

# Plan Preparation Guide

## Chapter 10

### Clear Zone ---- Guardrail

### Crash Cushions --- Barriers --- Walls

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## 1. Clear Zone Concept

The clear zone is the roadside area that should have traversable slopes and contain no natural or man made objects that are considered non-yielding. The clear zone begins at the edge of the travelway and extends a distance as determined by the following graph and table.

If the clear zone distance is impractical to meet, then a roadside barrier (guardrail, etc.) should be used.

**Clear Zone Distance Table**  
(in feet from edge of travelway)

Design Speed	Design ADT	Fill Slopes			Cut Slopes		
		6:1 or Flatter	5:1 to 4:1	3:1	3:1	4:1 to 5:1	6:1 or flatter
40 MPH or less	Under 750	7-10	7-10	**	7-10	7-10	7-10
	750-1500	10-12	12-14	**	10-12	10-12	10-12
	1500-6000	12-14	14-16	**	12-14	12-14	12-14
	Over 6000	14-16	16-18	**	14-16	14-16	14-16
45-50 MPH	Under 750	10-12	12-14	**	8-10	8-10	10-12
	750-1500	12-14	16-20	**	10-12	12-14	14-16
	1500-6000	16-18	20-26	**	12-14	14-16	16-18
	Over 6000	18-20	24-28	**	14-16	18-20	20-22
55 MPH	Under 750	12-14	14-18	**	8-10	10-12	10-12
	750-1500	16-18	20-24	**	10-12	14-16	16-18
	1500-6000	20-22	24-30	**	14-16	16-18	20-22
	Over 6000	22-24	26-32*	**	16-18	20-22	22-24
60 MPH	Under 750	16-18	20-24	**	10-12	12-14	14-16
	750-1500	20-24	26-32*	**	12-14	16-18	20-22
	1500-6000	26-30	32-40*	**	14-18	18-22	24-26
	Over 6000	30-32*	36-44*	**	20-22	24-26	26-28
65-70 MPH	Under 750	18-20	20-26	**	10-12	14-16	14-16
	750-1500	24-26	28-36*	**	12-16	18-20	20-22
	1500-6000	28-32*	34-42*	**	16-20	22-24	26-28
	Over 6000	30-34*	38-46*	**	22-24	26-30	28-30

\* Clear zones are limited to 30 feet for practicality and to provide a consistent roadway template as long as previous experience with similar projects or designs indicates satisfactory performance. Where a site specific investigation indicates a high probability of continuing accidents, or such occurrences are indicated by accident history, the designer may provide clear zone distances greater than 30 feet, as indicated.

\*\* Since recovery is less likely on the unshielded, traversable 3:1 slopes, fixed objects should not be present in the vicinity of the toe of these slopes. Recovery of high speed vehicles that encroach beyond the edge of shoulder may be expected to occur beyond the toe of slope. Determination of the width of the recovery area at the toe of slope should take into consideration right-of-way availability, environmental concerns, economic factors, safety needs, and accident histories. Also, the distance between the edge of the travel lane and the beginning of the 3:1 slope should influence the recovery area provided at the toe of slope.

A clear zone distance graph, embankment examples and recommended ditch slope are shown on the following sheets.

