Chapter 4

Roadside Safety

Tables

Figures

THIS PAGE LEFT BLANK INTENTIONALLY

Chapter 4

Roadside Safety

4.1 General

The design criteria contained in ***Chapter 2*** of this Volume has been developed to minimize the probability that a vehicle will depart the roadway. Design elements that affect roadside safety include horizontal alignment and superelevation, vertical alignment, drainage design, sight distance, lane widths, pavement and markings, cross slopes, median widths, shoulders and lighting.

The evaluation of Roadside Safety design elements is necessary to address the occasional errant vehicle that does depart the roadway. These design elements include roadside geometries, lateral offsets to potential hazards, and the use of shielding.

This Chapter contains roadside safety design criteria for three project types:

- New Construction
- Transportation Design for Livable Communities (TDLC)
- Resurfacing, Restoration and Rehabilitation (RRR) projects

New Construction criteria must be met for new and reconstruction projects, and for improvements included with RRR projects. The RRR criteria may be used for establishing the minimum requirements for intersection improvement projects with the understanding that when right of way is adequate, new construction criteria will be used to the maximum extent feasible. Refer to ***Chapter 25*** of this Volume for RRR criteria usage requirements. Certain conditions may allow TDLC criteria to be used in accordance with the requirements provided in ***Chapter 21*** of this Volume.

The **AASHTO Roadside Design Guide (AASHTO RDG)** provides the foundation for the development of specific criteria contained in this Chapter and the FDOT ***Design Standards***.

4.2 Roadside Features

4.2.1 Roadside Geometry

Roadside geometry refers to the terrain features (slopes) that a vehicle will encounter when departing a roadway. The components of roadside geometry include front slopes, back slopes, and transverse slopes.

4.2.2 Roadside Slope Classification

Roadside Slopes include areas located beyond the edge of the traffic lane as shown in ***Figures 4.2.2*** and ***4.2.3***. These areas are divided into the following classifications:

1. Traversable Slope – Smooth terrain, unobstructed by fixed objects, and sloped at 1:3 or flatter
2. Recoverable Slope – Traversable Slope 1:4 or flatter
3. Traversable Non-Recoverable Slope – Traversable Slope steeper than 1:4 and flatter than 1:3
4. Non-Traversable Slope – Rough, obstructed, or slopes steeper than 1:3
5. Critical Slope – Non-Traversable Slope steeper than 1:3

4.2.3 Clear Zone Criteria

Providing a sufficient amount of Recoverable Slope adjacent to the roadway provides an opportunity for an errant vehicle to safely recover. The amount of recoverable area provided beyond the traveled way is defined as the Clear Zone, and includes shoulders and bike lanes. The Clear Zone must be free of aboveground fixed objects, water bodies and Non-Traversable Slopes.

Traversable Back Slopes 1:3 or flatter may be located within the Clear Zone.

A clear zone width must be provided so that the sum of all Recoverable Slopes is equal to or greater than the required clear zone width obtained from ***Table 4.2.1***. Clear zone widths may be widened based on crash history and horizontal curvature; see ***AASHTO RDG, Section 3.1***. Visuals of the basic clear zone concepts are shown in ***Figure 4.2.1*** and ***Figure 4.2.2***. For Roadside Slope Criteria, see ***Section 4.2.6***.

Figure 4.2.1 Clear Zone Plan View

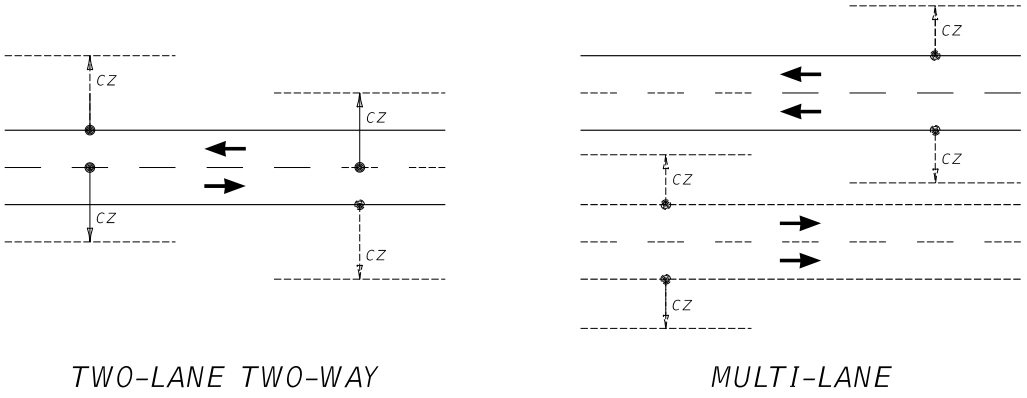
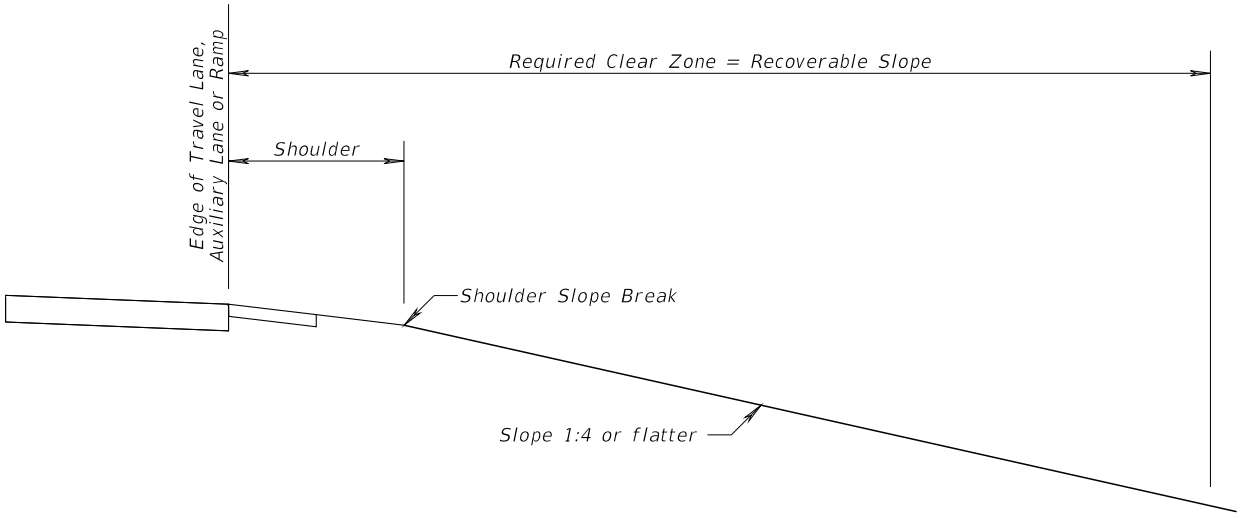


Figure 4.2.2 Basic Clear Zone Concept



When a Traversable Non-Recoverable Slope is present within the clear zone, extend the clear zone width until the amount of Recoverable Slope equals the required clear zone width obtained from ***Table 4.2.1***. The additional width provided beyond the Traversable Non-Recoverable Slope is known as the Clear Run-out Area and is illustrated in ***Figure 4.2.3.*** The Clear Run-out Area should be a minimum of 10 feet wide when right of way is adequate.

Figure 4.2.3 Adjusted Clear Zone Concept

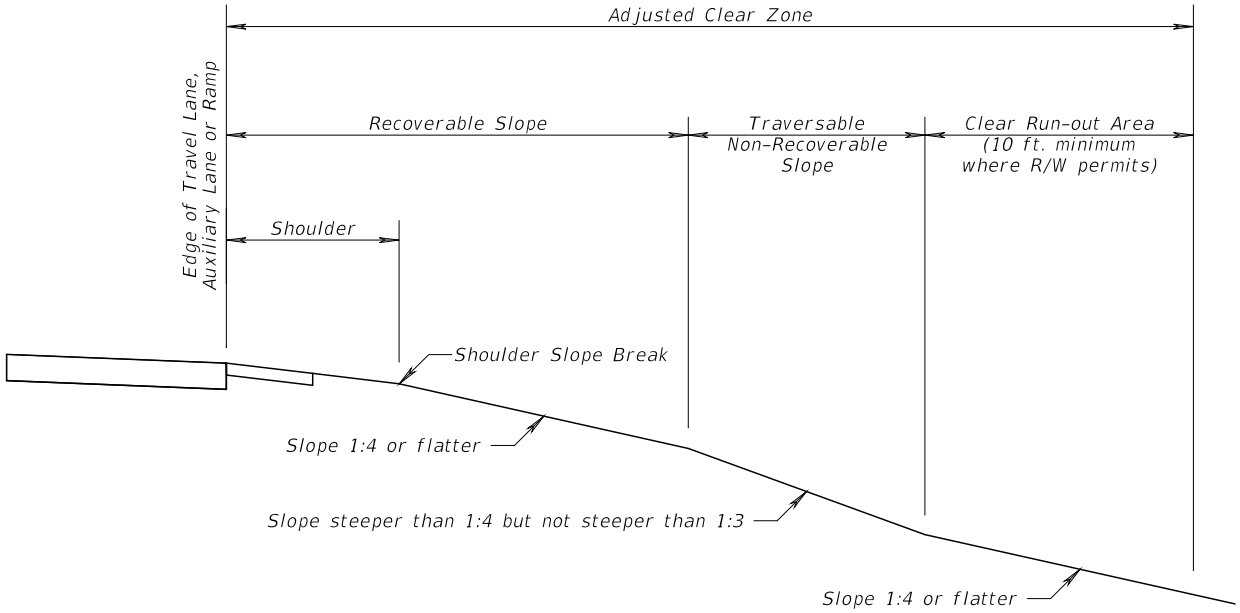


Table 4.2.1 Clear Zone Width Requirements

NEW CONSTRUCTION				
	≥ 1500 AADT (1)		< 1500 AADT (1)	
DESIGN SPEED (mph)	TRAVEL LANES & MULTILANE RAMPS (feet)	AUXILIARY LANES & SINGLE LANE RAMPS (feet)	TRAVEL LANES & MULTILANE RAMPS (feet)	AUXILIARY LANES & SINGLE LANE RAMPS (feet)
< 45	18	10	16	10
45	24	14	20	14
50	24	14	20	14
55	30	18	24	14
> 55	36	24	30	18

TDLC PROJECTS	
DESIGN SPEED (mph)	ALL LANE TYPES (feet)
≤ 30	12
35	14
40	16

RESURFACING, RESTORATION AND REHABILITATION (RRR) PROJECTS (2)		
DESIGN SPEED (mph)	TRAVEL LANES & MULTILANE RAMPS (feet)	AUXILIARY LANES & SINGLE LANE RAMPS (feet)
< 45	6	6
45 (3)	14	8
> 45	18	8

(1) Annual Average Daily Traffic (AADT) for projected 20-year traffic.

(2) RRR Criteria does not apply to Interstate and Freeways

(3) May be reduced to <45 mph widths if conditions more nearly approach those for lower speeds (40 mph or less).

Clear Zone widths for work zones are provided in ***Table 4.2.2***. Clear Zone widths in work zones are measured from the edge of Traveled Way defined by the Temporary Traffic Control (TTC) Plan.

Base the clear zone width within work zones on the regulatory speed established for construction; i.e. Work Zone Speed. For information on Regulatory Speeds within work zones refer to ***Chapter 10*** of this Volume.

Table 4.2.2 Clear Zone Width Requirements for Work Zones

WORK ZONE SPEED (mph)	TRAVEL LANES & MULTILANE RAMPS (feet)	AUXILIARY LANES & SINGLE LANE RAMPS (feet)
All Speeds w/Curb & Gutter	4’ Behind Face of Curb	4’ Behind Face of Curb
30 to 40	14	10
45 to 50	18	10
55	24	14
60 to 70	30	18

4.2.4 Lateral Offsets

Lateral offset is the lateral distance from a specified point on the roadway, such as the edge of traveled way or face of curb, to a roadside feature or object that is more than 4 inches above grade. Lateral offset requirements apply to all roadways. The requirements for various objects or features are based on:

- Design speed,
- Location; i.e. rural areas or within urban boundary,
- Flush shoulder or with curb,
- Traffic volumes, and
- Lane type; e.g. travel lanes, auxiliary lanes, and ramps.

Rural roadways typically have sufficient right of way, to provide the required clear zone widths. Therefore, lateral offset requirements for certain features and aboveground objects are based on maintaining the required clear zone width provided in ***Table 4.2.1***.

In urban areas, lateral offsets based on clear zone requirements for rural highways should be provided. However, roadways with curbing in urban areas typically do not have sufficient right of way to provide the required clear zone widths. Therefore, lateral offset requirements for these roadways are based on offsets needed for normal operation and not on maintaining a clear roadside for errant vehicles.

Table 4.2.3 provides lateral offset requirements for roadside features and aboveground objects typically encountered and considered functionally necessary for normal operation of the roadway (e.g. signing, lighting, utilities, etc.). For crashworthy objects, meet or exceed the Lateral Offset requirements provided in ***Table 4.2.3***. Locate objects that are not crashworthy as close to the right of way line as practical and no closer than the lateral offsets provided.

If an aboveground object is to be placed behind a barrier that is justified for other reasons, the lateral offset to the object may be reduced to meet the setback requirements (deflection distance) of the barrier, see ***Section 4.4.6***. For permissible attachments to barriers, refer to ***Section 4.5***.

Table 4.2.3 Lateral Offset Criteria

<table>
<tr><th colspan="2" rowspan="2">Design Element</th><th colspan="3">Urban Curb or Curb and Gutter
Design Speed ≤ 45 mph</th><th rowspan="2">All Other</th></tr>
<tr><th>New Construction</th><th>RRR</th><th>TDLC</th></tr>
<tr><td rowspan="3">Light Poles</td><td rowspan="2">Conventional [1] Lighting</td><td colspan="4">Do not locate in Medians, except in conjunction with barriers that are justified for other reasons</td></tr>
<tr><td>4 feet from face of curb</td><td>1.5 feet from face of curb</td><td>1.5 feet from face of curb</td><td>20 feet from Travel Lane, 14 feet from Auxiliary Lane or Clear Zone width, whichever is less</td></tr>
<tr><td>High Mast Lighting</td><td colspan="4">Outside Clear Zone</td></tr>
<tr><td colspan="2" rowspan="2">Signal Poles and [1] Controller Cabinets</td><td colspan="4">Do not locate in Medians</td></tr>
<tr><td>4 feet from face of curb</td><td>1.5 feet from face of curb</td><td>1.5 feet from face of curb</td><td>Outside Clear Zone</td></tr>
<tr><td colspan="2">Traffic Infraction Detectors</td><td colspan="4">For Traffic Infraction Detector placement and installation specifications, refer to the State Traffic Engineering and Operations Office web page: http://www.dot.state.fl.us/trafficoperations/</td></tr>
<tr><td rowspan="4">ITS Poles and Related Items</td><td rowspan="2">Pole and [1] Other Aboveground Fixed Objects</td><td colspan="4">Do not locate in Medians, except in conjunction with barriers that are justified for other reasons</td></tr>
<tr><td colspan="2">4 feet from face of curb</td><td>1.5 feet from face of curb</td><td>Outside Clear Zone</td></tr>
<tr><td>Equipment Shelters and Towers</td><td colspan="4">Do not locate within the limited-access right of way, except as allowed by Policy No. 000-625-025, Telecommunications Facilities on Limited Access Rights of Way.</td></tr>
<tr><td>Breakaway Objects</td><td colspan="2">4 feet from face of curb</td><td>1.5 feet from face of curb</td><td>As Close to R/W as possible</td></tr>
<tr><td colspan="6">(1) When location within sidewalk is necessary, provide a minimum 4 feet unobstructed sidewalk (not including width of curb).</td></tr>
</table>

Table 4.2.3 Continued Lateral Offset Criteria

Design Element		Urban Curb or Curb and Gutter Design Speed ≤ 45 mph			All Other
		New Construction	RRR	TDLC	
Traffic (1) Control Signs	**Single and Multi-Column**	Locate in accordance with ***Design Standards***. Use breakaway supports whether inside or outside the clear zone			
	Overhead Sign Supports	Outside Clear Zone			
Aboveground (2) Fixed Utilities (AFUs)	**New AFUs Other than mid-span poles**	≥ 4 feet from face of curb and as close to R/W as practical		1.5 feet from face of curb and as close to R/W as practical	Outside Clear Zone, and as close to R/W as practical
	New AFUs (3) Mid-span poles at intersecting roadways	≥ 4 feet from face of curb			Outside Clear Zone, and as close to R/W as practical
	Existing AFUs	Relocate as close to the R/W as practical and no closer than the below offsets:			
		4 feet from face of curb	1.5 feet (4) from face of curb	1.5 feet from face of curb	Outside (4) Clear Zone
Trees	**Where the diameter is or is expected to be > 4 inches measured 6 inches above the ground**	4 feet from face of curb	1.5 feet (5) from face of curb	4 feet from face of curb (1.5 feet under constrained conditions)	Outside Clear Zone

(1) When location within sidewalk is necessary, provide a minimum 4 feet unobstructed sidewalk (not including width of curb).

(2) Aboveground Fixed Utilities are objects owned by a public or private utility agency that are more than 4 inches above the grade and are not accepted by FDOT as crashworthy (such as strain poles, down guys, telephone load pedestals, temporary supports, etc.)

(3) Mid-span poles are new poles being installed as part of and within the alignment of an existing pole line.

(4) Existing AFUs are not to be relocated for RRR Projects unless they are adjacent to added or widened lanes or have been hit 3 times in 5 years.

(5) Requirements provided for Existing trees. Meet New Construction requirements for New Plantings.

Table 4.2.3 Continued Lateral Offset Criteria

Design Element	Urban Curb or Curb and Gutter Design Speed ≤ 45 mph			All Other
	New Construction	RRR	TDLC	
Railroad Grade Crossing Traffic Control Devices	Locate in accordance with ***Design Standards,* Index 17881** and ***Index 17882***			
Roadways Overpassing Railroads	For Horizontal Clearances where roadways overpass railroads refer to ***Chapter 6*** of this Volume.			
Canal and Drop-off Hazards	See ***Section 4.3***			
Bridge Piers and Abutments (6) (7)	The greater of the following: 16 feet from Edge of Travel Lane; or Outside Curb: 4 feet from face of curb Median: 6 feet from Edge of Traffic Lane (See ***Section 4.4.5.4*** for Pier Protection criteria and ***Figures 2.10.4.A*** and ***2.10.4.B***)			Outside Clear Zone
Drainage Structures (e.g. Wingwalls, Endwalls, and Flared End Sections)	Refer to the ***FDOT Drainage Manual***			
Mailboxes	Locate in accordance with ***Design Standards, Index 532***			
Bus Benches and Transit Shelters	Locate in accordance with ***Rule Chapter 14-20.003, Florida Administrative Code***. Transit bus benches must be located in accordance with ***Rule Chapter 14-20.0032, F.A.C.***			
Other Roadside Obstacles (1)	4 feet from face of curb	1.5 feet from face of curb		Outside Clear Zone

(1) When location within sidewalk is necessary, provide a minimum 4 feet unobstructed sidewalk (not including width of curb).
(6) Coordinate with Vertical Clearance requirements in ***Section 2.10*** of this Volume.
(7) When shielding is used refer to setback requirements for barriers in ***Section 4.4.6*** and ***Section 2.10*** of this Volume.

4.2.5 Control Zones

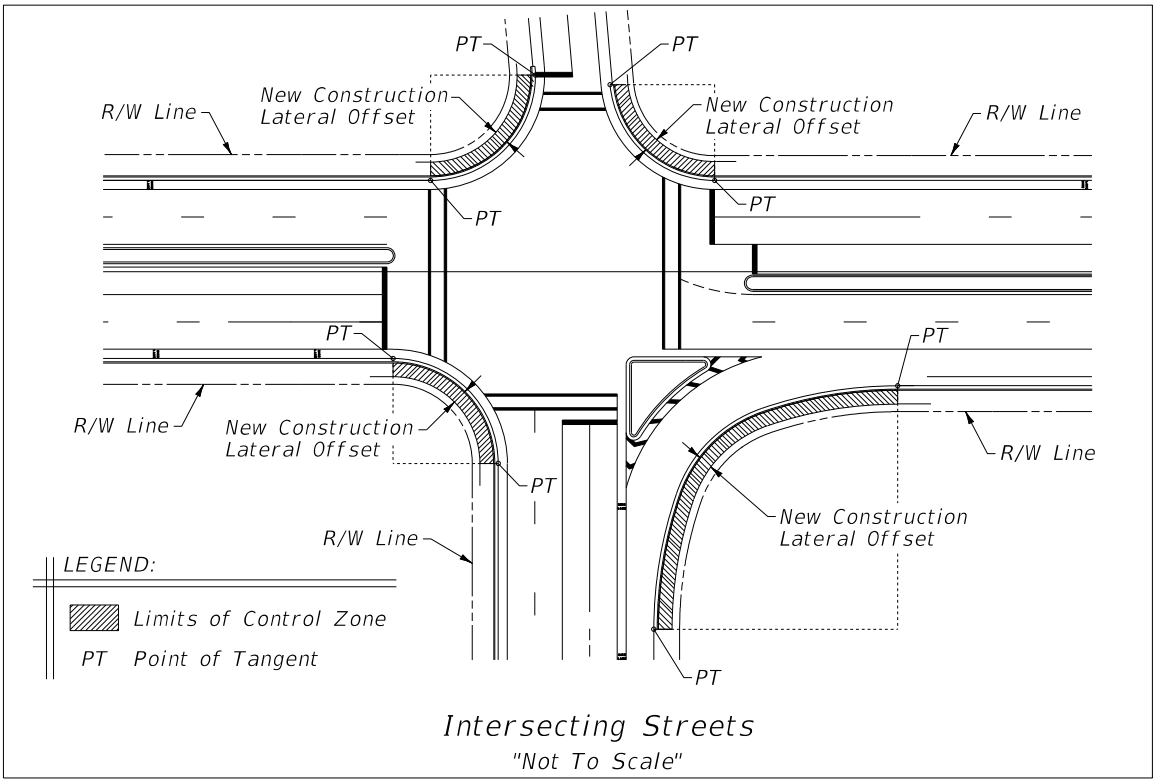
Control Zones apply only to RRR projects and do not include Aboveground Fixed Utilities (AFUs).

Control Zones are high-risk areas in which roadway departures occur with greater frequency which increases the risk of impact with aboveground objects. To address this condition, lateral offset and clear zone width requirements in Control Zones are to be based on New Construction criteria. A Control Zone violation is when RRR lateral offset requirements are met, but New Construction criteria is not. Control Zone violations are to be treated as Design Variations.

