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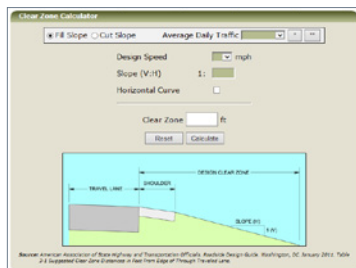
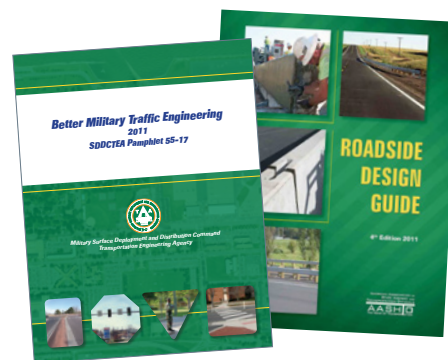
Clear Zones

Definitions and Overview

The American Association of State Highway and Transportation Officials (AASHTO) publishes the *Roadside Design Guide (RDG)*, which is available for purchase at https://bookstore.transportation.org/collection_detail.aspx?ID=105. The *RDG* defines a clear zone as **the unobstructed, traversable area provided beyond the edge of the traveled way for the recovery of errant vehicles**. The clear zone includes the shoulder, curb and gutter, bike lanes, and auxiliary lanes *unless* the auxiliary lane functions as a through lane.

Required clear zone distance is not the same for all roadways, as clear zone distance is based on traffic volumes, speeds, and roadside geometry. Roadside geometry may include foreslopes, backslopes, and/or drainage channels. Foreslopes may be recoverable, non-recoverable, or critical. Guidance on how each of these impact clear zone distance can be found in

Chapter 3 of the *RDG*. Additional guidance is contained in Chapter 9 of SDDCTEA Pamphlet 55-17 “Better Military Traffic Engineering” and a Clear Zone Calculator is provided in the Better Military Traffic Engineering Software located on the SDDCTEA website.



SDDCTEA Clear Zone Calculator

Providing adequate clear zone is critical to protecting drivers from hazards along the side of the road, whether those be natural (trees, rocks, etc.) or man-made (bridge piers, sign supports, culverts, etc.). When adequate clear zone is not available, it will be necessary to provide some type of mitigation for hazards.

Clear Zone vs. Horizontal Clearance

It is a common misconception that “clear zone” is the same as “horizontal clearance.”

Horizontal clearance is defined in AASHTO’s Policy on Geometric Design of Highways and Streets (the “Green Book”) as a lateral offset distance needed to provide clearance for vehicular traffic. For example, the *RDG* states that along roadways with curb, a 3-foot lateral offset beyond the face of curb should be provided at intersections and driveway openings. At other locations along roadways with curb, a 1.5-foot lateral offset beyond the face of curb should be provided. This clearance may be needed for trucks and buses that are traveling in the right-most lane of traffic (or the left-most lane on a divided roadway) and have wide mirrors that might come in contact with a roadside object (such as signs, landscaping, etc.). Because curbs do not have significant redirection capability, this horizontal clearance should not be misconstrued as constituting the clear zone. Obstructions located behind a curb should be located beyond the clear zone requirements or properly mitigated. Horizontal clearance only protects vehicles traveling within the designated travel way while clear zone is necessary to protect vehicles that have exited the travel way and might come in contact with a hazard located outside the shoulder or curb.

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Clear Zone Distance

The required clear zone distance is based on traffic volumes, speed, and roadside geometry. General guidance for clear zone distances is found in Chapter 3 of the *RDG* and replicated below. These distances may be modified for roadways that are on a horizontal curve. Normally, modifications for horizontal curvature are only applied for areas that have a history of high crash rates. It also is important to note that the suggested clear zone distances are ranges to be considered and not to be held to an exact value. Every design situation is different in terms of geometry, traffic patterns, crash histories, and space constraints. Engineering judgment needs to be applied before determining final clear zone requirements for a roadway. These values should be considered the minimum required, and all other options should be exhausted before using values less than those in the table.

