Chapter Thirty-three

GEOMETRIC DESIGN OF EXISTING HIGHWAYS

BUREAU OF LOCAL ROADS AND STREETS MANUAL

Chapter Thirty-three
GEOMETRIC DESIGN OF EXISTING HIGHWAYS

Table of Contents

Chapter Thirty-three
GEOMETRIC DESIGN OF EXISTING HIGHWAYS

33-1 GENERAL

Chapter 32 presents the design criteria that apply to new construction and reconstruction projects. For these projects, the designer often has the flexibility to design the highway to meet the most desirable and stringent criteria possible. Therefore, exceptions to these criteria should be relatively rare.

Highways constructed to meet nationally recognized design criteria provide measurable advantages for the motoring public. The safety, comfort, and convenience of modern highways present strong incentives for funding programs based on ideal design considerations. However, available finances do not always permit the reconstruction of existing highways to an ideal level. A comparison of statewide needs demonstrates that, with available revenues, problems must be addressed not only at a project level but on a system-wide basis.

Therefore, the geometric design of projects on existing highways must be viewed from a different perspective. These projects are often initiated for reasons such as pavement deterioration rather than geometric design deficiencies, and they often must be designed within restrictive right-of-way, financial limitations, and environmental constraints. As a result, the design criteria for new construction and reconstruction are often not attainable without major and, frequently, unacceptable adverse impacts. At the same time, the local agency must exercise the opportunity to make cost-effective, practical improvements to the geometric design of existing highways and streets.

For these reasons, this chapter provides geometric design values for projects on existing highways that are, in many cases, less than the values for new construction/reconstruction. These criteria are based on a sound engineering assessment of the underlying principles behind geometric design, and on how the criteria for new construction/reconstruction can be legitimately modified to apply to existing highways while still providing a safe highway facility. These criteria are intended to find the balance among many competing and conflicting objectives. These include the objective of improving local agency's existing highways; the objective of minimizing the adverse impacts of highway construction on existing highways; and the objective of improving the greatest number of miles (kilometers) within the available funds.

33-2 3R POLICIES

33-2.01 Background

The *Federal-aid Highway Act of 1976* amended the term "construction" to permit Federal-aid funding of resurfacing and widening and resurfacing of existing rural and urban pavements with or without revision to the horizontal or vertical alignment or other geometric features. The 1982 *Surface Transportation Assistance Act* stipulated that resurfacing, rehabilitation, and restoration (3R) projects be constructed to standards to preserve and extend the service life of highways and enhance safety. Section 49-2 of the *BDE Manual* provides further history on the background and development of 3R criteria for existing highways and streets.

33-2.02 Objectives

From an overall perspective, the 3R program is intended to improve the greatest number of highway miles (kilometers) with the available funds for highway projects. "Improve" is meant to apply to all aspects that determine a facility's serviceability, including:

- the structural integrity of the pavement, bridges, and culverts;
- the drainage design of the facility to provide pavement drainage and to prevent roadway flooding during the design-year storm;
- from a highway capacity perspective, the level of service provided for the traffic flow;
- the adequacy of access to abutting properties;
- the geometric design of the highway to safely accommodate expected vehicular speeds and traffic volumes;
- the roadside safety design to reduce, within some reasonable boundary, the adverse impacts of run-off-the-road vehicles; and
- the traffic control devices to provide the driver with critical information and to meet driver expectancies.

The objectives of 3R projects are summarized as follows:

1. 3R projects are intended to extend the service life of the existing facility and to return its features to a condition of structural or functional adequacy. This includes providing smoother riding surfaces and structurally improving bridges.

2. 3R projects are intended to enhance highway safety. This includes upgrading roadside safety and improving identified high-crash locations and over-represented crash locations.

3. 3R projects are intended to incorporate cost-effective, practical improvements to the geometric design of the existing facility. This includes increasing roadway and bridge widths and providing spot improvements to correct alignment deficiencies.

To achieve these objectives, IDOT has adopted its policy for the geometric design of 3R projects.

33-2.03 Application

The design policies and criteria in Sections 33-2 and 33-3 apply to 3R projects using Federal, State, or MFT funds on existing facilities within the general constraints of the existing alignment and right-of-way. Section 33-2.04 contains guidance on when it is appropriate to replace a pavement using 3R guidelines. If the purpose and scope of the project is intended to replace or expand the facility, then Chapter 33 is not appropriate, and reconstruction criteria will apply. For definitions and application to new construction and reconstruction projects, see Section 27-2.

The criteria presented in Sections 33-2 and 33-3 apply to the following local agency facilities that is functionally classified as:

- rural and urban local roads and streets,
- rural and urban collectors, and
- urban arterial streets.

For suburban and rural arterials, see the 3R criteria presented in Chapter 49 of the *BDE Manual*.

The local agency may use either the criteria in Sections 33-2 and 33-3 or the criteria in Chapter 32 when designing a 3R project.

33-2.04 3R Project Evaluation

Section 33-3 presents the specific geometric design and roadside safety criteria that will be used to define the scope of 3R projects. Items not discussed in Section 33-3 do not need to be considered in the development of a 3R project. In addition, the designer should consider several other factors and conduct applicable technical evaluations. The potential evaluations are discussed below:

1. Conduct Field Review. The local agency should normally conduct a thorough field review of the proposed 3R project to ascertain the appropriateness of 3R criteria and on-site conditions and their effects on project development decisions. Other personnel should accompany the designer as appropriate, including personnel from the district. Objectives of the field review should be to collect relevant field data, to identify potential

safety problems, and to determine the type of improvements to the facility needed to extend its service life.

2. Document Existing Geometrics. The designer will normally review the most recent as-built highway plans and combine this with the field review to determine the adequacy of the existing geometrics within the project limits. The review includes lane and shoulder widths, horizontal and vertical alignment, intersection geometrics, and the roadside safety design. A field survey may also be needed to verify certain geometric features.

3. Crash Data. Crash data and analysis of the data are critical to the identification of problem areas. This should include the following:

   - Evaluate the last three years of crash data available from the IDOT Division of Traffic Safety and from the local agency's records.
   - Identify over-represented crash trends and High Accident Locations (HAL) and propose appropriate countermeasures.
   - Evaluate Wet-Pavement Crash Location clusters in accordance with the Illinois Skid-Accident Reduction Program.

4. Right-of-Way (ROW) Acquisition. 3R projects are generally constructed within the constraints of the existing ROW. However, ROW acquisition is sometimes justified for 3R projects to flatten slopes, for changes in horizontal and vertical alignment, and for safety enhancements. Therefore, determine the improvements that will be incorporated into the project design as early as feasible. If significant right-of-way can be obtained, give consideration to using the criteria for new construction or reconstruction presented in Chapter 32.

5. Pavement Condition. 3R projects are often programmed because of a significant deterioration of the pavement structure. The extent of deterioration will influence the decision on whether a project can be designed using the 3R design criteria or whether it should be designed using new construction/reconstruction criteria. The use of the 3R Policy for full-depth pavement replacement may be justified in some instances. This includes projects with short sections of pavement replacement within longer project lengths and projects where the existing alignment is adequate, but the pavement needs to be replaced and the existing R.O.W. width is too narrow to accommodate the required side slopes and clear zones for reconstruction. See Chapter 37 for the policies, procedures, and criteria for the rehabilitation of existing pavements.

6. Geometric Design of Adjacent Highway Sections. Consistency is an important factor to be considered in the development of 3R projects. The designer should examine the geometric features and operating speeds of highway sections adjacent to the 3R project. This will include investigating any highway improvements in the planning stages. The 3R project should provide design continuity with the adjacent sections. This involves a consideration of factors such as driver expectancy, geometric design consistency, and proper transitions between sections of different geometric designs. Continuity of design

may justify constructing certain highway elements to higher or lower design criteria than normally prescribed.

7. Level of Service. 3R projects are based on current traffic; however, consider if the 3R project will adequately accommodate traffic during the design life of the project. Except for relatively short sections, 3R work does not include the addition of continuous through lanes that change the basic number of lanes throughout the project.

8. Physical Constraints. The physical constraints within the limits of the 3R project may determine what geometric improvements are practical and cost-effective. These include topography, adjacent development, right-of-way, utilities, and environmental constraints. Identified safety countermeasures relative to impacts and costs should be considered and an appropriate balance achieved. The designer should work with the district to identify possible geometric and safety deficiencies that will remain in place (i.e., no improvement will be made.

9. Traffic Control Devices. Ensure all signing and pavement markings on 3R projects meet the criteria of the *ILMUTCD*.

10. Urban Streets. Urban widening and resurfacing may include lane widening, addition of auxiliary lanes, channelization, median installation, revision of median type, median widening, resurfacing in conjunction with appropriate widening, new or replaced curb and/or gutter, curb ramps for the disabled, pavement markings, landscaping, highway lighting, and any associated adjustments.

11. Bridges within Project Limits. One or more bridges may be within the limits of a 3R project. If bridge improvements are needed, they may be performed prior to, simultaneous with, or deferred from highway projects in accordance with the priorities established in Section 33-3.13.

    Highway bridge improvements include all work necessary for the improvement of existing rural or urban bridges to be consistent with 3R objectives for increased safety, improved operating conditions, and structural adequacy. Bridge improvements could include complete replacement of a bridge when no other cost-effective means of meeting these criteria are feasible. For definition and clarification, a bridge constructed at a different location or an existing bridge requiring replacement of all elements as a part of a 3R project is designated as a replacement rather than a new bridge. New bridge designations are reserved for new construction/reconstruction projects because they generally are subject to different width requirements than replacement bridges.

12. Design Variances. The use of lower design criteria than that described in Section 33-3 or Chapter 32 will require approval from IDOT. Where variances from these criteria are necessary, they should be processed according to the procedures described in Section 27-7. There are no minimum design criteria for the geometric design elements not addressed in Section 33-3.