Control Zones include the following:

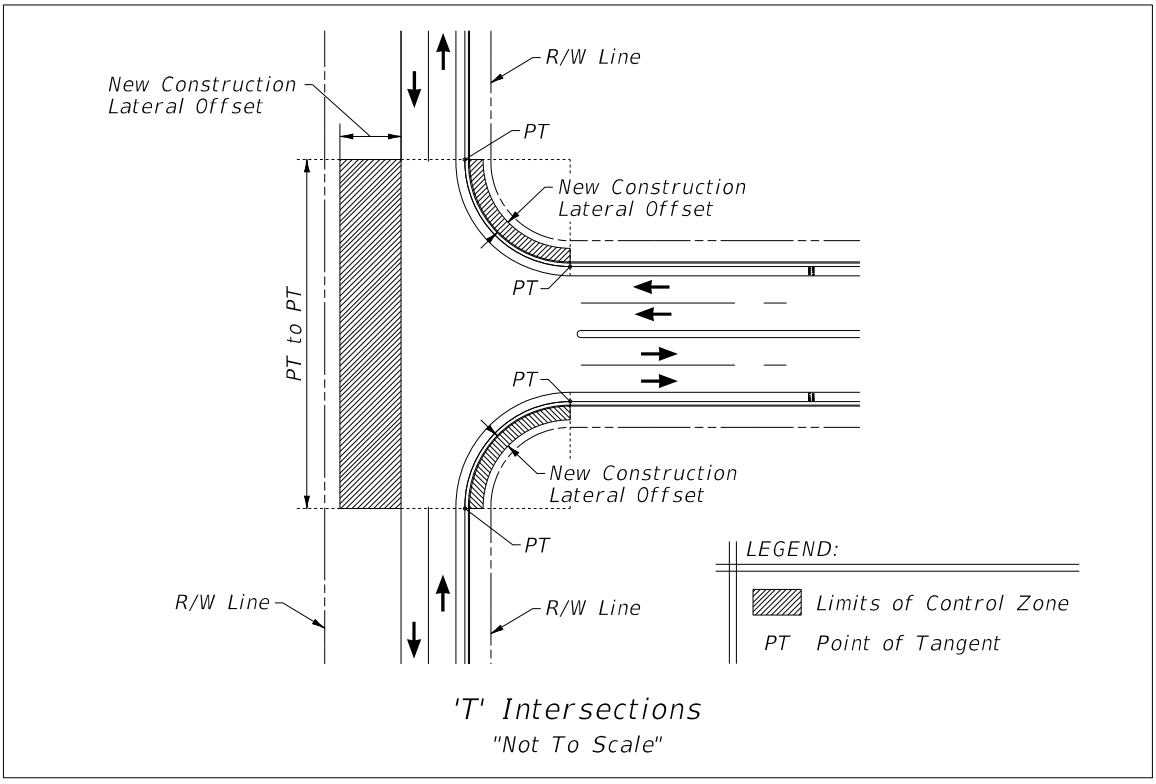
1. A location where an aboveground object has been hit 3 times or more in the last 5 years.
2. Intersection Radii – Within the New Construction lateral offset of the return radii of an intersecting street from begin point of tangent (PT) to end point of tangent (PT), see ***Figure 4.2.4***.

Figure 4.2.4 Intersection Radii



3. 'T' Intersection – On the non-intersection side of 'T' intersections within the area directly across and between each radii return point of tangent (PT) extended to the New Construction lateral offset, see ***Figure 4.2.5***.

Figure 4.2.5 'T' Intersection



4. Right Turn Deceleration – Within the New Construction lateral offset for a length of 100 feet measured downstream from the beginning of the full width lane, see ***Figure 4.2.6*** for right turn deceleration lane on a tangent. For right turn deceleration lane constructed with a reverse curve the beginning of the Control Zone starts at the point of intersection (PI), see ***Figure 4.2.7***.

5. Merge Section – Within the New Construction lateral offset for a length of 100 feet measured downstream from the beginning of the taper of a skewed merge section. See ***Figure 4.2.8*** for merge section constructed on a tangent. For merge section constructed with a reverse curve the beginning of the Control Zone starts at the point of intersection (PI), see ***Figure 4.2.9***.

6. Service Facility (i.e. alley way or easement) Driveway – For a distance of 3 feet from a driveway flare within the new construction lateral offset distance at the intersection of a dedicated intersecting service facility, see ***Figure 4.2.10***.

Figure 4.2.6 Right Turn Deceleration with Tangent

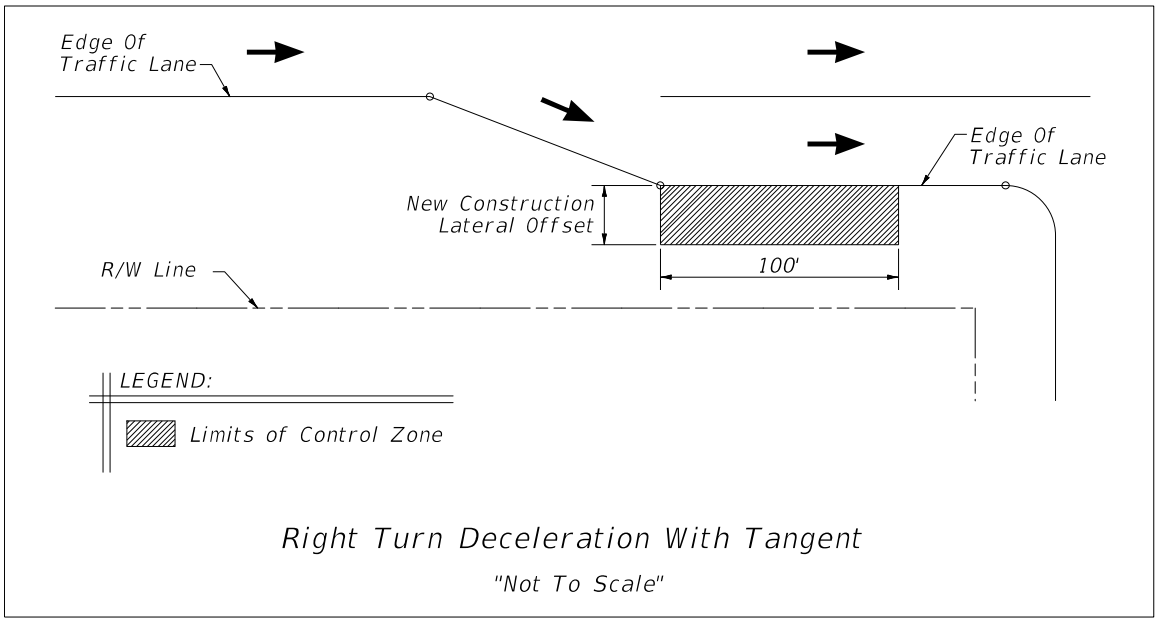


Figure 4.2.7 Right Turn Deceleration with Reverse Curve

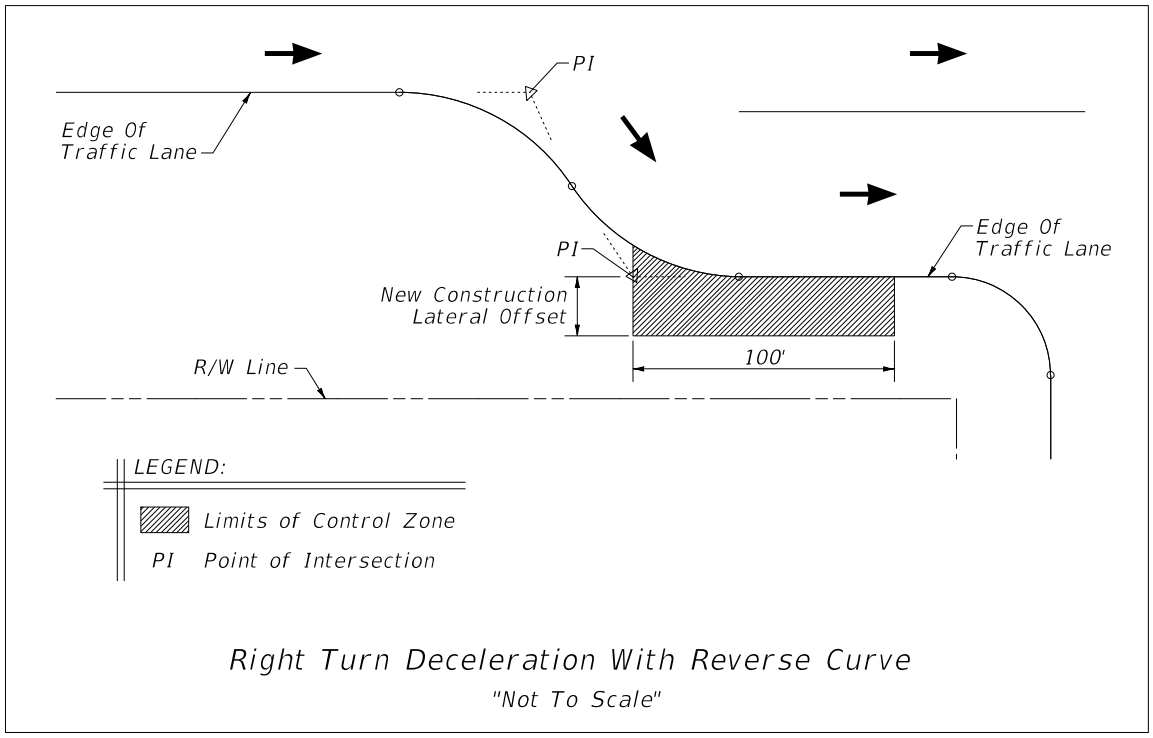


Figure 4.2.8 Merge Section with Tangent

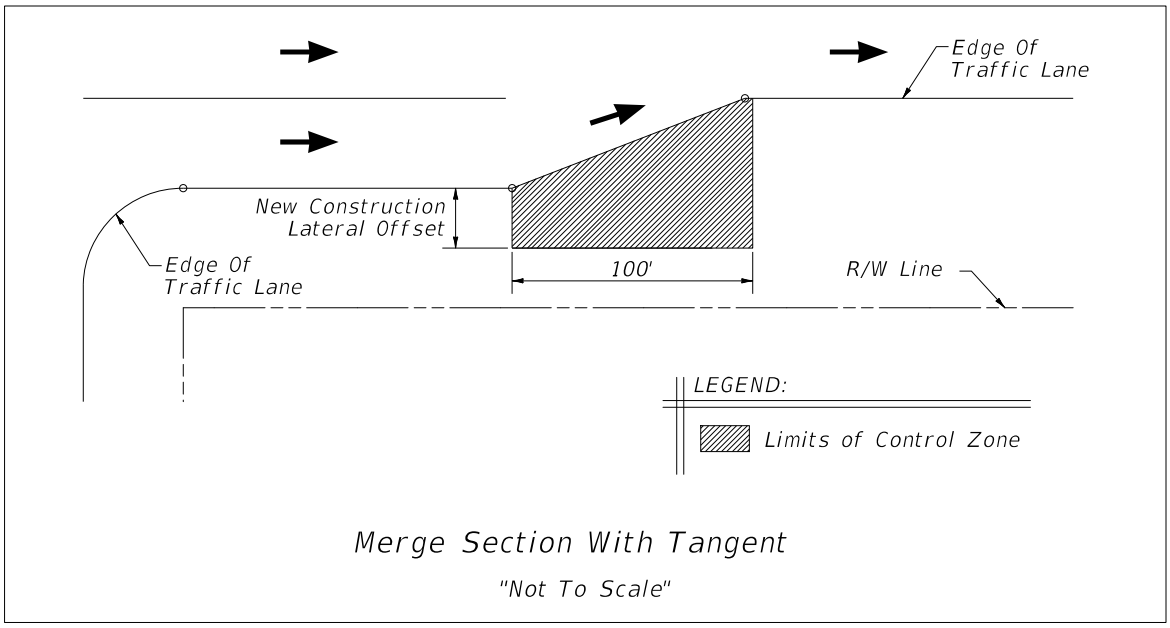


Figure 4.2.9 Merge Section with Reverse Curve

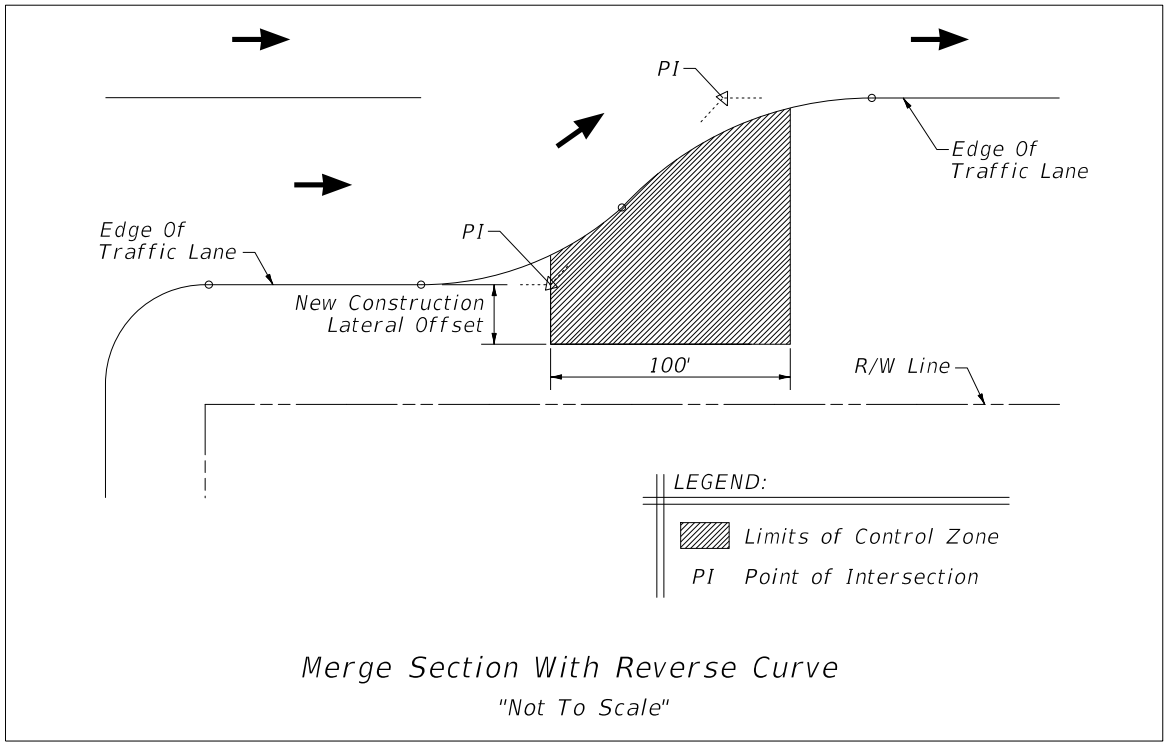
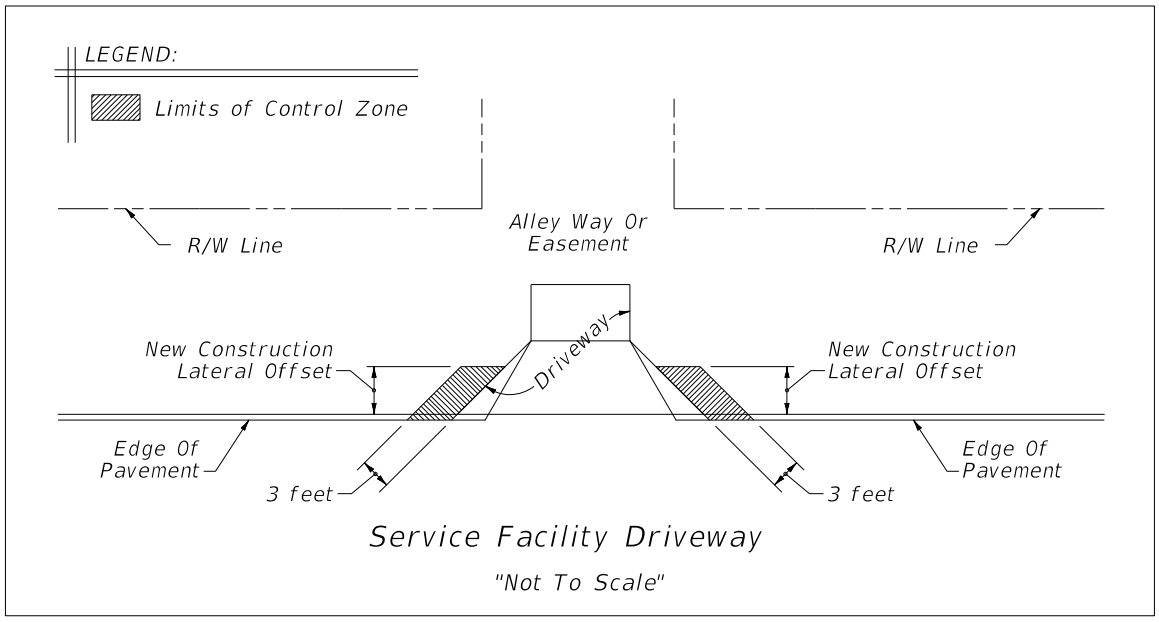
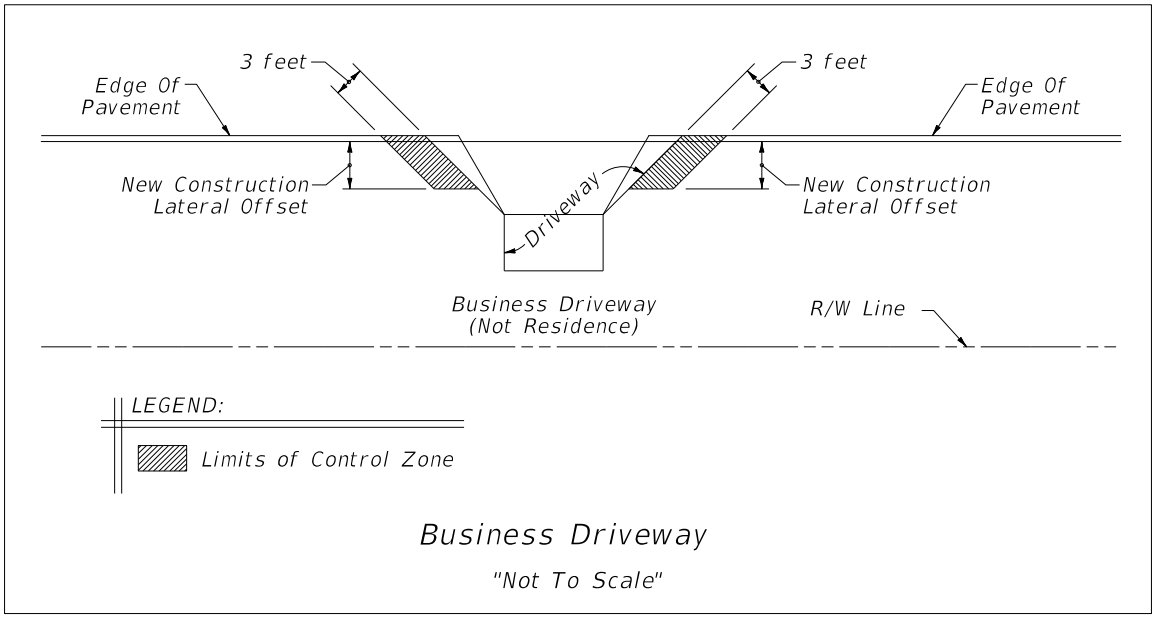


Figure 4.2.10 Service Facility Driveway



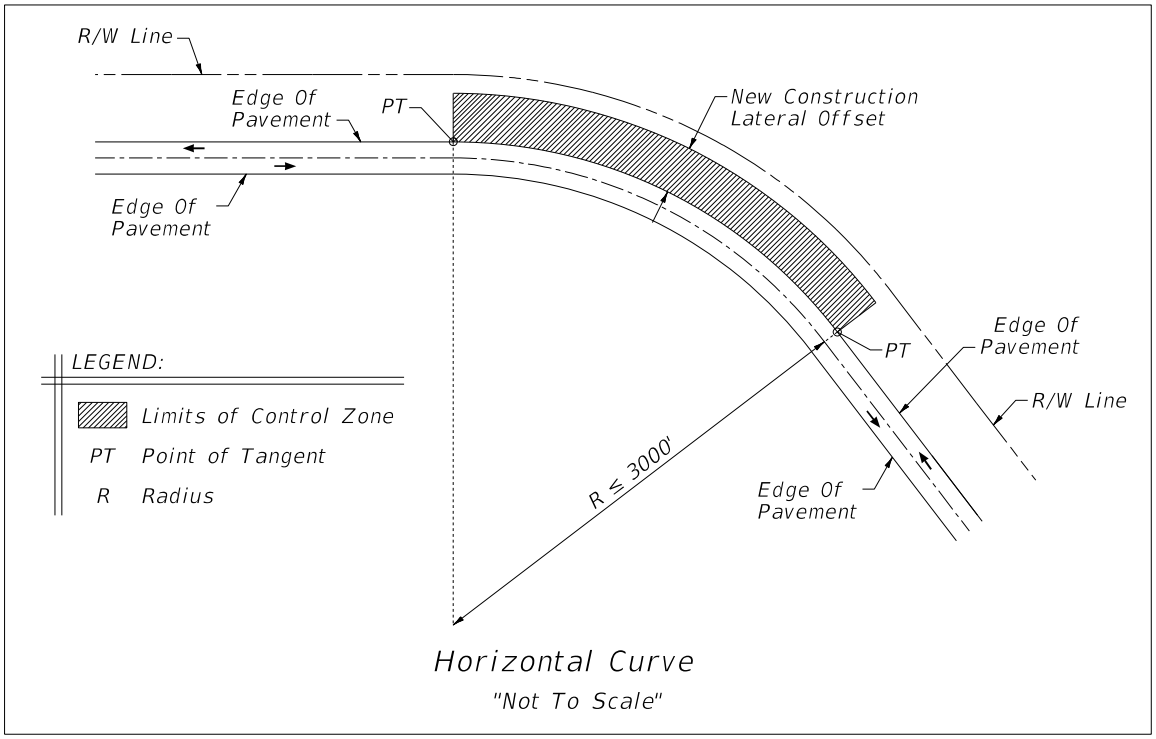
7. Business (i.e. non-residential) Driveway – For a distance of 3 feet from a driveway flare within the new construction lateral offset distance at the entrance turnout for use other than a private residence, see ***Figure 4.2.11***.

