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SECTION 1 – STREET DESIGN CRITERIA

1.1 GENERAL

This section provides design criteria for the various functional classifications of streets and roadways within the City. The criteria described in this section are the minimum values. The design engineer shall provide higher values where feasible. Exceptions to these criteria shall be as specifically approved by the Transportation Director.

One of the primary design criteria for a new facility is the design speed. The proper design speed selection is influenced by the character of terrain, the density and type of adjacent land use, the classification and function of the roadway, the traffic volumes expected to use the roadway and by economic and environmental considerations. It is important to recognize and treat individual roadways based on their specific characteristics. The design speed should be determined based on the design engineer's judgments on what design criteria are the most feasible for that particular roadway. The design speeds specified in Tables 1-1a, 1-1b, and 1-1c shall be used for each of the street classifications, unless otherwise directed by the Transportation Director.

When designing a new facility, or modifications to an existing facility, the operating speed of vehicles is assumed to be, in order of desirability, a) the 85th percentile speed, b) the posted speed limit, or c) in the case of a new facility, the design speed.

In order to provide a facility that is as safe and predictable as possible, it is desirable to have a uniform design speed. Therefore, the design speed shall remain constant throughout the facility.

This manual is intended to provide design criteria for urban streets with a design speed of 45 mph or less. The designer shall refer to the design resources listed in the Bibliography for highways with a design speed of 50 mph or greater.

All streets shall be planned to properly integrate with the existing and proposed system of local, collector and arterial streets. The following plans available from the City (latest version, as adopted) shall be referred to:

- Comprehensive Transportation Master Plan;
- Comprehensive Parks, Recreation and Open Space Master Plan;
- Southwest Downtown Plan; and,
- Downtown Master Plan.

Refer to the Transportation Master Plan for designation of Arterials and Collectors within the City limits and extraterritorial jurisdiction. Other street classifications shall be as designated through the planning process in consultation with the Transportation Department.

Street classifications shall be as designated by the Transportation Director.

The City of Round Rock Transportation Director, or their designated representative shall have the authority to apply these standards to proposed street and infrastructure design and construction within the City of Round Rock. Authorized Transportation Department staff may allow or require different values for design parameters than those given in this

manual to resolve unusual field conditions, to increase the safety of the travelling public, and/or to better meet other needs of the public infrastructure.

The design criteria for the various street classifications are summarized in Tables 1-1a, 1-1b, and 1-1c on the following page. Figures 1-1 through 1-12 depict the typical section for each street classification. Figures 1-13 through 1-18 provide geometric criteria for elbow-type and cul-de-sac streets. Figures 1-19 through 1-21 provide graphical information regarding medians, tapers and intersection sight triangles.

1.1.1 Reference Standards

The most current version of the reference documents shall be used for project development of transportation facilities. Engineering judgment shall be used to justify waivers from the design criteria; however, Design Exceptions or Waivers shall only be granted at the sole discretion of the City's Transportation Department. Inconsistencies between references shall be resolved in consultation with the City's Transportation Department.

1.2 STREET CLASSIFICATIONS

Street classifications are used to categorize streets according to their functions. There are four street classifications for urban roadways: Local Street, Collector Street, Arterial Street and Alley. Freeway design criteria are not included in this Manual, and therefore the designer should reference the appropriate design criteria in the Texas Department of Transportation (TxDOT) Roadway Design Manual.

The functional classification for each street shall be identified upon the time of the submittal of preliminary plans and shall be as approved by the City.

- **Local Streets.** The primary function of a local street is to serve abutting land use and traffic within a neighborhood or limited residential district. A local street is not generally continuous through several districts. Designations include the following:
  - Two Lane Local Queuing Street (L [Local] 52-30 [52' ROW, 30' Road Width). See Figure 1-1.
  - Two Lane Local Street with Parking (L 61-39). See Figure 1-2.

- **Collector Streets.** The primary function of a collector street is to collect traffic from intersecting local streets and expedite the movement of this traffic to an arterial street or other collector street. Designations include the following:
  - Two Lane Commercial Collector with On-Street Parallel Parking (C 70-41). See Figure 1-3.
  - Three Lane Collector with Off-Street Shared Path (C 70-39). See Figure 1-4.
  - Two Lane Collector with Diagonal and Parallel Parking (C 80-52). See Figure 1-5.
  - Three Lane Collector with Off-Street Shared Path and Parallel Parking (C 80-53, C 90-53). See Figure 1-6 and Figure 1-7.

- **Arterial Streets.** Arterial streets are designed to carry high volumes of through traffic. Access is usually limited to intersections and major driveways. Arterial streets serve as a link between major activity centers within the urban area. Designations include the following:
  - Four Lane Arterial with Off-Street Shared Path (A 110-54, A 120-54). See Figure 1-8 and Figure 1-9.
  - Six Lane Arterial with Off-Street Shared Path (A 135-76, A 150-76). See Figure 1-10 and Figure 1-11.

- **Alley**. An alley is a passageway designed primarily to provide access to or from the rear or side of property otherwise abutting on a public street. See Figure 1-12.

Table 1-1a: Geometric Criteria - Local Streets		
	Local Residential Street (L 52-30)	**Two Lane Local Street with Parking (L 61-39)**
Cross Section Elements		
Transportation Criteria Manual Figure: Typical Section	1-1	1-2
Average Daily Traffic (ADT) (vehicles per day)	< 2,000	< 2,000
Design Speed (mph)	30	30
ROW Width (ft)	52	60
Pavement Width Curb-Curb (ft)	30	39
Median Width Curb-Curb (ft)	n/a	n/a
Sidewalk Width (ft)	4 (both sides)	4 (both sides)
Typical Spacing of Cross Street (ft)	300	300
Clear Zone (ft)	3 (from face of curb)	3 (from face of curb)
Horizontal Alignment		
Minimum Centerline Radius (ft) (Note 4)	300	300
Stopping Sight Distance (ft)	200	200
Superelevation rate “e” maximum	None	None
Minimum tangent between curves (ft)	50	50
Minimum Horizontal Tangent Length approaching an Intersection (ft)	50	50
Vertical Alignment		
Maximum Grade (%)	8	8
Minimum Grade (%)	0.5	0.5
Minimum Crest K-value	19	19
Minimum Sag K-value	37	37
Vertical Clearance:		
Over/Under Roadway (ft)	16.5	16.5
Over Railroad (ft)	23	23
Intersections		
Intersection Sight Distance	See Section 1.8.3	
Curb Return Radius	See Section 1.6.3	
Design Vehicle Type	Passenger Vehicle (P) and Single Unit Truck (SU)	

Notes:

1. This table lists the minimum design criteria. Deviations from listed criteria shall be as approved by the Transportation Director.
2. Design speed shall be used for design purposes; however the posted speed may be different.
3. See bibliography for reference standards.
4. Minimum centerline radius may be reduced to 180 feet if the design speed is 25 mph.
5. Refer to typical sections for further information.

Table 1-1b: Geometric Criteria – Collector Streets				
	Two Lane Collector with Diagonal & Parallel Parking (C 80-52)	Two Lane Commercial Collector with On-Street Parallel Parking (C 70-41)	Three Lane Collector with Off-Street Shared Path and Parallel Parking (C 80-53 & C 90-53)	Three Lane Collector with Off-Street Shared Path (C 70-39)
Cross Section Elements				
Transportation Criteria Manual Figure: Typical Section	1-5	1-3	1-6, 1-7	1-4
Average Daily Traffic (ADT) (vehicles per day)	2,000-6,000	2,000-6,000	2,000-6,000	2,000-6,000
Design Speed (mph)	35	35	35	35
ROW Width (ft)	80	70	80 or 90	70
Pavement Width Curb-Curb (ft)	52	41	53	39
Median Width Curb-Curb (ft)	n/a	n/a	n/a	n/a
Sidewalk / Shared Use Path Width (ft)	7 (both sides)	7.5 (both sides)	5 & 8 (C 80-52) 7 (both sides) (C 90-52)	5 & 10
Typical Spacing of Cross Street (ft)	300	500	300	300
Clear Zone (ft)	3 (from face of curb)	3 (from face of curb)	3 (from face of curb)	3 (from face of curb)
Horizontal Alignment				
Minimum Centerline Radius (ft)	300 (Note 4)	470	470	470
Stopping Sight Distance (ft)	200	250	250	250
Superelevation rate “e” maximum	None	None	None	None
Minimum tangent between curves (ft)	100	100	100	100
Minimum Horizontal Tangent Length approaching an Intersection (ft)	50	50	75	75
Vertical Alignment				
Maximum Grade (%)	6	6	6	6
Minimum Grade (%)	0.5	0.5	0.5	0.5
Minimum Crest K-value	19	29	29	29
Minimum Sag K-value	37	49	49	49
Vertical Clearance:				
Over/Under Roadway (ft)	16.5	16.5	16.5	16.5
Over Railroad (ft)	23	23	23	23
Intersections				
Intersection Sight Distance	See Section 1.8.3			
Curb Return Radius	See Section 1.6.3			
Design Vehicle for Intersection & Driveway Design	Single-Unit Truck (SU) and Intermediate Semitrailer (WB-40)			

Notes:

1. This table lists the minimum design criteria. Deviations from listed criteria shall be as approved by the Transportation Director.
2. Design speed shall be used for design purposes; however the posted speed may be different.
3. See bibliography for reference standards.
4. Minimum centerline radius shall be increased to 470 feet if the design speed is 35 mph.
5. Refer to typical sections for further information.

Table 1-1c: Geometric Criteria – Arterial Streets						
	Four Lane Arterial with Off-Street Shared Path (A 110-54, A 120-54)			Six Lane Arterial with Off-Street Shared Path (A 135-76, A 150-76)		
Cross Section Elements						
Transportation Criteria Manual Figure: Typical Section	1-8, 1-9			1-10, 1-11		
Average Daily Traffic (ADT) (vehicles per day)	8,000 – 12,000			> 12,000		
ROW Width (ft)	100, 110 or120			125, 135, 140 or150		
Pavement Width Curb-Curb (ft)	2@27			2@38		
Median Width Curb-Curb (ft) (Varies with Turn Lanes)	17 to 28			18 to 28		
Shared Path Width (ft)	10 & 5 (110-54) 10 & 10 (120-54)			10 (both sides)		
Typical Spacing of Cross Street (ft)	1,000			1,000		
Clear Zone (ft)	3 (from face of curb)			3 (from face of curb)		
Design Speed (mph) (Note 7)	45	50	55	45	50	55
Horizontal Alignment						
Minimum Centerline Radius (ft) Low speed Urban Street Criteria (with no superelevation)	1,000	N/A	N/A	1,000	N/A	N/A
Stopping Sight Distance (ft)	360	425	495	360	425	495
Superelevation rate "e" maximum	4%	6%	6%	4%	6%	6%
Minimum tangent between curves (ft) (Note 5)	150			200		
Minimum Horizontal Tangent Length Approaching an Intersection (ft)	75			75		
Vertical Alignment						
Maximum Grade (%)	4			4		
Minimum Grade (%)	0.5			0.5		
Minimum Crest K-value	61	84	115	61	84	115
Minimum Sag K-value	79	96	115	79	96	115
Vertical Clearance:						
Over/Under Roadway (ft)	16.5			16.5		
Over Railroad (ft)	23.5			23.5		
Intersections						
Intersection Sight Distance	See Section 1.8.3					
Curb Return Radius	See Section 1.6.3					
Design Vehicle for Intersection & Driveway Design	Intermediate Semi-Trailer (WB-50) Note: WB-67 may be required based on the typical delivery vehicle for the site.					

Notes:

1. This table lists the minimum design criteria. Deviations from listed criteria shall be as approved by the Transportation Director.
2. Design speed shall be used for design purposes; however the posted speed may be different.
3. See bibliography for reference standards.
4. Increase minimum centerline radius to 1,400 feet for a design speed of 50 mph.
5. If superelevation is provided, the tangent length between curves shall be increased to include both transition lengths.
6. Refer to typical sections for further information.
7. Design speed as approved by the Transportation Director.

1.3 RIGHT OF WAY, STREET AND LANE WIDTHS

The minimum right of way (ROW) for each street classification is shown in Tables 1-1 a-c. The City may require wider widths depending on the need for additional turning lanes or variable terrain.

The minimum lane width shall be 12 feet.

1.4 SINGLE OUTLET STREETS

Traffic issues pertaining to single outlet streets are partially mitigated by: (1) providing mid-block turnarounds (or cross-streets/loop streets), (2) increased pavement widths and (3) utilization of divided roadways, as noted in Table 1-2.