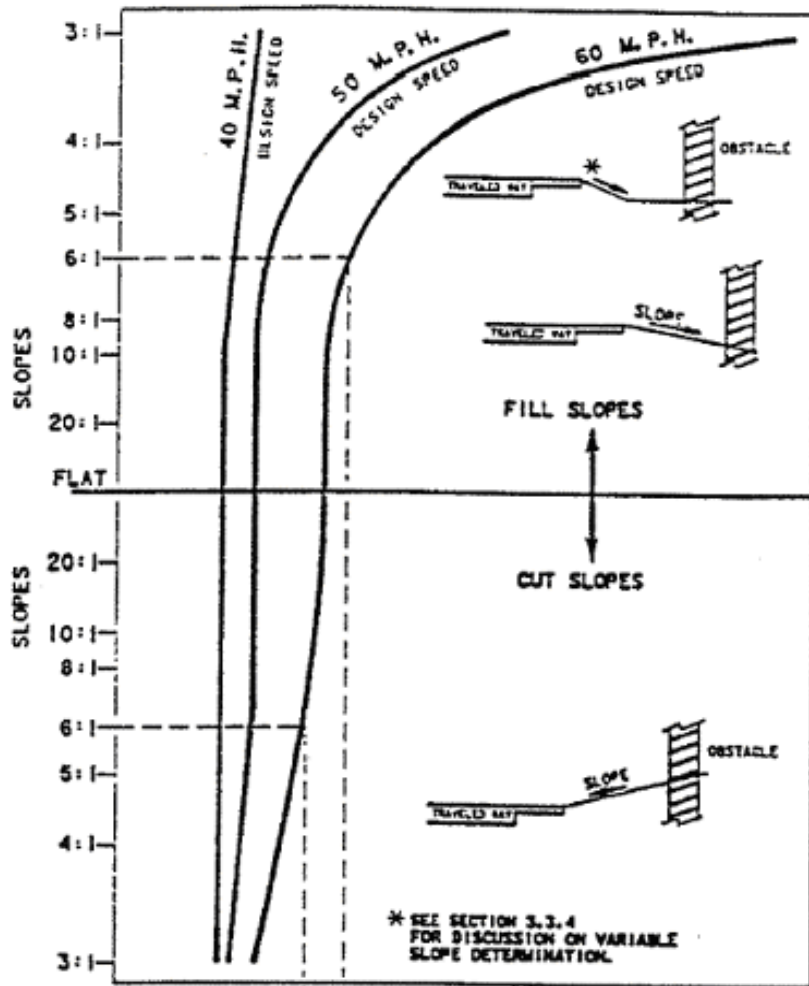
**CLEAR ZONE DISTANCE GRAPH**  
(In feet from edge of travelway)

**EXAMPLE # 1**  
6:1 SLOPE  
(FILL SLOPE)  
60 M.P.H.  
5000 V.P.D.

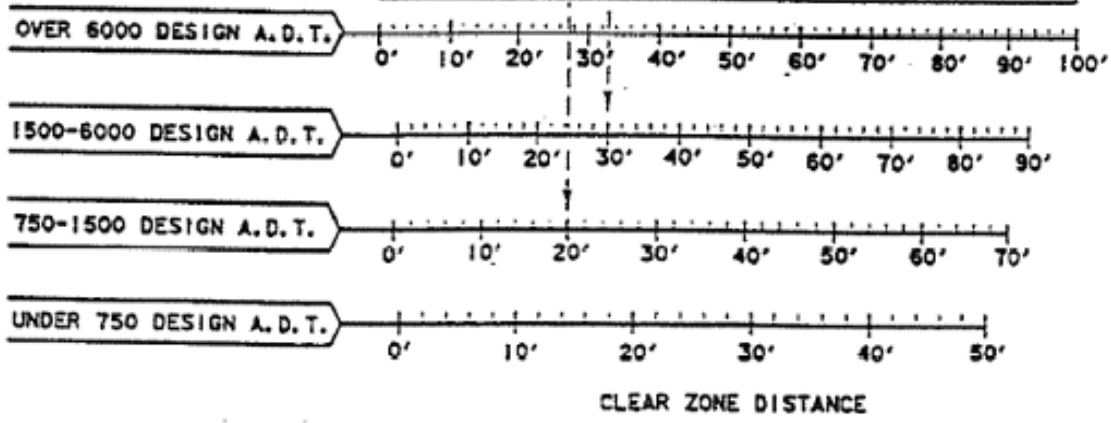
**ANSWER:**  
CLEAR ZONE  
WIDTH = 30 FT

