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Section 8 -Guide Rail and Median Barriers

8.1 Introduction

These guidelines are based on the Roadside Design Guide, AASHTO, 2011.

The information in this section is intended to serve as guidelines that will assist the designer in determining conditions that warrant the installation of guide rail and the dimensional characteristics of the installations. Also, this section contains information to serve as guidelines to assist the designer in determining conditions that warrant the installation of a median barrier.

It is important that application of these guidelines be made in conjunction with engineering judgment and thorough evaluation of site conditions to arrive at a proper solution.

It should be emphasized that guide rail should not be installed indiscriminately. Every effort should be made to eliminate the obstruction for which the guide rail is being considered.

In some cases, another type of traffic barrier may be more effective than guide rail. For example, obstructions in gores can often be more effectively shielded with a crash cushion. The designer should consider such alternatives and choose the most suitable solution based on safety requirements, economic limitations, maintenance, and aesthetic considerations.

8.2 Guide Rail Warrants

8.2.1 General

Guide rail is considered a longitudinal barrier whose primary functions are to prevent penetration and to safely redirect an errant vehicle away from a roadside or median obstruction.

8.2.2 How Warrants are Determined

An obstruction's physical characteristics and its location within the clear zone are the basic factors to be considered in determining if guide rail is warranted. Although some wide ranges of roadside conditions are covered below, special cases will arise for which there is no clear choice about whether or not guide rail is warranted. Such cases must be evaluated on an individual basis and in the final analysis must usually be solved by engineering judgment. In the absence of pertinent criteria, a cost-effective analysis such as the Roadside Safety Analysis Program (RSAP) could be used to evaluate guide rail needs. The report and its appendices are available for download in PDF format at the following:
http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP22-27_FR.pdf

8.2.3 Clear Zone

Clear zone is defined as the area starting at the edge of the traveled way that is available for safe use by errant vehicles. The clear zone includes shoulders, bike lanes, acceleration lanes and deceleration lanes. The clear zone for auxiliary lanes that function like through lanes will be measured from the outside edge of the auxiliary lane.

The width of the clear zone (LC) varies with the speed, roadside slope and horizontal roadway alignment. The design speed should be used when determining the clear

zone. Use "Table 2-1 Design Speed vs. Posted Speed" to determine the design speed for locations where the design speed is unavailable.

Figure 8-A contains the suggested range of clear zone distances on tangent sections of roadway based on selected traffic volumes, speed and roadside slopes. Clear zones on land service highways may be limited to 30 feet for practicality and to provide a consistent roadway section if previous experience with similar projects or designs indicates satisfactory performance. According to the Roadside Design Guide, AASHTO, 2011, the designer may provide clear zone distances greater than 30 feet as indicated in Figure 8-A, where such occurrences are indicated by crash history.

Figure 8-B1 and 8-B2 contains examples of determining clear zone distances. More examples and further explanation are contained in the Roadside Design Guide, AASHTO, 2011.

Horizontal alignment can affect the clear zone width. Therefore, clear zone widths on the outside of horizontal curves should be adjusted by multiplying the clear zone width determined from Figure 8-A by the curve adjustment factor in Figure 8-C.

8.2.4 Warrants

A warranting obstruction is defined as a non-traversable roadside or a fixed object located within the clear zone and whose physical characteristics are such that injuries resulting from an impact with the obstruction would probably be more severe than injuries resulting from an impact with guide rail.

A. Non-traversable Roadside

Examples of a non-traversable roadside that may warrant guide rail include rough rock cuts, large boulders, streams or permanent bodies of water more than 2 feet in depth, roadside channels with slopes steeper than 1H:1V and depths greater than 2 feet, embankment slopes and slopes in cut sections as described in the following:

1. Embankment (Fill) Slopes

A critical slope is one in which a vehicle is likely to overturn. Slopes steeper than 3H:1V generally fall into this category. If a slope steeper than 3H:1V begins closer to the traveled way than the suggested clear zone distance, guide rail might be warranted if it is not practical to flatten the slope. Guide rail warrants for critical slopes are shown in Table 8-1.

Table 8-1

Critical Slope Warrants

Critical Embankment (Fill) Slopes	Maximum Height Without Guide Rail
1½ H:1V	3 ft.
2H:1V	6 ft.
2½ H:1V	9 ft.

A non-recoverable slope is defined as one that is traversable but the vehicle can be expected to travel to the bottom of the slope before steering recovery can be obtained. Embankments from 3H:1V to steeper than 4H:1V generally fall into

this category. Where such slopes begin closer to the traveled way than the suggested clear zone distance, fixed objects should not be constructed on the slope. Recovery of high speed vehicles may be expected to occur beyond the toe of slope. A clear runout area at the base of these slopes is desirable; see Figure 8-B2 for an example. The designer should evaluate each site before providing non-recoverable slopes without guide rail.

When flattening existing slopes to remove guide rail, the proposed side slopes should be recoverable (4H:1V or flatter). Where embankment slopes are being constructed, the designer should investigate the feasibility of providing a recoverable slope instead of a critical slope with guide rail. Rounding should be provided at slope breaks; see Figures 5-B, 5-B1, 5-B2, 5-H and 5-I.

2. Slopes in Cut Sections

   Slopes in cut sections should not ordinarily be shielded with guide rail. However, there may be obstructions on the slope that warrant shielding, such as bridge piers, retaining walls, trees, rocks, etc. that may cause excessive vehicle snagging rather than permit relatively smooth redirection.

   Slopes in cut section of 2H:1V or flatter may be considered traversable. As the cut slope steepens, the chance of rollover increases. Where feasible, slopes steeper than 2H:1V should be flattened. If there is a warranting obstruction on the cut slope, the following apply:

   a. Guide rail should be installed if the warranting obstruction is on a slope flatter than 0.7H:1V and is within the clear zone width specified in Figure 8-A for a 3H:1V slope.

   b. Guide rail should be installed if the warranting obstruction is on a slope of 0.7H:1V or steeper and is less than 6 feet (measured along the slope) from the toe of the slope and is within the clear zone width specified in Figure 8-A for a 3H:1V slope.

   c. Guide rail is not required if the warranting obstruction is on a slope of 0.7H:1V or steeper and is 6 feet or more (measured along the slope) from the toe of the slope.

3. Drainage Features

   Channels should be designed to be traversable. Where feasible, existing channels should be reconstructed to be traversable. The presence of channels or ditches may be regulated streams, wetlands or open waters. Changes to these channels must be coordinated with the Hydrology and Hydraulic Unit and the applicable e-Team.

   Figures 8-U and 8-V show criteria for preferred cross sections for channels. *According to the Roadside Design Guide, AASHTO, 2011:*

   "Cross sections shown in the shaded region of each figure are considered to have traversable cross sections. Channel sections that fall outside the shaded region are considered less desirable and their use should be limited where high-angle encroachments can be expected, such as the outside of relatively sharp curves. Channel sections outside the shaded region may be acceptable for projects having one or more of the following characteristics: restrictive right-of-way; environmental constraints; rugged terrain; resurfacing, restoration, or rehabilitation (3R) projects; or low-volume or low-speed roads and streets, particularly if the channel bottom and backslopes are free of any fixed objects or located beyond suggested clear

zone distance. If practical, drainage channels with cross sections outside the shaded regions and located in vulnerable areas may be reshaped and converted to a closed system (culvert or pipe) or, in some cases, shielded by a traffic barrier."

B. Fixed Objects

Examples of fixed objects that may warrant guide rail are: overhead sign supports, high-level lighting supports, traffic signals and luminaires supports of non-breakaway design, concrete pedestals extending more than 4 inches above the ground, bridge piers, abutments and ends of parapets and railings, wood poles or posts with a cross sectional area greater than 50 square inches (except as modified by Subsection 8.2.4.B.2. "Utility Poles"), and drainage structures.

In no case on new or upgraded guide rail installations shall breakaway, bendaway or non-breakaway design supports, highway lighting, signal poles, signal controller and meter cabinets, trees, utility poles, fire hydrants, mailboxes and signs remain in front of guide rail.

Signal poles shall be located as noted in subsection 12.3.8 "Traffic Signal Standards". Shielding of steel poles on roadways with posted speeds of 50 mph or greater can be considered when there is a history of run-off-the-road crashes and there is the required recovery area or clear area behind the approach end terminal (see Figures 8-D and 8-P1).

Signs with bendaway (steel U-post) supports may be placed in front of dual faced guide rail in the median. Desirably, allow 7 feet between face of rail element and nearest sign post. If possible, relocate the sign behind guide rail at the nearest structure or place a single post sign inside the dual faced guide rail (between the two rail elements).

Overhead sign supports should be located as close to the right-of-way line as practical. Guide rail protection for all overhead sign supports should be provided regardless of location beyond the clear zone. This will limit severe implications resulting from impacts to the sign support.

1. Trees

Trees are considered fixed objects. However, trees are generally not considered a warranting obstruction for guide rail. The following guidance is provided for the treatment of trees within the clear zone:

a. On freeways and interstate routes, trees shall not be located within the clear zone.

b. Although it is desirable to provide a clear zone free of trees on land service roads, it is likely that situations will be encountered where removal of trees within the clear zone cannot be accomplished. For instance, the aesthetic appeal of the trees may cause local opposition to their removal, the trees may not be within the right-of-way, or removal of the trees may not be environmentally acceptable.

c. In some cases it may be appropriate to plant replacement trees outside the clear zone so that the removal of trees in close proximity to the roadway may be accomplished without public criticism.

d. Factors such as crash experience, traffic volume, speed, clearance from the traveled way and roadway geometry should be evaluated when determining whether it is appropriate to leave trees within the clear zone.

Sick and diseased trees that are beyond reasonable repair, along with dead trees, trees that cause sight distance problems and trees with a significant crash history shall be removed regardless of public criticism. Also, trees that will be harmed beyond reasonable repair due to construction shall be removed (i.e. new curb that destroys the main root system). The Office of Landscape Architecture should be consulted for the tree's physical assessment.

Trees that have grown behind guide rail, that are less than 4 feet from the back of the rail element, shall be removed regardless of size. Trees, shrubs and overhanging branches shall be removed where they block or obscure horizontal sight distance whether they are behind guide rail or not. As a minimum, branches overhanging the roadway shall be removed up to a height of 16 feet. Trees and shrubs within the roadside recovery area at the approach guide rail terminal should be removed. The following areas should be checked for sight distance problems due to vegetative interference:

a. Along the inside of horizontal curves (mainline, ramps and jughandles)

b. Ramp and jughandle entrances and exits

c. Within the sight triangle at intersections

d. Sign obstructions

If clearing work is necessary within existing utility lines, the designer should request the utility company to perform regular trimming maintenance (at their cost) in the locations during the utility notification process. However, if clearing work is necessary where poles are to be relocated, then the utility company or the contractor shall be compensated for this work.

Trees removed for safety (i.e. clear zone, sight distance, guide rail and crash cushion recovery areas or clearance to utility lines) are not included in the "No Net Loss Reforestation Calculation". The removal of trees and shrubs may be regulated under the Flood Hazard Area Control Act for riparian zones or the Freshwater Wetlands Protection Act, and should be coordinated with the Hydrology and Hydraulic Unit and the applicable e-Team.

Table 8-2 provides guidance for the location of new plantings on Interstate highways, freeways and land service highways.

Table 8-2

Guidance for Landscape Plantings

Interstate and Freeways	Land Service State Highways
No plantings in median areas except for glare screen	Plantings in median area will be limited to flowers and/or small shrubs, unless for glare screen
No plantings in clear zone except for flowers (no shrubs)	Plantings in clear zone will be limited to flowers and small shrubs
Plantings behind guide rail shall be at least: • 8' minimum for shrubs* • 10' minimum for shade trees* • 14' minimum for evergreen trees*	Plantings behind guide rail shall be at least: • 6' minimum for shrubs and shade trees* • 10' minimum for evergreen trees*

No plantings within the roadside recovery area (see 8.3.3) except flowers	No plantings within the roadside recovery area (see 8.3.3) except flowers
No plantings within the sight triangle on curves and ramps	No plantings within the sight triangle on curves and ramps
On curves and ramps, plantings shall be placed at least 2’ from the sight triangle for shrubs and shade trees and 10’ for evergreen trees	On curves and ramps, plantings shall be placed at least 2’ from the sight triangle for shrubs and shade trees and 6’ for evergreen trees
No planting of trees above underground utility lines	No planting of trees under aerial facilities or above underground utility lines and service connections

* Measured from the back of the guide rail post

2. Utility Poles

   Although utility poles have a cross-sectional area greater than 50 square inches (8 inches in diameter), utility poles should not be handled the same as other warranting obstructions. It is questionable whether a safer roadside would result from installing guide rail for the sole purpose of shielding utility poles within the clear zone. Utility poles shall be located as close to the right-of-way line as practical. For the offset to the utility pole from the traveled way, the designer should refer to the current *Utility Accommodation Regulation (NJAC 16:25)*. For a quick and easy reference refer to the current *NJDOT Design Criteria for Above Ground Utilities*.

   Desirably on projects where new right-of-way is to be purchased, sufficient right-of-way should be acquired to permit the placement of the poles beyond the clear zone.

   On existing highways, where the utility pole offset does not meet the Department standards (*Utility Accommodation Regulation (NJAC 16:25)*), the designer should prepare a crash analysis of existing pole locations to determine if the relocation of the utility poles further from the edge of a through lane is warranted. Any utility pole that has been struck three times or more within three years, will require corrective action. Also, neighboring poles that have been struck a total of three or more times within three years will require corrective action. If corrective action is necessary, safety measures such as utility pole relocation and/or the improvement of the contributing roadway feature should be considered instead of guide rail.

   Utility poles should not be placed in vulnerable locations, such as in gore areas, small islands or on the outside of sharp horizontal curves. For the purpose of these guidelines, a sharp horizontal curve is considered as any horizontal curve with a safe speed less than the posted speed.

   In no case, shall utility poles on new or upgraded guide rail installations remain in front of the guide rail. The guide rail offset has preference to existing utility pole offsets where there is sufficient right-of-way. Therefore, where practical, relocate the pole behind the guide rail in lieu of placing the guide rail closer to the road. Guide rail is an obstruction in itself and should be placed as far from the traveled way as possible.

   Where utility poles are placed behind guide rail, desirably the face of the pole should be 4 feet or greater from the face of the rail. Where the offset is less

than 4 feet, provide reduced post spacing as per *Standard Roadway Construction Detail CD-609-8.* However as a minimum, the face of the pole shall be no closer than 1.5 feet from the face of the rail.

It should be noted that spacing of guide rail posts at long runs of guide rail or at bridge installations may conflict with the spacing of the utility poles. In this case when a pole will be located directly behind a post, the minimum pole offset should be no closer than 23 inches from the face of the rail, which equals 6 inches from the back of the post.

Utility poles shall not be located within the shaded adjacent recovery area shown in Figure 8-D. Also, utility poles should be at least 25 feet or greater in advance of a flared or tangent guide rail terminal.

3. Fire Hydrants

   Since fire hydrants do not meet the current AASHTO definition for breakaway design, they fall into the category of fixed objects that may warrant guide rail. The same reasoning applies here as was applicable to utility poles.

   The acceptable solution is to locate the hydrants as far from the traveled way as possible. In no case shall fire hydrants be located in front of the guide rail. However, the hydrants must be located to be readily accessible at all times.

   Where guide rail is required for some other reason and will be in front of a hydrant, the preferred treatment is to raise the hydrant to permit connection to be made over the guide rail. Usually, the connection may be a maximum of 3 feet above grade. It is the responsibility of the designer to confirm with the local Fire Department that such a treatment is acceptable. A less desirable treatment is to provide a short opening in the guide rail at the hydrant. Where an opening is provided, a flared guide rail terminal, tangent guide rail terminal or anchorage must be provided in accordance with Section 8.3.2. The guide rail must be modified as per *Standard Roadway Construction Detail CD-609-8* when the offset to the hydrant face from the face of rail element is less than 4 feet.

4. Mailbox Supports

   Limited crash data has shown that mailbox supports can contribute to the severity of a crash. The following guidelines should be followed on new construction, reconstruction and projects that involve resurfacing:

   a. No more than two mailboxes may be mounted on a single support structure unless the support structure and mailbox arrangement have been shown to be safe by crash testing. Lightweight newspaper boxes may be mounted below the mailbox on the side of the mailbox support.

   b. Mailbox supports shall not be set in concrete unless the support design has been shown to be safe by crash tests.

   c. A single 4 by 4 inch wooden post or a 4 inch diameter wooden post or a 1.5 inch to 2 inch diameter standard steel or aluminum pipe post, embedded no more than 2 feet into the ground, is the maximum acceptable as a mailbox support. A metal post shall not be fitted with an anchor plate, but it may have an anti-twist device that extends no more than 10 inches below the ground surface.

   d. In areas where snow removal is a problem or the mailbox is placed behind guide rail, a cantilever mailbox-type support may be permitted to allow snow plows to sweep under or near mailboxes without damage to their supports.

For information on cantilever mailbox design, see the *Roadside Design Guide, AASHTO 2011*.

e. The post-to-box attachment details should be of sufficient strength to prevent the box from separating from the post top if the installation is struck by a vehicle. The *Roadside Design Guide, AASHTO 2011,* shows acceptable attachment details.

f. The minimum spacing between the centers of support posts shall be 75 percent of the height of the posts above the ground line.

For more information on mail stop design and mailbox location, see the *Roadside Design Guide, AASHTO 2011.*

C. Pedestrians

Guide rail may be used where there is a reasonable possibility of an errant vehicle encroaching onto a sidewalk where there is considerable pedestrian traffic or into an unprotected area used by pedestrians. Some examples of the latter are where a playground, schoolyard, or a public beach is adjacent to the right-of-way line. The basis for assessing the needs should be the crash experience of the immediate area and the specifics for the cause(s) of the crashes. There may be times when no causative factor can be isolated, and sound engineering judgment must be applied.

This policy is not intended to indiscriminately permit the installation of guide rail at every location where a request for guide rail has been received, but to offer some flexibility to the designer when unique circumstances occur.

There are locations where existing guide rail and the PVI (top of the slope) of a steep slope are both located directly behind a pedestrian sidewalk area. If new guide rail is installed in front of the sidewalk area, the existing guide rail should either be left in place or the existing guide rail should be removed and a fence installed in its place. When guide rail is placed between the roadway and the sidewalk, a rail element may be attached to the back of the guide rail post so that pedestrians are shielded from the exposed back of post. The rail element, if added, shall not be located within the 37.5 foot length of a flared guide rail terminal or within the 50 foot length of a tangent terminal.

8.3 Dimensional Characteristics

NJDOT has chosen the MASH crash tested Midwest Guardrail System (MGS) to use for MASH implementation. This guide rail system has been designed for the high center of gravity vehicles found on today's roadways. The current system includes a higher mounting height (31 inches) and a rail splice that occurs midway between the standard 6'-3" post spacing. In addition, rub rail is no longer required when placing the guide rail at the curb. Details for the guide rail system and for transitioning from the current 31 inch high system to an existing NCHRP 350 27¼ inch high guide rail system are shown in the Department's *Standard Roadway Construction Details*.

8.3.1 Guide Rail Offset

A. Without Curb or Raised Berm in Front of Guide Rail

The mounting height for the guide rail is 31 inches measured from the top of rail to the ground line or gutter line as shown in the Department's *Standard Roadway Construction Detail CD-609-8A*.

A highly desirable characteristic of any roadway is a uniform clearance from the traveled way to the guide rail. It is desirable to place the guide rail at a distance

beyond which it will not be perceived as a threat by the driver, see Shy Line Offset in Figure 8-E, Table 1. In general, the following offsets and slopes should be used:

1. To the extent possible, guide rail should be located as far as possible from the traveled way to provide a recovery area for errant vehicles and to provide adequate sight distance along horizontal curves and at intersections.
2. On interstate highways and freeways, the front face of the guide rail should desirably be 4 feet or more from the outside edge of shoulder. Where this offset is not possible, the guide rail should be installed flush with the gutter line.
3. On land service highways where there is no sidewalk and the border area is not used by pedestrians, the front face of the guide rail may be placed any distance from the gutter line; however, an offset of 4 feet or more is preferred.

   Where providing an offset of 7 feet or more, the designer is advised that additional right-of-way or slope easements may be necessary to construct a flared offset and/or provide the 5 foot flat area (10H:1V minimum slope) adjacent to a flared guide rail terminal as shown in Figure 8-F. If the purchase of additional right-of-way is infeasible, a tangent terminal should be provided at an offset of 7 feet or more, instead of a flared guide rail terminal. If this is still infeasible, then the guide rail should be installed flush with the gutter line to permit the construction of a flared guide rail terminal with a flared offset and flat area.

B. Curb or Raised Berm in Front of Guide Rail

The mounting height for the guide rail is 31 inches measured from the top of rail to the gutter line or ground line depending upon the offset as shown in the Department's *Standard Roadway Construction Detail CD-609-8A*.

1. Curb or Raised Berm Requirement

   Curb or a raised berm in front of guide rail should be avoided, see Section 5.6, "Curbing", for the type and location of curb.

   On freeways and Interstate highways, new installations of vertical curb shall not be constructed. However, sloping curb may be constructed on urban freeways and urban and rural Interstate highways but the overall curb height shall not exceed 4 inches. On land service highways where curb is proposed, the curb height in front of the guide rail shall not exceed 4 inches.

   On projects that involve upgrading existing roadways, where there is a curb or a raised berm greater than 4 inches in height in front of guide rail, removal or modification of the curb or raised berm should be the first consideration. If a raised berm in front of the guide rail is necessary, it shall be regraded at 6H:1V and 4 inch maximum height. Where curb in front of guide rail is required, the curb shall be replaced with 4 inch vertical or sloping curb. Also, 75 feet of curb in advance of the front of a flared or tangent guide rail terminal shall be no greater than 4 inches.

