APPENDIX A

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INTRODUCTION

VDOT has formally adopted the 2011 AASHTO *A Policy on Geometric Design of Highways and Streets*, commonly referred to as the AASHTO “Green Book”, as our minimum design standards. Therefore, all design criteria must meet AASHTO minimum standards.

Highway improvement plans are based on established AASHTO geometric design standards for various elements of the roadway under design. The tables on the following pages provide the minimum geometric standards, which are to be used for development of VDOT projects except those projects which can be developed using the Guidelines for RRR Projects located in Appendix A, Section A-4 of this manual. Note that there are no specific RRR standards for Interstate projects. If the designer has determined that Guidelines for RRR Projects do not apply to the project in question, the Geometric Design Standard tables on pages A-11 to A-20 should be used for project development. See Appendix B(1) for the development of new residential and mixed-use streets functional classified as “local” streets and Appendix B(2) for multimodal design standards for mixed-use urban centers.

The Geometric Standard Tables were developed using *A Policy on Geometric Design of Highways and Streets* published by the American Association of State Highway and Transportation Officials (AASHTO). These tables present basic practical guidelines compatible with traffic, topography and safety; however, due to the restrictive format, all variables could not be included. The designer is urged to refer to the above named publication and other related chapters in the *Road Design Manual* for further discussion of design considerations before selecting the proper design speed criteria for a given project.

**THE APPLICATION OF THE CRITERIA PROVIDED IN THE GEOMETRIC DESIGN STANDARD TABLES MUST BE MADE IN RELATION TO THEIR EFFECT ON THE ROADWAY SYSTEM AND IN CONJUNCTION WITH SOUND ENGINEERING JUDGMENT TO ENSURE AN APPROPRIATE DESIGN.** The economic, environmental and social factors involved in highway design shall also be considered. The designer should always attempt to provide for the highest degree of safety and best level of service that is economically feasible. The "minimum" design criteria shown in the tables should only be used when overriding economic or environmental considerations so dictate.

FLEXIBILITY IN DESIGN

The policies and procedures addressed in IIM-LD-235 (Context Sensitive Solutions) and IIM-LD-255 (Practical Design Flexibility in the project development process) are intended to clarify and emphasize VDOT’s commitment to project and program development processes that provide flexibility, innovative design and Context Sensitive Solutions (CSS) to transportation challenges.

* Rev. 1/19
These processes have been structured and oriented to include stakeholders and citizens in the design of transportation systems that improve public mobility, while reflecting the community's values, preserving the scenic, aesthetic, historic and environmental resources, and without compromising safety and mobility.

This policy emphasizes the importance of recognizing the flexibility within established standards, especially AASHTO's *Policy on Geometric Design of Highways and Streets* (Green Book), AASHTO's *A Guide for Achieving Flexibility in Highway Design* and AASHTO's *Guidelines for Geometric Design of Low-Volume Local Roads (ADT ≤ 400)*. While practicable and innovative approaches to using the flexibility inherent in existing standards is encouraged by this policy, individual project development decisions on specific applications of flexibility ultimately rest with the responsible person working with the project manager and the project team. These decisions are made after carefully processing input from all project stakeholders as well as the project team, and evaluating this input with respect to project goals as well as safety and mobility concerns.

For applicable projects, the following note shall be placed on the title sheet under the Functional Classification and Traffic Data Block: NOTE: THESE PLANS WERE DESIGNED IN ACCORDANCE WITH THE AASHTO GUIDELINES FOR GEOMETRIC DESIGN OF VERY LOW-VOLUME LOCAL ROADS (ADT ≤ 400).

### SECONDARY PROJECT IMPROVEMENTS

The Special Session II of the 2008 General Assembly passed HB 6016, which amended and reenacted §33.2-326 of the Code of Virginia relating to improvements to the state secondary highway system components. The intent of this Bill is to ensure that the Department provides flexibility in the use of design criteria for improvements to any secondary highway system component(s) by not requiring the Department to comply with all design and engineering standards that would be applicable if the project involved new construction.

The Department currently utilizes the following flexible design Guidelines:

- **RRR Design Guidelines**, which involves the use of minimal improvements to extend the service life and safety for the existing roadway at a fraction of the cost. On Secondary projects that have a 15 year traffic projection of 750 vpd or less, the RRR guidelines are the design concept of choice.

- **Rural Rustic Road Design Guidelines**, which are used on the secondary highway system that have 1500 vpd or less to pave unpaved secondary roads with no or little geometric improvements.

In addition to the above mentioned practices that follow their own set of guidelines, the Department also encourages roadway designers to identify context sensitive solutions to project issues. It is the responsibility of the roadway design engineer working with the project manager to identify areas where flexibility can be introduced into the design process without compromising safety and mobility.

* Rev. 10/14
The Department has a process for documenting design solutions that do not meet current VDOT and AASHTO design geometric standards in the form of design waivers and design exceptions that shall be submitted in accordance with IIM-LD-227. Any design exception not granted may be appealed to the Chief Engineer.

ROADWAY WIDTH

Roadway width as referenced in this section is the portion of the highway, including graded shoulders, for vehicular use.

DESIGN SPEED (V)

Design speed is defined as a speed determined for design and correlation of the physical features of a highway that influence vehicle operation - the maximum safe speed maintainable over a specified section of highway when conditions permit design features to govern.

Except for local streets where speed controls are frequently included intentionally, every effort should be made to use as high a Design Speed as practical to attain a desired degree of safety, mobility, and efficiency within the constraints of environmental quality, economics, aesthetics, and social or political impacts (See 2011 AASHTO Green Book, Chapter 2).

The geometric tables indicate a design speed range, or a portion of a range, for each functional classification. The design speed range for each roadway classification is available in the AASHTO Green Book. The selection of the proper design speed to be used on a particular project is of primary importance in project development. The design speed selected should:

- be logical with respect to topography, anticipated operating speed, adjacent land use, and functional classification of the highway.

- be as high as practicable to attain a desired degree of safety, mobility and efficiency while under the constraints of environmental quality, economics, aesthetics and social or political impacts.

- be consistent with the speed a driver is likely to expect. Drivers do not adjust their speeds to the importance of the highway, but to their perception of the physical limitations and traffic.

Although the design speeds for rural highways are coupled with a terrain classification, terrain is only one of the several factors involved in determining the appropriate design speed of a highway.

Rev. 7/14
Although the selected design speed establishes the maximum degree of curvature and minimum sight distance necessary for safe operation, there should be no restriction on the use of flatter horizontal curves or greater sight distances where such improvements can be provided as a part of economic design. However, if a succession of flatter curves or tangent sections would encourage drivers to operate at higher speeds, that section of highway should be designed for a higher speed and all geometric features, particularly that of sight distance on crest vertical curves and intersection sight distance should be related to it.

The minimum Design Speed shall be based on the following criteria:

1) For roadways with a Posted Speed:
   a) For high-speed roadways (Posted 50 mph and higher) the Design Speed shall be a minimum of 5 mph higher than the Posted Speed.
      - Example - Design Speed 60 mph – Posted Speed 55 mph
   b) For low-speed roadways (Posted 45 mph and less) the Design Speed shall be equal to or higher than the Posted Speed.
      - Example - Design Speed 40 mph – Posted Speed 40 mph

2) For unposted roadways: Design Speed shall be equal to Statutory Speed or 85% percentile speed (based on speed analysis, rounded up to nearest 5 mph increment).

3) Roadways with ADT < 400, see the VDOT Road Design Manual, Appendix B(1), Tables 1 through 3 and AASHTO’s “Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT < 400)”.

<table>
<thead>
<tr>
<th>Posted Speed/Design Speed (All speeds in miles per hour-mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posted</td>
</tr>
<tr>
<td>Low-Speed Roadways</td>
</tr>
<tr>
<td>20</td>
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<tr>
<td>25</td>
</tr>
<tr>
<td>30</td>
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<td>35</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>45</td>
</tr>
<tr>
<td>High-Speed Roadways</td>
</tr>
<tr>
<td>50</td>
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<tr>
<td>55</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>65</td>
</tr>
<tr>
<td>70</td>
</tr>
</tbody>
</table>

* Added 7/16
Whenever VDOT criteria (provided above in cases 1-3) are not met, a design waiver is required to document the design speed.

A Design Exception is required if AASHTO minimum design speeds for individual geometric elements are not met.


For the determination of the roadway posted speed limits, the plans are to indicate the Design Speed (V) of each horizontal and vertical (crest and sag) curve along with the horizontal and vertical curve data.