Table 1-2: Single Outlet Streets

ADT (vehicles per day)	Street Width (Lip of Gutter to Lip of Gutter) (ft)
Less than 300	27’
300 – 2,500	37’
Greater than 2,500	2 @ 24’ w/20’ min. median width
Note: If the length of the street exceeds 750 feet, the single outlet street must be designed with 2 at 24’ with 20 foot median width.	

The criteria pertaining to single outlet streets are applicable to new developments whether the single outlet is temporary or permanent. When future extensions to the street system are anticipated, which will provide additional outlets, a temporary restriction may be placed on the amount of development allowed, until an additional outlet becomes available.

1.5 HORIZONTAL AND VERTICAL ALIGNMENT

1.5.1 Horizontal Alignment

Horizontal alignment shall conform to the currently adopted City of Round Rock Transportation Master Plan, approved ROW plans, and approved subdivision plats. Street alignment shall provide continuous alignment with existing, planned, or platted streets with which they will connect.

All streets shall be extended to the property lines across the property to be developed, unless the street to be constructed has been approved by the City as a cul-de-sac or other no-outlet street.

The minimum horizontal radii for the various functional classifications are shown in Tables 1-1 a-c. Refer to the TxDOT Roadway Design Manual for further discussion of low-speed and high speed highways with or without superelevation.

The minimum radius is calculated from the following formula:

$$\mathbf{R = V^2 / [15 \times (e+f)]}$$

Where:
R = curve radius, feet
V = design speed, mph
e = superelevation rate per foot
f = side friction factor: see Table 1-3

Table 1-3: Side Friction Factors	
Design Speed (mph)	Side Friction Factor (f)
30	0.22
35	0.20
40	0.18
45	0.16

If the roadway design is to include superelevation, a maximum rate of 4% is recommended for urban conditions, primarily due to narrow ROW widths, driveway grades, and ADA/TAS criteria for an accessible route within crosswalks and driveways. All roadway designs utilizing superelevation are subject to review and approval by the Transportation Director.

1.5.2 Vertical Alignment

The maximum grade for the various street classifications is shown in Tables 1-1 a-c. Short grades less than 500 feet in length may be up to 2% steeper if necessary.

The minimum grade specified in Tables 1-1 a-c shall be maintained for curb and gutter streets in order to provide adequate drainage of the pavement surface.

The vertical grade line shall be designed such that proposed or future cross walks meet the requirements of an accessible route in accordance with the ADA. The vertical grade shall consider the interface between back of sidewalk/shared path and the ultimate surface elevation just outside the ROW in order to accommodate drainage needs.

Designing a sag or crest vertical point of intersection without a vertical curve is generally acceptable where the grade difference is:

1.0% or less for design speeds equal to or less than 45 mph; or,
0.5% or less for design speeds greater than 45 mph

The minimum “K” value for vertical sag and crest curves is shown in Tables 1-1 a-c. The “K” value is used in the formula:

$$\mathbf{L = K \times A}$$

Where:
L = vertical curve length, feet
K = length of vertical curve per percent change in A (see Tables 1-1a-c)
A = algebraic difference in tangent grades, percent

The minimum vertical curve length should be at least three times the design speed.

1.6 INTERSECTIONS

1.6.1 Angles

Proposed public street must intersect one another at 90-degree angles or as close as possible within a range of 80 to 100 degrees.

1.6.2 Spacing and Offsets

Several studies of intersection design types have shown T-type intersections to be far safer than cross-type. Extensive use of "T" intersections in residential subdivisions is strongly recommended. One disadvantage, however, is "corner cutting" when inadequate offset exists between adjacent intersections. To reduce "corner cutting" due to inadequate offset distance, intersecting streets shall be offset at least 300 feet between the edge of pavement of the two streets.

Offset intersections have disadvantages when one (1) or both such streets is a collector intersecting an arterial street, if volumes will be such to warrant traffic signals. Operations at such locations are more complicated than those for normal cross-type intersections. Therefore, other design solutions should be sought if signalization might otherwise be required. When offset intersections are used at an arterial street, they should be located to avoid conflicting left turns (this is especially important where two (2) way, left-turn lanes are to be provided or where left-turn slots are used in a fairly narrow median). Such left-turn conflicts exist when an intersection offsets to the right rather than to the left.

Multi-leg intersections with more than four approaches shall not be allowed.

Signalized intersections shall be spaced at minimum one-half mile intervals, unless otherwise approved by the Transportation Director.

1.6.3 Corner Radii

Intersection corner radii shall be checked for the appropriate design vehicle using turning template software or the templates in AASHTO A Policy on Geometric Design of Highways and Streets.

The corner curb return radii for intersecting streets shall be in accordance with the following minimum values:

Street Classifications	Minimum Curb Return Radius
Local-Local Intersection	20 feet
Local-Collector Intersection	25 feet
Collector-Collector Intersection	25 feet
Collector-Arterial Intersection	30 feet
Arterial-Arterial Intersections	40 feet

The design of the intersection shall consider the requirements of an accessible route in accordance with the ADA, placement of signal poles, location of curb ramps, and drainage patterns.

1.6.4 Vertical Alignment within the Intersection Area

Intersection areas should be designed with as flat a grade as practicable. In some cases, this may not be feasible due to terrain constraints and may be economically impractical.

The design speed for the major street at any intersection shall be maintained through the intersection approaches. The minor street may be designed with a change in grade based on reduced design speeds between the maximum grade in the approach and the cross-slope of the intersected street not to exceed eight (8) percent for local streets and six (6) percent for collector streets. The change in grade shall be accomplished by means of a vertical curve of length equal to the minimum length for the design speed of that approach (minimum K value).

1.6.5 Horizontal Alignment within the Intersection Area

The horizontal approach to an intersection should be tangent for a length of one hundred (100) feet (see Tables 1-1 a-c). Note that this tangent length is considered a minimum. Longer tangents are highly desirable. The tangent distance is measured from the curb line of one street to the first point of curvature on the intersecting street. In this regard, centerline radii greater or equal to one thousand (1,000) feet may be considered a tangent.

1.7 CUL-DE-SAC

Cul-de-sac streets are open at one end, with the closed end constructed to allow traffic to turn around within the cul-de-sac. Single outlet streets serve a network of streets with one (1) point of access. The maximum length shall be 750 feet, measured from the centerline of the nearest intersecting street to the center point of the cul-de-sac. Lengths exceeding seven hundred and fifty (750) feet, however, will require a recommendation from the City's Fire Department and approval by the Planning and Zoning Commission.

Collector and arterial streets shall not terminate in a cul-de-sac.

The use of landscape islands within the cul-de-sac is not recommended..

Care shall be taken to design cul-de-sac drainage, utilities and incidentals to avoid perimeter conflicts such as curb inlets, utilities and proposed driveways.

Dead-end streets that are stubbed out for future extension to the adjacent property must terminate in an open-ended cul-de-sac as illustrated in Figure 1-17, unless the dead-end street is less than 150 feet long, in which case the cul-de-sac may be omitted. If the stubbed-out street is not extended when the adjacent property is developed, a cul-de-sac is required on the adjacent property, or access to the dead-end street from the adjacent property must be provided

1.8 SIGHT DISTANCE CRITERIA

1.8.1 Horizontal Stopping Sight Distance

Roadway and intersection design must provide the minimum horizontal stopping sight distance so that drivers can see objects in the road or the control device (i.e. signs or signal heads) in advance of providing the required action. Stopping sight distance is the sum of two distances: (1) the distance traversed by the vehicle from the instant the driver sights an object or traffic control device necessitating a stop to the instant the brakes are applied; and (2) the distance needed to stop the vehicle from the instant brake application begins. Table 1-4 lists the design values for stopping sight distance to be used for level terrain without excessive grades:

Table 1-4: Minimum Stopping Sight Distance
Including Brake Reaction Distance and Braking Distance (ft)

Design Speed (mph)	Street Grade In Percent				
	Upgrades		Flat	Down Grades	
	6%	3%	0%	-3%	-6%
30	184	200	200	205	215
35	229	237	250	257	271
40	278	289	305	315	333
45	331	344	360	378	400

Refer to the latest edition of AASHTO's A Policy on Geometric Design of Highways and Streets to calculate stopping sight distance for steeper grades.

1.8.2 Minimum Sight Distance for Signal Visibility

The geometry of each intersection to be signalized, including vertical grades, horizontal curves, and obstructions as well as the lateral and vertical angles of sight toward a signal face, as determined by the typical driver-eye position, shall be considered in determining the vertical, longitudinal, and lateral position of the signal face. Refer to the TMUTCD for determination of the minimum sight distance for signal visibility.

1.8.3 Intersection Sight Distance

Intersection sight distance shall be provided at intersections to allow the drivers of stopped vehicles a sufficient view of the intersecting highway to decide when to enter the intersecting highway or to cross it. Specified areas along intersection approach legs and across their included corners should be clear of obstructions that might block a driver's view of potentially conflicting vehicles. These specified areas are known as clear sight triangles and are illustrated in Figure 1-21. Refer to the latest edition of AASHTO's A Policy on Geometric Design of Highways and Streets to determine the intersection sight distance and clear sight triangle requirements, for design of new intersections or evaluation of sight distance for existing intersections.

It should be noted that the current zoning ordinance states "At an intersection of two streets or at the intersection of a driveway and a street nothing shall be erected, placed, allowed to grow, or planted so that it impedes vision between the height of three feet and ten feet above the curb within a triangle formed by the intersecting streets or street and driveway, and measuring 40 feet along the sides of the triangle that face the intersection.

Triangle sides shall be measured from the face of the curb to the face of the curb at intersections and driveways." See Figure 1-21 for illustration. This requirement may provide adequate sight triangle clearances to meet the intersection sight distance criteria and should be provided as a minimum. In situations where greater sight triangle lengths need to be provided for adequate intersection sight distance, the higher value will govern.

1.9 CLEAR ZONES AND PROTECTION

The term "clear zone" is used to describe the generally flat and unobstructed area that is provided beyond the travel lanes. The clear zone may include shoulders. The clear zone is measured from the edge of travel way for uncurbed streets, and from the face of curb for curbed streets.

1.9.1 Clear Zone Criteria

The minimum clear zone, measured from the face of curb, shall be 3.0 feet; however the clear zone may be reduced to 1.5 feet where it is not feasible to provide 3.0 feet.

Curbs are not regarded as an adequate barrier for redirecting vehicles. The provision of guardrails to redirect errant vehicles may only be necessary on high-speed facilities with design speed greater than or equal to 45 mph. The need for guardrails on low-speed facilities with design speed less than 45 mph should be based on engineering judgment, local conditions, and type of roadside hazard.

Because most curbs do not have a capability to redirect vehicles, especially at higher design speeds, obstructions should be located as far away as practical.

The minimum clear zone for rural, uncurbed roadways within the City and a design speed of 45 mph or less shall be 10 feet, however 20 feet should be provided where feasible.

If a roadside obstacle exists, treatment should be considered in the following priority:

1. Eliminate the obstacle;
2. Redesign the obstacle so it can be safely traversed;
3. Relocate the obstacle outside the clear zone to reduce the likelihood that it will be struck;
4. Treat the obstacle to reduce accident severity, i.e. use flush or yielding designs
5. Shield the obstacle with a barrier (metal beam guard fence, concrete barrier, or crash attenuator); and,
6. Delineate the obstacle if the above alternatives are not appropriate.

The types of obstacles that are commonly shielded using roadside barriers are as follows:

- Slopes greater than 3:1 or vertical drop-offs;
- Bridge ends and areas alongside bridges;
- Signs, traffic signal, and luminaire supports without breakaway design;
- A concrete base extending 6 inches or more above the ground;
- Retaining walls;
- Culverts;

- Street furniture;
- Rock or other natural formations;
- Trees with diameter greater than 6 inches (see discussion below); and,
- Utilities such as cabinets, fire hydrants, or poles.

1.9.2 Types of Barriers

Metal beam guard fence (MBGF) may be used to protect most roadside obstacles, if the hazard cannot be eliminated. MBGF, end treatment, and downstream anchor terminal shall be in accordance with the appropriate TxDOT Standards.

Refer to Section 6 of Appendix A in the TxDOT Roadway Design Manual, for the procedure to calculate the Length of Need for MBGF.

MBGF shall be placed at the edge of pavement for roadways with shoulders, and at the face of curb for curbed roadways. The installation shall allow for 2'-6" (minimum) or 5'-0" (desirable) deflection behind the guardrail posts. The MBGF installation shall include a concrete mow strip.

Pedestrian rails shall be in accordance with TxDOT Standard "Pedestrian Handrail Details".

Bridge railings shall be in accordance with TxDOT Standards and the "Bridge Railing Manual".

The ends of bridge railings shall be protected with metal beam guard fence/end treatment or a crash attenuator.