2. Guide Rail Offset Requirement

   If curb (vertical and/or sloping curb) is present and cannot be removed, the preferred guide rail offset for all posted speeds is flush with the gutter line for vertical curb and 6 inches behind the gutter line for sloping curb. Other offset options for locating proposed and existing guide rail at various posted speeds are as follows:

a. Highways With a Posted Speed More than 50 MPH

i. Proposed guide rail shall be located flush with the gutter line for vertical curb or 6 inches behind the gutter line for sloping curb.

ii. Existing guide rail that is not located at the gutter line shall be relocated flush with the gutter line for vertical curb or 6 inches behind the gutter line for sloping curb.

b. Highways With a Posted Speed of 40 to 50 MPH

i. On freeways and Interstate highways proposed guide rail may be located 4 to 12 feet behind the gutter line. However, an offset of 10 to 12 feet is preferred for safe mowing operations.

ii. On land service highways where there is a sidewalk or sidewalk area used by pedestrians, proposed guide rail may be located 6 to 12 feet behind the gutter line.

c. Highways With a Posted Speed less than 40 MPH:

i. Proposed guide rail may be located 4 feet or more behind the gutter line of freeway and Interstate ramps.

ii. On land service highways, proposed guide rail may be located any distance behind the curb. Generally an offset of 6 to 12 feet is preferred.

C. At Embankment Slopes

Where guide rail is located at the top of an embankment slope, the posts should be a minimum of 2 feet from the PVI to the back of the post.

When less than 2 feet is provided, the following post lengths, shown in Table 8-3, should be used:

Table 8-3

Additional Post Length Requirements Where Distance From PVI to Back of Post is Less Than 2 Feet

Offset from Back of Post to PVI	Embankment Slopes	Additional Post Length
Less than 2 ft. but greater or equal to 1 ft.	6H:1V or Flatter	No Change
	Steeper than 6H:1V to 3H:1V	1 ft.
	Steeper than 3H:1V to 2H:1V	2 ft.
Less than 1 ft. or at PVI	6H:1V or Flatter	1 ft.
	Steeper than 6H:1V to 3H:1V	2 ft.
	Steeper than 3H:1V to 2H:1V	3 ft.

1. Guide rail shall be placed on slopes 10H:1V or flatter provided the rollover between the pavement slope and the embankment slope is not greater than 10 percent. Rollovers greater than 10 percent are prone to occur where superelevation slopes in the opposite direction of the embankment slope. Where this happens, install guide rail flush to the gutter line.

2. Figure 8-F illustrates the grading treatment for embankment slopes at flared and tangent guide rail terminal.

D. At Fixed Objects

Where guide rail is used to shield an isolated obstruction, it is most important that the guide rail be located as far from the traveled way as possible to minimize the probability of impact. The distance from the face of the rail element to the face of obstruction should desirably be 4 feet or greater. If less than a 4 foot offset must be used, the guide rail system must be modified as shown in *Standard Roadway Construction Detail CD-609-8*. If the guide rail in advance of the obstruction is to be flared (including a flared terminal), the flare should be a minimum of 25 feet from the modified section of guide rail.

E. On Bridges

1. Safetywalks range in width from 1.5 feet to less than 4 feet. On existing freeway and interstate structures with safetywalks, where it is not feasible to remove the safetywalk and provide a concrete barrier shaped parapet, the guide rail shall be carried across the structure along the gutter line. However, on existing freeway and Interstate ramps where the posted speed or advisory speed is 40 mph or less and the safetywalk is 2.5 feet or less in width, it is not necessary to carry guide rail across the structure since vaulting is not likely to occur. In this case, guide rail should only be provided across the structure if the parapet does not meet NCHRP 350 or MASH crash test criteria.
2. Where the roadway approaching a structure has a curb or raised berm, the mounting height of guide rail located at the curb line on the structure shall be measured from the gutter line.
3. The guide rail mounting height shall be measured from the gutter line on those structures where the approach roadway is an umbrella section and the face of guide rail is set flush with the curb face on the structure.
4. Where there is a difference in the offset to the approach guide rail and the offset to the guide rail attachment to the bridge parapet, the straight flare rate shown in Table 1 of Figure 8-E should begin a minimum of 25 feet prior to the asymmetrical W-beam to thrie beam transition section.
5. Attachment of guide rail to bridges and structures shall be in accordance with the Department's *Standard Roadway Construction Details*, revised or modified Standard Details or Special Details. The designer shall specify at each location on the construction plans the specific guide rail attachment detail to be used and whether it is Type A or Type B.

   A TL-2 or TL-3 approach guide rail transition shall be provided when using a Type A attachment. The TL-2 approach guide rail transition shall be used when the design speed is 45 mph or less and the TL-3 approach guide rail transition shall be used when the design speed is greater than 45 mph. The appropriate approach guide rail transition *Standard Roadway Construction Detail* number shall be included on the construction plan.
6. Where there is considerable pedestrian traffic, the guide rail may be set flush to the curb face to physically separate pedestrians from vehicular traffic if feasible (see Section 8.2.4.C).

8.3.2 End Treatments

When the approach end of guide rail is terminated within the clear zone, a flared guide rail terminal or tangent guide rail terminal shall be provided in accordance with (A)

and (B) below. When there is insufficient area to install either a flared or tangent guide rail terminal, a crash cushion may be used. See Section 9 for more information on crash cushions.

A. Flared Guide Rail Terminals

1. Flared guide rail terminals shall be used on the approach ends of beam guide rail installations terminating within the clear zone, unless covered by conditions noted in Section 8.3.2.B, 8.3.2.C, 8.3.2.D or 8.3.2.E.

   If the approach end of guide rail for opposing traffic is within the clear zone, a flared guide rail terminal shall be used (see Figure 8-I1). The clear zone for the opposing traffic should also be adjusted for horizontal curvature (see Figure 8-C). On two lane highways where passing is permitted, the clear zone shall be measured from the outside edge of the approaching traffic lane.

   A 37.5 foot length straight flare shall be used with all flared guide rail terminal end treatments. This flare provides for a flare offset of 4 feet, see *Standard Roadway Construction Details*. The approach end of a flared guide rail terminal shall be placed a minimum distance of 12.5 feet beyond the length of need.

2. A flared guide rail terminal shall not be installed behind a curb greater than 4 inches in height. Where there is an existing curb or proposed curb greater than 4 inches in height, 75 feet of the curb immediately in advance of the front of a flared guide rail terminal shall be removed and replaced with vertical curb or sloping curb with a height no greater than 4 inches, see Figure 8-X.

3. A roadside recovery area should be provided behind a flared guide rail terminal installation. See Section 8.3.3 for additional discussion of Roadside Recovery Area.

4. When a flared guide rail terminal is proposed at the approach to a TL-2 or TL-3 approach guide rail transition, the flared terminal shall be a minimum of 15’-7½” beyond the approach end of the approach guide rail transition at a bridge as shown in Figure 8-O2.

5. Rub rail, reduced post spacing, or double rail elements shall not be used within the 37.5 feet flare of a flared guide rail terminal.

6. Where a flared guide rail terminal is installed along a horizontal curve, see Figure 8-X.

7. The flared terminal pay limit is shown on *Standard Roadway Construction Detail CD-609-5*.

B. Tangent Guide Rail Terminals

1. At locations where it is not possible to construct a flared guide rail terminal with a 4 foot flared offset, a tangent terminal should be used. A tangent terminal can be erected parallel to the roadway without needing a flare to function properly. The approach end of the tangent terminal shall be placed a minimum distance of 12.5 feet beyond the length of need.

2. Where the guide rail is installed flush with the gutter line, a tangent terminal shall be constructed with a straight flare with the approach end of the terminal offset 1 foot from the gutter line to reduce nuisance hits.

3. A roadside recovery area shall be provided behind a tangent guide rail terminal installation. See Section 8.3.3 for additional discussion of Roadside Recovery Area.

4. Where a tangent guide rail terminal is installed along a horizontal curve, see Figure 8-Y.
5. A tangent guide rail terminal shall not be installed behind a curb greater than 4 inches in height. Where there is an existing curb or proposed curb greater than 4 inches in height, 75 feet of the curb immediately in advance of the front of a tangent guide rail terminal shall be removed and replaced with vertical curb or sloping curb with a height no greater than 4 inches, see Figure 8-Y.
6. Rub rail, reduced post spacing, or double rail elements shall not be used within 50 feet of the approach end of a tangent guide rail terminal.
7. When a tangent guide rail terminal is proposed on the approach to a TL-2 or TL-3 approach guide rail transition, the tangent terminal shall be a minimum of 3'-1½" beyond the approach end of the approach guide rail transition at a bridge as shown in Figure 8-O2.
8. The tangent terminal pay limit is shown on *Standard Roadway Construction Detail CD-609-5*.

C. Beam Guide Rail Anchorages

1. On a one-way roadway or a divided roadway with a non-traversable median, trailing ends of guide rail installations should be anchored with a beam guide rail end anchorage, as shown in *Standard Roadway Construction Detail CD-609-4*.
2. In special cases, where the approach end of a guide rail installation is located so that an end hit is unlikely, the end may be anchored with a Beam Guide Rail End Anchorage as shown in *Standard Roadway Construction Detail CD-609-4*. One example would be where the approach end of a guide rail installation for opposing traffic is outside the clear zone, see Figure 8-I1, Condition 1.
3. A clear area should be provided behind beam guide rail anchorages. The clear area extends 37.5 feet upstream from the end post of the anchorage and varies in width from 2.5 feet to 10 feet, see Figure 8-I2.
4. A minimum of 2 feet must be provided between the back of the anchorage posts and the PVI of a fill slope.

D. Controlled Release Terminals (CRT)

The design shown in Figure 8-P1 is based on an intersection angle of 90 degrees. See Note E in Figure 8-P1 when the intersection angle is considerably different than 90 degrees. In addition, the following criteria also apply:

1. If a raised berm in front of a CRT cannot be removed, it shall be regraded at 15H:1V. Where curb in front of the CRT cannot be removed, curb shall be no higher than 2 inches.
2. A clear area free of any obstructions and graded at 2H:1V or flatter shall be provided behind the CRT. See Figure 8-P1 and *Standard Roadway Construction Detail CD-609-6* for the required clear area dimensions.
3. Since the rail height of the CRT is 27¼ inches, a 25 foot vertical transition as shown in *Standard Roadway Construction Detail CD-609-8* is required to attach the CRT to 31 inch high standard guide rail. The transition begins at the CRT line post.
4. Figure 8-P2 shows the minimum length of guide rail required when a CRT is to be installed in advance of an approach guide rail transition. If the

minimum length cannot be provided, a compressive crash cushion should be installed on the approach end of the guide rail.

E. Buried Guide Rail Terminal

In cut sections, the approach end of guide rail should be buried in the backslope as shown in Figure 8-N and in *Standard Roadway Construction Detail CD-609-9*. A straight flare should be used where the guide rail is buried in a cut slope. Table 1 of Figure 8-E shows the straight flare rate allowable for various speeds. A minimum L.O.N. measured from the point where the guide rail crosses the PVI of the foreslope and backslope to the obstruction being shielded shall not be less than 75 feet.

In cut sections where the border area slopes towards the roadway, the clearance to the top of rail along the flared portion of the guide rail shall be maintained at 31 inches above the ground line as shown in Figure 8-N, FORESLOPE GRADED TOWARD ROADWAY - SECTION VIEW.

In cut sections where the border area slopes away from the roadway, the height of the flared portion of the guide rail shall be constant relative to the normal guide rail offset until the guide rail is buried in the backslope as depicted in Figure 8-N, FORESLOPE GRADED AWAY FROM ROADWAY - SECTION VIEW. If the clearance from the ground to the bottom of rail exceeds 21 inches, rub rail and 8 foot long posts shall be used throughout the portion where the clearance exceeds 21 inches.

To provide the necessary anchorage, the rail shall be attached to the last two posts according to *Standard Roadway Construction Detail CD-609-9*. The beginning of the flare and the location of the buried end post shall be indicated by station and offset on the construction plans.

F. Existing Slotted Rail Terminals (SRT), Breakaway Cable Terminals (BCT), ET-PLUS and Eccentric Loader Terminals (ELT)

An existing SRT, BCT, ET-PLUS or ELT shall be replaced with the end treatments previously discussed in this section at the following locations:

1. An SRT, BCT, ET-PLUS or an ELT that must be replaced due to crash damage shall be upgraded with an end treatment other than an SRT, BCT, ET-PLUS, or an ELT. An SRT can be replaced in kind if it has a minimum adjacent recovery area of 175 feet long.
2. Any SRT, BCT, ET-PLUS or ELT installed within the clear zone shall be replaced in conjunction with regularly scheduled roadway work in the same area with an end treatment other than an SRT, BCT, ET-PLUS or an ELT. An SRT does not have to be replaced if it has a minimum adjacent recovery area of 175 feet long.

Where a BCT or an ELT require replacement in (1) and (2) above, upgrade the entire run of guide rail attached to the BCT or ELT since the guide rail is past its service life.

8.3.3 Roadside Recovery Area

Research has shown that over half of all fatal guide rail collisions involve a secondary event, either a second impact or a rollover. Many of these secondary events, e.g. trees, poles, and rollovers, typically carry a much higher fatality risk than a guide rail impact. Therefore, a roadside recovery area void of fixed objects is desirable, adjacent to, and behind the approach guide rail terminal and guide rail anchorage. In some cases, however, providing even a minimum runout area may not be practical because

of physical constraints such as right-of-way, environmental concerns, or inadequate resources.

Figure 8-D shows the roadside recovery area that should be provided at flared and tangent guide rail terminals and Figure 8-I2 shows the clear area behind an end anchorage.

The adjacent recovery distance (A) behind guide rail in Figure 8-D should desirably extend from the beginning of the guide rail terminal to the obstruction. In some cases, however, where it is not practical to provide the desirable distance, the minimum adjacent recovery distances (A) shown in Table 1 of Figure 8-D should be provided behind the guide rail. On land service highways where the length of guide rail in advance of the obstruction is restricted due to the location of driveways, intersecting streets or other features, and the minimum adjacent recovery distances (A) shown in Table 1 of Figure 8-D cannot be provided, the adjacent recovery distance will extend from the guide rail terminal to the obstruction.

An advanced recovery area shown in Figure 8-D should also be provided. On land service highways where there are utility poles, the location of utility poles should comply with the criteria in Subsection 8.2.4.B.2.

Desirably the lateral recovery distance (B) should equal the distance from the face of the guide rail terminal to the back of the obstruction. When it is not practical to provide the desirable lateral recovery distance, the minimum lateral recovery distances (B) shown in Table 1 of Figure 8-D should be used. If the distance from the face of the guide rail to the back of the obstruction is less than the minimum lateral recovery distance (B) shown in Table 1 of Figure 8-D, the minimum lateral recovery distance should be provided. However, in no case should the lateral recovery distance (B) extend beyond the clear zone or the R.O.W. line whichever is less.

On land service highways, the minimum lateral recovery distance (B) in Figure 8-D may be reduced when the typical lateral recovery distance in advance of the terminal is less than shown in Table 1 of Figure 8-D. The recovery area directly behind a terminal ideally should be at least as wide as the roadside clear distance immediately up stream of the terminal. The lateral recovery distance (B) that is selected should be consistent with that available elsewhere along the highway and is measured from the edge of roadway to existing roadside obstructions (trees, rock cuts, etc.).

In addition to providing a clear area void of fixed objects, proper grading in advance of, adjacent to, and behind the terminal is required to be sure the vehicle remains stable after hitting the terminal. Based on the 2003-2005 New Jersey Crash Record System (NJCRASH) and the 2000-2005 Fatality Analysis Reporting System (FARS), 14% of all fatal guide rail crashes in New Jersey resulted in rollover. The Standard Grading treatment shown in Figure 8-F shall be used for all flared terminals and wherever practical for tangent terminals. However, when upgrading existing guide rail sites or when there are site limitations at new guide rail locations (limited R.O.W., environmental constraints, etc.), the Alternate Grading treatment in Figure 8-F may be used for tangent terminals only.

The designer must provide on *Standard Roadway Construction Detail CD-609-10* the required longitudinal (A) and lateral (B) recovery distances for each flared and tangent guide rail terminal site. Furthermore, additional quantities for clearing site, selective clearing, and/or tree removal, and the necessary earthwork to provide the proper grading shown in Figure 8-F will be required to be shown on the contract plans. Also, the location for each site along with the type of grading treatment (Standard or Alternate) shall be provided on *Standard Roadway Construction Detail CD 609-10.*

8.3.4 Approach Length of Need (L.O.N.)

The approach length of need (L.O.N.) is the minimum length of guide rail required in advance of the warranting obstruction to shield it effectively (See Figure 8-E). The minimum length of guide rail in advance of an obstruction including the approach terminal shall not be less than the minimum adjacent recovery area (A) shown in Table 1 of Figure 8-D.

A. On Embankment Slopes

The approach L.O.N. on embankment (fill) slopes should be determined in accordance with Figures 8-E and 8-G. On a two-way, undivided highway or on a divided highway with a narrow traversable median, an "approach end" treatment may be required for both directions of traffic; see Figure 8-I1 to determine the approach L.O.N. for opposing traffic on the embankment (fill) slopes.

The guide rail treatment for critical embankment slopes is shown in Figure 8-H.

Figure 8-J, 8-K and Figure 8-L illustrate the guide rail layout when shielding an obstruction on an embankment slope in the median.

B. In a Cut Section

See Figure 8-M for an example of determining L.O.N. in a cut section.

When the distance from the ground to the bottom of the guide rail exceeds 21 inches, a rub rail shall be provided from that point to the slope. See Section 8.3.2.E for further guidance.

C. At Driveways

If the existing driveway falls outside the L.O.N., design guide rail as shown in Figure 8-E.

Where existing driveways are located within the L.O.N., the designer's first consideration should be to relocate the driveway as far away from the warranting obstruction as the property line allows. If the relocated driveway falls outside the L.O.N., design guide rail as shown in Figure 8-E.

If a driveway cannot be relocated beyond the L.O.N., use treatments shown in Figures 8-O1 or 8-P1. The CRT shown in Figure 8-P1 is the preferred design. Where the minimum functional length of a flared guide rail terminal in Figure 8-O1 is longer than the space available from the obstruction to the driveway and the right-of-way purchase is impractical for the CRT in Figure 8-P1, consideration should be given to using a crash cushion.

Driveway openings sometimes fall within a continuous guide rail run. An example of a guide rail treatment at this location is shown in Figure 8-Q.

D. At Gore Areas

It is desirable to provide a traversable and unobstructed gore area since the gore area may serve as a recovery area for errant vehicles. Every effort should be made to keep the gore area clear of warranting obstructions. However, urban areas, wetlands, parklands, etc. can put restrictions on this policy by placing warranting obstructions, such as critical embankment slopes, parapets or abutments close to gore areas. The closer the obstruction is to the gore area, the closer the L.O.N. is to the gore area, and the more limited the guide rail treatment becomes. Figures 8-R and 8-S provide guide rail treatment examples for gore areas, starting from less restricted or open gore areas in Figure 8-R to more restricted or limited gore areas in Figure 8-S.

E. In Medians

In very wide medians where an obstruction is within the clear zone from only one direction, the approach L.O.N. should be determined as shown in Figures 8-E and 8-G. For medians that do not require median crossover protection, but the obstruction is within the clear zone for both directions, Figure 8-J illustrates the guide rail layout for shielding the obstructions.

For medians that do require median crossover protection, Figures 8-K and 8-L illustrate the typical guide rail layout. However, when beam guide rail, dual faced is installed along one edge of the roadway as illustrated in Figure 8-L, any obstruction in the median shall be shielded regardless of its offset. To determine the required L.O.N., L_H shall be measured from the edge of traveled way to the back of the obstruction and when determining the L.O.N. for the approach end of a bridge parapet, L_H shall be measured to the back of the trailing parapet.

8.3.5 Nonvegetative Surface Under Guide Rail

In order to reduce soil erosion and highway maintenance costs associated with spraying vegetation killer or trimming vegetation underneath guide rail, nonvegetative surfaces should be applied underneath guide rail as follows:

Table 8-4

Guide Rail Types Conditions Warranting Use of Nonvegetative Surfaces *	
Existing Guide Rail	Where upgrading Where regrading berms Where resetting guide rail
New Guide Rail	All cases

* The following are examples of exceptions to Table 8-4:

- Areas adjacent to properties where adjacent property owners maintain NJDOT R.O.W.
- Where Environmental permits would be required (i.e.: stormwater management (Flood Hazard Control Act), riparian, freshwater or tidal wetlands, pinelands), individual sections of guide rail 1,000 feet or less in length may be exempt from nonvegetative surfaces. Caution should be taken on eliminating nonvegetative surfaces from underneath guide rail next to slopes 2 to 1 or steeper. Extreme caution should be taken where runoff from slope can enter a C-1 waterway.

All nonvegetative surfaces require maintenance to spray emergent non-selective herbicide treatment for total control of vegetation on the nonvegetative surface area.

Porous nonvegetative surfaces should be the first choice when designing guide rail. Nonvegetative Surface, Hot Mix Asphalt (HMA) is impervious and should be used as little as possible. It also requires a "leave out" which increases its cost. When Nonvegetative Surface, Hot Mix Asphalt (HMA) is to be constructed, a square or round "leave out" must be provided at each post. The dimension and material for the "leave out" is shown in *Standard Roadway Construction Detail CD-608-1*.

The net increase in impervious surface, including Nonvegetative Surface, Hot Mixed Asphalt, should be kept below one-quarter acre per project as per storm water management requirements. Also, the net increase in area of disturbance should be kept below one acre per project. If these requirements are exceeded, and other permits (IE: wetlands, tidal, C.A.F.R.A., etc.) are required by the Division of Land Use Regulations of the NJDEP for the project; then NJDEP will review the Storm Water Management Plan as part of the permit review. If these requirements are exceeded and no other permit is required by the Division of Land Use Regulations of the NJDEP for the project, the Hydrology and Hydraulic Unit of the Bureau of Landscape Architecture and Environmental Solutions at NJDOT will review the Storm Water Management Plan.