13. Spot Improvements. Recently completed spot improvements (e.g., safety or bridge projects) may be considered for omission from 3R projects. The proposed limits of an omission should be identified and the omissions reviewed to ensure that the omissions are in accordance with 3R policies. Identify and address any variances to the 3R criteria in accordance with the 3R procedures. For Federally funded projects, all applicable features within the limits of the spot improvement should be discussed at district coordination meetings and included in the Project Development Report.

33-3 3R GEOMETRIC DESIGN CRITERIA

33-3.01 Tables of Design Criteria

Figures 33-3A through 33-3E present summary tables of the design criteria for the geometric design of local agency 3R projects. They apply to local agency 3R projects for roads and streets functionally classified as local and collectors in both rural and urban areas, and for arterials in the urban areas. The criteria for suburban and rural arterials can be found in Chapter 49 of the *BDE Manual*. The designer should consider the following in the use of these tables:

1. Functional Classification. The selection of design values depends on the functional classification of the highway facility. Functional classification is discussed in Section 27-3. The first step in the design process is to determine the functional classification of the proposed improvement. If the classification is unknown, contact the district.

2. Manual Section References. These tables are intended to provide a listing of design values for easy use. However, the designer should review the *Manual* section reference for more information on the design elements.

3. Footnotes. The tables include many footnotes, which are identified by a number in parentheses. The information in the footnote is critical to the proper use of these design tables.

4. Cross Section Elements. The designer should realize that some of the cross section elements included in a table (e.g., median width) are not automatically warranted in the project design. The values in the tables will only apply after the decision has been made to include the element in the highway cross section.

5. Bridge Elements. Design criteria for bridge elements are provided in Section 33-3.13.

6. Controlling Design Criteria. Controlling design criteria are the elements judged to be the most critical indicators of highway safety and overall serviceability. The tables provide an asterisk to indicate controlling design criteria. Section 27-7 discusses this in more detail and presents the process for approving design variances to controlling criteria.

33-3.02 Design Speed

Figures 33-3A through 33-3E provide the minimum design speed based on functional classification of the facility. The selected design speed may be the regulatory speed or the posted speed, if it is less than the design speed for the functional classification. In urban and suburban areas, use a maximum design speed of 45 mph (70 km/h) where there is a two-way left-turn lane (TWLTL) in the street/highway design, and/or where there is continuous curbing used to delineate the edges of the traveled way.

Design Element				Manual Section	Design Volume (veh/day)			
					Under 400 ADT	400 – 1000 ADT	1000-3000 ADT	Over 3000 ADT
Design Controls	Design Forecast Year			27-6.02	Current	Current	Current	Current
	*Minimum Design Speed (1)	Level		27-5.03	40 mph	50 mph	50 mph	55 mph
		Rolling			30 mph	40 mph	40 mph	50 mph
	*Level of Service			27-6.04	Existing	Existing	Existing	Existing
Cross Section Elements	*Traveled Way Width			31-1.01	18′	22′ (2)	22′ (2)	24′ (2)
	Surface Type			Chapter 37	Aggregate Surface/ Bituminous Treated	High-Type Pavement	High-Type Pavement	High-Type Pavement
	*Shoulder Width			31-1.06	2′ (3a)	4′ (3b)	4′ (3b)	6′ (3b)
	Shoulder Type				Turf (4a) or Aggregate Wedge (4b)		Aggregate Wedge (4b)/Aggregate (4c)	
	*Auxiliary Lanes	Lane Width		31-1.03	9′	Des: 11′ Min: 10′	Des: 11′ Min: 10′	Des: 12′ Min: 11′
		Shoulder Width			2′	4′	4′	Des: 6′ Min: 4′
	Cross Slope	*Travel Lane (5a)		31-1.08	2% - 4% (5b)	1.5% - 2%	1.5% - 2%	1.5% - 2%
		Shoulder			Turf: 5-8% Agg: 4-6%	Turf: 5-8% Agg: 4-6%	Agg: 4-6% Paved: 4%	Agg: 4-6% Paved: 4%
		Rollover Factor (6)			12%	12%	12%	10%
Roadway Slopes	Side Slopes (7)	Cut Section	Front Slope	31-2.03 31-2.04	Existing	Existing	Existing	Existing
			Ditch Width		Existing	Existing	Existing	Existing
			Back Slope		Existing	Existing	Existing	Existing
		Rock Cut			Existing	Existing	Existing	Existing
		Fill Section			Existing	Existing	Existing	Existing

* Controlling design criteria (see Section 27-7).

GEOMETRIC DESIGN CRITERIA FOR RURAL TWO-LANE COLLECTORS (3R Projects)

Figure 33-3A (US Customary)

Design Element				Manual Section	Under 400 ADT	400 – 1000 ADT	1000 - 3000 ADT	Over 3000 ADT
					Design Volume (vehicles/day)			
Design Controls	Design Forecast Year			27-6.02	Current	Current	Current	Current
	*Minimum Design Speed (1)	Level		27-5.03	60 km/h	80 km/h	80 km/h	90 km/h
		Rolling			50 km/h	60 km/h	60 km/h	80 km/h
	*Level of Service			27-6.04	Existing	Existing	Existing	Existing
Cross Section Elements	*Traveled Way Width			31-1.01	5.4 m	6.6 m (2)	6.6 m (2)	7.2 m (2)
	Surface Type			Chapter 37	Aggregate Surface/ Bituminous Treated	High-Type Pavement	High-Type Pavement	High-Type Pavement
	*Shoulder Width			31-1.06	600 mm (3a)	1.2 m (3b)	1.2 m (3b)	1.8 m (3b)
	Shoulder Type				Turf (4a) or Aggregate Wedge (4b)		Aggregate Wedge (4b)/Aggregate (4c)	
	*Auxiliary Lanes	Lane Width		31-1.03	2.7 m	Des: 3.3 m Min: 3.0 m	Des: 3.3 m Min: 3.0 m	Des: 3.6 m Min: 3.3 m
		Shoulder Width			600 mm	1.2 m	1.2 m	Des: 1.8 m Min: 1.2 m
	Cross Slope	* Travel Lane (5a)		31-1.08	2% - 4% (5b)	1.5% - 2%	1.5% - 2%	1.5% - 2%
		Shoulder			Turf: 5-8% Agg: 4-6%	Turf: 5-8% Agg: 4-6%	Agg: 4-6% Paved: 4%	Agg: 4-6% Paved: 4%
		Rollover Factor (6)			12%	12%	12%	10%
Roadway Slopes	Side Slopes (7)	Cut Section	Front Slope	31-2.03 31-2.04	Existing	Existing	Existing	Existing
			Ditch Width		Existing	Existing	Existing	Existing
			Back Slope		Existing	Existing	Existing	Existing
		Rock Cut			Existing	Existing	Existing	Existing
		Fill Section			Existing	Existing	Existing	Existing

* Controlling design criteria (see Section 27-7).

GEOMETRIC DESIGN CRITERIA FOR RURAL TWO-LANE COLLECTORS
(3R Projects)

Figure 33-3A (Metric)

1. Design Speed. When the regulatory or posted speed is less than the design speed values in the table, the regulatory or posted speed may be used as the design speed. However, the selected design speed should not be less than 30 mph (50 km/h).

2. Traveled Way Width. On resurfacing only project, the traveled way width may be reduced by 2 ft (600 mm).

3. Shoulder Width.

    a. Where roadside barriers are included, provide a minimum offset of 4 ft (1.2 m) from the edge of the traveled way to the roadside barrier.
    b. Where the rural collector passes through a moderate to high density area, the shoulder width may be 4 ft (1.2 m). This width may include the width of Type B gutter or the gutter flag with curb and gutter at the edge of the shoulder.

4. Shoulder Type.

    a. Turf shoulders should consist of compacted stable roadway embankment or granular material capable of supporting growth and should not contain a high percentage of organic or unstable material.
    b. The width of the aggregate wedge should be 3 ft (900 mm) or equal to the width of the usable shoulder if less than 3 ft (900 mm). The minimum wedge thickness will equal the depth of the resurfacing at the edge of pavement and tapering to zero.
    c. For ADT's > 5000, provide a 6 in (150 mm) thick aggregate shoulder over the full width of a shoulder.

5. Cross Slopes.

    a. Cross slopes for outside auxiliary lanes will be at least 2% and desirably should be 0.5% greater than the adjacent travel lane. Inside auxiliary lane cross slopes are sloped at 1.5% to 2% with high-type pavements.
    b. Use 1.5% to 2% with high-type pavement.

6. Rollover Factor. The maximum rollover factor should be 10% when the shoulder is 6 ft (1.8 m) or wider.

7. Slopes. When the roadway is widened it may be necessary to steepen the existing front and back slopes to remain within the existing right-of-way or to maintain the existing drainage. Where existing right-of-way may permit significant slope flattening or grading, consider flattening slopes, particularly at horizontal curves. See Figure 32-2A for recommended slope criteria.