Figure 4.2.11 Business Driveway



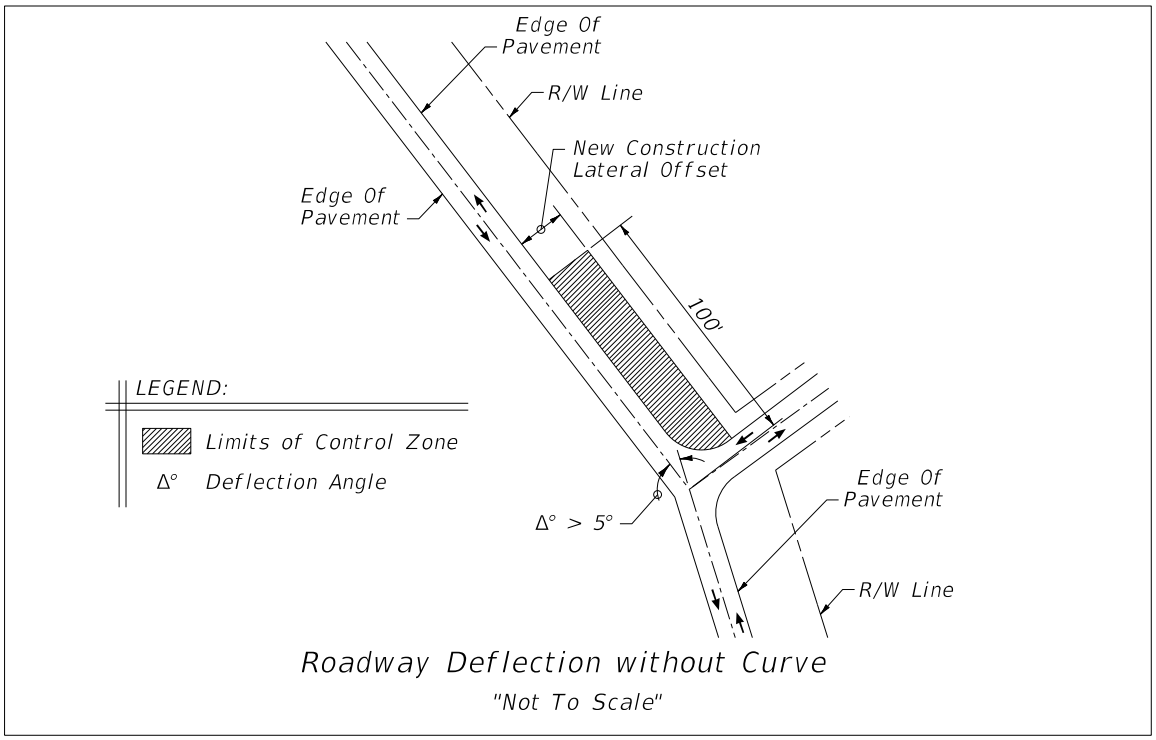
8. Horizontal Curves – Within the New Construction lateral offset in the outside area of a curve when the posted speed is greater than 35 mph and the curve radius is 3000 feet or less, see ***Figure 4.2.12***.

Figure 4.2.12 Horizontal Curve



9. Roadway Deflection without Curves – Within the New Construction lateral offset of roadway alignments with a deflection (kink) of more than 5 degrees for a distance of 100 feet from the point of intersection of the deflection, see ***Figure 4.2.13***.

Figure 4.2.13 Roadway Deflection without Curve



4.2.6 Roadside Slope Criteria

Roadside slopes consist of front slopes, back slopes, and transverse slopes.

4.2.6.1 New Construction Slope Criteria

New Construction Roadside Slope criteria is provided in ***Table 4.2.4***.

For slopes steeper than 1:3, consider the associated long term erosion control and maintenance costs. Coordinate the use of these slopes with the District Drainage, Maintenance, and Landscape Architect's Offices. For sod or turf slopes steeper than 1:3 and higher than 20 feet, provide a 10 foot wide flat (1:10 or flatter) area at the top and toe with suitable access for maintenance equipment. For sod or turf slopes steeper than 1:3 and higher than 35 feet, include a 10 foot wide flat maintenance berm not more than every 35 feet from the top of the slope. Slopes steeper than 1:2 require coordination with the District Geotechnical Office.

Modification for Non-Conventional Projects:
Delete the second and last sentences in above paragraph and see RFP for requirements.

For retaining walls greater than 5 feet in height, provide a 10 foot flat area in front of the wall face with suitable access for maintenance vehicles. See ***Structures Design Guidelines*** (***SDG***), Section 3.12 for information regarding partial height walls.

4.2.6.2 RRR Slope Criteria

Meet the Roadside Slope criteria provided in ***Table 4.2.4*** on RRR projects, except for the following:

1. Front Slopes:
    a. For constrained conditions, new slopes at 1:4 may be constructed within the Clear Zone.
    b. Existing 1:3 or flatter slopes within the Clear Zone may remain.
    c. Flattening slopes of 1:3 or steeper at locations where run-off-the-road type crashes are likely to occur (e.g., on the outsides of horizontal curves) should be evaluated.
    d. Existing front slopes steeper than 1:3 within the Clear Zone should be evaluated for shielding.
2. Back Slopes:
    a. For constrained conditions, new slopes at 1:3 may be constructed within the Clear Zone.
    b. Existing 1:2 or flatter slopes may remain.
    c. Existing back slopes steeper than 1:3 within the clear zone should be evaluated for shielding.

When the above criteria are applied, RRR lateral offset and clear zone requirements must also be met.

Modification for Non-Conventional Projects:
Delete ***Section 4.2.6.2*** and see RFP for requirements.

Table 4.2.4 Roadside Slopes

TYPE OF FACILITY	RURAL & URBAN FREEWAYS, RURAL & URBAN ARTERIALS AND COLLECTORS, WITH AADT ≥ 1500 (2) (INCLUDING SUBURBAN TYPICALS) DESIGN SPEED > 45 mph		RURAL ARTERIALS AND COLLECTORS WITH AADT < 1500 (2), URBAN ARTERIALS AND COLLECTORS WITHOUT CURB & GUTTER ALL SPEEDS		URBAN ARTERIALS AND COLLECTORS WITH CURB & GUTTER DESIGN SPEED ≤ 45 mph	
	Height (1) of Fill (feet)	Rate	Height (1) of Fill (feet)	Rate	Height (1) of Fill (feet)	Rate
Front Slope	0.0 - 5 5 - 10 10 - 20 >20	1:6 1:6 to edge of Clear Zone then 1:4 1:6 to edge of Clear Zone then 1:3 1:2 (with guardrail)	0.0 - 5 5 - 20 >20	1:6 Where R/W is insufficient, 1:6 to edge of Clear Zone then 1:3 1:6 to edge of Clear Zone then 1:3. Where, R/W is insufficient, 1:6 to edge of Clear Zone then 1:2. 1:2 (with guardrail)	All	1:2 or to suit property owner, not flatter than 1:6. R/W cost must be considered for high fill sections in urban areas
Back Slope	All	1:4 or 1:3 with a standard width trapezoidal ditch and 1:6 front slope	All	1:4 when R/W permits or 1:3	All	1:2 or to suit property owner. Not flatter than 1:6.
Transverse Slopes	All	1:10 or flatter (freeways) 1:4 (others)	All	1:4	All	1:4

(1) Height of Fill is the vertical distance from the edge of the outside travel lane to the toe of front slope.
(2) Annual Average Daily Traffic (AADT) for projected 20-year traffic.

4.2.7 Drainage Features

Drainage design is an important aspect of the long-term performance of a roadway, and to achieve an effective design, drainage features are necessary in close proximately to travel lanes. These features include ditches, curbs, and drainage structures (e.g. transverse/parallel pipes, culverts, endwalls, wingwalls, and inlets). The placement of these features are to be evaluated as part of roadside safety design. Refer to the Drainage Manual for information regarding proper hydraulic design.

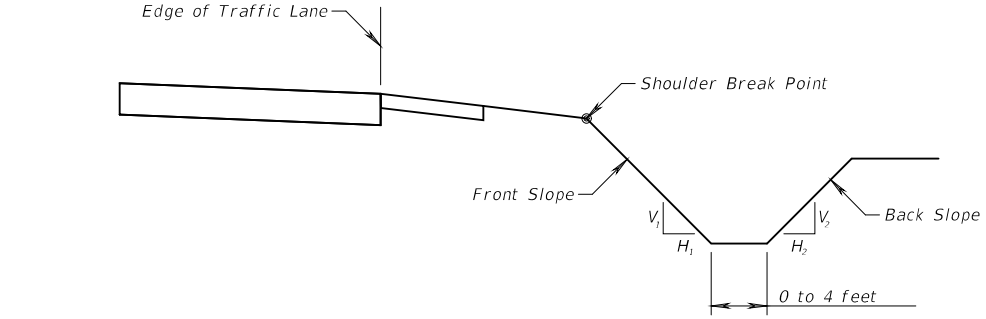
When evaluating the design of roadside topography and drainage features, consider the future maintenance implications of the facility. Routine maintenance or repairs needed to ensure the continued function of the roadway slopes or drainage may lead to long-term expenses and activities, which disrupts traffic flow and exposes maintenance personnel to traffic conditions.

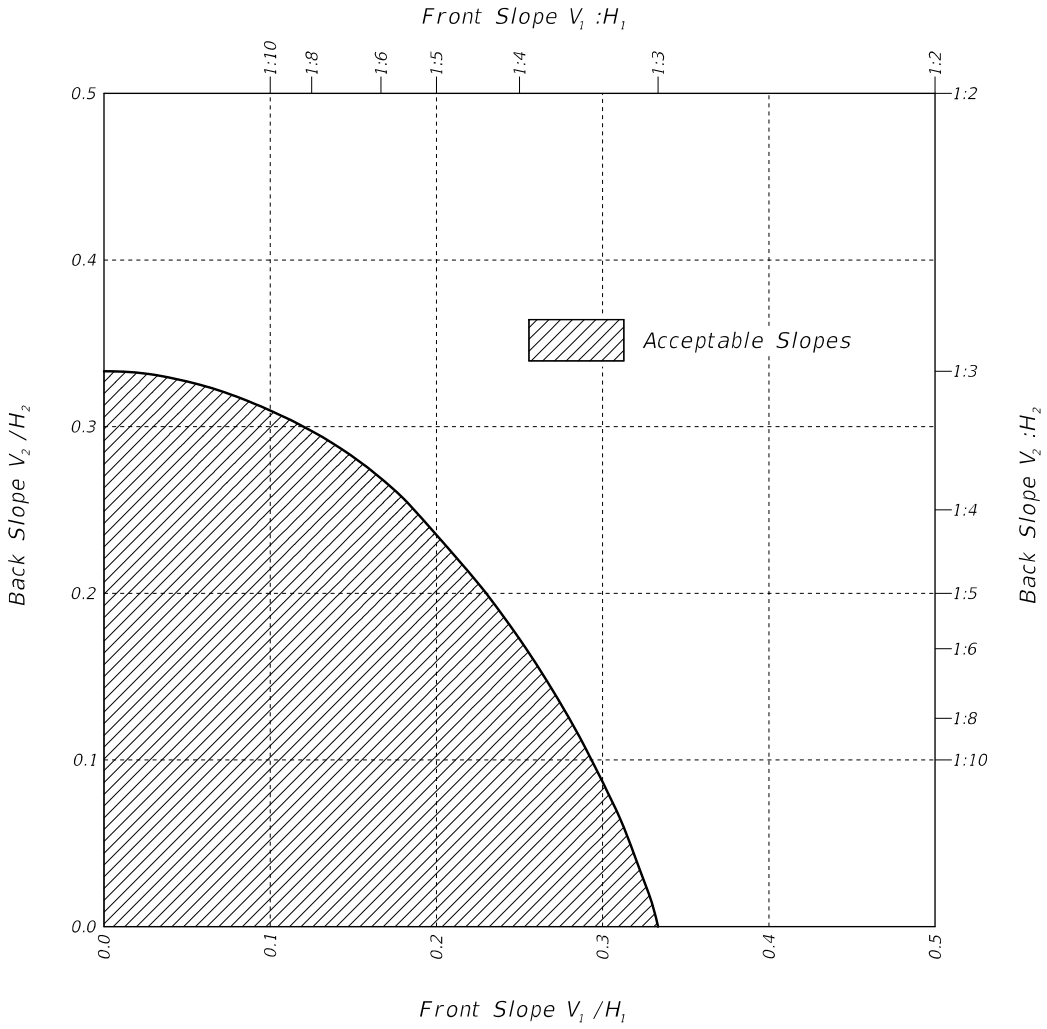
4.2.7.1 Roadside Ditches

Acceptable cross section slope criteria for roadside ditches within the clear zone is provided in ***Figure 4.2.14*** and ***Figure 4.2.15***. These roadside ditch configurations are considered traversable, as described in the ***AASHTO RDG***. Adjusted clear zone widths may be required for Non-Recoverable Slopes located within the clear zone (i.e. slopes stepper than 1:4 but flatter than 1:3, see ***Section 4.2.3***). The application of the ditch cross section slopes must be coordinated with Roadside Slope Criteria included in ***Section 4.2.6***.

The ***Drainage Manual, Chapter 2*** requires a minimum ditch bottom width of 5 feet to accommodate mitered end sections and maintenance mowers. Refer to the ***Drainage Manual*** for V-bottom ditch limitations. When a deviation from these requirements is approved by the District Drainage Engineer the ditch cross section slope criteria provided in ***Figures 4.2.14*** and ***4.2.15*** may be used

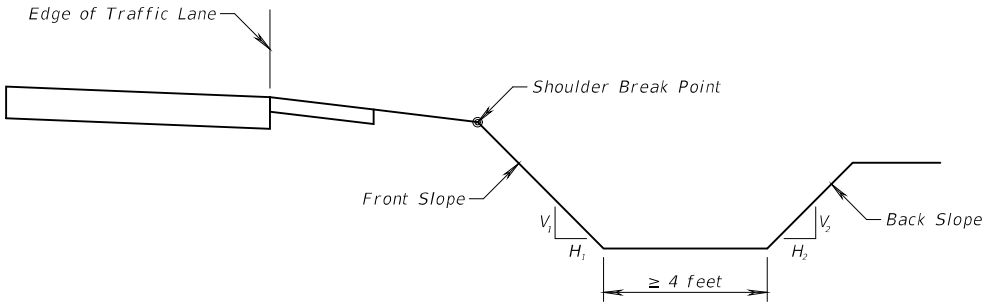
Figure 4.2.14 Roadside Ditches – Bottom Width 0 to 4 feet

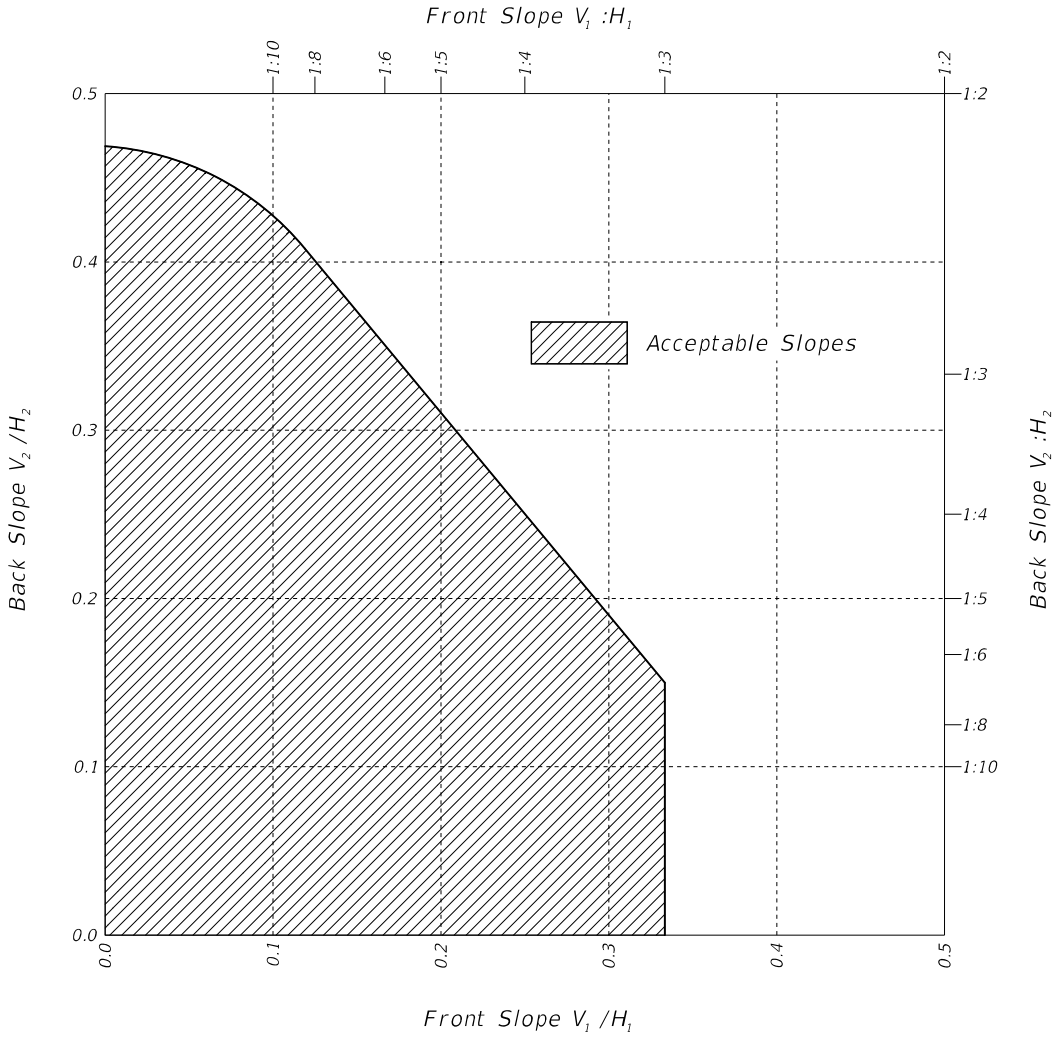




Ref: Figure 3-6, 2011 AASHTO Roadside Design Guide, 4th Edition

Figure 4.2.15 Roadside Ditches – Bottom Width ≥ 4 feet





Ref: Figure 3-6, 2011 AASHTO Roadside Design Guide, 4th Edition

4.2.7.2 Curbs

Curbs with closed drainage systems are typically used in urban areas to minimize the amount of right of way needed. Curbs also provide a tangible definition of the roadway limits and delineation of access points. These functions are important in urban areas because of the following typical characteristics:

- Low design speed (Design Speed ≤ 45 mph);
- Dense abutting development;
- Closely spaced intersections and accesses to property;
- Higher traffic, bicyclists and pedestrian volumes, and;
- Restricted right of way.

It should be noted that curbs have no redirectional capabilities except at speeds less than the lowest design speeds used on the State Highway System. Therefore, curb should not be considered effective in shielding a hazard and is not to be used to reduce lateral offset requirements.

See ***Design Standards, Index 300***, for standard FDOT curb shapes. Typical applications for FDOT roadways include Type E and Type F curbs. Both curb types have a sloped face; however, the Type E has a flatter face to allow vehicles to traverse it more easily. Shoulder Gutter is also frequently used along roadway fill sections and bridge approaches to prevent excessive runoff down embankment slopes. Refer to the Drainage Manual for Shoulder Gutter requirements.

Curbs are not permitted on high speed roadways (Design Speed > 45 mph) except for high speed urban and suburban sections, median openings, and transit stops. Use only Type E curb on high speed roadways with the face of the curb placed at the following offsets:

- High Speed Urban and Suburban Section
    - See ***Section 2.16*** of this Volume for requirements.
- Directional Median Openings
    - See ***Design Standards, Index 527***.
- Transit Stops
    - The curb face must be no closer to the edge of the traveled way than the required full width shoulder for a flush shoulder roadway.

4.2.7.3 Drainage Structures

Drainage structures, and their associated end treatments, located along the roadside should be implemented using either a traversable design or located outside the required clear zone. The various drainage inlets and pipe end treatments needed for an efficient drainage design typically contain curb inlets, ditch bottom inlets, endwalls, wingwalls, headwalls, flared end sections and/or mitered end sections. If not adequately designed or properly located, these features can create hazardous conditions (e.g. abrupt deceleration or rollovers) for vehicles. For detailed background information concerning traversable designs, refer to the ***AASHTO RDG***.

Design Standards for drainage structures and end treatments are provided in the ***Index 200 Series***. Drainage features shown in the ***Design Standards*** have the potential for conflict with a vehicle either departing the roadway or within a commonly traversed section of a roadway. Refer to the ***Drainage Manual*** for those standard drainage structures which are permitted within the Clear Zone.

4.2.7.4 Drainage Structures in RRR Projects

For RRR projects, evaluate existing drainage structures and end treatments located within the clear zone to determine if they present a potentially hazardous condition and whether or not the existing conditions necessitate relocation. At a minimum, review crash history and relocate any drainage structures impacted 3 times in 5 years. Side drains without mitered end sections, should be evaluated for replacement if they constitute an aboveground hazard.

New drainage structures added on RRR projects must meet New Construction location criteria.

4.2.8 Traffic Separators

Traffic separators are used to provide delineation of narrow roadway medians, manage access points and turning movements, provide for drainage, and offer pedestrian refuge areas. Refer to the ***Section 2.16.4*** of this Volume, the ***Florida Intersection Design Guide***, and ***Design Standards, Index 302*** for additional information.

Bridge mounted traffic separators are intended to match up geometrically with adjacent roadway traffic separators or the face of curb. Design separators on new and reconstruction projects in accordance with the ***Structures Design Guidelines***, and ***Design Standards, Index 302.***

4.2.9 Signing, Lighting, Traffic Signals, and Other Similar Roadside Features

Locate devices in accordance with ***Chapter 7*** and the Lateral Offset requirements provided in ***Section 4.2.4***. These devices may be installed within the lateral offset distance behind a traffic barrier, provided the barrier was justified for other reasons and the device is located within the barrier's Length of Need (See ***Section 4.4.6***).

Sign supports and conventional light poles, except overhead cantilever, truss type or bridge or barrier wall mounted, must be breakaway as defined in the ***AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*** and the ***AASHTO RDG***, unless installed behind a barrier. Sign supports must be of an acceptable and crashworthy design as detailed in the ***Design Standards***.

Do not locate high mast lighting poles in gore areas within the runout length as defined in the ***AASHTO RDG, Section 5.6.4***.

4.2.10 Roadside Flashing Beacon Assemblies

Roadside flashing beacon assemblies installed in accordance with ***Design Standards, Index 11862*** are considered crashworthy and are permitted within the clear zone. Locate in accordance with the offset in ***Design Standards, Index 17302***. Other ground mounted flashing beacon assemblies located within clear zone must be either crash tested or located behind a barrier that has been justified for other reasons. Flashing beacon assemblies that are mounted on mast arms are exempt from this requirement.

4.2.11 Mailbox Supports

See ***Design Standards*** for requirements.

4.2.12 Bus Benches and Transit Shelters

Refer to ***Table 4.2.3*** for criteria on the placement of benches and shelters.

