. The general types of facilities and their characteristics are summarized in **Table 3-1**. This table provides a broad guide in setting access spacing standards that are keyed to functional classes of roadways.

The City of Tucson has defined functional classifications of roadways through the Mayor and Council approved Major Streets and Routes Plan (MS&R). The MS&R document provides roadway classifications and the associated cross section and right-of-way requirements and can be accessed by contacting the Tucson Department of Transportation (TDOT) or Planning and Development Services Department.

Table 3-1 – Functional Route Classification

Characteristic	**Functional Classification**		
	Arterial Street	**Collector Street**	**Local Street**
Primary Function	Through traffic movement, limited direct land access	traffic movement, land access, collect & distribute traffic between streets and arterials	land access
Continuity	continuous	not necessarily continuous	not continuous
Spacing	1-2 miles	½ mile or less	as needed
Typical % of Surface Street System Travel Volume Carried	65-80%	5-20%	10-30%
Direct Land Access	limited	limited – less restrictive	local access
Speed Limit	30-55 mph	30-40 mph	25 mph
Parking	prohibited	prohibited, unless approved due to special conditions	permitted
Bicycle Facility	Yes, striped	Yes, striped	Yes, not striped

4.0 ACCESS SPACING

Access spacing guidelines are keyed to allowable access levels, roadway speeds, and operating environments. They apply to new land developments and to significant changes in the size and nature of existing developments. Access to land parcels that do not conform to the spacing criteria may be necessary when no alternative reasonable access is provided. However, the basis for these variations should be clearly indicated and approved by a City representative.

4.1 Signalized Intersections

In order to maintain efficient traffic flow and safety, signalized intersections should be limited to locations along the city arterial and collector streets where the progressive movement of traffic will not be significantly impeded. Uniform, or near uniform, spacing of traffic signals is critical for the progression of traffic in all directions. Failure to gain proper spacing will result in severe degradation to the system's operation. Spacing between traffic signals, pedestrian crossing needs, and left-turn arrows, are dictated by two critical factors to ensure good progression, 1) traffic signal cycle length, and 2) desired vehicle speed.

The majority of Tucson employs a grid system: arterials are spaced at 1-mile, and collectors are spaced at ½-mile. Consistent with the Tucson grid street system, traffic signals are to be spaced at ½ mile (2,640 feet). This spacing enables an operating speed of 40 miles per hour (mph) and a 90-second traffic signal cycle length that properly serves pedestrians and left-turn arrows. If additional green time is desired for pedestrians and left-turn arrows, a 120-second cycle length may be considered; however, this enables an operating speed of approximately 30 mph. This lower operating speed is often unacceptable to drivers and can lead to disregard of speed limits and rushing from red light to red light. The optimum spacing for signalized intersections is detailed in **Table 4-1**.

As a guideline, traffic signal cycle lengths should be kept as short as possible; cycle lengths of 150 seconds or more should be avoided. Excessively long cycle lengths result in long vehicle queues, unreasonable delays, and potential air quality problems. Special split phase operations should be avoided.

The Mayor and Council may approve deviations to ½-mile spacing of signals as conditions warrant. If non-standard traffic signal spacing is under consideration, the following actions should be taken to mitigate the associated problems:

1) The group proposing the installation or retention of the traffic signal shall pay for its installation.
2) The actual or proposed traffic levels shall meet 1.5 times the volume requirements published in the latest edition of the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) for traffic signal warrants. Warrants other than eight-hour volume warrants and crash warrants will be carefully evaluated before being accepted and approved by Traffic Engineering staff.

3) In order to mitigate negative effects of non-standard signal spacing, roundabout, or Florida "T" intersections/operations should be installed if possible. Florida "T" intersection designs may impact roadway access. A traffic engineering report will be required to address mitigation to impacted access.
4) Non-standard spaced traffic signals should be designed to operate in a two-phase mode. Additional phases and protected left-turn arrow movements are to be avoided whenever possible.

Table 4-1 – Optimum Spacing of Signalized Intersections[8]

Cycle Length (sec)	Operating Speed (mph)					
	30	35	40	45	50	55
	Distance in feet					
60	1320	1540	1760	1980	2200	2430
70	1540	1800	2050	2310	2560	2830
80	1760	2050	2350	2640	2930	3230
90*	1980	2310	2640	2970	3300	3630
100	2200	2570	2930	3300	3670	4030
110	2420	2830	3220	3630	4040	4430
120*	2640	3080	3520	3960	4400	4840
150**	3300	3850	4400	4950	5500	6050

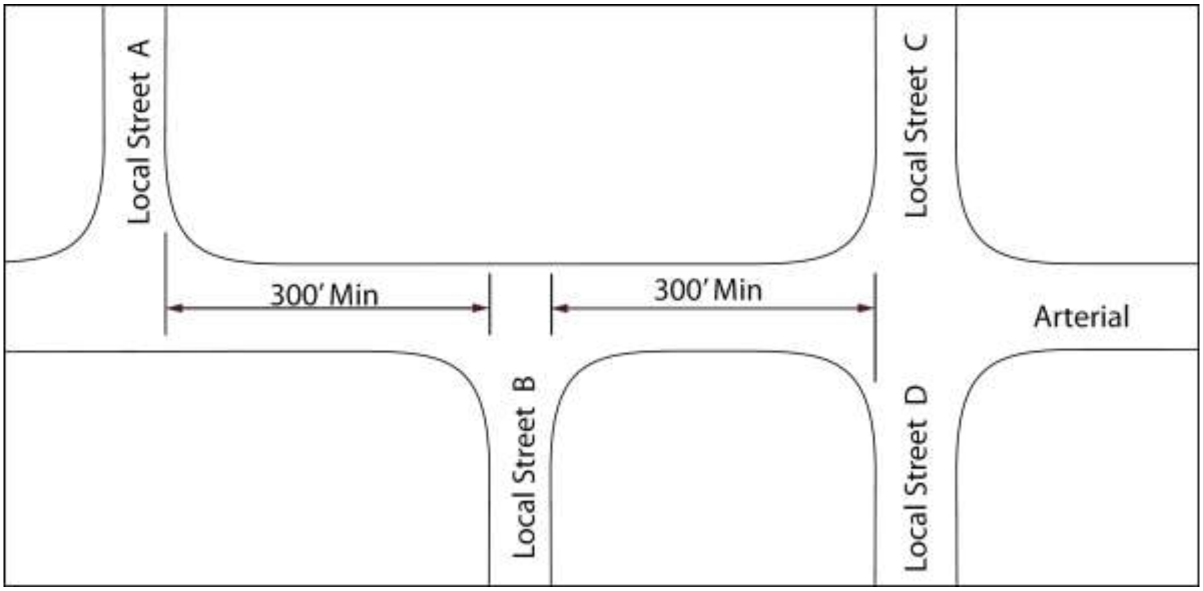
*90 and 120 cycles lengths are the most used cycle lengths for the City of Tucson
** Represents maximum cycle length for actuated signal if all phases are fully used. This cycle length or greater cycle lengths should be avoided.

4.2 Unsignalized Roadway Intersections

Unsignalized intersections typically consist of an intersection between a collector or arterial and a local street or high volume driveway. Unsignalized intersections are more common than signalized intersections and need to be designed to allow for proper spacing for safe access. The ideal spacing between unsignalized intersections is 600 feet or more. However, such spacing may be difficult to achieve based on existing roadway conditions and/or site development needs. To accommodate for such conditions, minimum distances between unsignalized roadway intersections can be applied. The minimum offset for consecutive unsignalized roadway intersections on the same or opposite side of an undivided street shall be 300 feet from adjacent edges of pavement along arterial roadways. Along collector roadways, the minimum offset shall be 150'. For streets with raised medians, intersections on opposite sides of the street can be treated separately. In addition to the 150-foot minimum, spacing, adequate intersection spacing should be provided for any dedicated turn lane needs. **Figure 4-1** illustrates the minimum unsignalized roadway intersection spacing for an undivided roadway. Driveway locations are addressed in Section 5.4.

[8] Source: Stover, Vergil G. "Access Control Issues Related to Urban Arterial Intersections," Transportation Research Board, 1993.

Unsignalized roadway intersection spacing guidelines should be applied to both public streets and private driveways, which are discussed in Section 5.4. The minimum acceptable spacing is affected by surrounding land uses; spacing between unsignalized intersections may need to be increased at large developments. Where intersection signalization is likely in the future, ½ mile intersection spacing should govern.



Note: 150' minimum on collector roadways

Figure 4-1 – Minimum Unsignalized Intersection Spacing

4.3 Median Openings

Median openings are provided at all signalized at-grade intersections, and generally at unsignalized junctions of arterial and collector streets. They may be provided where they will have minimum impact on roadway flow.

Minimum desired spacing of unsignalized median openings as functions of speed are given in **Table 4-2**. These minimum distances should be limited to retrofit situations. Ideally, spacing of median openings should be limited to locations that are suitable for future signalization. Directional median openings, where left-turns into a driveway are allowed, but left-turns exiting are prohibited, for driveway openings can be spaced so long as sufficient storage for left-turning vehicles is provided, subject to minimum unsignalized and driveway spacing requirements (see Figure 4-3).

Table 4-2 – Minimum Spacing Between Unsignalized Median Openings[9]

Speed Limit(mph)	Minimum Spacing (feet)
30	370
35	460
40	530
45	670
50	780
55	910

Minimum desired spacing of unsignalized median openings as a function of roadway functional classification are given in **Table 4-3.** This spacing will accommodate traffic signal requirements, storage space needed for left turns, bay tapers, and roadway aesthetic and landscaping goals. When evaluating the minimum spacing requirements, the most conservative requirements as specified in **Table 4-2** and **Table 4-3** shall govern.

Table 4-3 – Guidelines for Spacing Median Openings[10]

Street Functional Classification	Spacing of Median Openings (in feet)		
	Urban	Suburban	Rural
Arterial	660	660	1320
Collector	330	660	1320

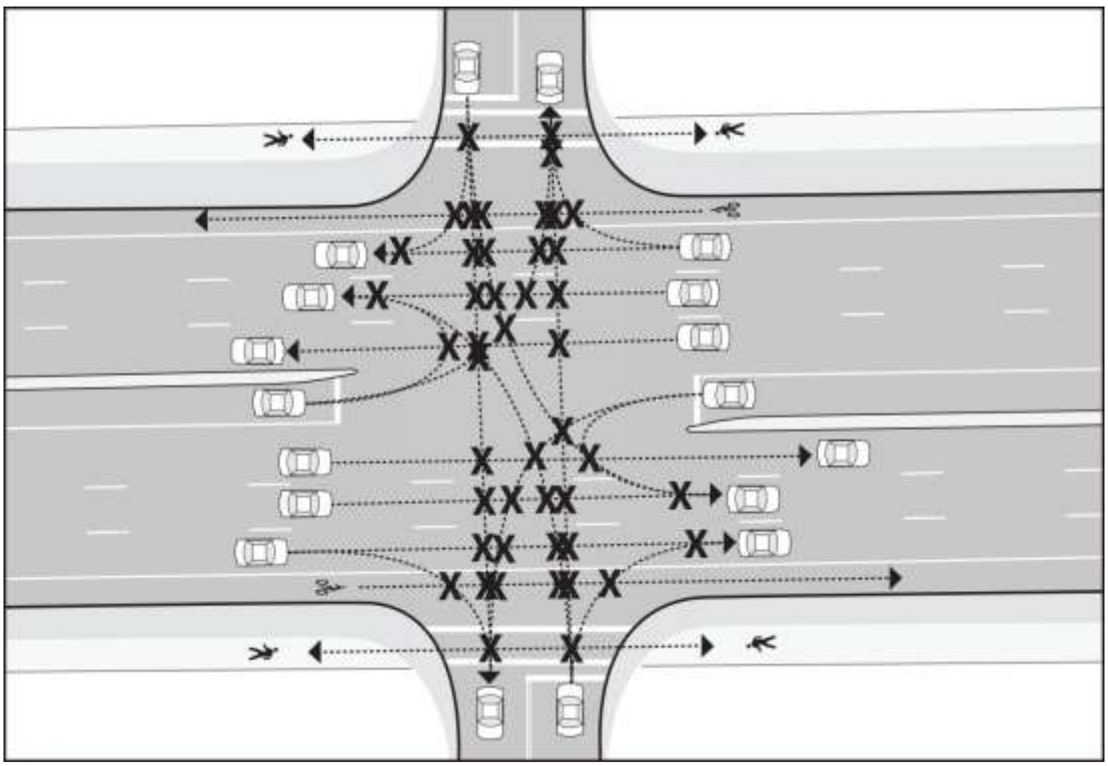
Median openings can be subject to closure where traffic volumes warrant signals, but signal spacing is inappropriate. Median openings should be set far enough back from nearby traffic signals to avoid possible interference with intersection queues. In all cases, left-turn storage within the median opening should be designed for the maximum future queue.

All median spacing guidelines are to be considered minimums and are not automatic. The following will be considered when evaluating a request for a median opening:

1) The City may require a traffic engineering analysis by a professional traffic engineer before approving any median opening request. Such an analysis should address the issues stated in 2 through 9, and should be at the sole expense of the requestor.
2) Directional median openings should be investigated as a first option over a full median opening. As shown in **Figures 4-2 and 4-3,** directional median openings reduce the number of conflicts and improve arterial safety.
3) The proposed median opening must be necessary for adequate access to an abutting property and must improve circulation both on- and off-site.
4) The proposed median opening will not cause a significant problem elsewhere (e.g. increased traffic in neighborhoods, increased crashes in another location, etc.)

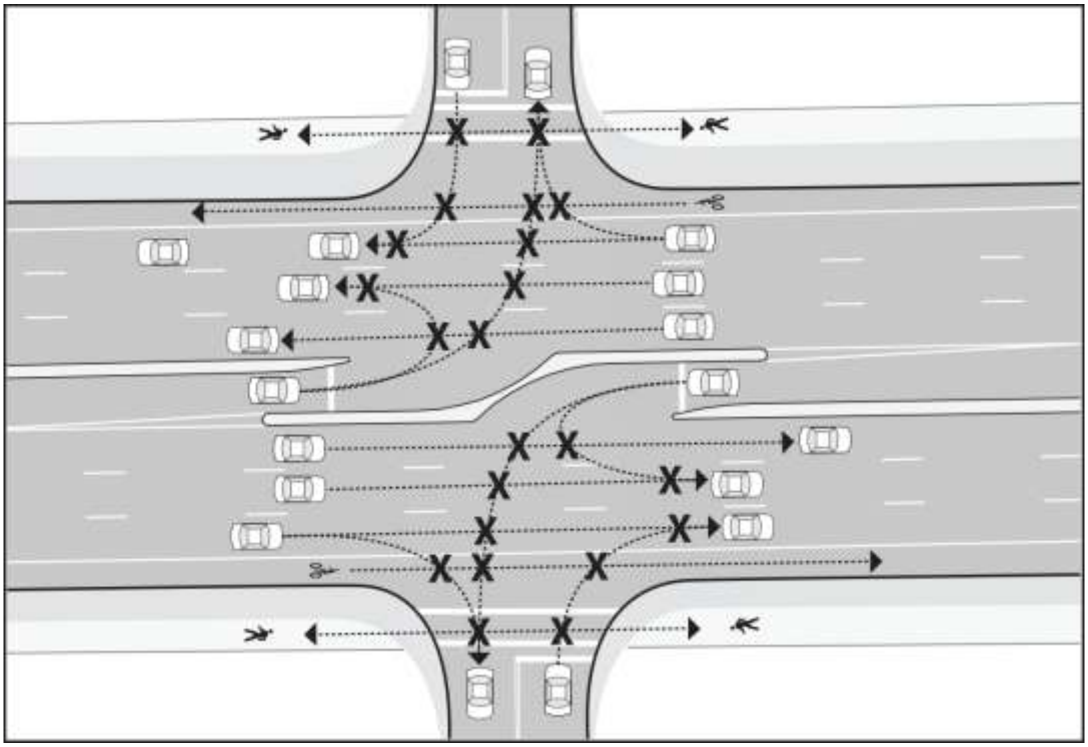
[9] Source: Koepke, Frank J., and Stover, Vergil G., 1988.
[10] Adapted from: Koepke, Frank J., and Stover, Vergil G., 1988.