The Design Speeds (V) are to be determined as follows:

- Crest Vertical Curves
  - See “Sight Distance on Crest Vertical Curves” (VDOT's Road & Bridge Standards, Section 600) to determine sight distance parameters.
  - See 2011 AASHTO Green Book “Crest Vertical Curve” criteria, pages 3-151 through 3-157 to determine the Design Controls.

- Sag Vertical Curves
  - See 2011 AASHTO Green Book “Sag Vertical Curve” criteria, pages 3-157 through 3-161 to determine the Design Controls.

Horizontal Curves

- The appropriate Transition Curve Standard (TC-5.01R, TC-5.01U, or TC-5.04ULS, TC-5.11R, TC-5.11U, or TC-5.11ULS) from VDOT’s Road and Bridge Standards, Section 800, provides the Design Speed (V) for horizontal curves (based on the radius of curvature (R) and the superelevation rate (E) provided by GeoPak.

SHOWING DESIGN SPEED (V) FOR HORIZONTAL CURVES ON PLANS

The Design Speed shown on the plans for each horizontal curve is not necessarily the Minimum Design Speed shown on the Title Sheet.

GEOPAK supplies the superelevation dependent upon the input (urban/rural, radius, etc.) for each curve but does not provide the design velocity.

Designers shall determine the Design Speed (V) for each curve. This data is to be shown on the plans in the horizontal curve data for each curve.

* Added 7/14
Example:

**Title Sheet:**
Urban Principal Arterial (TC-5.11U - 2011 AASHTO Green Book)
45 mph Minimum Design Speed

**Horizontal Curve on plans:**
Radius = 1533’
Superelevation = 3.3% (provided by GEOPAK)
V = ?

1. To verify the velocity of the horizontal curve compare project radius and superelevation with Design Factors Charts in Section 800 of the Road and Bridge Standards.

2. Start with Page 803.29 TC-5.11U for given Design Speed shown above (45 mph).
   - Chart shows that a curve with 3.3% superelevation and radius of 1446’ will support a velocity of 45 mph. The radius on the plans is greater than 1446’ (1533’).

3. Go to Section 803.30 (50 mph Design Speed).
   - Chart shows that a curve with 3.3% superelevation and radius of 1857’ will support a velocity of 50 mph, but the radius on the plans is less than 1857’ (1533’).

4. Therefore, the project radius and superelevation will not support a 50 mph design velocity. The more conservative V = 45 mph shall be shown on the plans as the velocity of the curve.

A Design Exception is required whenever the horizontal curve radius and/or superelevation rate does not support the minimum design speed. See IIM-LD-227 for information on Design Exceptions.

**ADDITIONAL RESOURCES**


*The Federal Aide Policy Guide* (FAPG)

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* Rev. 7/16
“Compatibility of Design Speed, Operating Speed and Posted Speed” (1995 - By FHWA and TXDOT)

ITE’s “Speed: Understanding Design, Operating and Posted Speed” (1997 - By Ray Krammes (FHWA) and Kay Fitzpatrick (TTI)


- Note that the statutory speed limit is 55 mph for cars and 45 mph for trucks with the following exceptions: 25 mph in residence and business districts; 35 mph in cities and towns; 35 mph on Rural Rustic Roadways; 35 mph on non-surface treated highways. See the Code of Virginia (Speed Limits).

SHOWING DESIGN SPEED ON TITLE SHEET

See the current version of Instructional and Informational Memorandum IIM-LD-204 for the method of showing design speed data on the plans.

An asterisk is to be shown adjacent to the Design Speed (Example - * 60 MPH) on the title sheet and the following note shown:

* See Plan and Profile Sheets for the horizontal and vertical curve design speeds.

OPERATING SPEED

Operating Speed is the speed at which drivers are observed operating their vehicles during free-flow conditions. The 85th percentile of the distribution of observed speeds is the most frequently used measure of the operating speed associated with a particular location or geometric feature of a highway, or highway segment.

POSTED SPEED

The Posted Speed for existing, new or reconstructed roadways should be determined by factors outlined in the MUTCD, Section 2B.13. The MUTCD requires that an engineering study be conducted in accordance with established engineering practice. VDOT has a standard study template for developing speed limit recommendations which incorporates the MUTCD, Section 2B.13 as well as other considerations pertaining to VDOT’s decision-making process for speed limit approvals, including enforcement consensus.

After a project is constructed, the responsible District Traffic Engineer will re-establish the speed limit based on established traffic engineering policies. An engineering study will be performed as needed in accordance with documented traffic engineering practices.

Rev. 1/17
It is important to note that the Design Speed shown on the project title sheet may not be the same as the Design Speed of the individual geometric elements. Each curve on the project (horizontal and vertical) should show a Design Speed for that particular feature. Although these curves may present isolated instances where the physical roadway dictates the speed of vehicles, they shall not be the sole basis for determining the posted speed limit. It is more appropriate to address these locations by warning signs. It is only where the physical roadway features dictate the speed of the vehicles on extended sections, for a major portion of the roadway that they should be considered as a limiting factor in setting the speed limit. Such limitations in speed due to physical features will become apparent in the speed analysis conducted as part of the engineering study.

For design criteria and instructions on signing roadways with a design speed < 25 mph, see the VDOT Road Design Manual, Appendix B(1), Tables 1 through 3 and AASHTO’s “Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT < 400).

**DESIGN VEHICLE**

The type of vehicle that makes frequent turns without encroaching into the adjacent lane when making turns. The tracking of the design vehicle is an important determinant of corner radii at intersections. When the design vehicle traverses an intersection, the design vehicle shall be able to turn from one street to another without deviating from the near travel lane and impeding other traffic flow. Therefore, the design vehicle determines the elements of design such as turning radius and lane width. The design vehicle is to be determined based on the LD-104 Request for Traffic Data and discussed at the Project Scoping Meeting and recorded on the Scoping Worksheet - Roadway Design.

The WB-67 shall be the design vehicle used for intersections of freeway ramp terminals with other arterial crossroads and for other intersections on state highways and industrialized streets that carry high volumes of traffic or that provide local access for large trucks.

**DESIGN WAIVERS**

Design Waivers are required when deviations from VDOT’s design criteria occur. When design criteria meet or exceed AASHTO minimal design but fall short of VDOT’s minimal design, a Design Waiver shall be required. Design Waivers will be applicable to all projects regardless of functional classification and funding and shall be documented and approved in accordance with the Design Waiver Request Form LD-448. Please refer to IIM-LD-227 for specific guideline on obtaining design waiver. This Design Waiver Policy is applicable to VDOT owned and maintained roadways only.
DESIGN EXCEPTIONS

If there are geometric values that are below AASHTO minimum guidelines, the Project Manager/ Design Engineer shall seek to obtain approval of these design exceptions from the State Location and Design Engineer (all projects) and FHWA (if applicable) no later than Public Hearing Stage. Please refer to IIM-LD-227 for specific guideline on obtaining design exceptions.

FUNCTIONAL CLASSIFICATION

The highway system in Virginia has been functionally classified as Principal Arterial, Minor Arterial, Collector and Local Service. The American Association of State Highway and Transportation Officials (AASHTO) utilizes, as presented in the publication: *A Policy on Geometric Design of Highways and Streets*, referred to as the AASHTO “Green Book”, a similar functional classification system. The designations used are: Freeway, Arterial, Collector, and Local Roads and Streets. Relationships between these two classification systems have been generally developed.

Principal and Minor Arterial Highways provide direct service between cities and larger towns and are high speed, high volume facilities. Collector highways serve small towns directly, connecting them and local roads to the arterial system.
BACKGROUND

• All roadways are classified as to how the facility functions in accordance with Federal guidelines.

• The Geometric Design Standards in Appendix A of VDOT’s Road Design Manual are divided by Functional Classification (FC).*

• The terms “Urban” and “Rural” used in the FC do not necessarily coincide with the terms as applied to highway systems in Virginia.

  Urban - Urbanized areas within set boundaries having a population of 5,000 or more. This may include areas outside of incorporated cities and towns.

  Rural - Areas not designated as Urban. Includes incorporated cities and towns with populations less than 5,000.

VIRGINIA HIGHWAY SYSTEMS

Urban - Roadways within the boundaries of incorporated towns and cities with a population of 3,500 or more plus eight other designated urbanized areas (Bridgewater, Chase City, Elkton, Grottoes, Narrows, Pearisburg, Saltville and Woodstock). The urban program is administered by the Local Assistance Division.

Primary - Primary Roadways

Secondary - All secondary roadways except those in Arlington and Henrico Counties. Projects are administered by the Local Assistance Division.

• A project classified as Urban in FC may be part of the Interstate, Arterial, Primary, or Secondary System and will be administered as such. This applies also to projects classified as Rural.

• The Functional Classification block on the title sheet is to show the Geometric Design Standard used.