GEOMETRIC DESIGN CRITERIA FOR RURAL TWO-LANE COLLECTORS (3R Projects)

Footnotes to Figure 33-3A

Design Element				Manual Section	Design Volume (vehicles/day)				
					Under 250 ADT	250 – 400 ADT	400 – 1000 ADT	1000 - 3000 ADT	Over 3000 ADT
Design Controls	Design Forecast Year			27-6.02	Current	Current	Current	Current	Current
	*Design Speed (1)	Level		27-5.02	30 mph (1a, b, c)	40 mph (1c)	50 mph	50 mph	50 mph
		Rolling			30 mph (1a, b, c)	30 mph (1c)	40 mph	40 mph	40 mph
	*Level of Service			27-6.04	Existing	Existing	Existing	Existing	Existing
Cross Section Elements	*Traveled Way Width			31-1.01	18′ (2a, c)	18′ (2c)	22′ (2b)	22′ (2b)	24′ (2b)
	Surface Type			Chapter 37	Bituminous Treated or Aggregate		High-Type Pavement		
	*Shoulder Width			31-1.06	2′ (3a)	2′ (3a)	4′ (3b)	4′ (3b)	6′ (3b)
	Shoulder Type				Turf (4a)	Turf (4a) or Aggregate Wedge (4b)		Aggregate Wedge (4b)/Aggregate (4c)	
	*Auxiliary Lanes	Lane Width		31-1.03	N/A	9′	Des: 11′ Min: 10′	Des: 11′ Min: 10′	Des: 12′ Min: 10′
		Shoulder Width			N/A	2′	Des: 4′ Min: 2′	Min: 4′	Min: 4′
	Cross Slope (5a)	*Travel Lane		31-1.08	2%-4% (5b)	2%-4% (5b)	1.5%-2%	1.5%-2%	1.5%-2%
		Shoulder			Turf: 5-8%	Turf: 5-8% Agg: 4-6%	Turf: 5-8% Agg: 4-6%	Agg: 4-6% Paved: 4%	Agg: 4-6% Paved: 4%
		Rollover Factor (6)			12%	12%	12%	12%	10%
Roadway Slopes	Side Slopes (7)	Cut Section	Front Slope	31-2.03 31-2.04	Existing	Existing	Existing	Existing	Existing
			Ditch Width		Existing	Existing	Existing	Existing	Existing
			Back Slope		Existing	Existing	Existing	Existing	Existing
		Rock Cut			Existing	Existing	Existing	Existing	Existing
		Fill Section			Existing	Existing	Existing	Existing	Existing

* Controlling design criteria (see Section 27-7).

GEOMETRIC DESIGN CRITERIA FOR RURAL TWO-LANE LOCAL ROADS (3R Projects)

Figure 33-3B (US Customary)

Design Element				Manual Section	Design Volume (vehicles/day)				
					Under 250 ADT	250 – 400 ADT	400 – 1000 ADT	1000 - 3000 ADT	Over 3000 ADT
Design Controls	Design Forecast Year			27-6.02	Current	Current	Current	Current	Current
	*Design Speed (1)	Level		27-5.02	50 km/h (1a, b, c)	60 km/h (1c)	80 km/h	80 km/h	80 km/h
		Rolling			50 km/h (1a, b, c)	50 km/h (1c)	60 km/h	60 km/h	60 km/h
	*Level of Service			27-6.04	Existing	Existing	Existing	Existing	Existing
Cross Section Elements	*Traveled Way Width			31-1.06	5.4 m (2a, c)	5.4 m (2c)	6.6 m (2b)	6.6 m (2b)	7.2 m (2b)
	Surface Type				Bituminous Treated or Aggregate		High-Type Pavement		
	*Shoulder Width			31-1.01	600 mm (3a)	600 mm (3a)	1.2 m (3b)	1.2 m (3b)	1.8 m (3b)
	Shoulder Type			Chapter 37	Turf (4a)	Turf (4a) or Aggregate Wedge (4b)		Aggregate Wedge (4a)/Aggregate (4b)	
	*Auxiliary Lanes	Lane Width		31-1.03	N/A	2.7 m	Des: 3.3 m Min: 3.0 m	Des: 3.3 m Min: 3.0 m	Des: 3.6 m Min: 3.0 m
		Shoulder Width			N/A	600 mm	Des: 1.2 m Min: 600 mm	Min: 1.2 m	Min: 1.2 m
	Cross Slope (5a)	*Travel Lane		31-1.08	2%-4% (5b)	2%-4% (5b)	1.5%-2%	1.5%-2%	1.5%-2%
		Shoulder			Turf: 5-8%	Turf: 5-8% Agg: 4-6%	Turf: 5-8% Agg: 4-6%	Agg: 4-6% Paved: 4%	Agg: 4-6% Paved: 4%
		Rollover Factor (6)			12%	12%	12%	12%	10%
Roadway Slopes	Side Slopes (7)	Cut Section	Front Slope	31-2.03 31-2.04	Existing	Existing	Existing	Existing	Existing
			Ditch Width		Existing	Existing	Existing	Existing	Existing
			Back Slope		Existing	Existing	Existing	Existing	Existing
		Rock Cut			Existing	Existing	Existing	Existing	Existing
		Fill Section			Existing	Existing	Existing	Existing	Existing

* Controlling design criteria (see Section 27-7).

GEOMETRIC DESIGN CRITERIA FOR RURAL TWO-LANE LOCAL ROADS (3R Projects)

Figure 33-3B (Metric)

1. Design Speed. The design speed may be reduced to the posted or regulatory speed if less than the values in the figure, but should not be less than 30 mph (50 km/h) with the following exceptions:

   a. For ADT's under 50 vehicles/day the design speed may be 20 mph (30 km/h).
   b. For projects constructed with other than Federal funds on the district road system with ADT's fewer than 150 vehicles/day, no design speed is required.
   c. For highway-rail grade crossing approaches constructed with other than Federal funds on the district road system, the design speed may be reduced by 10 mph (15 km/h);); however, the crossing surface should be at the same plane as the top of the rails for a distance of 2 ft (0.6 m) outside the rails and the surface of the highway should also not be more than 3 in (75 mm) higher or lower than the top of the nearest rail at a point 30 ft (9 m) from the rail unless track superelevation makes a different level appropriate.

2. Traveled Way Width.

   a. For projects constructed with other than Federal funds on the district road system with ADT's fewer than 150 vehicles/day, the minimum width is 16 ft (4.8 m).
   b. On resurfacing only projects the traveled way width may be reduced by 2 ft (600 mm).
   c. For highway-rail grade crossings constructed with other than Federal funds on the district road system, the traveled way width may be 16 ft (4.8 m) or the existing traveled way width, whichever is greater.

3. Shoulder Width.

   a. Where roadside barriers are included, provide a minimum offset of 4 ft (1.2 m) from the edge of the traveled way to the roadside barrier.
   b. Where the rural local road passes through a moderate to high density area, the shoulder width may be 4 ft (1.2 m). This width may include the width of Type B gutter or the gutter flag with curb and gutter at the edge of the shoulder.

4. Shoulder Type.

   a. Turf shoulders should consist of compacted stable roadway embankment or granular material capable of supporting growth and should not contain a high percentage of organic or unstable material.
   b. The width of the aggregate wedge should be 3 ft (900 mm) or equal to the width of the usable shoulder if less than 3 ft (900 mm). The minimum wedge thickness will equal the depth of the resurfacing at the edge of pavement and tapering to zero.
   c. For ADT's > 5000, provide a 6 in (150 mm) thick aggregate shoulder over the full width of a shoulder.

5. Cross Slopes.

   a. Cross slopes for outside auxiliary lanes will be at least 2% and desirably should be 0.5% greater than the adjacent travel lane.
   b. Use 1.5% to 2 % for high-type pavements.

6. Rollover Factor. The maximum rollover factor s 10% when the shoulders are 6 ft (1.8 m) or wider.

7. Side Slopes. Where the roadway is widened, it may be necessary to steepen the front and back slopes to remain within existing right-of-way and maintain existing drainage. Where existing right-of-way may permit significant slope flattening or grading, consider flattening slopes, particularly at horizontal curves. See Figure 32-2B for recommended slope criteria.

GEOMETRIC DESIGN CRITERIA FOR RURAL TWO-LANE LOCAL ROADS
(3R Projects)
Footnotes to Figure 33-3B

Design Element			Manual Section	Two-Way DHV < 1400 (1)	Two-Way DHV 1400-2400 (1)	Two-Way DHV 2400-3400 (1)
Design Controls	Highway Type		—	TWS-2	TWS-4	TWS-6
	Design Forecast Year		27-6.02	Current	Current	Current
	* Design Speed		27-5.02	30 mph – 40 mph	30 mph – 40 mph	30 mph – 40 mph
	* Level of Service		27-6.04	D	D	D
Cross Section Elements	* Surface Width	Number of Travel Lanes	31-1.02	2	4	6
		Travel Lane	31-1.01	Des: 11′ Min: 10′	Des: 11′ Min: 10′	Des: 11′ Min: 10′
		Travel Lane (Shared with Bicycles)	42-3.03	Des: 14′ Min: 13′	Des: 14′ Min: 13′	Des: 14′ Min: 13′
		Parking Lane (2)	31-1.04	8′	8′	8′
		Auxiliary Lane (2)	31-1.03	Single Left & Right: Des: 11′, Min: 10′	Dual Lefts: Des: 22′, Min: 20′	
	Cross Slope	*Travel Lanes (Minimum)	31-1.08	1.5% - 2%	1.5% - 2% (3a)	1.5% - 2% (3a)
		Auxiliary Lanes		2% (3b)	(3b)	(3b)
	Outside Curb and Gutter Type		31-1.07	B-6.24, B-6.18 or B-6.12 CC&G (4)		
	Median Width	Flush/TWLTL (5)	31-1.06	N/A/11′	Existing/11′	Existing/11′
		Traversable		N/A	Existing	Existing
		Raised-Curb		N/A	Existing	Existing
	Sidewalk Width (6)		31-2.02	Des: 5′ Min: 4′	Des: 5′ Min: 4′	Des: 5′ Min: 4′
	* Clear Zone (7)		35-2	1.5′	1.5′	1.5′
Roadway Slopes	Side Slopes (8)	Cut Section (Curbed)	31-2.03	—	—	—
		Rock Cut		—	—	—
		Fill Section (Curbed)		—	—	—
	Median Slopes	Concrete Surface/Traversable	31-1.06	N/A	1.5%	1.5%
		Flush/TWLTL Surface		1.5%	1.5%	1.5%
		Grass/Landscape Surface		N/A	5% (Towards C&G)	5% (Towards C&G)