**EXAMPLE # 2**  
6:1 SLOPE  
(CUT SLOPE)  
60 M.P.H.  
750 V.P.D.

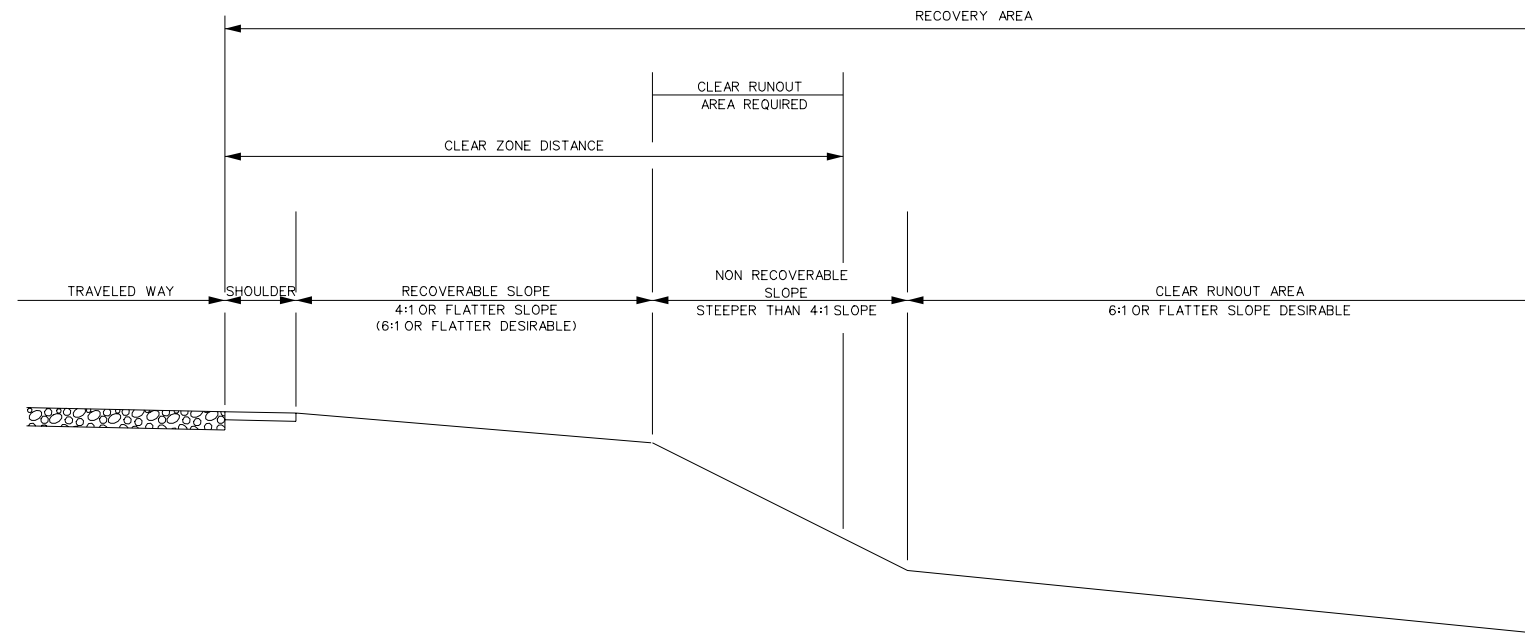
**ANSWER:**  
CLEAR ZONE  
WIDTH = 20 FT