Concrete safety barrier is not typically used for urban street construction but may be used, if necessary, for example, at the top of an MSE retaining wall.

1.9.3 Transportation Guidelines for Landscaping

Safety shall be the foremost consideration in the placement and selection of plant material in the City's right-of-way. The main focus of these guidelines is the prevention of traffic hazards that can be created by the placement of landscaping which restricts the sight distance or creates roadside obstacles. The following addresses acceptable criteria for landscaping and planting on roadsides, within the median, and at intersections. All dimensions specified for trunk diameter and height will include plants at maturity unless it is stated otherwise on the Drawings.

Table 1-5 lists the criteria for placement of trees within the ROW.

Table 1-5: Minimum Setback Requirements For Existing And Newly Planted Trees					
Design Speed (mph)	Tree Diameter At Maturity (inches)	Roadways with Barrier Curb		Roadways with Shoulders[1]	
		Existing (feet)	New (feet)	Existing (feet)	New (feet)
≤45	=6	1.5 (minimum) 3 (desirable)	3	10	10 (minimum) 20 (desirable)
	>6	4 (minimum) 6 (desirable)	6	18	25
50	=6	2 (minimum) 3 (desirable)	4	10	20 (minimum) 30 (desirable)
	>6	4 (minimum) 6 (desirable)	6	30	30

[1] Includes roadways with side slope of 6H:1V or flatter within the clear zone

Trees shall be set back 2 feet from the edge of sidewalk, measured from the edge of sidewalk to edge of mature trunk. Trees shall not be allowed in sidewalks less than 12 feet in width.

On roadways with shoulders having side slopes steeper than 6H:1V, no tree shall be planted or allowed to remain within the recommended clear zone as shown Table 1-6.

Table 1-6: Lateral Clearance On Cut And Fill Sections Roadways With Shoulders (Feet)						
Design Speed (mph)	Fill Section Side Slope			Cut Section Side Slope		
	5H:1V	4H:1V	3H:1V & Steeper	5H:1V	4H:1V	3H:1V & Steeper
≤45	18	19	20	16	16	16
50	24	30	56	19	18	17

A minimum clearance height of 8 feet above the street level must be provided and maintained for all existing and newly planted trees if adjacent to a sidewalk. However, if the limbs of trees overhang the curb line or edge of travel lane of any street, a minimum clearance height of 14 feet is required.

All plantings, except ground covers with no more than 12 inches in height, shall be located greater than seventy-five (75) feet from the end of the median nose.

Ground covers with no more than 12 inches in height and trees with a mature trunk diameter of 6 inches or less is recommended in the area from a point 75 feet to 150 feet from the nose of the median. All trees shall be maintained to provide an 8 foot minimum foliage clearance height. A minimum 15 feet spacing (center-to-center) shall be provided for all trees.

Only small trees and low growing shrubs no greater than 2 feet in height are recommended within 150 feet of a school crossing to assure pedestrian safety by not restricting the sight visibility of motorists.

Only low growing shrubs no greater than a height of 2 feet and small trees are recommended within 250 feet of a railroad crossing to assure adequate sight visibility.

Landscaping shall not restrict visibility to traffic control devices such as signs and traffic signals.

No landscaping of any type shall obstruct vision within the intersection sight triangle as defined in this section of the manual. These requirements will apply to any material from a height of two feet to a clearance height of eight feet above the top of curb including, but not limited to, full grown trees, full-grown shrubs, fences, structures, any signs except traffic control signs, etc.

The designer shall adhere to the City of Round Rock Code of Ordinances Chapter 43: Tree Protection and Preservation as amended and adopted, if existing trees are within the public ROW, or may otherwise be impacted by construction. If existing trees are closer than the minimum distances stated above, an exception may be granted if the City determines it is preferable to preserve the tree.

Any new trees to be planted shall be as listed on the City of Round Rock approved tree list, which is available from the Planning and Development Services Department.

1.10 TAPER TERMINOLOGY

The following terminology is used when describing the criteria for the various tapers in roadway design:

1) ROAD WIDTH TRANSITION TAPER is a taper necessary to transition between different roadway widths.
2) APPROACH TAPER is a taper from the point where all approaching traffic must shift laterally, to the point where the bay taper begins.
3) BAY TAPER is a taper from the edge of the adjacent through traffic lane to the beginning of the full width of the turn storage lane.
4) DEPARTURE TAPER of a left-turn bay is a taper from the point where through traffic beyond the intersection begins a lateral shift to the left to the point where the through lane is adjacent and parallel to the centerline.

Refer to Figure 1-20 for the illustration of the various taper lengths for a typical left turn bay configuration.

1.11 STREET WIDTH TRANSITION TAPERS

Where two street sections of different widths are to be connected, a transition taper is required between the outside traveled edges of the two sections. The length of the transition taper shall be calculated using the following equation:

$L = W \times S$ For Design Speed of 45 mph or higher

$L = (W \times S^2) / 60$ For Design Speed less than 45 mph

Where: L = Taper length, feet
W = Width of offset, feet
S = Design Speed, mph

This transition length calculation is not to be used in the design of left-turn storage lanes or speed change lanes.

When tapers are located on a curve, the separate halves of the roadway should be designed with different curve radii to create a smooth taper without any angle points in the curvature.

1.12 LEFT TURN LANES

Refer to Figures 1-19 and 1-20 for typical configuration and taper lengths of left-turn lanes. The following sections describe the criteria for each taper.

1.12.1 Approach Tapers

Approach tapers shall be calculated using the following formulas:

$L = W \times S$ For Design Speed of 45 mph or higher

$L = (W \times S^2) / 60$ For Design Speed less than 45 mph

Where: L = Taper length, feet
W = Width of offset, feet
S = Design Speed, mph

1.12.2 Bay Tapers

Bay tapers for left turn bays on City streets shall be designed using two reverse curves with radii equal to 300 feet each. The length of the bay taper using the symmetrical reverse curve will be approximately 118 feet for a twelve foot-wide turn lane. Alternatively, the bay taper may be calculated using the following formula:

L = (W x S) / 3

Where: L = Taper length, feet
W = Width of offset, feet
S = Design Speed, mph

1.12.3 Deceleration Length

Deceleration length assumes that moderate deceleration will occur in the through traffic lane and the vehicle entering the left-turn lane will clear the through traffic lane at a speed of 10 mph slower than through traffic. Table 1-7 lists the deceleration lengths for various design speeds.

Table 1-7: Deceleration Length

Design Speed (mph)	Deceleration Length (ft)
30	160
35	215
40	275
45	345

On City streets, due to driveways and median openings, the required length of the speed change lanes may not be feasible to design. Therefore, in most cases the deceleration length can be omitted from the design.

1.12.4 Storage Length

At a minimum, storage lengths shall be 150 feet when turning from an Arterial into a Collector or an Arterial, and 100 feet when turning from an Arterial into a Local street.

At a minimum, storage lengths shall be 100 feet when turning from a Collector into an Arterial. Minimum storage length for a left turn bay into a driveway shall be 100 feet.

If a TIA or similar traffic study is required, it shall be used to document the minimum storage lengths to be provided for left turns. The minimum storage lengths stated in this section may be used if; in the City's opinion a TIA or traffic study is not needed for a particular development.

The calculated queue storage at unsignalized locations shall be based on a traffic model or simulation model, or by the following:

L = (V/30)(S)

Where: L = storage length, feet
V = left-turn vehicles per hour
S = queue storage length, feet, per vehicle (see Table 1-8)

At signalized intersections, the turn lane should be of sufficient length to store the turning vehicles and clear the equivalent lane volume of all other traffic on the approach, whichever is the longest. This length is necessary to ensure that full use of the separate turn lane will be achieved and that the queue in the adjacent lane on the approach will not block vehicles from the turn lane. The required storage may be obtained using an acceptable traffic model such as the latest version of the Highway Capacity Manual (HCM) software (HCS), SYNCHRO, VISSIM or other approved model. Where such model results have not been applied, the following may be used:

L = (V/N)(2)(S)

Where:
L = storage length, feet
V = left-turn volume per hour, vph
N = number of cycles
2 = a factor that provides for storage of all left-turning vehicles on most cycles; a value of 1.8 may be acceptable on collector streets
S = queue storage length, feet, per vehicle (see Table 1-8)

Table 1-8: Queue Storage Length

% of trucks	S (ft)
<5	25
5-9	30
10-14	35
15-19	40

1.12.5 Departure Taper Length

The desired length for a departure taper on City streets shall begin at the end of the storage lane and end at the beginning of the approach taper.

1.13 RIGHT-TURN/DECELERATION LANES

Site driveways and roadways shall include a right turn deceleration lane if the projected right turn peak hour volume is 50 or more vehicles per hour.

The length of a right-turn storage lane shall be a minimum of 100 feet. The storage length for a right-turn bay into a driveway shall be a minimum of 100 feet. Where a TIA has been completed, the right-turn storage length should be based on the analysis results.

Right-turn acceleration lanes typically are not used on urban streets.

1.14 TURN LANE WARRANTS

Left-turn and right-turn deceleration lanes shall be provided when required by the findings of a city-approved Traffic Impact Analysis (TIA).

Refer to the latest edition of AASHTO's A Policy on Geometric Design of Highways and Streets to evaluate left-turn lane requirements at unsignalized intersections on two-lane roadways.

1.15 MEDIANS

The median width for divided arterials shall be a minimum of 27 feet measured from face of curb to face of curb as shown in the typical section figures 1-8 through 1-11.

Medians as measured from nose to nose on divided arterials shall have a minimum opening distance equal to the width of the intersecting street. The minimum width of a mid-block median opening shall be not less than 60 feet, or greater than 70 feet. The median opening shall be checked using the turning radius template for the appropriate design vehicle.

Full-function median openings on arterials should be allowed only where the minimum spacing for signalized intersections are practicable. At intermediate locations along major arterials, limited-function openings may be provided at the spacing listed in Table 1-9.

High volume driveways on arterials should only be located opposite streets or other driveways when the minimum spacing requirements for signalized locations are met. Otherwise, T-intersection configurations should be designed. When driveways are located opposite street intersections the two shall have compatible design elements.

On streets other than arterials, full-function median openings are acceptable at the spacing listed in Table 1-9. Access to public streets will have priority over access to private property on arterial streets.

The primary purpose of left-turn lanes at intersections is to provide storage space. A secondary purpose of turn lanes is to provide a location for deceleration removed from the through traffic lanes, thereby maintaining the capacity of the through roadway. Studies have demonstrated that accident experience is significantly reduced when left-turn lanes are provided at intersections of two (2) major streets, i.e., collectors and arterials.

Table 1-9: Median Opening Criteria

(Refer to Figure 1-19)

Design Speed (mph)	**Minimum Spacing Distance "B" + "C" (Figure 1-19)**
	150' Minimum Storage Requirement*
30	500'
35	575'
40	650'
45	750'
50	900'

* Minimum storage when turning into a collector or arterial street

At a minimum, storage lengths should be one hundred and fifty (150) feet when turning into a collector or an arterial and one hundred (100) feet when turning into a local street. At any unsignalized intersections, the storage length, exclusive of taper may be based on the number of turning vehicles likely to arrive in an average two (2) minute period within the peak hour with each vehicle accounting for approximately twenty (20) feet of storage. At signalized intersections, the storage length depends on the signal cycle length, the signal phasing arrangement and the rate of arrivals and departures of left-turning vehicles (see Table 1-8).

Median breaks on Arterial roadways for residential driveways shall not be provided unless otherwise approved by the Transportation Director. Median breaks for non-residential driveways shall only be provided if sufficient spacing between other median breaks is maintained, and there is adequate room to accommodate deceleration and storage length.

End treatment of medians at intersections should be designed to accommodate the appropriate design vehicle. Semicircular radii may be used on the noses of medians up to six feet wide. Bullet-nosed medians should be used for medians of greater width. Table 1-10 lists the required control radii for the intersection of the various street classifications and shall be used to define turning radii through intersections when designing the median opening and nose.

Table 1-10: Required Control Radii

Street Classification	Intersecting Street	Control Radius (Turning Radius through Intersection) (ft)
Arterial	Arterial	75
	Major collector (Divided)	
	Major collector (Undivided)	50
	Local Collector	
Major Collector (Divided)	Major Collector (Divided)	
	Major Collector (Undivided)	
Major Collector (Divided or Undivided)	Local Residential Collector	
	Local Street	
Local Residential Collector	Local Residential Collector	
	Local Street	
Local Street	Local Street	35

Medians and islands shall be landscaped with grass turf or constructed of stamped pattern concrete, brick, stone or concrete pavers, or other engraved concrete surfaces as approved by the City. Grass turf areas shall be not less than 6 feet in width. All medians and islands shall be bordered by standard curb and gutter, unless otherwise approved by the City.