5) Full consideration should be given to adjacent and opposite properties. Median opening locations for individual developments should be coordinated with other affected property owners.
6) The location and design of any proposed median opening must meet acceptable engineering design standards for expected traffic speeds and volumes.
7) The proposed median opening will not interfere with the continuity of traffic flow at or between intersections.
8) The proposed full median opening will not be at a location where driveways on opposite sides of the roadway do not align.
9) Emergency vehicle access should be reviewed to provide adequate police and fire vehicle entry.
10) The group proposing the median opening is responsible to pay for the design and construction of improvements.
11) The City may require cross access agreements for adjacent developments and properties if a median opening request is granted.



X = potential conflict
Number of conflicts = 60

Figure 4-2 – Full Median Opening



X = potential conflict
Number of conflicts = 22

Figure 4-3 – Directional Median Opening

4.4 Alternatives to Standard Signalized Intersections

When traffic volumes exceed the capacity of standard signalized intersections or construction of a standard signalized intersection is not otherwise desirable or feasible, alternative designs such as grade-separated, indirect left turn, continuous flow, roundabouts, and Florida T-intersections should be considered. When a developer proposes an alternative intersection design, the developer will be responsible for funding the project, providing a traffic study, and documenting public response of the alternate design.

Due to potential geometric and right-of-way requirements associated with alternative designs, special consideration and coordination with adjacent land owners will be required.

4.5 Pedestrian and Bicycle Crossing Device Guidelines

Guidelines for the installation of pedestrian and bicycle traffic control devices are set forth in the MUTCD, published by the Federal Highway Administration. Final approval of all devices and locations will be by the City of Tucson Department of Transportation.

4.5.1 Marked Crosswalks

Crosswalk lines should not be used indiscriminately. An engineering study should be performed before a marked crosswalk is installed at a location away from a traffic control signal or an approach controlled by a STOP or YIELD sign. The engineering study should consider the number of lanes, the presence of a median, the distance from adjacent signalized intersections, the pedestrian volumes and delays, the average daily traffic (ADT), the posted or statutory speed limit or 85th-percentile speed, the geometry of the location, the possible consolidation of multiple crossing points, the availability of street lighting, and other appropriate factors. Crosswalk markings are normally not used at intersections with driveways. Refer to the Manual on Uniform Traffic Control (MUTCD) for details on crosswalk marking installation. All proposed crosswalks shall be approved by the City of Tucson Department of Transportation.

When used, crosswalk markings shall be located so that the curb ramps are within the extension of the crosswalk markings. Refer to the City of Tucson/Pima County Pavement Marking Design Manual for details for crosswalk installation.

4.5.2 School Crosswalks

The developer shall consult with City of Tucson Traffic Engineering Division staff for assistance regarding school crosswalk considerations.

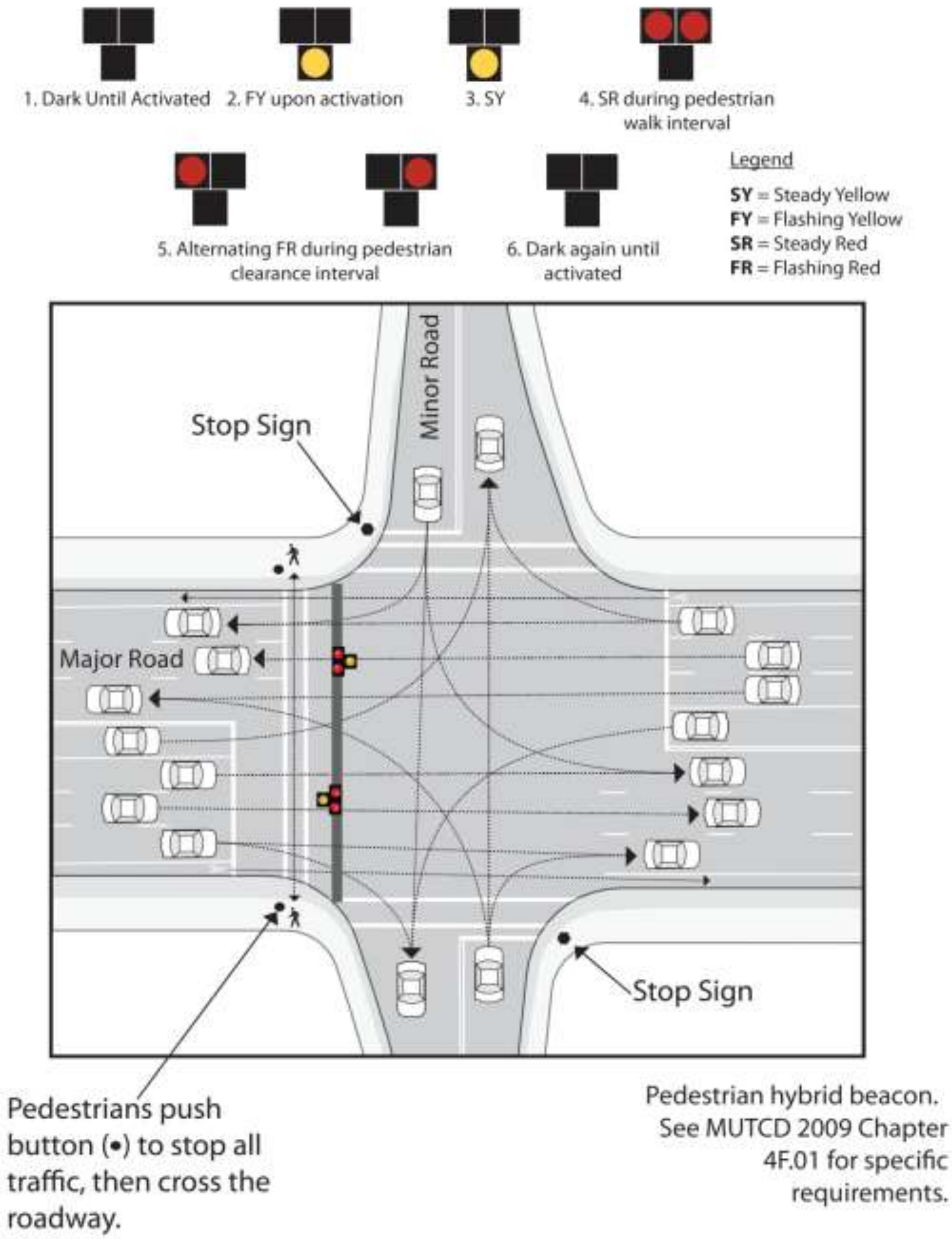
*4.5.3 HAWK – **H**igh Intensity **A**ctivated Cross**W**al**K***

The High Intensity Activated Crosswalk (HAWK) consists of Red-Yellow-Red signal format for motorists. The signals remain off until a pedestrian activates the system by pressing a button. First, a FLASHING YELLOW light warns motorists that a pedestrian is present. The signal then changes to SOLID YELLOW, alerting drivers to prepare to stop. The signal then turns SOLID RED and shows the pedestrian a "WALK" symbol. The signal then begins FLASHING RED, and the pedestrian is shown a flashing "DON'T WALK" symbol with a countdown timer. During the FLASHING RED drivers are to make a full stop to ensure that the crosswalk is free of pedestrians, and then proceed. In school zones, drivers must wait until the children and crossing guard are completely out of the crossing before proceeding.

Locations considered for the installation of marked crosswalks with pedestrian actuated beacon signal lights and signage should generally meet the following criteria:

1) Meet the warrants and design guidelines provided in the Manual on Uniform Traffic Control Devices 2009 (or latest edition), Chapter 4F Pedestrian Hybrid Beacons.
2) A traffic engineering analysis with approval from the Director of Transportation and Mayor and Council.
3) There is no other crossing controlled by a traffic signal, stop sign, or crossing guard within 600 feet of the proposed location.

Figure 4-4 illustrates the various vehicular, pedestrian, and bicycle movements that are made at a HAWK.



*Striping Details to be coordinated with the City of Tucson Department of Transportation staff.

Figure 4-4 – HAWK

4.5.4 TOUCAN – TwO GroUps CAN Cross

The TwO GroUps CAN cross (TOUCAN) system was designed to provide a safe crossing for two groups, pedestrians and bicyclists. TOUCANs are placed at intersections of major streets where bicycle and pedestrian crossing activity is heavy. They are also placed along roadways that are prioritized for non-motorized uses, such as along "Bicycle Boulevards" at intersections with arterials or major collectors.

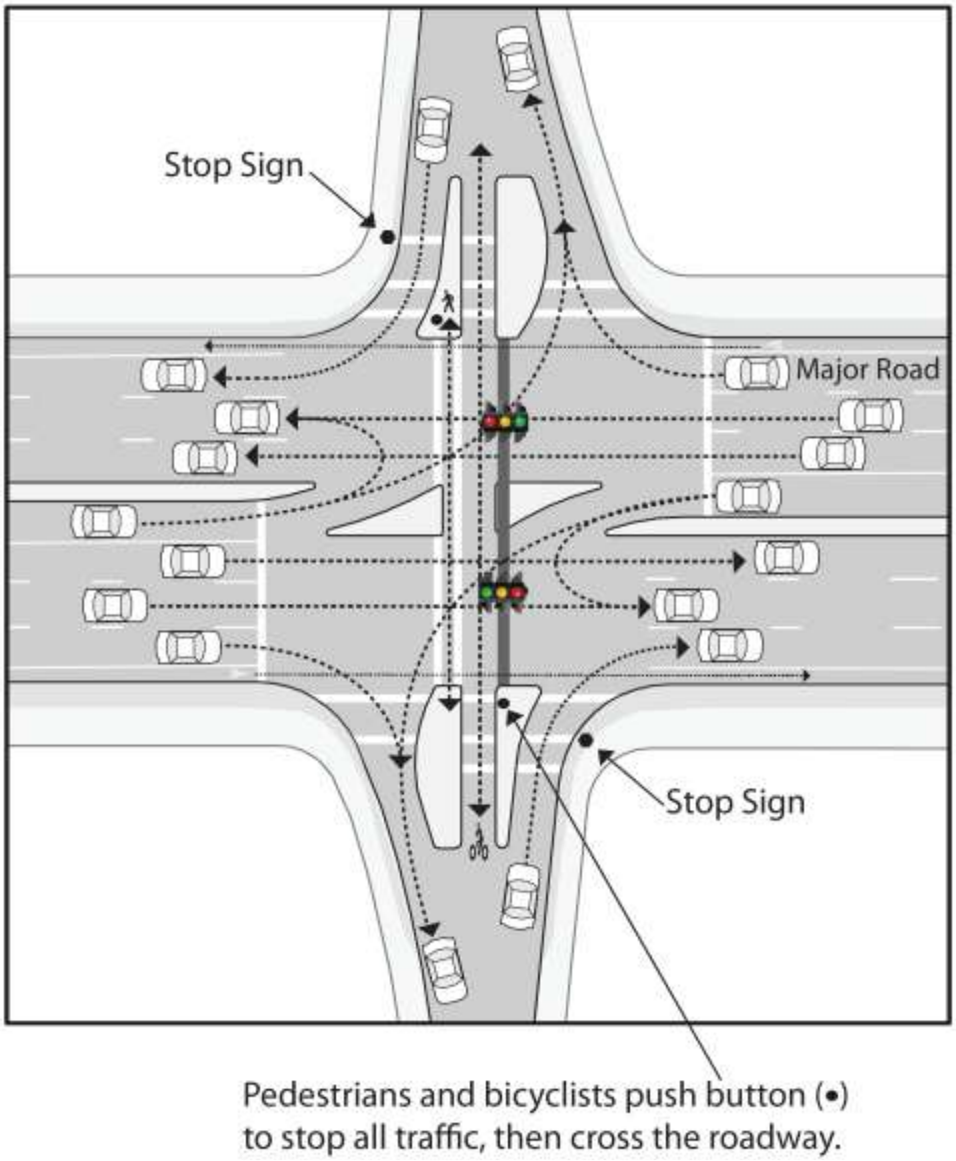
At a TOUCAN signal, motorized traffic on the minor street is not allowed to proceed through the intersection, decreasing the number of cars on neighborhood streets, and enhancing the neighborhood's quality of life.

A TOUCAN rests on a green for the major road. A bicyclist or pedestrian activates the signal by depressing a push button. Bicyclists respond to a bicycle signal and use a special lane when crossing. Pedestrians get a standard WALK indication and have a separate, adjacent crosswalk. The system uses a standard signal for motorists.

The TOUCAN crossing is designed specifically to facilitate bicycle access. Locations considered for the installation of a TOUCAN should generally meet the following criteria:

1) Meet MUTCD warrants for consideration of a traffic signal installation or conduct a traffic engineering analysis for justification, to be approved by the Director of Transportation and approved by Mayor and Council.
2) Ability to install barrier islands to prohibit motor vehicle traffic on the minor street from crossing the street; only right turns are permitted from the minor street to the major street.
3) Coordinate with emergency services to determine if through movements for emergency vehicles will be required, and design accordingly.
4) TOUCANs should be used mainly on major bicycle routes and bicycle boulevards.

Figure 4-5 illustrates the various vehicular, pedestrian, and bicycle movements that are made at a TOUCAN.



*Striping Details to be coordinated with the City of Tucson Department of Transportation staff.