4.2.13 Breakaway Devices

The criteria for breakaway supports is covered in the ***AASHTO RDG, Chapter 4***. Department-approved breakaway devices are covered in the ***Design Standards*** and included on the Approved Products List (***APL***).

Breakaway devices are designed to be impacted at normal bumper heights with vehicles traveling along relatively flat level ground. If impacted at a significantly higher point the breakaway mechanism may not function as designed resulting in non-activation or improper fracturing of the device. For this reason do not locate breakaway supports in ditches or along slopes steeper than 1:6.

4.2.14 Other Appurtenances

Locate these devices in accordance with the ***Design Standards*** and ***Table 4.2.3***.

4.3 Roadside Hazards

4.3.1 Aboveground Hazards

An aboveground hazard is anything within the Clear Zone that is greater than 4 inches in height and is firm and unyielding or doesn't meet breakaway criteria. Evaluate the location of temporary and permanent aboveground hazards and ensure that their placement is in accordance with the Lateral Offset and Clear Zone requirements of ***Section 4.2***.

Curbs are not considered an aboveground hazard when utilized in accordance with ***Section 4.2.7.2***.

4.3.1.1 Aboveground Hazards in Work Zones

Aboveground hazards in work zones are to be considered part of the “work area” and treated with appropriate work zone traffic procedures included in the ***Design Standards, Index 600 Series***. During non-working hours, place objects, materials, and equipment that constitute an aboveground hazard outside clear zone widths for work zones or behind a barrier.

4.3.2 Canal Hazards

A canal hazard is defined as an open ditch parallel to the roadway for a minimum distance of 1000 feet and with a seasonal water depth in excess of 3 feet for extended periods of time (i.e., 24 hours or more).

The lateral offset requirements for canal hazards exceed standard Clear Zone width criteria. Canal hazard lateral offsets are measured from the edge of travel lane, auxiliary lane or ramp to the top of the canal side slope nearest the road. Minimum required distances are as follows (see ***Figures 4.3.1*** and ***4.3.2***):

- Not less than 60 feet for flush shoulder roadways with design speeds of 50 mph or greater.
- Not less than 50 feet for flush shoulder roadways with design speeds of 45 mph or less.
- Not less than 40 feet for curb or curb and gutter roadways.

When new canal or roadway alignment is required, provide distances greater than those above to accommodate future widening of the roadway.

On fill sections, provide a flat berm (1:10 or flatter slope) no less than 20 feet in width between the toe of the roadway front slope and the top of the canal side slope nearest the roadway.

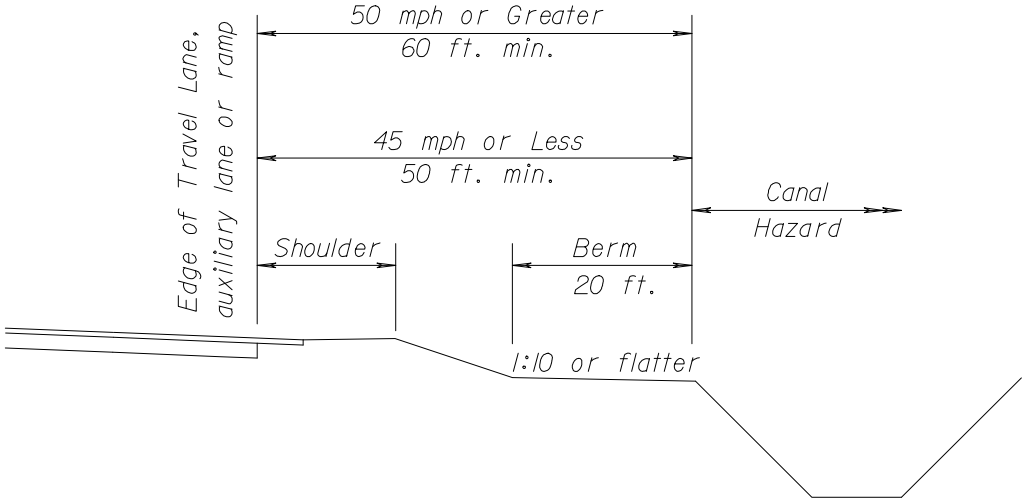
When the slope between the roadway and the "extended period of time" water surface is 1:6 or flatter, the minimum distance can be measured from the edge of the travel lane, auxiliary lane, or ramp to the "extended period of time" water surface and a berm is not required.

In sections with ditch cuts, provide a minimum of 20 feet between the toe of the front slope and the top of the canal side slope nearest the roadway.

Using the following criteria, shield the canal hazard with an approved roadside barrier when the required minimum lateral offset cannot be met:

- Locate the barrier as far from the travel way as practical and outside of the Clear Zone where possible.
- Locate Guardrail no closer than 6 feet from the canal front slope.
- Locate High Tension Cable Barrier no closer than 15 feet from the canal front slope.

Figure 4.3.1 Minimum Offsets for Canal Hazards
Rural and Urban Flush Shoulders



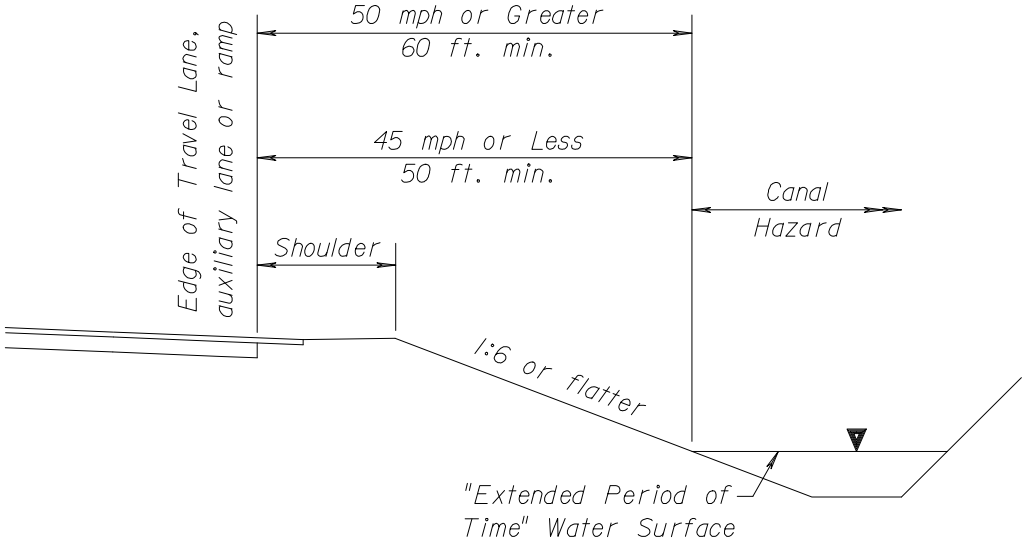
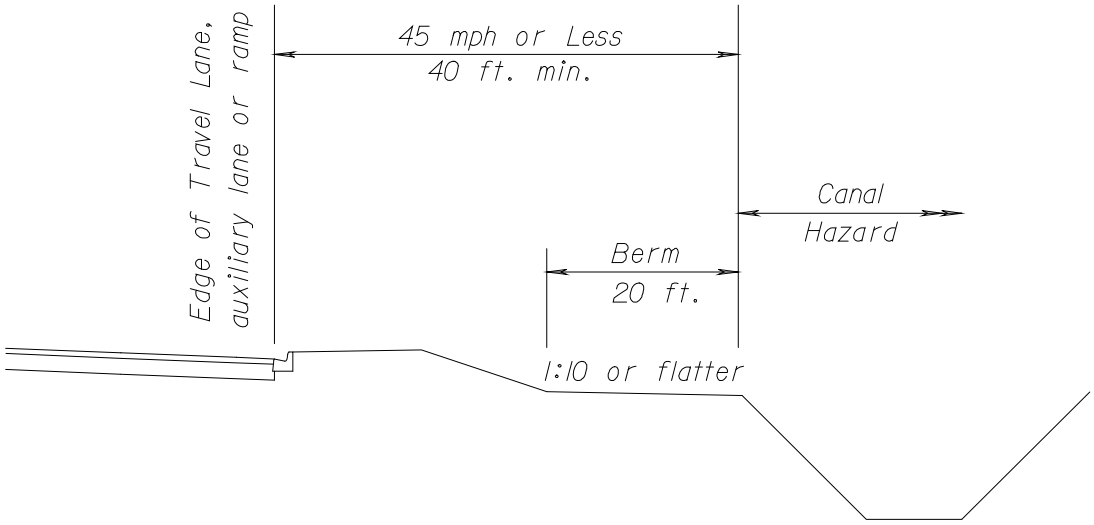


Figure 4.3.2 Minimum Offsets for Canal Hazards
Urban Curb or Curb and Gutter



4.3.3 Drop-off Hazard

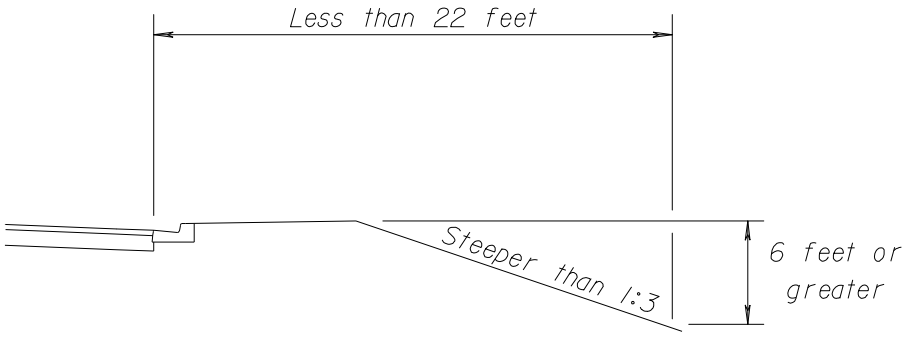
Drop-off hazards are defined as steep or abrupt downward slopes that can be perilous to vehicle occupants, pedestrians and cyclists. Shield any drop-off determined to be a hazard. Use the following guidelines in the identification of drop-off hazards for vehicles.

Drop-off hazards for vehicles:

1. Any vertical faced structure (e.g. retaining wall, wing-wall, etc.) located within the Clear Zone.
2. A drop-off of 6 feet or more with a slope steeper than 1:3 located within the Clear Zone.
3. In urban sections with curb or curb and gutter (Design Speed ≤ 45 mph), a drop-off of 6 feet or greater with a slope steeper than 1:3 located within 22 feet of the traveled way (See ***Figure 4.3.3***).
4. Drop-offs that have had 3 crashes within a 5 year period. Five years of crash data for a particular site can be obtained from the Safety Office.

For drop-off hazards for pedestrians and bicyclists, see ***Section 8.8*** of this Volume.

Figure 4.3.3 Drop-off Hazards in Urban Sections



4.3.3.1 Drop-offs in Work Zones

For drop-off criteria in work zones see ***Design Standards, Index 600***. Anticipate drop-offs that are likely to occur during construction and provide the appropriate devices. For those projects where barrier wall would be needed and yet it is not practical, such as in urban areas where numerous driveways exist, add plan notes that require conditions to be returned to acceptable grade by the end of the day's operation.

4.3.4 Additional Hazard Considerations

Some roadside conditions may create situations which are hazardous for persons other than the motorist departing the roadway. Engineering judgment should be used when evaluating hazardous conditions, and should consider; roadway geometry, proximity to facility or building, level of activity, traffic conditions, etc. These conditions include, but are not limited to, bridge piers that are not designed for vehicle impact loads, bicycle and pedestrian facilities, residential buildings, schools, businesses, and the presence of personnel in work zones. Specific requirements for Bridge Pier Protection are provided in ***Section 4.4.5.4***, and for considerations regarding Positive Protection in Work Zones see ***Section 4.4.7.4***.

4.4 Longitudinal Barriers, Barrier Transitions, End Treatments & Crash Cushions

Roadside barriers, transitions, end treatments (trailing anchorages and approach terminals), and crash cushions must be full-scale crash tested in accordance with either ***NCHRP Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features*** (***NCHRP 350***) or the ***AASHTO Manual for Assessing Safety Hardware, 2009*** (***MASH-09***).

Bridge Traffic Railings must be evaluated and designed in accordance with the ***Structures Design Guidelines*** *(**SDG**)*.

The criteria for crash testing specified in ***NCHRP 350*** and ***MASH-09*** provides six Test Levels (TL-1 thru TL-6) for the evaluation of roadside hardware suitability with consideration for vehicle type, mass, speed and impact angle. Each Test Level provides an increasing level of service in ascending numerical order. For additional information regarding appropriate application of Test Levels for Barrier Type Selection refer to ***Section 4.4.5*** and the ***AASHTO RDG***.

Barriers, transitions, and end treatments consist of both proprietary and non-proprietary devices. Non-proprietary/Standardized devices are detailed in the ***Design Standards***. Proprietary products are included on the ***APL***. These device address the majority of roadside needs on the State Highway System.

Non-standard roadside hardware (i.e. devices not included in either the ***Design Standards*** or the ***APL***) may sometimes be needed to address unique situations, but are not permitted without prior approval by the Structures Design Office (SDO) for traffic railings (e.g. bridges, noise walls and wall copings), or the Roadway Design Office (RDO) for other roadside hardware. For additional information on the use of Non-Standard Roadside Safety Hardware refer to ***Section 4.8***.

4.4.1 Standard Longitudinal Barriers

4.4.1.1 Flexible Barrier

Flexible Barrier systems provide the least severe impact conditions with the greatest deflections. The only Department-approved flexible barrier system is High Tension Cable Barrier (HTCB) and is currently available for implementation through the Departments ***Developmental Design Standards*** (***DDS***) process. Detailed information on the usage

requirements and design criteria of HTCB can be found on the Departments ***DDS*** Website (*http://www.dot.state.fl.us/rddesign/DS/Dev.shtm*), which includes the following:

- ***Instructions for Developmental Design Standards (IDDS)***, ***D450***
- ***Developmental Design Standards (DDS) Index D450***
- ***Developmental Specification***, ***Dev540***

When considering the use of a ***Developmental Design Standards*** device, review the *Developmental Design Standards Usage Process* included on the ***DDS*** Website (*http://www.dot.state.fl.us/rddesign/DS/Dev.shtm*).

4.4.1.2 Semi-Rigid Barrier

Semi-Rigid Barriers include the following:

1. W-Beam Guardrail – ***Design Standards***, ***Index 400***
    a. General, TL-3 Guardrail – Post spacing at 6'-3" (TL-3, MASH)
    b. Low-Speed, TL-2 Guardrail – Post spacing at 12'-6" (TL-2, MASH)
2. Modified Thrie-Beam Guardrail – ***Design Standards***, ***Index 400*** (TL-4, NCHRP 350)

W-Beam Guardrail with posts at 6'-3" spacing, rail height of 2'-1" to center of panel and midspan splices, as detailed in ***Design Standards***, ***Index 400***, was developed based on the ***31" Midwest Guardrail System*** (***MGS***). Compatible proprietary components may be referred by the 31" height.

TL-3 Guardrail installations may be used for all design speeds; however, installations on roadways with Design Speeds > 45 mph must have a minimum length of 75 feet, unless attached to a permanent rigid barrier.

The use of Low-Speed, TL-2 Guardrail is limited to flush shoulder roadways with Design Speeds ≤ 45 mph.

Installations of W-Beam Guardrail with 8-in offset blocks on wood or steel posts are detailed in ***Design Standards***, ***Index 400***. W-Beam guardrail may also be installed at a reduced post spacing (i.e. less than 6'-3") to reduce deflection of the system. Reduced post spacing may be used for all design speeds in accordance with spacing and setback requirements provided in ***Table 4.4.2***.

The use of Thrie-Beam Guardrail panels is restricted to Modified Thrie-Beam, Thrie-Beam

Retrofits (e.g., Metal Traffic Railings) and Barrier Transitions only.

Although Modified Thrie-Beam has been crash tested to NCHRP 350, TL-4 requirements as a longitudinal barrier, it presents unique challenges due to a lack of proven options for end treatments and transitions. As a result, project specific details are required for Modified Thrie-Beam installations.

4.4.1.3 Rigid Barrier

For the purposes of design and evaluation, Rigid Barriers are assumed to exhibit no deflection under impact conditions; however, crash severity will likely be the highest of all barrier options. Rigid barrier includes Concrete Barriers and Traffic Railings. Concrete barriers are included for roadway applications and Traffic Railings are designed for structural applications (e.g. bridges, noise walls, and wall copings).

Modifications to Rigid Barriers require approval from Office of Design (SDO or RDO). Modifications may include but are not limited to the following:

- reinforcement details
- surface treatments
- material substitutions
- geometric discontinuities along the length of the barrier
- non-standardized attachments that do not meet the requirements of either this manual or ***SDG***
- non-standardized and unfilled pockets or blockouts
- end transition details
- traffic face geometry

Rigid Barriers include the following:

1. Concrete Barriers (roadside applications):
    a. Median – ***Design Standards***, ***Index 410*** (TL-4, NCHRP 350)
    b. Shoulder – ***Design Standards***, ***Index 410*** (TL-4, NCHRP 350)
    c. Pier Protection – ***Design Standards***, ***Index 411*** (TL-5, NCHRP 350)
2. Traffic Railings (bridges, noise walls, and wall copings):
    a. Bridges – ***Design Standards***, ***Index 420 thru 424*** (TL-4, NCHRP 350) ***Index 425*** (TL-5, NCHRP 350)

b. Thrie-Beam Retrofits – ***Design Standards***, ***Index 470 thru 476*** (TL-4, NCHRP 350) ***Index 477*** (TL-2, NCHRP 350)

c. Vertical Face Retrofits – ***Design Standards***, ***Index 480 thru 484*** (TL-4, NCHRP 350)

   Note: Use Tapered End Transition, ***Index 484*** Sheet 2 of 10, for Design Speed ≤ 40 mph only. Not permitted within the clear zone of approaching traffic unless site-specific justification is provided and approved by the District Design Engineer.

d. Noise Wall – ***Design Standards***, ***Index 5210 thru 5215*** (TL-4, NCHRP 350) (TL-5 option available from Structures Design Office)

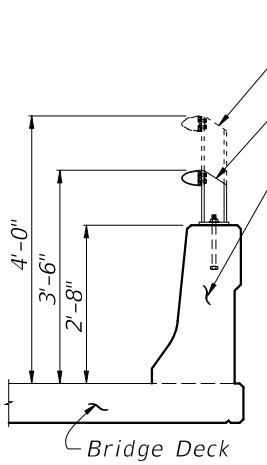
e. Wall Coping – ***Design Standards***, ***Index 6110 and 6120*** (32" F-Shape and 42" Vertical, TL-4, NCHRP 350) (42" F-Shape, TL-5, NCHRP 350)

Design bridge railings in accordance with the ***SDG***. On projects where an existing bridge is to remain, the bridge railings must be replaced or upgraded unless the railing meets criteria for new railings. Superseded FDOT Standard New Jersey Shape and F-Shape Traffic Railings conforming to the designs shown in the ***Instructions for Design Standards (IDS), Index 402****, "A Historical Compilation of Superseded Florida Department of Transportation 'Structures Standard Drawings' for 'F' and 'New Jersey' Shape Structure Mounted Traffic Railings"*, are both structurally and functionally adequate.

Other former FDOT bridge traffic railings not listed above, and any other traffic railings that are not based on crash tested designs, are inadequate and must be replaced, retrofitted or an exception granted, as appropriate, using the criteria included in the ***SDG***.

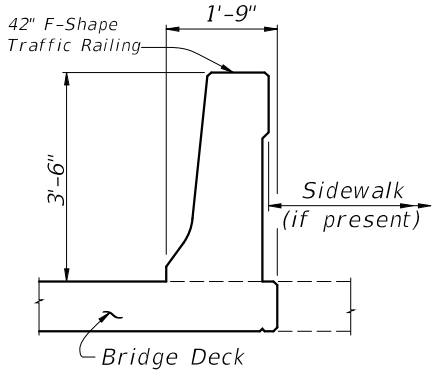
Details and typical applications of various bridge railings, including crashworthy pedestrian/bicycle railings and fencing, are provided in ***Figures 4.4.1 – 4.4.10***.

Figure 4.4.1 Bridge Traffic Railings – F-Shapes



- TL-4 Traffic Railing.
- Typical application is a Traffic Railing on a bridge deck edge or between a shoulder and a sidewalk.
- Not suitable as a pedestrian or bicycle railing at bridge deck edge unless used with Bullet Railing shown in Design Standard, Indexes 821 & 822.
- Section thru Railing on Bridge Deck Shown, Section thru Railing on Approach Slab and Permanent Retaining Wall Similar.

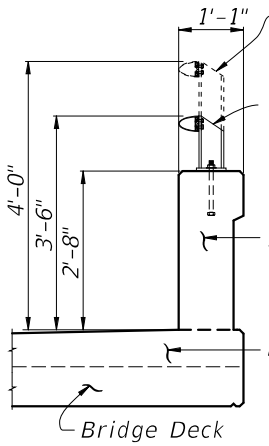
SECTIONAL VIEW NO. 1 – 32" F SHAPE TRAFFIC RAILING
DESIGN STANDARDS, INDEX 420
W/INDEXES 821 & 822 (OPTIONAL)



- TL-5 Traffic Railing.
- Typical application is a Traffic Railing on a bridge deck edge or between a shoulder and a sidewalk.
- No additional pedestrian rails permitted.
- Section thru Railing on Bridge Deck Shown, Section thru Railing on Approach Slab and Permanent Retaining Wall Similar.

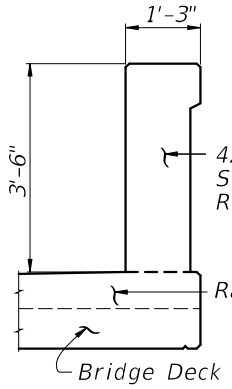
SECTIONAL VIEW NO. 2 – 42" F-SHAPE TRAFFIC RAILING
DESIGN STANDARDS, INDEX 425

Figure 4.4.2 Bridge Traffic Railings – Vertical Shapes



- TL-4 Traffic Railing.
- Typical application is a bridge deck edge Traffic Railing at the back of a raised sidewalk, design speed ≤ 45 mph or as a pedestrian railing behind a Traffic Railing (without a raised sidewalk See Sectional View No 10).
- Section thru Railing on Bridge Deck Shown, Section thru Railing on Approach Slab and Permanent Retaining Wall Similar.

SECTIONAL VIEW NO. 3 – 32" VERTICAL-SHAPE TRAFFIC RAILING
DESIGN STANDARDS, INDEX 423
W/INDEXES 821 & 822 (OPTIONAL)



- TL-4 Traffic Railing.
- Typical application is a bridge deck edge Traffic Railing at the back of a raised sidewalk, design speed ≤ 45 mph or as a pedestrian railing behind a Traffic Railing (without a raised sidewalk).
- No additional pedestrian rails permitted.
- Section thru Railing on Bridge Deck Shown, Section thru Railing on Approach Slab and Permanent Retaining Wall Similar.