* Controlling design criteria (see Section 27-7). TWS = Two-Way Street

GEOMETRIC DESIGN CRITERIA FOR URBAN TWO-WAY ARTERIALS AND COLLECTORS (3R Projects)

Figure 33-3C (US Customary)

Design Element			Manual Section	Two-Way DHV < 1400 (1)	Two-Way DHV 1400-2400 (1)	Two-Way DHV 2400-3400 (1)
Design Controls	Highway Type		—	TWS-2	TWS-4	TWS-6
	Design Forecast Year		27-6.02	Current	Current	Current
	* Design Speed		27-5.02	50 km/h – 60 km/h	50 km/h – 60 km/h	50 km/h – 60 km/ h
	* Level of Service		27-6.04	D	D	D
Cross Section Elements	* Surface Width	Number of Travel Lanes	31-1.02	2	4	6
		Travel Lane	31-1.01	Des: 3.3 m Min: 3.0 m	Des: 3.3 m Min: 3.0 m	Des: 3.3 m Min: 3.0 m
		Travel Lane (Shared with Bicycles)	42-3.03	Des: 4.2 m Min: 4.0 m	Des: 4.2 m Min: 4.0 m	Des: 4.2 m Min: 4.0 m
		Parking Lane (2)	31-1.04	2.4 m	2.4 m	2.4 m
		Auxiliary Lane (2)	31-1.03	Single Left & Right: Des: 3.3 m, Min: 3.0 m		Dual Lefts: Des: 6.6 m, Min: 6.0 m
	Cross Slope	*Travel Lanes (Minimum)	31-1.08	1.5% - 2%	1.5% - 2% (3a)	1.5% - 2% (3a)
		Auxiliary Lanes		2% (3b)	(3b)	(3b)
	Outside Curb and Gutter Type		31-1.07	B-15.60, B-15.45 or B-15.30 CC&G (4)		
	Median Width	Flush/TWLTL (5)	31-1.06	N/A/3.3 m	Existing/3.3 m	Existing/3.3 m
		Traversable		N/A	Existing	Existing
		Raised-Curb		N/A	Existing	Existing
	Sidewalk Width (6)		31-2.02	Des: 1.5 m Min: 1.2 m	Des: 1.5 m Min: 1.2 m	Des: 1.5 m Min: 1.2 m
	* Clear Zone (7)		35-2	450 mm	450 mm	450 mm
Roadway Slopes	Side Slopes (8)	Cut Section (Curbed)	31-2.03	—	—	—
		Rock Cut		—	—	—
		Fill Section (Curbed)		—	—	—
	Median Slopes	Concrete Surface/Traversable	31-1.06	N/A	1.5%	1.5%
		Flush/TWLTL Surface		1.5%	1.5%	1.5%
		Grass/Landscape Surface		N/A	5% (Towards C&G)	5% (Towards C&G)

* Controlling design criteria (see Section 27-7). TWS = Two-Way Street

GEOMETRIC DESIGN CRITERIA FOR URBAN TWO-WAY ARTERIALS AND COLLECTORS (3R Projects)

Figure 33-3C (Metric)

(1) Traffic Volumes. The design hourly volumes (DHV) are calculated using a peak hour factor = 1.0; adjust these values using local peak-hour factors. For more information, see the *Highway Capacity Manual*.

(2) Parking Lane Width and Auxiliary Lane Width. The minimum width lane may include the gutter width.

(3) Cross Slope.

(a) Use 2% minimum cross slopes for travel lanes not adjacent to the crown.
(b) Curbed left-turn lanes may be sloped at 1.5% to 2% away from the median. TWLTL and flush left-turn lanes are sloped at the same rate as the adjacent traveled way. Cross slopes for outside auxiliary lanes will be at least 2% and desirably should be 0.5% greater than the adjacent travel lane.

(4) Gutter Width. Under restricted conditions, the gutter width adjacent to the edge of the turn lane may be eliminated adjacent to a 10 ft (3.0 m) turn lane.

(5) TWLTL Width. For resurfacing projects on collectors, the width of a TWLTL may be 10 ft (3.0 m).

(6) Sidewalk Width. Desirably, include a 2 ft to 3 ft (600 mm to 1.0 m) buffer strip between the curb and sidewalk. For sidewalks without a buffer strip, consider providing a 6 ft (1.8 m) sidewalk width behind the curb.

(7) Clear Zone. Distance is measured from the face of the curb.

(8) Side Slopes. For rural cross sections, possible side slopes flattening will be determined on a case-by-case basis considering roadside development and right-of-way restrictions.

GEOMETRIC DESIGN CRITERIA FOR URBAN TWO-WAY ARTERIALS AND COLLECTORS (3R Projects) Footnotes for Figure 33-3C

Design Element			Manual Section	One-Way DHV < 1450 (1)	One-Way DHV 1450-2150 (1)	One-Way DHV > 2150 (1)
Design Controls	Highway Type		—	OWS-2	OWS-3	OWS-4
	Design Forecast Year		27-6.02	Current	Current	Current
	*Design Speed		27-5.02	30 mph – 40 mph	30 mph – 40 mph	30 mph – 40 mph
	*Level of Service		27-6.04	D	D	D
Cross Section Elements	*Surface Width	Number of Travel Lanes	31-1.02	2	3	4
		Travel Lane	31-1.01	Des: 11′ Min: 10′	Des: 11′ Min: 10′	Des: 11′ Min: 10′
		Travel Lane (Shared with Bicycles)	42-3.03	Des: 14′ Min: 13′	Des: 14′ Min: 13′	Des: 14′ Min: 13′
		Parking Lane (2)	31-1.04	8′	8′	8′
		Auxiliary Lane (2)	31-1.03	Single Left & Right: Des: 11′, Min: 10′		Dual Lefts: Des: 22′, Min: 20′
	Cross Slope	*Travel Lanes (Minimum)	31-1.08	1.5% (3a)	1.5% (3a)	1.5% (3a)
		Auxiliary Lanes		2% (3b)	(3b)	(3b)
	Outside Curb and Gutter Type		31-1.07	B-6.12, B-6.18, or B-6.24 CC&G (4)		
	Sidewalk Width (5)		31.2.02	Des: 5′ Min: 4′	Des: 5′ Min: 4′	Des: 5′ Min: 4′
	*Clear Zone (6)		35-2	1.5′	1.5′	1.5′
Roadway Slopes	Side Slopes (7)	Cut Section (Curbed)	31-2.03	—	—	—
		Rock Cut		—	—	—
		Fill Section (Curbed)		—	—	—

* Controlling design criteria (see Section 27-7). OWS = One-Way Street

Figure 33-3D (U.S. Customary)
GEOMETRIC DESIGN CRITERIA FOR URBAN ONE-WAY ARTERIALS AND COLLECTORS
(3R Projects)

Design Element			Manual Section	One-Way DHV < 1450 (1)	One-Way DHV 1450-2150 (1)	One-Way DHV > 2150 (1)
Design Controls	Highway Type		—	OWS-2	OWS-3	OWS-4
	Design Forecast Year		27-6.02	Current	Current	Current
	*Design Speed		27-5.02	50 km/h - 60 km/h	50 km/h - 60 km/h	50 km/h – 60 km/h
	*Level of Service		27-6.04	D	D	D
Cross Section Elements	*Surface Width	Number of Travel Lanes	31-1.02	2	3	4
		Travel Lane	31-1.01	Des: 3.3 m Min: 3.0 m	Des: 3.3 m Min: 3.0 m	Des: 3.3 m Min: 3.0 m
		Travel Lane (Shared with Bicycles)	42-3.03	Des: 4.2 m Min: 4.0 m	Des: 4.2 m Min: 4.0 m	Des: 4.2 m Min: 4.0 m
		Parking Lane (2)	31-1.04	2.4 m	2.4 m	2.4 m
		Auxiliary Lane (2)	31-1.03	Single Left & Right: Des: 3.3 m, Min: 3.0 m		Dual Lefts: Des: 6.6 m, Min: 6.0 m
	Cross Slope	*Travel Lanes (Minimum)	31-1.08	1.5% (3a)	1.5% (3a)	1.5% (3a)
		Auxiliary Lanes		2% (3b)	(3b)	(3b)
	Outside Curb and Gutter Type		31-1.07	B-15.30, B-15.45, or B-15.60 CC&G (4)		
	Sidewalk Width (5)		31.2.02	Des: 1.5 m Min: 1.2 m	Des: 1.5 m Min: 1.2 m	Des: 1.5 m Min: 1.2 m
	*Clear Zone (6)		35-2	450 mm	450 mm	450 mm
Roadway Slopes	Side Slopes (7)	Cut Section (Curbed)	31-2.03	—	—	—
		Rock Cut		—	—	—
		Fill Section (Curbed)		—	—	—

* Controlling design criteria (see Section 27-7). OWS = One-Way Street

GEOMETRIC DESIGN CRITERIA FOR URBAN ONE-WAY ARTERIALS AND COLLECTORS (3R Projects)

Figure 33-3D (Metric)

(1) Traffic Volumes. The design hourly volumes (DHV) are calculated using a peak hour factor = 1.0; adjust these values using local peak-hour factors. For more information, see the *Highway Capacity Manual*.

(2) Parking Lane Width and Auxiliary Lane Width. The minimum width lane may include the gutter width.

(3) Cross Slope.

(a) Use 2% minimum cross slopes for travel lanes not adjacent to the crown.
(b) Cross slopes for outside auxiliary lanes will be at least 2% and desirably should be 0.5% greater than the adjacent travel lane.