AASHTO Clear Zone Distances

Design Speed (mph)	Design ADT (vpd)	Foreslopes			Backslopes		
		1V: 6H or flatter	1V:5H to 1:4H	1V:3H	1V:3H	1V:5H to 1V:4H	1V:6H or flatter
≤40	Under 750	7-10	7-10	*	7-10	7-10	7-10
	750-1,500	10-12	12-14	*	12-14	12-14	12-14
	1,500-6,000	12-14	14-16	*	14-16	14-16	14-16
	Over 6,000	14-16	16-18	*	16-18	16-18	16-18
45–50	Under 750	10-12	12-14	*	8-10	8-10	10-12
	750-1,500	14-16	16-20	*	10-12	12-14	14-16
	1,500-6,000	16-18	20-26	*	12-14	14-16	16-18
	Over 6,000	20-22	24-28	*	14-16	18-20	20-22
55	Under 750	12-14	14-18	*	8-10	10-12	10-12
	750-1,500	16-18	20-24	*	10-12	14-16	16-18
	1,500-6,000	20-22	24-30	*	14-16	16-18	20-22
	Over 6,000	22-24	26-32	*	16-18	20-22	22-24
60	Under 750	16-18	20-24	*	10-12	12-14	14-16
	750-1,500	20-24	26-32	*	12-14	16-18	20-22
	1,500-6,000	26-30	32-40	*	14-18	18-22	24-26
	Over 6,000	30-32	36-44	*	20-22	24-26	26-28
65–70	Under 750	18-20	20-26	*	10-12	14-16	14-16
	750-1,500	24-26	28-36	*	12-16	18-20	20-22
	1,500-6,000	28-32	34-42	*	16-20	22-24	26-28
	Over 6,000	30-34	38-46	*	22-24	26-30	28-30

* Recovery is less likely on the unshielded, traversable 1V:3H foreslopes, so fixed objects should not be located at the toe of these slopes.

Source: AASHTO RDG



Clear Zone Components



Shoulder

A shoulder is the portion of the roadway contiguous with the traveled way that accommodates stopped vehicles and emergency use. In some cases, the shoulder can accommodate bicyclists. The shoulder can be paved or unpaved.



For very low-volume roadways (ADT < 400 vpd), even minimum values shown in the *RDG* may not be practical based on available funding and cost effectiveness.

Curb

Many questions arise when considering how curb impacts clear zone distance. There are two types of curb: barrier (referred to as “vertical” in the *RDG*) and mountable (referred to as “sloping” in the *RDG*). When either type of curb is installed, clear zone should be calculated in the same manner as if there were a shoulder present. Mountable curb allows the vehicle to easily travel up onto the curb, providing no resistance or redirection to a vehicle entering the clear zone. Although barrier curb is generally used to discourage vehicles from leaving the roadway, it does not have significant redirection capability and therefore cannot be used as standalone barrier for a hazard in the clear zone.

It is acceptable to place guardrail along curbed roadways; however, careful consideration should be taken when installing guardrail or other barrier behind curb. When a vehicle strikes a curb, depending on speed, angle, curb characteristics, and vehicle characteristics, it can become airborne. It is very important that a vehicle does not strike the curb, leave the ground, and then strike improperly placed guardrail or other barrier. The *RDG* provides guidance on recommended placement for strong-post W-beam guardrail along curbed roadways.

85th Percentile Speed	Curb Type	Curb Height	Recommended Guardrail Placement
< 45 mph	Barrier	≤ 6 inches	Face of curb or more than 8' beyond face of curb
	Mountable*		
45 - 50 mph	Mountable*	≤ 6 inches	Face of curb
45 - 50 mph	Mountable*	≤ 4 inches	Face of curb or more than 13' beyond face of curb
51 - 60 mph	Mountable*	≤ 4 inches	Face of curb
> 60 mph	Mountable* (1V:3H or flatter)	≤ 4 inches	Face of curb

Source: *RDG*

*Refer to local State DOT for standard mountable curb

Although it is not common practice, it should be noted that there are proprietary curb/guardrail combinations that have been crash tested and approved by AASHTO that allow for the guardrail to be placed at a certain offset behind the curb. These are outlined in section 5.6.2.1.2 of the *RDG*.

When determining whether to place barrier along a curbed roadway, the designer should consider the following: curb type, speed, volume, characteristics of the objects, and barrier deflection. As shown in the above table, it is typically recommended to place guardrail flush with the face of curb. To properly protect a vehicle from a roadside hazard, a hazard cannot be located directly behind the guardrail within its deflection area. The guardrail, or other barrier, must have the room to reach maximum deflection after a vehicle strike prior to contacting the hazard. For example, if a guardrail section is 1.5 feet deep and has a maximum deflection of 3 feet, the roadside hazard must be located at least 4.5 feet beyond the face of curb. Otherwise, a vehicle may come in contact with the hazard prior to the barrier reaching its maximum deflection. If right-of-way or other geometric constraints are present, it is possible to decrease the maximum deflection of guardrail through various stiffening practices: nesting an additional W-beam, decreasing post spacing, or adding rub rails.