SECTIONAL VIEW NO. 4 – 42" VERTICAL SHAPE TRAFFIC RAILING
DESIGN STANDARDS, INDEX 422

Figure 4.4.3 Bridge Traffic Railings – Other Shapes

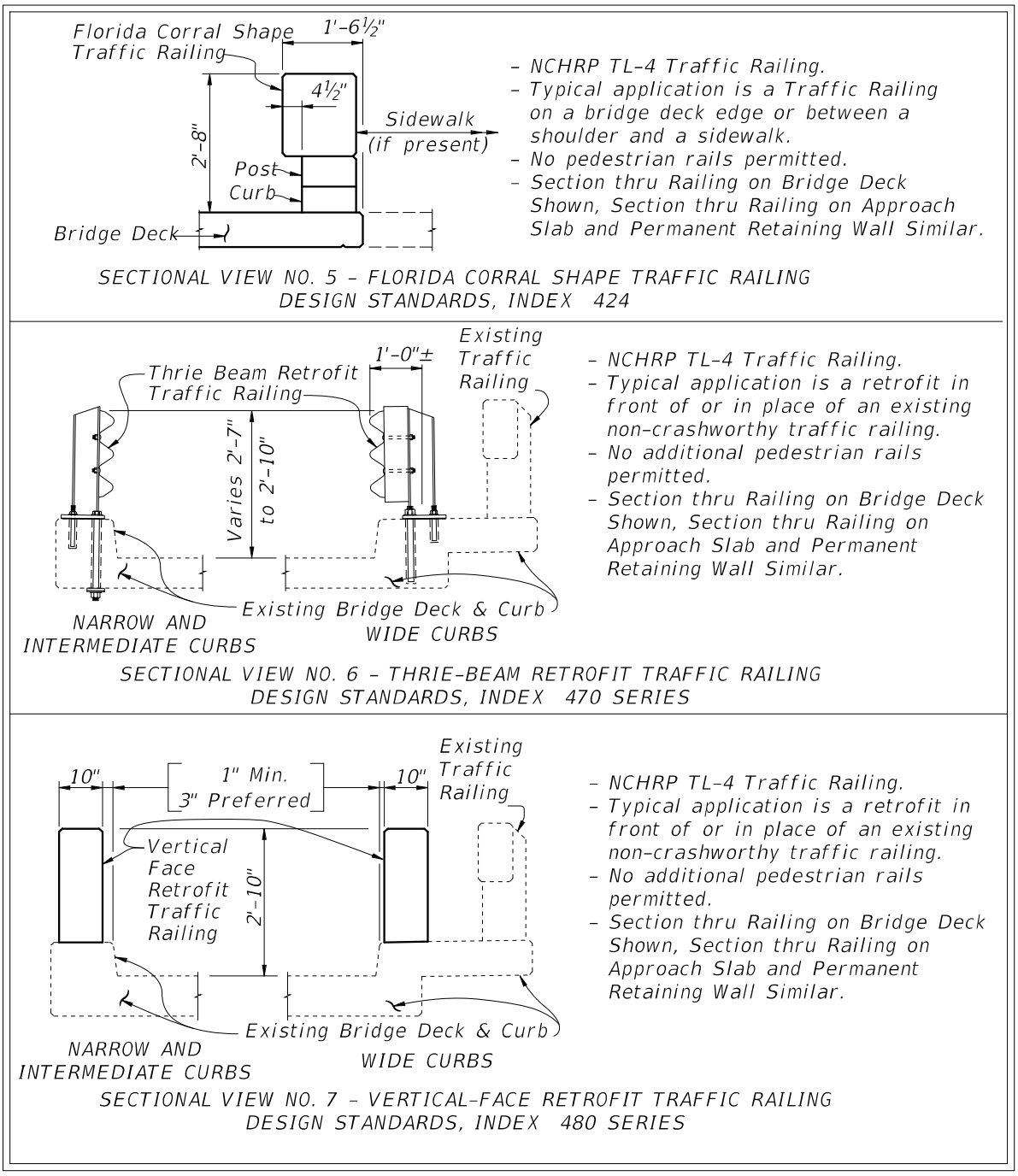


Figure 4.4.4 Bridge Traffic Railings – Median Traffic Railing and Traffic Railing/Noise Wall Combination

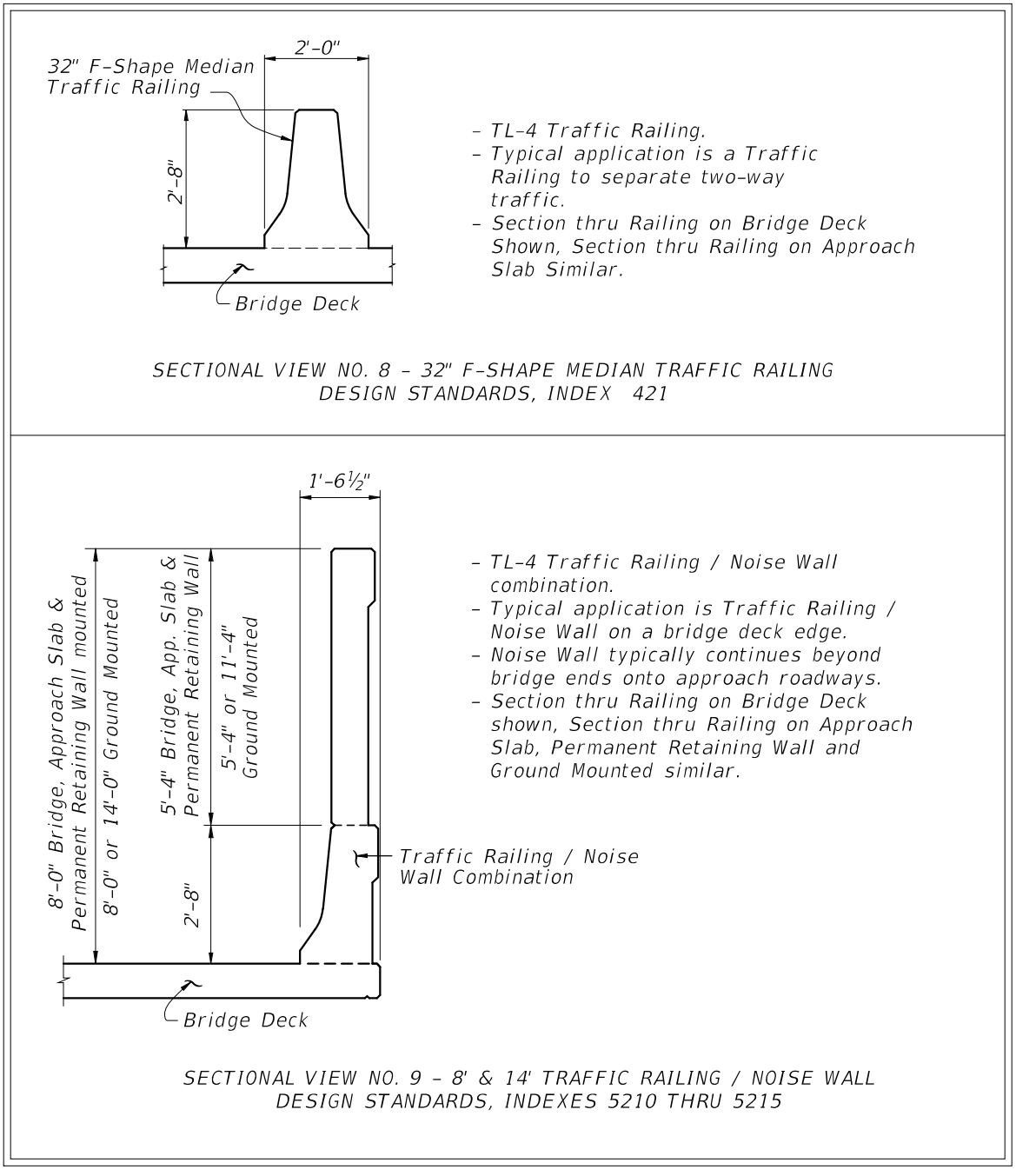


Figure 4.4.5 Bridge Railing – Pedestrian/Bicycle Railing (Index 820)

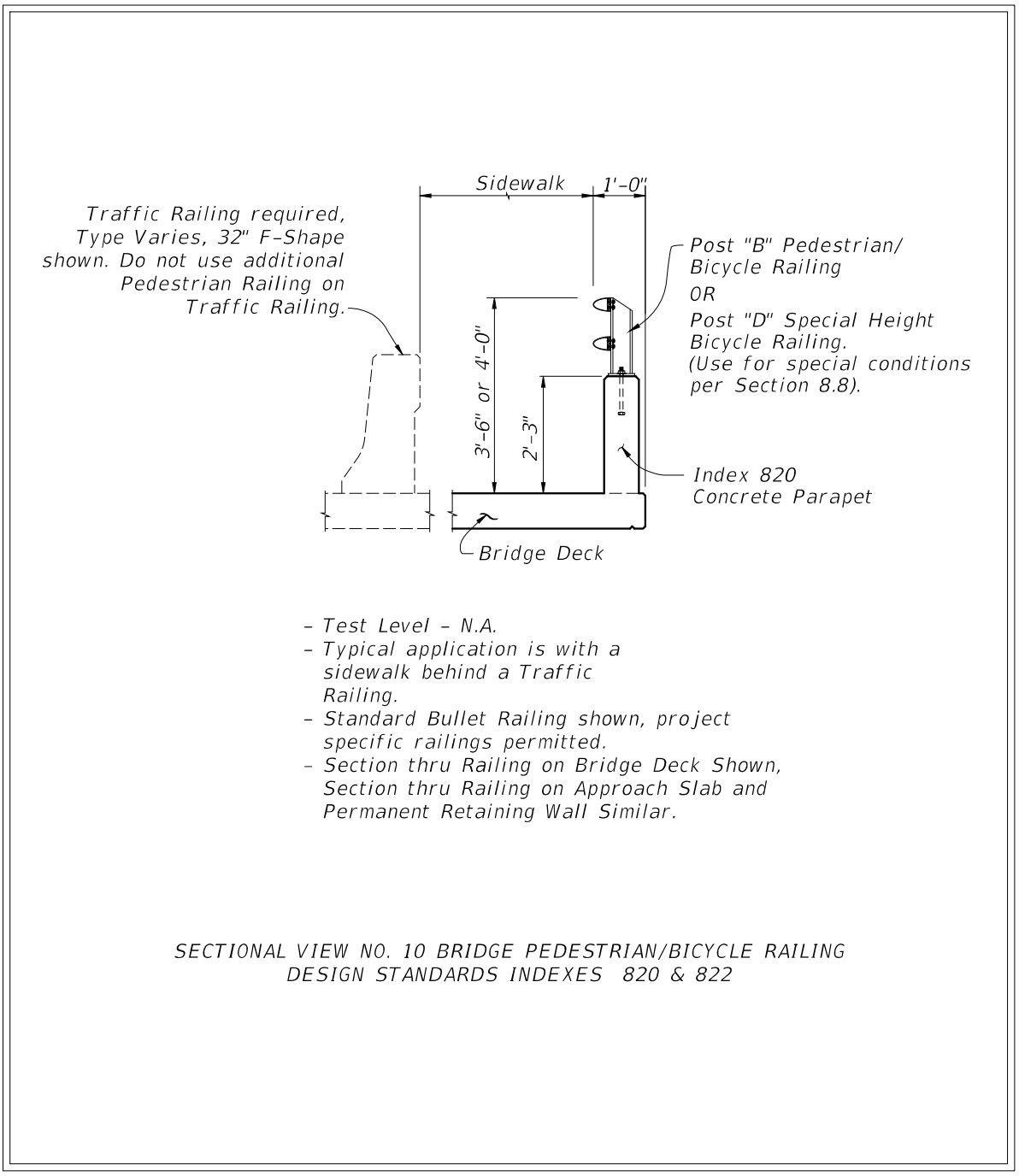


Figure 4.4.6 Bridge Railing – Pedestrian/Bicycle Railing (Index 851 & 861)

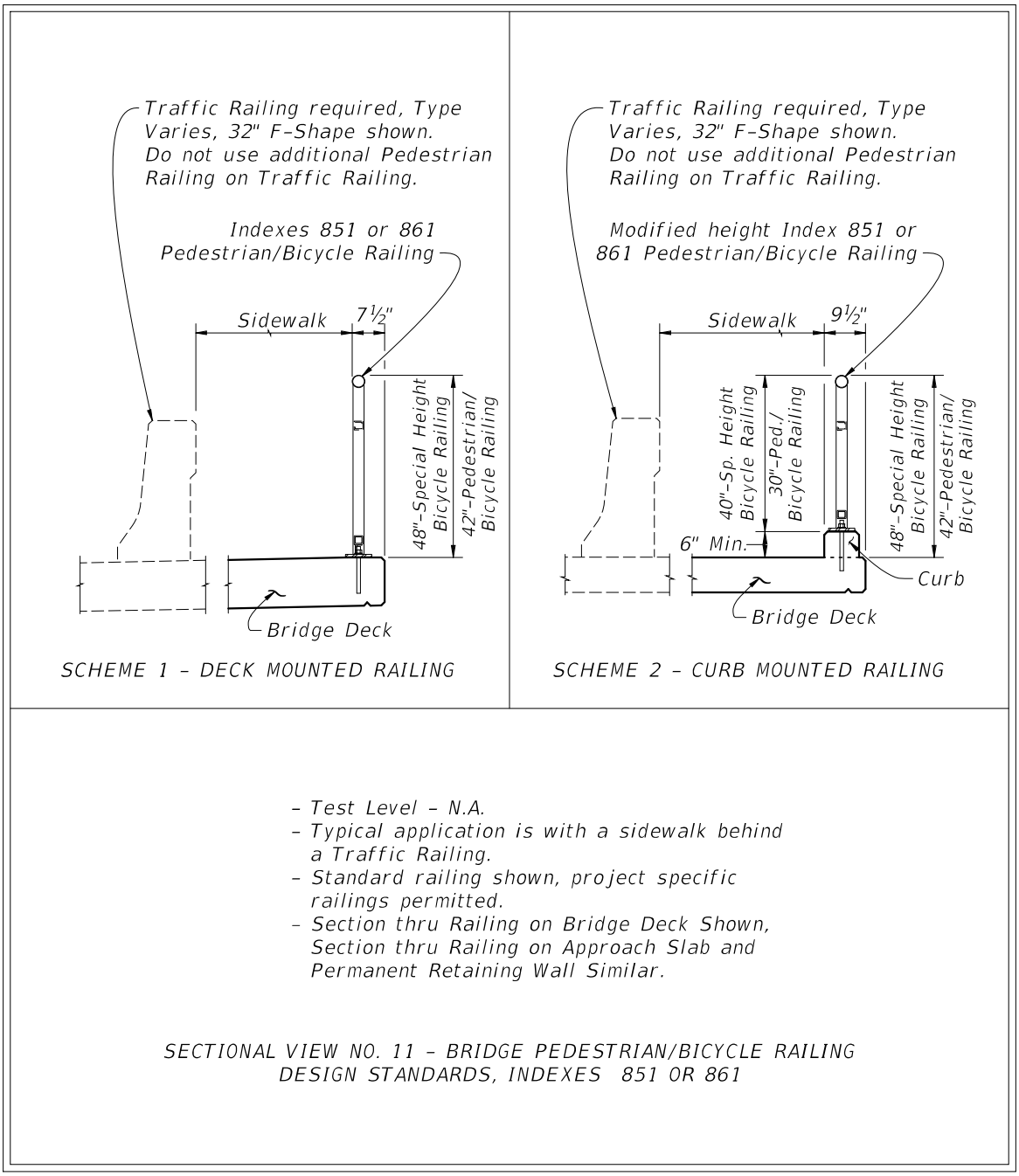


Figure 4.4.7 Bridge Railing – Pedestrian/Bicycle Railing (Index 825)