  If more than one standard is used in the design, it will be necessary to set up two Functional Classification blocks since in most cases there would be a change in traffic volumes and scope of work.

* Rev. 7/09
EXAMPLE

• When the Functional Classification for a project would normally warrant either Geometric Design Standard GS-1, GS-2, GS-3, or GS-4 and Geometric Design Standard GS-5, GS-6, GS-7 or GS-8, respectively, is used then it will be necessary to show the standard used in the design on the title sheet under the Functional Classification.

• If the normal Geometric standard would be GS-3 and Geometric Standard GS-7 is used, the title sheet is to show:

RURAL COLLECTOR-ROLLING-DIVIDED (Urban St’d. GS-7 was used)

LANE/SOULDER/PAVEMENT TRANSITIONS, MERGING TAPERS & SPEED CHANGE LENGTHS

Lane/shoulder/pavement transitions typically occur where new or reconstructed roadways tie-in to existing roadways. This also applies to where roadways tie-in to bridges. Lane/pavement transitions, merging tapers and speed change lengths shall meet the minimum length provided by the following equations:

\[
\begin{align*}
\text{For 40 mph or less} & : & L &= S^2W / 60 \\
\text{For 45 mph or greater} & : & L &= W \times S
\end{align*}
\]

L = length of transition
S = Design Speed
W = Width of offset on each side

Source: 2009 MUTCD, Section 6, Table 6C-4

For Temporary Merging, Temporary Shifting and Temporary Shoulder Tapers see 2009 MUTCD, Section 6, Table 6C-3 and 6C-4.

For Passing/ Left Turn lanes on Two-Lane Highway See Appendix “F”, Figure 3-4.

NOTE:

A pavement transition length of 1/2L (calculate L by using the applicable formula above) is to be used when establishing project termini for the majority of small bridge replacement and/or major bridge rehabilitation projects when “NO” horizontal or vertical geometric changes are required to tie into the existing approach alignment. For additional information see Volume 5, Part 2, of the Structure and Bridge Manual.

Pavement transition is separate from the length of need for guardrail. Length of need and shoulder prep for guardrail shall be in accordance with the VDOT RDM Appendix A and the Road & Bridge Standards.

* Rev. 1/18
**GEOMETRIC DESIGN STANDARDS FOR INTERSTATE SYSTEM (GS-INT)**

<table>
<thead>
<tr>
<th>INTERSTATE</th>
<th>TERRAIN</th>
<th>MINIMUM DESIGN SPEED (MPH)</th>
<th>MINIMUM RADIUS</th>
<th>(7) MINIMUM STOPPING SIGHT DISTANCE</th>
<th>MINIMUM WIDTH OF LANE</th>
<th>(1) MINIMUM WIDTH OF TOTAL SHOULDERS (GRADED + PAVED) (CUT &amp; FILL)</th>
<th>(2,3,4) MINIMUM PAVED SHOULDER WIDTH</th>
<th>(5) MINIMUM WIDTH OF DITCH FRONT SLOPE</th>
<th>(6) SLOPE</th>
<th>NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rural Non-Mountainous (Level or Rolling)</td>
<td>75</td>
<td>2215'</td>
<td>820'</td>
<td>12'</td>
<td>16'</td>
<td>4' ** Min.</td>
<td>10' Min.</td>
<td>12' @ 6:1</td>
<td>CS-4B</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>70</td>
<td>1821'</td>
<td>730'</td>
<td>12'</td>
<td>16'</td>
<td>4' ** Min.</td>
<td>10' Min.</td>
<td>12' @ 6:1</td>
<td>CS-4B</td>
</tr>
<tr>
<td></td>
<td>Rural Mountainous</td>
<td>50</td>
<td>760'</td>
<td>425'</td>
<td>14'</td>
<td>10'</td>
<td>4' ** Min.</td>
<td>8' ** Min.</td>
<td>** AASHTO Minimum, See Interstate Guide</td>
<td></td>
</tr>
</tbody>
</table>

**GENERAL NOTES**

Interstates - All new and major reconstructed Interstate facilities will have a posted +5 mph design speed unless concurrence from the State Location and Design Engineer is obtained.

Medians in urban or mountainous areas shall be wide enough to accommodate the left total shoulder width plus the space needed for a barrier. See Interstate Guide.

When barriers are provided right of traffic or in the median the total shoulder shall be paved.

Where curbs are provided, they shall not be closer to the traveled way than the outer edge of the paved shoulder, shall have a sloping face and be limited to the height of 4 inches (St'd CG-3). See Interstate Guide.

**FOOTNOTES**

(1) Total shoulder widths include the paved portion and are applicable to the left and right shoulder.

Where truck traffic exceeds 250 DDHV, a wider total shoulder should be considered (14' without guardrail; 18' with guardrail).

(2) When the mainline is 6 or more lanes in rural non-mountainous or urban terrain, the left paved shoulder width shall be the same as the right paved shoulder.

** AASHTO Minimum, See Interstate Guide.

(3) When the mainline is 8 or more lanes in rural mountainous terrain, the median paved shoulder width shall be the same as the right paved shoulder.

** AASHTO Minimum, See Interstate Guide.

Where truck traffic exceeds 250 DDHV, additional shoulder width may be beneficial. Refer to AASHTO’s Green Book Chapter 8 for more information.

(4) Additional guidance on shoulder widths for tunnels and long bridges (overall length over 200 ft) is provided in the AASHTO Interstate Guide.

(5) A hydraulic analysis is necessary to determine actual depth requirement.

(6) Additional or modified slope criteria to apply where shown on typical sections.

(7) For additional information on sight distance requirements on grades of 3 percent or greater, see Section 3.2.2, page 3-5, Tables 3-2 of the AASHTO Green Book.


**FIGURE A - 1 - INT**

* Grades 1% Steeper than the value shown may be used in urban areas

* Grades (%) of Terrain

<table>
<thead>
<tr>
<th>Type of Terrain</th>
<th>Design Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Level</td>
<td>4</td>
</tr>
<tr>
<td>Rolling</td>
<td>5</td>
</tr>
<tr>
<td>Mountainous</td>
<td>6</td>
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* Added 1/19
# GEOMETRIC DESIGN STANDARDS FOR RURAL PRINCIPAL ARTERIAL SYSTEM (GS-1)

<table>
<thead>
<tr>
<th>TERRAIN</th>
<th>DESIGN SPEED (MPH)</th>
<th>MINIMUM RADIUS</th>
<th>(6) MINIMUM STOPPING SIGHT DISTANCE</th>
<th>MINIMUM WIDTH OF LANE</th>
<th>(1) MINIMUM WIDTH OF TOTAL SHOULDERS (GRADED + PAVED) CUT &amp; FILL</th>
<th>(2) MINIMUM PAVED SHOULDER WIDTH</th>
<th>(3) MINIMUM WIDTH OF DITCH FRONT SLOPE</th>
<th>(4) SLOPE</th>
<th>NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES</th>
</tr>
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<tbody>
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<td>FREeways</td>
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<tr>
<td>LEVEL</td>
<td>75</td>
<td>2215'</td>
<td>820'</td>
<td>12'</td>
<td>16', 12', 4', 10'</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>ROLLING</td>
<td>70</td>
<td>1821'</td>
<td>730'</td>
<td>12'</td>
<td>16', 12', 4', 10'</td>
<td></td>
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<td>12'</td>
<td>16', 12', 4', 8'</td>
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</table>

## GENERAL NOTES

Freeways - A design speed of 75 mph should be used for Rural Freeways. Where terrain is mountainous, a design speed of 60 mph or 50 mph which is consistent with driver expectancy, may be used.

Other Principal Arterials - A design speed of 40 to 70 mph should be used depending on terrain, driver expectancy and whether the design is constructed on new location or reconstruction of an existing facility. An important safety consideration in the selection of one of the lower design speeds in each range is to have a properly posted speed limit.

Incorporated towns or other built-up areas, Urban Standard GS-5 may be used for design. “Built-up” is where there is sufficient development along the roadway that justifies a need to channelize traffic into and out of properties utilizing curb and gutter.

Standard TC-5.11R superelevation based on 8% maximum is to be used for all Rural Principal Arterials.

Clear Zone and Recoverable Area information can be found in Appendix A, Section A-2 of the Road Design Manual. If medians are included, see Section 2E-3 of Chapter 2E of the Road Design Manual.

For additional information on roadway widths and maximum grades relative to terrain and design speed, see AASHTO Green Book, Chapter 7, Section 7.2.2, page 7-4, Tables 7-2 and Section 7.2.3, page 7-5, Table 7-3; for Freeways, see Chapter 8, Section 8.2.7, page 8-4, Table 8-1.