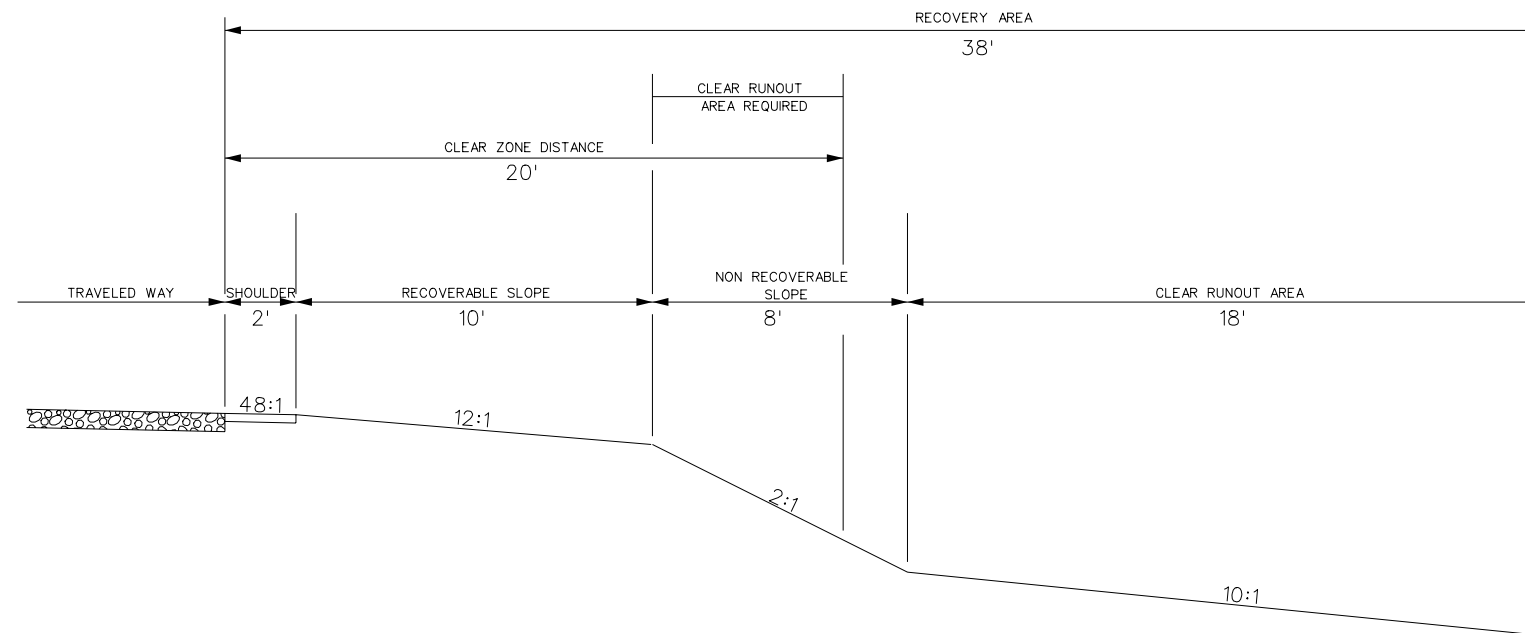
\* SEE SECTION 3.3.4 FOR DISCUSSION ON VARIABLE SLOPE DETERMINATION.