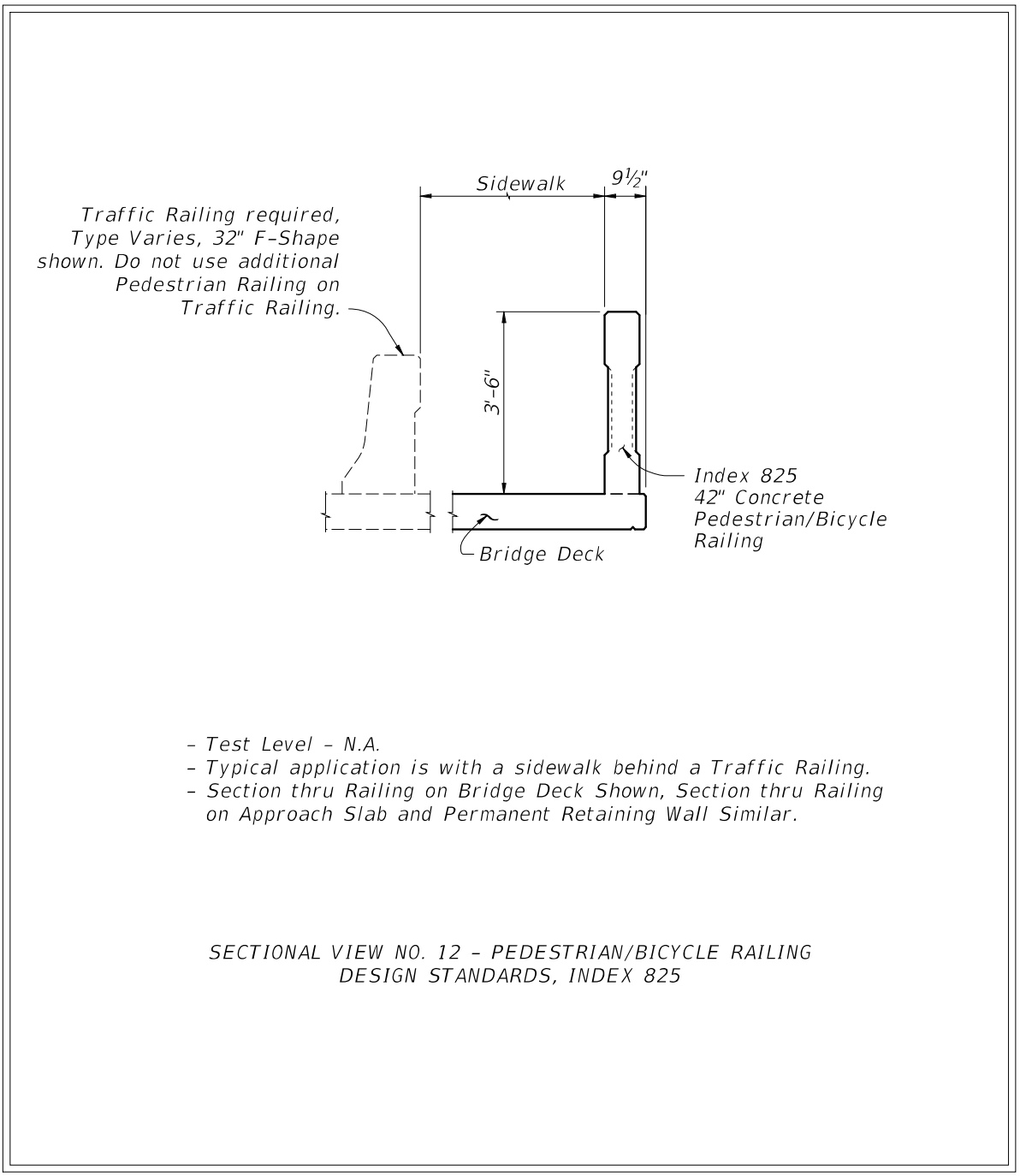


Figure 4.4.8 Bridge Railing and Pedestrian/Bicycle Railing Retrofit

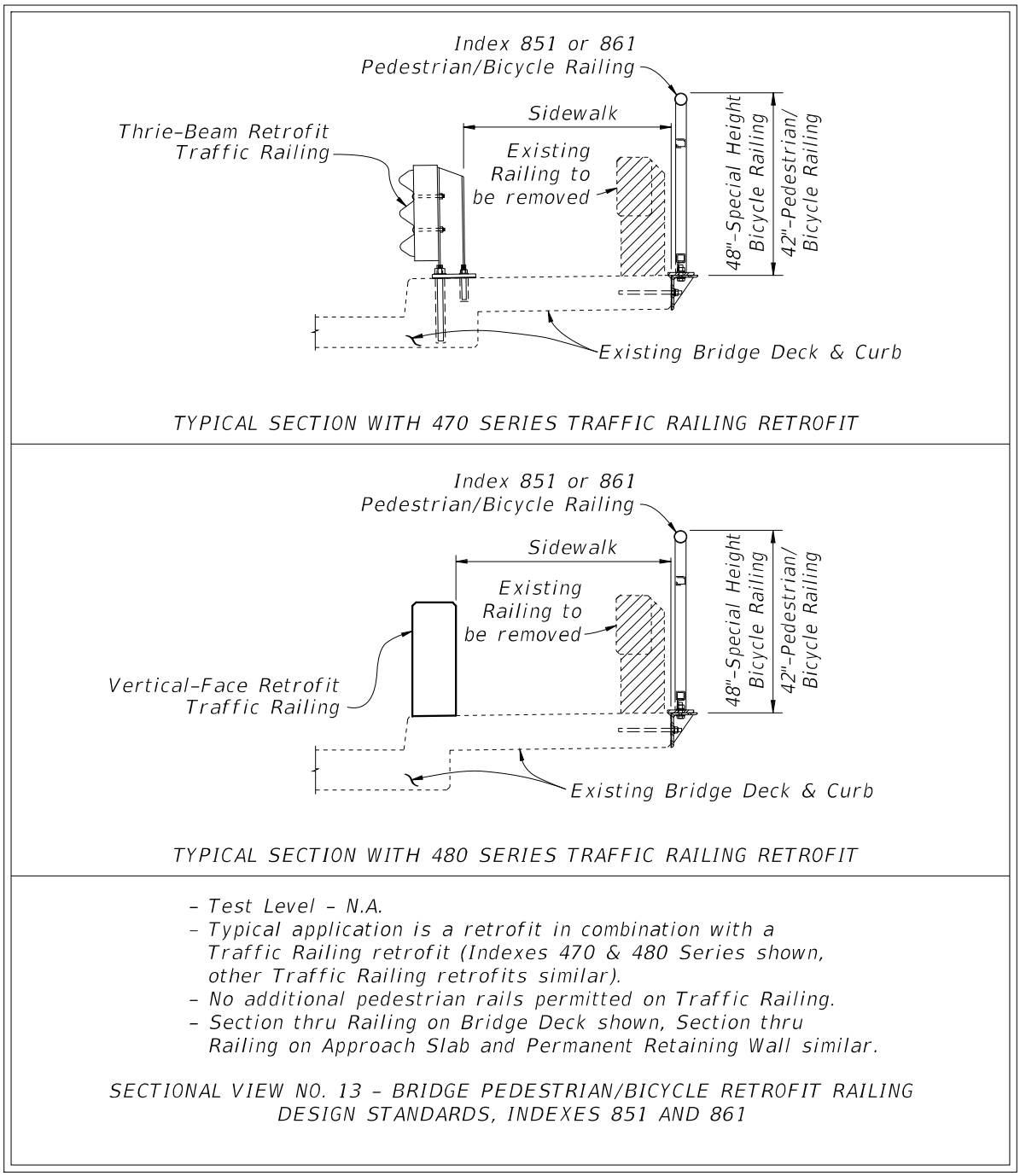
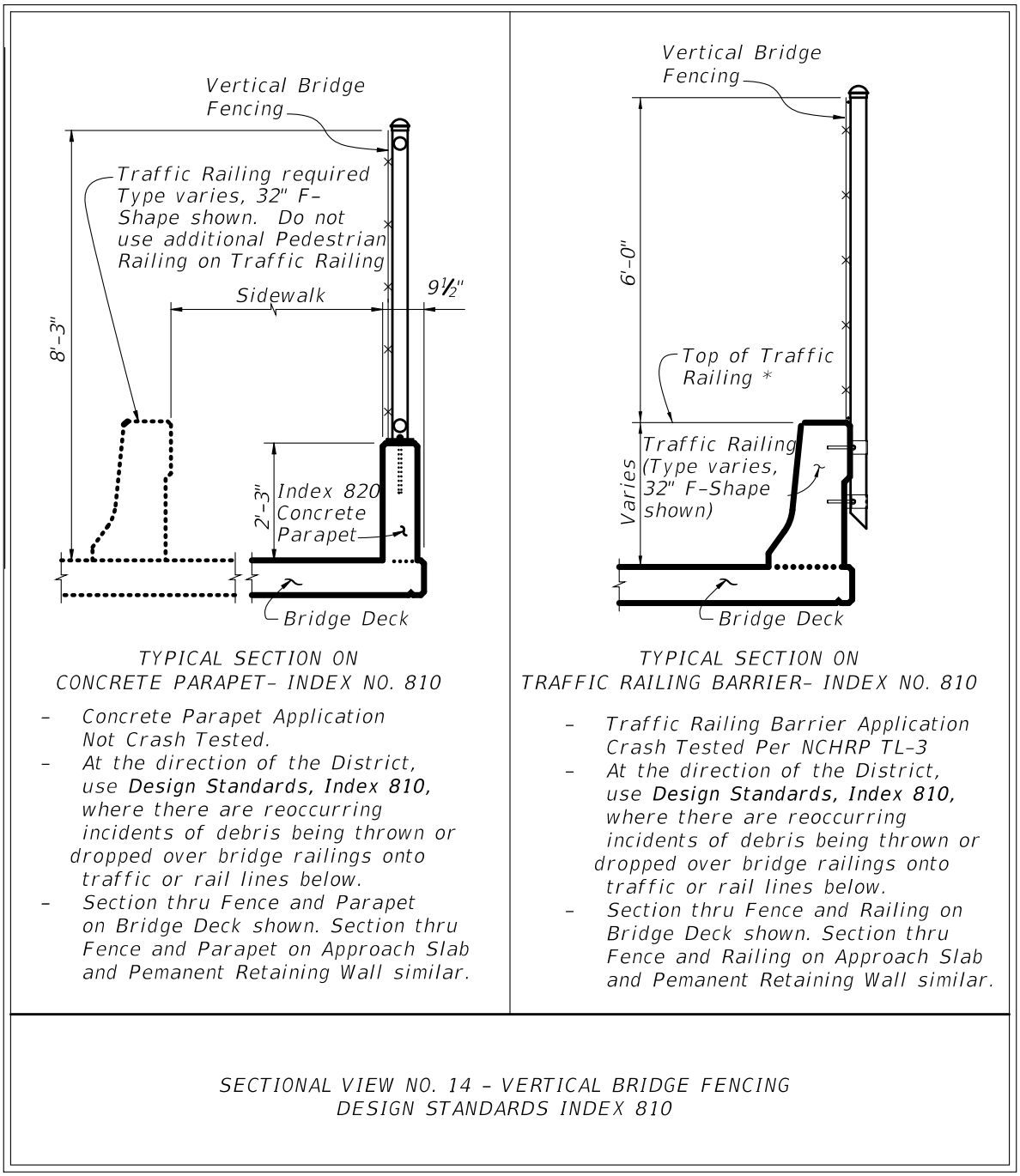


Figure 4.4.9 Bridge Railing and Bridge Parapet Fencing



TYPICAL SECTION ON CONCRETE PARAPET- INDEX NO. 810

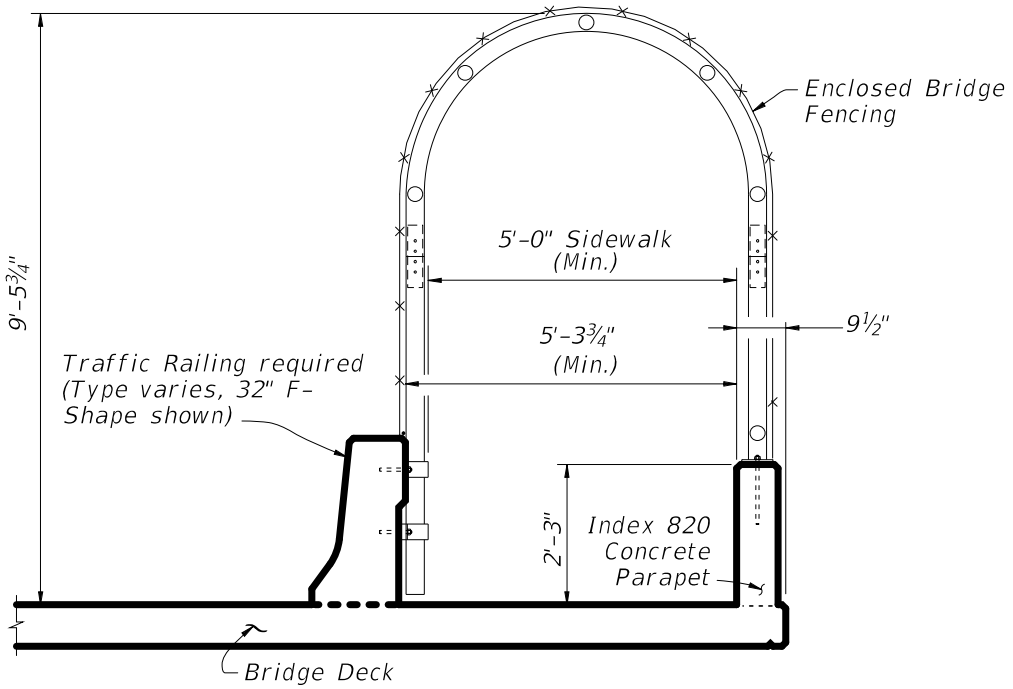
- *Concrete Parapet Application Not Crash Tested.*
- *At the direction of the District, use* ***Design Standards, Index 810,*** *where there are reoccurring incidents of debris being thrown or dropped over bridge railings onto traffic or rail lines below.*
- *Section thru Fence and Parapet on Bridge Deck shown. Section thru Fence and Parapet on Approach Slab and Pemanent Retaining Wall similar.*

TYPICAL SECTION ON TRAFFIC RAILING BARRIER- INDEX NO. 810

- *Traffic Railing Barrier Application Crash Tested Per NCHRP TL-3*
- *At the direction of the District, use* ***Design Standards, Index 810,*** *where there are reoccurring incidents of debris being thrown or dropped over bridge railings onto traffic or rail lines below.*
- *Section thru Fence and Railing on Bridge Deck shown. Section thru Fence and Railing on Approach Slab and Pemanent Retaining Wall similar.*

SECTIONAL VIEW NO. 14 - VERTICAL BRIDGE FENCING DESIGN STANDARDS INDEX 810

Figure 4.4.10 Bridge Railing – Enclosed Fencing



- *Test Level – Fence attachment to traffic railing is based on a TL-3 crash tested design.*
- *At the direction of the District, use* ***Design Standards Index 812*** *when a Traffic Railing, sidewalk and parapet exists on a bridge and when Pedestrian Traffic from schools, residential neighborhoods, playgrounds and recreational facilities is encountered. The Engineer should work with the District to determine when the enclosed fencing option is warranted.*
- *Section thru Fence, Parapet and Traffic Railing on Bridge Deck shown, Section thru Fence, Parapet and Traffic Railing on Approach Slab and Permanent Retaining Wall similar.*

SECTIONAL VIEW NO. 15 – ENCLOSED BRIDGE FENCING
DESIGN STANDARDS INDEX 812

4.4.1.4 Temporary Barriers

Temporary Barriers are used in work zones to protect motorists and to safeguard construction workers while construction actives are taking place (i.e. Positive Protection).

Temporary Barriers include the following:

1. Low Profile Barrier – ***Design Standards***, ***Index 412*** (TL-2, NCHRP 350)
2. Type K Barrier – ***Design Standards***, ***Index 414*** (TL-3, NCHRP 350)
3. Proprietary Temporary Barrier – ***Design Standards***, ***Index 415*** & ***APL*** (TL-2 & TL-3, NCHRP 350 and MASH)

Low Profile Barriers are limited to Work Zone Speeds of ≤ 45 mph and required for urban applications where temporary barrier is needed within 100 feet of an intersection, residential driveway or business entrance. Use of other barriers is not permitted at these locations due to sight distance limitations. Transitions from Low Profile Barrier to other temporary barriers within a run of barrier (i.e. from begin length of need to end length of need) is not permitted.

Type K Barrier is a portable concrete barrier which has the capability of being anchored (i.e. staked or bolted) to limit deflections. See ***Design Standards***, ***Index 414*** for specific requirements for the use of Type K Temporary Concrete Barrier. For requirements of portable concrete barriers used on bridges and retaining wall sections, see the ***SDG, Section 6.7***. Refer to ***Design Standards***, ***Index 414*** for details on transitioning between the Type K Temporary Concrete Barrier on bridges and other concrete barrier systems on the adjoining roadway.

Anchored (bolted) temporary barriers are not permitted on bridge superstructures that contain post-tensioned tendons within the concrete deck (top flange of concrete box girders) or on bridge superstructures consisting of longitudinally prestressed, transversely post-tensioned, solid, or voided concrete slab units.

Proprietary Steel Barriers, Water Filled Barriers and portable concrete barriers must be used in accordance with the Vendor drawings on the ***APL*** and ***Design Standards***, ***Index 415***. To allow for the use of ***APL*** devices the Plans should not refer specifically to 'Temporary Concrete Barrier', unless specific limitations are required. Proprietary steel barriers listed on the ***APL*** are capable of being anchored to limit deflections; however, barrier heights and drainage performance may limit some systems.

If Flexible (HTCB, ***Index D450***) or Semi-Rigid (Guardrail, ***Index 400***) barrier is used in a temporary configuration, or allowed to remain during a portion of the Temporary Traffic Control (TTC) Plan, requirements for the permanent application of barrier must be met (i.e. grading, deflection space, offset from Edge of Traveled Ways, etc.).

4.4.2 End Treatments

Longitudinal barrier ends which are not crashworthy are hazardous if they terminate within the Clear Zone of an approach direction. The Department's crashworthy end treatments for each barrier type (i.e. flexible, semi-rigid, and rigid) are detailed in the Design Standards.

Flexible barrier End Treatments are vendor-specific. For additional information regarding the end treatment of HTCB, refer to IDDS-D450, as referenced above.

4.4.2.1 Guardrail End Treatments

Guardrail End Treatments are necessary to provide crashworthy ends for approaches and anchorage of the guardrail system. For the guardrail to provide adequate redirective capabilities during a vehicle impact, anchorage of the system is needed for tensile (ribbon) strength to develop in the guardrail panels. Approach Terminals provide both anchorage of the guardrail system and a crashworthy approach. End Treatments for guardrail are categorized as follows:

1. Approach Terminals – required for guardrail ends within the Clear Zone of approaching traffic. Guardrail approach terminals must be a proprietary device listed on the ***APL***. Approach Terminals are classified by Test Level (TL-2 for Design Speeds ≤ 45 mph or TL-3, which is acceptable for all Design Speeds) and as follows:
    a. Flared – preferred terminal for locations where sufficient space is available to offset barrier end from approaching traffic.
    b. Parallel – use only when sufficient space is not available for a flared terminal.
    c. Double Face – preferred end treatment for double faced guardrail installations.
2. Crash Cushion – See ***Section 4.4.3***.
3. Trailing End Anchorages (Type II) – required for anchoring of the trailing ends of guardrail. Trailing End Anchorages are considered non-crashworthy as an approach end treatment, and are not permitted as a guardrail end treatments on the approach end within the Clear Zone, unless shielded by another run of barrier. The Type II Trailing End Anchorage, is detailed in the ***Design Standards***, ***Index 400***.

4.4.2.2 Rigid Barrier End Treatments

Rigid Barrier ends must be terminated by either transitioning into another barrier system (e.g. guardrail), or by shielding with a Crash Cushion. Details and requirements are provided in the ***Design Standards***.

Sloped Concrete End Treatments (i.e., the 10' long vertical height transitions detailed on Sheets 12 and 13 of ***Design Standards***, ***Index 410***) are not permitted within the clear zone of approaching traffic lanes unless site-specific justification is provided and approved by the District Design Engineer. When used, sloped end treatments are only permitted for Design Speeds < 40 mph and only when no other more crashworthy solution is available.

Treatment of the trailing end of rigid barriers is not required unless additional hazards exist beyond the rigid barrier or the barrier is within the clear zone of opposing traffic.

4.4.2.3 Temporary Barrier End Treatments

The required treatments for exposed ends of Temporary Barriers are:

1. Connecting to an existing barrier (smooth, structural connections are required - Refer to ***Design Standards, Indexes 410*** and ***414***, or the ***APL***);
2. Shield end with a crash cushion as detailed in the ***Design Standards*** or ***APL*** for the specific type of Temporary Barrier (i.e. Temporary Concrete, Steel, or Water Filled);
3. Attaching or Transitioning to a crashworthy end treatment as described above; or,
4. Flaring outside of the Work Zone Clear Zone (See ***Table 4.2.2***)

Design Standards, Index 415 provides details for shielding exposed ends of temporary concrete barrier wall using crash cushions. A minimum of four (4) units or 50 feet of bolted or staked Type K Barrier is required for temporary concrete barriers attached to a crash cushion.

No modifications to the end treatments included in the ***Design Standards*** or ***APL*** are permitted. Special conditions may require end treatments other than those included above. If this occurs, consult the State Roadway Design Office (RDO***)*** and provide special details in the Plans.

4.4.3 Crash Cushions

Crash cushions (impact attenuators) are used to protect motorists from the exposed ends of barriers, fixed objects and other hazards within the clear zone. They are energy absorbing devices that may be redirective non-gating, or non-redirective gating. Crash cushions are classified based on Test Level and Design Speed, as shown for each system on their respective ***APL*** drawings.

The design of a crash cushion system must not create a hazard to opposing traffic. ***APL*** drawings provide details for transitions for optional barrier types with and without bi-directional traffic.

An impacting vehicle should strike the systems at normal height, with the vehicle's suspension system neither collapsed nor extended. Therefore, the terrain surrounding crash cushions must be flat (1:10 or flatter) in advance of and along the entire design length of the system. Do not locate curbs within the approach area of a crash cushion.

4.4.3.1 Permanent Crash Cushions

Permanent crash cushions must be redirective non-gating. Standard details of systems for typical installations shielding concrete barrier wall ends and guardrail ends can be found on the ***APL*** under ***Section 544***. In addition, some of these systems have standard details for shielding wide hazards. For applications not covered in the ***APL*** drawings, crash cushion vendors normally provide design assistance for their systems. Special designs must be detailed in the Plans and based on meeting the performance criteria for the established design speed of the facility (i.e. barrier system Test Level).

4.4.3.2 Temporary Crash Cushions

Two types of temporary crash cushions are permitted; redirective non-gating crash cushions and non-redirective gating crash cushions. Redirective crash cushions will shield hazards by redirecting errant vehicles impacting the side of the crash cushion and decelerate errant vehicles from a direct, in-line impact at the terminus of the crash cushion by absorbing the energy.

Gating crash cushions are designed to decelerate errant vehicles from a direct, in-line impact at the terminus of the crash cushion by absorbing the energy, but provide no redirective capabilities for side impacts. Gating crash cushions are permitted only with prior approval from the State Roadway Design Office (RDO). They may be appropriate on low speed facilities and in work zones with higher speeds where only low impact angle

hits are expected. An adequate clear runout area must be provided beyond a gating crash cushion (between the departure line and the clear zone). Plan details for site specific design are required.

Approved temporary crash cushions for use on Department contracts are listed on the ***APL*** under ***Section 102***. Sand barrel gating systems are not permitted.

Anchored (bolted) temporary crash cushions are not permitted on bridge superstructures that contain post-tensioned tendons within the concrete deck (top flange of concrete box girders) or on bridge superstructures consisting of longitudinally prestressed, transversely post-tensioned, solid, or voided concrete slab units.

4.4.4 Barrier Transitions

Guardrail transitions are necessary, whenever standard W-Beam guardrail converges with rigid barriers. Guardrail transitions must include sound structural connections, nested panels and additional posts for increased stiffness, as shown in the ***Design Standards***. Use the guardrail transitions included in the ***Design Standards*** as follows:

1. General, Guardrail Approach Transition to Rigid Barrier – ***Design Standards, Index 400*** (Single or Double Face Guardrail, TL-3, MASH), Approved for all Design Speeds.
2. Low Speed, Guardrail Approach Transition to Rigid Barrier – ***Design Standards, Index 400*** (Single Face Guardrail only, TL-2, MASH), Approved for Design Speeds ≤ 45 mph only with Flush Shoulder or Curb.
3. Trailing End Transition Connection – ***Design Standards, Index 400*** (Test Level N/A), Approved for all Design Speeds.

Various other barrier transitions are detailed throughout the ***Design Standards*** and ***APL*** drawings for transitions from temporary barriers to permanent rigid barriers and transitions from variable height/shape rigid barriers.

4.4.5 Barrier Type Selection

The evaluation of numerous factors is required to ensure that the appropriate barrier type is selected for a given application. Provide consideration for the following factors when evaluating each particular site:

1. Barrier Placement requirements (see ***Section 4.4.6***)

2. Traffic characteristics (e.g. vehicles types/percentages, volume, and growth)
3. Site characteristics (e.g. terrain, alignment, geometry, access facility type, access locations, design speed, etc.)
4. Expected frequency of impacts
5. Initial and replacement/repair costs
6. Ease of maintenance
7. Exposure of workers when conducting repairs/maintenance
8. Aesthetics

For additional information about considerations for barrier selections refer to the ***AASHTO RDG***. Document barrier type selection decisions and warrants.

4.4.5.1 Longitudinal Barrier Selection

Refer to the ***SDG*** for barrier type and test level selection of Traffic Railings.

For Longitudinal Barriers along roadways, the three primary options are HTCB, W-Beam Guardrail, and Rigid Barriers. See ***Table 4.4.1*** for information regarding the standard barrier types and relevant selection characteristics.

Table 4.4.1 Roadway Barrier Type Selection

Barrier Type	Deflection Space Requirement (feet)	Order of Bias			Test Level	Design Vehicles
		Initial Cost	Vehicle Impact Severity	Maintenance Cost		
HTCB	12	LOW	LOW	HIGH	TL-4 (NCHRP 350)	Passenger Car, Pickup Truck, & Single-Unit Truck
W-Beam Guardrail	5				TL-2 & TL-3 (MASH)	Passenger Car & Pickup Truck
Modified Thrie-Beam	3				TL-3 & TL-4 (NCHRP 350)	Passenger Car, Pickup Truck, & Single-Unit Truck
Rigid Barrier	0	HIGH	HIGH	LOW	TL-4 & TL-5 (NCHRP 350)	Passenger Car, Pickup Truck, Single-Unit Truck & Tractor-Van Trailer

Specific requirements for the selection of HTCB are provided in ***IDDS-D450***.

Based on the limitations noted in ***Section 4.4.1.2***, the use of Modified Thrie-Beam should be restricted to locations where site specific conditions warrant a more robust guardrail system but not the added cost of rigid barrier system.

4.4.5.2 End Treatment Selection

Select end treatments in accordance with ***Section 4.4.2***, the ***Design Standards*** and the ***Instructions for Design Standards*** (***IDS***) for each applicable barrier type.

4.4.5.3 Crash Cushion Selection

Various types of energy absorbing devices eligible for use on Department projects as Crash Cushions can be found on the Approved Products List (***APL***). Detailed information about these systems is provided in the ***Design Standards***, ***APL***, and in each manufacturer's publications. Each system has unique physical and functional characteristics.

For permanent crash cushion applications, indicate in the Plans the location (station and side), barrier system (concrete barrier wall or guardrail), design length, design speed, crash test level, hazard width and length restriction requirements for each given location (in accordance with ***Design Standards***, ***Index 430***, and ***Chapter 7*** of Volume 2,).