## FOOTNOTES

1. Total shoulder widths include the paved portion and are applicable to the left and right shoulder.

On Freeways, if truck traffic exceeds 250 DDHV, a wider total shoulder should be considered (14' without guardrail and 18' with guardrail).

2. When the mainline is 6 or more lanes, the left paved shoulder width shall be the same as the right paved shoulder. On Freeways, if truck traffic exceeds 250 DDHV, a wider right paved shoulder should be considered (12').

3. A hydraulic analysis is necessary to determine actual depth requirement.

4. Additional or modified slope criteria to apply where shown on typical sections.


6. For additional information on sight distance requirements on grades of 3 percent or greater, see Section 3.2.2, page 3-5, Tables 3-2 of the AASHTO Green Book.

## FIGURE A - 1 - 1

* Rev. 1/19
### Geometric Design Standards for Rural Minor Arterial System (GS-2)

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<td>LEVEL</td>
<td>70</td>
<td>182'</td>
<td>12'</td>
<td>14'</td>
<td>10'</td>
<td>LT. 6' @ 6:1 CS-4, CS-4A, OR CS-4C</td>
</tr>
<tr>
<td></td>
<td>ROLLING</td>
<td>60</td>
<td>120'</td>
<td>570'</td>
<td>6'</td>
<td>4'</td>
<td>RT. 6' @ 4:1 CS-3/CS-3B</td>
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<tr>
<td></td>
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<td>50</td>
<td>760'</td>
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<td>360'</td>
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<td>360'</td>
<td>446'</td>
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<td>LEVEL</td>
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<td>182'</td>
<td>12'</td>
<td>12'</td>
<td>8'</td>
<td>LT. 6' @ 4:1 CS-4, CS-4A, OR CS-4C</td>
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<td>570'</td>
<td>6'</td>
<td>4'</td>
<td>RT. 6' @ 4:1 CS-3/CS-3B</td>
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<td>589'</td>
<td>360'</td>
<td>446'</td>
<td>305'</td>
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</tr>
<tr>
<td>CURRENT ADT Under 400</td>
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<td>70</td>
<td>182'</td>
<td>12'</td>
<td>10'</td>
<td>6'</td>
<td>LT. 6' @ 4:1 CS-4, CS-4A, OR CS-4C</td>
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<td>45</td>
<td>589'</td>
<td>360'</td>
<td>446'</td>
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**General Notes**

Rural Minor Arterials are designed with design speeds of 50 to 70 MPH, dependent on terrain features and traffic volumes, and occasionally may be as low as 40 MPH in mountainous terrain.

In incorporated towns or other built-up areas, Urban Standard GS-6 may be used for design. "Built-up" is where there is sufficient development along the roadway that justifies a need to channelize traffic into and out of properties utilizing curb and gutter.

Standard TC-5.11R superelevation based on 8% maximum is to be used for Rural Minor Arterials.

If medians are included, see Section 2E-3 of Chapter 2E of the Road Design Manual. Clear Zone and Recoverable Area information can be found in Appendix A, Section A-2 of the Road Design Manual.

For Passing Sight Distance Criteria, see AASHTO Green Book, Section 3.2.4, page 3-8.

For maximum grades relative to terrain and design speed, see AASHTO Green Book, Chapter 7, Section 7.2.2, page 7-4, Table 7-2.

**Footnotes**

1. Use Design Year ADT for new construction and reconstruction projects (not applicable to R.R.R. projects or roads with ADT < 400) in accordance with Road Design Manual, Chapter 2A, "REQUEST FOR TRAFFIC DATA" and Form TD-104.
2. Lane width to be 12' at all interchange locations. For projects not on the National Highway System, width of traveled way may remain at 22' on reconstructed highways where alignment and safety records are satisfactory.
3. Where the mainline is 6 or more lanes, both right and median paved shoulders shall be 8' in width. For additional guidance on shoulder widths/reductions, see AASHTO Green Book, Ch. 7, Section 7.2.11, pg. 7-13 & Section 7.2.3, Table 7-3.
4. A hydraulic analysis is necessary to determine actual depth requirement.
5. Additional or modified slope criteria to be applied where shown on typical sections.
7. For additional information on sight distance requirements on grades of 3 percent or greater, see AASHTO Green Book, Chapter 3, Section 3.2.2, page 3-5, Table 3-2.
8. Total shoulder widths include the paved portion and are applicable to the left and right shoulder.

**FIGURE A - 1 - 2**

* Rev. 1/19
GEOMETRIC DESIGN STANDARDS FOR RURAL COLLECTOR ROAD SYSTEM (GS-3)

<table>
<thead>
<tr>
<th>TRAFFIC VOLUME</th>
<th>TERRAIN</th>
<th>DESIGN SPEED (MPH)</th>
<th>MINIMUM RADIUS</th>
<th>(8) MINIMUM STOPPING SIGHT DISTANCE</th>
<th>(2) MINIMUM WIDTH OF LANE</th>
<th>(3) (4) MINIMUM WIDTH OF GRADED SHOULDER CUT &amp; FILL</th>
<th>(5) MINIMUM WIDTH OF DITCH FRONT SLOPE</th>
<th>(6) SLOPE</th>
<th>NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES</th>
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<td>120'</td>
<td>570'</td>
<td>12'</td>
<td>12'</td>
<td>10' @ 6:1</td>
<td>CS-4, CS-4A OR CS-4C</td>
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<tr>
<td></td>
<td>ROLLING</td>
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<td>760'</td>
<td>425'</td>
<td></td>
<td></td>
<td>6' @ 4:1</td>
<td>CS-3 / CS-3B</td>
<td></td>
</tr>
<tr>
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<td>MOUNTAINOUS</td>
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<td>589'</td>
<td>360'</td>
<td>11'</td>
<td>10'</td>
<td>6' @ 4:1</td>
<td>CS-4, CS-4A OR CS-4C</td>
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<td></td>
<td></td>
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<td>446'</td>
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<td></td>
<td>4 @ 3:1</td>
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<td>(1) ADT 1500 TO 2000</td>
<td>LEVEL</td>
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<td>4 @ 3:1</td>
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<td>200'</td>
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<td>(1) ADT 400 TO 1500</td>
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<td>CS-3/ CS-3B</td>
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<td>250'</td>
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Geometric design features should be consistent with a design speed appropriate for the conditions.

Low design speeds (45 MPH and below) are generally applicable to highways with curvilinear alignment in rolling or mountainous terrain and where environmental conditions dictate.

High speed design (50 MPH and above) are generally applicable to highways in level terrain or where other environmental conditions are favorable.

Intermediate design speeds would be appropriate where terrain and other environmental conditions are a combination of those described for low and high design speed.

The designer should strive for higher values than the minimum where conditions of safety dictate and costs can be supported.

In incorporated towns or other built-up areas, Urban Standard GS-7 may be used. “Built-up” is where there is sufficient development along the roadway that justifies a need to channelize traffic into and out of properties utilizing curb and gutter.

Standard TC-5.11R superelevation based on 8% maximum is to be used for Rural Collectors.

Clear zone and Recoverable Area information can be found in Appendix A, Section A-2 of the Road Design Manual.

For Passing Sight Distance Criteria see AASHTO Green Book, Chapter 3, Section 3.2.4, page 3-8.

For maximum grades relative to terrain and design speed, see AASHTO Green Book, Chapter 6, Section 6.2.1, page 6., Table 6-2.

FOOTNOTES

(1) Use Design Year ADT for new construction and reconstruction projects (not applicable to R.R.R. projects or roads with ADT < 400) in accordance with Road Design Manual, Chapter 2A, “REQUEST FOR TRAFFIC DATA” and Form LD-104.

(2) Lane width to be 12’ at all interchange locations.

(3) When the mainline is 2 lanes provide 4’ wide paved shoulders (right and left) when design year ADT exceeds 2000 VPD, with 5% or more truck and bus usage. Provide 5’ wide right paved shoulder when design year ADT exceeds 2000 VPD, with 5% or more truck and bus usage and the route is an AASHTO approved U.S. Bicycle Route (1, 76 or 176) or designated as a bicycle route on a locally adopted transportation plan. All shoulders not being paved will have the mainline pavement structure extended 1’ on the same slope into the shoulder to eliminate raveling at the pavement edge. For additional guidance on shoulder widths, see AASHTO Green Book, Chapter 6, Section 6.2.2, page 6-6.

(4) When the mainline is 4 lanes with ADT >2000, a minimum paved shoulder width of 6’ right of traffic and 3’ left of traffic shall be provided.

(5) A hydraulic analysis is necessary to determine actual depth requirement.