Also, the thresholds for impervious surface and the area of disturbance are much smaller for stormwater management in the Pinelands and in the D & R Canal Commission, coordinate with the Hydrology and Hydraulic Unit.

Several types of porous nonvegetative surfaces are available in order to keep the net impervious surface to a minimum:

- Nonvegetative Surface, Porous Hot Mix Asphalt: NJDEP considers Porous HMA as impervious cover for stormwater management (Flood Hazard Control Act). The Delaware and Raritan Canal Commission considers Porous HMA as porous cover for stormwater management.
- Nonvegetative Surface, Polyester Matting: NJDEP considers Polyester Matting as porous cover for stormwater management (Flood Hazard Control Act).
- Nonvegetative Surface, Broken Stone: NJDEP considers Broken Stone porous for wetland transition areas and for stormwater management (flood hazard control act). The NJ Pinelands Commission considers Broken Stone as porous for stormwater management.

Where there is currently no nonvegetative surface under the guide rail, all types of nonvegetative surfaces are considered as vegetative disturbance in a Riparian zone and will require a permit from NJDEP.

Porous types are limited on where they can be placed as shown in Table 8-5.

Table 8-5

Placement of Porous Nonvegetative Surfaces Based on Guide Rail Offset

	Curb Section	Berm Section			Umbrella Section		
	Guide Rail Offset	Guide Rail Offset			Guide Rail Offset		
Nonvegetative Surface	All	0′	4′	6′ or more	0′	4′	6′ or more
Porous HMA 4″ Thick	Yes	Yes	No	Yes	Yes	No	Yes
Porous HMA 6″ Thick	No	No	Yes	No	No	Yes	No
Polyester Matting	Yes	No	No	Yes	No	No	Yes

Broken Stone 4" Thick*	Yes	No	No	Yes	Yes	Yes	Yes

* New Broken Stone installations must have a minimum shoulder width of 8 feet adjacent to it. Broken Stone is limited only in areas where broken stone exists. For example: additional guide rail is being provided in a project and the existing guide rail within the project limits has broken stone underneath. Concurrence is needed from the Regional Maintenance Engineer.

Broken Stone is the least expensive nonvegetative surface, followed by Porous HMA, HMA, and then Polyester Matting.

The nonvegetative surface shall be constructed as shown in *Standard Roadway Construction Detail CD-608-1*.

8.3.6 Sidewalks

Where there is considerable pedestrian traffic, the guide rail may be set flush to the curb face to physically separate pedestrians from vehicular traffic if feasible (see Section 8.2.4.C). The minimum width of sidewalk behind the post shall conform to Section 5.7.

Where guide rail is to be installed flush with the gutter line and the concrete sidewalk extends to the back of curb, a "leave out" shall be provided at each post to minimize the need to repair the sidewalk should the guide rail be struck. The "leave out" is typically square (15" x 15") or round (15" diameter).

The "leave out" shall be constructed as shown in *Standard Roadway Construction Detail CD-608-1*.

8.3.7 Underground Structures

The location of inlets and underground structures such as, drainage pipes, subbase outlet drains, culverts, utility lines, fiber optic lines, etc. may conflict with the placement of guide rail posts. When it is not practical to adjust the location of an inlet, underground structure or the guide rail posts, the designer has the option of adding additional blockouts, omitting one to three guide rail posts (12'-6", 18'-9" or 25'-0" unsupported span lengths) or attaching the guide rail to a concrete sidewalk.

A. Additional Blockouts

Should the designer elect to provide additional blockouts, one additional blockout may be provided at each post for any length of guide rail. However, if two additional blockouts are required, they are limited to only one post in any 75 feet of guide rail. Additional blockouts are not permitted within the limits of guide rail terminals.

B. Omitting one post (12'-6" Unsupported Span)

When it is necessary to eliminate a post to avoid a conflict with an inlet, underground utility or underground structure, the following apply:

1. A minimum of 56.25 feet (nine 6'-3" post spaces) between two consecutive post omissions.
2. The omitted post must be a minimum of 62.5 feet (ten 6'-3" post spaces) from the approach end of a tangent terminal, 68.75 feet (eleven 6'-3" post spaces) from the approach end of a flared terminal, and 31.25 feet (five 6'-3" post spaces) from the beginning of a flare or reduced post spacing.

3. An omitted post must be a minimum of 62.5 feet (ten 6’-3” post spaces) from the last post of an end anchorage.
4. The omitted must be a minimum of 37.5 feet (six 6’-3” post spaces) from the upstream end of a thrie beam to W-beam asymmetrical transition.
5. The omitted post must be at least 43.25 feet (seven 6’-3” post spaces) from an outer CRT post of an 18’-9” or 25-0”’ unsupported span.
6. Fixed objects within the limits of the unsupported span must be a minimum of 5 feet behind the face of rail (see *Standard Roadway Construction Detail CD-609-8A*.
7. Where there is curb at the omitted post, the curb height shall not be greater than 2 inches for 18’-9” on both the approach and trailing end of the omitted post.
8. The 12’-6” unsupported span shall be constructed as shown in *Standard Roadway Construction Detail CD-609-8A*.
9. The designer must show the location of a proposed 12’-6” unsupported span on the construction plans.

C. Omitting Two or Three Posts (18’-9” or 25’-0” Unsupported Span)

When it is necessary to eliminate two or three posts to avoid an inlet or underground structure the following apply:

1. A minimum of 62.5 feet (ten 6’-3” post spaces) of tangent guide rail is required between the outer CRT posts of consecutive unsupported spans.
2. The outer CRT posts must be a minimum of 62.5 feet (ten 6’-3” post spaces) from the approach end of a tangent terminal and 87.5 feet (fourteen 6’-3” post spaces) from the approach end of a flared terminal.
3. The outer CRT posts must be a minimum of 50 feet (eight 6’-3” post spaces) from the beginning of a guide rail flare.
4. The outer CRT posts must be a minimum of 62.5 feet (ten 6’-3” post spaces) from the last post of an end anchorage.
5. The outer CRT posts must be a minimum of 37.5 feet (six 6’-3” post spaces) from a thrie beam to W-beam asymmetrical transition section.
6. Fixed objects within the limits of the unsupported spans shall be a minimum of 7 feet behind the face of rail for an unsupported length of 18’-9” and 8 feet for an unsupported span length of 25’-0”.
7. Where there is curb within the unsupported span, the curb height shall not be greater than 2 inches. The 2 inch maximum curb height should begin a minimum of 25 feet in advance of the first CRT post on the approach end and continue for a minimum of 25 feet past the last CRT post on the trailing end.
8. If the unsupported span is over a culvert, the culvert headwalls shall not extend more than 2 inches above the ground line.
9. If there is a fill slope behind the CRT posts on either side of the unsupported length, a minimum of 2 feet must be provided between the back of post and the PVI of the fill slope.
10. If there is a vertical drop off behind the unsupported span, the face of rail must be a minimum of 3 feet from the drop off.

11. Unsupported span lengths of 18’-9” and 25’-0” shall be constructed as shown in *Standard Roadway Construction Detail CD-609-8A.*

12. The designer must show the location of a proposed unsupported span including the length of the unsupported span on the construction plans.

D. Concrete Sidewalk

When an underground structure would require an unsupported span length greater than 25’-0”, an 8” thick sidewalk with guide rail bolted to the sidewalk may be provided. The width of the sidewalk shall be the same as required for the nonvegetative surface shown in Standard Roadway Construction Detail CD-608-1. Standard Roadway Construction Detail CD-609-11 illustrates the method for attaching guide rail to a sidewalk.

8.3.8 Guide Rail Details

The dimensions and other characteristics of beam guide rail posts, rail elements, fasteners, etc. are shown in the *Standard Roadway Construction Details*.

8.3.9 General Comments

A. All new guide rail installations shall be constructed 31 inches high, see *Standard Roadway Construction Details*. The 31 inch high guide rail has a construction tolerance of +3/-3 inches.

B. Existing guide rail within the limits of a reconstruction project shall be replaced if it does not meet current offsets, height or splice location as shown in the *Standard Roadway Construction Details*. However, existing NCHRP 350 (i.e.: 27¼ inch high guide rail with synthetic blockouts) that does not need to be reset may be retained provided it is less than 20 years old (service life). The height of existing NCHRP 350 guide rail that is to remain must be between 26½ and 29 inches high.

C. On improvement projects to enhance safety, maintenance guide rail replacement projects and preventive maintenance projects, existing NCHRP 350 guide rail may be retained provided it is less than 20 years old. However, when at least 50 percent of an existing guide rail run is repaired, lengthened, reset or upgraded, then the entire run where practical shall be upgraded to the current 31 inch high standard including the approach guide rail transition and/or the end treatment.

D. When only a portion of the existing guide rail is to be upgraded to the 31 inch height, the guide rail shall be transitioned as shown in the *Standard Roadway Construction Detail CD-609-8*.

E. Only NCHRP 350 guide rail (27¼ inch high guide rail with synthetic blockouts) can be left in place if the guide rail is less than 20 years old. NCHRP 230 guide rail (rail elements connected without rectangular washers to 14 inch high steel blockouts on 6’ long posts) and Pre-NCHRP 230 guide rail (rail elements connected with rectangular washers to 13” high steel blockouts on 5’-9” long posts) shall not be reset. Full replacement is the only option for NCHRP 230 and Pre-NCHRP 230 guide rail.

F. Guide rail should not restrict sight distance. Sight distances should be checked when guide rail is to be installed at intersections, ramp terminals, driveways, along sharply curving roadways, etc. If the sight distance is determined to be inadequate, the guide rail placement shall be adjusted.

G. Project limits should end outside the limits of a guide rail run where practical.

H. Gaps of 200 feet or less between individual guide rail installations should be avoided where possible.

I. Guide rail should not be installed beyond the right-of-way unless easements or necessary right-of-way is acquired.

J. For the guide rail treatment at adjacent bridges, see *Standard Roadway Construction Detail CD-609-7A.* The purpose of the guide rail between the bridges is to protect mower operators from the drop off and to potentially stop a slow moving (10 mph or less) errant vehicle from encroaching into the area under the bridges. Guide rail between parapets is not required if there is a concrete connecting wall 2.25 feet high (minimum) between parapets.

K. Proposed guide rail set flush with the curb line along intersection radius returns should be checked with a truck turning template. Existing guide rail along radius returns that experience truck overhang or oversteering crashes shall either be reset farther from the curb line or redesign the radius returns for a larger design vehicle.

L. The preferred method for locating all end treatments on construction plans is to dimension from physical objects (i.e. lateral offset from edge of road, longitudinal dimensions from utility pole). Another method is by station and offset.

M. The grading work necessary for the construction of flared and tangent guide rail terminals shall be shown on the construction plans. The grading shall conform to the *Standard Roadway Construction Detail CD-609-10.*

N. Conduits

The plans shall indicate the location of existing conduits or shall include a notation where there is a possibility of conflict in driving the guide rail posts.

8.4 Median Barrier

A median barrier is a longitudinal system used to prevent an errant vehicle from crossing that portion of a divided highway separating traveled ways for traffic in opposite directions.

8.4.1 Warrants for Median Barriers

A. Interstate and Freeways

Figure 8-T presents the warrants for median barriers on high speed, access-controlled highways with traversable slopes 10H:1V or flatter.

When the need for a median barrier is determined to be optional from Figure 8-T, an evaluation of the cross median crash history should be made to determine if a median barrier is warranted regardless of the median width and volume. The warrant for a median barrier based on crash history should meet one of the following conditions:

1. 0.50 cross median crashes per mile per year of any crash severity

2. 0.12 fatal cross median crashes per mile per year

Note: The calculation of conditions (1) and (2) above requires a minimum of three crashes occurring within a five year period.

Research of cross median crashes indicate that crashes are more likely to occur within one mile of an interchange and this factor has been included as a median barrier warrant in Figure 8-T.

Figure 8-T depicts the relationship of low ADT's to median widths less than 60 feet to determine if a median barrier is warranted. As presented in Figure 8-T, if the

median width is 60 feet or less and the ADT is greater than 50,000 a median barrier is warranted. At low ADT's, the probability of a vehicle crossing the median is relatively small. Thus, for ADT's less than 20,000 and median widths within the optional areas of Figure 8-T, a median barrier is warranted only if there has been a history of cross-median crashes. Likewise, for relatively wide medians the probability of a vehicle crossing the median is also low. Thus, for median widths greater than 60 feet and within the optional area of the figure, a median barrier may or may not be warranted, again depending on the cross-median crash history.

B. Land Service Highways

Careful consideration should be given to the installation of median barriers on land service highways or other highways with partial control of access. Problems are created at each intersection or median crossover because the median barrier must be terminated at these points.

An evaluation of the number of crossovers, crash history, alignment, sight distance, design speed, traffic volume and median width should be made before installation of median barriers on land service highways. Each location should be looked at on a case-by-case basis. A median barrier should be installed if the crash history meets either of the conditions in (1) and (2) above for Interstate and freeways. For the clear zone for median cross over protection on land service highways, see Figure 8-A.

8.4.2 Median Barrier Type

Median barrier type, when warranted, is related to median width as shown in Table 8-6.

Table 8-6

Median Width vs. Median Barrier Type

Median Width	Median Barrier Type
Up to 12 ft.	Concrete Barrier Curb
13 ft. to 26 ft.	Concrete Barrier Curb (Preferred Treatment) or Beam Guide Rail, Dual Faced or Modified Thrie Beam, Dual Faced
Above 26 ft.	Beam Guide Rail, Dual Faced or Modified Thrie Beam, Dual Faced

It is recommended to use modified thrie beam, dual faced in lieu of beam guide rail, dual faced in medians where one of the following occurs:

1. The horizontal radius of the roadway is less than 3,000 feet or there is a split profile with 6H:1V side slopes or steeper creating opposing roadways with different elevations.
2. Guide rail is placed flush with the edge of a shoulder 5 feet or less in width.
3. There are 12 percent or more trucks in the project area.
4. The truck volume is greater than 15,000 vehicles per lane (IE: 4 lane section>60,000 AADT).

On reconstruction projects, existing dual faced beam guide rail in the median shall be replaced with 31 inch high dual faced beam guide rail. However, dual faced thrie

beam guide rail should be installed to replace the existing dual faced beam guide rail when the above criteria are applicable. Existing NCHRP 350 dual faced guide rail (27¼ inch high guide rail with synthetic blockouts) can be left in place if it is less than 20 years old.

It is recommended to use 42" concrete barrier curb in lieu of 32" concrete barrier curb in medians where one of the following occurs:

1. The horizontal radius of the roadway is less than 3,000 feet.
2. There are 12 percent or more trucks in the project area.
3. The truck volume is greater than 15,000 vehicles per lane (IE: 4 lane section>60,000 AADT).

Where barrier curb is used to shield an obstruction (bridge piers, abutments, sign bridges, etc.), a minimum offset of 3.25 feet from the gutter line to the face of the obstruction should be used, since high profile vehicles have a tendency to lean when impacting barrier curb at a high speed (60 mph or greater) and angle (25 degrees) and may strike the obstruction behind it, see Figure 5-K.

8.4.3 Median Barrier Location

Roadside slopes between the traveled way and the median barrier can have a significant effect on the barrier's impact performance. When a vehicle traverses a roadside slope in the median, the vehicle's suspension system can be compressed or extended. As a result, a vehicle that traverses a roadside slope prior to impact with beam guide rail, dual faced beam guide rail or dual faced modified thrie beam guide, a vehicle may go over or under the rail, or snag on the support posts. For concrete barrier curb, a vehicle could go over the barrier, or the barrier could impart an additional roll moment thus increasing the potential for vehicle rollover.

The following guidelines are recommended for the placement of median barriers:

A. Concrete Barrier Curb

Concrete barrier curb is normally placed at or near the centerline of the median. The area between the traveled way and the concrete barrier curb shall be paved and the slope should not exceed 10 percent.

B. Beam Guide Rail, Dual Faced or Modified Thrie Beam, Dual Faced

1. Umbrella Sections

In umbrella sections, dual faced beam guide rail or dual faced modified thrie beam should be placed a minimum of 6 feet from the centerline of the median swale when the median slopes are 10H:1V or flatter (Figure 8-W1). The centerline of the median swale is determined by the centerline of the median inlets.

Existing modified thrie beam guide rail, dual faced may be retained on a 6H:1V side slope, provided the face of rail is installed 6 feet from the centerline of the median swale and a minimum of 12 feet from the slope break with rub rail installed on the swale side of the barrier (Figure 8-W2).

Where medians have 6H:1V side slopes, dual faced beam guide rail or dual faced modified thrie beam shall be installed 2 feet in advance of the slope break with rub rail installed on the swale side of the barrier (Figure 8-W3).

For median slopes that are steeper than 6H:1V, beam guide rail or modified thrie beam shall be place on both sides of the median a minimum of 2 feet in advance of the slope break (Figure 8-W4).

Where the median is on a split profile (opposing roadways constructed with different elevations) and the cross slope from the higher roadway is equal to or greater than 6H:1V, the dual faced beam guide rail or modified thrie beam guide rail should be placed on the high side of the median 2 feet in advance of the slope break with the rub rail installed on the swale side of the barrier (Figure 8-W5).

Where there is insufficient width between the edge of shoulder and the slope break to provide the 2 foot offset, the face of the barrier shall be placed flush with the edge of shoulder and additional post lengths provided in accordance with Table 8-3.

2. Curbed Sections

   Where proposed curb is required in narrow medians, the preferred treatment is to use concrete barrier curb.

3. Existing Curbed Sections

   The preferred treatment for existing unprotected curbed medians up to 26 feet wide is to replace with concrete barrier curb and shoulders. This reduces maintenance costs and keeps drainage out of the lanes.

   If it is not practical to install concrete barrier curb and shoulder, as mentioned above, due to environmental issues do either one of the following:

   a. Convert the curbed section to an umbrella section with dual faced beam guide rail or dual faced modified thrie beam.

   b. Reduce curb height to 4 inches or less and provide dual faced beam guide rail or modified thrie beam at the gutter line on one side of the median.

   In (a) and (b) above, place a nonvegetative surface across the entire median if mowing and trash collection is a problem due to safety and median width.

8.4.4 Emergency and Maintenance U-Turns

Median openings for emergency vehicles are sometimes provided on land service highways, Interstates, and freeways, see Section 6.5.5 for location of emergency U-turns.

Where continuous median crossover protection is provided, a need may arise to provide median U-turns for maintenance vehicles (lawn mowers, etc.). Maintenance U-turns should be provided approximately every 1.5 to 2 miles at bridge piers or overhead sign structures in wide grass medians where no emergency U-turns exist. See Figure 8-K for the design of maintenance vehicle U-turns at bridge piers or overhead sign structures. Do not place these maintenance vehicle U-turns at every bridge pier or overhead sign structure.

8.4.5 Median Barrier End Treatments

A. Crash Cushion

   The approach end of new or existing concrete barrier curb within the median including intersections and openings for emergency vehicles shall be protected with a compressive crash cushion regardless of the posted speed.

   When terminating the trailing end of barrier curb separating same direction traffic or outside the clear zone, a barrier curb tapered end as shown in the *Standard Roadway Construction Detail CD-607-6* should be used.

See Figures 6-J and 6-K for treatment of the concrete barrier curb at median openings.

B. Telescoping Guide Rail End Terminal (TGRET)

1. A telescoping guide rail end terminal (TGRET) shall be used when terminating dual faced beam guide or dual faced modified thrie beam guide rail within a grass median, see Figure 8-J. The designer is advised to check the Department's MASH Qualified Products List (QPL) for terminals that may be used with dual faced beam guide or dual faced modified thrie beam guide rail.
2. A TGRET shall be installed on relatively flat surfaces (8 percent or flatter slope). Use on raised islands or behind curbs is not recommended. If there is a cross slope of more than 8 percent at the telescoping guide rail end terminal location, a leveling pad must be used.
3. All curbs, islands, or elevated objects (delineators, signs) present at the TGRET site and over 2 inches high should be removed. Curbs greater than 2 inches high should be removed a minimum of 75 feet in front of the telescoping guide rail end terminal system and as far back as the rear of the system, and replaced with 2 inch high curb.
4. The designer should check with the manufacturer to determine where the point of redirection occurs. The length of the TGRET is as per the manufacturer's recommendation, see the MASH QPL. See *Standard Roadway Construction Details CD-609-7 and CD-609-7A*.
5. When terminating the approach end of beam guide rail, or modified thrie beam guide rail shielding bridge piers or sign supports in the median (Figure 8-J), a TGRET may be used. A 31'-3" transition will be required when terminating dual faced modified thrie beam guide rail with a telescoping guide rail end terminal. See *Standard Roadway Construction Detail CD-609-7A*.

C. Beam Guide Rail Anchorage

When terminating the trailing end of dual faced beam guide rail or dual faced modified thrie beam guide rail separating same direction traffic, a beam guide anchorage is required as shown in the *Standard Roadway Construction Details CD-609-4* and *CD-609-20.*

8.5 Diversionary Roads (Road Closure with Diversion)

During construction when traffic must be diverted onto the opposing side of a freeway or Interstate highway that is not divided by a barrier curb, the existing guide rail in the median must be revised when the duration of the diversion road will be greater than two weeks. Since traffic will now be traveling in the opposite direction adjacent to the median, existing guide rail lengths may need to be increased. The L.O.N. shall be checked based upon the proposed design speed of the diversionary road and revised if required. See Section 14 for guidance on design speed of diversionary roads. In addition, existing guide rail trailing end treatments shall be upgraded to approach end treatments and bridge attachments Type B shall be converted to Type A. New or reconstructed pylons may be required on some existing bridges to accommodate the Type A attachment.