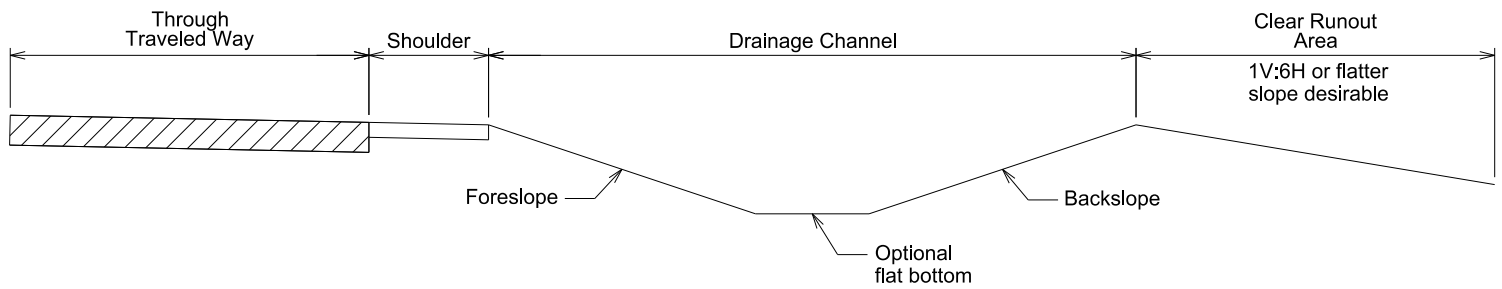
Example of stiffened guardrail placed along curb. Source: Kimley-Horn.



Beyond the Shoulder

The geometry beyond the shoulder of a roadway can be composed of foreslopes and backslopes. While a drainage channel also can run parallel to the roadway, it is essentially a combination of a foreslope followed by a backslope, sometimes with a flat bottom in between.

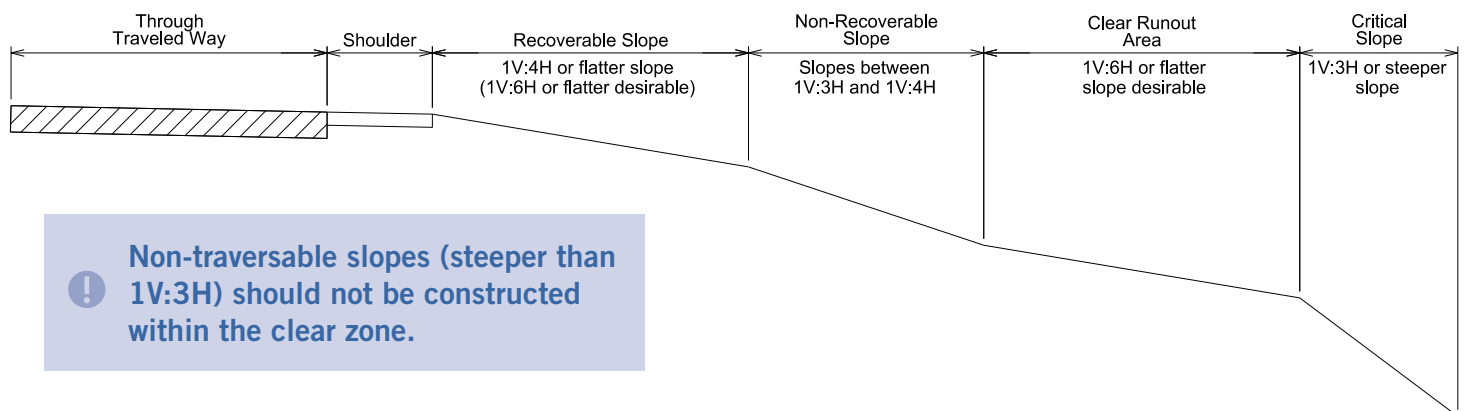
Clear Zone Components



Foreslopes

- **Recoverable Slope:** A recoverable slope is a traversable slope on which a motorist may, to a greater or lesser extent, retain or regain control of a vehicle by slowing or stopping. Slopes flatter than 1V:4H are generally considered recoverable.
- **Non-Recoverable Slope:** A non-recoverable slope is a traversable slope on which an errant vehicle will continue to the bottom. Embankment slopes between 1V:3H and 1V:4H may be considered traversable but non-recoverable if they are smooth and free of hazards.
- **Critical Slope:** A critical slope is one on which an errant vehicle has a higher propensity to overturn. Slopes steeper than 1V:3H are generally considered critical.
- **Clear Run-Out Area:** A clear run-out area is the area at the toe of a non-recoverable slope available for safe use by errant vehicles.