(6) Additional or modified slope criteria to be applied where shown on typical sections.


(8) For additional information on sight distance requirements on grades of 3 percent or greater, see AASHTO Green Book, Chapter 3, Section 3.2.2, page 3-2, Table 3-2.

(9) Shoulder width may be reduced to 4’ (8’ with guardrail) where appropriate as long as a minimum roadway width of 30’ is maintained. See AASHTO Green Book, Chapter 6, Section 6.2.2, page 6-6, Table 6-5.

FIGURE A - 1 - 3*

* Rev. 1/19
## Geometric Design Standards for Rural Local Road System (GS-4)

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<td>22'</td>
<td>10' @ 4:1</td>
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<td>30</td>
<td>215'</td>
<td>200'</td>
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<td>135'</td>
<td>155'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moutainous</td>
<td>20</td>
<td>77</td>
<td>125'</td>
<td></td>
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</tr>
</tbody>
</table>

### General Notes

Low design speeds are generally applicable to roads with winding alignment in rolling or mountainous terrain where environmental conditions dictate.

High design speeds are generally applicable to roads in level terrain or where other environmental conditions are favorable.

Intermediate design speeds would be appropriate where terrain and other environmental conditions are a combination of those described for low and high speed.

For minimum design speeds for 250 ADT and under, see AASHTO Green Book, Chapter 5, Section 5.2.1, page 5-2, Table 5-1.

For passing sight distance criteria, see AASHTO Green Book, Chapter 3, Section 3.2.4, page 3-8.

For maximum grades relative to terrain and design speed, see AASHTO Green Book, Chapter 5, Section 5.2.1, page 5-3, Table 5-2.

For recreational access road design standards, see AASHTO Green Book, Chapter 5, Section 5.4.2, page 5-24.

### Footnotes

1. Use Design Year ADT for new construction and reconstruction projects in accordance with Road Design Manual, Chapter 2A, “REQUEST FOR TRAFFIC DATA” and Form LD-104. For RRR projects or roads with ADT < 400, See Road Design Manual, Appendix A, “GUIDELINES FOR RRR PROJECTS.”

2. Lane width to be 12' at all interchange locations.

3. In mountainous terrain or sections with heavy earthwork, the graded width of shoulder in cuts may be decreased by 2', but in no case shall the cut shoulder width be less than 2'.

4. Minimum shoulder slope shall be 8% on low side and same slope as pavement on high side (See Std. GS-12).

5. When the mainline is 2 lanes provide 4' wide paved shoulders (right and left) when design year ADT exceeds 2000 VPD, with 5% or more truck and bus usage. Provide 5' wide paved shoulder when design year ADT exceeds 2000 VPD, with 5% or more truck and bus usage and the route is an AASHTO approved U.S. Bicycle Route (1, 76 or 176) or designated as a bicycle route on a locally adopted transportation plan All shoulders not being paved will have the mainline pavement structure extended 1' on the same slope into the shoulder to eliminate raveling at the pavement edge. For additional guidance on shoulder widths, see AASHTO Green Book, Chapter 5, Section 5.2.2, page 5-8.

6. A hydraulic analysis is necessary to determine actual depth requirement.

7. Additional or modified slope criteria to be applied where shown on typical sections.


9. For additional information on passing sight distances on grades of 3 percent or greater, see AASHTO Green Book, Chapter 3, Section 3.2.2, page 3-6, Table 3-2.

### Figure A - 1 - 4

* Rev. 1/19
### Geometric Design Standards for Urban Principal Arterial System (GS-5)

<table>
<thead>
<tr>
<th>Design Speed (MPH)</th>
<th>Minimum Radius</th>
<th>(13) Minimum Stopping Sight Distance</th>
<th>Minimum Width of Lane (With GRA)</th>
<th>Minimum Width of Lane (Without GRA)</th>
<th>(2) Minimum Paved Shoulder Width</th>
<th>(3) Minimum Width of Ditch Front Slope</th>
<th>(4) New and Reconstructed Minimum Bridge Widths and Vertical Clearances</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Freeways</strong></td>
<td></td>
<td></td>
<td>LT.</td>
<td>RT.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>-</td>
<td>730'</td>
<td>12'</td>
<td>16'</td>
<td>12'</td>
<td>12' @ 6:1</td>
<td>CS-4 OR 4B</td>
</tr>
<tr>
<td>60</td>
<td>-</td>
<td>570'</td>
<td>12'</td>
<td>12'</td>
<td>4'</td>
<td>10'</td>
<td>CS-4 OR 4E</td>
</tr>
<tr>
<td>50</td>
<td>-</td>
<td>425'</td>
<td>12'</td>
<td>12'</td>
<td>4'</td>
<td>8'</td>
<td>CS-4 OR 4E</td>
</tr>
<tr>
<td><strong>Other Principal Arterial with Shoulder Design</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>500'</td>
<td>570'</td>
<td>12'</td>
<td>14'</td>
<td>10'</td>
<td>10' @ 6:1</td>
<td>CS-4 OR 4E</td>
</tr>
<tr>
<td>45</td>
<td>713'</td>
<td>593'</td>
<td>305'</td>
<td>6'</td>
<td>8'</td>
<td>6' @ 4:1</td>
<td>CS-3 OR 3B</td>
</tr>
<tr>
<td>40</td>
<td>536'</td>
<td>408'</td>
<td>250'</td>
<td>6'</td>
<td>8'</td>
<td>6' @ 4:1</td>
<td>CS-4 OR 4E</td>
</tr>
<tr>
<td>35</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>30</td>
<td>251'</td>
<td>273'</td>
<td>200'</td>
<td>6'</td>
<td>8'</td>
<td>6' @ 4:1</td>
<td>CS-3 OR 3B</td>
</tr>
<tr>
<td>25</td>
<td>156'</td>
<td>167'</td>
<td>155'</td>
<td>6'</td>
<td>8'</td>
<td>6' @ 4:1</td>
<td>CS-3 OR 3B</td>
</tr>
</tbody>
</table>

### General Notes

Freeways - Urban Freeways should accommodate desired safe operating speeds during non-peak hours, but should not be so high as to exceed the limits of prudent construction, right of way and socioeconomic costs due to the large proportion of vehicles which are accommodated during periods of peak flow when lower speeds are necessary. The design speeds for Freeways shall not be less than 50 mph. On many Urban Freeways, particularly in suburban areas, a design speed of 60 mph or higher can be provided with little additional cost above that required for 50 mph design speed. The corridor of the mainline may be relatively straight and the character and location of interchanges may permit a higher design speed. Under these conditions, a design speed of 70 mph should be considered.

Other Principal Arterials - Design speeds for Urban Arterials generally range from 40 to 60 mph, and occasionally may be as low as 25 mph. The lower (40 mph and below) speeds apply in the central business district and intermediate areas. The higher speeds are more applicable to the outlying business and developing areas.

Standard TC-5.11R (Urban) superelevation based on 8% maximum is to be used for **All Freeways** (50 – 70 mph) and for Other Principal Arterials with a design speed of 60 mph. For minimum radius, see GS-1.

Standard TC-5.11U (Urban Low Speed) superelevation based on 4% maximum is to be used on Other Principal Arterials with a design speed of 50 mph and less.

Standard TC-5.11ULS (Urban Low Speed) superelevation based on 2% maximum is may be used on Other Principal Arterials with a design speed less than or equal to 45 mph.

Clear Zone and Recoverable Area information can be found in Appendix A, Section A-2 of the Road Design Manual.

If medians are included, see Section 2E-3 of Chapter 2E of the Road Design Manual. For minimum widths for roadway & right of way used within incorporated cities or towns to qualify for maintenance funds see Code of Va. Section 33.2-319.

For maximum grades relative to terrain and design speed, see AASHTO Green Book, Chapter 7, Section 7.3.3, page 7-29, Table 7-4, for Freeways, see Chapter 8, Section 8.2.7, page 8-4, Table 8-1.