Landscaping, signs, and other objects placed in the median shall comply with the minimum sight triangles described in section 1.8.3.

Isolated, small channelization islands should be avoided. Islands with at least 50 square feet are desirable but, under very restricted conditions, islands with at least 35 square feet may be used. Islands used for pedestrian refuge should be 6 feet wide, and must be in accordance with ADA/TAS requirements for an accessible route.

1.16 DRAINAGE STRUCTURES

The location of drainage structures, inlets, catch basins, etc., shall be consistent with the intended use of the roadway and in accordance with the City's Design and Construction Standards (DACS) - Drainage Criteria Manual.

Inlets or catch basins shall not be located within the corner curb return. Clearance is needed to allow space for street lights, street name signs, utility poles, pedestrians, sidewalk ramps, etc.

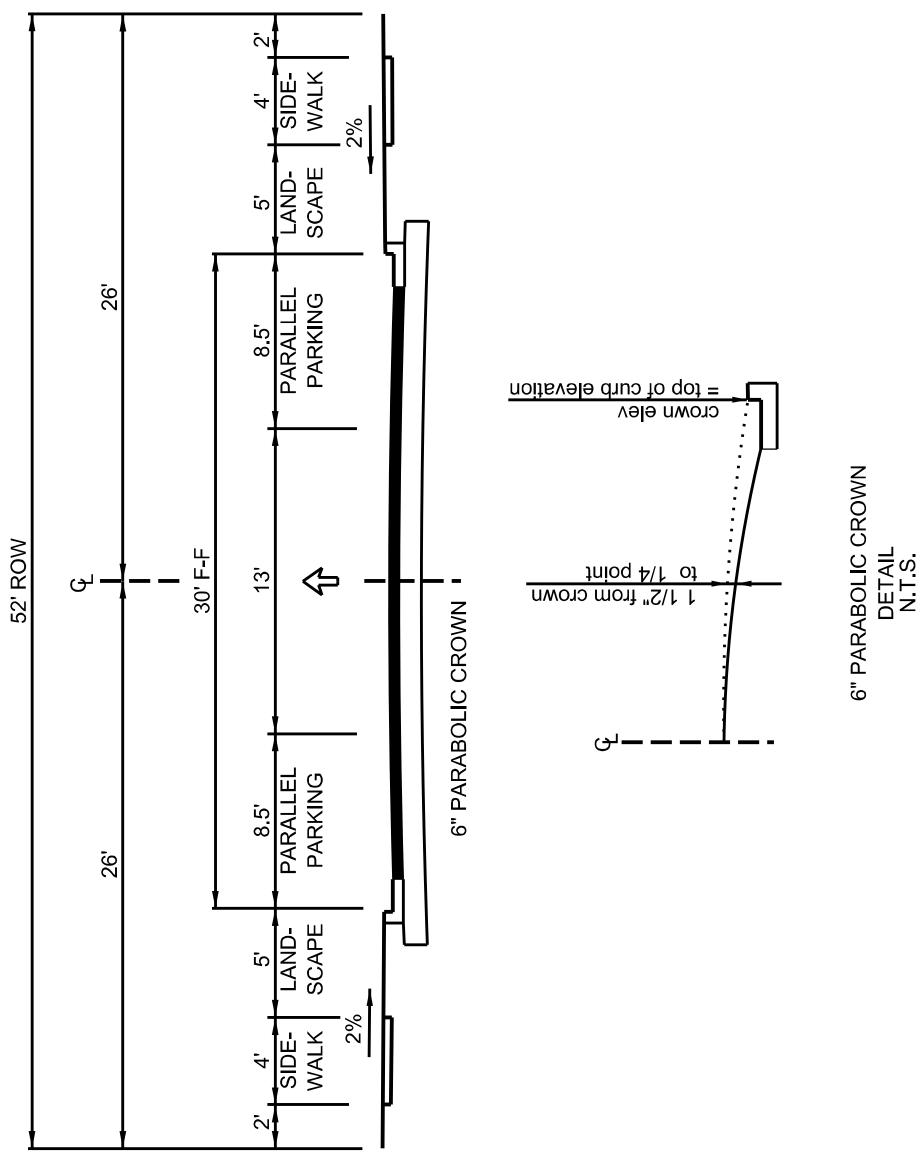
At intersections which have valley drainage, the crowns of the intersecting streets will culminate in a distance of forty (40) feet from the intersecting curb lines unless otherwise noted on the construction plans. Inlets on intersecting streets shall not be constructed within fifty (50) feet of the valley drainage.

Valley gutters shall not be constructed across streets with collector or higher classification.

1.17 PAVEMENT CROSS SLOPE

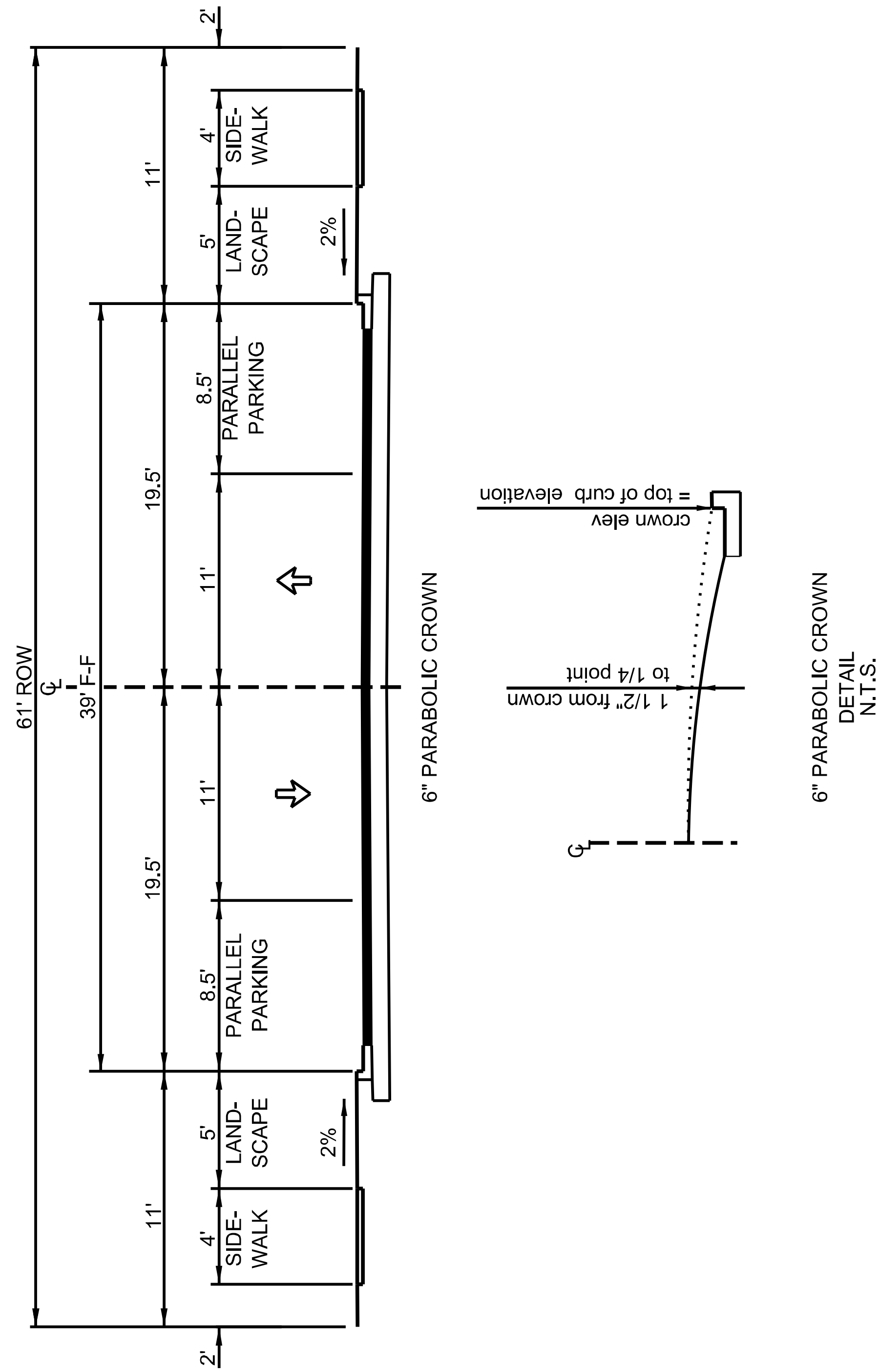
The typical cross slope for roadways with less than three lanes in one direction shall be 2.00%. The cross slope shall be increased to 2.50% for roadways with three lanes in each direction. Local streets shall have a parabolic crown as shown in the Typical Sections.

Figure 1-1 Typical Section
Local Residential Street (L 52-30)



NOTE: PER ADA RULES A 5'X5' PASSING SPACE
IS REQUIRED EVERY 200' FOR SIDEWALKS < 5' WIDE

Figure 1-2 Typical Section Two Lane Local Street With Parking (L 61-39)



NOTE: PER ADA RULES A 5'X5' PASSING SPACE
IS REQUIRED EVERY 200' FOR SIDEWALKS < 5' WIDE

Figure 1-3 Typical Section Two Lane Commercial Collector with on Street Parallel Parking (C 70-41)

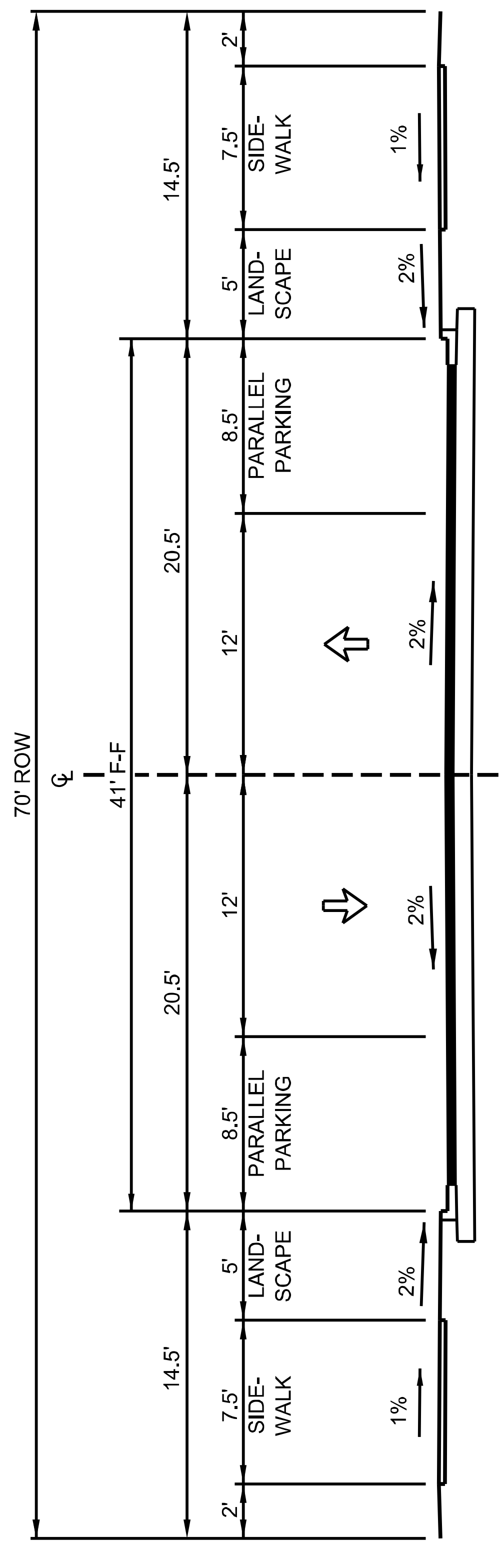


Figure 1-4 Typical Section Three Lane Collector with Off-Street Shared Path (C 70-39)