(4) Gutter Width. Under restricted conditions, the gutter width adjacent to the edge of the turn lane may be eliminated adjacent to a 10 ft (3.0 m) turn lane.

(5) Sidewalk Width. Desirably, include a 2 ft to 3 ft (600 mm to 1.0 m) buffer strip between the curb and sidewalk. For sidewalks without a buffer strip, consider providing a 6 ft (1.8 m) sidewalk width behind the curb.

(6) Clear Zone. Distance is measured from the face of the curb.

(7) Side Slopes. For rural cross sections, possible side slopes flattening will be determined on a case-by-case basis considering roadside development and right-of-way restrictions.

GEOMETRIC DESIGN CRITERIA FOR URBAN ONE-WAY ARTERIALS AND COLLECTORS
(3R Projects)
Footnotes for Figure 33-3D

Design Element			Manual Section	ADT < 1000	ADT > 1000
Design Controls	Highway Type		—	TWS-2/OWS-2	TWS-2/OWS-2
	Design Forecast Year		27-6.02	Current	Current
	* Design Speed		27-5.02	30 mph (1)	30 mph
	* Level of Service		27-6.04	D	D
Cross Section Elements	Surface Width	Number of Travel Lanes	31-1.02	2	2
		*Travel Lane	31-1.01	Min: 10′	Des: Min: 11′ Min: 10′
		Travel Lane (Shared with Bicycles)	42-3.03	Des: 14′ Min: 13′	Des: 14′ Min: 13′
		Parking Lane (2)	31-1.04	8′	8′
		Auxiliary Lane	31-1.03	10′	Des: 11′ Min: 10′
	Cross Slope	*Travel Lanes (Minimum)	31-1.08	1.5% - 2%	1.5% - 2%
		Auxiliary Lanes		(3)	(3)
	Outside Curb and Gutter Type		31-1.07	B-6.24, B-6.18 or B-6.12 CC&G (4)	
	Sidewalk Width		31-2.02	Des: 5′ Min: 4′	Des: 5′ Min: 4′
	* Clear Zone (5)		35-2	1.5′	1.5′
Roadway Slopes	Side Slopes (6)	Cut Section (Curbed)	31-2.03	—	—
		Rock Cut		—	—
		Fill Section (Curbed)		—	—

* Controlling design criteria (see Section 27-7). TWS = Two-Way Street OWS = One-Way Street

GEOMETRIC DESIGN CRITERIA FOR URBAN LOCAL STREETS (3R Projects)

Figure 33-3E (US Customary)

Design Element			Manual Section	ADT < 1000	ADT > 1000
Design Controls	Highway Type		—	TWS/OWS-2	TWS-2/OWS-2
	Design Forecast Year		27-6.02	Current	Current
	* Design Speed		27-5.02	50 km/h (1)	50 km/h
	Level of Service		27-6.04	D	D
Cross Section Elements	* Surface Width	Number of Travel Lanes	31-1.02	2	2
		Travel Lane	31-1.01	Min: 3.0 m	Des: 3.3 m Min: 3.0 m
		Travel Lane (Shared with Bicycles)	42-3.03	Des: 4.2 m Min: 4.0 m	Des: 4.2 m Min: 4.0 m
		Parking Lane (2)	31-1.04	2.4 m	2.4 m
		Auxiliary Lane	31-1.03	3.0 m	Des: 3.3 m Min: 3.0 m
	Cross Slope	*Travel Lanes (Minimum)	31-1.08	1.5% - 2%	1.5% - 2%
		Auxiliary Lanes		(3)	(3)
	Outside Curb and Gutter Type		31-1.07	B-15.60, B-15.45 or B-15.30 CC&G (4)	
	Sidewalk Width		31-2.02	Des: 1.5 m Min: 1.2 m	Des: 1.5 m Min: 1.2 m
	Clear Zone (5)		35-2	450 mm	450 mm
Roadway Slopes	Side Slopes (6)	Cut Section (Curbed)	31-2.03	—	—
		Rock Cut		—	—
		Fill Section (Curbed)		—	—

* Controlling design criteria (see Section 27-7). TWS = Two-Way Street OWS = One-Way Street

GEOMETRIC DESIGN CRITERIA FOR URBAN LOCAL STREETS (3R Projects)

Figure 33-3E (Metric)

(1) Design Speed. A 20 mph (30 km/h) design speed may be used where the posted speed limit is 20 mph.

(2) Parking Lane. The minimum width of the parking includes the gutter width.

(3) Cross Slope. Use 2% minimum for lanes away from the crown.

(4) Gutter Width. Under restricted conditions, the gutter width adjacent to the edge of the turn lane may be eliminated adjacent to a 10 ft (3.0 m) lane or included in the width of the turn lane. A valley gutter may be used in place of curb and gutter.

(5) Clear Zone. Distance is measured from the face of the curb.

(6) Side Slopes. For rural cross sections, possible side slope flattening will be determined on a case-by-case basis considering roadside development and right-of-way restrictions.

GEOMETRIC DESIGN CRITERIA FOR URBAN LOCAL STREETS
(3R Projects)

Footnotes for Figure 33-3E

33-3.03 Horizontal Alignment

33-3.03(a) Rural and Open Roadway Conditions

An existing horizontal curve may remain in place if its design speed is not less than the design speed required by Figure 33-3A or Figure 33-3B or more than 15 mph (25 km/h) less than the regulatory speed for the highway but not less than 30 mph (50 km/h). Advisory speed signs may be provided on horizontal curves where the comfortable operating speed is more than 5 mph (10 km/h) below the regulatory speed.

Ensure that the superelevation rates for horizontal curves on rural facilities to remain-in-place are commensurate with the comfortable operating speed of the curve using a maximum rate of 8%. See Section 29-2 for guidance on determining the design speed on curves to remain in place.

Through horizontal curves, the maximum "rollover" factor (algebraic difference between slopes) at the traveled way/shoulder intersection should not be greater than 10% where the proposed (or remaining) shoulder width is wider than 4 ft. (1.2 m). Where the shoulder width is 4 ft (1.2 m) or less, the maximum rollover factor may be 12%. Where 1 ft (300 mm) paved shoulders are used, the rollover factor should be applied at the edge of the paved shoulder rather than at the traveled way edge for ease of construction.

33-3.03(b) Urban Conditions

For low-speed ($V \leq 45$ mph (70 km/h)) urban arterials, use Figure 29-4B to determine the acceptability of existing horizontal curves. Where a horizontal curve will be improved (i.e., flatten the radius and/or increase the superelevation), the designer should also use Figure 29-4B for the reconstructed horizontal curve. The basic objective for improving conditions on the existing horizontal alignment of low-speed urban streets is to retain the existing alignment and to check for comfortable operating speeds. See Section 29-4 for more information.

Where a considerable amount of right-of-way is being acquired along a significant length of a project on a collector to accommodate widening and resurfacing, the horizontal alignment should be in accord with reconstruction requirements. For other projects the horizontal alignment should be consistent with site conditions.

33-3.04 Vertical Alignment

33-3.04(a) Crest Vertical Curves

The following will apply to rural crest vertical curves:

Current ADT	Treatment
1000 or more	Existing crest curves that do not meet the criteria for the design speed in Figures 33-3A and 33-3B and are not within 15 mph (25 km/h) of the posted or regulatory speed, as determined from the available stopping sight distance (SSD), will be upgraded by one of the following options: • flatten the crest curve within the existing right-of-way to desirably satisfy the design speed required by Figures 33-3A or 33-3B; or if the design speed is 50 mph or greater, to a minimum 45 mph (70 km/h) design speed; or • flatten the crest curve by obtaining additional right-of-way to satisfy the required design speed if the design speed is less than or equal to 50 mph (80 km/h) or to meet a 50 mph to 55 mph (80 km/h to 90 km/h) design speed if the required design speed is greater than 50 mph (80 km/h). The designer should consider sight distances, intersection influences, overall safety, and the need for road closures, detours, stage construction, and especially the prevailing vertical alignment in evaluating the above alternatives. This analysis will allow designers to determine the most practical alternative for flattening crest vertical curves.
Less than 1000	Crest curves may be retained if the available SSD is adequate for the required design speed or for 20 mph (30 km/h) less than the posted or regulatory speed, but not less than a 30 mph (50 km/h).

Unless safety indicates otherwise, existing crest vertical curves on urban streets may be retained.

33-3.04(b) Sag Vertical Curves

Sag curves generally may be retained.

33-3.04(c) Grades

On 3R projects, retaining the existing roadway grades is acceptable. Flattening grades is typically not within the scope of a 3R project.

33-3.04(d) Vertical Clearance

The minimum vertical clearance for bridges to remain in place is 14 ft (4.3 m).

33-3.05 Intersections

33-3.05(a) Superelevation Rates through Intersections

Superelevation rates less than that specified for the design speed may be used on the major road through certain intersections where there is no stop control for the major road so that slowing or stopped vehicles do not slide across the pavement during wet or icy conditions. An appropriate advisory speed should be posted for the curve and noted in the Project Development Report.

33-3.05(b) Stop-Controlled Approaches on Horizontal Curves

On curved, stop-controlled approaches to intersections, it is desirable to have as flat an alignment as practical, with lower superelevation rates, even though traffic is operating at lower speeds than on comparable non-stopped approaches. On a project-by-project basis, the benefits of higher superelevation rates for high-operating speeds (during clear conditions) versus the benefits of lower superelevation for low-operating speeds (during icy pavement conditions) should be carefully considered when selecting an appropriate superelevation rate.

33-3.05(c) Side Road Approach Grades

Where considerable amounts of additional right-of-way are required, geometric design criteria for side road approach grades should be in accordance with applicable new construction/reconstruction criteria where practical. Some elements may be consistent with site conditions when based on special study and analysis results.