Figure 4-5 – TOUCAN

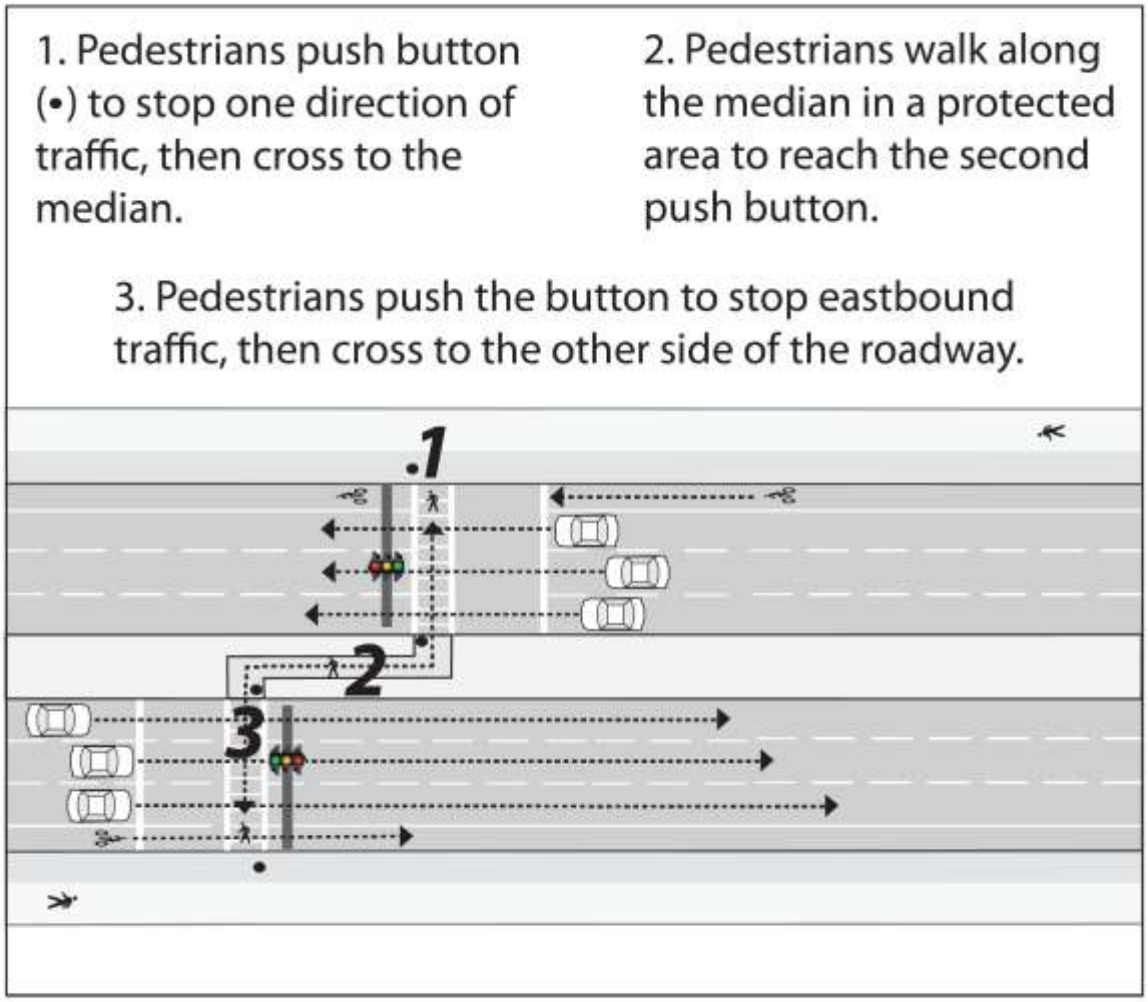
*4.5.5 PELICAN – **P**edestrian **LI**ght **C**ontrol **A**ctivatio**N***

The PEdestrian LIght Control ActivatioN (PELICAN) is placed mid-block on major streets and provides a safe, two-stage crossing for pedestrians. The PELICAN uses two, standard Red-Yellow-Green signals. The signals remain green for motorists until a pedestrian activates them using a push button. When a pedestrian presses the button, the signal turns YELLOW, then RED, alerting oncoming motorized traffic to stop. A "WALK" symbol prompts the pedestrian to proceed across half of the road to the median. The pedestrian then walks a short distance along the median to activate the second push button to cross the second half of the road. The same process is followed. The pedestrian presses the button, the traffic signal turns RED and oncoming traffic stops. The pedestrian then proceeds to the other side of the road. Artwork is sometimes incorporated into the design of PELICANs to make them easily noticeable. PELICANs minimize the potential for stops, delays, and crashes. Bicyclists using the PELICAN should yield to pedestrians using the device.

Locations considered for the installation of this combination of devices should generally meet the following criteria:

1) The location shall have a demonstrated need for a pedestrian crossing through a traffic analysis.
2) If designed as a school crossing the location of the PELICAN should be on the the school's "School Route Plan."
3) The proposed location is not within 600 feet of another signalized crossing, STOP sign, or flashing beacon and sign crossing.

Figure 4-6 illustrates the various vehicular, pedestrian, and bicycle movements that are made at a PELICAN.



*Striping Details to be coordinated with the City of Tucson Department of Transportation staff.

Figure 4-6 – PELICAN

5.0 DESIGN STANDARDS

5.1 Street Cross Sections

The reader is referred to the City of Tucson Major Streets & Routes Plan for specific cross sections of roadways.

Cross sections are the combination of the individual design elements that typify the design of the roadway. Cross section elements include the pavement surface for driving and parking lanes, curb, bike lanes, alternate mode facilities, sidewalks and additional buffer/landscape areas.

The design of cross-section elements depends upon the facility's intended use. Roads with higher design volumes and speeds require more travel lanes and wider right-of-way than low volume, low speed roads. Furthermore, arterials should include wider shoulders and medians, separate turn lanes, shoulders for use by bicycles, elimination of on-street parking and control of driveway access. For most roadways, an additional buffer area is provided beyond the curb line. This buffer area accommodates the sidewalk area, landscaping, and local utilities. Locating the utilities outside the travel way can minimize traffic disruption if utility repairs or service changes are required.

Typical elements of the roadway cross sections are identified in the following sections. However, few of the dimensions used in street design have been precisely determined by research. Instead, the cross sections usually represent a consensus of opinion based upon engineering judgment and operating experience. Therefore, each of the roadway design elements can be altered to better accommodate various conditions found in Tucson.

5.1.1 Local Streets

Local streets provide direct access to abutting land uses and accommodate local traffic movement. Local streets should be designed to encourage slow speeds and relatively low traffic volumes. The posted speed limit shall be 25 mph. Local streets are not typically striped. On-street parking is usually permitted and bicycles can be accommodated without a separate travel lane.

5.1.2 Collectors

Collector streets provide for traffic movement between local streets and arterial streets. Collector streets also provide access to abutting land uses. Parking is not allowed on collector streets unless approved by Mayor and Council. Individual driveway openings onto collectors should be designed to eliminate backing movements onto the street. Curbside lanes should be wider than 15 feet to provide for bicycle travel. Bicycle lanes shall be provided on any new collector roadway. They should be striped and have a minimum width of 5 feet.

5.1.3 Arterials

Arterial streets provide for major through traffic movement between geographic areas. These roadways typically have some form of access control that limits the locations of driveways. A curbed median should be included in the design of all arterial streets where the curb to curb width exceeds 75 feet. Where traffic volumes create the need for additional capacity, intersection modifications should be pursued prior to further widening. Additional right-turn lanes and dual left-turn lanes or traffic signal modifications can be provided in-lieu of additional travel lanes or roadway widening.

The maximum width of an arterial street should be no more than 6 lanes in the midblock, except where the additional lanes are designated for buses, bicycles, and high-occupancy vehicles. Parking is not allowed on arterial streets unless approved by Mayor and Council, or it is located in the downtown central business district.

5.2 Sight Distance

It is essential to provide sufficient sight distance for vehicles using a driveway. Vehicles should be able to enter and leave the property safely. Refer to the City of Tucson Development Standards for Sight Visibility Triangle Requirements. Alternatively, an engineering analysis may be conducted with the approval from the City of Tucson Department of Transportation, Traffic Engineering Division.

5.3 Turning Lanes

Turning lanes for right and left turns at intersections and driveways may be necessary to improve intersection safety or capacity where speeds, traffic volumes, or turning volumes are high.

Rear-end crashes can be severe on shared lanes. Research has found (**Table 5-1)** that crash rates increase exponentially as the speed differential in the traffic stream increases. As shown, on an arterial street, a vehicle traveling 35 mph slower than other traffic is 180 times more likely to become involved in a crash than a vehicle traveling at the same speed as other traffic.

Table 5-1 – Relative Crash Involvement Rates[11]

Speed Differential (mph)	Relative Crash Potential for:	
	At-Grade Arterials	Freeways
	0-mph Differential	0-mph Differential
0	1	1
-10	2	3.3
-20	6.5	20
-30	45	67
-35	180	N/A

N/A = not available

Separate turning lanes remove the turning vehicle from through traffic, removing the speed differential in the main travel lanes, thereby reducing the frequency and severity of rear-end collisions.

Left-turn lanes increase intersection capacity where left turns would otherwise share the use of a through lane. Shared use of a through lane dramatically reduces capacity, especially when opposing traffic is heavy. One left turn per signal cycle delays 40 percent of the through vehicles in the shared lane; two turns per cycle delays 60 percent.[12]

Figure 5-1 provides City of Tucson Transportation Department left turn lane warrant criteria. Alternatives to these criteria shall be supported by a traffic analysis. The minimum turn lane width is 12 feet unless approved by the Director of Transportation. **Figures 5-2** and **5-3** provide right turn lane warrant criteria. Alternatives to these criteria shall be supported by a traffic analysis.

[11] Source: Institute of Transportation Engineers, 1998.
[12] Source: Transportation Research Board, “Access Management Manual,” 1989.

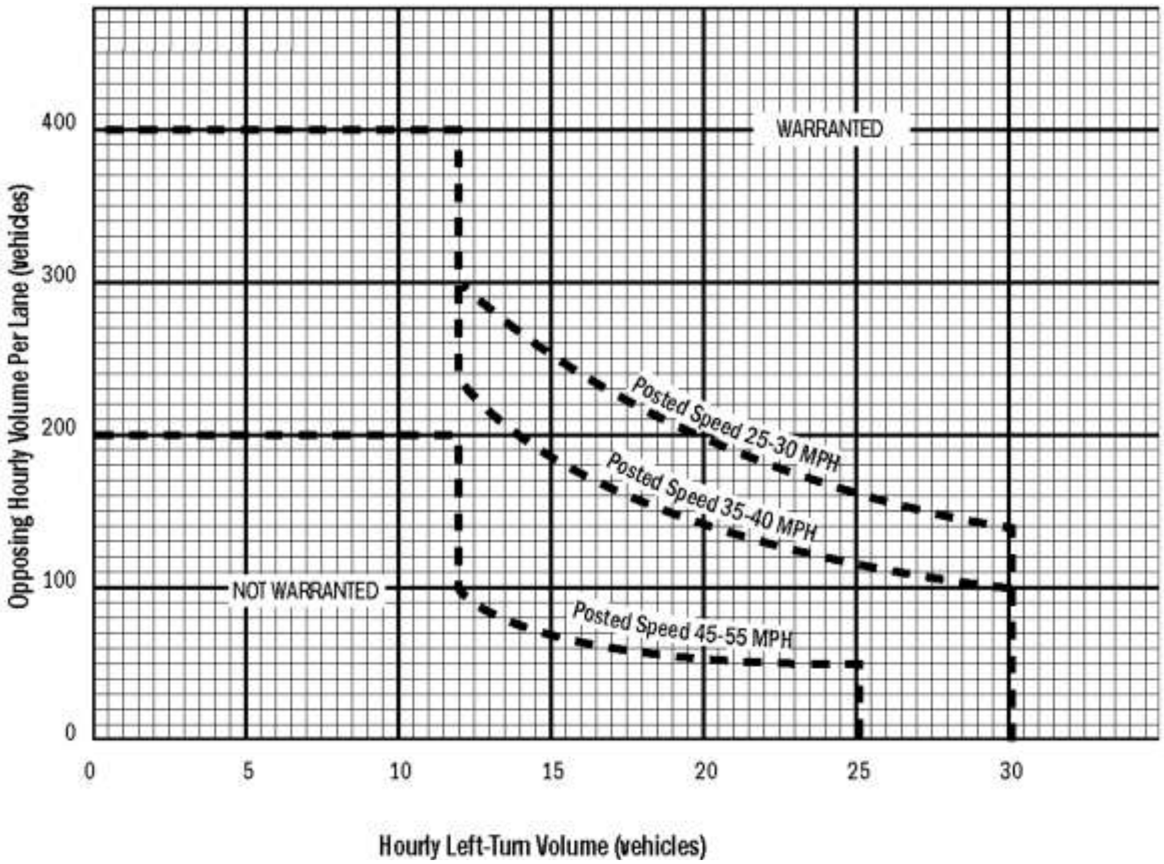


Figure 5-1 – Left Turn Lane Warrant[13]

[13] Idaho Transportation Department, "Traffic Manual," 2011; and, Transportation Research Board, NCHRP Report 348, "Access Management Guidelines for Activity Centers."