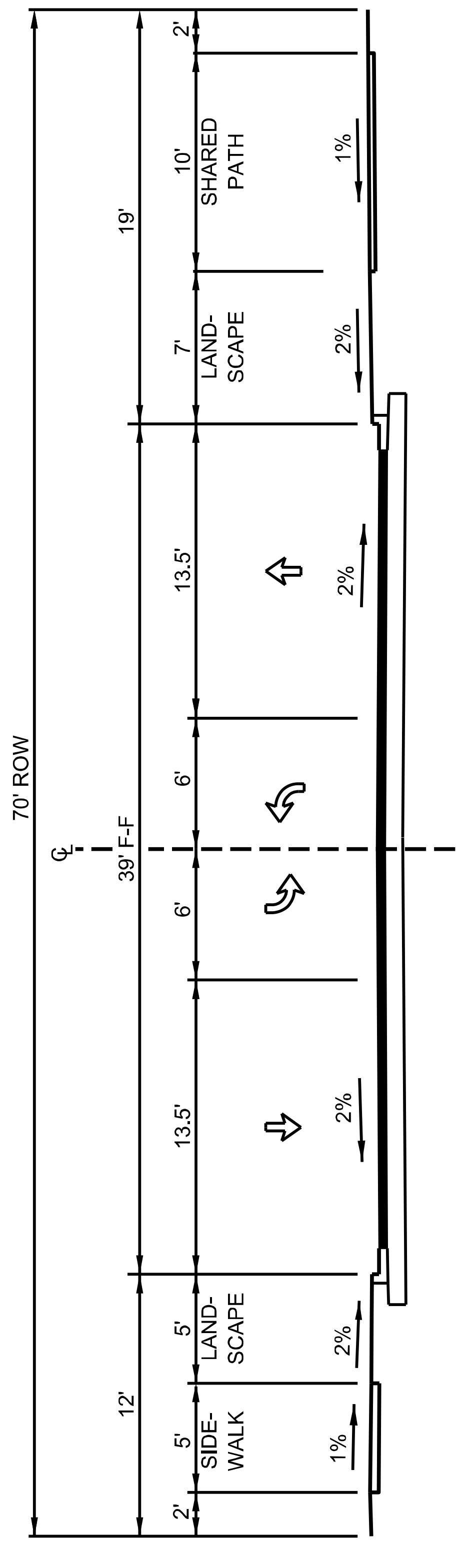


Figure 1-5 Typical Section Two Lane Collector with Diagonal and Parallel Parking (C 80-52)

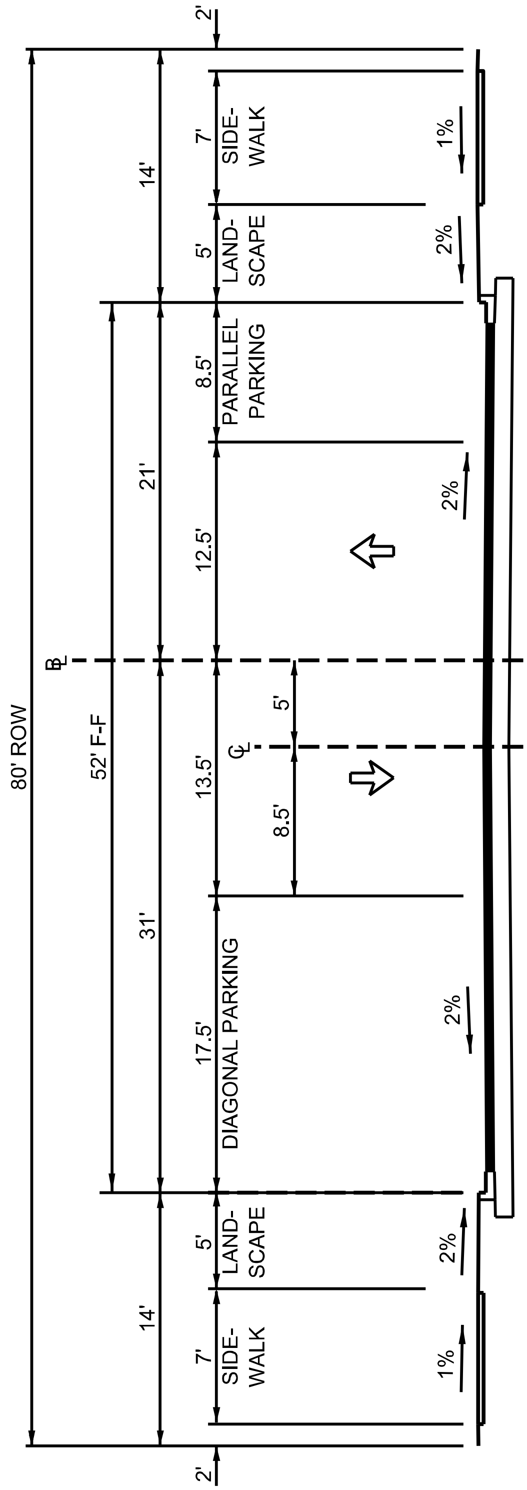


Figure 1-6 Typical Section Three Lane Collector with Off-Street Shared Path and Parallel Parking (C 80-53)

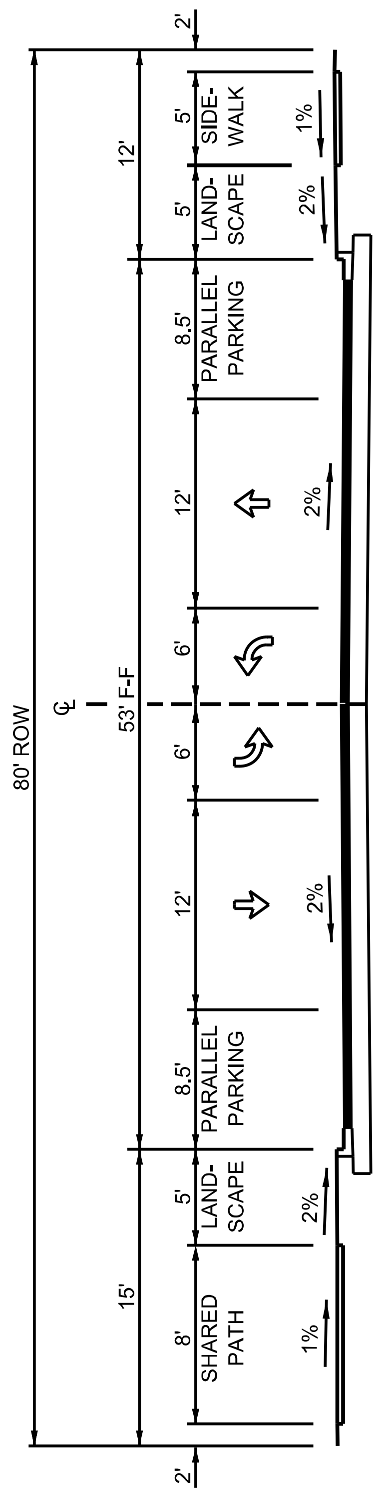


Figure 1-7 Typical Section Three Lane Collector with Off-Street Shared Paths and Parallel Parking (C 90-53)

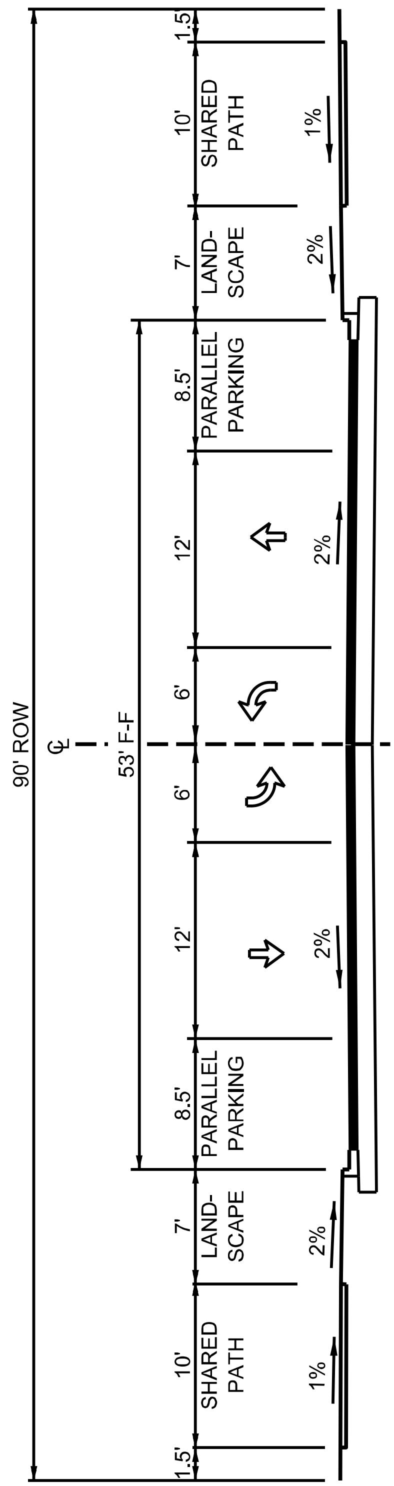


Figure 1-8 Typical Section Four Lane Arterial with Off-Street Shared Path (A 110-54)

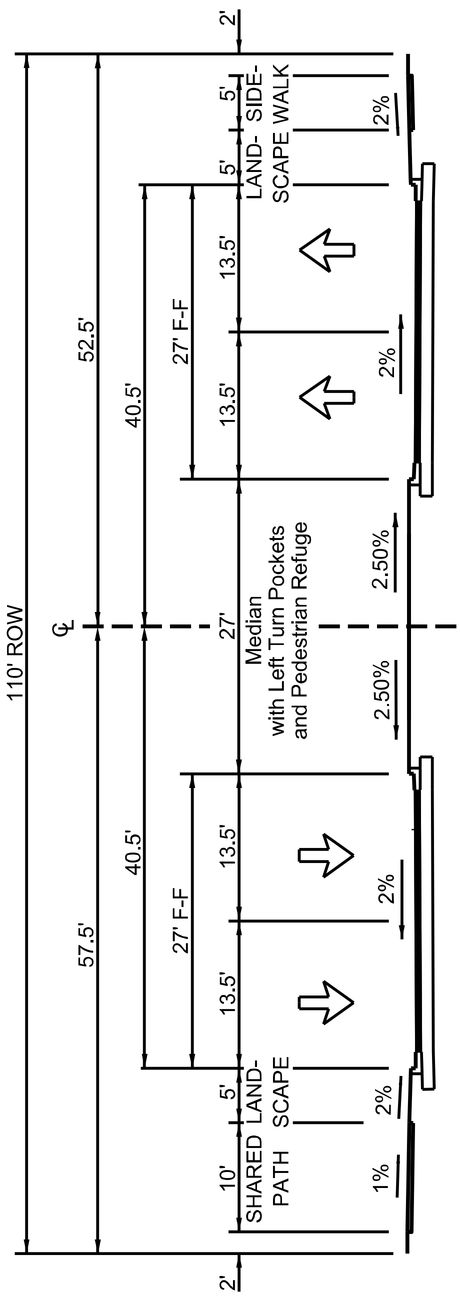


Figure 1-9 Typical Section Four Lane Arterial with Off-Street Shared Paths (A 120-54)

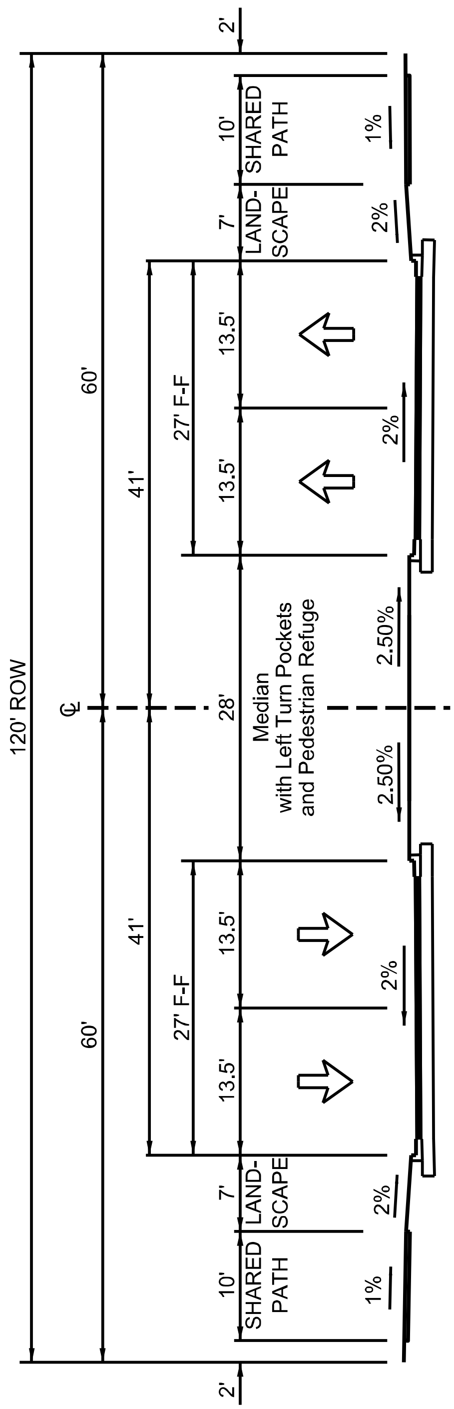


Figure 1-10 Typical Section Six Lane Arterial with Off-Street Shared Path (A 135-76)