33-3.05(d) Turning Radii

In urban areas, right-turn radii maneuvers at intersections are important for two reasons. The radius affects the speed at which the design vehicle can make a right turn from the main road onto a side street. The radius also determines how much encroachment, assuming the selected design vehicle, will occur into opposing lanes when the design vehicle makes a right turn onto the main road. For right turns at urban intersections, consider the following guidelines for 3R projects:

1. Passenger Cars. Simple radii of 15 ft to 25 ft (4.5 m to 7.5 m) are adequate for a passenger car design vehicle. These radii may be retained on existing side streets:

   (a) where very few trucks are expected to turn into the side street,

   (b) where encroachment by a single unit or tractor/semitrailer unit into opposing lanes of the main road is acceptable, or

(c) where a parking lane is present and parking is restricted a sufficient distance from the intersection thereby providing a larger area for a right-turn maneuver.

2. Trucks. Where practical, use a simple radius of 30 ft (9 m) or a two-centered curve at all major intersections and at all minor intersections that have some frequency of truck turning volumes. This design will provide for the single-unit vehicle and the occasional tractor/ semitrailer unit.

3. Tractor/Semitrailers. At intersections where tractor/semitrailer combinations and buses turn frequently, provide a simple radius at a minimum of 40 ft (12 m) or a two-centered curve.

33-3.05(e) Curb Cuts/Ramps

Ensure that curb cuts/ramps meet the accessibility criteria presented in Section 41-6.

33-3.05(f) Intersection Sight Distance

At rural, public road intersections with a stop condition on the side road, the designer should strive to provide the intersection sight distance as shown in Section 28-3, based on the selected design speed. However, the designer may use a maximum sight distance of 465 ft (140 m) for the stopped approach in both the left and right directions along the free-flowing highway and a 12 ft (3.5 m) distance from the edge of the traveled way to the driver's eye.

33-3.06 Diagonal Parking

Parking (existing or proposed) should generally be parallel and adjacent to the curb. Diagonal parking may be permitted to remain if an engineering analysis of the existing angle parking clearly demonstrates that there will be no adverse effect on street capacity and safety. The analysis must describe parking characteristics, crash history, and an observation of street operations and potential problems. For federally funded projects, this analysis should be included in the Project Development Report.

Proposed diagonal parking, where none previously existed and that will not interfere with the free movement of traffic in the travel lanes, may be permitted if spaces are available for entering and exiting the parking space off of the traveled way. Section 31-1.04 provides the minimum criteria for this backing maneuver. Diagonal parking should be monitored after implementation to determine whether the effects on operational safety and efficiency might warrant a change to the configuration.

33-3.07 Roadside Hazards and Highway Appurtenances

33-3.07(a) General

The intent of these guidelines is to provide cost-effective design that may reduce the number and severity of run-off-the-road crashes. Remove or shield obstacles within the clear zone, including protrusions that extend greater than 4 in (100 mm) above the groundline, where cost effective.

33-3.07(b) Earth Slopes

Other than specifically described in Section 33-3.07, existing earth slopes should generally be retained. Where existing right-of-way permits significant slope flattening or where grading within existing right-of-way is necessary, the designer should consider flattening earth slopes, particularly at horizontal curves.

33-3.07(c) Clear Zone

The roadside environment on a 3R project may include any number of natural and man-made obstacles. To remove or relocate these obstacles can present significant problems and public opposition, and it can be very costly. On the other hand, the designer cannot ignore the consequences to a run-off-the-road vehicle. Therefore, the designer must exercise considerable judgment when determining the appropriate clear zone on a 3R project. The designer should consider the following:

1. Application. The designer may consider a selective application of the roadside clear zone criteria. Along some sections of highway, it may be practical to provide the 3R clear zone criteria; along other sections, it may be impractical. In addition, some obstacles will be more hazardous than others. Judgment will be necessary for the application of the clear zone criteria.

2. Public. Public acceptance of widened clear zones can be a significant issue, especially when the removal of trees is being considered. The designer must judge the community impact and subjectively factor this into the decision-making process.

3. Rural Roads. The recommended clear zone widths, measured from the traveled way edge, are shown in Figure 33-3F. Figure 35-2A may also be used.

Roadway Criteria		Cross Sections	Clear Zone
On Tangent	Regulatory Speed 50 mph (80 km/h) or greater and/or ADT greater than 1000	Fill or Traversable Ditch(1)	14 ft (4 m) or ROW Line (2)
		Non-Traversable Ditch	14 ft (4 m) or Toe of Back Slope (2)
	All Others	All	10 ft (3 m)
On Curve (3)	Curve Design Speed less than 50 mph (80 km/h)	Fill or Traversable Ditch(1)	20 ft (6 m) or ROW Line (2)
		Non-Traversable Ditch	20 ft (6 m) or Toe of Back Slope (2)
	Curve Design Speed 50 mph (80 km/h) or greater	Same as Tangent Clear Zone above	

Notes:

(1) Traversable ditch cross sections are those with at least 1V:4H front slopes, 1V:3H back slopes, and 2 ft (600 mm) wide ditches. If any of these criteria are not satisfied, the ditch cross section is considered non-traversable.

(2) Use whichever is less.

(3) Clear zone values apply only to the outside of curve. Tangent clear zone values apply to inside of curve.

(4) The clear zone values in Figure 35-2A may be used in lieu of the above values.

CLEAR ZONES FOR RURAL ROADS
(3R Projects)

Figure 33-3F

4. Urban Streets. Clear zones along urban streets are as follows:

   a. Curb Streets. Where the street has curbs, no obstacles should be located closer than 1.5 ft (500 mm) from the face of curb. This distance is not considered a clear zone but an operational offset. Where parallel parking lanes are included, a 1 ft (300 mm) clearance to the face of curb may be considered.

   b. Streets with Shoulders. Where the street has a rural cross section, make every effort to provide the clear zones. Minimum clear zone widths should be:

      - 18 ft (5.4 m) for arterials and 14 ft (4 m) for collectors, or the non-traversable ditch if less, where the regulatory speed is 50 mph (80 km/h) or greater;
      - 10 ft (3 m) where the regulatory speed is 45 mph (70 km/h); or
      - the shoulder width where the regulatory speed is 40 mph (60 km/h) or less.
      - The clear zone width in Figure 35-2A may be used in place of the above widths.

5. Crash Data. The designer should review the crash data to estimate the extent of the roadside safety problem. In particular, there may be sites where clusters of run-off-the-road crashes have occurred.

6. Safety Appurtenances. During the design of a 3R project, all existing safety appurtenances should be examined to determine if they meet IDOT's current safety performance and design criteria. This includes guardrail, sign supports, luminaire supports, etc. Normally, all existing safety appurtenances will be upgraded to meet the most recent criteria.

7. Other. For the treatment of roadsides and highway appurtenances other than described above, use the clear zone widths appropriate for the cross section.

33-3.07(d) Guardrail

Installing guardrail is an alternative to providing a wider clear zone. However, this can lead to lengthy runs of barrier along the roadside. The designer should realize that barrier warrants are based on the relative severity between hazard and barrier; they do not address the question of whether or not a barrier installation is cost-effective. Therefore, on 3R projects, the designer must judge whether or not barrier should be installed to shield a hazard within the clear zone.

Guardrail warrants on 3R projects can be especially difficult to resolve. The evaluation process will be:

1. Determine if guardrail is warranted. As part of this process, the designer must decide if the guardrail will create a greater hazard than the obstacle that it is shielding.

2. If an existing run of guardrail is located where none is warranted, remove the guardrail.

3. If guardrail is warranted, consider removing or relocating the hazard; reducing the hazard (e.g., flattening a slope); or making it breakaway.

4. If the hazard cannot be eliminated and guardrail is considered cost effective, then install guardrail. For existing runs of guardrail, ensure that they meet the applicable performance and design criteria, including:

    - operational acceptability (e.g., hardware, height, etc.);
    - dynamic deflection criteria;
    - length of need;
    - flare rate;
    - lateral placement;
    - placement on slopes and behind curbs;
    - terminal treatments; and
    - transitions.

Chapter 35 presents the criteria for the layout of roadside barriers. The following also applies:

1. Guardrail Removal. An existing guardrail installation should be removed when the hazard can be removed at a cost less than guardrail upgrading and maintenance.

2. Guardrail Upgrading. Existing guardrail that is warranted should be upgraded where:

    - the post spacing, blockouts, and height do not conform to the *IDOT Highway Standard*, except steel blockouts may remain, and it may have a height deficiency not more than 3 in (75 mm); or
    - the guardrail is seriously damaged or deteriorated.

3. Terminal Sections. Existing Breakaway Cable Terminal (BCT) end sections, regardless of the amount of flare, may remain in place if no other upgrading of the guardrail is required for the installation. Connections to bridges which are rigid to minimize deflection may also remain in place if no other upgrading of the guardrail is required. When a terminal is replaced, the new terminal must meet the *IDOT Highway Standards.*

4. Length of Need. Use the length-of-need criteria in Section 35-4 to determine the sufficiency of the existing length of guardrail based on the design speed. Upgrade

existing guardrail that is deficient in length by more than 37.5 ft. (34 m) to provide a proper length of need. Other guardrail with a deficient length of need may remain in place unless crash data shows that the additional length will reduce crash severity. Also, provide the proper length of need if placement of a new terminal is required.

5. New Guardrail Installation. Install new guardrail in accordance with Chapter 35. For embankments, new guardrail is warranted based on Section 35-3.04 or Figure 33-3G. For roadside obstacles, guardrail should be installed where it is cost effective to shield an obstacle.