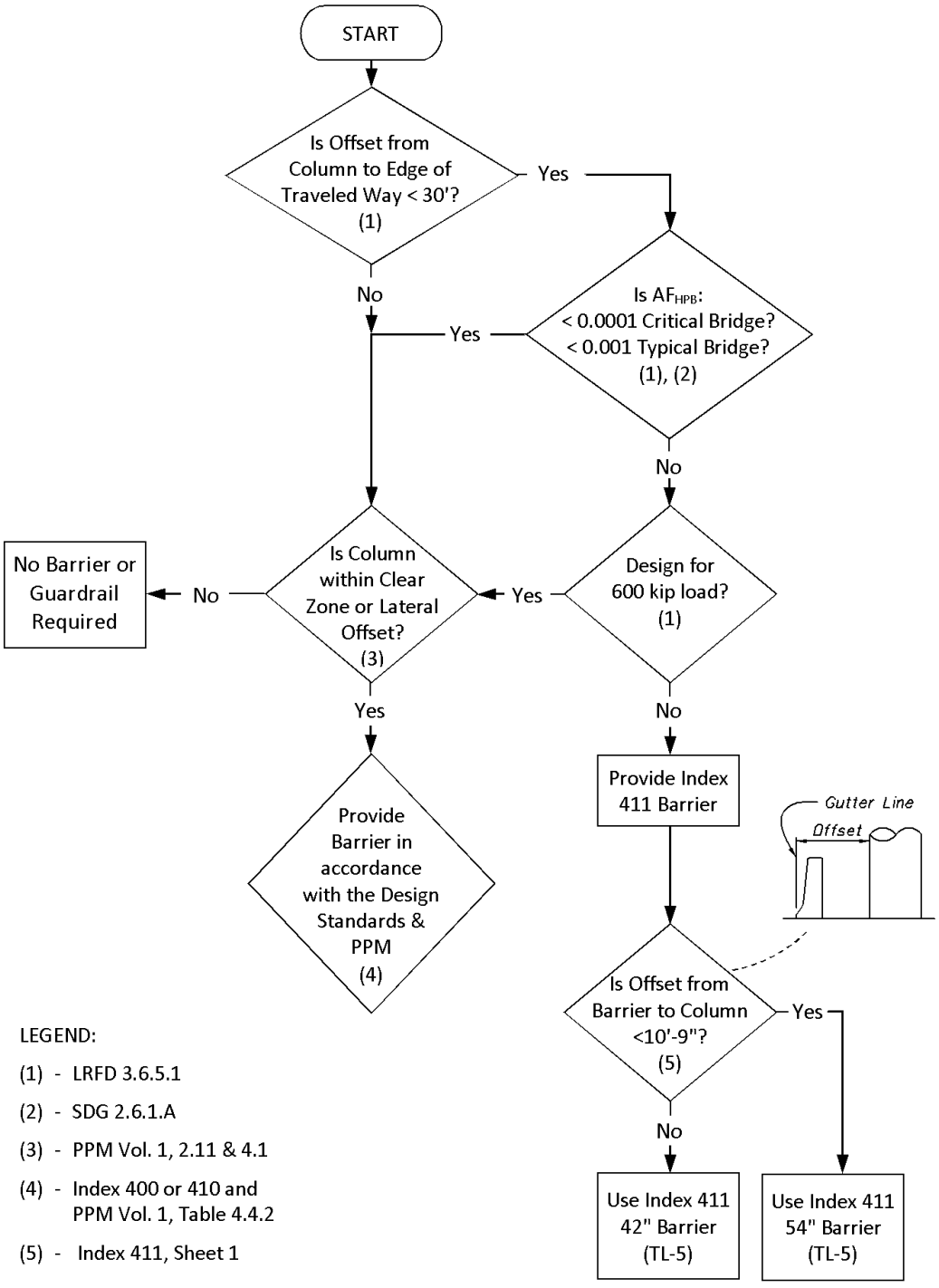
Site characteristics and economics dominate crash cushion selection considerations. Some crash cushion systems are relatively low in initial cost, but usually must be completely replaced when struck, so are more appropriate in locations with a low likelihood of collision. There are a number of other systems that have higher initial costs but can be repaired after collisions relatively quickly and inexpensively, so are more appropriate where frequent collisions are anticipated. The ability of maintenance forces to perform routine maintenance and to place a crashed system back into service quickly should be a major consideration. Do not use crash cushions that require stocking unusual and expensive parts or those that are complex to replace.

4.4.5.4 Pier Protection

In addition to shielding bridge piers to protect motorists from a hazard within the Clear Zone, some bridge piers may need shielding for protection from damage due to design limitations (i.e. piers not designed for vehicular collision forces). Coordination with the Structural Engineer of Record is required to determine if pier protection is warranted.

The requirements for Pier Protection are outlined in the ***SDG, Section 2.6***. The process for determining the appropriate level of Pier Protection for New Construction projects is presented in ***Figure 4.4.11*** (Pier Protection Selection Flowchart). For RRR and railroad requirements, refer to the ***SDG***. Detail Pier Protection barrier in accordance with ***Design Standards, Index 411***.

Figure 4.4.11 Pier Protection Selection Flowchart (New Construction)



4.4.6 Barrier Placement

The primary design factors associated with barrier placement are:

1. Lateral Offset from the Edge of Traveled Way
2. Deflection Space Tolerance
3. Terrain Effects
4. Length of Need
5. Space for End Treatments
6. Outside Shoulder or Median Application

4.4.6.1 Barrier Offset

Offset roadside barriers as far from the travel lanes as practical with consideration for maintaining the proper performance of the barrier. See ***IDDS-D450*** for the barrier placement requirements for HTCB.

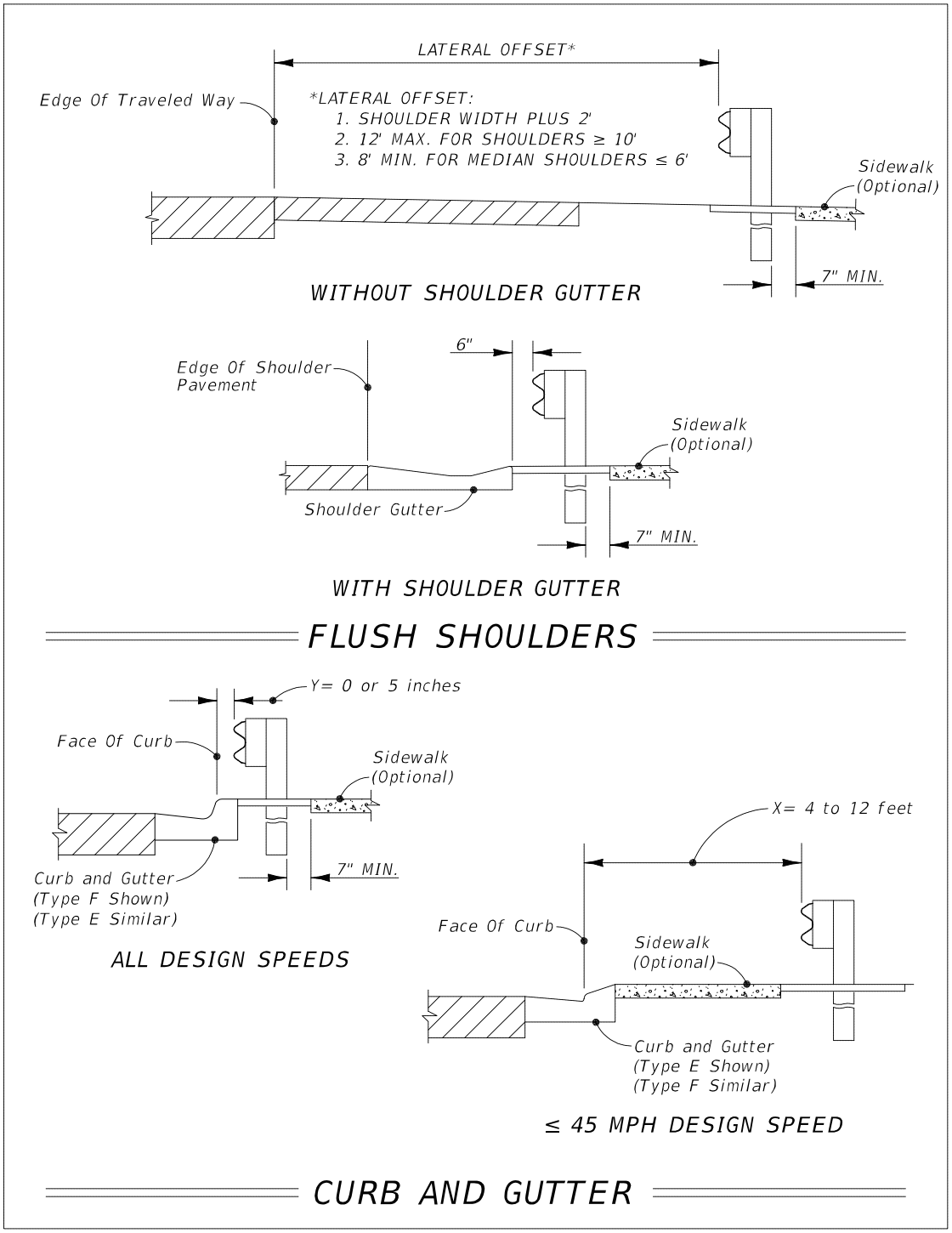
The standard offset for W-Beam Guardrail from the Edge of Traveled Way is the shoulder width plus 2 feet, not to exceed 12 feet. Requirements for guardrail offsets are illustrated in ***Figure 4.4.12***. When curb is present, the preferred configuration is to place the face of the guardrail panel 5 inches from the face of curb. For design speeds ≤ 45 mph, placing the guardrail between 4 feet and 12 feet from the face of curb is also allowable.

The 12 feet maximum offset for guardrail is established to reduce the potential for impacts where the vehicle is behaving significantly different than the crash tested conditions (i.e. non-tracking, fish-tailing, excessive approach angle, etc.). Guardrail offsets greater than 12 feet require site-specific justification in accordance with ***Section 4.4.7***, unless location is based on the requirements of ***Section 4.4.6.4***, ***Median Barrier*** or ***Section 4.3.2, Canal Hazards***.

Rigid Barrier is typically used when there are barrier deflection or right-of-way limitations. Rigid Barrier offsets should be based on site-specific conditions, but as far from the traveled way as possible.

Rigid Barrier, with the exception of F-Shapes with a height less than 42”, may be used in combination with curbs, and provide an acceptable alternative to the areas excluded for guardrail use in ***Figure 4.4.12***.

Figure 4.4.12 Lateral Offset to Guardrail



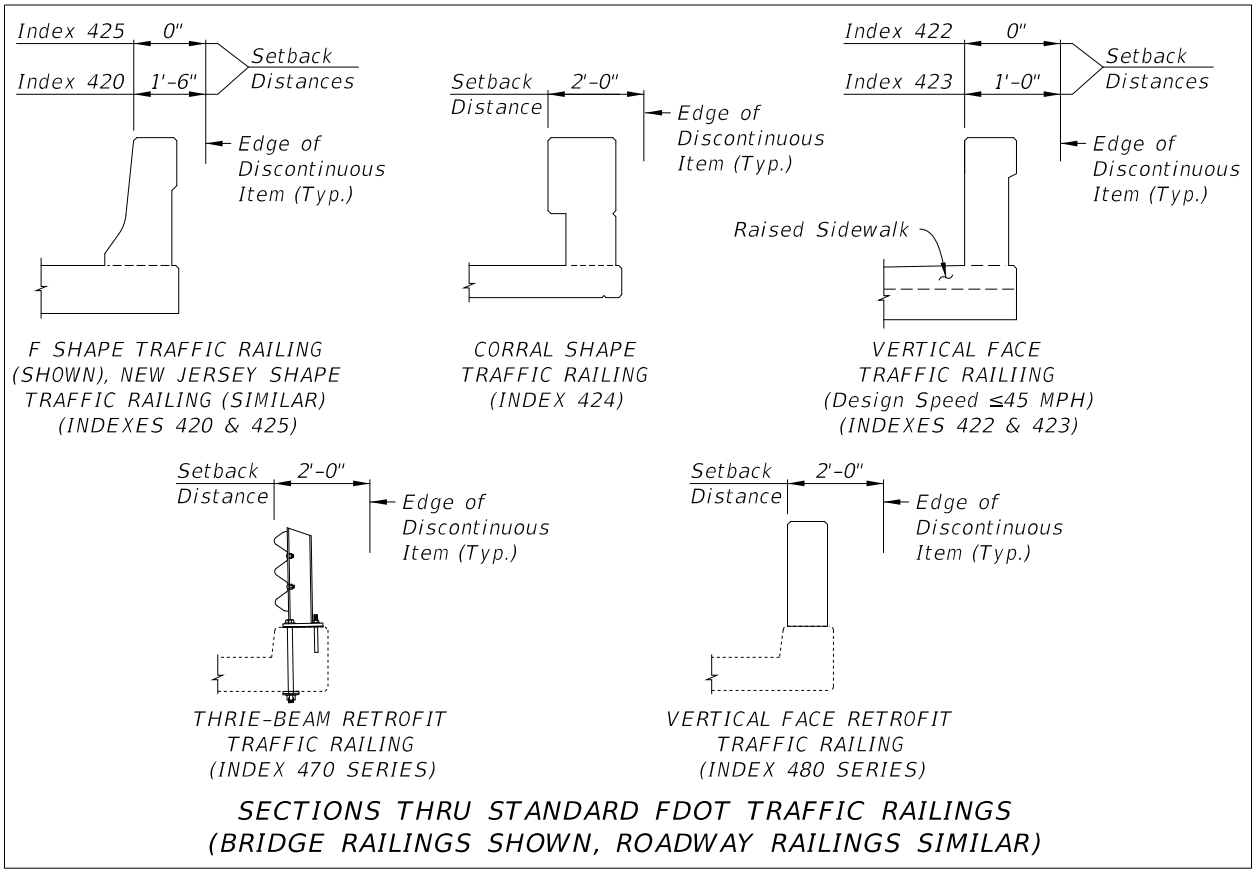
In addition to travel lane lateral offset considerations, an adequate setback must be provided behind the barrier to ensure proper function. For flexible and semi-rigid barriers the setback is based on deflection tolerances and is required to prevent the barrier from contacting aboveground objects.

For rigid barriers the setback is required to keep the area above and behind the barrier face free of obstructions that could penetrate or damage the vehicle compartment. This requirement is based on the Zone of Intrusion (ZOI) concept as described in the ***AASHTO RDG***. ***Table 4.4.2*** provides the Setback requirements for FDOT standard barriers. Additionally, ***Figure 4.4.13*** includes setback distances to rigid barriers for discontinuous elements. These requirements do not apply to devices located within the setback distance detailed in the ***Design Standards*** (e.g. pedestrian/bicycle railing, fencing, noise walls, etc.).

Table 4.4.2 Minimum Barrier Setback (Measured from the face of the barrier)

Barrier Type	Setback Distance
Flexible Barrier	
High Tension Cable Barrier (HTCB)	12’-0”
Semi-Rigid Barrier	
W-Beam with Post Spacing @ 6'-3" (TL-3)	5’-0”
W-Beam with Post Spacing @ 12'-6" (TL-2)	5’-0”
W-Beam with Post Spacing @ 3'-1½" (½ Spacing)	3’-10”
W-Beam with Post Spacing @ 1'-6¾" (¼ Spacing)	3’-2”
Nested W-Beams with Post Spacing @ 3'-1½" (½ Spacing)	3’-0”
Nested W-Beams with Post Spacing @ 1'-6¾" (¼ Spacing)	2’-8”
Deep Post W-Beam installed on 1:2 Slope Break with Post Spacing @ 6'-3" (TL-3)	5’-6”
Modified Thrie-Beam with Post Spacing @ 6’-3”	3’-0”
Rigid-Barrier	
Concrete Barrier < 40” Height Non-crash Tested Continuous or Discontinuous Items Concrete Barrier ≥ 40” Height Non-crash Tested Continuous or Discontinuous Items	 1’-6” 0’-0”
Bridge Traffic Railing < 40” Height Non-crash Tested Continuous Items Non-crash Tested Discontinuous Items	 5’-0” See ***Figure 4.4.13***
Temporary Barriers See “Deflection Space” of applicable ***Design Standards***, ***Index*** or ***APL*** drawing.	

Figure 4.4.13 Setback Distances for Discontinuous Elements



Noise Wall/Traffic Railing combinations located within the setback distance must be crash tested to or accepted as TL-4 under ***NCHRP 350*** or ***MASH-09***. Other continuous items (e.g. glare screens and fences) located within this setback distance must be crash tested to or accepted as TL-3 under ***NCHRP 350*** or ***MASH-09***.

See ***Section 4.5*** for additional information regarding discontinuous attachments to rigid barriers.

4.4.6.2 Grading Requirement

The terrain effects between the traveled way and a barrier can have a significant impact on whether or not a barrier will perform as intended. Proper grading around a barrier will ensure that as a vehicle approaches a barrier its suspension is not dramatically affected, causing the vehicle to underride or override a barrier.

Install barriers on slopes 1:10 or flatter. Continue the slope to a distance at least 2 ft. beyond the barrier (i.e. from either the guardrail post or rigid barrier) before providing a slope break.

With approval of the District Design Engineer and where conditions are constrained, the Deep Post guardrail option, as detailed in ***Design Standards***, Index 400 "Slope Break Condition", may be used in lieu of providing a 2 ft. setback to the slope break point. Coordinate the use of the Deep Post guardrail option with the District Drainage Engineer and District Maintenance Engineer.

Modification for Non-Conventional Projects:
Delete the last paragraph and see RFP for requirements.

Grading is particularly important for barrier ends shielded by crashworthy devices. Provide for the grading requirements around the end treatments as shown in the ***Design Standards***.

For superelevated roadway sections, a maximum 7% algebraic difference is permitted between the travel lanes and shoulder in advance of barriers. See ***Section 4.4.6.5*** for temporary barrier requirements in superelevated roadway sections.

4.4.6.3 Length of Need

The Length of Need (LON) for a particular barrier type is dependent on the design speed, the offset distance to the face of the barrier and the lesser distance to either the back of the hazard or to the clear zone. Establish Length of Need (LON) for installations using the requirements included in the ***Instructions for Design Standards*** (***IDS***) for Guardrail, ***IDS-400*** or the ***Design Standards*** for other standard barrier types. On all facilities, barrier requirements must consider traffic from both directions.

4.4.6.4 Median Barriers

This Section applies to barriers placed in the median for the mitigation of median crossover crashes (i.e., reduce the number of vehicles that might enter opposing lanes of traffic after traversing a median).

Locate median barrier in accordance with guidelines included in the ***AASHTO RDG, Section 6.6*** and in accordance the ***Design Standards***.

The preferred barrier option for median applications is High Tension Cable Barrier (HTCB), provided the requirements of ***IDDS-D450*** can be met. Evaluate other barrier options when the deflection and placement requirements for HTCB cannot be met.

Include Rub Rail on double faced w-beam guardrail installations as shown in ***Design Standards, Index 400***. Based on the shoulder width and as shown in ***Figure 4.4.12***, locate double faced w-beam guardrail at a lateral offset of between 8 feet and 12 feet from the edge of traveled way. For medians with cross slopes of 1:6 of flatter, locate the barrier closest to the traveled way with the most likelihood or history of lane departure (e.g. outside of horizontal curves and sections with outside merge lanes). If median cross slopes greater than 1:6 exist, and HTCB is not feasible, install w-beam guardrail along both sides of the median or consider a grade separated (bifurcated) median with a concrete barrier.

Use concrete median barrier when the barrier offset requirements for flexible or semi-rigid barrier cannot be met or a higher test level barrier is justified. Implement concrete median barrier in accordance with ***Design Standards, Index 410***.

4.4.6.5 Temporary Barriers

Installation instructions and flare rates are given in the ***Design Standards, Indexes 412, 414, 415*** and ***600***.

A temporary or permanent pavement surface with a maximum cross slope of 1:10 is required when a Temporary Barrier is used. The paved surface must extend the full distance of the required deflection space behind the barrier.

Show or note the location of temporary barriers in the Temporary Traffic Control (TTC) Plans. Also provide a Work Area Access Plan for projects with work zones shielded with a barrier. For additional information regarding TTC Plans, refer to ***Chapter 10*** of this Volume.

The presence of barriers on both shoulders may eliminate any effective shoulder width or refuge area. The effective shoulder width is required to ensure an area is available for both disabled vehicles during normal traffic conditions and access for emergency responders during stopped conditions. Therefore, on interstate or freeway projects requiring barriers on both sides of the work zone traveled way, a minimum 10-foot lateral offset from the edge of the traveled way to the barrier is required on at least one side of

the roadway. Bridge construction and associated roadway approaches are exempt from this requirement. Providing this 10-foot lateral offset on arterials and collectors should be considered. For all other applications, provide the minimum lateral offset required per ***Design Standards, Index 415***.

When using existing barrier during a temporary traffic control operation or when 2-way traffic is placed on a facility that is normally one-way, the existing permanent or temporary barriers must be modified as necessary to ensure their proper crashworthiness during the temporary situation. This will include eliminating non-crashworthy end treatments, snag points or other protrusions normally angled away or hidden from approaching vehicles.

Existing permanent barriers used during temporary traffic control operations must meet grading, offset, and setback (i.e. deflection space) requirements for the permanent installation.

Temporary barriers, as defined in ***Section 4.4.1.4***, located in superelevated roadway sections must be installed on the same roadway cross slope as the travel lanes (i.e. no slope break in advance of the barrier).

4.4.7 Warrants for Roadside Barriers

The evaluation of Roadside Safety is highly dependent on site specific conditions and constraints which are unique to a given situation. Therefore the determination as to when shielding is warranted for given hazardous roadside feature must be made on a case-by-case basis, and generally requires engineering judgment. It should be noted that the installation of roadside barriers presents a hazard in and of itself, and as such, the designer must analyze whether or not the installation of a barrier presents a greater risk than the feature it is intended to shield. The analysis should be completed using the *Roadside Safety Analysis Program* (***RSAP***) or in accordance with the *AASHTO Highway Safety Manual* (***HSM***). Refer to ***Section 23.5*** of this Volume for guidance on evaluating the benefits of shielding using ***RSAP*** or the ***HSM***.

4.4.7.1 Evaluation of Roadside Hazards

Roadside barriers are recommended when hazards exist within the clear zone, hazards cannot be cost effectively eliminated or corrected, and collisions with the hazards are more serious than collisions with the barriers.

The following conditions within the clear zone are normally considered more hazardous than a roadside barrier:

1. Drop-off Hazards, as defined in ***Section 4.3.3***.
2. Bridge piers, abutments and railing ends.
3. Non-traversable culverts, pipes and headwalls.
4. Non-traversable parallel or perpendicular ditches and canals.
5. Canals, ponds and other bodies of water (other than parallel ditches).
6. Parallel retaining walls with protrusions or other potential snagging features.
7. Retaining walls at an approach angle with the edge of pavement larger than 7 degrees (1:8).
8. Non-breakaway sign or luminaire supports.
9. Trees greater than 4 inches in diameter measured 6 inches above the ground.
10. Utility poles.
11. Aboveground hazards.

In addition to the above hazards, there are other conditions which merit barrier consideration, such as nearby pedestrian or bicycle facilities, schools, residences or businesses.

4.4.7.2 Shielding Requirements

If natural or man-made hazards, including slopes steeper than 1:3, occur within the clear zone, implement one of the following treatments, in order of priority:

Modification for Non-Conventional Projects:
Delete the sentence above and replace with the following: If natural or man-made hazards, including slopes steeper than 1:3, occur within the clear zone, apply the following treatments, in order of priority:

1. Eliminate the hazard.
    a. Remove the hazard.
    b. Relocate the hazard outside the clear zone.
    c. Make the hazard traversable or crashworthy.
2. Shield the hazard with a longitudinal barrier or crash cushion.
3. Leave the hazard unshielded when any of the following apply:
    - Longitudinal barrier or crash cushion would be a greater hazard than the

hazard to be shielded; or

- The likelihood of striking the hazard is negligible; or
- The expense of shielding the hazard outweighs the benefits in terms of crash reduction as determined through the use of ***RSAP*** or ***HSM*** analyses.

If crash data or safety reports indicate that early treatment of the hazards will result in fewer or less severe crashes, implementing those treatments should be the first order of work.