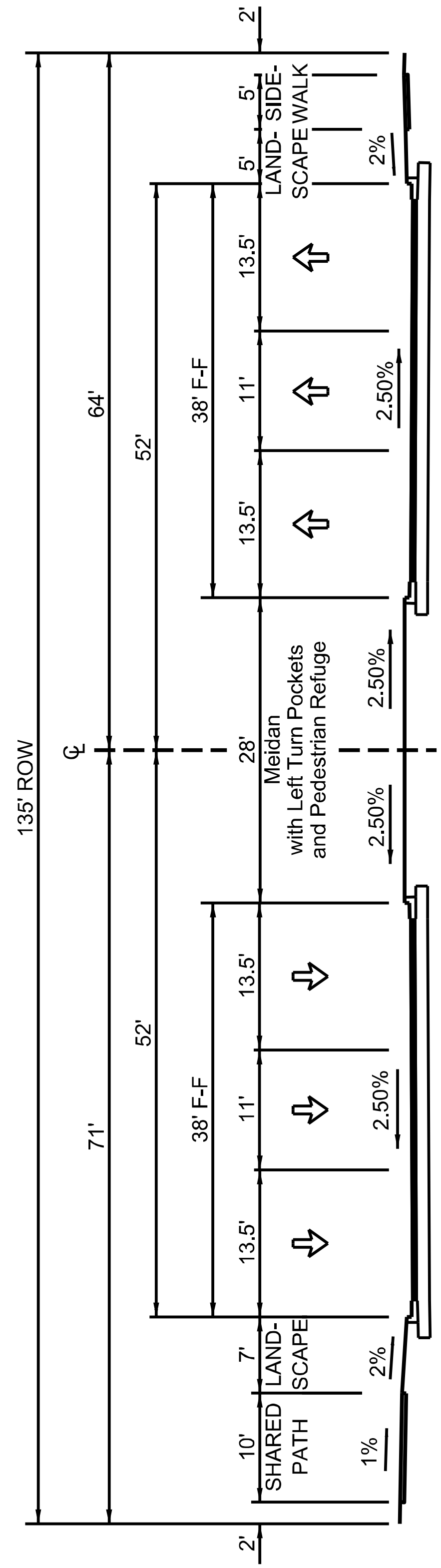


Figure 1-11 Typical Section Six Lane Arterial with Off-Street Shared Path (A 150-76)

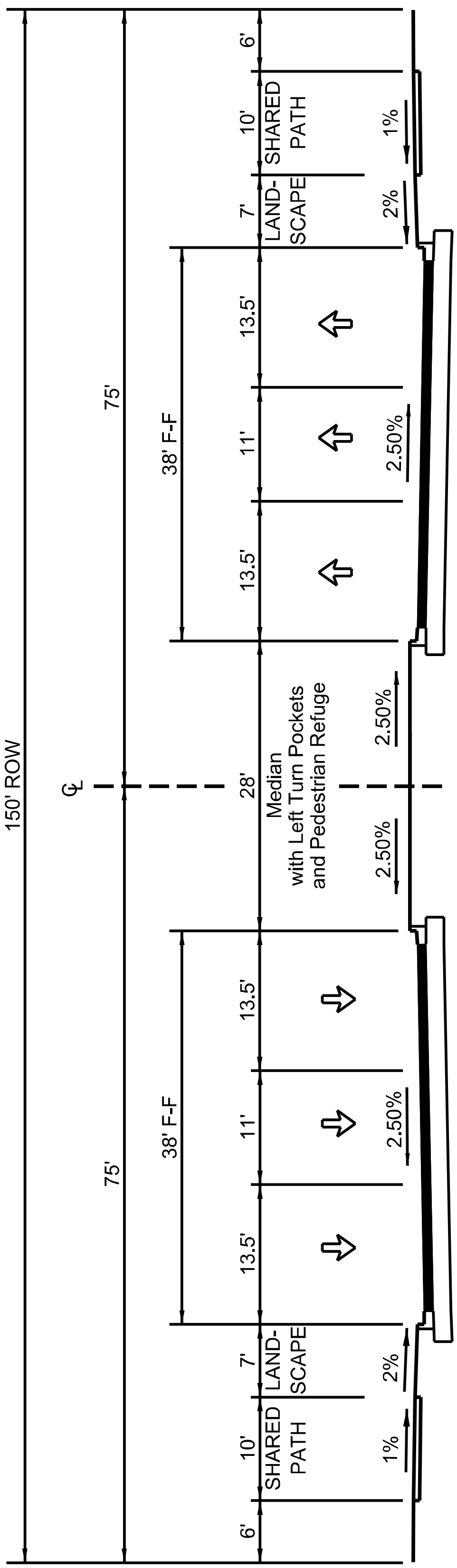
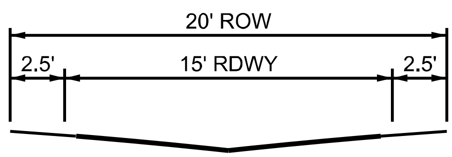


Figure 1-12 Typical Section
Residential Rear Alley (RA 20-15)



NOTE: Utility obstructions not permitted in roadway.