### Footnotes

1. Total shoulder widths include the paved portion and are applicable to the left and right shoulder. On Freeways, if truck traffic exceeds 250 DDHV, a wider total shoulder should be considered (14’ without guardrail and 18’ with guardrail).
2. When the mainline is 6 or more lanes, the left paved shoulder width shall be the same as the right paved shoulder. On Freeways, if truck traffic exceeds 250 DDHV, a wider right paved shoulder should be considered (12’).
3. A hydraulic analysis is necessary to determine actual depth requirement.
4. Additional or modified slope criteria apply where shown on typical sections.
5. Minimum lane widths to be 12’ at all interchange locations.
6. Where heavy truck volume (equal to or greater than 10%) or bus traffic is anticipated, an additional 1 foot width should be considered.
8. Or equivalent City or Town design.
9. Width of 8’ or more may be needed in commercial areas.
10. 3:1 and flatter slopes shall be used when the right of way is behind the sidewalk (or sidewalk space) in residential or other areas where slopes will be maintained by the property owner.
11. For buffer strip widths see Appendix A(1), Section A(1)-1 Bicycle & Pedestrian Facility Guidelines.
12. Situations having restrictions on trucks may allow the use of lanes 1 foot less in width.
13. For additional information on sight distance requirements on grades of 3 percent or greater, see AASHTO Green Book, Section 3.2.2, page 3-2, Table 3-2. For Intersection sight distance requirements see Appendix F, Table 2-5.
14. Where bicycle accommodation is next to curb or curb and gutter, mountable curb (CG-3) or mountable curb and gutter (CG-7) shall be used for design speeds of 45 mph and below.

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* Rev. 1/20
GEOMETRIC DESIGN STANDARDS FOR URBAN MINOR ARTERIAL STREET SYSTEM (GS-6)

<table>
<thead>
<tr>
<th>DESIGN SPEED (MPH)</th>
<th>MINIMUM RADIUS</th>
<th>MINIMUM STOPPING DISTANCE</th>
<th>MINIMUM WIDTH OF LANE</th>
<th>STANDARD CURB / CURB &amp; GUTTER BUFFER STRIP WIDTH</th>
<th>MINIMUM SIDEWALK WIDTH</th>
<th>SLOPE</th>
<th>NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>U ULS</td>
<td>(1)</td>
<td>(10)</td>
<td>(11)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>1204'</td>
<td>570'</td>
<td>12'</td>
<td>CG-3 / CG-7</td>
<td>(9)</td>
<td>5'</td>
<td>2:1</td>
</tr>
<tr>
<td>50</td>
<td>929'</td>
<td>425'</td>
<td>(1) (2) 11'</td>
<td>(13) (14) CG-2 / CG-6</td>
<td>(11)</td>
<td>10'</td>
<td>6' @ 4:1</td>
</tr>
<tr>
<td>45</td>
<td>713'</td>
<td>360'</td>
<td>(1) (2) 11'</td>
<td>(15) MINIMUM WIDTH OF TOTAL SHOULDER Widths (GRADED + PAVED) CUT &amp; FILL</td>
<td>(8)</td>
<td>10'</td>
<td>6' @ 4:1</td>
</tr>
<tr>
<td>40</td>
<td>536'</td>
<td>280'</td>
<td>(1) (2) 11'</td>
<td>(12) (7) MINIMUM PAVED SHOULDERS WIDTH</td>
<td>(8)</td>
<td>10'</td>
<td>6' @ 4:1</td>
</tr>
<tr>
<td>35</td>
<td>373'</td>
<td>200'</td>
<td>(1) (2) 11'</td>
<td>(10) MINIMUM WIDTH OF TOTAL SHOULDER Widths (GRADED + PAVED) CUT &amp; FILL</td>
<td>(8)</td>
<td>10'</td>
<td>6' @ 4:1</td>
</tr>
<tr>
<td>30</td>
<td>251'</td>
<td>120'</td>
<td>(1) (2) 11'</td>
<td>(9)</td>
<td>(5)</td>
<td>10'</td>
<td>6' @ 4:1</td>
</tr>
<tr>
<td>25</td>
<td>155'</td>
<td>155'</td>
<td>(1) (2) 11'</td>
<td>(8)</td>
<td>(5)</td>
<td>10'</td>
<td>6' @ 4:1</td>
</tr>
</tbody>
</table>

GENERAL NOTES*

Design Speeds for Urban Arterials generally range from 40 to 60 mph and occasionally may be as low as 25 mph. The lower (40 mph and below) speeds apply in the central business district and intermediate areas. The higher speeds are more applicable to the outlying business and developing areas.

Standard TC-5.11R (Rural) superelevation based on 8% maximum is to be used for 60 mph design speed.

Standard TC-5.11U (Urban) superelevation based on 4% maximum is to be used for design speeds less than 60 mph.

Standard TC-5.11ULS (Urban Low Speed) superelevation based on 2% maximum may be used for design speeds less than or equal to 45 mph.

Clear Zone and Recoverable Area information can be found in Appendix A, Section A-2 of the Road Design Manual.

If medians are included, see Section 2E-3 of Chapter 2E of the Road Design Manual.

For minimum widths for roadway and right of way used within incorporated cities or towns to qualify for maintenance funds see Code of Virginia Section 33.2-319.

For maximum grades relative to terrain and design speed, see AASHTO Green Book, Chapter 7, Section 7.3.2, page 7-29, Table 7-4.

FOOTNOTES

(1) Lane width to be 12' at all interchanges.

(2) Where heavy truck volume (equal to or greater than 10%) or bus traffic is anticipated, an additional 1 foot width should be considered.

(3) Or equivalent City or Town design.

(4) A width of 8' or more may be needed in commercial areas.

(5) Slopes 3:1 and flatter shall be used when the right of way is behind the sidewalk (or sidewalk space) in residential or other areas where slopes will be maintained by the property owner.


(7) Where the mainline is 6 or more lanes, both right and median paved shoulders shall be 8' in width. For additional guidance on shoulder widths/reductions, see AASHTO Green Book, Chapter 7, Section 7.2.11, page 7-13.

(8) A hydraulic analysis is necessary to determine actual depth requirement.

(9) See Appendix A, Section A(1), Section A(1)-1 Bicycle & Pedestrian Facility Guidelines.

(10) Situations having restrictions on trucks may allow the use of lanes 1 foot less in width.

(11) For additional information on sight distance requirements on grades of 3 percent or greater, see AASHTO Green Book, Chapter 3, Section 3.2.2, page 3-2, Table 3-2.

(12) For information on reduced shoulder widths, see AASHTO Green Book, Chapter 7, Section 7.2.3, page 7-5, Table 7-3.

(13) Where bicycle accommodation is next to curb or curb and gutter, mountable curb (CG-3) or mountable curb and gutter (CG-7) shall be used for design speeds of 45 mph and below.

(14) See Appendix J for guardrail installation adjacent to curb or curb and gutter.

(15) Total shoulder widths include the paved portion and are applicable to the left and right shoulder.

FIGURE A - 1 - 6

* Rev. 1/20
### GEOMETRIC DESIGN STANDARDS FOR URBAN COLLECTOR STREET SYSTEM (GS-7)

| STREET WITH CURB & GUTTER | DESIGN SPEED (MPH) | MINIMUM RADIUS | (10) MINIMUM STOPPING DISTANCE | (13) MINIMUM WIDTH OF LANE | (3) STANDARD CURB & GUTTER | BUFFER STRIP WIDTH | (4) MINIMUM SIDEWALK WIDTH | (5) SLOPE | (6) MINIMUM WIDTH OF DITCH | (7) (11) MINIMUM WIDTH OF GRADED SHOULDERS CUT & FILL | (5) SLOPE | (7) MINIMUM WIDTH OF DITCH FRONT SLOPE | (8) MINIMUM WIDTH OF DITCH FRONT SLOPE | (9) SLOPE | (10) MINIMUM WIDTH OF DITCH FRONT SLOPE | (11) MINIMUM WIDTH OF DITCH FRONT SLOPE | (12) MINIMUM WIDTH OF DITCH FRONT SLOPE | (13) MINIMUM WIDTH OF DITCH FRONT SLOPE | (14) MINIMUM WIDTH OF DITCH FRONT SLOPE | (15) MINIMUM WIDTH OF DITCH FRONT SLOPE | (16) MINIMUM WIDTH OF DITCH FRONT SLOPE |
|---------------------------|-------------------|----------------|------------------|---------------------------|---------------------------|-----------------|--------------------------|-----------|---------------------------|-------------------------------|-----------|-----------------------------------|--------------------------------|-----------|-----------------------------------|--------------------------------|-----------|-----------------------------------|--------------------------------|-----------|-----------------------------------|--------------------------------|-----------|
| U ULS                    |                   |                |                  |                           |                           |                 |                          |           |                           |                                 |           |                                   |                                   |           |                                   |                                   |           |                                   |                                   |           |                                   |                                   |           |
| 50 929' ULS              | 45 713'           | 30 251'        | 12'              | CG-3 / CG-7              |                           |                 |                          |           |                           |                                 |           |                                   |                                   |           |                                   |                                   |           |                                   |                                   |           |                                   |                                   |           |
| 40 536'                  | 35 373'           | 30 251'        | 12'              | CG-2 / CG-6              |                           |                 |                          |           |                           |                                 |           |                                   |                                   |           |                                   |                                   |           |                                   |                                   |           |                                   |                                   |           |
| 25 115'                  |                   |                |                  |                           |                           |                 |                          |           |                           |                                 |           |                                   |                                   |           |                                   |                                   |           |                                   |                                   |           |                                   |                                   |           |
| (1) (2) 12'             | (12) 11'          |                |                  |                           |                           |                 |                          |           |                           |                                 |           |                                   |                                   |           |                                   |                                   |           |                                   |                                   |           |                                   |                                   |           |

### GENERAL NOTES

A minimum design speed of 25 mph or higher should be used for collector streets, depending on available right of way, terrain, adjacent development and other area controls.