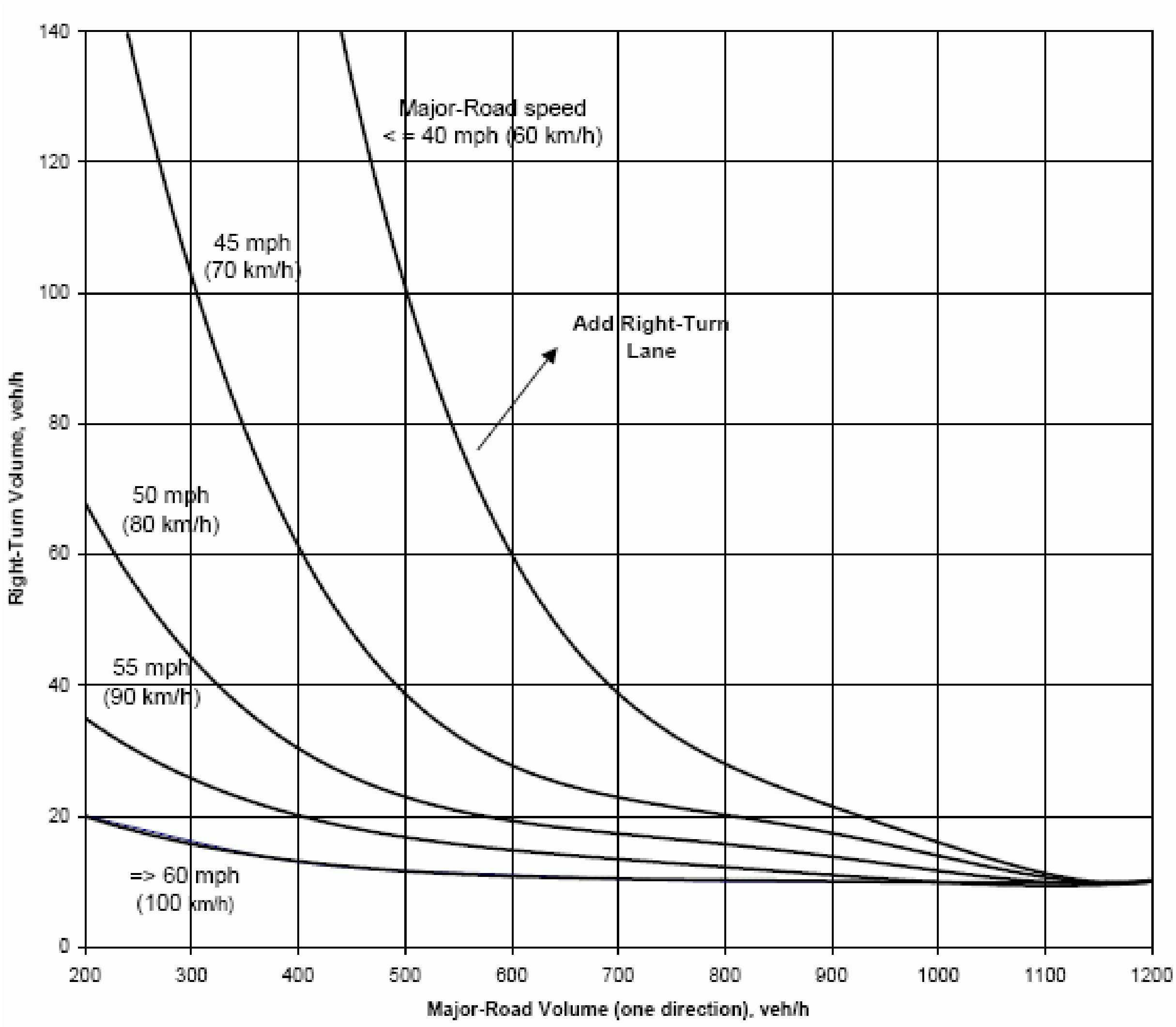
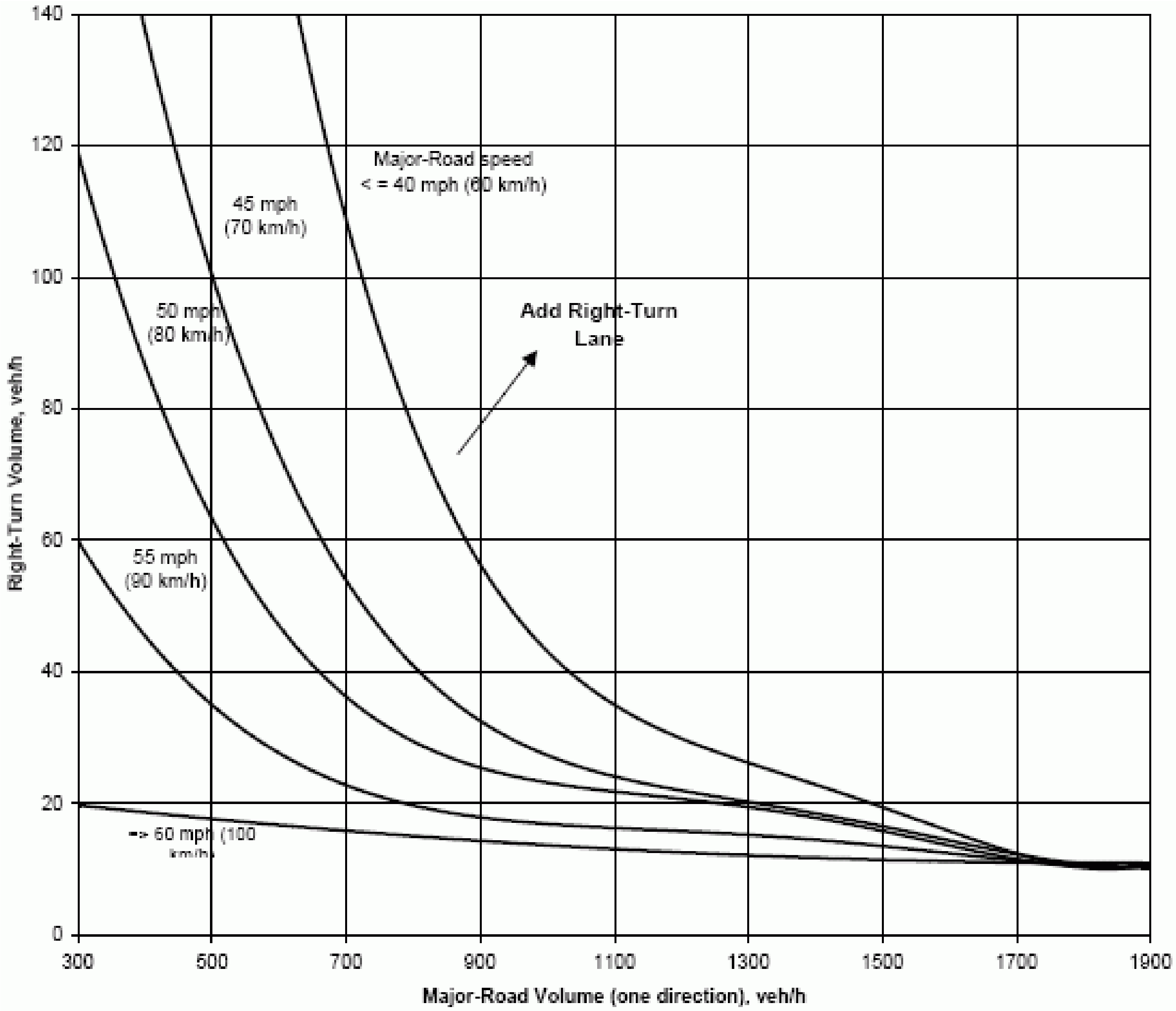


Figure 5-2 – Right Turn Lane Guidelines for Two-Lane Roadway[14]

[14] Source: MoDOT. Engineering Policy Guide. Sheet 940.9.8 "Right Turn Lane Guidelines for Two-Lane Roadways," 2007.



Note: Existing roadway constraints may restrict the ability or need to install turning lanes. Traffic Engineering may require a traffic engineering analysis to support alternative recommendations for the installation of turning lanes.

Figure 5-3 – Right Turn Guidelines for Four-Lane Roadways[15]

5.3.1 Total Turn Lane Length

A separate turning lane consists of a taper plus a full width auxiliary lane. The design of turn lanes is primarily based on the speed at which drivers turn into the lane, the speed to which drivers must reduce in order to turn into the driveway, and the required vehicular storage length. Other special considerations include the volume of trucks that will use the turning lane and the steepness of an ascending or descending grade.

The Pima County Department of Transportation (PCDOT) and the City of Tucson Department of Transportation (TDOT) provide design guidelines for minimum

[15] Source: MoDOT. Engineering Policy Guide. Sheet 940.9.9 "Right Turn Lane Guidelines for Four-Lane Roadways." 2007.

recommended transitions and storage lengths within the PCDOT/COT Pavement Marking Design Manual. Refer to the PCDOT/COT Pavement Marking Design Manual for minimum standards, Chapter 4 for transition and storage lengths.

At intersections with high traffic volumes, high turning movements, large amounts of truck traffic, steep grades, high speed differentials, and large activity centers, it is recommended that the minimum distances should not be used and a traffic engineering analysis shall be provided. Computerized methods of analysis are recommended, such as the latest addition of the Highway Capacity Software, Trafficware Synchro Software or an equivalent program.

The storage length should be sufficient to store the number of vehicles likely to accumulate during a critical period. The storage length should be sufficient to avoid the possibility of turning vehicles blocking the through lanes due to a lack of storage.

At unsignalized intersections, the storage length, exclusive of taper, may be based on the number of turning vehicles likely to arrive in an average two-minute period in the peak hour. Storage for at least two passenger cars should be provided; with over 10 percent truck traffic, storage should be provided for at least one car and one truck.

At signalized intersections, the required storage length is dependent on the signal cycle length, the signal phasing, and the rate of arrivals and departures of turning vehicles. The required storage length should be based on 1.5 to 2 times the average number of vehicles that would store per cycle. This length will be sufficient to serve heavy surges that occur from time to time. Approved computerized method of analysis can be used to determine queue lengths. The recommended method of analysis is the use of the latest edition of the Highway Capacity Software, Trafficware Synchro Software or an equivalent program.

The Director of Transportation or designated staff may grant written permission from the minimum and maximum guidelines based on site conditions or land use. Conditions that may impact required turn lane length are:

- Right-of-way constraints
- Excessive or expensive utility relocations
- Physical constraints with adjacent driveways, roadways, and/or bus pullouts

5.4 Driveway Locations

Design requirements for driveway locations onto arterial and collector roadways in all new development are as follows:

1) Entrance and exit drives crossing arterials and collectors are limited to two per 300 feet of frontage along any major roadway. The nearest pavement edges should be spaced at least 80 feet apart (**Figure 5-4**).
2) A minimum of one hundred and fifty feet, measured at curbline, shall separate the nearest pavement edge of any ingress or egress driveway and the curbline to any signalized or major intersection with arterial and collector roadways. (**Figure 5-4**)
3) On divided arterial and collector roadways, at full median openings, access points on both sides of the roadway should align (**Figure 5-5**) or be offset from the median opening by at least 150 feet (**Figure 5-6**). If the noted design requirements for driveway locations cannot be met, then driveway turning movement restrictions may be imposed. See Section 5.10 for movement restrictions.
4) On undivided arterial and collector roadways, at the access points on both sides of the roadway should align, or be offset by at least 300 feet for arterials, and 150 feet for collectors (**Figure 5-7**). If the noted design requirements for driveway locations cannot be met, then driveway turning movement restrictions may be imposed. See Section 5.10 for movement restrictions.
5) There should be no direct residential lot access to arterials. Direct residential lot access to collectors should be avoided in new roadway development.
6) All new development should promote cross access agreements to limit the number of driveways crossing arterial and collector roadways. See **Figure 5-8** for the benefits of shared and cross access management.
7) To limit access on major roadways, a local access lane can be incorporated into the design when multiple existing parcels have direct access to a collector or arterial roadway (**Figure 5-9**).
8) Area, neighborhood, and corridor plans and studies may further restrict driveway locations. For example, the Houghton Area Master Plan limits driveways on Houghton Rd. to ¼ mile spacing.
9) At locations near major intersections where the property is adjacent to a bus stop, consideration shall be provided for safe loading and unloading of passengers. See the Transit Facilities section (Section 5.16) and Bus Bay Details (**Figures 5-14 and 5-15**).