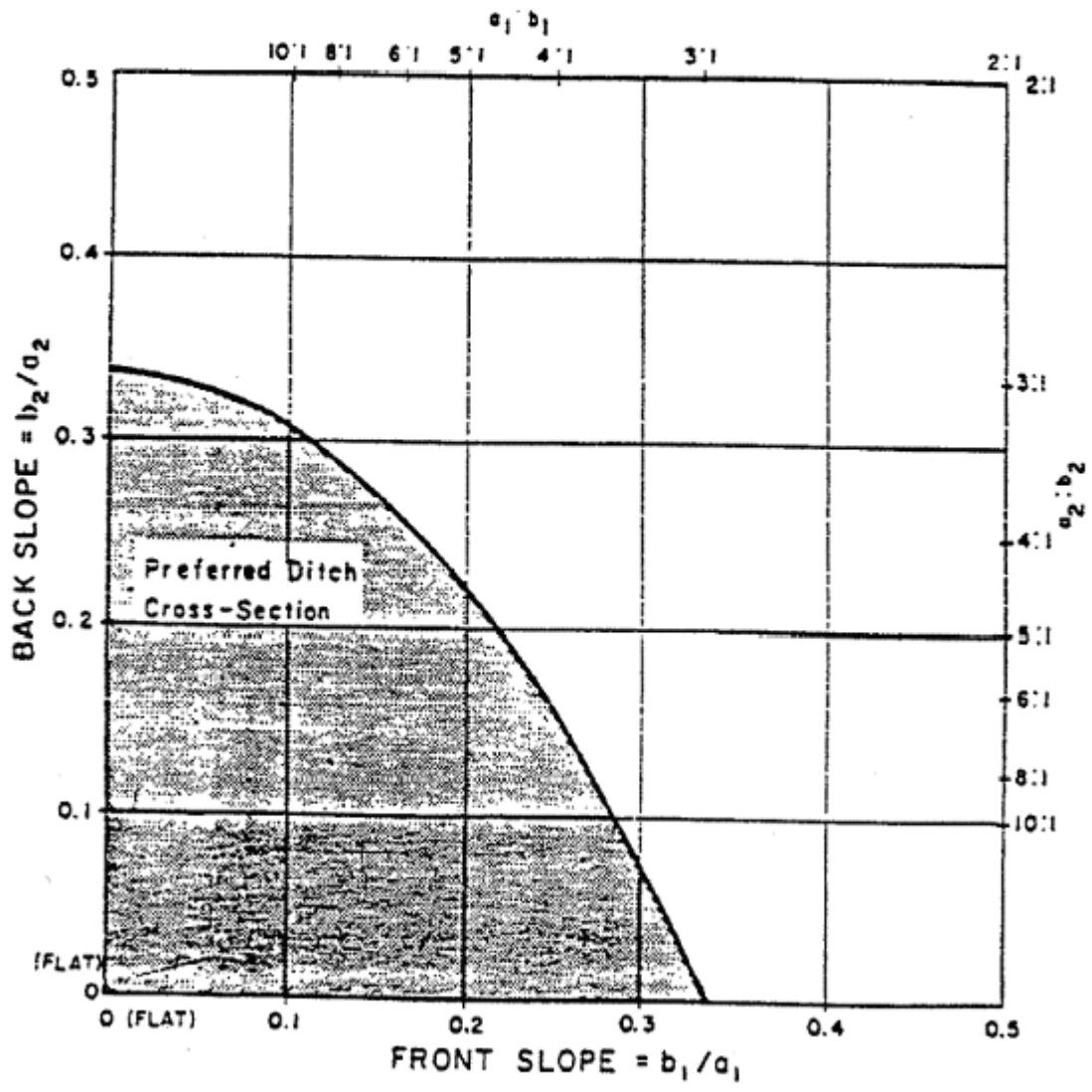
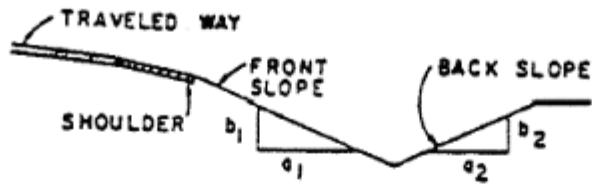
# CLEAR ZONE EXAMPLE OF AN EMBANKMENT