Foreslopes Diagram



Non-traversable slopes (steeper than 1V:3H) should not be constructed within the clear zone.

Backslopes

A backslope is needed on the backside of a drainage channel or when a roadway is located in a cut section. Like foreslopes, backslopes can be traversable, in which case they are considered to be inside the clear zone. A backslope is not considered part of the clear zone if it is not traversable, contains a hazard, or is a steep rock cut.



Practices for Objects Within the Clear Zone

Often times the clear zone available is limited by a variety of factors (e.g., geometric constraints, right-of-way constraints, funding, etc.). If the necessary clear zone distance cannot be accommodated, the hazard needs to be properly mitigated. For roadside hazards that are commonly within the clear zone, it is essential that they be crashworthy, as outlined in Section 2A of the Federal Highway Administration's (FHWA's) *Manual on Uniform Traffic Control Devices (MUTCD)*.

When objects are located within the clear zone, the RDG provides the following options as guidance on how to properly mitigate the hazard:

1.	Remove the hazard.	5.	Shield the hazard with a longitudinal traffic barrier designed for redirection, use a crash cushion, or use both if the hazard cannot be eliminated, relocated, or redesigned.
2.	Redesign the hazard so it can be traversed safely.	6.	Delineate the hazard with an object marker if the above alternatives are not appropriate or feasible.*
3.	Relocate the hazard to a point where it is less likely to be struck (i.e., outside the clear zone).		
4.	Reduce the impact severity by using an appropriate breakaway device.		

**When a project is planned but not yet constructed, delineation should always be used as an interim mitigation for existing hazards.*

The options above should be considered in the order in which they are presented. In ideal conditions, options 1 and 2 should always be applied, but those are not always possible solutions in the real world, especially when certain objects must be located near the travel way.

Breakaway Devices for Roadside Features

Signs, Luminaires, and Traffic Signals

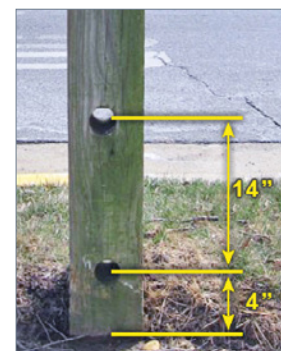
Roadside features commonly found near the travel way include signs, luminaires, and traffic signal poles. Because these features must be located in close proximity to the roadway in order to be most effective, the potential impact of these objects should be mitigated as describe in option 4 from the *RDG*. Additionally, the *MUTCD* states, "Signs should be located outside the clear zone unless placed on a breakaway or yielding device." A breakaway device is a type of support that is designed to yield, fracture, or separate when impacted by a vehicle. If a driver exits the travel way and impacts one of these devices, the device will break upon impact, reducing the amount of damage to the vehicle and injury to its occupants.



Improper and correct usage of a breakaway device.

Utility Facilities

Utility facilities such as poles and transformer boxes can also present hazards if placed within the clear zone. Military installations typically own not only the roadway and adjacent property, but also the utilities located within them; however, in some cases there may be private utilities located within an installation. For these instances in which utilities are privately owned, frequent coordination with the utility owners during the design process is essential to ensure optimal locations for utility facilities along the roadway. Utility facilities should be placed outside of the clear zone to the extent possible, or as far from the edge of the travel way as possible. As with all roadside objects, relocating existing utility facilities (either underground or outside the clear zone) is not always practical. Therefore, a breakaway device should be considered to mitigate the hazard. There are several options available that have proven to be satisfactory in crashworthiness.