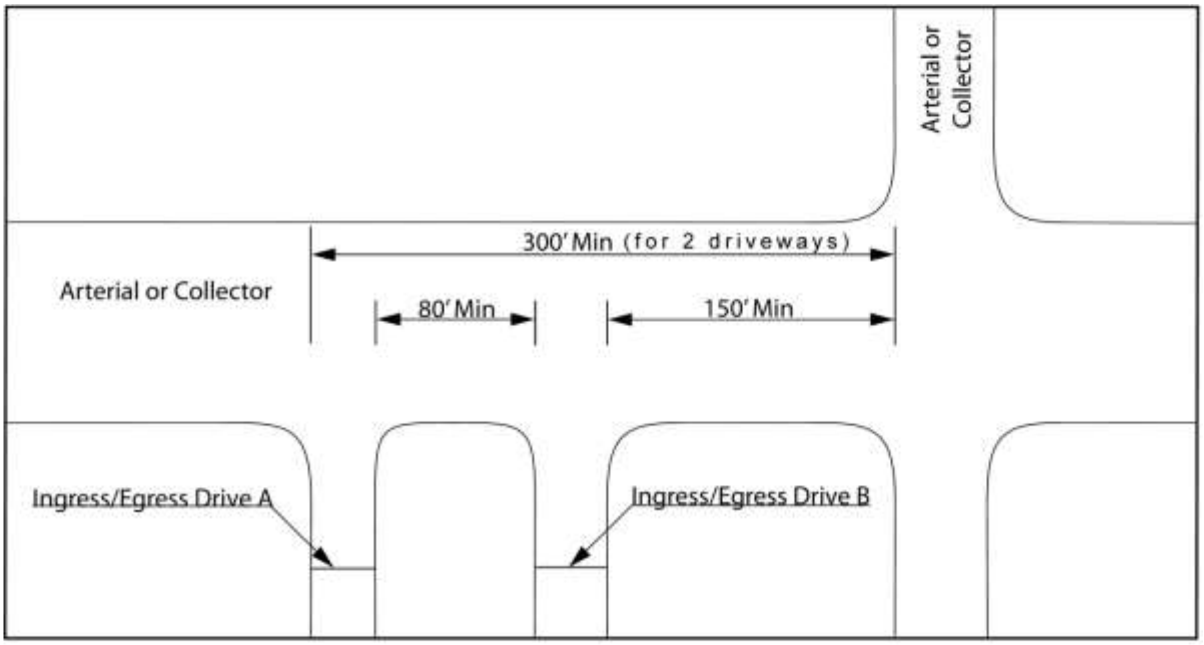


Figure 5-4 – Driveway Location Distances

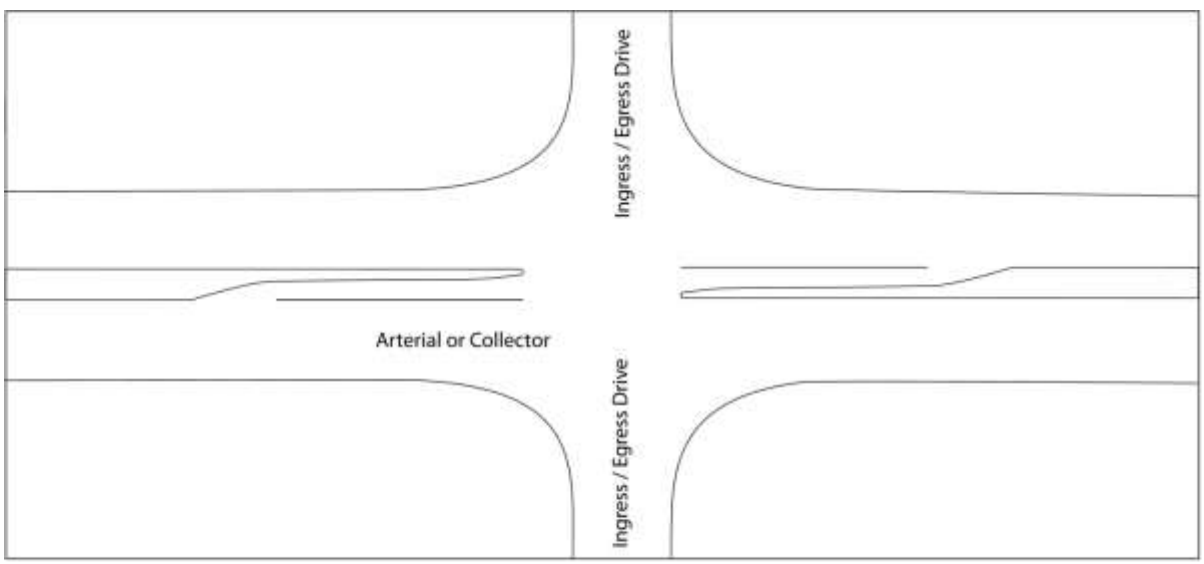


Figure 5-5 – Divided Roadway, Aligned Driveway Locations – Median Opening

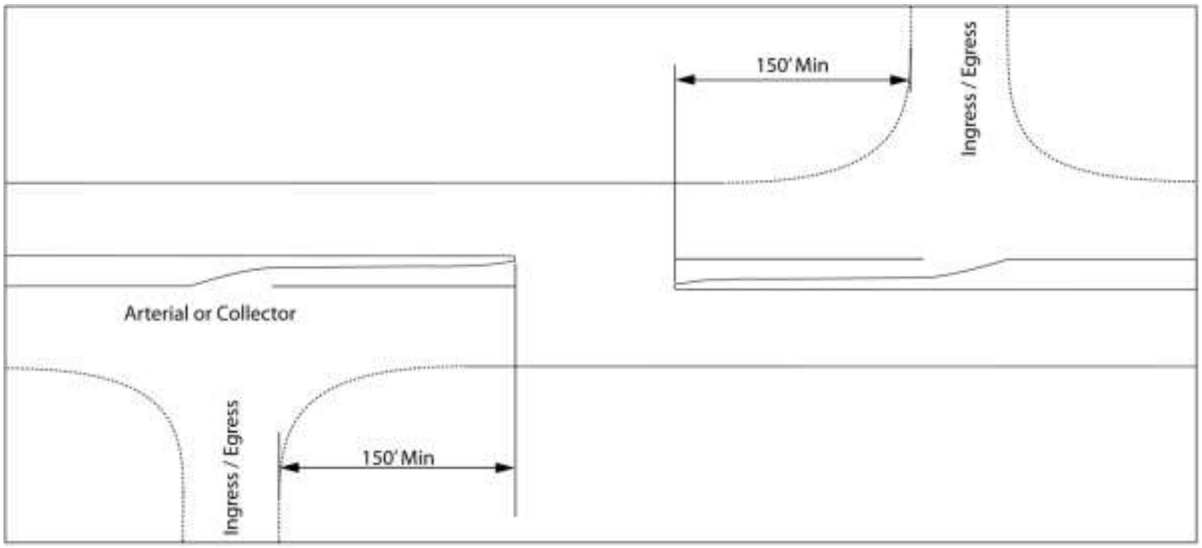


Figure 5-6 – Divided Roadway, 150' Offset Driveway Locations – Median Opening

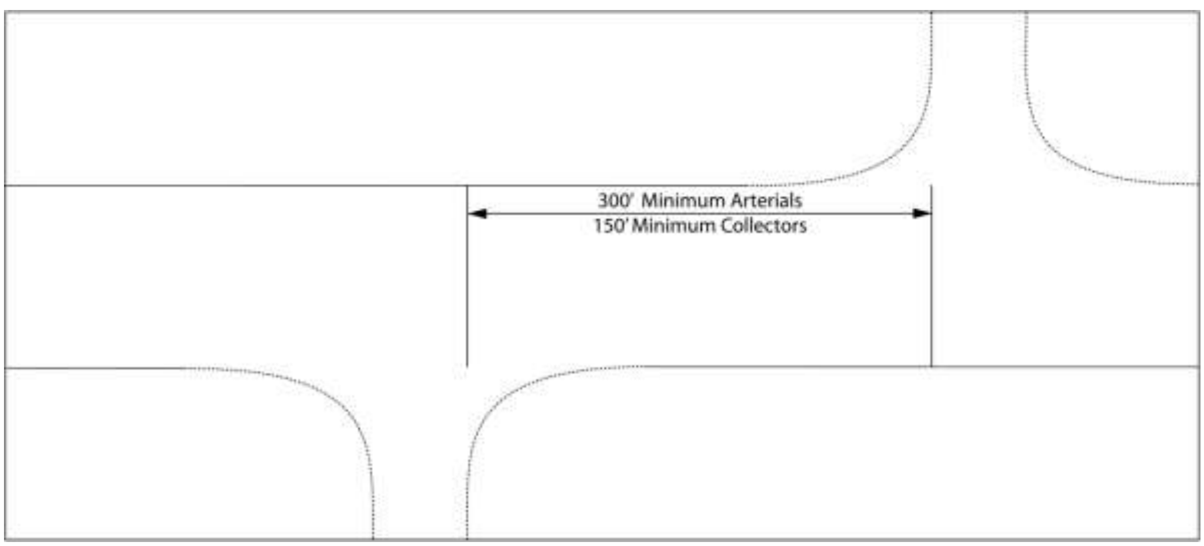


Figure 5-7 – Undivided Roadway, (Major Traffic Generators)

5.5 Cross and Shared Access

Cross access is achieved when property owners agree to allow other parcels to cross their property to access a driveway access point. Shared access is achieved when adjacent property owners agree to share a single driveway that accesses both adjacent properties.

Cross and shared access reduces the number of driveways, the number of driveway conflict points along the arterial, and helps traffic move smoothly along the roadway. **Figure 5-8** illustrates cross and shared access.

Benefits of cross and shared access include:

- Reduces the number of conflict points between vehicles, pedestrians, and bicyclists.
- Reduces congestion by maintaining the flow of traffic along the arterial roadway.
- Provides more area for landscaping.
- Makes the bicycle and pedestrian environment safer.
- Business patrons encounter less congestion; thereby experience fewer delays accessing businesses.

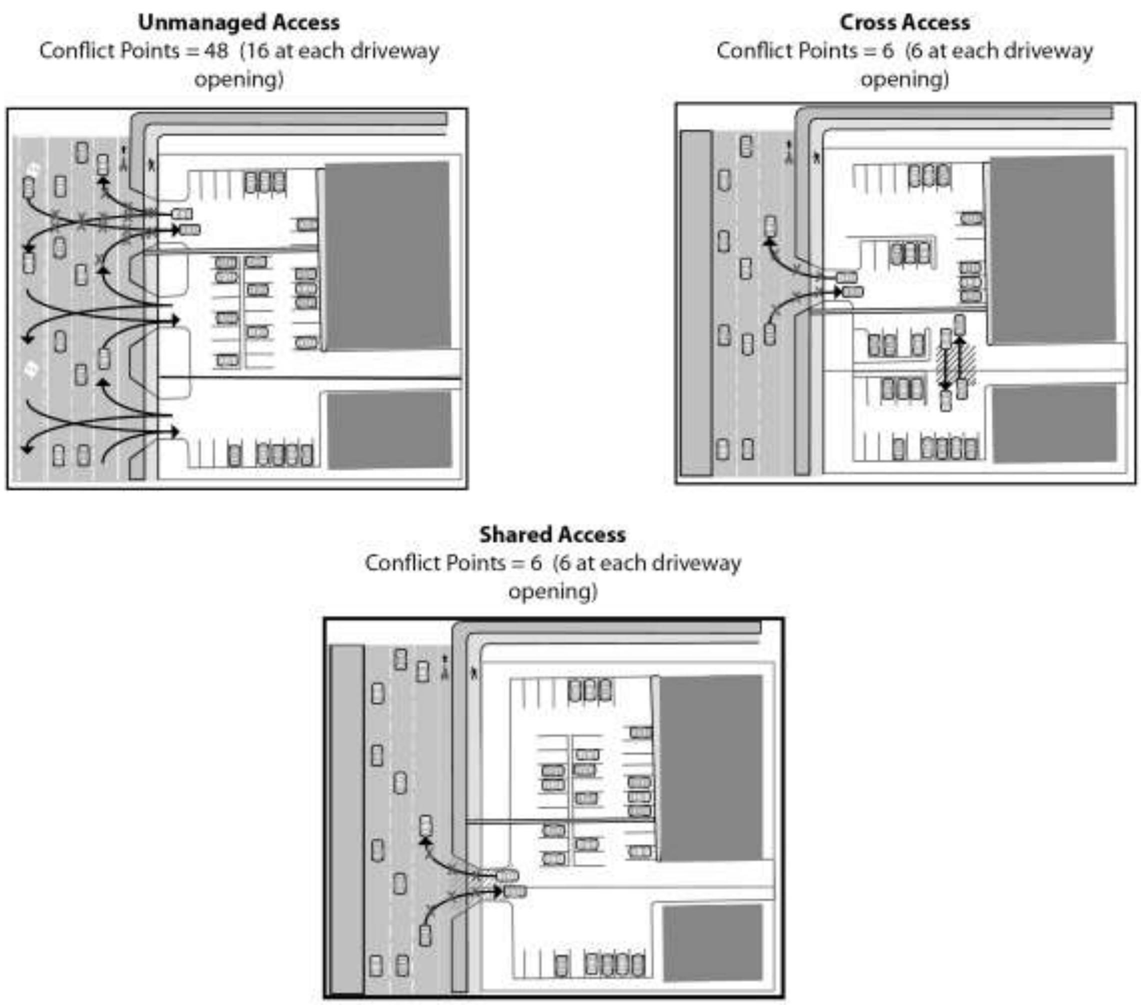


Figure 5-8 – Cross and Shared Access

5.6 Local Access Lanes

Local access lanes may be used in residential or commercial areas. Local access lanes reduce the number of driveways on the arterial, and the number of conflict points. **Figure 5-9** illustrates how a local access lane can be used to provide multiple access points to individual parcels (or different users on a single property), while limiting the number of driveways on the arterial.

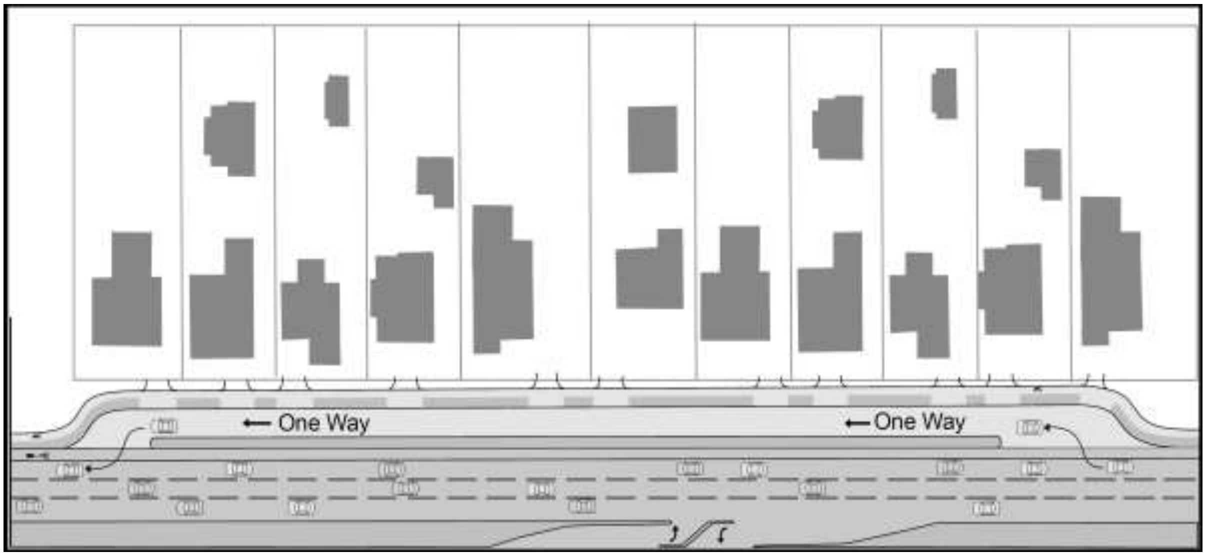


Figure 5-9 – Local Access Lane

Local access lanes include the following benefits:

- Reduces the number of conflict points between vehicles, pedestrians and bicyclists
- Reduces congestion by maintaining the flow of traffic
- Provides more area for landscaping
- Makes the bicycle and pedestrian friendly environment safer
- Business patrons encounter less congestion, thereby experience fewer delays accessing businesses
- Provides parking lane

This concept is not recommended for new developments.

5.7 Driveway Curb Radius

The preferred curb radius is dependent on the type of vehicles to be accommodated, the number of pedestrians crossing the access road, and the operating speed of the accessed roadway. **Table 5-2** presents the minimum curb return radius for connection between two types of streets.

Table 5-2 – Minimum Curb Return Radius[16]

	Arterial Street	Collector Street	Local Street	Driveway/ PAAL
Arterial Street	30'	25'	25'	25'
Collector Street	25'	25'	25'	25'
Local Street	25'	25'	18'	18'
Driveway/PAAL	25'	25'	18'	18'

Note: Traffic study to allow radii reduction or approval by TDOT

5.8 Unsignalized Driveway Entry Width

The entry width is the width needed at the driveway throat to accommodate the path of the turning design vehicle. Design vehicle requirements should be based on land use. Most locations will likely use passenger vehicles as the design vehicle when determining driveway entry widths; land uses with high truck volumes will need to use a truck as the design vehicle. The curb return radii given in **Table 5-2** represent the minimums developed for commonly used design vehicles turning into a driveway from the right-most lane. The entry width will differ from the driveway's overall width, depending on how the driveway is expected to operate. Driveway entries should be placed outside of steep slopes, no access easements, or restricted utility easements.

All curb cuts, curb returns, curb radii, and curb depressions should be located in accordance with the City of Tucson Code, Chapter 25 (see guidelines in **Table 5-3** and illustrated in **Figure 5-10**). For example, the presence of utility poles, catch basins, steep slopes on a property, abnormally high bicycle and/or pedestrian volumes can be cause for an exception. The existing design and land use of the abutting property may also support a change from the guidelines. The exception, however, cannot be against the public interest, safety, convenience or general welfare.

[16] Source: City of Tucson Development Standard No. 3-01.1 Figure 6.

Table 5-3 – Unsignalized Driveway Entry Widths[17]

	Residential Districts	Business Districts	Industrial Districts
Driveway width (min./max.)	**10' / 20'**	**35' max**	**35' max**
Max. driveway width for two adjoining properties (shared access)	**30'**	**35' max**	**35' max**
Max. driveway width at the property line	**n/a**	**30'**	**30'**

Note: The provisions established for curb cuts and driveways for business zoned district shall prevail in all industrial zoned districts for properties fronting on a through street, as defined in the City of Tucson Code, or on a major street as shown on the latest MS&R Plan on file with the Director of Transportation or designated staff.

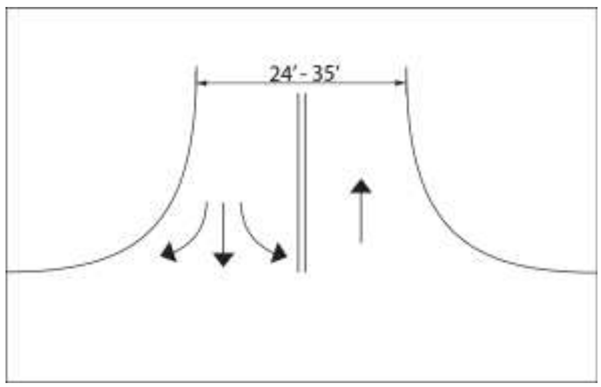


Figure 5-10 – Unsignalized Driveway Entry Width

5.9 Driveway Profiles

The slope of a driveway can dramatically influence its operation. Usage by large vehicles can have a tremendous effect on operations if slopes are severe. The profile, or grade, of a driveway should be designed to provide a comfortable and safe transition for those using the facility, and to accommodate the storm water drainage system and reduce erosion or not impact erosion control, of the roadway. Driveways should also be designed in compliance with Americans with Disabilities Act (ADA) guidelines.