4.4.7.3 Warrants for Median Barrier

Provide a median barrier on interstate and expressway facilities where reconstruction reduces the median width to less than what is required for the facility. Deviation from this criteria is not permitted. An ***RSAP*** or ***HSM*** analysis may be used to evaluate barrier alternatives and supplement the following requirements.

On Interstate and expressway projects, review crashes that occurred in the most recent 5-year period within the limits of 1 mile in advance of the exit ramp gore to 1 mile beyond the entrance ramp gore. If one or more are determined to be cross median crashes, provide shielding with a median barrier. The District may require shielding outside these areas after reviewing the most recent 5-year crash history.

For High Speed (Design Speed ≥ 50 mph), High Volume facilities that lack full access control, the most recent 5-year cross median crash history must also be reviewed for potential shielding with a median barrier. For these facilities, alignment, sight distance, design speed, traffic volume, median width and frequency of median openings should be evaluated on a case-by-case basis for implementation of median barrier.

4.4.7.4 Positive Protection in Work Zones

For locations where work zone traffic barriers are required, refer to ***Design Standards, Index 600***. Work zone traffic barriers are positive protection devices and temporary barriers that can be easily relocated. They have four specific functions:

1. Protect traffic from entering work areas, such as excavations or material storage sites;
2. Provide positive protection for workers;
3. Separate two-way traffic; and,
4. Protect construction such as false work for bridges and other exposed objects.

The designer should anticipate when and where barriers will be needed and include this information and the quantities on the Plans. At a minimum, consider positive protection devices in work zone situations that place workers at increased risk from vehicular traffic, and where positive protection devices offer the highest potential for increased safety for workers and road users, such as:

1. Work zones that provide workers no means of escape from vehicular traffic (e.g., tunnels, bridges, etc.);
2. Long duration work zones (e.g., two weeks or more at the same location) resulting in substantial worker exposure to vehicular traffic;
3. Projects with anticipated Work Zone Speeds ≥ 45 mph, especially when combined with high traffic volumes;
4. Work operations that place workers close to travel lanes open to traffic; or,
5. Roadside hazards, such as drop-offs or unfinished bridge decks, that will remain in place overnight or longer.

4.5 Attachments to Barriers

Attachments to flexible or semi-rigid barriers (discontinuous or continuous) not detailed in the ***Design Standards*** are not permitted.

Design and detail attachments to rigid barriers in accordance with ***SDG 1.9***. Provide setback distances as shown in ***Table 4.4.2*** and ***Figure 4.4.13*** to non-crash tested discontinuous items (e.g., light poles, sign supports, traffic signal controller boxes, flood gauges, etc.) that are attached to or behind rigid barriers located along the outside shoulder. Discontinuous items located within these setback distances must be crash tested to or accepted as TL-3, at a minimum, under ***NCHRP 350*** or ***MASH-09*** as attachments to traffic railings.

For continuous items attached to rigid barriers, refer to the requirements of ***Section 4.4.6.1***.

Design Standards, ***Index 11871*** can only be used to mount permanent signs to rigid barriers along the shoulder if there is insufficient space for ***Design Standards***, ***Index 11870***, and when the sign is critical to safety. Otherwise, use ***Design Standard***, ***Index 11870***.

Fender access ladders are exempt from these requirements. Sign panels may be placed within the given setback distances, however the setback to the sign support must be increased to assure sign panels do not extend past the top inside face of the traffic railing.

4.5.1 Median Barrier Attachments

Only median barrier mounted lighting in accordance with ***Design Standards, Index 17515*** will be permitted. Overhead sign supports may be located on median traffic railings to reduce span or cantilever lengths and provide more cost effective designs. When placing overhead sign supports on rigid barriers within the median, project specific details that supplement ***Design Standards***, ***Index 410*** (i.e. foundation and reinforcement details) are required to be shown in the Plans.

Do not place single column sign supports on median traffic railings unless AASHTO or FDOT requirements for sign visibility cannot be met by placing the sign supports on the outside shoulder of the roadway or outside shoulder of bridge or roadway traffic railing as shown in ***Figure 4.4.13***. If single column sign supports must be attached to or placed on a median traffic railing, utilize ***Design Standards***, ***Index 11871***. For permanent signs, ***Design Standards***, ***Index 11871*** can only be used for the signs listed in ***Section 7.2.5*** of this Volume.

These requirements also apply to attachments made to back-to-back outside shoulder concrete barriers and traffic railings that are located so close together that the required setback distances cannot be provided for both barriers. However, the concrete traffic railings and supporting decks shown in ***Figure 4.4.13*** that are located back-to-back are exempt from these requirements.

4.5.2 Existing Attachments to Median Barriers and Traffic Railings

Evaluate existing rigid barrier attachments on a case-by-case basis to ensure they are installed in accordance with the provisions of this Section and ***Design Standards***, ***Index 11870***, ***Index 11871***, or ***Index 17515***. Remove existing attachments not meeting these requirements.

4.5.3 Temporary Attachments to Barriers

For temporary/work zone signs, when ***Design Standards***, ***Index 600*** cannot be achieved for post mounted signs, and concrete barrier or traffic railing exists, use ***Design Standards***, ***Index 11871***.

For additional information on the attachment and design of Temporary Lighting in combination with temporary barrier, refer to ***Section 10.12.13*** of this Volume.

4.6 Surface Finishes

Class 5 coatings, tints or stains may be applied to roadway concrete barriers in order to be compatible with the treatment of bridge or retaining wall mounted traffic railings or for corridor uniformity. Approval by the District Design Engineer is required for the use of Class 5 coatings, tints or stains on the outside of concrete roadside barriers. Approval by the Chief Engineer is required for the use of Class 5 coatings, tints or stains on median barriers and the inside and top surfaces of concrete roadside barriers. Abrupt changes of aesthetic treatment of barriers/railings/parapets from a bridge to a roadway should be avoided. See ***SDG***, ***Section 1.4.5*** for the policy on bridge, noise wall and retaining wall surface finishes.

The Department will cover the cost for coating, tints or stains on roadway concrete barriers only as described above. If a Local Maintaining Agency desires a roadway concrete barrier with coatings, tints or stains and the concrete barrier does not qualify for such treatment as determined by the Department, the barrier may be treated with approval by the District Secretary. The Local Maintaining Agency must provide the additional construction funding for the coatings, tints, or stains and must commit to cover the associated maintenance costs for the service life of the barrier.

Modification for Non-Conventional Projects:
Delete ***PPM Section 4.6*** and see RFP for requirements.

4.7 Upgrading Existing Barrier Systems

When existing barrier is present on a project for which reconstruction of the roadside is not required, including RRR projects, the barrier should be reviewed for deficiencies. In making this determination, investigate the existing installation and determine if the barrier meets adequate structural, functional and crashworthy requirements. Any barrier installation which is found to be non-crashworthy or crash tested prior to ***NCHRP 350*** test criteria must be removed or replaced. The investigation should consider the following at a minimum:

1. Whether there is a need for the barrier. If cost effective, the hazard should be removed, relocated, or redesigned and the barrier removed.
2. Length of Need.
3. Proper guardrail panel height.
4. Adequate offset at terminal end.
5. Proper deflection distance between the barrier and the shielded object.
6. Proper placement with respect to the traveled way.
7. Proper placement with respect to the face of curb.
8. Placement on the proper slope.
9. Adequate clear recovery area behind gating end terminals.
10. The overall condition of the barrier installation (e.g. corrosion of metal components, erosion around posts, degradation of wood blockouts/posts, etc.)
11. Post type, condition and spacing.
12. Existing unshielded hazards. For RRR projects, existing roadside hazards within the project corridor should be evaluated for adequate end treatment applications.

In some cases the deficiencies are so obvious that the best course of action is readily apparent. However, many times the deficiencies are marginal and the extent of the barrier upgrade must be based on engineering judgment. Factors which should be considered are:

1. Nature and extent of barrier deficiency.
2. Past crash history.
3. Cost effectiveness of recommended improvement.
4. Whether future scheduled reconstruction or RRR work in the 5 year work program will address the deficiency.

In addition to the above evaluation requirements, roadside safety hardware on RRR projects must comply with the requirements of the following Sections.

4.7.1 Resetting Guardrail

For installations of guardrail where the barrier is determined to be deficient or requires relocating due to other work, but otherwise determined to consist of panels in good condition, the guardrail may be reset. If the guardrail system is determined to be non-reusable, remove and replace with new guardrail. Refer to ***Specification, Section 538*** for additional information on reusable and non-reusable guardrail components.

When resetting existing guardrail, the guardrail will be reinstalled as ***31" Guardrail*** reusing existing guardrail panels and posts (steel only) as shown in the current ***Design Standards, Index 400***. This resetting requires panels be reinstalled with the panel splices located at the midspan. As such, consideration must be given to the effect this will have on the overall system length and if adjustments to the Begin/End Guardrail Station are needed.

Rigid-Barrier Approach Transitions, Approach End Terminals and Trailing Anchorages must be replaced with new hardware, panels, and posts when resetting guardrail.

4.7.2 Existing Longitudinal Roadway Barriers on RRR Projects

Existing longitudinal guardrail sections that do not conform to ***31" Guardrail*** must be upgraded or replaced on RRR projects, with the following exceptions:

1. ***27" Guardrail*** – Existing W-Beam guardrail installations installed to a 1'-9" mounting height (27" top height), meeting the requirements of the ***2013 Design Standards*** with regards to delineation, height, grading, mounting hardware, and consisting of crashworthy end treatments tested to at least ***NCHRP 350***, is acceptable and allowed to remain in place.

2. ***Thrie-Beam Guardrail*** – Existing Thrie-Beam guardrail meeting the installation requirements of ***2013 Design Standards***, and consisting of crashworthy end treatments tested to at least ***NCHRP 350***, is acceptable and allowed to remain in place.

3. ***Steel Blocks*** – Existing ***27" Guardrail*** constructed with steel blocks, which is not being evaluated for upgrading according to the criteria above, may remain in place for projects with Design Speeds ≤ 45 mph.

Replacing or resetting existing ***27" Guardrail*** to meet the ***31" Guardrail*** mounting height requirement is at the discretion of the District. Typically, if 50% or more of an existing run of ***27" Guardrail*** is affected or if the existing installation is extended by 50% or more, the entire run should be replaced or reset with ***31" Guardrail***.

Modification for Non-Conventional Projects:
Delete the last paragraph and see RFP for requirements.

Existing concrete barriers conforming to the current ***Design Standards***, ***Index 410***, New Jersey shape barriers, and approved vertical faced concrete barriers may remain in place. Other concrete barrier shapes must be replaced.

Replacements and new installations must conform to the current ***Design Standards***.

See ***Section 4.4.5.4*** and ***SDG, Section 2.6***, for barrier requirements for Pier Protection.

4.7.3 Existing End Treatments & Crash Cushions on RRR Projects

Ends treatments and crash cushions which have not been crashed tested and approved for use under at least ***NCHRP 350*** must be removed and replaced.

Existing guardrail end treatments must be upgraded or replaced unless they conform to one of the systems identified on the ***APL***, the current ***Design Standards***, or the ***2013 Design Standards***.

Replacements and new installations must conform to the current ***Design Standards***.

End treatments for concrete barrier ends should be evaluated on a case-by-case basis to ensure adequate Length of Need (LON) and crashworthiness. Review the crash history in the vicinity of concrete barrier ends which are not protected by a crash cushion or otherwise transitioned to a guardrail approach end terminal (i.e. Sloped Concrete End Treatments).

4.7.4 Bridge Traffic Railing on RRR Projects

Bridge mounted traffic and pedestrian railings must meet the requirements specified in the ***SDG, Sections 6.7*** and ***6.8***, respectively, except for the cases identified herein. FDOT policy is to bring bridge traffic and pedestrian railings to current standards on bridges that are being widened or rehabilitated and to evaluate them for possible replacement or retrofitting on RRR projects. Bridge traffic and pedestrian railings are required to be evaluated for conformance to current criteria and standards whenever any improvements are made to any bridge or its approach roadway.

An existing structurally continuous narrow or recessed curb post-and-beam bridge traffic railing within a RRR project may be left in place when the following three criteria are met:

1. No structural work is being performed on the bridge;
2. The existing approach roadway alignment or cross section is to remain unchanged; and,
3. There is no crash history or evidence of any impact into the bridge traffic railing.

Evaluate the need to retrofit these railings for compliance with pedestrian railing criteria on a case-by-case basis and retrofit as necessary. See ***IDS-404*** for details of structurally continuous narrow and recessed curb post-and-beam bridge traffic railings.

An existing structurally continuous wide curb post-and-beam bridge traffic railing within a RRR project may be left in place if the above three criteria are met and the Design Speed is ≤ 45 mph. See ***IDS-405*** for details of structurally continuous wide curb post-and-beam bridge traffic railings.

The ***Design Standards, Index 470*** and ***480 Series***, (used in conjunction with ***Design Standards, Index 402***), may be used to retrofit existing obsolete structurally continuous post-and-beam bridge traffic railings and approach guardrail transitions when the bridge traffic railing does not meet the criteria listed above. See ***IDS-477*** for details of obsolete structurally continuous post and beam traffic railings. For additional information, see the ***IDS***'s for the entire ***Index 470*** and ***480 Series***.

All other existing obsolete bridge traffic railings within a RRR project must be brought up to current standards, or a Design Variation must be obtained for the project, providing that railing replacement or retrofit, or entire bridge replacement, is scheduled within a reasonable time.

The Thrie-Beam Guardrail Retrofit and Vertical Face Retrofit shown in the ***Design Standards, Index 470*** and ***480 Series*** respectively, are suitable for retrofitting specific types of obsolete bridge traffic railings. These retrofits provide a more economical solution for upgrading obsolete traffic railings when compared with replacing the obsolete traffic railings and portions of the bridge decks that support them. As these retrofits do not provide for any increase in clear width of bridge deck, and in a few cases actually decrease clear width slightly, they should only be considered for use on existing bridges where adequate lane and shoulder widths are present. Detailed guidance and instructions on the use of these retrofits is included in the ***IDS***'s for the ***Index 470*** and ***480 Series***.

Superseded FDOT Standard Traffic Railings conforming to the designs shown in ***IDS-402***, "A Historical Compilation of Superseded Florida Department of Transportation "Structures Standard Drawings" for "F" and "New Jersey" Shape Structure Mounted Traffic Railings", are both structurally and functionally adequate.

Existing bridge traffic railing retrofits constructed in accordance with ***1987*** through ***2000 Roadway and Traffic Design Standards, Index 401****, Scheme 16, "Guardrail Continuous Across Bridge"* may be left in place provided the following four criteria are met:

1. The retrofit railing is in good condition.
2. There is not a history of severe crashes at the site.
3. The bridge is not on an Interstate or a high-speed-limited-access facility.
4. The dimension from the center of the W-beam guardrail to the roadway surface is at least 1'-9" (1" tolerance acceptable).
5. Approach Transition must be in accordance with the ***2013 Design Standards***, ***Index 403***.

Existing bridge traffic railing retrofits constructed in accordance with ***1987*** through ***2000 Roadway and Traffic Design Standards, Index 401****, Schemes 1 and 19 "Concrete Safety Barrier"* may be left in place provided the height of the railing is at least 2'-5" measured from the roadway surface.

Other former FDOT bridge traffic railings not listed above and any other traffic railings that are not based on crash tested designs are inadequate and must be replaced, retrofitted, or receive a Design Variation, as appropriate, using the criteria included in the ***SDG****.*

Remove existing fences other than those in compliance with ***Design Standards, Indexes 810*** or ***812***, and existing pedestrian railings that are mounted on existing traffic railings located between the shoulder and the sidewalk (a.k.a. "inboard" traffic railings). Replace or retrofit the existing pedestrian railing or fence rather than completely removing it if there is a documented issue of traffic incidents involving pedestrians (at the site before installation of the existing pedestrian railing or fence on the inboard traffic railing) that would likely reoccur if the existing installation were to be removed. Use ***Design Standards, Indexes 810*** or ***812***, or another crashworthy pedestrian railing or fence that is compatible with the traffic railing, as appropriate. Retrofit existing bullet-type railings that are to remain on inboard traffic railings and that do not have the bullet railing member(s) oriented towards the traffic side of the railing to match ***Design Standards***, ***Index 821***.

Retrofit existing installations of ***Design Standards***, ***Index 821***, and other similar bullet-type railings, to include rail splice assemblies and tapered end transitions as shown on ***Design Standards, Index 822*** if they are not present. Retrofit the ends of other existing crashworthy traffic railing mounted pedestrian railings to include a similar tapered end transition, or other appropriate approach end transition, if one is not present.

Remove existing non-crashworthy pedestrian railings and fences that are not mounted on existing traffic railings if they are located within the lateral offset as defined in ***Table 4.2.3***, "*Lateral Offset to Other Roadside Obstacles"*, unless there is a documented issue of traffic incidents involving pedestrians at the site before installation of the existing pedestrian railing or fence that would likely reoccur if it were to be removed.

4.7.5 Guardrail to Bridge Railing Transitions on RRR Projects

For guardrail to bridge rail transition requirements, whether bridge traffic railing is retrofitted or not, meet the requirements of this Section.

Existing guardrail to bridge traffic railing approach and trailing end transitions must be upgraded or replaced unless they conform to one of the following systems:

1. For approach ends of existing standard New Jersey Shape and F-Shape bridge traffic railings:
    a. The nested Thrie-Beam approach transition shown as in the current ***Design Standards*** or the ***2013 Design Standards***, ***Index 400***.

b. For retrofitted installations, the appropriate nested Thrie-Beam transition shown in the current ***Design Standards*** or the ***2013 Design Standards***, ***Index 402***.

c. For a design speed ≤ 45 mph the nested w-beam approach transition shown as ***Detail J*** in the ***1998 Roadway and Traffic Design Standards***, ***Index 400***, Sheet 7 of 21. This detail is also shown in the ***2000 Roadway and Traffic Design Standards***, ***Index 401***, Sheet 1 of 9.

2. For approach ends of existing bridge traffic railing retrofits constructed in accordance with the ***1987 through 2000 Roadway and Traffic Design Standards, Index 401,*** *Schemes 1 and 19, "Concrete Safety Barrier"*:

   a. The appropriate nested Thrie-Beam transition shown in ***Design Standards***, ***Index 402***.

   b. For design speeds ≤ 45 mph the w-beam approach transition shown as ***Detail J*** in the ***1987 Roadway and Traffic Design Standards***, ***Index 400***, Sheet 9 of 13, upgraded as shown in the ***2013 Design Standards***, ***Index 403*** by the installation of a nested section of W-beam guardrail, additional guardrail posts and offset blocks and a transition block if a curb is not present beyond the bridge end.

   c. For design speeds ≤ 45 mph the nested W-beam approach transition shown as ***Detail J*** in the ***1998 Roadway and Traffic Design Standards*** Sheet 7 of 21, upgraded as shown in the ***2013 Design Standards***, ***Index 403*** by the installation of a transition block if a curb is not present beyond the bridge end.

3. For trailing ends of existing bridge traffic railing retrofits constructed in accordance with the ***1987 through 2000 Roadway and Traffic Design Standards, Index 401,*** *Schemes 1 and 19, "Concrete Safety Barrier":*

   a. In the absence of additional hazards on the trailing end, no end treatment is required.

   b. When additional hazards are present on the trailing end, a w-beam trailing end treatment as shown in ***Design Standards***, ***Index 400***.

4. For approach ends of existing structurally continuous Post and Beam bridge traffic railings that are not being retrofitted per ***Section 4.7.4***:

   a. A custom designed nested Thrie-Beam approach transition based the current ***Design Standards***, ***Index 400***.

   b. A nested Thrie-Beam approach transition based on the current ***Design Standards***, ***Indexes 402***, ***404*** or ***405***.

c. A custom designed nested Thrie-Beam approach transition based on the ***1987*** through ***2000 Roadway and Traffic Design Standards****, **Index 401**, Scheme 29.*

5. For trailing ends of existing structurally continuous Post and Beam bridge traffic railings that are not being retrofitted, per ***Section 4.7.4***:

   a. In the absence of additional hazards on the trailing end, no end treatment is required.

   b. When additional hazards are present on the trailing end, a w-beam trailing end treatment as shown in the current ***Design Standards***, ***Index 400*** or the ***1987*** through ***2000 Roadway and Traffic Design Standards***, ***Index 401***.

   c. When additional hazards are present on the trailing end, a custom designed nested Thrie-Beam approach transition based on any design listed in No. 4 above.

Guardrail replacements and new installations connecting to standard New Jersey Shape and F-Shape bridge traffic railings must conform to the current ***Design Standards***, ***Index 400***. For guardrail retrofits connecting to existing bridge traffic railings, see the current ***Design Standards***, ***Indexes 402*** or ***477*** and their associated ***IDS***.

Guardrail replacements, retrofits and new installations connecting to structurally continuous post and beam bridge traffic railings must conform to ***Design Standards***, ***Indexes 404*** or ***405*** and their ***IDS's***. See the ***IDS*** for details of structurally continuous post and beam traffic railings.

4.8 Non-Standard Roadside Safety Hardware

The ***APL*** includes proprietary devices and products that have been evaluated for compliance with FDOT ***Standard Specifications for Road and Bridge Construction*** and the ***Design Standards***. The majority of proprietary roadside safety hardware eligible for use on the State Highway System are identified on the ***APL***. However, the devices included on the ***APL*** may not cover every roadside safety application. Unique situations will sometimes require unique devices. Examples of available devices that are not covered by the ***APL*** include but are not limited to barrier wall gates, aesthetic guardrail, temporary steel barriers, and crashworthy stop gates. When the need arises for a unique crashworthy device not included on the ***APL***, carefully investigate the applicability of the device for the situation, as well as the crash performance characteristics of the device. For some of these devices, the State Roadway Design Office (RDO) may have information and be of assistance in establishing the appropriateness of the device for a given situation.

If a device not included on the ***APL*** or barrier system not detailed in the ***Design Standards*** is deemed appropriate the following supporting documentation is required for approval:

1. FHWA, Federal-Aid Reimbursement Eligibility Letter
2. Crash Test Reports, including review of test results. Performance characteristics must be reviewed, including post impact vehicle behavior and post impact test article deflection, debris scatter, etc.
3. Compatibility with adjacent and/or connecting standard roadside safety devices.
4. Maintenance requirements and characteristics, including coordination with the District Maintenance Office.
5. For devices such as barrier gates, operational plans and training as appropriate.

The use of Non-Standard Roadside Safety Hardware must be approved by the State Roadway Design Office (RDO).

Project specific plan details, technical special provisions (TSP), and method of payment will be required and must be coordinated with the appropriate Department Offices.

Other barrier designs may be required by specific site conditions. Site specific conditions are identified and detailed in the plans on a project-by-project basis.