Source: FHWA

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Longitudinal Traffic Barriers ✓

If a roadside obstacle cannot be removed from the clear zone, relocated outside the clear zone, redesigned, or made crashworthy, a longitudinal (or roadside) barrier should be used to shield vehicles from the obstacle. The purpose of a roadside barrier is to reduce the likelihood that a vehicle departing the travel way will strike a fixed roadside object. In addition, a roadside barrier might be used to protect pedestrians from vehicular traffic. Typically, a roadside barrier is designed for a vehicle to impact the device and then be redirected, thereby protecting the vehicle from hitting a roadside hazard that is not as forgiving. Devices to be used as traffic barriers go through rigorous testing to ensure they are safe and effective for vehicles. AASHTO dictates a roadside barrier must meet one of the follow testing and evaluation criteria to be considered crashworthy:

1. A barrier system has met all of the evaluation criteria listed in AASHTO's *Manual for Assessing Safety Hardware (MASH)* or the National Cooperative Highway Research Program's (NCHRP) Report 350: *Recommended Procedures for the Safety Performance Evaluation of Highway Features* for each of the required crash tests, or
2. A barrier system has been evaluated and found acceptable as a result of an in-service performance.

Barriers themselves are also hazards, and their intent is to reduce the severity—not the frequency—of crashes. Barriers should therefore be used only where the severity of striking the object or leaving the roadway is greater than the severity of striking the barrier and all other options have been exhausted.

When it is determined that a longitudinal barrier system is required, different options for type and installation are available. Roadside barrier systems are typically categorized as flexible, semi-rigid, or rigid. Each of these categories reflects the systems' deflection characteristics upon vehicle impact. It should be noted that while guidance is provided in this bulletin, designers should reference their State DOT's list of approved barriers for more specific recommendations.

Flexible Systems

Flexible barriers will deflect between approximately 4 feet and 8 feet upon vehicle impact. Flexible barriers include cable barriers and weak post systems. Flexible barriers are among the most commonly used roadside barriers used today.

Cable Barriers: Cable barriers include both low and high-tension systems. Cable barriers are among the lowest initial cost options for roadside barriers, but they become non-functional after an impact and are very sensitive to accurate height installation and maintenance. If the cables are not installed or anchored properly, the whole system can fail.

Weak Post Systems: Weak post barrier systems that are considered flexible include standard weak post W-beam guardrail. This type of barrier is very common along roadways. Weak-post W-beam systems perform very much like the cable barrier systems in that the posts are spaced far apart and will bend or break upon impact, leading to large deflections after a vehicle strike. Unlike cable barriers, a weak post W-beam section will retain some of its performance effectiveness after a minor vehicle strike. It is important, however, to repair the system after vehicle strikes to ensure optimal performance.



Source: FHWA



Source: Kimley-Horn



Longitudinal Traffic Barriers, continued

Semi-Rigid Systems

Semi-rigid systems are typically some variation of post system and include box beam guardrail, blocked-out W-beam guardrail, and blocked-out thrie-beam guardrail. Semi-rigid systems generally deflect between 2 feet and 4 feet upon vehicle impact. It should be noted that there are proprietary options for these systems, and if a proprietary system is installed, it should be verified that the system has gone through the proper testing and evaluation procedures.

Box Beam Guardrail (Weak Post): Although considered a semi-rigid system, box beam guardrail is attached by weak posts that will fracture upon vehicle impact. Box beam guardrail has a rectangular longitudinal beam connected by the posts as opposed to a common W-beam section.

Blocked-Out W-Beam Guardrail (Strong Post): Blocked-out W-beam guardrail is the most common barrier used along roadways today. This system is composed of a steel W-beam section. Instead of connecting the W-beam directly to the larger steel posts, wood or composite blocks are installed on the posts, and the W-beam is secured to the blocks. The installation of the block-outs minimizes the risk of a vehicle getting caught on the posts and the likelihood that a vehicle will go over the barrier upon impact.

Blocked-Out Thrie-Beam Guardrail (Strong Post): Blocked-out thrie-beam guardrail is very similar to the blocked-out W-beam system. The biggest difference is the longitudinal section: a thrie beam has additional corrugation compared to a W-beam. This stiffens the beam and makes a thrie beam less prone to damage after minor vehicle impacts.

Rigid Systems

Rigid barriers generally are constructed of reinforced concrete. Typical shapes for concrete barrier are New Jersey, F-shape, and constant slope. Bridge railings also are considered a rigid barrier as their main purpose is to prevent a vehicle from running off the edge of a bridge or culvert. Each of these barrier types has been tested and approved by the FHWA performance evaluation. These rigid systems do not cushion a vehicle or deflect upon impact like flexible and semi-rigid systems and therefore create a greater potential for injury and vehicle damage. Rigid systems do, however, minimize the risk of a vehicle with a high-profile overturning the barrier compared to flexible and semi-rigid systems.