In addition to the above, when it is anticipated that the diversion road will be in place for 1.5 years or more, new guide rail in the median shall be lapped in the direction of traffic and existing guide rail in the median shall be re-lapped in the direction of

traffic. Also, a clear runout area shall be provided behind new approach flared or tangent terminals in the median.

After the diversionary road is no longer required, the guide rail in the median shall be re-lapped in the direction of traffic if the diversion road has been in place for more than 1.5 years. Furthermore, any additional lengths of guide rail installed in the median due to the diversion should be removed and appropriate end terminals added. However, bridge attachments that were converted to Type A may be retained when the guide rail on the trailing end of the bridge parapet is to remain.

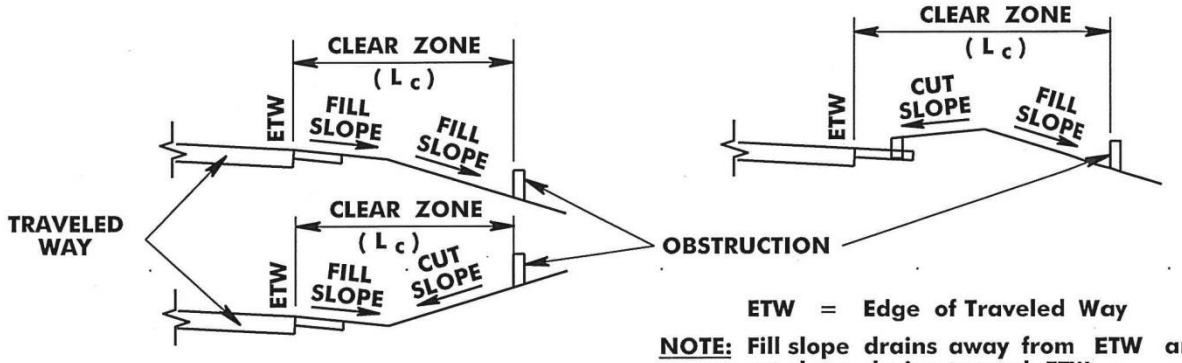
The above requirements also apply to land service highways with grass medians or those separated by development between the opposing roadways when a diversionary road is required.

FIGURE 8–A:
CLEAR ZONE (L_c)

The following table contains the suggested range of clear zone distances on tangent sections of roadway based on selected traffic volumes, speed and roadside slopes:

DESIGN SPEED	DESIGN ADT	CLEAR ZONE DISTANCES (IN FEET FROM EDGE OF THROUGH LANE)				
		FILL SLOPES*		CUT SLOPES		
		6: 1 OR FLATTER	5: 1 TO 4:1	3: 1 OR STEEPER	4: 1 TO 5:1	6: 1 OR FLATTER
40 MPH OR LESS	UNDER 750	7–10	7–10	7–10	7–10	7–10
	750–1,500	10–12	12–14	10–12	10–12	10–12
	1,500–6,000	12–14	14–16	12–14	12–14	12–14
	OVER 6,000	14–16	16–18	14–16	14–16	14–16
45 – 50 MPH	UNDER 750	10–12	12–14	8–10	8–10	10–12
	750–1,500	14–16	16–20	10–12	12–14	14–16
	1,500–6,000	16–18	20–26	12–14	14–16	16–18
	OVER 6,000	20–22	24–28	14–16	18–20	20–22
55 MPH	UNDER 750	12–14	14–18	8–10	10–12	10–12
	750–1,500	16–18	20–24	10–12	14–16	16–18
	1,500–6,000	20–22	24–30	14–16	16–18	20–22
	OVER 6,000	22–24	26–32	16–18	20–22	22–24
60 MPH	UNDER 750	16–18	20–24	10–12	12–14	14–16
	750–1,500	20–24	26–32	12–14	16–18	20–22
	1,500–6,000	26–30	32–40	14–18	18–22	24–26
	OVER 6,000	30–32	36–44	20–22	24–26	26–28
65 – 70 MPH	UNDER 750	18–20	20–26	10–12	14–16	14–16
	750–1,500	24–26	28–36	12–16	18–20	20–22
	1,500–6,000	28–32	34–42	16–20	22–24	26–28
	OVER 6,000	30–34	38–46	22–24	26–30	28–30

* See RDM Section 8.2.4 for fill slopes 3:1 to 4:1



ETW = Edge of Traveled Way

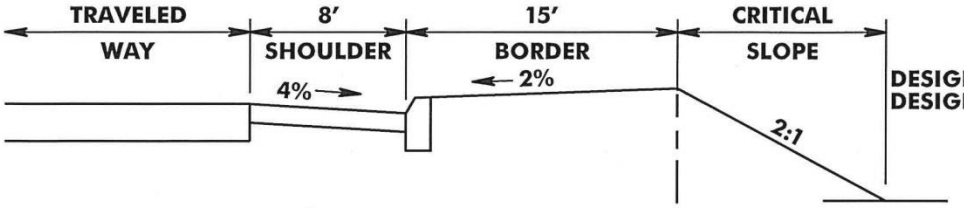
NOTE: Fill slope drains away from ETW and cut slope drains toward ETW.

FILL AND CUT SLOPES

SOURCE: "Chapter 3: Roadside Topography and Drainage Features." Roadside Design Guide, 4th Edition, AASHTO, 2011 and Errata Sheet Dated July 2015

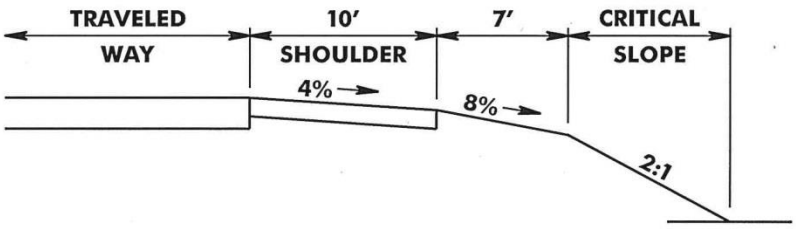
MAY 2017

FIGURE 8–B1:
CLEAR ZONE EXAMPLES



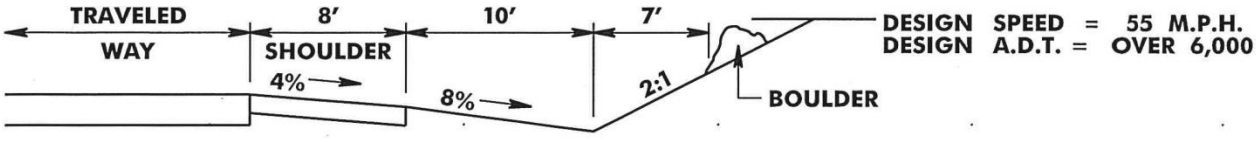
The suggested clear zone distance for the 2% slope (See Figure 8–A, Cut Slope, 6:1 or flatter) = 20–22 feet.

The available 23 feet is 1 to 3 feet greater than the suggested recovery area, therefore, the critical slope (2:1) is outside the clear zone.



The suggested clear zone distance for the 8% slope (See Figure 8–A, Fill Slope, 6:1 or flatter) = 30–32 feet.

The available 17 feet is 13 to 15 feet less than the suggested recovery area, therefore, the critical slope (2:1) is inside the clear zone.



The suggested clear zone distance for the 8% slope (See Figure 8–A, Fill Slope, 6:1 or flatter) = 22–24 feet. The available 18 feet to the channel is 4 to 6 feet less than the suggested recovery area for the fill slope. The channel is not within the preferred cross section area of Figure 8–U, but to the boulder there is 25 feet available, which is 1 to 3 feet outside the clear zone for the fill slope. Since the channel bottom and backslope are free of obstructions within the clear zone, guide rail is not required.

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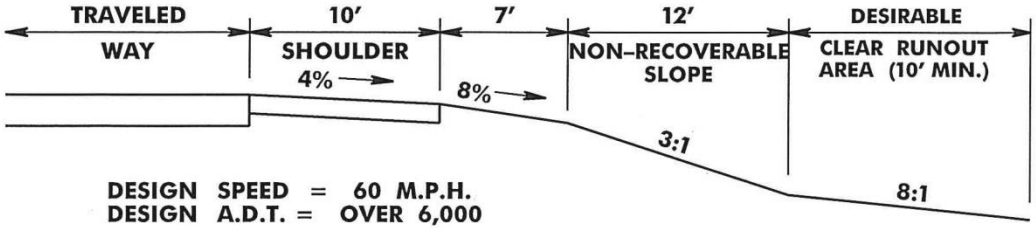
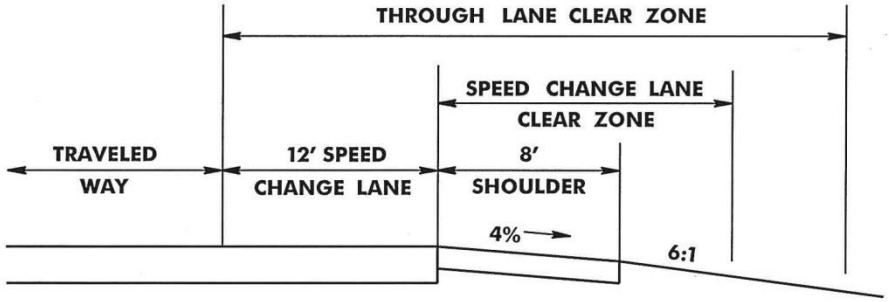
FIGURE 8–B2:
CLEAR ZONE EXAMPLES



DESIGN SPEED = 60 M.P.H.
DESIGN A.D.T. = OVER 6,000

The suggested clear zone distance for the 8:1 slope in the clear runout area (See Figure 8–A, Fill Slope 6:1 or flatter) = 30–32 feet. The recovery distance before breakpoint of non–recoverable slope = 17 feet. Therefore the desirable clear runout area is : 30–32 feet minus 17 feet = 13 to 15 feet. If the calculated clear runout area is less than 10′, a minimum 10′ clear runout area should be provided.



DESIGN SPEED = 60 M.P.H. (THROUGH LANE),
45 M.P.H. (SPEED CHANGE LANE)
DESIGN A.D.T. = OVER 6,000 (THROUGH LANE)
LESS THAN 750 (SPEED CHANGE LANE)

The suggested clear zone distance for the 6:1 slope (See Figure 8–A, Fill Slope, 6:1 or flatter) = 30–32 feet for the through lane and 10–12 feet for the speed change lane. Measured from the through lane, the speed change lane total is 22–24 feet (10–12 feet plus the 12′ speed change lane width). The design clear zone is the greater of the two clear zones (in this case, 30–32 feet). Design speeds for speed change lanes are obtained from Figure 6–H.

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FIGURE 8–C:
HORIZONTAL CURVE ADJUSTMENTS FOR CLEAR ZONE

The clear zone widths obtained from Figure 8–A should be increased on the outside of curves. The amount of increase can be determined by the following table:

RADIUS (Ft.)	Kcz (CURVE CORRECTION FACTOR) DESIGN SPEED, MPH						
	40	45	50	55	60	65	70
2,950	1.1	1.1	1.1	1.2	1.2	1.2	1.2
2,300	1.1	1.1	1.2	1.2	1.2	1.2	1.3
1,970	1.1	1.2	1.2	1.2	1.3	1.3	1.4
1,640	1.1	1.2	1.2	1.3	1.3	1.3	1.4
1,475	1.2	1.2	1.3	1.3	1.4	1.4	1.5
1,315	1.2	1.2	1.3	1.3	1.4	1.4	
1,150	1.2	1.2	1.3	1.4	1.5	1.5	
985	1.2	1.3	1.4	1.5	1.5	1.5	
820	1.3	1.3	1.4	1.5			
660	1.3	1.4	1.5				
495	1.4	1.5					
330	1.5						

$$CZc = (Lc)\,(Kcz)$$

CZc = CLEAR ZONE ON OUTSIDE OF HORIZONTAL CURVE, FEET.
Lc = CLEAR ZONE DISTANCE FROM FIGURE 8–A, FEET.
Kcz = CURVE CORRECTION FACTOR.

NOTE:

Clear zone correction factor is applied to outside of horizontal curves only. Curves flatter than 2,950 ft. do not require an adjusted clear zone. Also, adjustments are not necessary for design speeds less than 40 MPH.

SOURCE: "Chapter 3: Roadside Topography and Drainage Features." Roadside Design Guide, 4th Edition, AASHTO, 2011

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FIGURE 8–D:
ROADSIDE RECOVERY AREA AT FLARED AND TANGENT TERMINALS

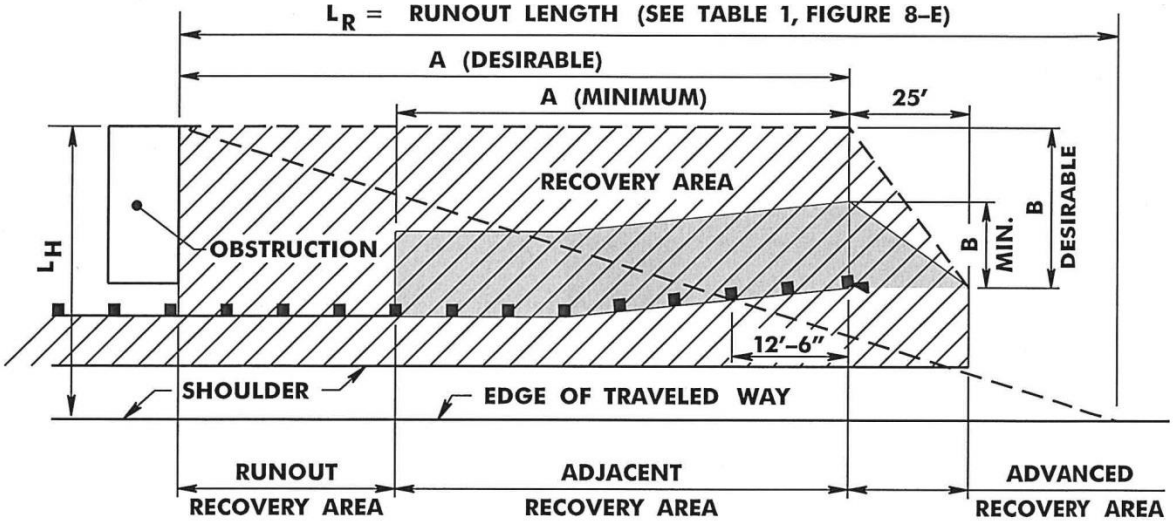

TABLE 1

MINIMUM ADJACENT RECOVERY AREA BEHIND GUIDE RAIL (SHADED AREA)

Design Speed (mph)	A (ft.)	B (ft.) See Note C
40 or less	50	10
45	55	12
50	60	15
55	65	18
60 or greater	75	20

NOTES

A. No fixed objects should be within the crosshatched area. Desirably, dimension (A) should equal the L.O.N. plus 12'–6", and dimension (B) should extend from the face of the terminal to the offset L_H (See Note B). When it is not practical to provide a roadside recovery area behind the guide rail based on the desirable dimensions, the minimum adjacent recovery area dimensions in Table 1 may be used along with the advanced recovery area.

B. If dimension (B) extends the area to be cleared beyond the R.O.W. line or L_H, the roadside recovery area should extend to the R.O.W. line when L_H is outside of the R.O.W. line, and no further than L_H when L_H is within the R.O.W. line.

C. If the typical lateral roadside recovery area in advance of the terminal is smaller than shown in Table 1, a lesser value for dimension (B) may be used but it should be consistent with that available elsewhere along the roadway.

D. See RDM Section 8.2.4.B.2 for discussion on utility placement.

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FIGURE 8–E:
APPROACH LENGTH OF NEED ON EMBANKMENT (FILL) SLOPE

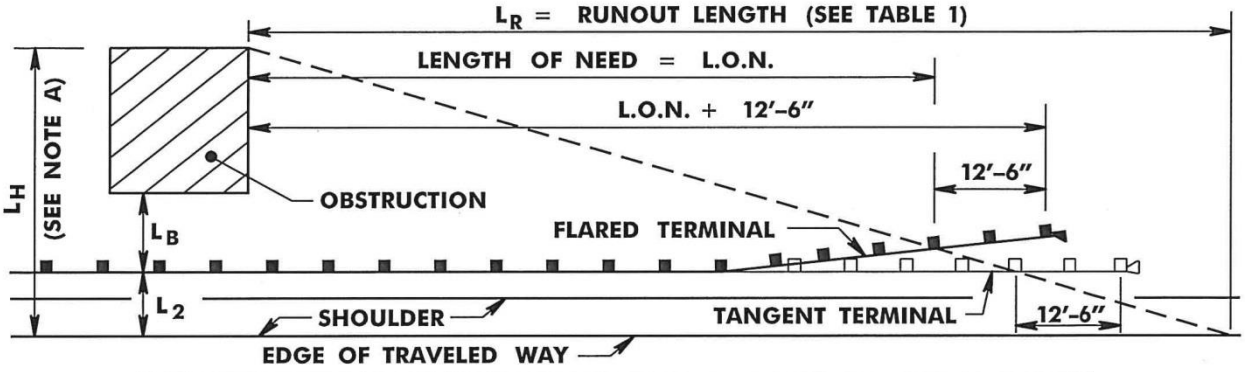

TABLE 1

DESIGN SPEED (M.P.H.)	TRAFFIC VOLUME (A.D.T.) OVER 10,000 L_R	5,000 TO 10,000 L_R	1,000 TO 5,000 L_R	UNDER 1,000 L_R	SHY LINE OFFSET (FEET)	STRAIGHT FLARE RATE
70	360	330	290	250	9	15:1
60	300	250	210	200	8	14:1
55	265	220	185	175	7	12:1
50	230	190	160	150	6.5	11:1
45	195	160	135	125	6	10:1
40	160	130	110	100	5	8:1
30	110	90	80	70	4	7:1

STEP 1. Determine the required L.O.N. for:

FLARED TERMINAL

$$L.O.N. = \frac{L_R\ (L_H - L_2 - 2.7)}{L_H}$$

TANGENT TERMINAL

$$L.O.N. = \frac{L_R\ (L_H - L_2)}{L_H}$$

NOTE A. If the obstruction extends beyond the clear zone, make L_H equal to the clear zone, except if the obstruction is a critical slope, See Figure 8–H.

NOTE B. If the roadway is curved, draw the layout to scale and obtain L.O.N. directly by scaling from the drawing.

STEP 2. Increase the L.O.N. to the nearest multiple of 12′–6″ (length of one rail element).

STEP 3. Add an additional 12′–6″ to get the required length from the obstruction to the approach end of the flared or tangent terminal.

STEP 4. Compare the required length from Step 3 to the minimum length in Table 2 and to the minimum recovery area length from Figure 8–D, Table 1. Use the greater of the three lengths.

TABLE 2

DISTANCE FROM FACE OF RAIL ELEMENT TO OBSTRUCTION (L_B)	MINIMUM LENGTH BASED ON POST SPACING (NOTE C) FLARED TERMINAL	TANGENT TERMINAL
$L_B \geq 4'$	43′–9″	50′–0″
$2.5' \leq L_B < 4'$	75′–0″	62′–6″
$1.5' \leq L_B < 2.5'$	81′–3″	68′–9″

NOTE C: Minimum distance from the obstruction to the approach end of terminal for standard and reduced post spacing. See CD–609–8.1.

NOTE D: The total length of a freestanding guide rail installation including the approach and trailing end treatments should not be less than 75′. See Figure 8–02 for min. approach guide rail transition lengths.