Figure 1-13 Design Criteria for Elbow Streets

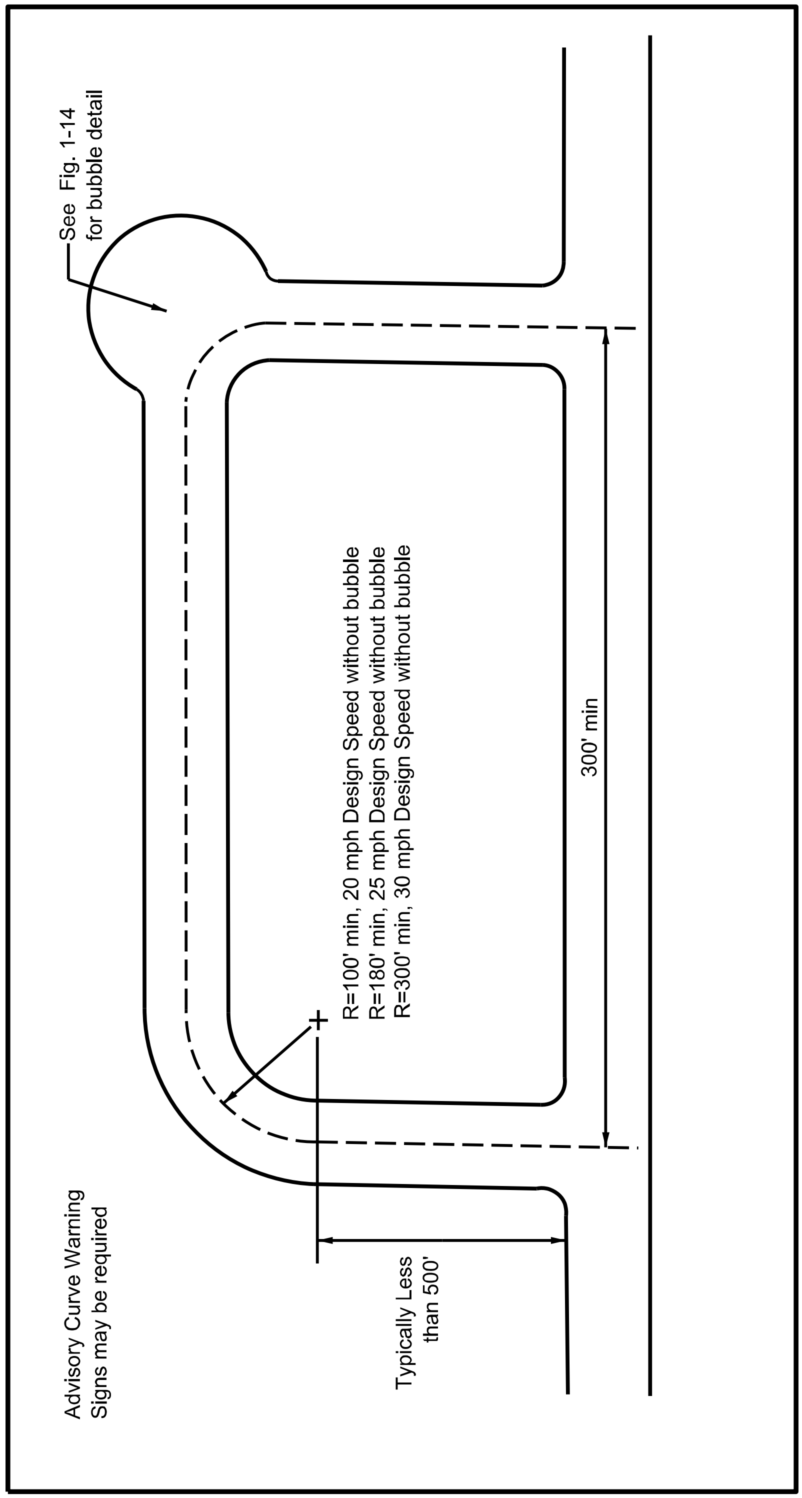


Figure 1-14 Design Criteria for Corner Bubble

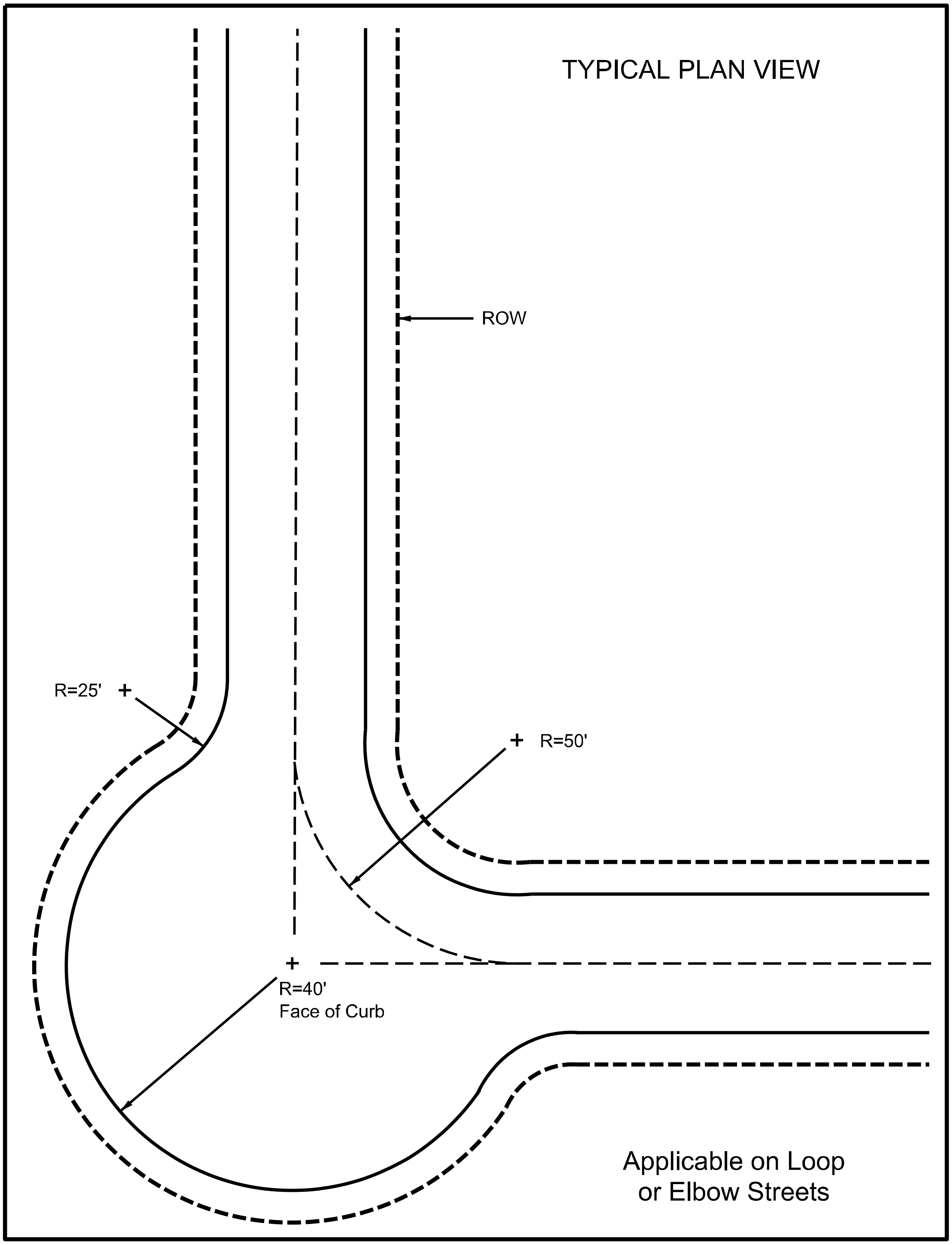


Figure 1-15 Design Criteria for Local Cul-de-Sac

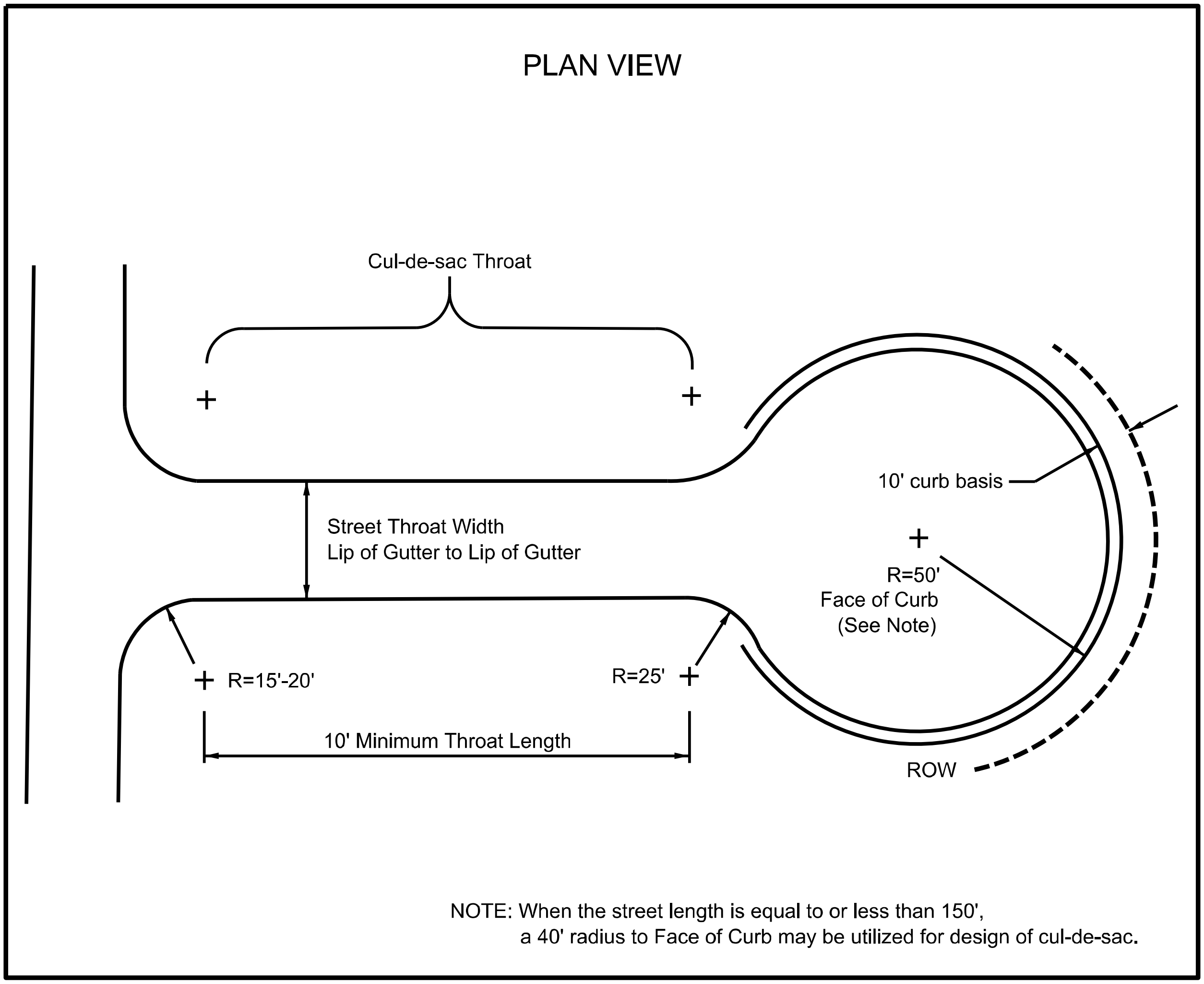
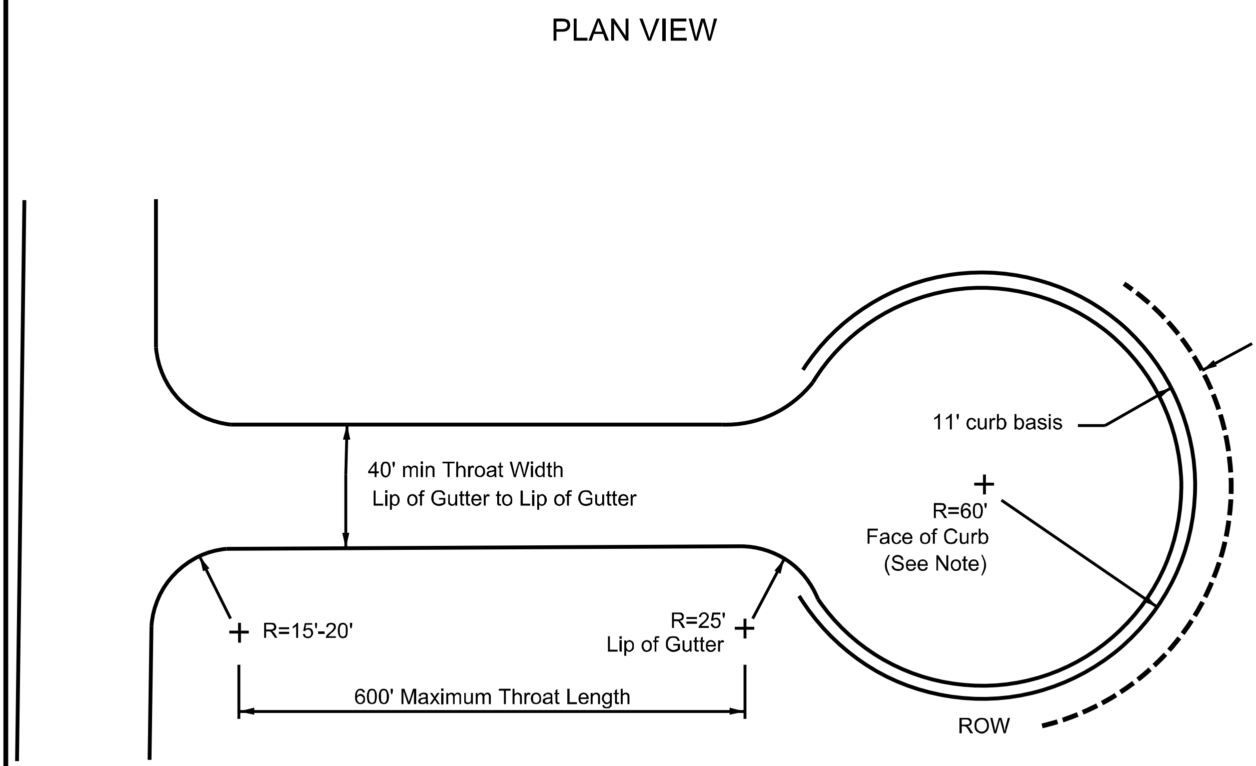


Figure 1-16 Design Criteria for Commercial Cul-de-Sac



NOTE: When the street length is equal to or less than 150', a 40' radius to Face of Curb may be utilized for design of cul-de-sac.