Source: Kimley-Horn



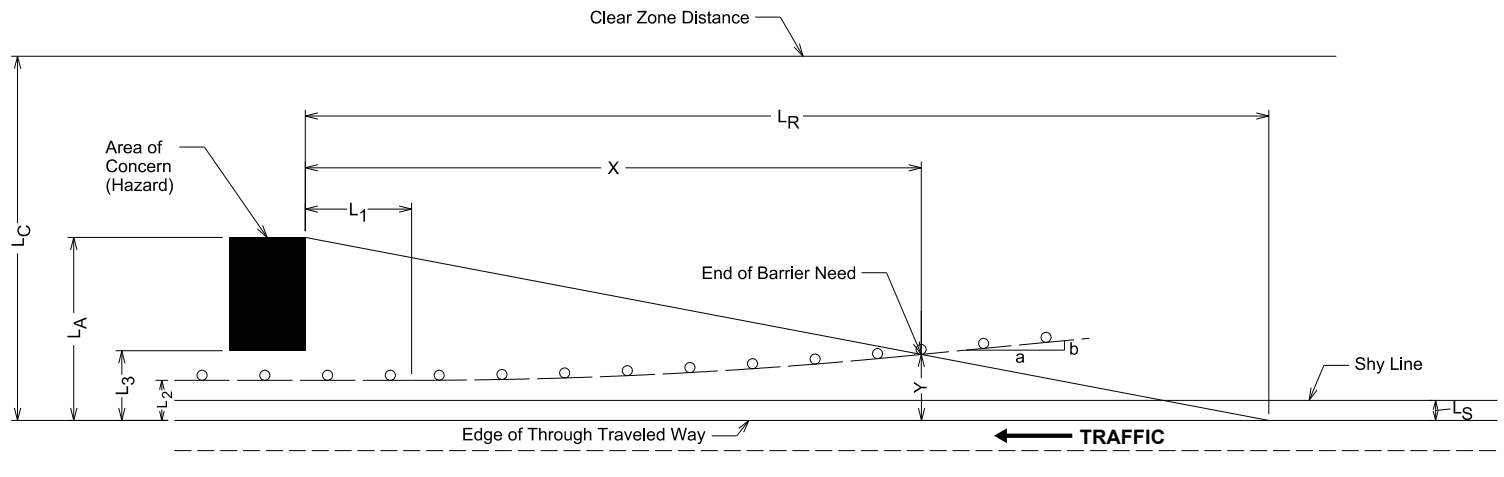
Source: FHWA

Which Barrier Type Should Be Used?

If barrier is warranted as a hazard mitigation, the most appropriate barrier type to be used will depend on traffic volumes, vehicle types, speed, and driver behavior along the corridor on which the barrier will be placed. Installations should contact the SDDCTEA for assistance in determining which type of barrier should be used. Barrier types described in this bulletin can be further reviewed in the *RDG*. In addition, installations can consult their local State DOT's approved list of barriers with guidance from SDDCTEA.

Length-of-Need

When a longitudinal barrier is installed to protect vehicles from a roadside object, the *RDG* dictates that the length-of-need point shall be calculated. The length-of-need is the location where the barrier system will prevent a vehicle from impacting the roadside object. Depending on the type, a portion of the end-treatment can be included in the length-of-need. If the barrier system does not extend far enough upstream of the hazard, a vehicle that exits the travel way may still be able to travel behind the barrier system and impact the hazard. A graphic representation of the length-of-need location is shown in the figure below.



The primary variables of note are the Lateral Extent of the Area of Concern (L_A) and the Runout Length (L_R). The Lateral Extent of the Area of Concern is the distance from the edge of the traveled way to the far side of the fixed object. Runout length is the distance from the object being shielded to the location where the vehicle departs the roadway. Runout lengths are recommended based on design speed and traffic volume. **SDDCTEA provides a runout length calculator in the Better Military Traffic Engineering Software located on the SDDCTEA website.** This calculator is based on the suggested runout lengths provided in Section 5.6.4 in the *RDG*.

The ratio, b/a , is the flare rate of the barrier, as noted in the figure above. The *RDG* suggests using flare rates between 7:1 and 30:1, dependent upon speed and whether the barrier is inside or beyond the shy line. The other two variables, L_1 and L_2 , are the tangent length of barrier upstream of the hazard and the distance between the barrier and the edge of traveled way, respectively. The formulas and values for variables are intended to provide the designer with an approximation for the length-of-need. Chapter 5 of the *RDG* should be thoroughly reviewed before calculating length-of-need.