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FIGURE 8–F:
GRADING TREATMENT AT FLARED AND TANGENT TERMINALS

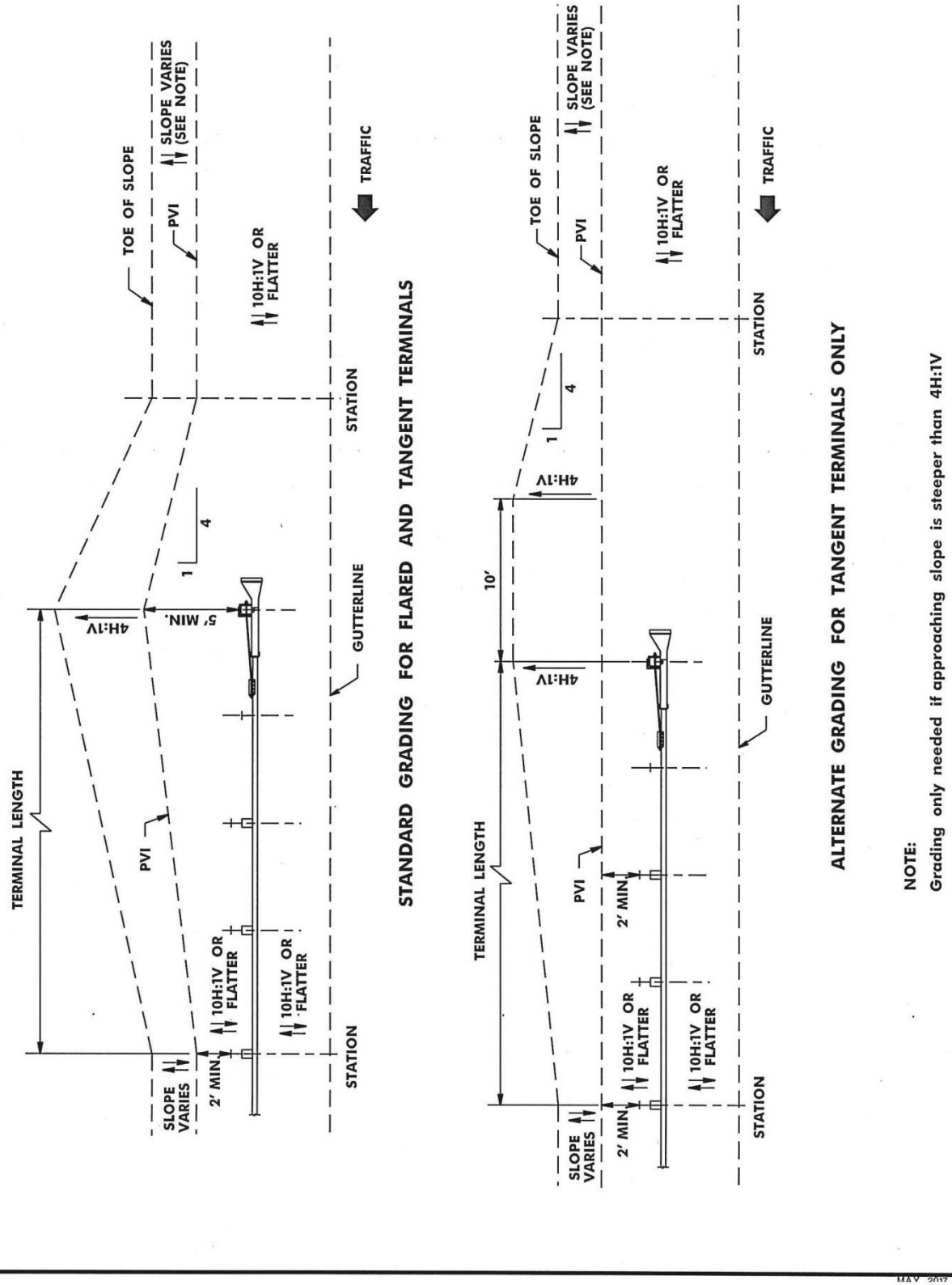

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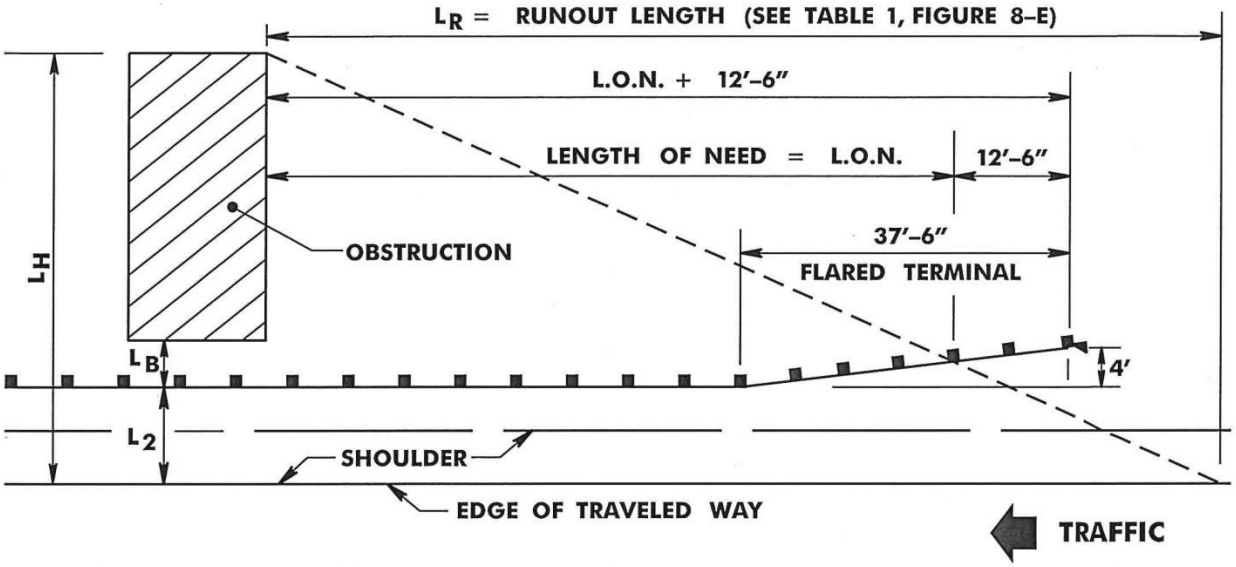
FIGURE 8–G:
EXAMPLE OF APPROACH LENGTH OF NEED ON EMBANKMENT (FILL) SLOPES



EXAMPLE

DESIGN SPEED = 70 MPH
TANGENT ROADWAY
A.D.T. = 7000
L_B = 4′
L_H = 22′
L_R = 330′
L_2 = 16′

STEP 1. $$\text{L.O.N.} = \frac{L_R\,(L_H - L_2 - 2.7')}{L_H}$$

$$\text{L.O.N.} = \frac{330'\,(22' - 16' - 2.7')}{22'}$$

L.O.N. = 49.5′

STEP 2. Increase 49.5′ to nearest multiple of 12′–6″, L.O.N. = 50′.

STEP 3. Add an additional 12′–6″ to get required L.O.N. including the terminal, use L.O.N. + 12.5′ = 62.5′.

STEP 4. From Figure 8–D, the minimum recovery area length is 75′. Since L.O.N. + 12.5′ is less than 75′, use 75′.

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FIGURE 8–H:
GUIDE RAIL TREATMENT FOR CRITICAL EMBANKMENT SLOPES

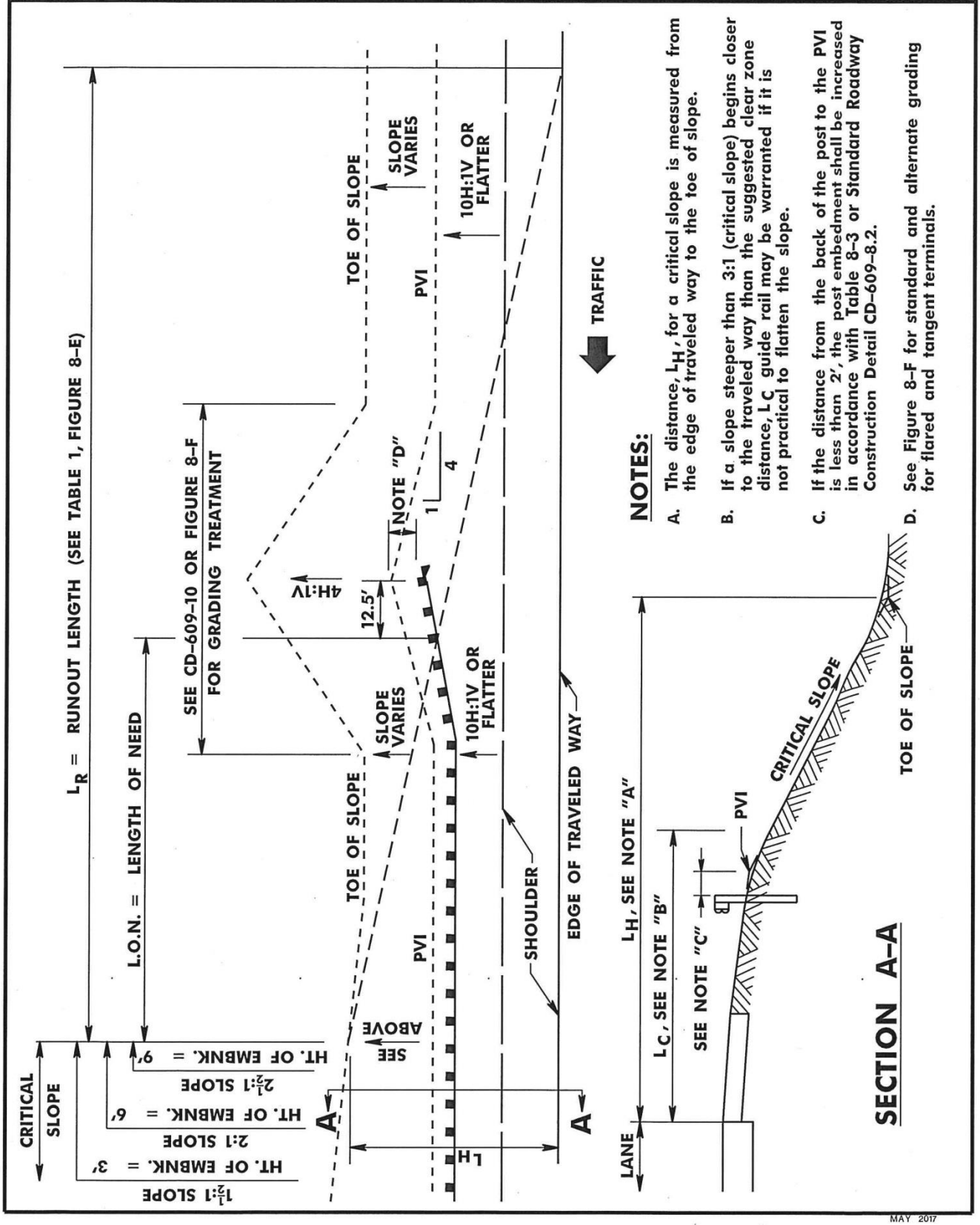
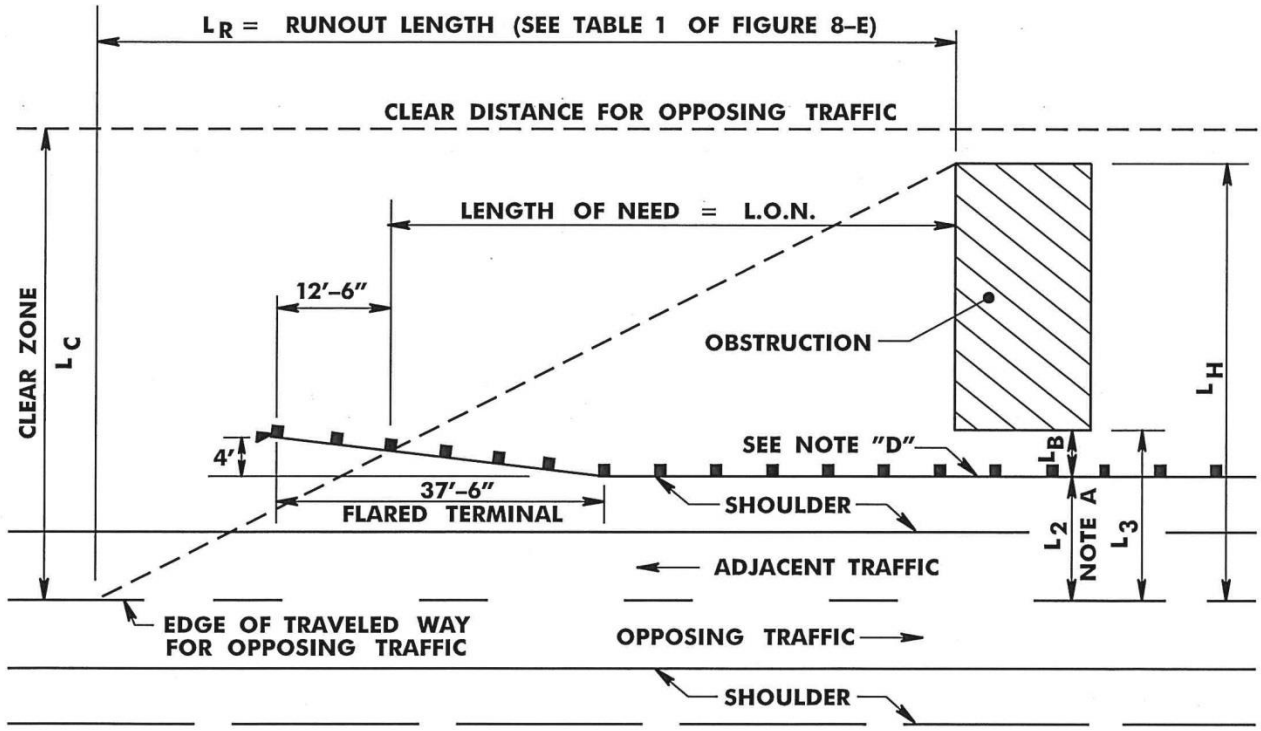


FIGURE 8–I1:
APPROACH LENGTH OF NEED FOR OPPOSING TRAFFIC ON EMBANKMENT (FILL) SLOPES

CONDITION 1. $L_2 > L_C$:
If guide rail is outside the clear zone (L_C), no additional guide rail or approach end treatment is required. Use beam guide rail anchorage as shown in Figure 8–I2 and the Standard Roadway Construction Details.

CONDITION 2. $L_2 < L_C$ and $L_3 > L_C$:
If guide rail is within the clear zone, but the obstruction is beyond it, use a flared or tangent terminal with the minimum recovery length (A) shown in Table 1, Figure 8–D.

CONDITION 3. $L_3 < L_C$:
If the obstruction is within the clear zone (L_C), see below. Use variables as shown below and Steps 1 through 4 as shown in Figure 8–E to determine the required L.O.N.



NOTES:

A. L_2 shall be measured from the outside edge of the approaching traffic lane where passing is permitted.

B. If there is a traversable median separating traffic, the median width should be included when determining L_2, L_3, and L_H for opposing traffic.

C. For a divided highway with a nontraversable median, use a beam guide rail anchorage as shown in Figure 8–I2 and the Standard Roadway Construction Details.

D. Where the distance from the obstruction to the face of the rail element (L_B) is less than 4', See Standard Roadway Construction Detail CD–609–8 for post spacing requirements. Under Condition 2 & 3 above, the post spacing requirements apply to both the approach and the trailing end.

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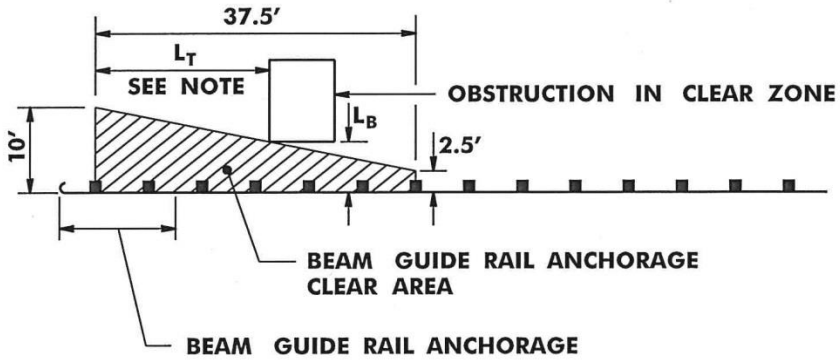
FIGURE 8–I2:
BEAM GUIDE RAIL ANCHORAGE CLEAR AREA



NOTE:

Where a beam guide rail anchorage is used to terminate guide rail past an obstruction, the guide rail should be extended so that the obstruction is outside of the anchorage clear area. The distance from the last post of the beam guide rail anchorage to the obstruction shall not be less than 12′–6″. See Table 1.

TABLE 1

DISTANCE FROM FACE OF RAIL TO OBSTRUCTION (L_B) *	MINIMUM DISTANCE FROM LAST POST OF ANCHORAGE TO THE OBSTRUCTION (L_T)
2.5′ OR LESS	37.5′
3′	35′
4′	30′
5′	25′
6′	20′
7′	15′
7.5′ OR GREATER	12.5′

*** Where clearance from the face of rail to the obstruction is less than 4′, reduced post spacing is required. See Standard Roadway Construction Details.**

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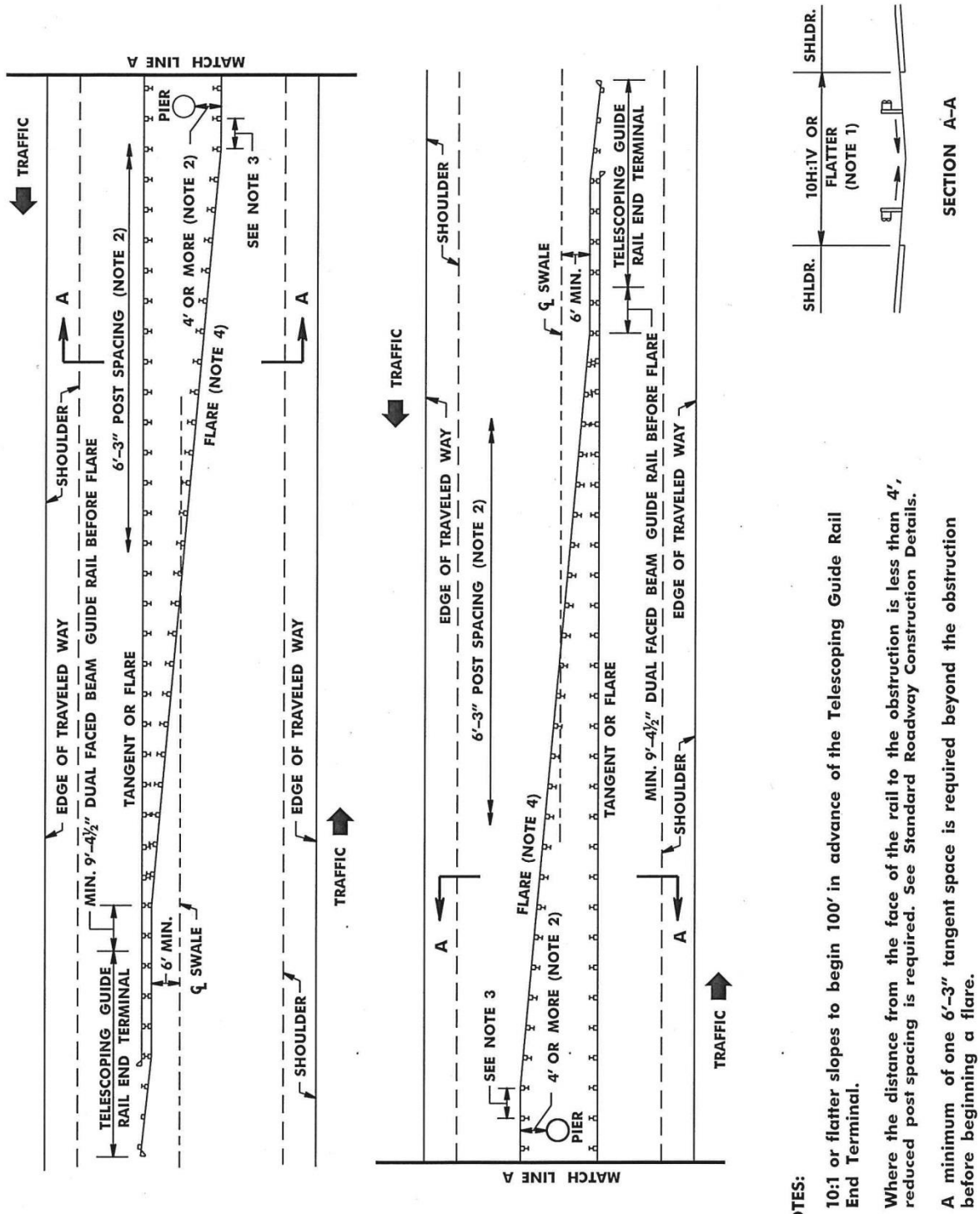
FIGURE 8–J:
TELESCOPING GUIDE RAIL END TERMINAL IN MEDIAN



NOTES:

1. 10:1 or flatter slopes to begin 100′ in advance of the Telescoping Guide Rail End Terminal.
2. Where the distance from the face of the rail to the obstruction is less than 4′, reduced post spacing is required. See Standard Roadway Construction Details.
3. A minimum of one 6′–3″ tangent space is required beyond the obstruction before beginning a flare.
4. See Figure 8–E, Table 1 for maximum flare rate.

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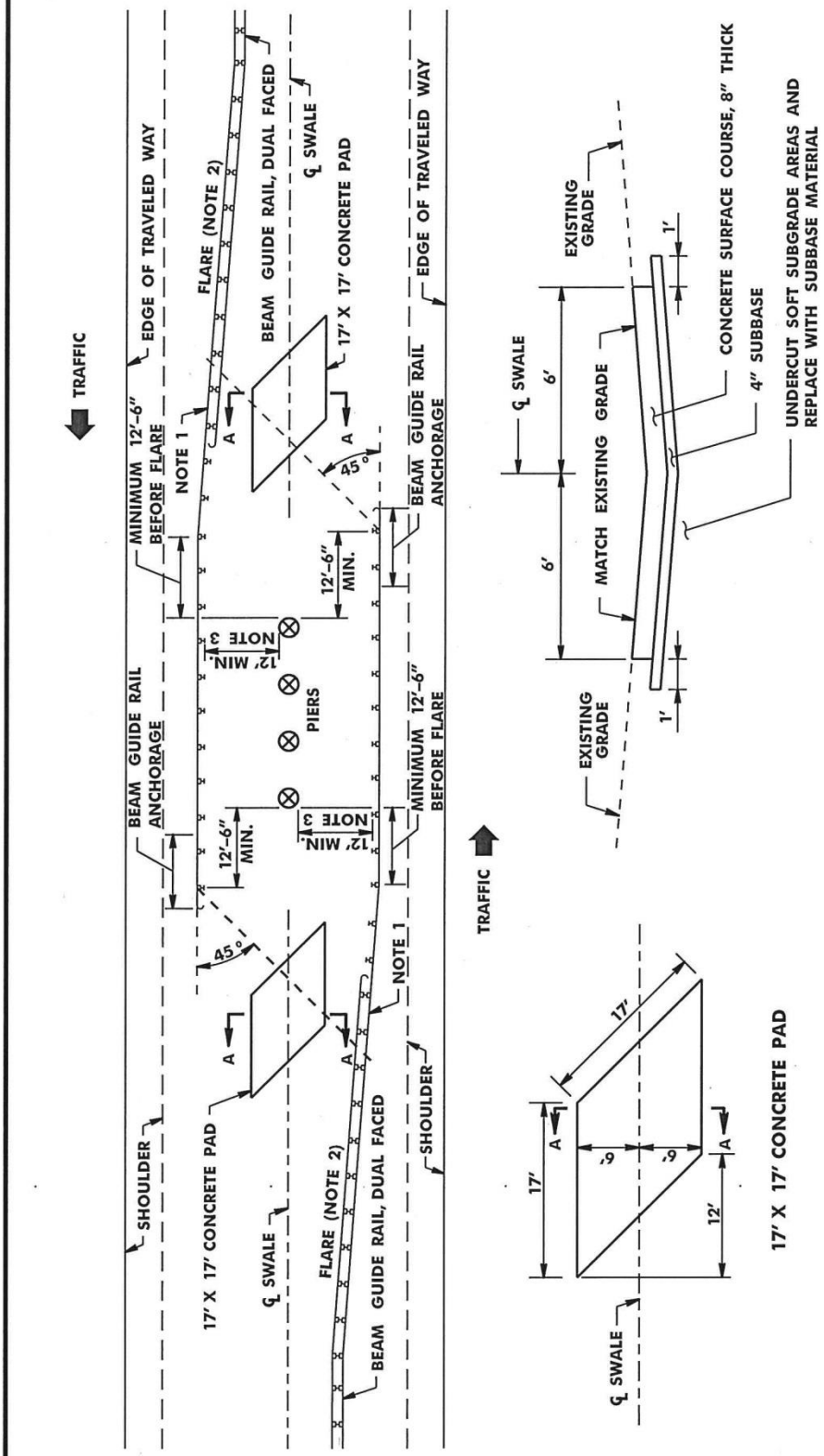
FIGURE 8–K:
OVERLAPPING MEDIAN GUIDE RAIL WITH CONCRETE PAD FOR MAINTENANCE VEHICLE U–TURN



NOTES:

1. Extend dual faced guide rail a minimum of one 6'–3" space (two posts) beyond a 45 degree line extending from the last post of the beam guide rail anchorage.
2. See Figure 8–E, Table 1, for maximum flare rate.
3. A 12' minimum offset from back of guide rail post to face of pier is required for operational U–turns.
4. Use an SU turn template to locate concrete pad on swale.
5. Locate concrete pad on plan by station.