DESIGN ADT: 7000  
 DESIGN SPEED: 60 MPH  
 CLEAR ZONE DISTANCE FROM TABLE: 30'



# RECOMMENDED DITCH SLOPES & BACK SLOPES



## 2. Guardrail

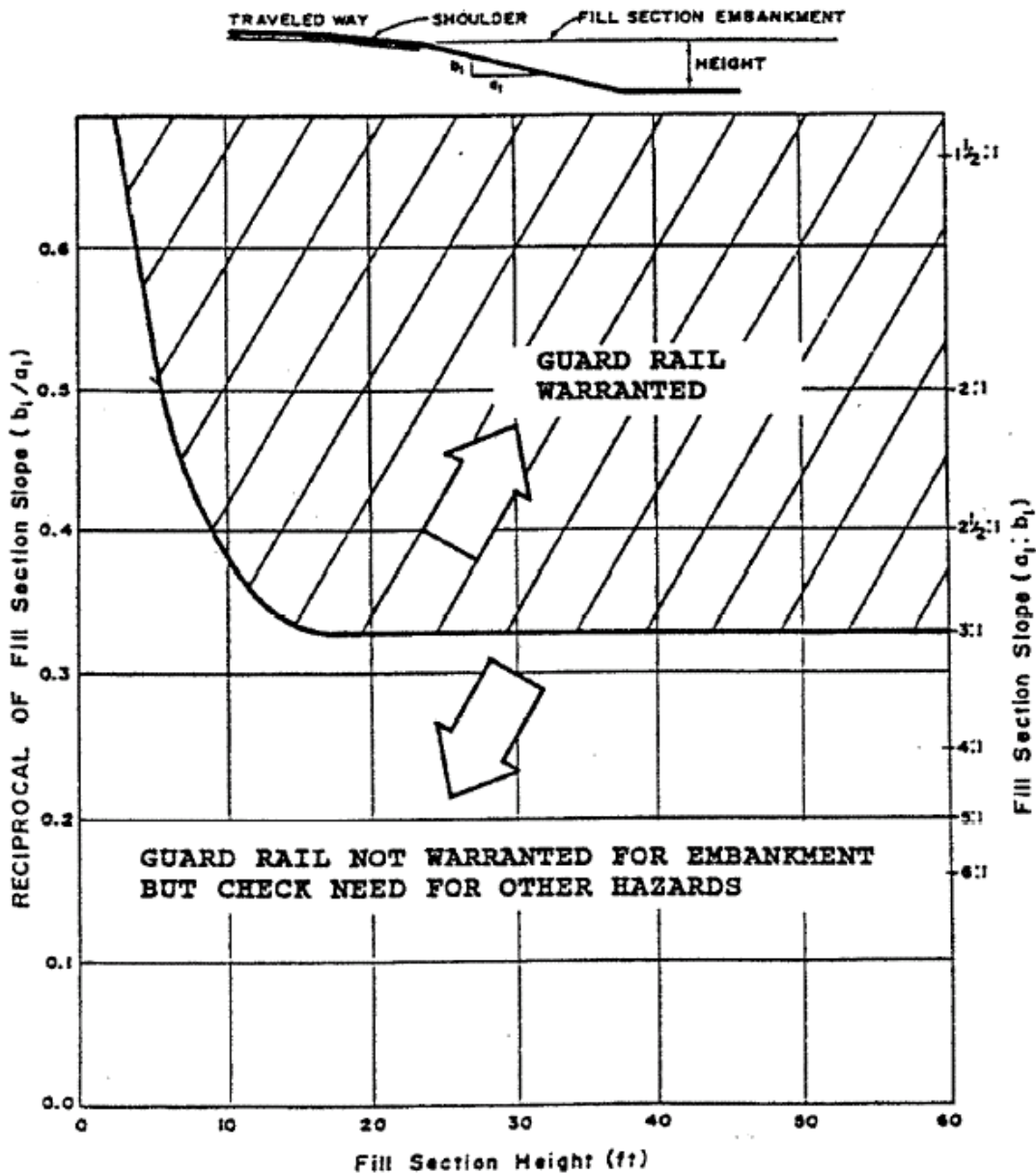
Guardrail is used to protect traffic from roadside obstacles and steep slopes. SCDOT does not use guardrail on secondary ('C') projects except at bridge ends or low speed urban projects, which are usually curb and gutter.

Guardrail is figured in multiples of 12.5'. There are three types of standard guardrails. They are Steel Beam Guardrail (W-Beam), Thrie Beam Guardrail, and Tubular Guardrail. Tubular Guardrail is not generally used due to maintenance problems.

Guardrail is discouraged with curbs on high speed highways (greater than 45 mph).

The extra width of shoulder and widening for end anchors should be plotted on the cross sections and construction lines shown on plan sheet.

Below is a table recommending where guardrail should be used due to steep slopes.