Another variable of note is L_s , which is the lateral distance to the shy line. The shy line is defined as the distance from the edge of the traveled way beyond which a roadside hazard will not be perceived as an obstacle and result in a motorist's reducing speed or changing vehicle position on the roadway. While the shy line is not directly considered in the length-of-need or lateral offset calculations, barrier should be placed an adequate distance from the edge of the traveled way so the barrier itself is not perceived as an obstacle.



Longitudinal Traffic Barriers, continued

Length-of-Need

The calculation for length-of-need is taken from Chapter 5 of the *RDG*:

$$X = \frac{L_A + \left(\frac{b}{a}\right) (L_1) - L_2}{\left(\frac{b}{a}\right) + \left(\frac{L_A}{L_R}\right)}$$

Where: X = Length-of-need
 L_A = Lateral Extent of the Area of Concern
 L_R = Runout length
 b/a = Flare rate of barrier
 L_1 = Tangent length of barrier upstream from Area of Concern
 L_2 = Distance from edge of travel way to front of barrier

Lateral Offset

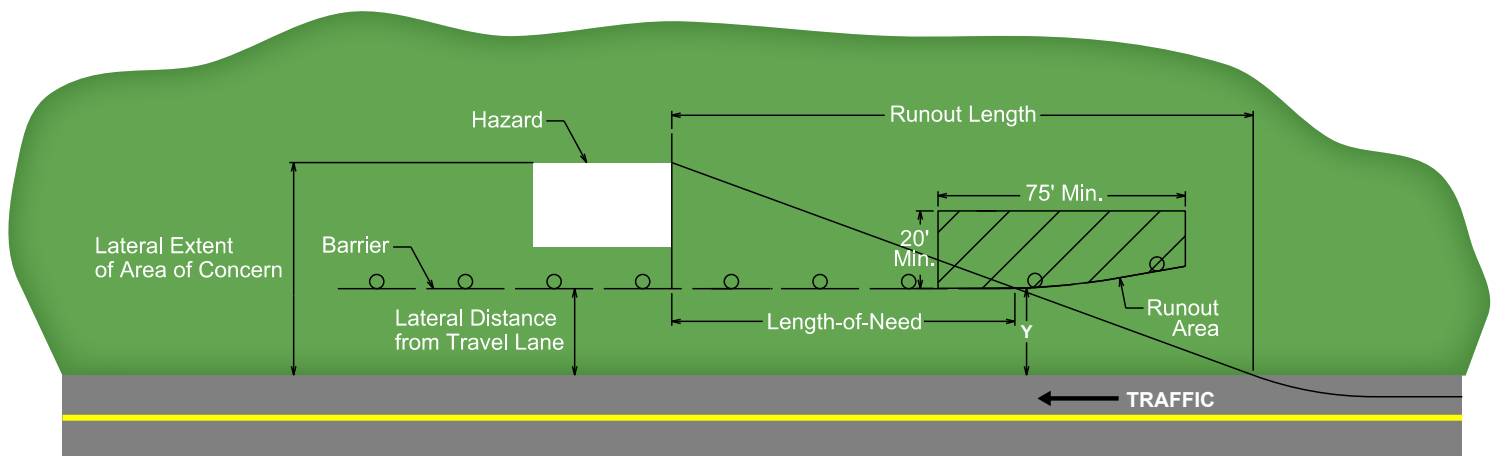
After calculating length of need, the lateral offset (Y) should be calculated. The lateral offset is the distance from the edge of the traveled way to the beginning of the length-of-need point. The calculation for lateral offset is also taken from Chapter 5 of the *RDG*.

$$Y = L_A - \frac{L_A}{L_R} * X$$

Where: Y = Lateral offset
 L_A = Lateral Extent of the Area of Concern
 L_R = Runout length
 X = Length-of-Need

Runout Area

A clear area should be provided for a vehicle that impacts an end treatment ahead of its length-of-need point. This area is referred to as runout area and is shown in the figure below. This area is both parallel and perpendicular to the barrier. Clear runout areas need to be provided because it has been found that after vehicles impact an end treatment, they can travel up to 200 feet beyond the impact location. It is important that a vehicle not come in contact with a hazard after they travel beyond the end treatment. Chapter 8 of the *RDG* indicates that a runout (or “recovery”) area behind and beyond a terminal should be an obstacle-free area a minimum of 75 feet long and 20 feet wide (or at least as wide as the upstream clear zone). This area should be essentially flat so a vehicle does not roll or fall after impact with the terminal. The *RDG* indicates this area should only contain slopes of 1V:4H or flatter. There are many instances where geometric or other constraints make providing this area difficult. Designers should evaluate the practicality of providing this minimum distance on a case-by-case basis.