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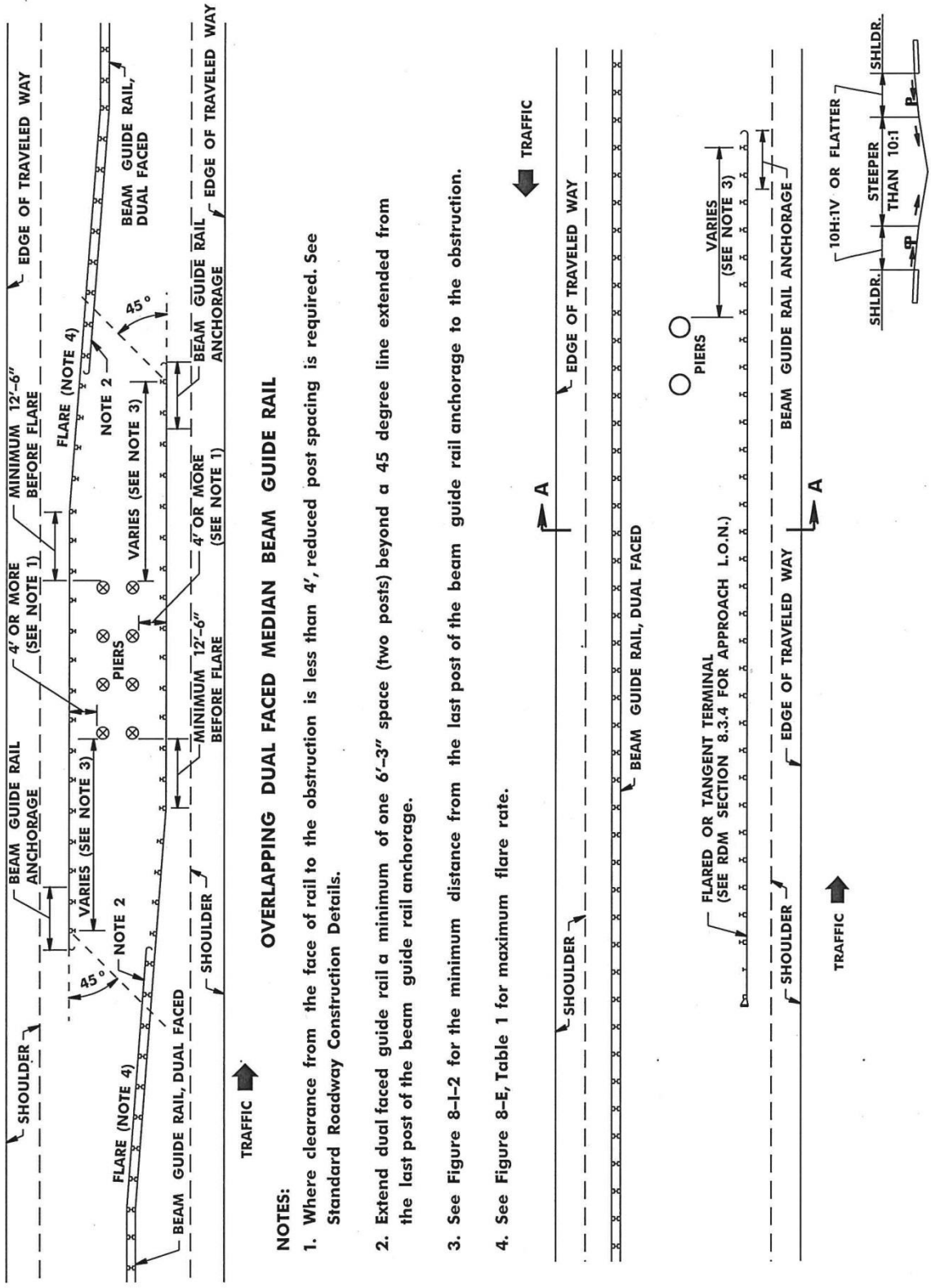
FIGURE 8–L:
DUAL FACED MEDIAN GUIDE RAIL TREATMENTS



NOTES:

1. Where clearance from the face of rail to the obstruction is less than 4', reduced post spacing is required. See Standard Roadway Construction Details.
2. Extend dual faced guide rail a minimum of one 6'–3" space (two posts) beyond a 45 degree line extended from the last post of the beam guide rail anchorage.
3. See Figure 8–I–2 for the minimum distance from the last post of the beam guide rail anchorage to the obstruction.
4. See Figure 8–E, Table 1 for maximum flare rate.

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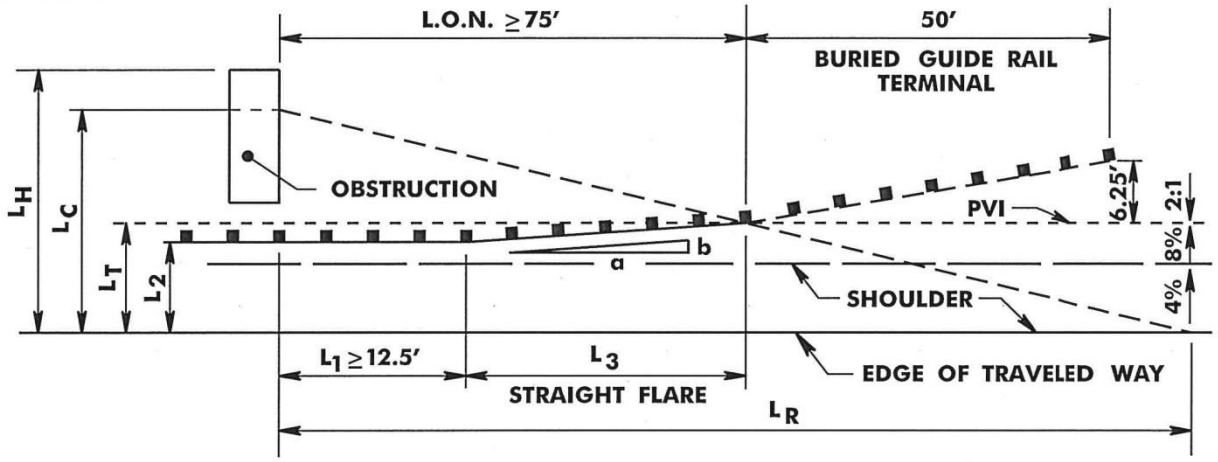
FIGURE 8–M:
APPROACH LENGTH OF NEED FOR BURIED GUIDE RAIL TERMINAL

Where an obstruction is encountered in a cut section and it is to be shielded with a buried guide rail terminal, it is desirable that the length of need (L.O.N.) end at the PVI (See Figure 8–N for additional details). In order to accomplish this, the length of guide rail parallel to the PVI (L_1) must be obtained. The following example shows how the L.O.N. is computed:

EXAMPLE



V = 60 MPH

A.D.T. = 6,000

L_2 = 16′

L_H = 32′

L_R = 250′ (from Figure 8–E, Table 1)

L_T = 19′

$\frac{a}{b}$ = 14:1 straight flare (from Figure 8–E, Table 1)

L_C = 30′ (from Figure 8–A, L_C = 26′– 30′) for 8% fill slope

If $L_H > L_C$ use L_C in formula below, If $L_H < L_C$, replace L_C with L_H in formula below

$$L_1 = L_R - \frac{L_R L_T}{L_C} - \frac{a}{b}(L_T - L_2)$$

$$L_1 = 250 - \frac{250 \times 19}{30} - \frac{14}{1}(19 - 16) = 49.7'$$

49.7′/6.25′ post spacing = 7.95 posts, therefore, use 8 posts at 6.25′ = 50′ = L_1

Flare length $L_3 = \frac{a}{b}(L_T - L_2) = \frac{14}{1}(19 - 16) = 42'$

42′/6.25′ post spacing = 6.72 posts, therefore, use 7 posts at 6.25′ = 43.75′ = L_3

L.O.N. = $L_1 + L_3$ = 50′ + 43.75′ = 93.75′

The minimum L.O.N. as shown in the Figure above = 75′.

Since L.O.N. is greater than 75′, use L.O.N. = 93.75′

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FIGURE 8–N:
BEAM GUIDE RAIL TREATMENT FOR BURIED GUIDE RAIL TERMINAL

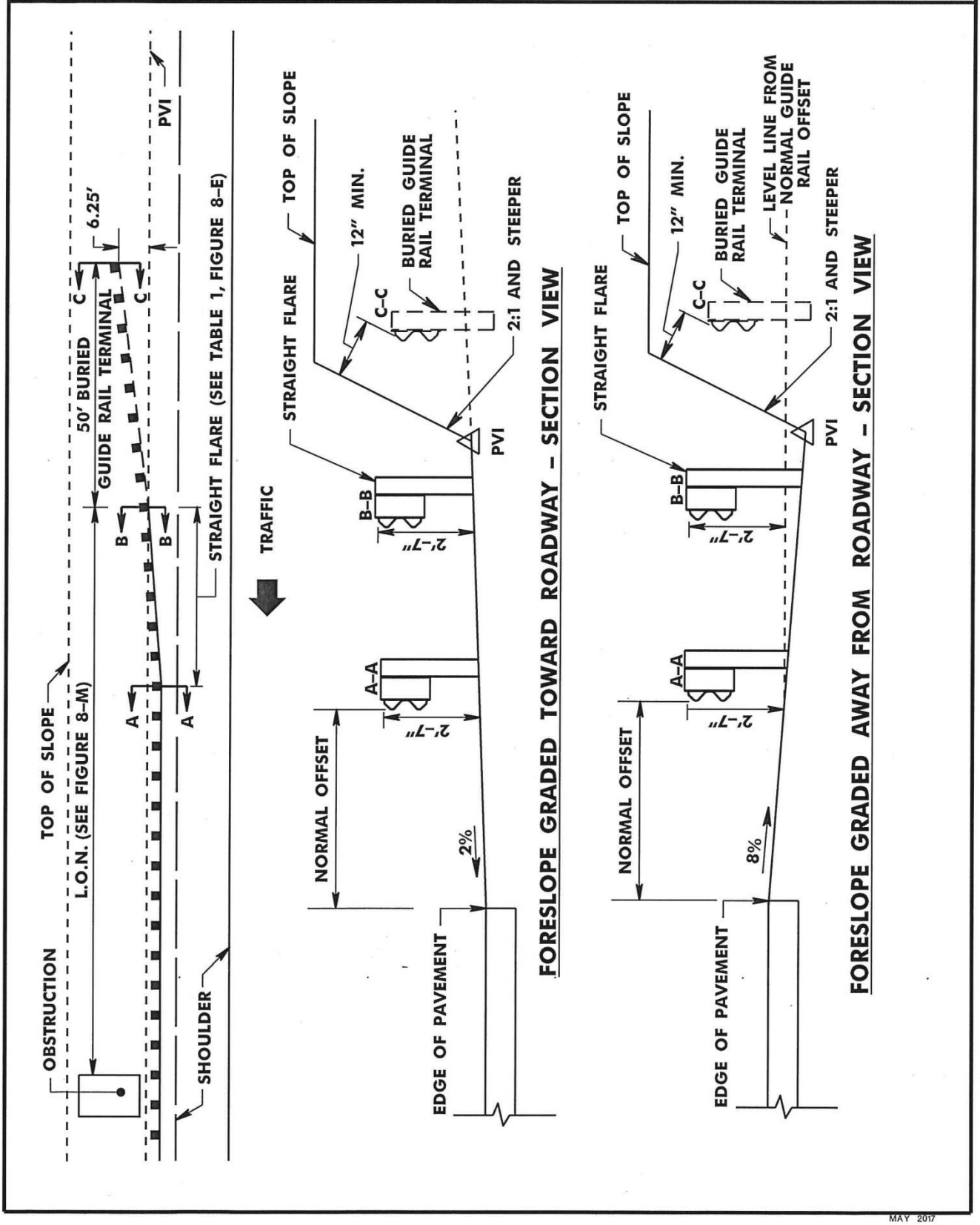

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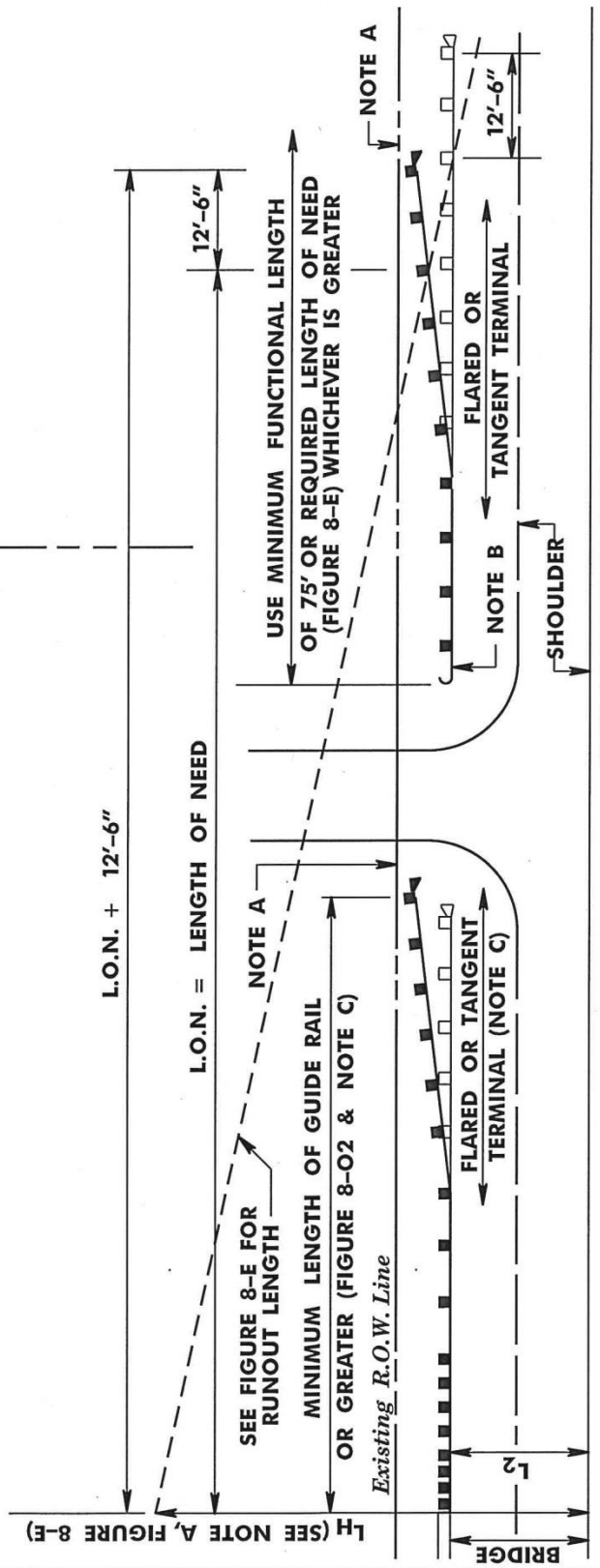
FIGURE 8–O1:
EXAMPLE OF GUIDE RAIL TREATMENT AT DRIVEWAY LOCATED WITHIN LENGTH OF NEED



Step 1. Determine L.O.N., see Figure 8–E.

Step 2. If driveway falls within L.O.N., relocate driveway as far away from obstruction as the property line allows. See the New Jersey Highway Access Management Code for the minimum driveway offset to property line (lot line).

Step 3. If driveway still falls within L.O.N., use treatments shown in Figures 8–O1 or 8–P1. If driveway falls outside L.O.N., design guide rail as shown in Figure 8–E.

Step 4. Check sight distance at driveway, see Figure 6–A. Draw the line of sight for vehicle exiting driveway. Position guide rail at driveway so it does not interfere with line of sight.

NOTES

A. The grading treatment at an end terminal (Figure 8–F) may require slope easement parcels.

B. End terminal or anchorage, see Figure 8–I1. If an end terminal is required, a tangent terminal is preferred, however, a flared terminal may be required to obtain proper sight distance for vehicles exiting the driveway.

C. A flared terminal is preferred, however, a tangent terminal may be used. If you cannot fit the minimum length for the approach guide rail transition and a flared or tangent terminal, try using Figure 8–P1 or a crash cushion.

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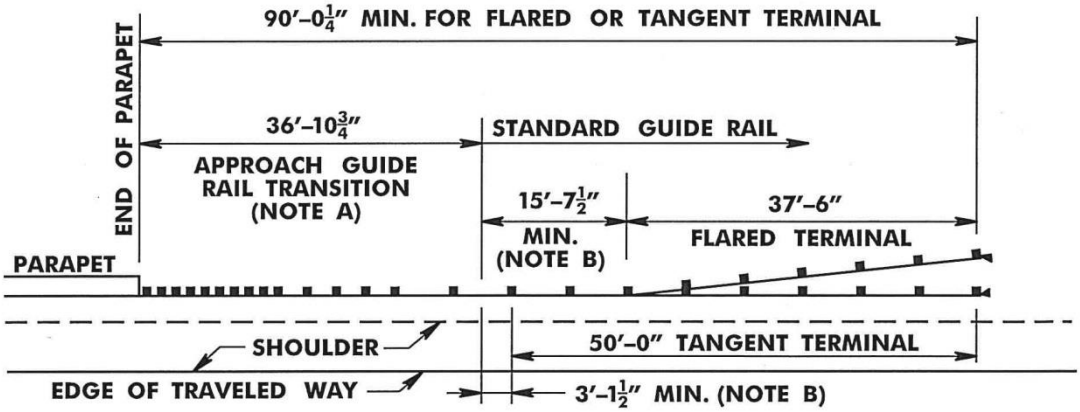
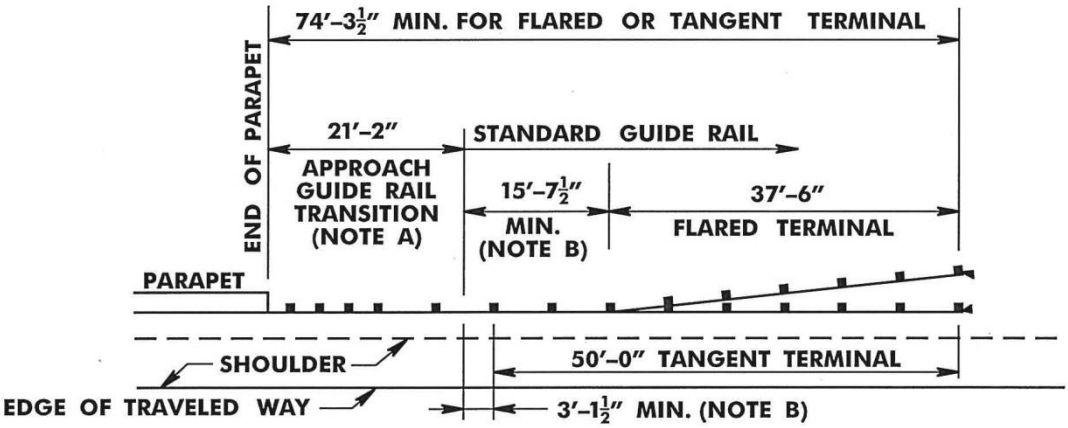
FIGURE 8–02:
APPROACH GUIDE RAIL TRANSITION
MINIMUM LENGTH OF GUIDE RAIL



DESIGN SPEED GREATER THAN 45 MPH (TL–3)



DESIGN SPEED 45 MPH OR LESS (TL–2)

NOTES

A. See Standard Roadway Construction Details.

B. Any multiple of 6′–3″ may be added to the minimum length if a longer length of guide rail is required.

C. The designer should indicate the type of attachment on the plans (TL–2 or TL–3).

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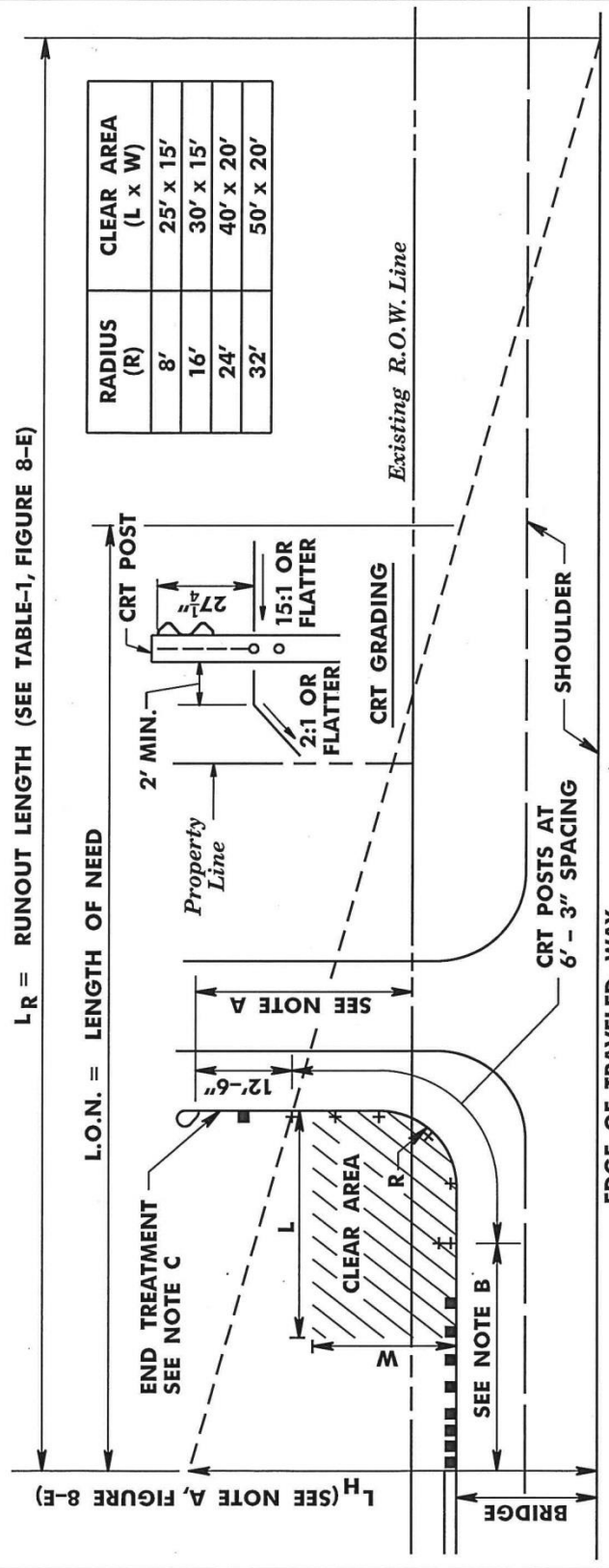
FIGURE 8–P1:
EXAMPLE OF A CONTROLLED RELEASE TERMINAL AT DRIVEWAY LOCATED WITHIN LENGTH OF NEED



STEP 1: See steps 1 to 3 in Figure 8–O1. If there is insufficient length for Figure 8–O1, try using Figure 8–P1 or a crash cushion.