Figure 1-17 Design Criteria for Industrial Cul-de-Sac

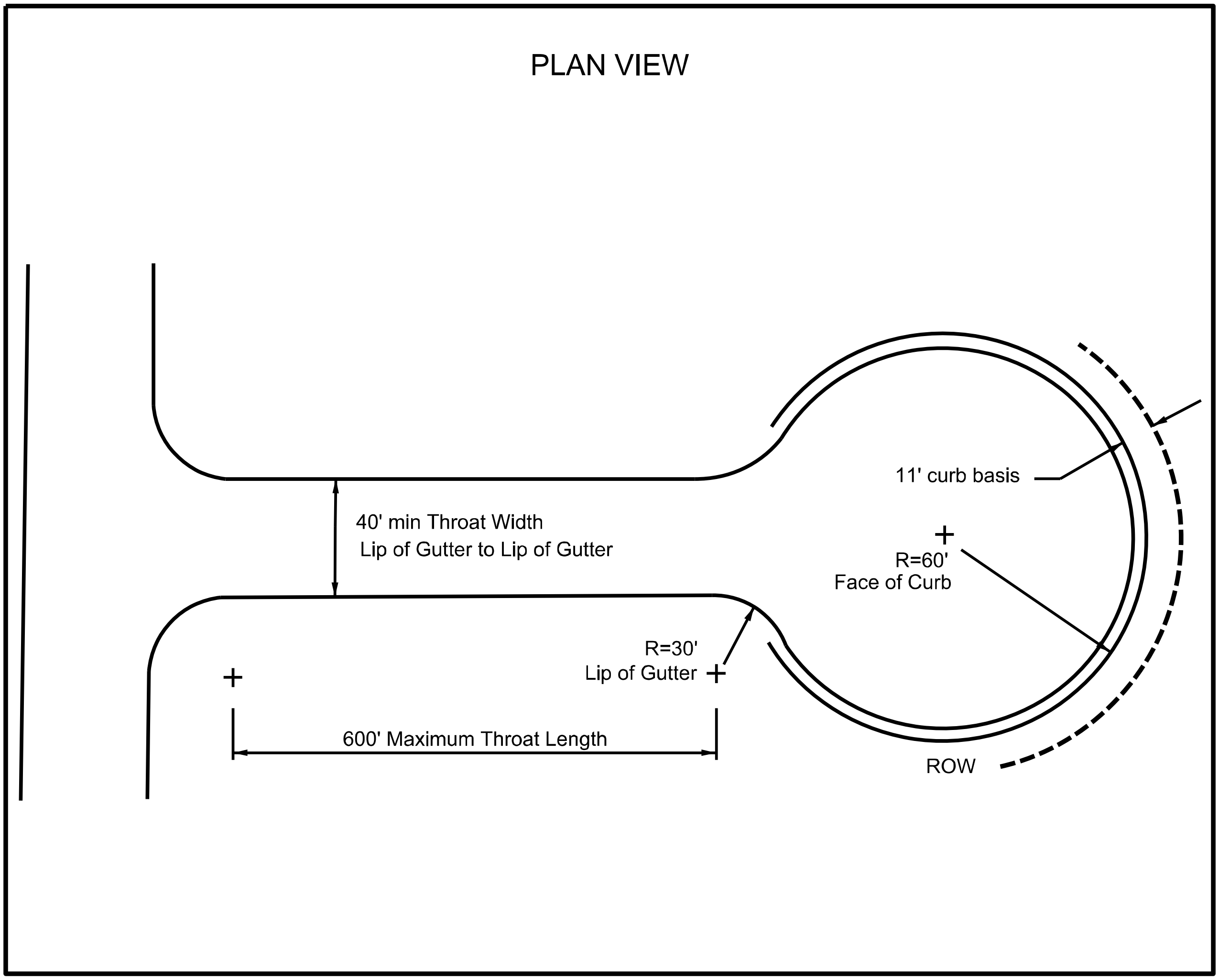


Figure 1-18 Design Criteria for Open-Ended Cul-de-Sac

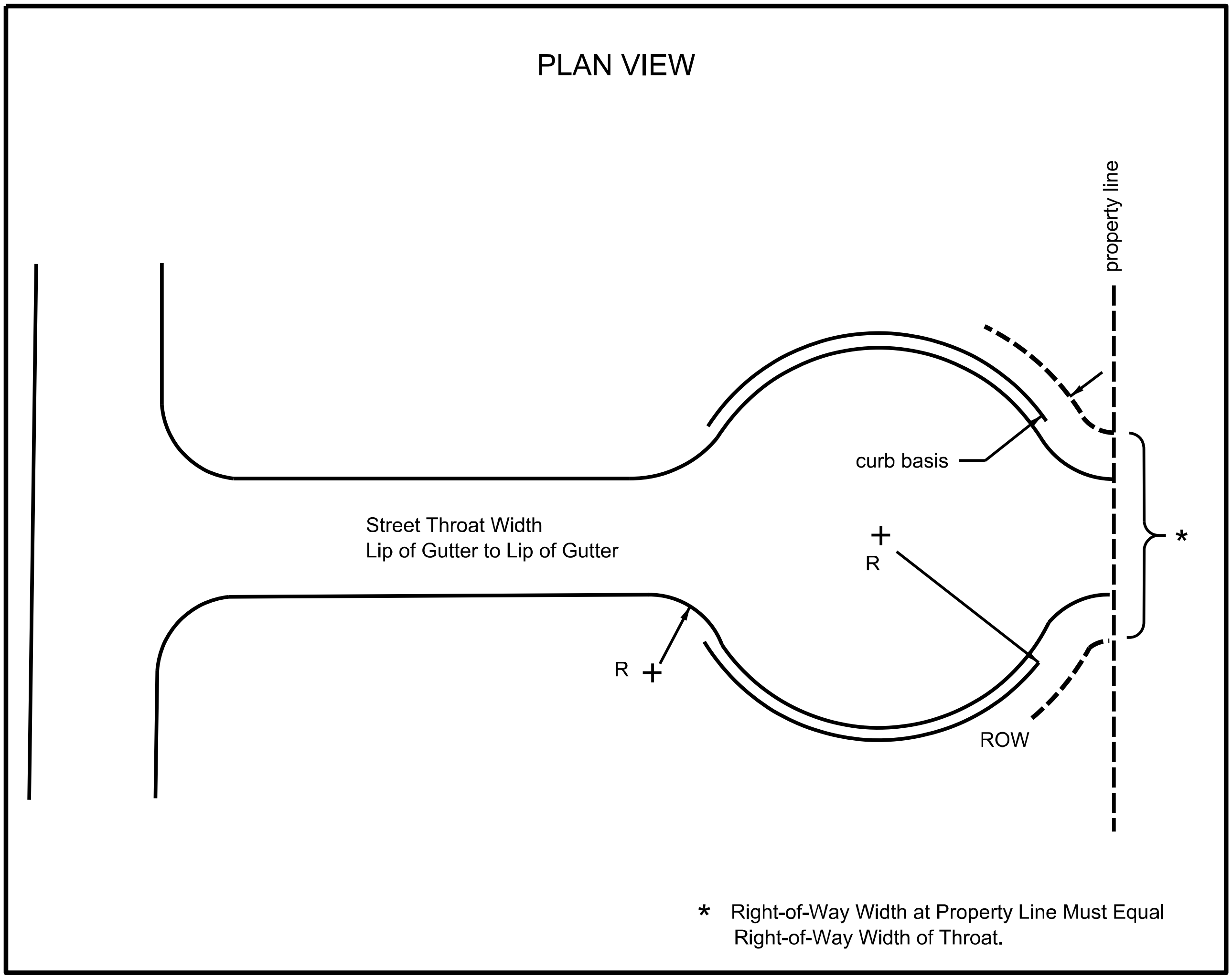
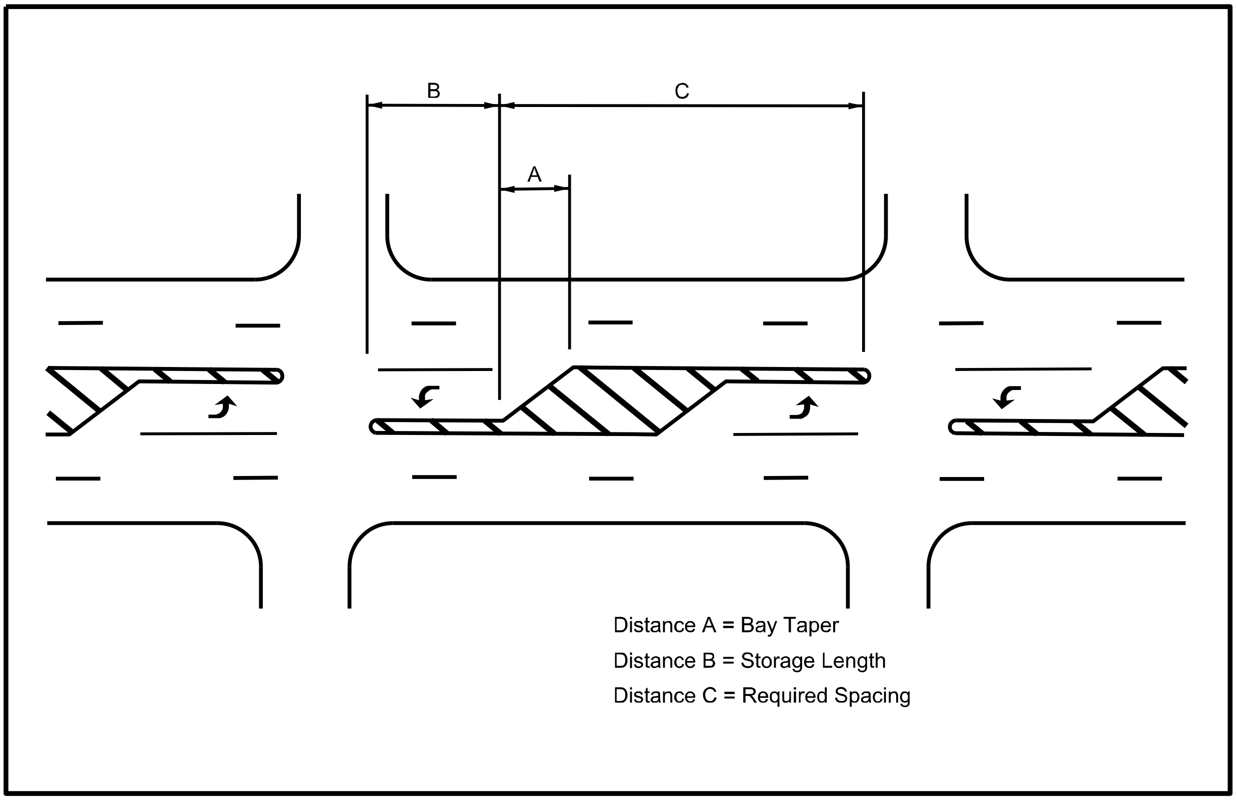


Figure 1-19 Median Breaks



Median Opening Criteria		
Design Speed (mph)	Minimum Spacing* Distance "C"	Minimum Spacing Distance "B" + "C"
	100' Minimum Storage Requirement**	150' Minimum Storage Requirement***
30	350'	500'
35	425'	575'
40	500'	650'
45	600'	750'
50	750'	900'

* Plus storage lengths based on peak hour volumes
** Minimum storage when turning into a local street
*** Minimum storage when turning into a collector or arterial street

Figure 1-20 Left Turn Channelization

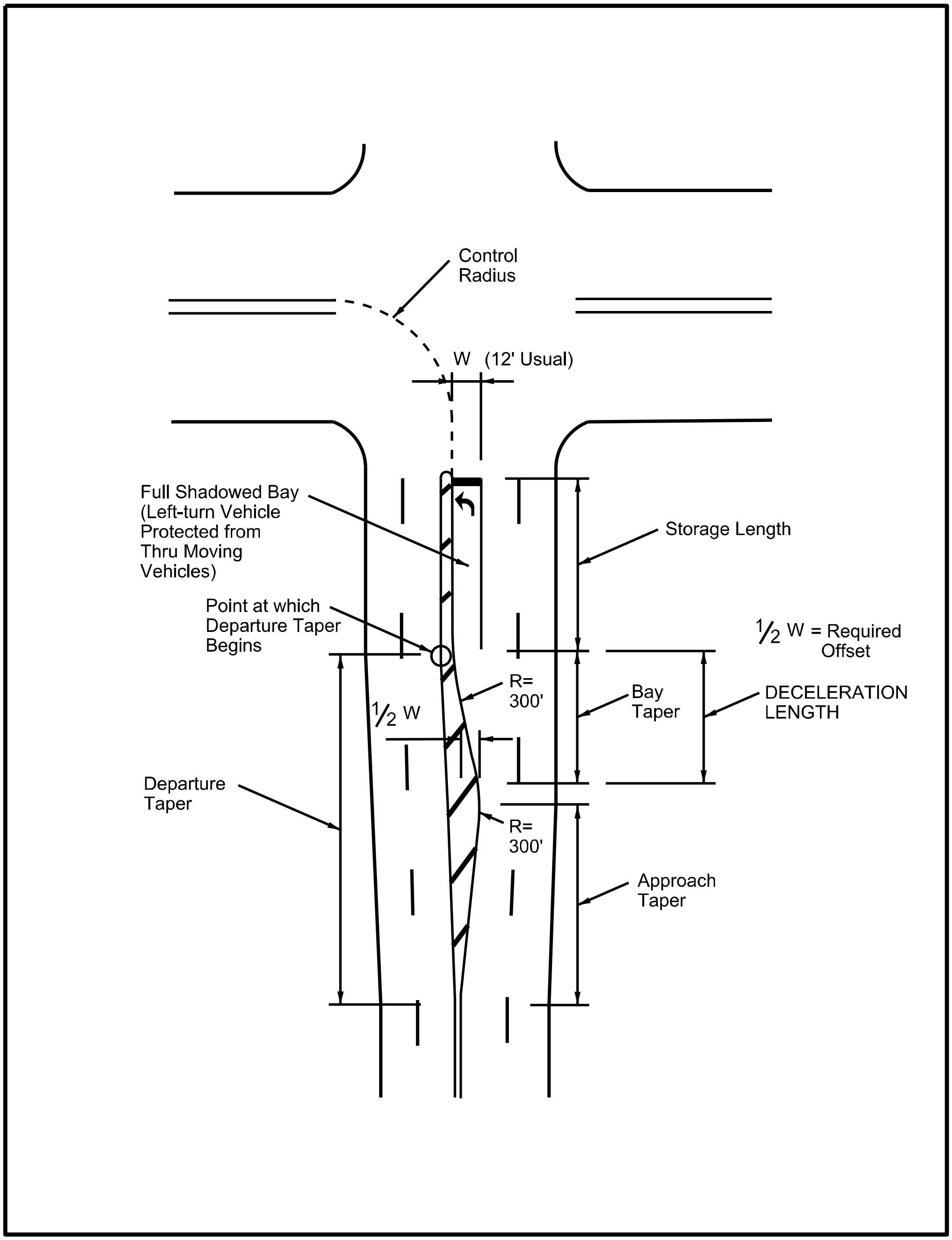
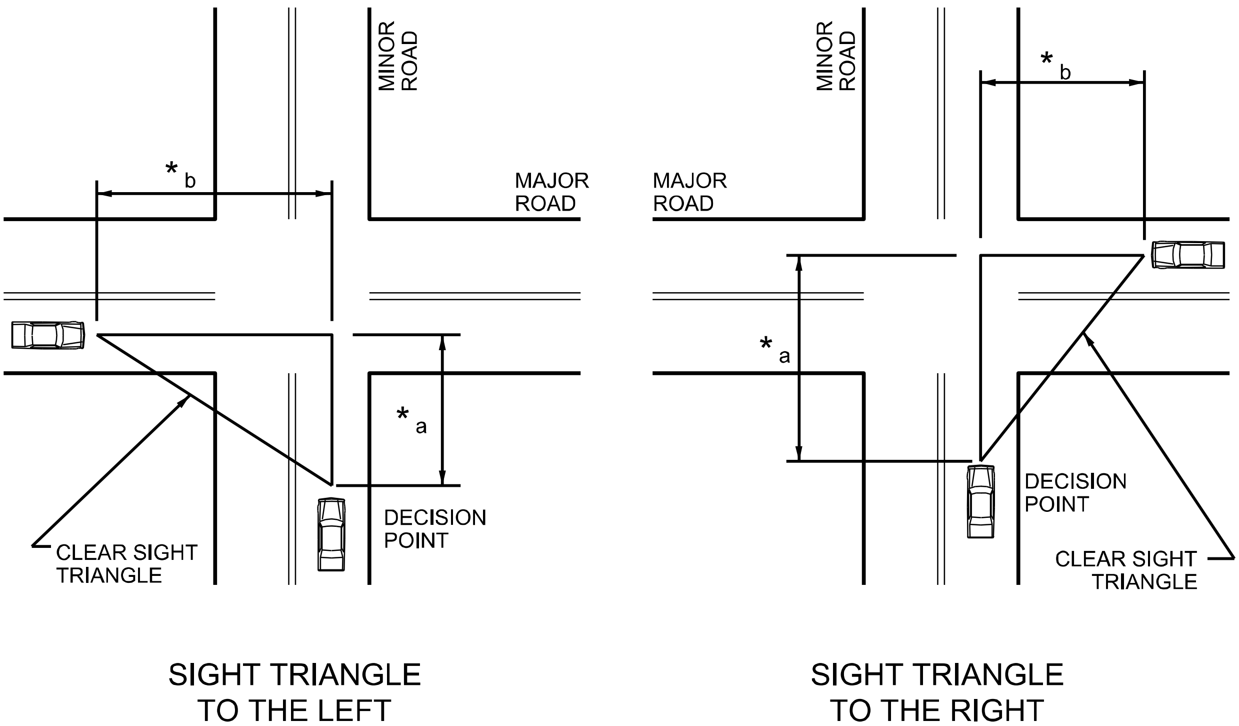


Figure 1-21 Intersection Sight Triangles



* Refer to latest edition of AASHTO'S A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS to evaluate sight triangles