5.10 Driveway Turning Movement Restrictions

Where full-access will impact the safety along the adjacent roadway, the traffic engineering staff may require turning restrictions at driveways. The restriction may be for left-turn movements in or out of the driveway. Turning restrictions may be imposed for driveways that are too close to signalized intersections, or where existing driveways or roadway characteristics may increase accident potential or at locations with a history of high accident rates. **Figure 5-11** provides examples of potential restrictions to turning movements.

[17] Source: Tucson City Code, Section 25-38 to 25-40

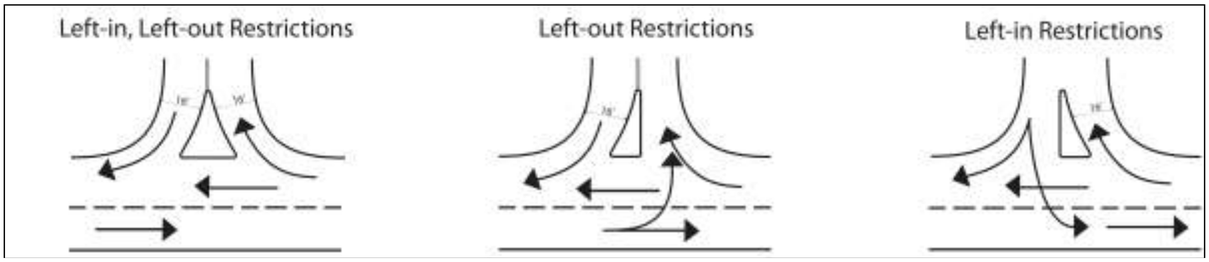


Figure 5-11 – Turning Movement Restrictions

5.11 Driveway Throat Length

The driveway throat should be of sufficient length to enable the intersection of the driveway and abutting roadway and the on-site circulation to function without interference with each other. Drivers entering the site should be able to clear the intersection of the roadway and the driveway before encountering any on-site intersections that are part of the redevelopment circulation. Inadequate throat length results in poor access circulation in the vicinity of the access drive. This produces congestion and high crash rates on the abutting streets as well as on site. Pedestrian/vehicular conflicts may also result from confusion caused by the complex pattern of over-lapping conflict areas.

The exit side of an access connection should be designed to enable traffic leaving the site to do so efficiently. Stop-controlled connections should be of sufficient length to store three passenger cars (one passenger car = 20 feet). **Figure 5-12** illustrates the recommended practices for designing driveway throat lengths.

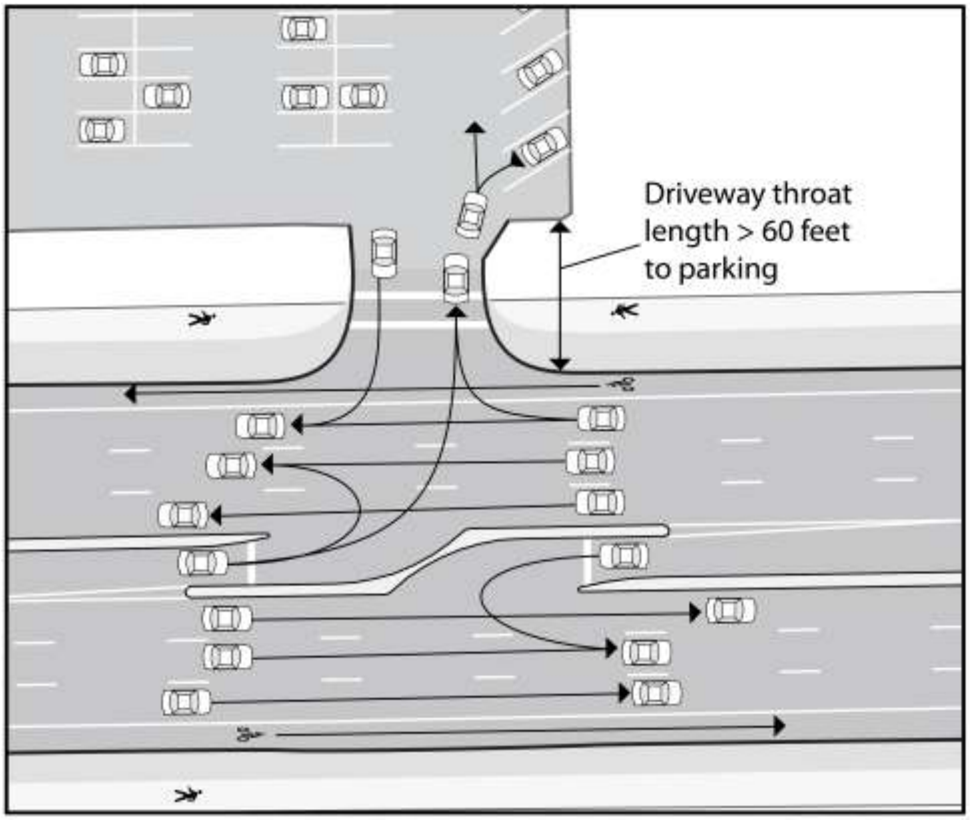


Figure 5-12 – Driveway Throat Length

5.12 Truck Loading Area

Truck loading areas should be designed to minimize conflict with on-site traffic and circulation. Drop-off/loading areas should not be located where they will have an effect on traffic operations on the adjoining roadway.

5.13 Median Design

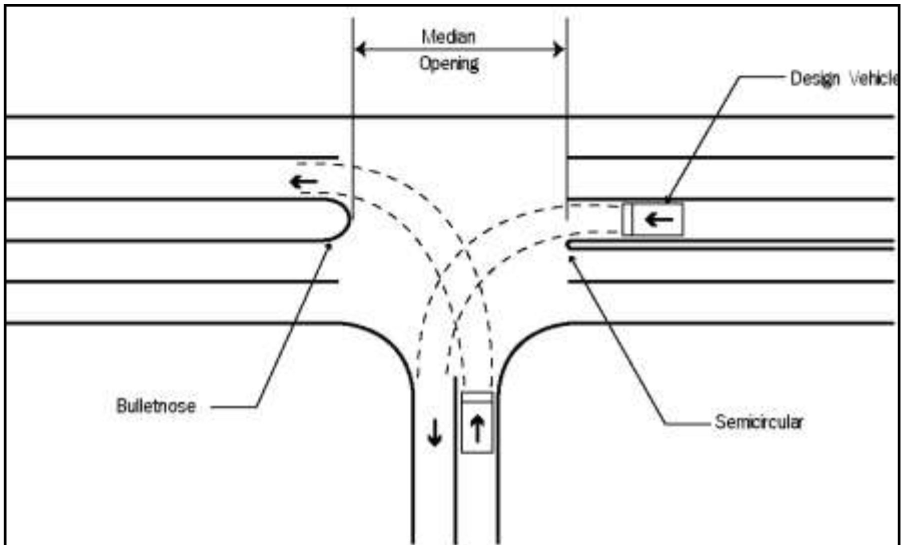
On median-divided roadways, left-turn ingress or egress to a site requires a median opening. Median design elements include the median width, the spacing of median openings (see Section 4.3), and the geometrics of median noses at openings.

Median widths ranging from 6 to 20 feet are desirable for providing separate left-turn lanes.

The design of the median nose can vary from semicircular, usually for medians in the 4-foot to 10-foot range, to bullet nose design, for wider medians and for intersections that will accommodate semi-trailer trucks.

The bullet nose is formed by two symmetrical portions of control radius arcs that are terminated by a median nose radius that is normally one-fifth the width of the median (e.g., a bullet nose design for a median opening in a 20-foot-wide median would have a small nose radius of 4 feet that could connect two 50-foot radii).

The large radii should closely fit the path of the inner rear wheel of the selected design vehicle. The advantages are that the driver of the left-turning vehicle, especially a truck, has a better guide for the maneuver. The median opening can be kept to a minimum, and vehicle encroachment is minimized. **Figure 5-13** indicates the various elements of a median opening design.



Median Openings Design Controls		
Control Radius (feet)	Design Vehicles Accomodated	
	Predominant	Occasional
40	P	SU
50	SU	WB-40
75	WB-40	WB-50

Median Width (feet)	Minimum Median Opening (feet)	
	Semicircular	Bullet Nose
12	88	58
18	82	47
20	80	44
30	70	40 minimum
40	60	40 minimum
50	50	40 minimum
60	40 minimum	40 minimum

Figure 5-13 – Minimum Median Openings[18]

[18] Source: American Association of State Highway and Transportation Officials, "A Policy on Geometric Design of Highways and Streets – 4th Edition," 2001.

5.14 Pedestrian Facilities[19]

Pedestrian facility improvements on major roadway projects should utilize all applicable City of Tucson Development Standards, Pima County/City of Tucson Standard Specifications and Details, and Arizona Department of Transportation (ADOT) Standards, and should be compliant with the transportation and public accommodation provisions of the Americans with Disabilities Act (ADA).

All major roadway projects should include sidewalks on both sides of the improved roadway section. When adequate right-of-way is available, consideration should be given to providing sidewalks and landscape areas between the sidewalk and the roadway of greater width than minimum Development Standard specifications. The path of travel along sidewalks should generally be straight without unnecessary curving or offsets. Consideration should be given to extending sidewalks to local and regional activity centers up to one-quarter mile beyond the project limit, in order to create a convenient, safe, and attractive pedestrian network. Consideration should be given to the utilization of alternative paving materials and designs, such as permeable concrete, unit pavers, scored or sandblasted concrete patterns, and the integration of public art in paving that enhance the overall aesthetic value of the project, contribute to the effectiveness of rainwater harvesting elements, and complement existing and planned future urban design character. Pedestrian access within the public right-of-way should also take into consideration the guidelines and requirements for on-site pedestrian improvements that exist within city codes, area and neighborhood plans, and other land use policy documents that shape development adjacent to the road. Installation of crosswalks across streets and driveways requires approval from the Traffic Engineering Division

5.15 Bicycle Facilities

The City of Tucson desires to provide facilities and infrastructure that support bicycling as a safe and reliable mode of transportation. The City of Tucson frames the development of the City's bikeway network around five types of bicycle facilities:

- Bicycle Route – lower volume streets with a maximum speed limit of 30 mph, with "Bike Route" signs.
- Bicycle Route with Striped Shoulder – on major streets with speed limits 25 mph or more. Striped shoulder consists of a 5-foot-wide paved shoulder with a white edge line.
- Shared-use Path – a paved pathway, 10-foot to 12-foot-wide, physically separated from the street. Shared-use paths are shared with pedestrians and other non-motorized users, and occasionally equestrians. These are suitable for slower speeds. Shared-use-Paths shall be designed in accordance with the American Association of State Highway and Transportation Officials (AASHTO) Guide for Development of Bicycle Facilities. Special consideration should be given to address safety issues where shared use paths are located adjacent to roadways.

[19] Source: City of Tucson Roadway Development Policies, 1998.

- Residential Streets – Selected local streets that have low traffic volumes, and a maximum speed limit of 25 mph. Bicycles and vehicles share the roadway.
- Bicycle boulevards – Bicycle boulevards are low-volume and low-speed streets that have been optimized for bicycle travel through treatments such as traffic calming and traffic reduction, signage and pavement markings, and intersection crossing treatments. The improvements prioritize bicycle travel on the streets, and lead to an attractive, convenient, and comfortable bicycling environment. These treatments allow through movements for cyclists while discouraging similar through trips by non-local motorized traffic. Motor vehicle access to properties along the route is maintained. Bicycle boulevards are designed to offer the advantages of cycling on shared roadways, but allow the bicyclist to experience lower traffic volumes and lower traffic speeds.

Architects and developers should consider these five types of bicycle facilities throughout the development planning and design process.

The City of Tucson requires that all major roadway projects be designed with a minimum 5-foot-wide or preferred 6-foot-wide bicycle lanes. Additionally, 6-foot-wide bicycle lanes are required on roadways with speeds at or exceeding 40 miles per hour. Bicycle facility improvements on major roadway projects should utilize all appropriate AASHTO design guidelines, MUTCD, City of Tucson Development Standards, and the City of Tucson Specifications and Details.

All major roadway projects involving the reconstruction of intersections should provide for bicycle lanes with striped shoulders or additional outside vehicle lane width for bicycle lanes as part of the intersection improvement. Bicycle-sensitive actuated signal detection or video camera detection should be provided so that the bicyclist can actuate the traffic signal.

All new development should provide safe bicycle access to and from their facility. Development which requires new turn lanes shall maintain or install new bike lanes.

5.16 Transit Facilities

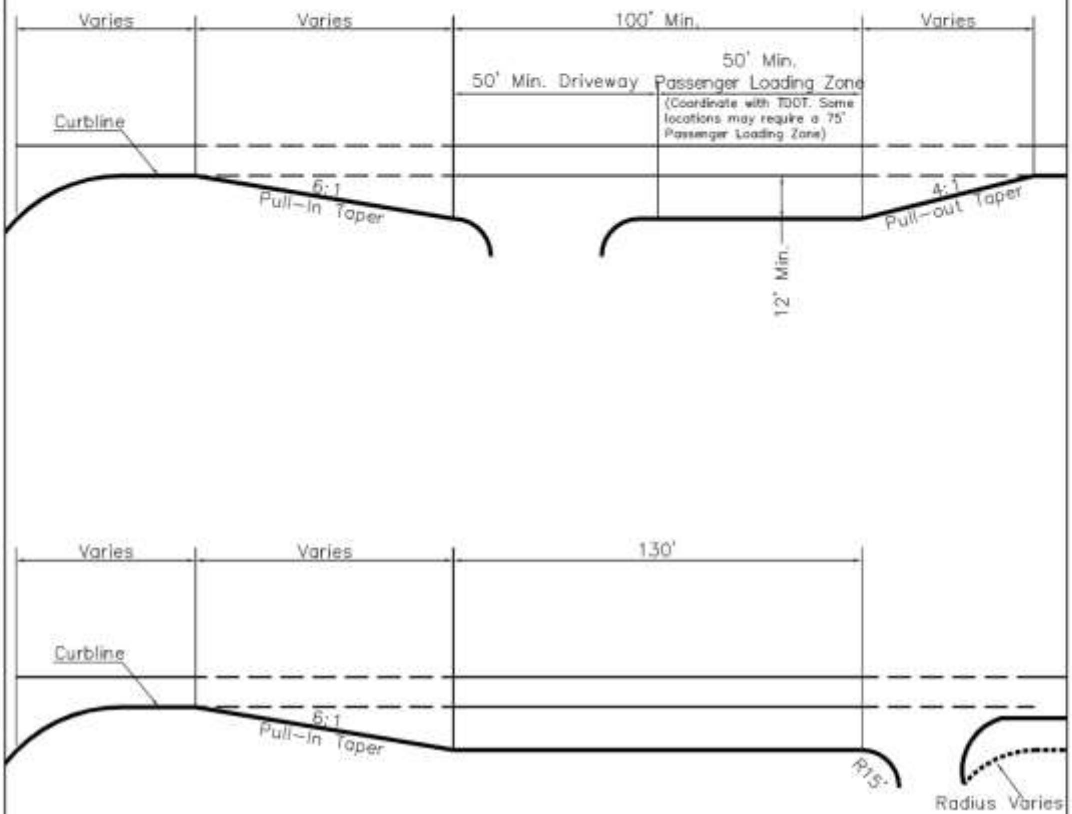
In order to provide convenient access to public transit, bus stops should be placed every one-quarter mile on major roadway projects located along existing local transit routes, and every one-half mile to one mile along express or limited routes. Additional stops may be considered to serve major trip generators. Unless otherwise warranted by overriding safety concerns or passenger convenience issues, bus stops should be located on the far side of the intersection.