NOTES

A. A Right of Way fee parcel is required for the guide rail system and grading outside the R.O.W. line. A construction and maintenance easement parcel is required for the clear area outside the R.O.W. line. If the guide rail system ties into existing guide rail outside the R.O.W. line, then a construction and maintenance easement is required for the guide rail system, grading, and clear area.

B. Approach guide rail transition or standard guide rail or as required. A minimum 25′ vertical transition is required between the approach guide rail transition or standard guide rail to transition from a 31″ rail height to a 27.25″ rail height for the Controlled Release Terminal. For bridge attachments see Figure 8–P2 for minimum lengths of guide rail.

C. Where the driveway is 'in only' or the exit driveway speed is 25 M.P.H or less, use the Controlled Release Terminal Anchorage. Where the exit speed is greater than 25 M.P.H., use a flared or tangent terminal.

D. This guide rail treatment is not applicable where sidewalk is located behind guide rail.

E. For hardware information and each CRT radius design, see CD–609–6. These designs are based on an intersecting angle of 90 degrees. If field conditions vary considerably from 90 degrees, a special detail shall be made of the curved guide rail section so that the curved rails will fit the driveway or intersection geometry and that only full sections of rail element will be shop bent for installation.

F. If curb or raised berm is present and cannot be removed, see Section 8.3.2.D.1.

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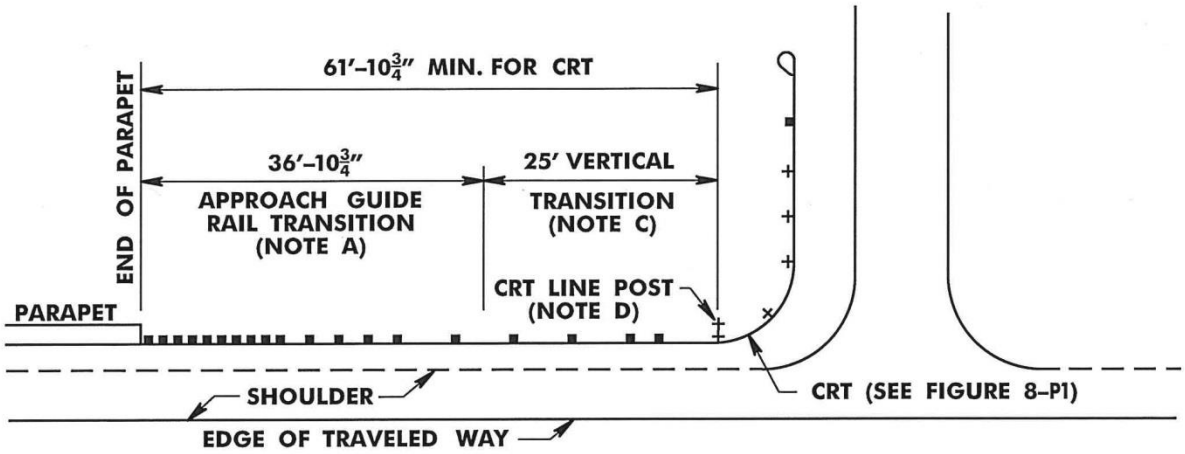
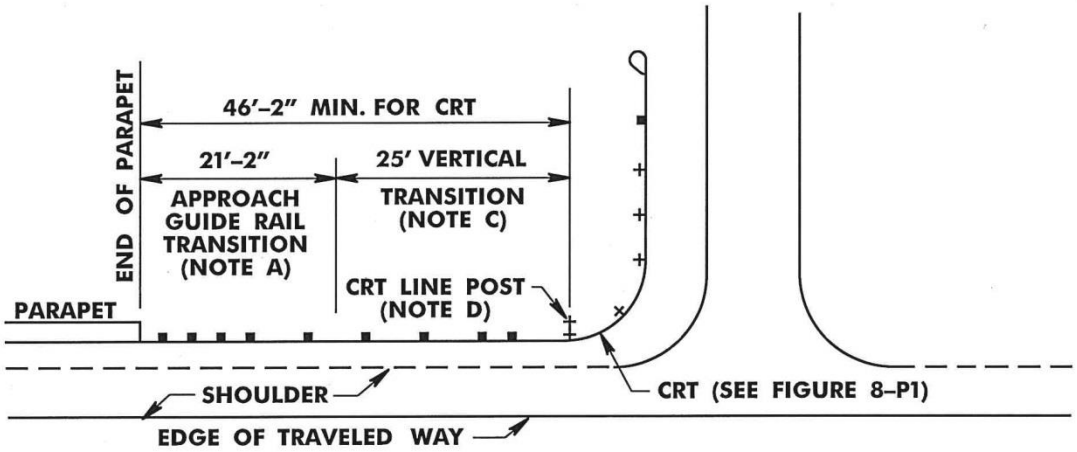
FIGURE 8–P2:
APPROACH GUIDE RAIL TRANSITION
MINIMUM LENGTH OF GUIDE RAIL FOR CRT



DESIGN SPEED GREATER THAN 45 MPH (TL–3)



DESIGN SPEED 45 MPH OR LESS (TL–2)

NOTES

A. See Standard Roadway Construction Details.

B. The designer should indicate the type of attachment on the plans (TL–2 or TL–3).

C. A minimum 25′ vertical transition is required to transition from a 31″ rail height for standard guide rail to a 27.25″ rail height for the CRT. See CD–609–6.

D. See CD–609–6 for location of CRT line post for various CRT radii.

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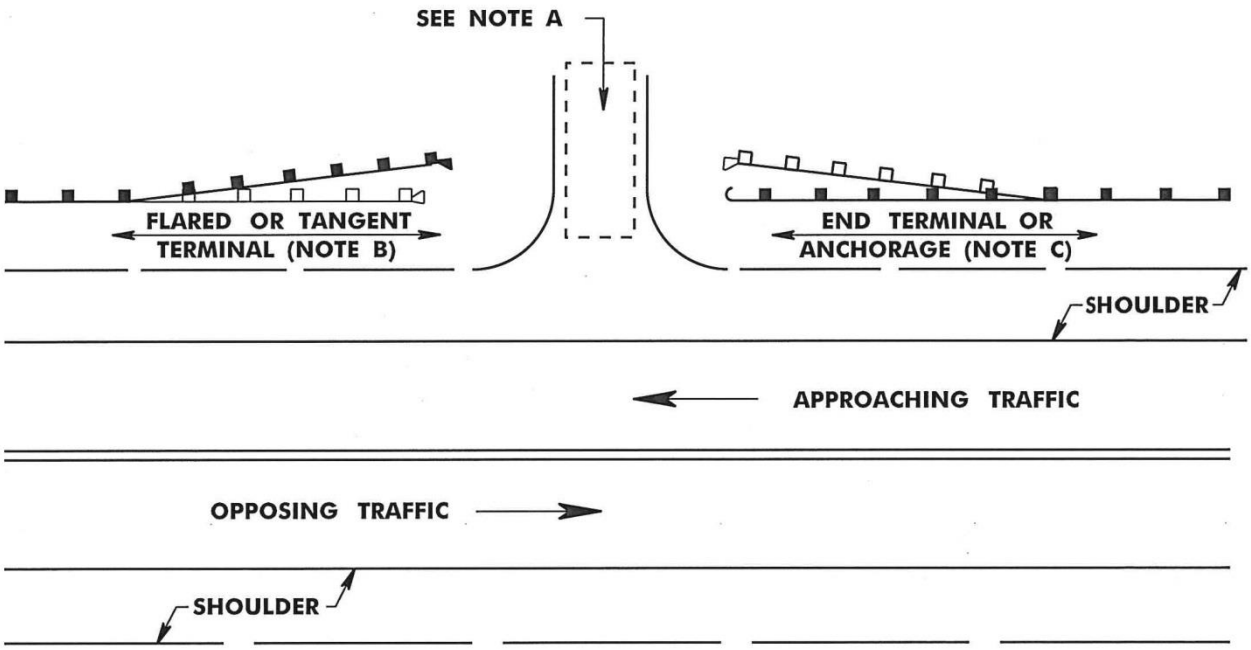
FIGURE 8–Q:
EXAMPLE OF A TREATMENT AT DRIVEWAY OPENING LOCATED WITHIN A CONTINUOUS GUIDE RAIL RUN



NOTES

A. Check sight distance at driveway, see Figure 6–A. Draw a line of sight for vehicle exiting driveway. Position guide rail at driveway so it does not interfere with the line of sight.

B. A flared terminal is preferred, however, a tangent terminal may be used. The slope treatment at a flared terminal may require slope easement parcels. See Figure 8–F for standard and alternate grading for flared and tangent terminals.

C. End terminal or anchorage, see Figure 8–I1. If an end terminal is required, a tangent terminal is preferred, however, a flared terminal may be required to obtain proper sight distance for vehicles exiting the driveway.

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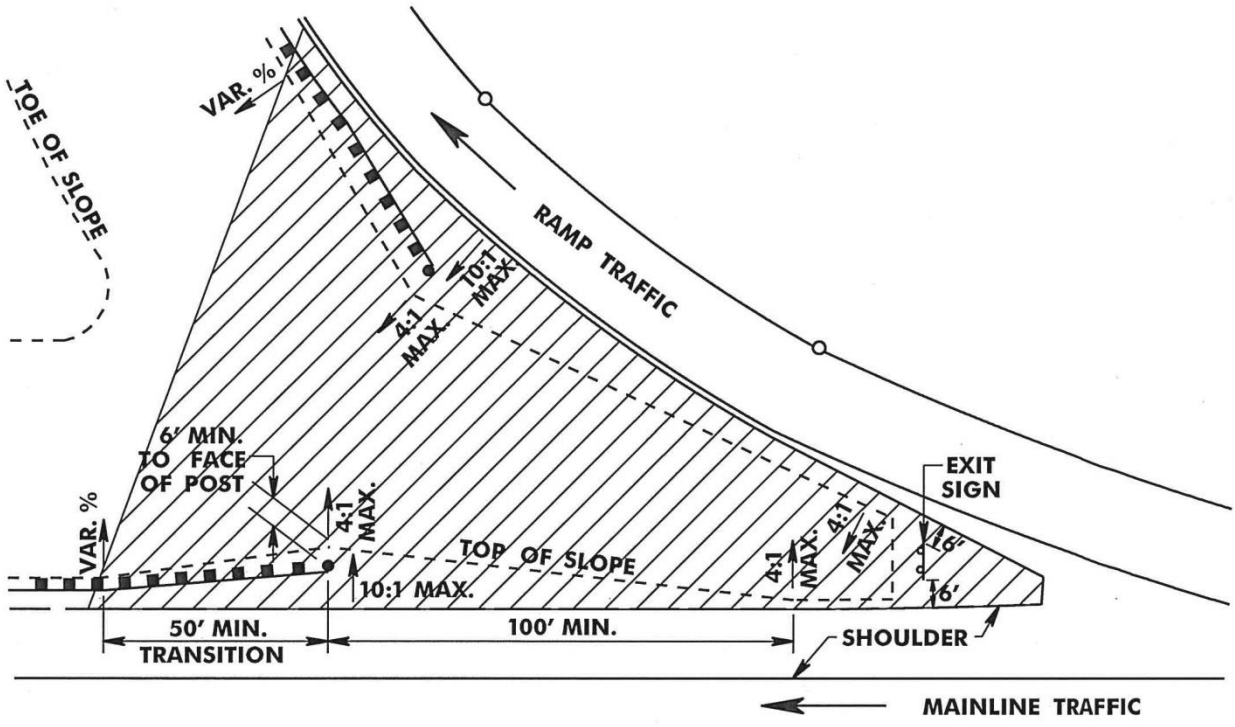
FIGURE 8–R:
GUIDE RAIL TREATMENT EXAMPLES FOR OPEN GORE AREAS



NOTE
See Figure 8–E, Table 1 for straight flare rate.

RECOVERY AREA

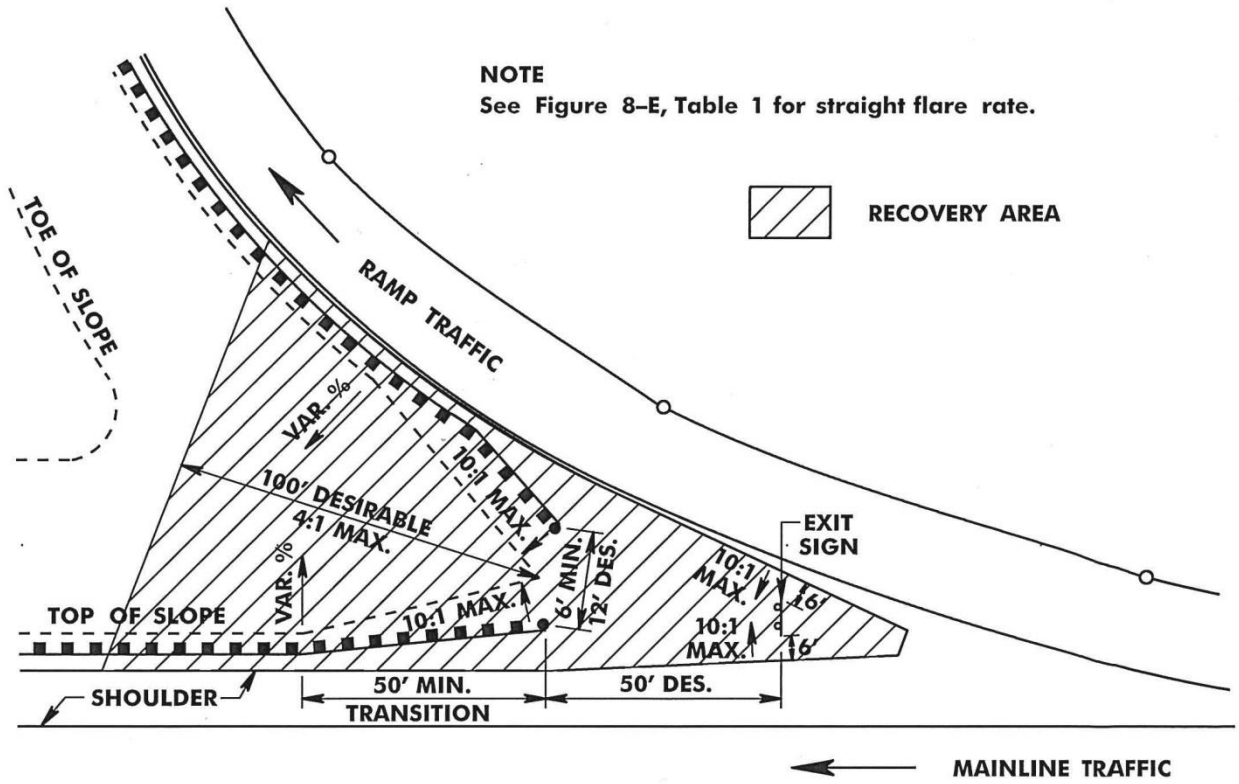


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FIGURE 8–S:
GUIDE RAIL TREATMENT EXAMPLES FOR LIMITED GORE AREAS

END TREATMENT		
TYPE	LENGTH (L)	WIDTH
CRASH CUSHION	SEE SECT. 9	2′ MIN.
TELESCOPING GUIDE RAIL END TERMINAL (SEE CD–609–7)	37.5′	2.4′

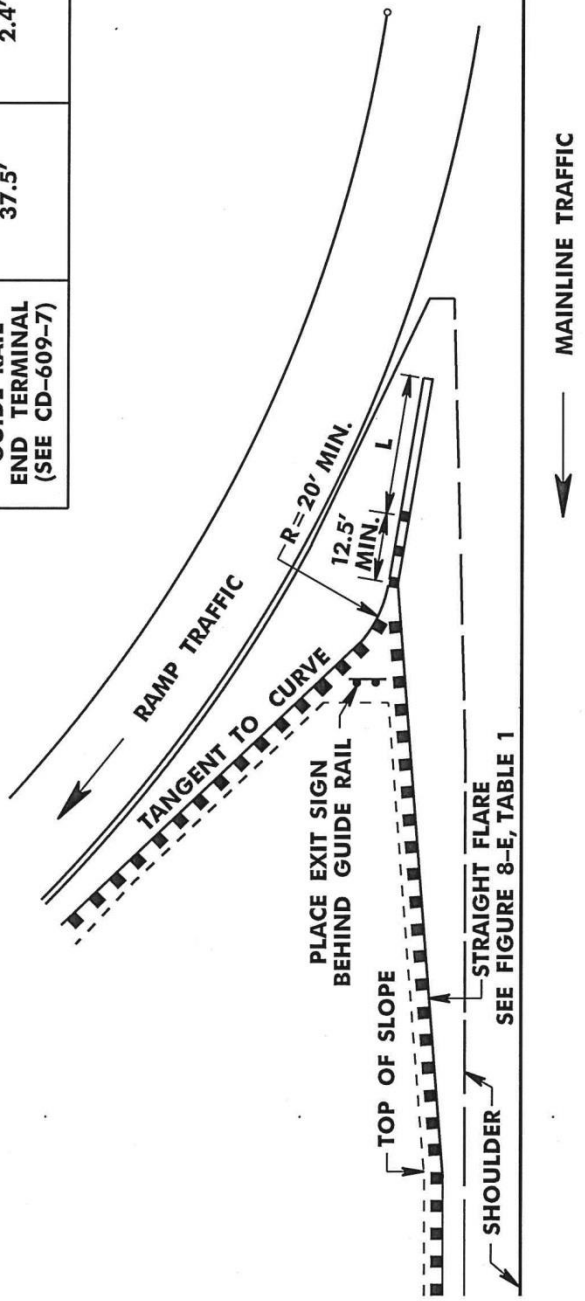

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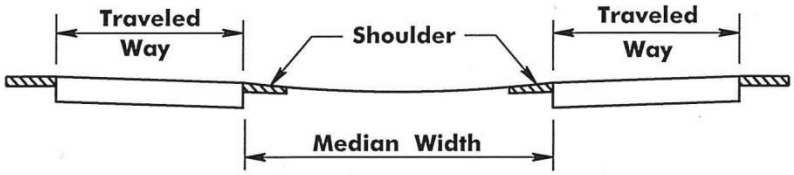
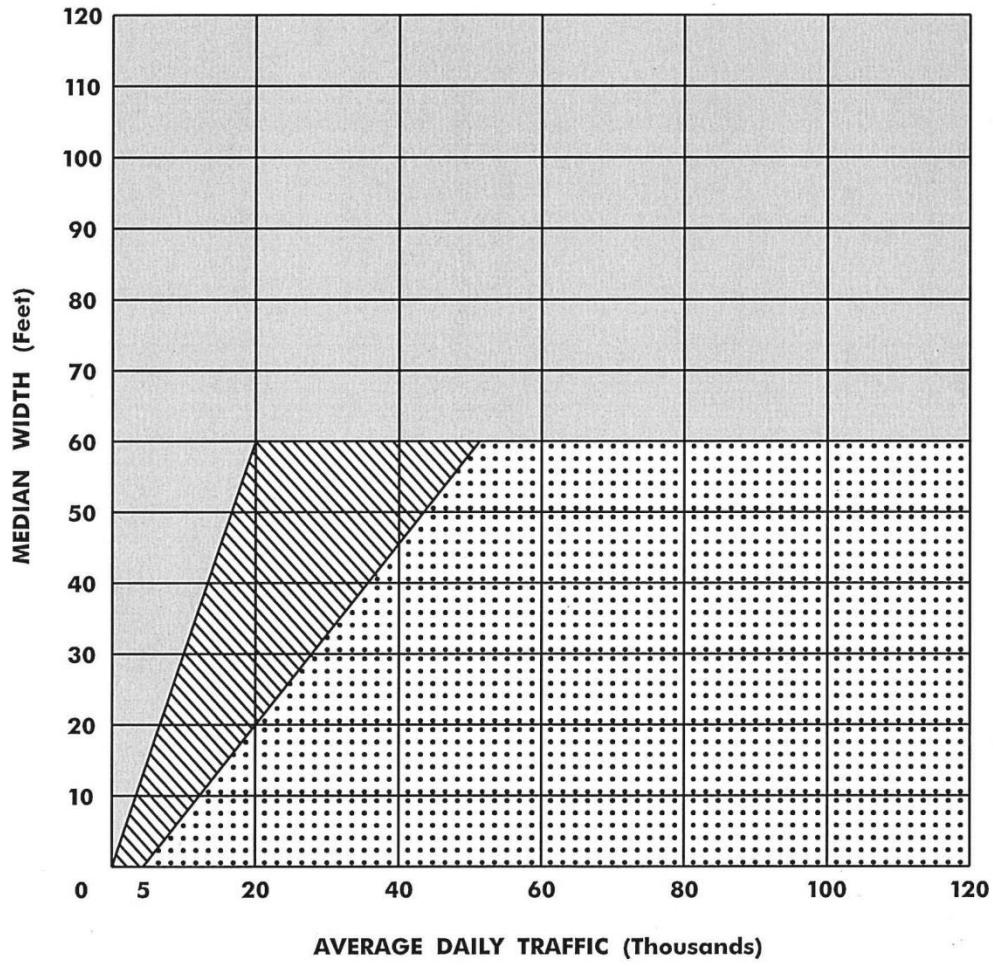
FIGURE 8–T:
WARRANTS FOR MEDIAN BARRIER FOR FREEWAYS AND EXPRESSWAYS