In the typical street grid, the closely spaced intersections usually limit vehicular speeds and thus make the effect of design speed of less significance. Nevertheless, the longer sight distances and curve radii commensurate with design speeds higher than the value indicated result in safer highways and should be used to the extent practicable.

Standard TC-5.11U (Urban) superelevation based on 4% maximum.

Standard TC-5.11ULS (Urban-Low Speed) superelevation based on 2% maximum may be used with a design speed of 45 mph or less.

For minimum widths for roadway and right of way used within incorporated cities or towns to qualify for maintenance funds see Code of Virginia Section 33.2-319.

Clear zone and Recoverable Area information can be found in Appendix A, Section A-2 of the Road Design Manual.

For maximum grades relative to terrain and design speed, see AASHTO Green Book, Chapter 6, Section 6.3.1, page 6-12, Table 6-8.

### FOOTNOTES

1. Lane width should be 12' in industrial areas. Where Right of Way is restricted 11' lanes may be used in industrial areas. (See AASHTO Green Book Chapter 6, Section 6.2.2 and 6.3.2, page 6-5, Table 6-5).
2. Lane width to be 12' at all interchange locations.
3. Or equivalent City or Town Design.
4. 8' or more may be needed in commercial areas.
5. 3:1 and flatter slopes shall be used when right of way is behind the sidewalk (or sidewalk space) in residential or other areas where the slopes will be maintained by the property owner.
6. A hydraulic analysis is necessary to determine actual depth requirement.
7. When Design year ADT exceeds 2000 VPD, with greater than 10% total truck and bus usage: Provide 4' wide paved shoulders (right and left) when the graded shoulder is 5' wide or greater. Provide 5' wide paved shoulder when design year ADT exceeds 2000 VPD, with 5% or more truck and bus usage and the route is an AASHTO approved U.S. Bicycle Route (1, 76 or 176) or designated as a bicycle route on a locally adopted transportation plan. All shoulders not being paved will have the mainline pavement structure extended 1', on the same slope, into the shoulder to eliminate raveling at the pavement edge. (See Standard GS-11 for shoulder design).
9. For buffer strip widths see Appendix A(1), Section A(1)-1 Bicycle & Pedestrian Facility Guidelines.
10. For additional information on sight distance requirements on grades of 3 percent or greater, see AASHTO, Green Book, Chapter 3, Section 3.2.2, page 3-3, Table 3-2.
11. Where shoulders are provided, roadway widths in accordance with Table 6-5, page 6-6 should be considered. (See AASHTO Green Book, Chapter 6, Section 6.3.2, page 6-13.)
12. Where heavy truck volume (equal to or greater than 10%) or bus traffic is anticipated, an additional 1 foot width should be considered.
13. Situations having restrictions on trucks may allow the use of lanes 1 foot less in width.
14. Where bicycle accommodation is next to curb or curb and gutter, mountable curb (CG-3) or mountable curb and gutter (CG-7) shall be used for design speeds of 45 mph and below.

### FIGURE A - 1 - 7*

* Rev. 1/20
GEOMETRIC DESIGN STANDARDS FOR URBAN LOCAL STREET SYSTEM (GS-8)

<table>
<thead>
<tr>
<th>DESIGN SPEED (MPH)</th>
<th>MINIMUM RADIUS</th>
<th>MINIMUM MAXIMUM PERCENT OF GRADE</th>
<th>MINIMUM STOPPING SIGHT DISTANCE</th>
<th>MINIMUM WIDTH OF LANE</th>
<th>STANDARD CURB / CURB &amp; GUTTER BUFFER STRIP WIDTH</th>
<th>MINIMUM SIDEWALK WIDTH</th>
<th>SLOPE</th>
<th>NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>STREET WITH CURB &amp; GUTTER</td>
<td>30</td>
<td>25'</td>
<td>15</td>
<td>200'</td>
<td>(12) CG-2 / CG-6</td>
<td>(4)</td>
<td>5'</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>15'</td>
<td>167'</td>
<td>155'</td>
<td>10'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>8'</td>
<td>92'</td>
<td>125'</td>
<td>9'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STREET WITH SHOULDER DESIGN</td>
<td>(11)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>25'</td>
<td>15</td>
<td>200'</td>
<td>(12) CG-2 / CG-6</td>
<td>(4)</td>
<td>5'</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>15'</td>
<td>167'</td>
<td>155'</td>
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<td></td>
<td>20</td>
<td>8'</td>
<td>92'</td>
<td>125'</td>
<td>9'</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GENERAL NOTES**

Design Speed is not a major factor for local streets. For consistency in design elements, design speeds ranging from 20 to 30 mph may be used, depending on available right of way, terrain, adjacent development and other area controls.

In the typical street grid, the closely spaced intersections usually limit vehicular speeds, making the effect of a design speed of less significance.

Design speeds exceeding 30 mph in residential areas may require longer sight distances and increased curve radii, which would be contrary to the basic function of a local street.

Standard TC-5.11U (Urban) superelevation based on 4% maximum.

Standard TC-5.11ULS (Urban Low Speed) superelevation based on 2% maximum may be used with a design speed of 45 mph or less.

For minimum widths for roadway and right of way used within incorporated cities or towns to qualify for maintenance funds see Code of Virginia Section 33.2-319.

**FOOTNOTES**

1. Grades in commercial and industrial areas should be less than 8 percent; desirably, less than 5 percent. For maximum grades relative to terrain and design speed, see AASHTO Green Book, Chapter 5, Section 5.2.1, page 5-3, Table 5-2.

2. Where feasible, lanes should be 11' wide and in industrial areas should be 12' wide; however, where available or attainable right of way imposes severe limitations, 9' lanes can be used in residential areas and 11' lanes can be used in industrial areas.

3. Or equivalent City or Town design.

4. For buffer strip widths see Appendix A(1), Section A(1)-1 Bicycle & Pedestrian Facility Guidelines.

5. A width of 8' or more may be needed in commercial areas.

6. 3:1 and flatter slopes shall be used when the right of way is behind the sidewalk (or sidewalk space) in residential or other areas where slopes will be maintained by the property owner.

7. When Design year ADT exceeds 2000 VPD, with greater than 5% total truck and bus usage: Provide 4' wide paved shoulders when the graded shoulder is 5' wide or greater. Provide 5' wide paved shoulder when design year ADT exceeds 2000 VPD, with 5% or more truck and bus usage and the route is an AASHTO approved U.S. Bicycle Route (1, 76 or 176) or designated as a bicycle route on a locally adopted transportation plan. All shoulders not being paved will have the mainline pavement structure extended 1', on the same slope, into the shoulder to eliminate raveling at the pavement edge (See Standard GS-12 for shoulder design).

8. A hydraulic analysis is necessary to determine actual depth requirement.


10. For additional information on sight distance requirements on grades of 3 percent or greater, see AASHTO Green Book, Chapter 3, Section 3.2.2, page 3-2, Table 3-2.

11. For information on reduced shoulder widths, see AASHTO Green Book, Chapter 5, Section 5.2.2, page 5-6, Table 5-5.

12. Where bicycle accommodation is next to curb or curb and gutter, mountable curb (CG-3) or mountable curb and gutter (CG-7) shall be used for design speeds of 45 mph and below.

**FIGURE A - 1 - 8**

* Rev. 1/19
### General Notes

The minimum design speed for service roads should be 20 mph except for one lane service roads serving one property which may have a minimum design speed of 10 mph.

Standard TC-5.11R superelevation is based on 8% maximum.

For Passing Sight Distance Criteria See AASHTO Green Book, Chapter 3, Section 3.2.4, page 3-8.

### Footnotes

1. For through service roads and dead end service roads with over 25 VPD, use Standards shown for Local Roads and Streets (Also See Standard GS-12).

2. Under adverse conditions, intermittent shoulder sections or turnouts for passing may be required (see AASHTO Green Book, Chapter 5, Section 5.4.2, page 5-29).

3. A hydraulic analysis is necessary to determine actual depth requirement.

4. Slopes to be same as mainline when service road is parallel to or otherwise visible from the mainline. For other cases, slopes should be in accordance with standards for Local Roads and Streets.