Bus shelters should be provided at all bus stops located along major roadways to provide for passenger comfort and safety.

Major roadway or large scale development projects should include bus pullouts at high activity bus stops when warranted by peak hour traffic, peak hour bus frequency, passenger safety concerns, and when adequate right-of-way is available. Bus pullouts should be located on the far side of the intersection in order to utilize signal protection for re-entry into the stream of traffic. Bus pullouts should be carefully planned and designed to minimize transit vehicle delay in re-entering the stream of traffic. Bus pullouts should include shelters and other passenger amenities to provide for customer safety and convenience and should be designed to not conflict with driveway access.

For the design of a bus bay, it is recommended that a minimum 6:1 bay taper be used to provide a 12-foot minimum width bus bay. The bus bays should provide for 100 feet of storage length, unless it is a layover location, and a 4:1 exit taper. **Figures 5-14 and 5-15** provide the bus bay details for two types of design.

BUS PULLOUT EXHIBIT



NOTES:

1. DRIVEWAYS ARE NOT RECOMMENDED IN BUS BAY.
2. IF A DRIVEWAY IS INSTALLED IT SHOULD BE LOCATED PRIOR TO THE 50' MIN. PASSENGER LOADING ZONE OR 45' AWAY FROM THE DESIGNATED BUS STOP.
3. EXISTING ROADWAY CONSTRAINTS MAY RESTRICT THE ABILITY OR NEED TO INSTALL A 12' WIDE BUS BAY. TRAFFIC ENGINEERING MAY REQUIRE A TRAFFIC ENGINEERING ANALYSIS TO SUPPORT ALTERNATIVE RECOMMENDATIONS FOR THE INSTALLATION OF BUS BAYS.

Figure 5-14 – Bus Bay Detail 1 – Major Intersections

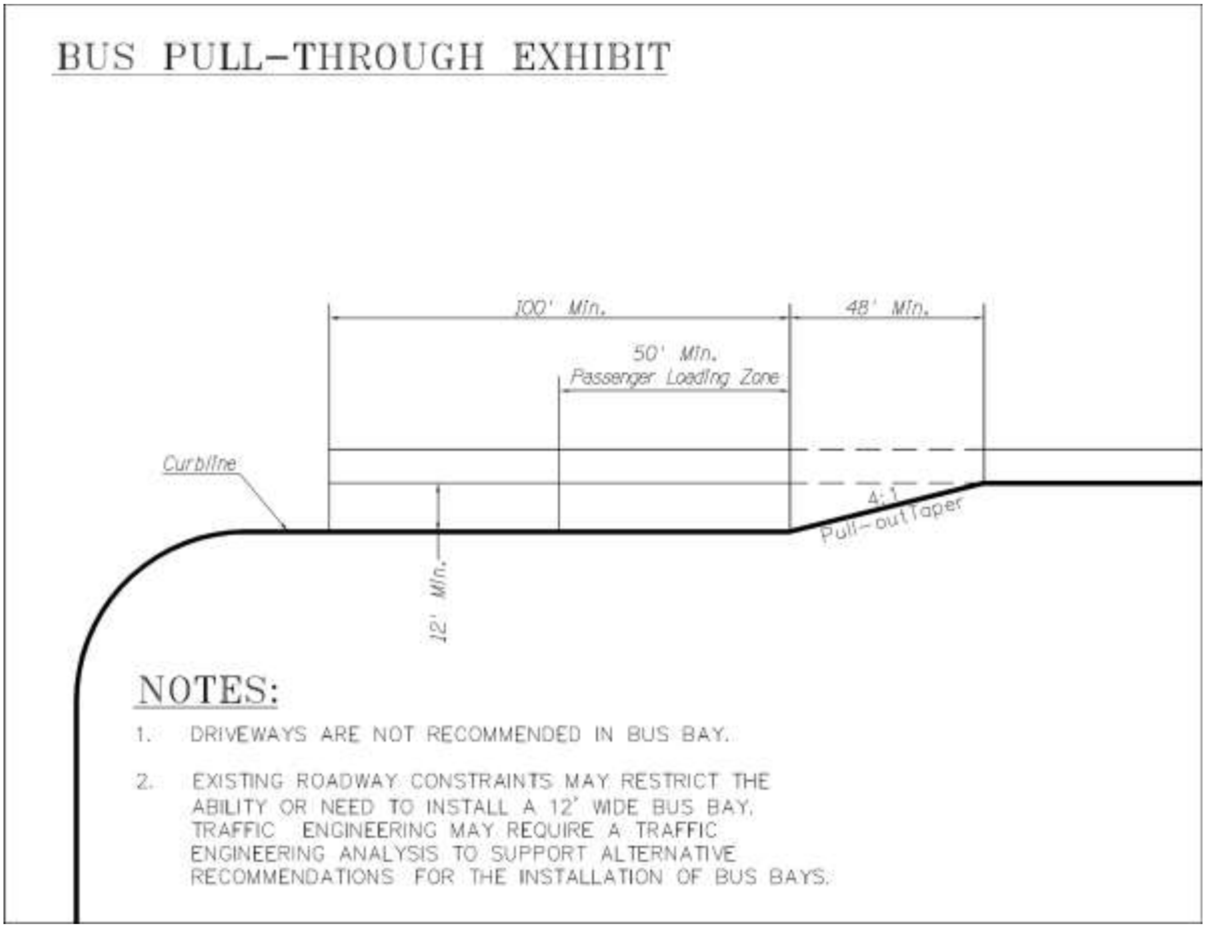


Figure 5-15 – Bus Bay Detail 2 – Minor Intersections

6.0 METHODS OF APPLICATION

6.1 Traffic Impact Analysis

The City may request that a Traffic Impact Analysis (TIA) be prepared for proposed developments consistent with its policies. A detailed description of the methodology and necessary data is presented in Section 6.3.2.

6.2 Variations

Where the City of Tucson finds extraordinary hardships or practical difficulties resulting from strict compliance with approved requirements, the City may approve variations to the requirements, provided that safety standards are met, so that the public interest is served. The City may require that a TIA or other information be submitted when reviewing a request for a variation. Variations may be necessary for exceptions to turning restrictions or spacing standards where it can be demonstrated that no other reasonable options are available.

A petition for any variation should be submitted in writing to the City by the developer or by the developer's traffic engineer. The developer must prove that the variation will not be contrary to the public interest and that unavoidable practical difficulty or unnecessary hardship will result if not granted. The developer should establish and substantiate that the variation conforms to the City's requirements and standards.

Care should be taken in issuing variations. No variation should be granted unless it is found that the following relevant requirements and conditions are satisfied. The City may grant variations whenever it is determined that all of the following criteria have been met:

1) The granting of the variation should be in harmony with the general purpose and intent of the regulations and should not result in undue delay or congestion or be detrimental to the safety of the public using the roadway.
2) There should be proof of unique or existing special circumstances or conditions where strict application of the provisions would deprive the developer of reasonable access. Circumstances that would allow reasonable access to a road or street other than a primary roadway, circumstances where indirect or restricted access can be obtained, or circumstances where engineering or construction solutions can be applied to mitigate the condition should not be considered unique or special.
3) There should be proof of the need for the access and a clear documentation of the practical difficulty or unnecessary hardship. The difficulty or hardship must result from strict application of the provision, and it should be suffered directly and solely by the owner or developer of the property in question.

The City shall render a decision in writing to the developer. Materials documenting the variation are maintained in the City's permit files.

6.3 Site Design

This sub-section sets forth criteria for access control and traffic impact analyses, as they apply to individual developments.

6.3.1 Access Control

Typical access control requirements for arterials and collectors are provided as follows:

1) No driveway access to an arterial street should be allowed for any residential lot. Driveway access to collectors from residential lots should be discouraged and approved on a case-by-case evaluation.
2) No driveway access should be allowed within 150 feet of the nearest curb line of a signalized or major intersection. See Section for 5.0 for specific design criteria.
3) Driveways giving direct access may be denied if alternate access is available.
4) When necessary for the safe and efficient movement of traffic, access points may be required to be designed for right turns in and out only.
5) In most cases driveways will be treated with curb returns along arterial and collector roadways (see Table 5-2).

6.3.2 Traffic Impact Analysis

A TIA is a specialized study of the impacts that a certain type and size of development will have on the surrounding transportation system. A TIA is essential for many access management decisions, such as spacing of driveways, traffic control devices, and traffic safety issues. It is specifically concerned with the generation, distribution, and assignment of traffic to and from new development. A TIA should also be used as part of the site planning process, not merely justification of the site plan. The purpose of this sub-section is to establish uniform guidelines for when a TIA is required and how the study is to be conducted.

6.3.2.1 Requirements A complete TIA should be performed if any of the following situations are proposed:

1) All new developments or additions to existing developments, which are expected to generate more than 100 new peak-hour vehicle trips (total in and out vehicular movements). The peak-hour will be determined by the City's representative.
2) In some cases, a development that generates less than 100 new peak hour trips may require a TIA or a Traffic Statement, if it affects local "problem" areas. These would include high crash locations, currently congested areas, or areas of critical local concern. These cases will be based on the City representative's judgment.
3) All applications for rezoning or special exception (e.g. big box).
4) All applications for annexation.

5) Any change in the land use or density that will change the site traffic generation by more than 15 percent, where at least 100 new peak-hour trips are involved.
6) Any change in the land use that will cause the directional distribution of site traffic to change by more than 20 percent.
7) When the original TIA is more than 2 years old, access decisions are still outstanding, and changes in development have occurred in the site environs.
8) When development agreements are necessary to determine "fair share" contributions to major roadway improvements.
9) Parking in areas of minimum requirements is proposed.

The specific analysis requirements, and level of detail, are determined by the following requirements.

- **CATEGORY I TIA** -- Developments which generate from 100 up to 500 peak hour trips. The study horizon should be limited to the opening year of the development. The minimum study area should include site access drives and adjacent signalized intersections and/or major unsignalized street intersections.

- **CATEGORY II TIA** -- Developments that generate from 500 up to 1,000-peak hour trips. The study horizon should include both the opening year of the development and five years after opening. The minimum study area should include the site access drives and all signalized intersections and/or major unsignalized street intersections within one-half mile of the development.

- **CATEGORY III TIA** -- Developments that generate 1,000 or more peak hour trips. The study horizon should include the opening year of the development, five years after opening and ten years after opening. The minimum study area should include the site access drives and all signalized intersections and/or major unsignalized street intersections within one mile of the development.

6.3.2.2 Qualifications for Preparing Traffic Impact Analysis Documents. The TIA should be conducted and prepared under the direction of a registered professional engineer. The subject engineer should have special training and experience in traffic engineering.

6.3.2.3 Analysis Approach and Methods. The traffic study approach and methods should be guided by the following criteria.

6.3.2.3.1 **STUDY AREA**. The minimum study area should be determined by project type and size in accordance with the criteria previously outlined. The extent of the study area may be either enlarged, or decreased, depending on special conditions as determined by the City's representative.

6.3.2.3.2 **STUDY HORIZON YEARS**. The study horizon years should be determined by project type and size, in accordance with the criteria previously outlined.

6.3.2.3.3 **ANALYSIS TIME PERIOD**. Both the morning and afternoon weekday peak hours should be analyzed, unless the proposed project is expected to generate no trips, or a very low number of trips, during either the morning or evening peak periods. If this is the case, the requirement to analyze one or both of these periods may be waived by the City's representative.

Where the peak traffic hour in the study area occurs during a different time period than the normal morning or afternoon peak travel periods (for example mid-day), or occurs on a weekend, or if the proposed project has unusual peaking characteristics, these additional peak hours should also be analyzed.

6.3.2.3.4 **SEASONAL ADJUSTMENTS**. When directed by the City's representative, the traffic volumes for the analysis hours should be adjusted for the peak season, in cases where seasonal traffic data is available.

6.3.2.3.5 **DATA COLLECTION REQUIREMENTS**. All data should be collected in accordance with the latest edition of the ITE Manual of Traffic Engineering Studies, or as directed by the City of Tucson's Traffic Engineer.

6.3.2.3.5.1 **Traffic volumes.** Manual turning movement counts should be obtained for all existing cross-street intersections to be analyzed during the morning and afternoon peak periods. Turning movement counts may be required during other periods as directed by the City's representative.

6.3.2.3.5.2 **Daily traffic volumes.** The current and projected daily traffic volumes should be presented in the report. If available, daily count data from the City of Tucson, Pima County, or the Pima Association of Governments (PAG) may be used. Where daily count data is not available, mechanical counts will be required at locations agreed upon by the City's representative.

6.3.2.3.5.3 **Crash data.** Traffic crash data should be obtained for the most current three-year period available.

6.3.2.3.5.4 **Roadway and intersection geometrics.** Roadway geometric information should be obtained. This includes, but is not limited to, roadway width, number of lanes, turning lanes, vertical grade, and location of nearby driveways, pedestrian facilities, and lane configuration at intersections.

6.3.2.3.5.5 **Traffic control devices.** The location and type of traffic controls should be identified.

6.3.2.3.5.6 **Bicycle and pedestrian volumes.** When directed by the City of Tucson's traffic engineering staff, bicycle and pedestrian volumes should be collected.

6.3.2.3.6 **TRAFFIC VOLUME FORECASTS**. Future traffic volumes should be estimated using information from transportation models, or applying an annual growth rate to the base-line traffic volumes. The future traffic volumes should be representative of the horizon year for project development. If the annual growth rate method is used, the traffic engineering staff must give prior approval to the growth rate.