When a longitudinal traffic barrier is installed, it is critical that appropriate end treatments be installed where the barrier terminates to protect vehicles from impacting the unprotected end of the barrier system. There are many options for end treatments. The type of end treatment used will depend on barrier type and traffic characteristics, and which end of the barrier the treatment will be installed. The *RDG* identifies three types of end treatments: anchorages, terminals, and crash cushions. When determining the proper end treatment, designers should review Chapter 8 of the *RDG* and consult the local State DOT.

Anchorage

Anchorage is used to anchor a flexible or semi-rigid barrier to the ground. This anchor develops the tensile strength in the barrier during a vehicle impact. An anchorage is sometimes referred to as a “turned-down end” due to the physical nature of the end treatment. **It is essential to note that anchorages are *not* crashworthy and therefore should only be used if reviewed and approved for situational use by SDDCTEA.** For example, anchorages may sometimes be used on the trailing (downstream) end of a traffic barrier along a divided roadway, provided that the barrier is not located within the clear zone of the opposing traffic stream.



Anchorage located at trailing (downstream) end of traffic barrier. Source: Kimley-Horn

Terminals

Terminals are used for the run-on end of flexible and semi-rigid traffic barriers. Terminals must be crashworthy to provide protection for a vehicle impact. The length of terminals are predetermined, but depending on terminal type, a portion of the length-of-need can be accommodated within the terminal. Designers should see their State DOT's approved list of terminals for standard lengths and details regarding length-of-need. Terminals can be energy-absorbing or non-energy-absorbing. An energy-absorbing terminal is designed to dissipate a significant amount of energy in a head-on crash. By dissipating energy, the energy-absorbing terminal is able to stop a vehicle in a relatively short distance. If a terminal is energy absorbing, it also can be attached to the end of rigid barriers. The decision to install energy-absorbing or non-energy-absorbing terminals should be determined based on the likelihood of a vehicle impacting the traffic barrier end head-on.

Energy-Absorbing Terminal



Non-Energy-Absorbing Terminal



Source: Kimley-Horn

End Treatments, continued

Crash Cushions

Crash cushions are devices that significantly reduce the severity of impacts with fixed objects. Due to the non-crashworthy nature of rigid traffic barrier systems, crash cushions—also called impact attenuators—are used as the end treatment. Crash cushion options are outlined in Section 8.4 of the *RDG* and include bullnose guardrail systems, sand filled traffic barriers, and many proprietary options. Designers must ensure that any selected proprietary systems are approved by the FHWA. Descriptions of approved proprietary systems can be found in the *RDG*. Designers should also reference their State DOT's approved list of crash cushions and contact SDDCTEA for final guidance and assistance.



Source: Missouri DOT



Delineation

In situations where a roadside hazard cannot be mitigated using barrier, the hazard should be properly delineated. Guidance on delineating hazards with object markers can be found in the *MUTCD* and in Chapter 9 of SDDCTEA Pamphlet 55-17 “Better Military Traffic Engineering.” Typical hazards requiring delineation include underpass piers, bridge abutments, handrails, ends of traffic barriers, utility poles, and culvert headwalls. These hazards should be marked with a Type 2 or Type 3 object marker as outlined in Section 2C.65 of the *MUTCD*.



Type 3 object marker used to delineate end of bridge railing. Source: Kimley-Horn.

TRAFFIC ENGINEERING & HIGHWAY SAFETY BULLETIN



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for pamphlets, bulletins, and studies

Sources

- American Association of State Highway and Transportation Officials, *Roadside Design Guide*, 4th Edition, 2011
- American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets* ("Green Book"), 6th Edition, 2011
- American Association of State Highway and Transportation Officials, *Manual for Assessing Safety Hardware*, http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/ctrmeasures/mash
- Federal Highway Administration, *Manual on Uniform Traffic Control Devices*, 2009
- National Cooperative Highway Research Program, "Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features," http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_350-a.pdf
- SDDCTEA, DoD Programs for National Defense, Traffic Engineering Branch, <http://www.sddc.army.mil/sites/TEA/Functions/SpecialAssistant/TrafficEngineeringBranch/Pages/default.aspx>
 - SDDCTEA Pamphlet 55-17: Better Military Traffic Engineering 2011