### Relationship of Maximum Grades to Design Speed

<table>
<thead>
<tr>
<th>Type of Terrain</th>
<th>Design Speed (MPH)</th>
<th>Grades (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td>16</td>
</tr>
</tbody>
</table>

### Figure A - 1 - 9

* Rev. 1/19
Appendix A, Section A-1-Page 22

GEOMETRIC DESIGN STANDARDS FOR INTERCHANGE RAMPS (GS-R)

<table>
<thead>
<tr>
<th>RAMP DESIGN SPEED (MPH)</th>
<th>MINIMUM RADIUS</th>
<th>(5) MINIMUM STOPPING DISTANCE</th>
<th>(1) MINIMUM RAMP PAVEMENT WIDTHS</th>
<th>MINIMUM WIDTH OF SHOULDER</th>
<th>LEFT OF TRAFFIC</th>
<th>RIGHT OF TRAFFIC</th>
<th>(5) MINIMUM WIDTH OF DITCH FRONT SLOPE</th>
<th>NEW AND RECONSTRUCTED MINIMUM BRIDGE WIDTHS AND VERTICAL CLEARANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTERCHANGE RAMPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>120'</td>
<td></td>
<td></td>
<td></td>
<td>16'</td>
<td>10'</td>
<td>6' 4' 10' 8' 10' @ 6:1</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>760'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>589'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>446'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>316'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>215'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>135'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>77'</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AUXILIARY LANES (ACCEL/ DECEL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 - 20</td>
<td>25 - 30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 - 20</td>
<td>25 - 30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GENERAL NOTES

The determination of the proper design speed for any particular ramp should be made using guidelines shown in the AASHTO Green Book, Chapter 10, Section 10.9.6, pg. 10-89, Table 10-1.

Standard TC-5.11R is to be used. Maximum ramp superelevation is to be 8%.

Clear Zone and Recoverable Area information can be found in Appendix A, Section A-2 of the Road Design Manual.

RELATIONSHIP OF MAXIMUM GRADES TO DESIGN SPEED

<table>
<thead>
<tr>
<th>DESIGN SPEED (MPH)</th>
<th>GRADES (PERCENT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 - 20</td>
<td>6 - 8</td>
</tr>
<tr>
<td>25 - 30</td>
<td>5 - 7</td>
</tr>
<tr>
<td>35 - 40</td>
<td>4 - 6</td>
</tr>
<tr>
<td>45 - 60</td>
<td>3 - 5</td>
</tr>
</tbody>
</table>

FOOTNOTES

(1) Interchange ramp widths shown are for one lane traffic. For two lane or other conditions see Table 3-29 in the AASHTO Green Book.

(2) Paved shoulder widths on ramps with a design speed of 40 mph or less may be reduced to 6' right, or 3' left, when justifiable. However, the sum of the right and left shoulder shall not be less than 10'. See AASHTO Green Book, Chapter 10, Section 10.9.6, page 10-102.

(3) On ramps with a radius of less than 500', consider (depending on degree of curvature, percent of trucks) the extension of the full pavement structure (on the same slope as the pavement) through the inside paved shoulder area to eliminate raveling of the pavement edge.


(5) A hydraulic analysis is necessary to determine actual depth requirement.

(6) For additional information on sight distance requirements on grades of 3 percent or greater, see the AASHTO Green Book, Chapter 3, Section 3.2.2, page 3-2, Table 3-2.

(7) Graded shoulder width to be increased additional 4' when guardrail is required.

(8) See 2011 AASHTO Green Book, Chapter 10, Section 10.9.5, page 10-76 for further guidance on Auxiliary Lanes.

FIGURE A - 1 - 10*

* Rev. 1/19
GEOMETRIC DESIGN STANDARDS FOR TEMPORARY DIVERSION (GS-10)

TYPICAL SECTION

BRIDGE WIDTH + APPROACH ROADWAY WIDTH = CLEAR ROADWAY.

* SEE PLANS FOR BASE DEPTH AND TYPE AND PAVED SURFACE TREATMENT WHERE REQUIRED.

NOTE: WHEN GUARDRAIL IS REQUIRED IT SHALL BE INSTALLED IN ACCORDANCE WITH THE ROAD & BRIDGE STANDARDS.

WIDTHS FOR TWO WAY TRAFFIC
(LESSER WIDTH MAY BE USED FOR ONE WAY)

<table>
<thead>
<tr>
<th>TYPE</th>
<th>CURRENT ACT</th>
<th>MPH</th>
<th>SWAP</th>
<th>ROADWAY WIDTH</th>
<th>ROADWAY SHOULDER TO SHOULDER</th>
<th>DITCH WIDTH (FT)</th>
<th>DITCH DEPTH (INCHES)</th>
<th>MIN ITEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0-250</td>
<td></td>
<td></td>
<td>18</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>251-750</td>
<td></td>
<td></td>
<td>20</td>
<td>24 A-E. 30 DES.</td>
<td>4'</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>751-2000</td>
<td></td>
<td></td>
<td>22</td>
<td>30 A-E. 34 DES.</td>
<td>4'</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>2001-5000</td>
<td></td>
<td></td>
<td>24</td>
<td>40</td>
<td>6'</td>
<td>18</td>
<td>XX</td>
</tr>
<tr>
<td>E</td>
<td>5001-10,000</td>
<td></td>
<td></td>
<td>24</td>
<td>40</td>
<td>6'</td>
<td>18</td>
<td>XX</td>
</tr>
<tr>
<td>F</td>
<td>10,000+ ABOVE</td>
<td></td>
<td></td>
<td>24</td>
<td>40</td>
<td>6'</td>
<td>18</td>
<td>XX</td>
</tr>
</tbody>
</table>

NOTE: WIDTH FOR 2 WAY TRAFFIC SHALL NOT BE LESS THAN THE PROPOSED TYPICAL.
* CURVES TO BE WIDENED IN ACCORDANCE WITH ST. D.T.C.SD.R.
XX PAID FOR BY INDIVIDUAL QUANTITIES.

GEOMETRICS

<table>
<thead>
<tr>
<th>DESIGN SPEED MPH</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIN. MAX.</td>
<td>108 R</td>
<td>25 R</td>
<td>465 R</td>
<td>760 R</td>
<td>1204 R</td>
<td>1837 R</td>
</tr>
<tr>
<td>WASH. GRADE DES.</td>
<td>8%</td>
<td>7%</td>
<td>6%</td>
<td>5%</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td>WASH. ABS.</td>
<td>85%</td>
<td>75%</td>
<td>65%</td>
<td>55%</td>
<td>65%</td>
<td>55%</td>
</tr>
<tr>
<td>STORING DISTANCE DES.</td>
<td>125'</td>
<td>150'</td>
<td>225'</td>
<td>475'</td>
<td>650'</td>
<td>850'</td>
</tr>
<tr>
<td></td>
<td>305'</td>
<td>325'</td>
<td>570'</td>
<td>730'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8%</td>
<td>8%</td>
<td>8%</td>
<td>8%</td>
<td>8%</td>
<td>8%</td>
<td>8%</td>
</tr>
</tbody>
</table>

MINIMUM DESIGN CRITERIA FOR TEMPORARY DETOURS
(MAINTENANCE OF TRAFFIC)

FIGURE A - 1 - 11*

* Rev. 7/17
GEOMETRIC DESIGN STANDARDS FOR SHOULDER DESIGN (GS-11)

GRADED MEDIAN SHOULDERS

OUTSIDE SHOULDERS

NOTE: FOR WIDTH OF SHOULDERS (W) AND DITCHES (W) SEE GEOMETRIC DESIGN STANDARDS.

STANDARD SHOULDER DESIGN FOR ALL SYSTEMS EXCEPT LOCAL ROADS AND STREETS

FIGURE A - 1 - 12*
GEOMETRIC DESIGN STANDARDS FOR SHOULDER DESIGN FOR LOCAL ROAD AND STREETS (GS-12)

FIGURE A - 1 - 13

* Added 1/12
GEOMETRIC DESIGN STANDARDS FOR GRADED MEDIAN DESIGN (GS-13)

**MEDIAN EDGES OF SHOULDER AT SAME OR APPROXIMATELY SAME ELEVATION**

*(GRADING TO CENTER OF MEDIAN)*

---

**MEDIAN EDGES OF SHOULDER AT DIFFERENT ELEVATIONS**

*(GRADING FROM HIGH SHOULDER TO DITCH ADJACENT TO LOWER ROADWAY)*

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**STANDARD GRADED MEDIAN DESIGNS**

---

*FIGURE A - 1 - 14*

*Added 1/12*