Warranted

Warranted within 1 mile of interchange

Optional

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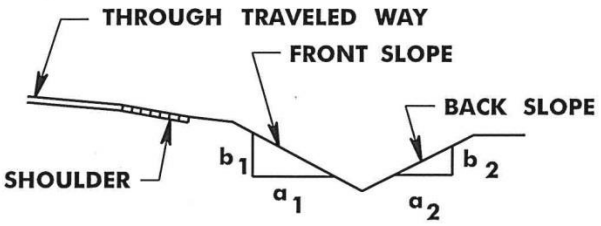
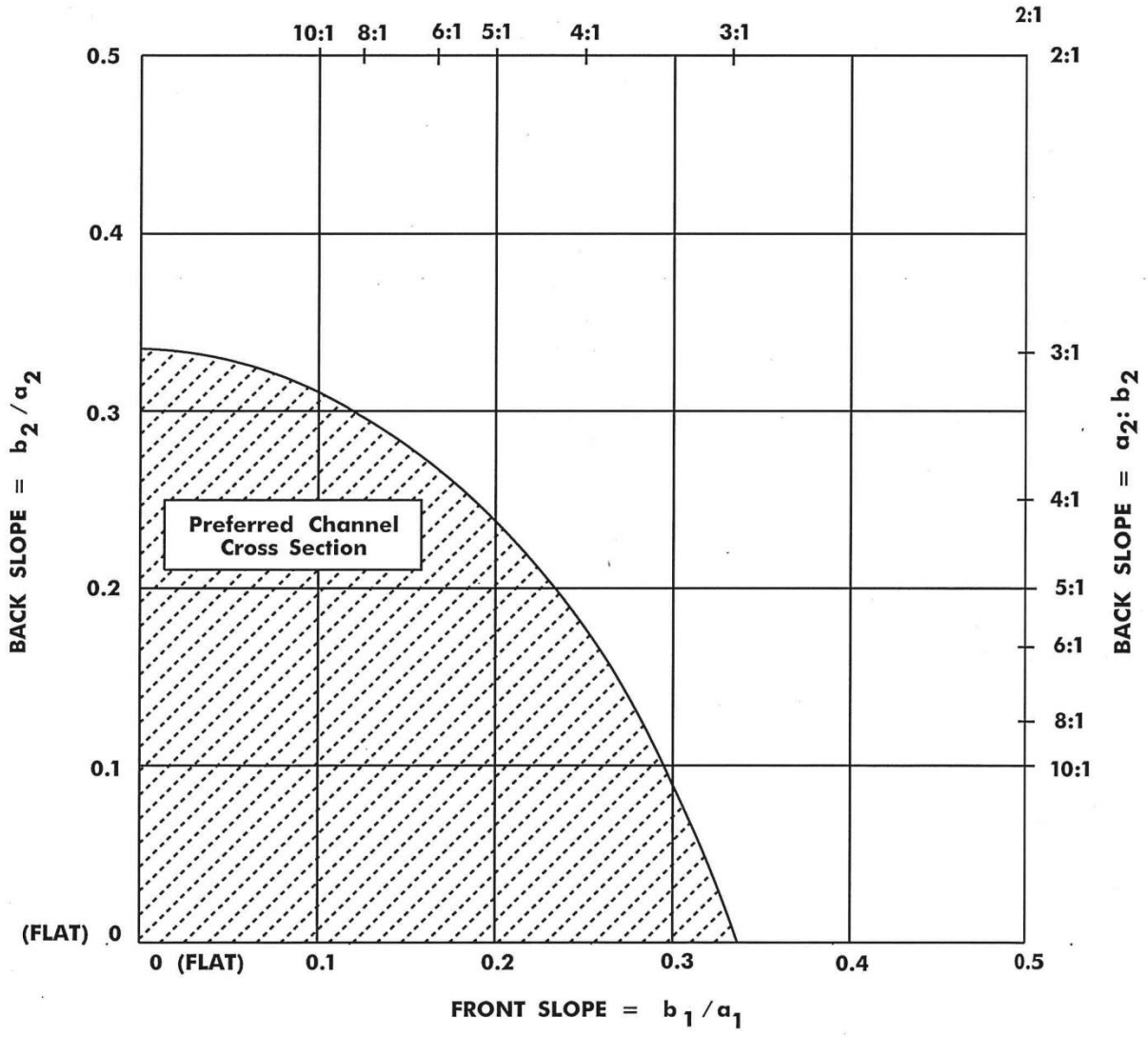
FIGURE 8–U:
PREFERRED CROSS SECTIONS FOR CHANNELS WITH ABRUPT SLOPE CHANGES



FRONT SLOPE = $a_1 : b_1$



NOTE:

This chart is applicable to all vee ditches, rounded channels with bottom widths less than 8 feet, and trapezoidal channels with bottom widths less than 4 feet.

SOURCE: "Chapter 3: Roadside Topography and Drainage Features." Roadside Design Guide, 4th Edition, AASHTO, 2011

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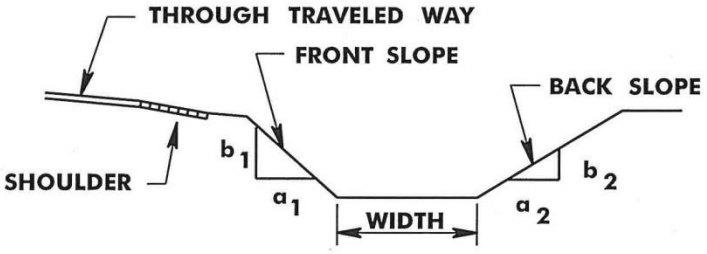
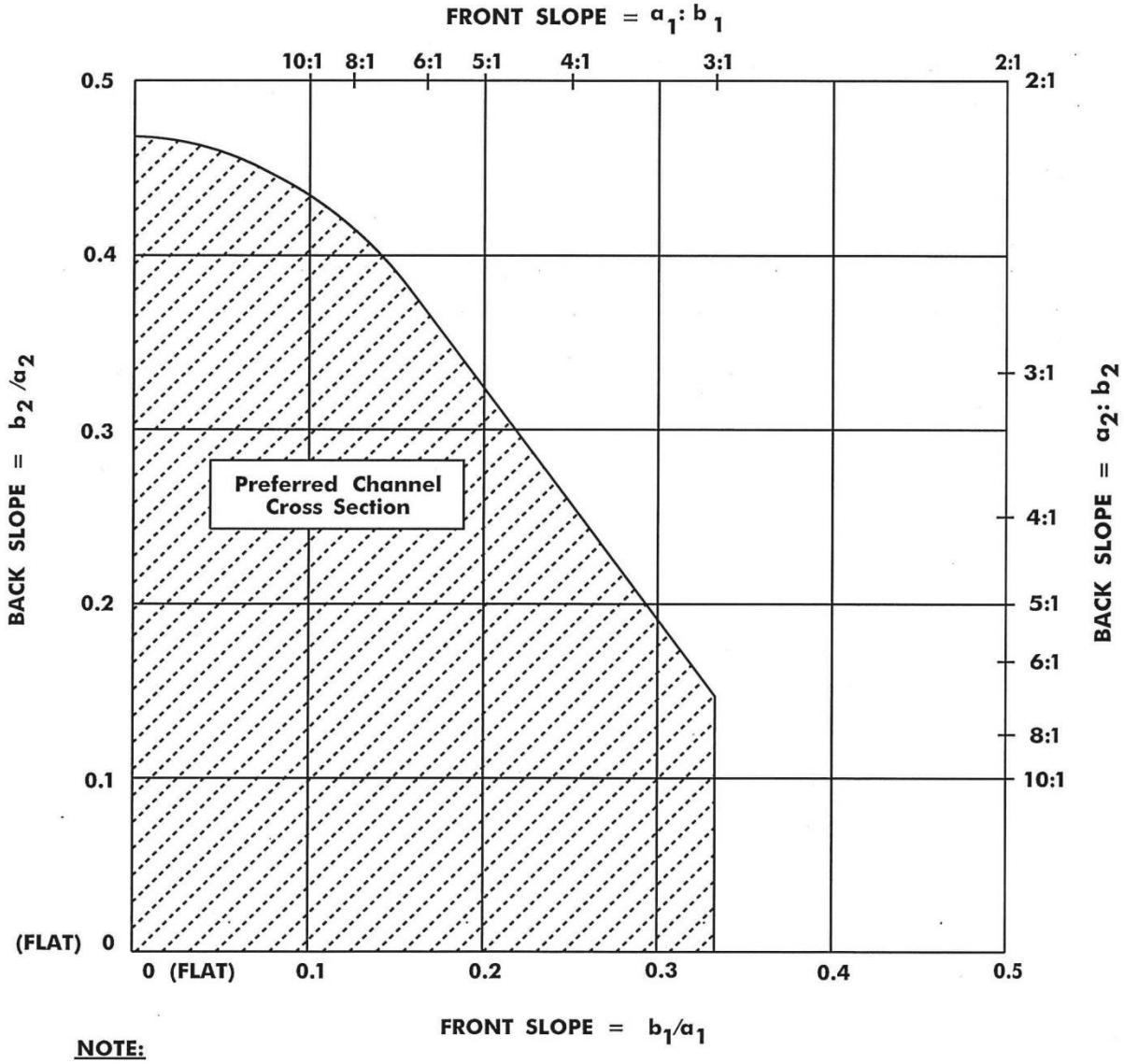
FIGURE 8–V:
PREFERRED CROSS SECTIONS FOR CHANNELS WITH GRADUAL SLOPE CHANGES





NOTE:

This chart is applicable to rounded channels with bottom widths of 8 feet or more, and to trapezoidal channels with bottom widths equal to or greater than 4 feet.

SOURCE: "Chapter 3: Roadside Topography and Drainage Features." Roadside Design Guide, 4th Edition, AASHTO, 2011

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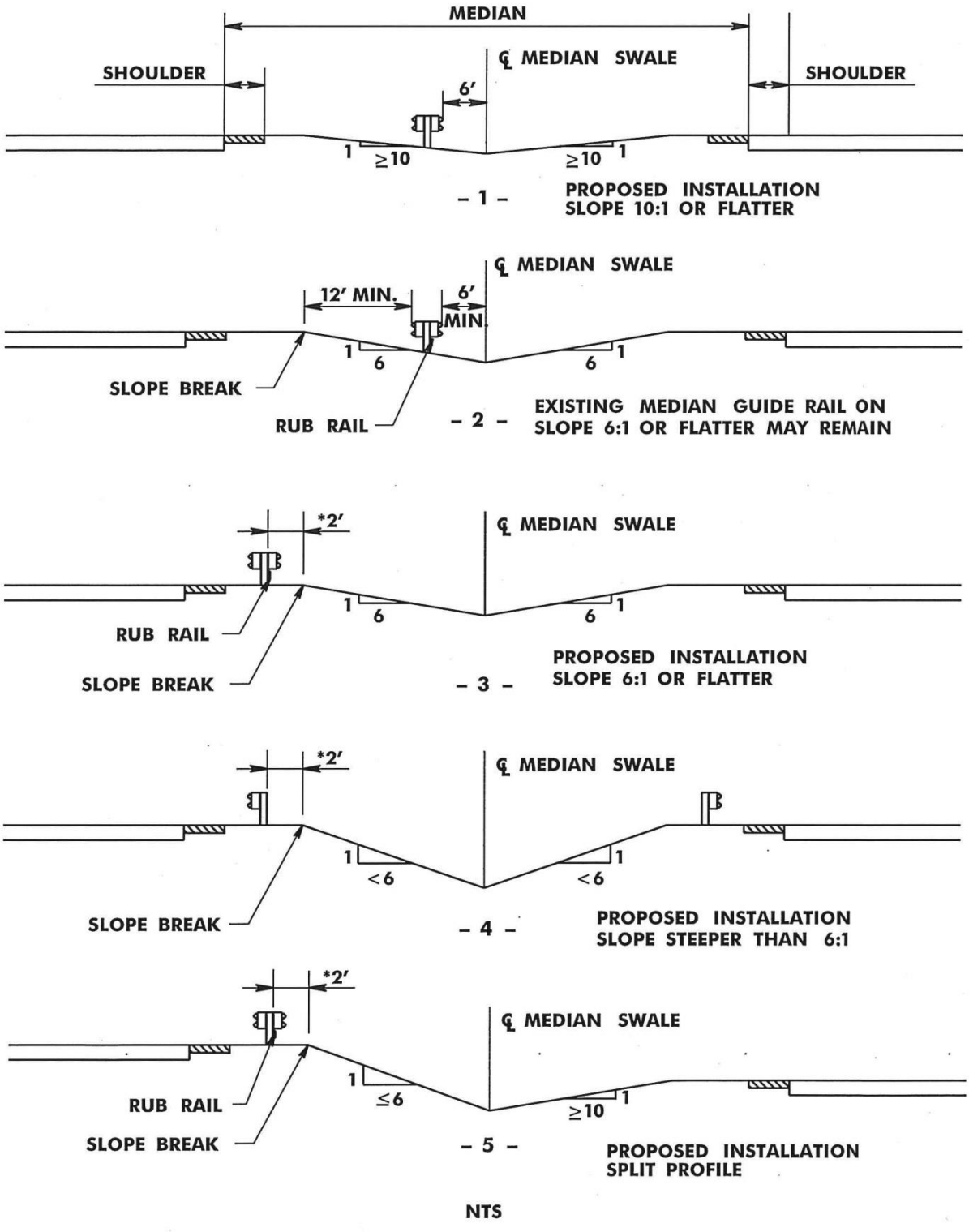
FIGURE 8–W:
MEDIAN GUIDE RAIL PLACEMENT



NTS

* Distance shown is 2′ minimum from the back of post to the slope break. If less than 2′ is used, the post embedment shall be increased in accordance with Table 8–3.

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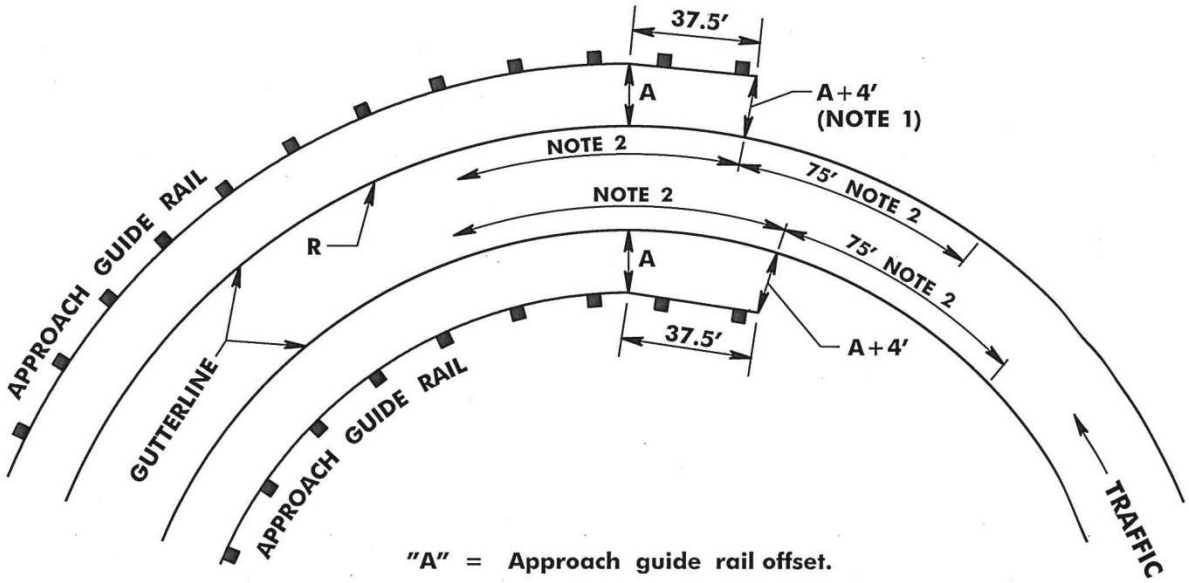
FIGURE 8–X:
FLARED GUIDE RAIL TERMINALS ON HORIZONTAL CURVES



"A" = Approach guide rail offset.

NOTES

1. To avoid installing the flared terminal within the roadway, the horizontal radius (R) must not be sharper than 175 ft. where the approach guide rail offset (A) is flush with the gutterline on the outside of the curve. If the radius is sharper than 175 ft., the warranting obstruction should be relocated or the guide rail extended to a point where the radius is 175 ft. or flatter.
2. Where there is curb, the maximum curb height is 4".
3. See Figure 8–F for standard and alternate grading for flared and tangent terminals.

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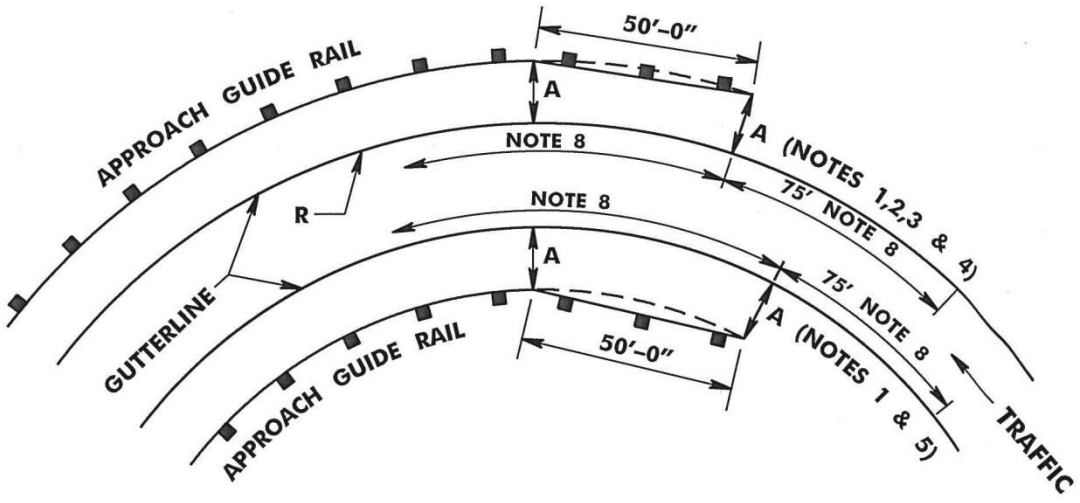
FIGURE 8–Y:
TANGENT GUIDE RAIL TERMINALS ON HORIZONTAL CURVES



"A" = Approach guide rail offset.

NOTES

1. Desirable the end of the tangent terminal should be at the same offset as the approach guide rail.
2. Where the horizontal radius (R) is flatter than 1,250 ft. and the approach guide rail offset (A) is flush with the gutterline, the end of the tangent terminal should be offset 1 ft. from gutterline.
3. Where the horizontal radius (R) is 625 ft. or flatter but less than 1,250 ft. and the approach guide rail offset (A) is flush with the gutterline, the end of the tangent terminal should be offset 2 ft. from gutterline.
4. For other combinations of radii and offset, the designer should make sure the tangent terminal does not encroach into the roadway. In no case should the end of the tangent terminal be offset more than 2 ft. greater than the approach guide rail offset.
5. Where the approach guide rail offset (A) is flush with the gutterline, the end of the tangent terminal should be offset 1 ft. from gutterline.
6. Where the approach guide rail is flush with the back of sidewalk, the offset to the end of the tangent terminal from the back of sidewalk should be in accordance with the offsets referenced in Notes 2, 3, 4, and 5 above.
7. See Figure 8–F for standard and alternate grading for flared and tangent terminals.
8. Where there is curb, the maximum curb height is 4".

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