In addition, any nearby proposed "on-line" development projects should be taken into consideration when forecasting future traffic volumes. The increase in traffic from proposed "on-line" projects should be compared to the increase in traffic by applying an annual growth rate. This information should be provided by the traffic engineering staff

If modeling information is unavailable, the greatest traffic increase from either the "on-line" developments, the application of an annual growth rate, or a combination of an annual growth rate and "on-line" developments, should be used to forecast the future traffic volumes.

6.3.2.3.7 **TRIP GENERATION**. The latest edition of *Institute of Transportation Engineers (ITE) Trip Generation Handbook* should be used for selecting trip generation rates. Other rates may be used with the approval of the traffic engineering staff in cases where the *ITE Trip Generation Handbook* does not include trip rates for a specific land use category, or includes only limited data, or where local trip rates have been shown to differ from the ITE rates.

Site traffic should be generated for daily, AM, and PM peak hour periods. Adjustments made for "passer-by" and "mixed-use" traffic volumes should follow the methodology outlined in the latest edition of the *ITE Trip Generation Handbook.* A "passer-by" traffic volume discount for commercial centers should not exceed twenty five percent unless approved by the City's representative.

A trip generation table should be prepared showing proposed land use, trip rates, and vehicle trips for daily and peak hour periods and appropriate traffic volume adjustments, if applicable.

6.3.2.3.8 **TRIP DISTRIBUTION AND ASSIGNMENT.** Projected trips should be distributed and added to the projected non-site traffic on the roadways and intersections under study. The specific assumptions and data sources used in deriving trip distribution and assignment should be documented in the report and approved by the City's representative.

Category III TIA's may require the use of a travel demand model based on direction from the City's representative.

The site-generated traffic should be assigned to the street network in the study area based on the approved trip distribution percentages. The site traffic should be combined with the forecasted traffic volumes to show the total traffic conditions estimated at development completion. A figure will be required showing daily and peak period turning movement volumes for each traffic study intersection. In addition, a figure should be prepared showing the base-line volumes with site-generated traffic added to the street network. This figure will represent site specific traffic impacts to existing conditions.

6.3.2.3.9 **CAPACITY ANALYSIS**. Level of service (LOS) should be computed for signalized and unsignalized intersections in accordance with the latest edition of the Highway Capacity Manual. The intersection LOS should be calculated for each of the following conditions (if applicable):

1) Existing peak hour traffic volumes (figure required).
2) Existing peak hour traffic volumes including site-generated traffic (figure required).
3) Future traffic volumes not including site traffic (figure required).
4) Future traffic volumes including site traffic (figure required).

5) LOS results for each traffic volume scenario (table required).

The LOS table should include LOS results for AM and PM peak periods if applicable. The table should show LOS conditions with corresponding vehicle delays for signalized intersections, and LOS conditions for the critical movements at unsignalized intersections. For signalized intersections, the LOS conditions and average vehicle delay should be provided for each approach and the intersection as a whole.

Unless otherwise directed by the City's representative, the capacity analysis for existing signalized intersections should be conducted using the Highway Capacity Manual's Operational Method for each study horizon year. When directed by the City's representative, the capacity analysis should be conducted using the Planning Analysis Method.

When the operational capacity analysis method is used for existing signalized intersections, it should include existing phasing, timing, splits, and cycle lengths during the peak hour periods when available from the City's representative.

For unsignalized intersections, the Highway Capacity Manual methodology should be used.

If the new development is scheduled to be completed in phases, the TIA will, if directed by the City's representative, include a LOS analysis for each separate development phase in addition to the TIA for each horizon year. The incremental increases in site traffic from each phase should be included in the LOS analysis for each preceding year of development completion. A figure will be required for each horizon year of phased development.

6.3.2.3.10 **QUEUE ANALYSIS.** If directed by the City's representative, a queue analysis should be completed using the methods outlined in Section 5.3.2.1 to determine appropriate storage lengths for right turn and left turn lanes into and out of the site.

6.3.2.3.11 **TRAFFIC SIGNAL WARRANT ANALYSIS.** A traffic signal warrant study should be conducted if directed by the City's representative. The analysis will be required for each horizon year.

Traffic signal warrant studies should be conducted by a method pre-approved by the City's representative.

6.3.2.3.12 **CRASH ANALYSIS**. If directed by the City's representative, an analysis of three-year crash data should be conducted to determine the level of safety of the study area and any possible mitigation efforts.

6.3.2.3.13 **SPEED ANALYSIS**. Vehicle speed is used to estimate safe stopping and cross corner sight distances. In general, the posted speed limit is representative of the 85th percentile speed and may be used to calculate safe stopping and cross corner sight distances. If directed by the City's representative, speed counts should be taken in the study area.

6.3.2.3.14 **TRAFFIC SIMULATION**. For a major development, a simulation using SYNCHRO or other approved software should be done to show existing traffic flows and future traffic flows if directed by the City's representative.

6.3.2.3.15 **MITIGATION REQUIREMENTS**. The roadways and intersections within the study area should be analyzed, with and without the proposed development to identify any projected impacts in regard to level of service and safety.

Where the roadway will not operate at Level of Service D or better with the development, the traffic impact of the development on the roadways and intersections within the study area shall be mitigated to Level of Service D.

6.3.2.3.16 **INTER-AGENCY COORDINATION**. When a new development falls within the boundaries of more than one government agency jurisdiction, the TIA should be distributed as an informational report to all affected agencies. The agency with governing powers over the development site will have final approval of the TIA.

6.3.2.4 Report Format. This sub-section provides the format requirements for the general text arrangement of a TIA. Deviations from this format must receive prior approval of the City's representative.

6.3.2.4.1 **TABLE OF CONTENTS**

6.3.2.4.2 **TABLE OF FIGURES**

6.3.2.4.3 **LIST OF TABLES**

6.3.2.4.4 **EXECUTIVE SUMMARY**

Purpose of Report and Study Objectives
Site Location and Study Area
Development Description
Principal Findings

Conclusions

6.3.2.4.5 **PROJECT DESCRIPTION**

Site Location
Land Use and Intensity
Proposed Development Details
Site Plan (readable version should be provided)
Access Geometrics
Development Phasing and Timing

6.3.2.4.6 **EXISTING CONDITIONS**

Study Area
- Roadway System
- Pedestrian/Bicycle Facilities
- Transit
- Sight Distance
- Existing Land Use

6.3.2.4.7 **EXISTING TRAFFIC DATA**

Traffic Counts
Pedestrian Counts (if necessary)
Bicycle Counts (if necessary)
Times Collected
Locations
Types - Daily, Morning, and Afternoon Peak Periods
(two hours minimum, and others as required)

6.3.2.4.8 **TRIP GENERATION**

Trip Generation
Pass-by Traffic (if applicable)

6.3.2.4.9 **TRIP DISTRIBUTION AND ASSIGNMENT**

Trip Distribution
Trip Assignment

***6.3.2.4.10* ACCESS**

Site Access
Driveways

***6.3.2.4.11* CRASH ANALYSIS**

Analysis Years
Types of Crashes
DUI
Injury
Non-injury
Fatalities

***6.3.2.4.12* EXISTING TRAFFIC OPERATIONS**

Level of Service
Morning Peak Hour, Afternoon Peak Hour
(And others as required)

***6.3.2.4.13* FUTURE TRAFFIC OPERATIONS WITHOUT PROJECT**

Projections of non-site traffic (Methodology for projections should receive prior approval of City's representative)
Roadway Improvements
Improvements Programmed to Accommodate Non-site Traffic
Additional Alternative Improvements to Accommodate Site Traffic
Level of Service Analysis without Project (for each horizon year including any programmed improvements)

***6.3.2.4.14* TRAFFIC SIGNAL WARRANT ANALYSIS**

Warrant Analysis should be performed for each horizon year with and without project (Methodology for analysis should receive prior approval of City's representative)

6.3.2.4.15 **FUTURE TRAFFIC OPERATIONS WITH PROJECT**

Level of Service Analysis with Project (for each horizon year, including any programmed improvements)

6.3.2.4.16 **SUGGESTED TRAFFIC MITIGATIONS**

Pedestrian/Bicycle Considerations
Traffic Control Needs
Intersection Channelization Mitigation
Neighborhood Traffic Mitigation

6.3.2.4.17 **TURN LANE ANALYSIS**

Turn lane need
Turn lane storage lengths

6.3.2.4.18 **CONCLUSION**

- Trips Generated
- Trip Impacts
  - Vehicular
  - Pedestrian
  - Bicycle
  - Transit
- Recommendations
- Other

6.3.2.4.19 **APPENDICIES**

Traffic Volume Counts
Capacity Analyses Worksheets
Traffic Signal Warrant Analysis
Crash Data and Summaries
Miscellaneous Addendum

6.4 Existing Problem Areas

Introducing a "retrofit" program of access control to an existing roadway is often difficult. Land for needed improvements is often unavailable, making certain access management techniques impossible to implement and requiring the use of minimum rather than desirable standards. Rights of property access should be respected. Social and political pressures will emerge from abutting property owners who perceive that their access will be unduly restricted and their businesses hurt. The needed cooperation of proximate, sometimes competitive, developments in rationalizing on-site access and driveway locations may be difficult to achieve, as is a comparison of the cost of economic hardship to an individual to the benefits accruing to the general public. Accordingly, the legal, social, and political aspects of access management are particularly relevant in retrofit situations and should be thoroughly understood by public agencies and private groups responsible for implementing access control programs for retrofit projects.

The general reasons underlying retrofit actions include the following:

1) Increased congestion and crashes along a given section of road that are attributed to random or inadequate access;
2) Major construction or design plans for a road that make access management and control essential;
3) Street expansions or improvements that make it practical to reorient access to a cross street and remove (or reduce) arterial access; and
4) Coordinating driveways, on one side of a street, with those planned by a development on the other side.

6.4.1 Types of Action

Most retrofit actions involve the application of accepted traffic engineering techniques that limit the number of conflict points, separate basic conflict areas, limit speed adjustment problems, and remove turning vehicles from the through travel lanes. **Tables 6-1** through **6-4** present the various access management techniques that achieve each of these objectives and mainly apply to retrofit situations.

Table 6-1 – Retrofit Techniques – Category A[20]

CATEGORY A – Limit Number of Conflict Points	
No.	Description
A-1	Install median barrier with no direct left-turn access
A-2	Install raised median divider with left-turn deceleration lanes
A-3	Install one-way operations on the roadway
A-4	Install traffic signal at high-volume driveways
A-5	Channelize median openings to prevent left-turn ingress and/or egress maneuvers
A-6	Widen right through lane to limit right-turn encroachment onto the adjacent lane to the left
A-7	Install channelizing islands to prevent left-turn deceleration lane vehicles from returning to the through lanes
A-8	Install physical barrier to prevent uncontrolled access along property frontages
A-9	Install median channelization to control the merge of left-turn egress vehicles
A-10	Offset opposing driveways
A-11	Locate driveway opposite a three-leg intersection or driveway and install traffic signals where warranted
A-12	Install two one-way driveways in lieu of one two-way driveway
A-13	Install two two-way driveways with limited turns in lieu of one standard two-way driveway
A-14	Install two one-way driveways in lieu of two two-way driveways
A-15	Install two two-way driveways with limited turns in lieu of two standard two-way driveways
A-16	Install driveway channelizing island to prevent left-turn maneuvers
A-17	Install driveway channelizing island to prevent driveway encroachment conflicts
A-18	Install channelizing island to prevent right-turn deceleration lane vehicles from returning to the through lanes
A-19	Install channelizing island to control the merge area of right-turn egress vehicles
A-20	Regulate the maximum width of driveways

[20] Adapted from: Federal Highway Administration, 1982.

Table 6-2 – Retrofit Techniques – Category B[21]

CATEGORY B – Separate Basic Conflict Areas	
No.	Description
B-1*	Regulate minimum spacing of driveways
B-2	Regulate minimum corner clearance
B-3	Regulate minimum property clearance
B-4*	Optimize driveway spacing in the permit authorization stage
B-5*	Regulate maximum number of driveways per property frontage
B-6	Consolidate access for adjacent properties
B-7	Require roadway damages for extra driveways
B-8	Purchase abutting properties
B-9	Deny access to small frontage
B-10	Consolidate existing access whenever separate parcels are assembled under one purpose, plan, entity, or usage
B-11*	Designate the number of driveways regardless of future subdivision of that property
B-12	Require access on collector street (when available) in lieu of additional driveway on arterial

* = not directly applicable for retrofit

Table 6-3 – Retrofit Techniques – Category C[22]

CATEGORY C – Limit Speed-Adjustment Problems	
No.	Description
C-1	Install traffic signals to slow roadway speeds and meter traffic for larger gaps
C-2	Restrict parking on the roadway next to driveways to increase driveway turning speeds
C-3	Install visual cues of the driveway
C-4	Improve driveway sight distance
C-5	Regulate minimum sight distance
C-6*	Optimize sight distance in the permit authorization stage
C-7	Increase the effective approach width of the driveway (horizontal geometrics)
C-8	Improve the driveway profile (vertical geometrics)
C-9	Require driveway paving
C-10	Regulate driveway construction (performance bond) and maintenance
C-11	Install right-turn acceleration lane
C-12	Install channelizing islands to prevent driveway vehicles from backing onto the arterial
C-13	Install channelizing islands to move ingress merge point laterally away from the arterial
C-14	Move sidewalk-driveway crossing laterally away from the arterial.

* = not directly applicable for retrofit

[21] Adapted from: Federal Highway Administration, 1982.
[22] Adapted from: Federal Highway Administration, 1982.

Table 6-4 – Retrofit Techniques – Category D[23]

CATEGORY D – Remove Turning Vehicles from the Through Lanes	
No.	Description
D-1	Install two-way left-turn lane
D-2	Install continuous left-turn lane
D-3	Install alternating left-turn lane
D-4	Install isolated median and deceleration lane to shadow and store left-turning vehicles
D-5	Install left-turn deceleration lane in lieu of right-angle crossover
D-6	Install median storage for left-turn egress vehicles
D-7	Increase storage capacity of existing left-turn deceleration lane
D-8	Increase the turning speed of right-angle median crossovers by increasing the effective approach width
D-9	Install continuous right-turn lane
D-10	Construct a local service road
D-11*	Construct a bypass road
D-12*	Reroute through traffic
D-13	Install supplementary one-way right-turn driveways to divided roadway (non-capacity warrant)
D-14	Install supplementary access on collector street when available (non-capacity warrant)
D-15	Install additional driveway when total driveway demand exceeds capacity
D-16	Install right-turn deceleration lane
D-17	Install additional exit lane on driveway
D-18	Encourage connections between adjacent properties (even when each has arterial access)
D-19	Require two-way driveway operation where internal circulation is not available
D-20	Require adequate internal design and circulation plan

* = not directly applicable for retrofit

[23] Adapted from: Federal Highway Administration, 1982.

7.0 GUIDELINE REFERENCES

References to standard engineering documents mentioned throughout the text refer to the latest publication or edition of the work.

The following documents were used in developing the City of Tucson Transportation Access Management Guidelines:

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U.S. Department of Transportation – Federal Highway Administration. *Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD).* Washington, DC: 1988, 2009.

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