33-3.07(e) Culverts

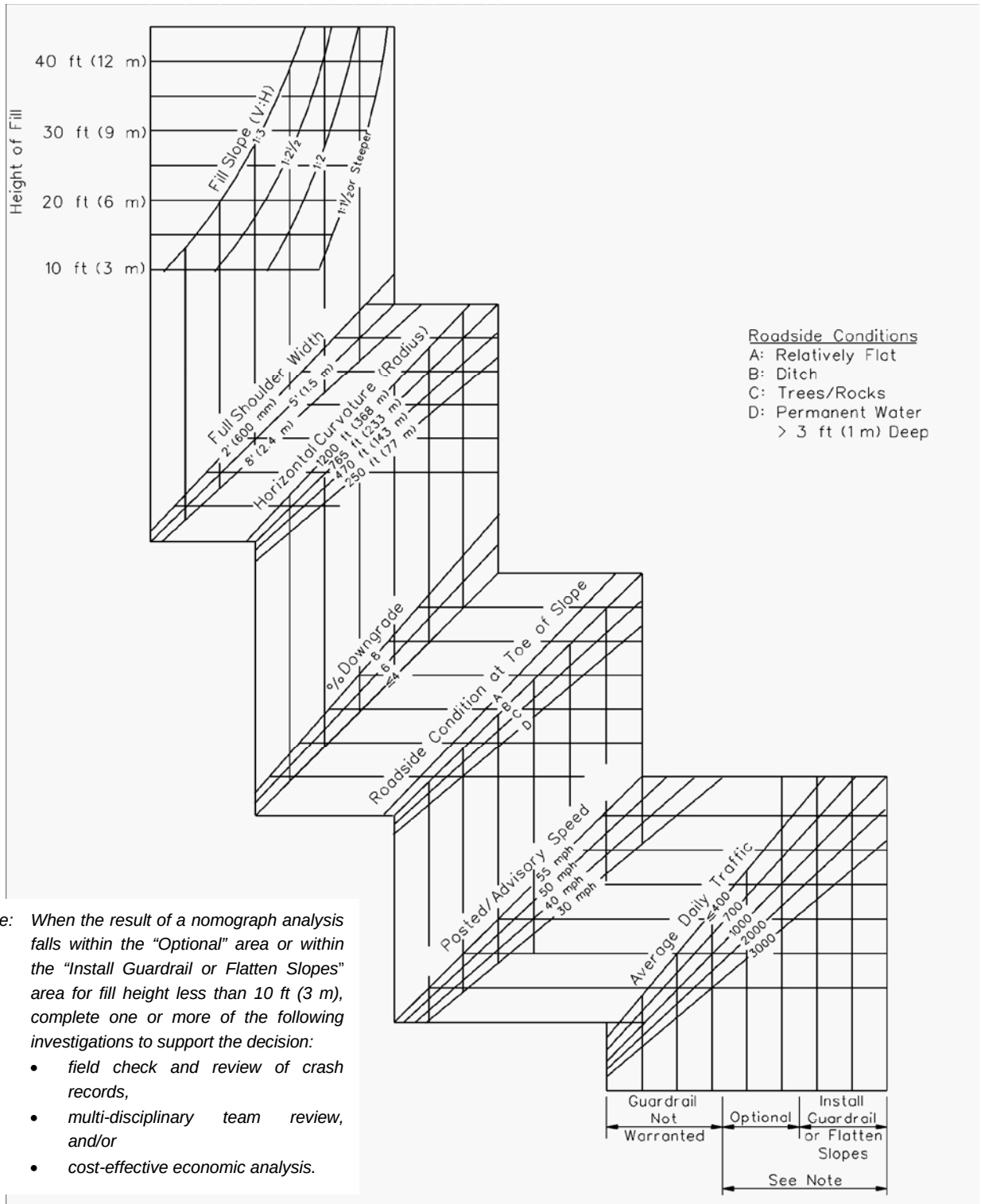
Crossroad culverts with headwalls within the proposed shoulder width should be extended to the shoulder edge (or existing shoulder edge if wider). Culvert end treatments should be applied to existing or proposed culvert openings within the appropriate clear zone. End treatments will meet the criteria in Chapter 35 or as follows:

- for culverts 36 in (915 mm) or less and headwalls protruding more than 4 in (100 mm) above ground, the designer should remove or shield by re-grading; however, end sections are not required; no treatment is required for culverts 36 in (915 mm) or less provided that no existing headwall extends more than 4 in (100 mm) above ground;
- flared end sections with grating for culverts greater then 36 in to 54 in (915 mm to 1400 mm);
- for culverts over 54 in (1400 mm), use an appropriate end design and conduct an analysis in accordance with the procedures in Chapter 35 to determine guardrail needs. In lieu of analytical calculations, Figure 33-3H may be used.

Review headwalls and large culverts at side roads and private entrances within the clear zone and consider safety improvements, (e.g., relocation, guardrail protection).

33-3.07(f) Sign and Light Supports

Posts or poles used to support signs or lights to remain within the clear zone should be made breakaway. Wood sign supports may be modified to properly reduce the cross sectional area or replaced with breakaway supports. Where pedestrian traffic is significant, do not use breakaway sign and light supports.

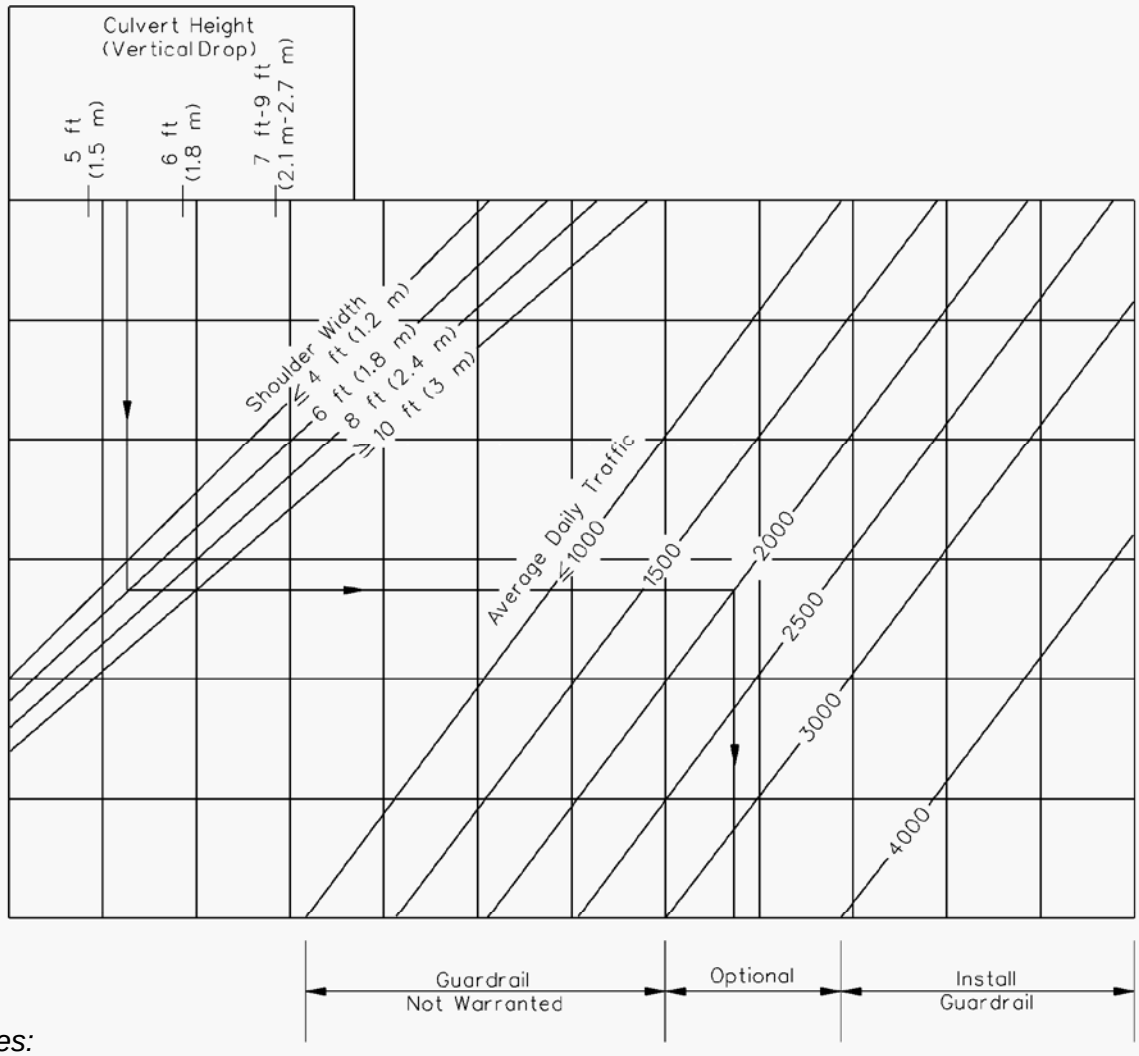


Note: When the result of a nomograph analysis falls within the "Optional" area or within the "Install Guardrail or Flatten Slopes" area for fill height less than 10 ft (3 m), complete one or more of the following investigations to support the decision:

- *field check and review of crash records,*
- *multi-disciplinary team review, and/or*
- *cost-effective economic analysis.*

GUARDRAIL WARRANTS FOR EMBANKMENTS ON 3R PROJECTS

Figure 33-3G



Notes:

1. *This nomograph supplements but does not supersede Figure 33-3G.*

2. *Culvert height includes the earth cover immediately above the culvert if it increases the "drop-off." When the culvert height is 10 ft (3 m) or greater, guardrail is warranted.*

3. *When the result of a nomograph analysis falls within the "optional" area, complete one or more of the following investigations and document it in the Project Development Report to support the decision:*

   - *field check and review of alignment and crash records*,
   - *multi-disciplinary team review, and/or*
   - *cost-effective economic analysis.*

3R GUARDRAIL WARRANTS FOR CULVERTS > 54 IN (1400 MM)

Figure 33-3H

33-3.07(g) Trees

Unless shielded by a protective device required for other purposes, remove trees within the clear zone that will mature to a diameter greater than 4 in (100 mm). Where the removal of trees may adversely affect the roadside environment, remove these trees only where it is necessary for reasons of safety. In cases where unusual specimens are in jeopardy, guardrail or attenuator protection may be considered as an alternative to removal. Trees on backslopes that are not likely to be impacted by vehicles may generally remain in place.

33-3.07(h) Concrete Signal Bases

Remove concrete signal bases (Type B) if they are within the clear zone and extend higher than 4 in (100 mm), and install standard supports with frangible bases where appropriate. Mast arm signal supports cannot have frangible bases.

33-3.07(i) Curbs

Curbs higher than 4 in (100 mm) within the shoulder area should be removed where posted speeds are greater than 45 mph. Review the proper placement of traffic control devices before considering the removal of corner island curbs where these devices are located.

Curb removal is not intended to include intermittent center channelizing islands separating two-lane, two-way traffic and supplemented by illumination. Place reflectorizing devices on these curbs in accordance with the IDOT Bureau of Operations practices to improve delineation.

33-3.07(j) Above-Ground Utilities

Utility poles are a common roadside obstacle on 3R projects. Relocation is mandatory when the utility poles physically interfere with construction. Other relocations for safety benefits must be evaluated on a project-by-project basis. Where practical, above-ground utility facilities should not be allowed to remain inside the clear zone, except where protected by devices required for other purposes. Existing utility facilities may generally remain:

- where located beyond non-traversable ditch cross sections, or
- where right-of-way is so narrow that the maximum adjustment practical within the existing right-of-way is minimal and considered impractical.

Where re-grading of the back slopes is necessary for a significant length within the area of utility facilities, the utilities should be relocated in accordance with the criteria in Section 41-11.

33-3.07(k) Other

There may be other objects within the desired clear zone that may be roadside obstacles. They should receive the appropriate attention.

Where appropriate, the designer should discuss the mailbox supports considered hazardous and within the clear zone with the property owners:

- to inform the owner of the potential severity of the support, such as the results of pertinent research and tests as reported in the TRR No. 769 Paper "The Rural Mailbox – A Little Known Roadside Hazard";
- to inform the owner of the possibility of personal liability; and
- to request the owner to change the support to reduce the potential seriousness of the hazard. Changed supports will be consistent with the designs contained in the AASHTO publication *A Guide for Erecting Mailboxes on Highways.*

33-3.08 Traffic Control Devices

Ensure all traffic control devices are in conformance with the *ILMUTCD*.

33-3.09 Mailbox Turnouts

The design and construction of mailbox turnouts should be in accordance with Section 41-8.02.

33-3.10 Lighting and Landscaping

Consider installing lighting to improve operations and/or safety in accordance with Section 41-7. Generally, landscaping should be directed toward replacing appropriate existing plants and turf removed or damaged by construction and, where practical, planting for safety or erosion control purposes.

33-3.11 Railroad Crossings and Signals

Railroad crossings and signals should be upgraded prior to, or concurrent with, 3R projects. Where the existing railroad crossing surface is in good condition and will remain, taper the roadway overlay to match the existing crossing profile. If required by current practices, the crossing surface outside the traveled way should consist of bituminous or other approved material. Where the crossing surface is not in good condition, consider having the railroad adjust the tracks to the traveled way elevation and installing a new crossing surface.

The railroad will need to locate the crossing warning signal devices in accordance with current safety requirements and upgrade if not in conformance with the guidelines discussed in Chapter 40 and in the IDOT publication *Requirements for Railroad/Highway Grade Crossing Protection*. Any other associated work performed must also meet ICC guidelines and the *ILMUTCD*.

If, as an exceptional case, there will be a significant lapse of time in the relocation of railroad warning signal devices, the widened pavement should be constructed up to the crossing. Offsets to the existing warning signal devices should temporarily consist of tapered edge lines and diagonal pavement markings. If the location of the existing warning signal devices precludes this treatment, taper the widened pavement to the existing pavement width at or near the signal location.

Contact the railroad for required changes in railroad facilities early in the project to enable agreement negotiations to be concluded so that railroad work may proceed concurrently with that of the highway contract.

33-3.12 Pavement Design

The pavement design for 3R projects will be in accordance with the guidelines in Chapter 46. In addition, all pavement surfaces in a 3R project are required to meet the IDOT's skid resistance criteria.

33-3.13 Bridges

33-3.13(a) Scope of Work

These guidelines can be used for all work necessary for the improvement of existing rural or urban bridges to be consistent with 3R objectives for increased safety and improved operating conditions. This includes the total replacement of a bridge when other cost-effective means of meeting these criteria are not feasible. For definition and clarification purposes, a bridge constructed at a different location, or an existing bridge requiring replacement of all elements as a part of a 3R project, is designated as a replacement rather than a new bridge. New bridge designations are reserved for new construction/reconstruction projects because they are generally subject to different width requirements than replacement bridges.

Bridge work may be performed prior to, simultaneous with, or deferred from highway projects according to the guidance provided in this section. Bridges will be improved to correct operational, structural, and significant safety deficiencies, and will be subject to the following conditions:

- The roadway template is not anticipated to be widened beyond the proposed bridge cross section within the next 20 years.

- Where an existing bridge is not of sufficient width to remain in place, it may be gapped within the project limits if its future rehabilitation or replacement is committed as stage construction to be completed within 5 years of the completion of the roadway project. No bridge will be gapped for more than 1 year if the clear roadway bridge width is less than the approach traveled way width.
- Hazard panels and appropriate pavement markings will be required for all bridges that remain in place and that are narrower than the improved traveled way width.

33-3.13(b) Criteria for Rural Bridges to Remain in Place

Bridges on rural roads may remain in place provided that the clear roadway bridge width is equal to or greater than the values given in Figure 33-3I and that the structural capacity is met.

Current ADT [2] Under 400	Current ADT 400 - 999	Current ADT 1000-3000	Current ADT Over 3000
Clear Roadway Bridge Width [3][4]			
20 ft (6.0 m)	22 ft (6.6 m)	24 ft (7.2 m)	28 ft (8.4 m)

Notes:

(1) In all cases, except as noted in (2) below, the bridge to remain in place must have a structural capacity of H-15 (M-13.5) loading.

(2) When the current ADT is less than 75, a bridge with a structural capacity of H-10 (M-9) loading will be acceptable if it meets the width criteria.

(3) Between rails or between curbs if the curb projects more than 9 in (225 mm) beyond the face of the rail.

(4) In no case will the bridge be narrower than the approach traveled way.

3R WIDTHS OF RURAL BRIDGES TO REMAIN IN PLACE

Figure 33-3I

The designer should repair, retrofit, or replace any rails on bridges to remain in place that could be easily penetrated by a passenger vehicle, that show evidence of crash damage, that are in questionable condition, or that contain irregularities that could cause intolerable vehicular decelerations. If replaced, ensure rails and their connections to the deck are designed to meet current AASHTO strength and safety performance standards.

Curb sections that project horizontally more than 9 in (225 mm) but less than 3 ft (900 mm) from the face of rail shall be removed, or new rail elements installed in accordance with the standards for bridge rail retrofit.

Structurally sound bridge decks with poor riding quality that could jeopardize the safety of the motorist or cause undue discomfort should be repaired and resurfaced. However, resurfacing may not be extended across decks without necessary repair or when the additional dead load resulting from the resurfacing would cause a load posting on the bridge.

33-3.13(c) Criteria for Improved Bridges

Construct all rehabilitated or replaced bridges to a minimum clear roadway width equal to the values in Figure 33-3J. The widths assume a rural type cross section approaching the bridge.

Current ADT Under 400	Current ADT 400 - 999	Current ADT 1000 - 2999	Current ADT 3000 - 5000	Current ADT Over 5000
Clear Roadway Bridge Width (1)				
22 ft (6.6 m)	26 ft (7.8 m)	28 ft (8.4 m)	32 ft (9.6 m)	36 ft (10.8 m)

Notes:

(1) The designer may use the width criteria in Chapter 36 if it is less than stated above.

3R WIDTHS OF IMPROVED RURAL BRIDGES

Figure 33-3J

33-3.13(d) Criteria for Urban Bridges to Remain in Place

Urban bridges may remain in place:

- where they meet the structural requirements for rural bridges including the requirements for decks and bridge rails;
- where the clear roadway bridge width is sufficient to accommodate the number of approach lanes; and
- where the clear roadway bridge width includes traffic lanes 10 ft (3 m) or wider.

For urban bridges, bridge deck repairs similar to those cited for rural bridges may be undertaken.

33-3.13(e) Criteria for Improved Urban Bridges

Urban bridges not meeting the criteria to satisfactorily remain in place should be improved:

- to meet the structural requirements of improved rural bridges,
- to accommodate the number of lanes and the median on the approach roadways, and
- to provide lane widths equal to those on the roadway approaches but not less than 11 ft (3.3 m) or as allowed in Chapter 36.

Parking lanes on the approach roadways usually are not carried across urban bridges.

33-4 REFERENCES

1. *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2004.

2. Special Report 214 *Designing Safer Roads; Practices for Resurfacing, Restoration and Rehabilitation*, TRB, 1987.

3. Technical Advisory T5040.28 “Developing Geometric Design Criteria and Processes for Non-Freeway RRR Projects,” FHWA, 1988.

4. Chapter 49, “3R Guidelines for Rural and Urban Highways (Non Freeways),” *Bureau of Design and Environment Manual*, IDOT, December 2002.