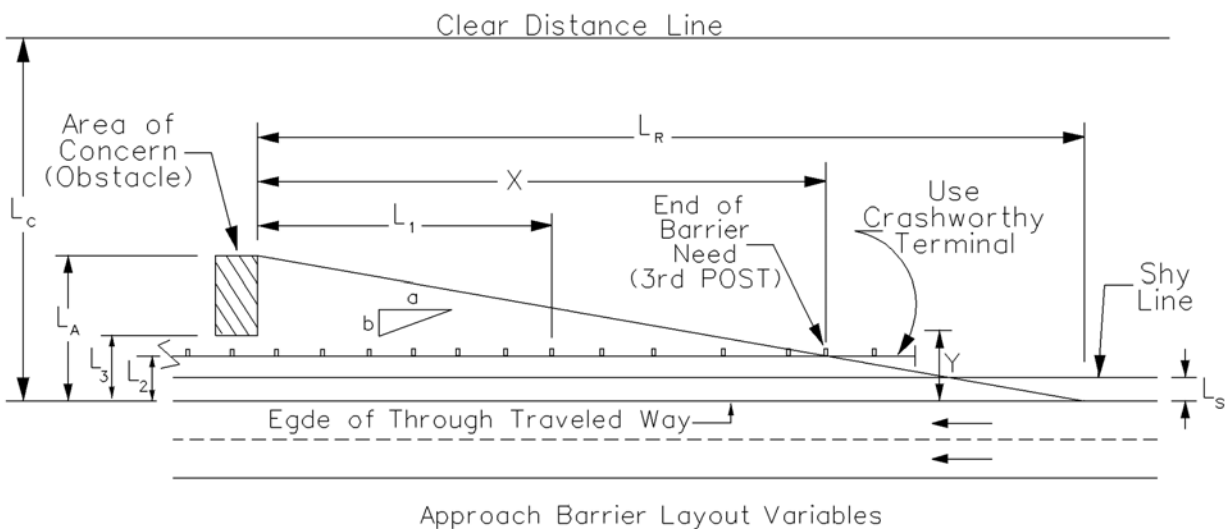


### 3. Guardrail Length of Need Computations

To compute the length of guardrail needed, determine the length of runout ( $L_r$ ) from the table on the following sheet and establish this distance from the edge of the hazard to a point of the outside edge of the approaching lane. Draw a line from this point on the outside edge of the hazard within the clear zone or to the edge of the clear zone at the hazard.

The length of guardrail needed from the hazard is the distance from the hazard (normally) to the third post of the end treatment. This may vary depending upon which end treatment is used. The remaining section of rail in the end treatment may be included in the length of rail needed. Add the length of guardrail needed upstream of the hazard for the total length of guardrail. Round off the guardrail length to the next highest multiple of 12.5.

The outside edge of the hazard ( $L_a$ ) could be a bridge column, sign footing, tow of the first non-traversable fill slope, top of bank of a crossing stream or other object which is a danger to traffic.



**Legend:**

- $L_c$  Width of clear zone
- $L_h$  Distance to back of hazard
- $L_3$  Front edge of hazard
- $L_2$  Guardrail offset
- $L_r$  Length of runout (from table)
- $L_s$  Shy line offset (from table)
- $Y$  Offset at end of guardrail
- $X$  Length of guardrail needed form hazard



### Runout Lengths for Guardrail Design

	Traffic Volume (ADT)			
	Over 6000	2000-6000	800-2000	Under 800
Design Speed (mph)	Runout Length L <sub>R</sub> (ft)	Runout Length L <sub>R</sub> (ft)	Runout Length L <sub>R</sub> (ft)	Runout Length L <sub>R</sub> (ft)
70	480	440	400	360
65	440	400	365	330
60	400	360	330	300
55	360	325	295	270
50	320	290	260	240
45	280	255	230	210
40	240	220	200	180
35	205	190	170	155
30	170	160	140	130

### Shy Line Offsets

Design Speed (mph)	Shy Line Offset L <sub>s</sub> (feet)
80	12.0
70	10.0
60	8.0
50	6.5
40	5.0
30	3.5

#### **4. Impact Attenuators**

Impact Attenuators are designed on a per case bases with a force of 7 g's being the maximum deceleration. They are used to stop or redirect an errant vehicle. Nine bay construction (work) zone portable terminal impact attenuators (crash cushions) are now available for use in areas with speeds up to 70 mph. The nine bay units mentioned above will be required on all interstate projects and any facility with speed limits posted for 65 mph or more. Six bay units may continue to be used on secondary and primary roadways with speed limit postings of 60 mph or lower. Three bay units can be used sparingly on low speed facilities most commonly found in urban areas. The permanent speed limit posted in place before beginning of construction shall be used for determining which units are to be used. A reduction of the speed limit for construction is not a factor in the determination of attenuators due to the lack of observance of the reduction of speed in work zones by the motoring public.

When using a QuadGuard on the end of a Concrete Median Barrier, a concrete back-up is to be specified as shown on Standard Drawing Number 805-18.

When using a QuadGuard on the end of a bridge parapet wall, a tension strut back-up is to be specified. The tension strut allows the QuadGuard to be shifted several inches to better line up with the parapet wall. Transition panels will be used with the tension strut to protect opposing traffic, when necessary. If a bridge approach slab is used, Bridge Design should be advised to widen the slab to accommodate the QuadGuard. If an approach slab is not used, grading for an anchor pad must be done.

#### **5. Type "T" End Treatment**

Type "T" End Treatments are a tangential end terminal that does not require an offset. However, it can be offset up to maximum of two (2) feet if constructed of a 25:1 taper over the full length of the terminal.

#### **6. Retaining Wall**

SUBJECT: Location of Retaining Walls

REFERENCE: Memorandum for Director of Preconstruction dated 8-1-88

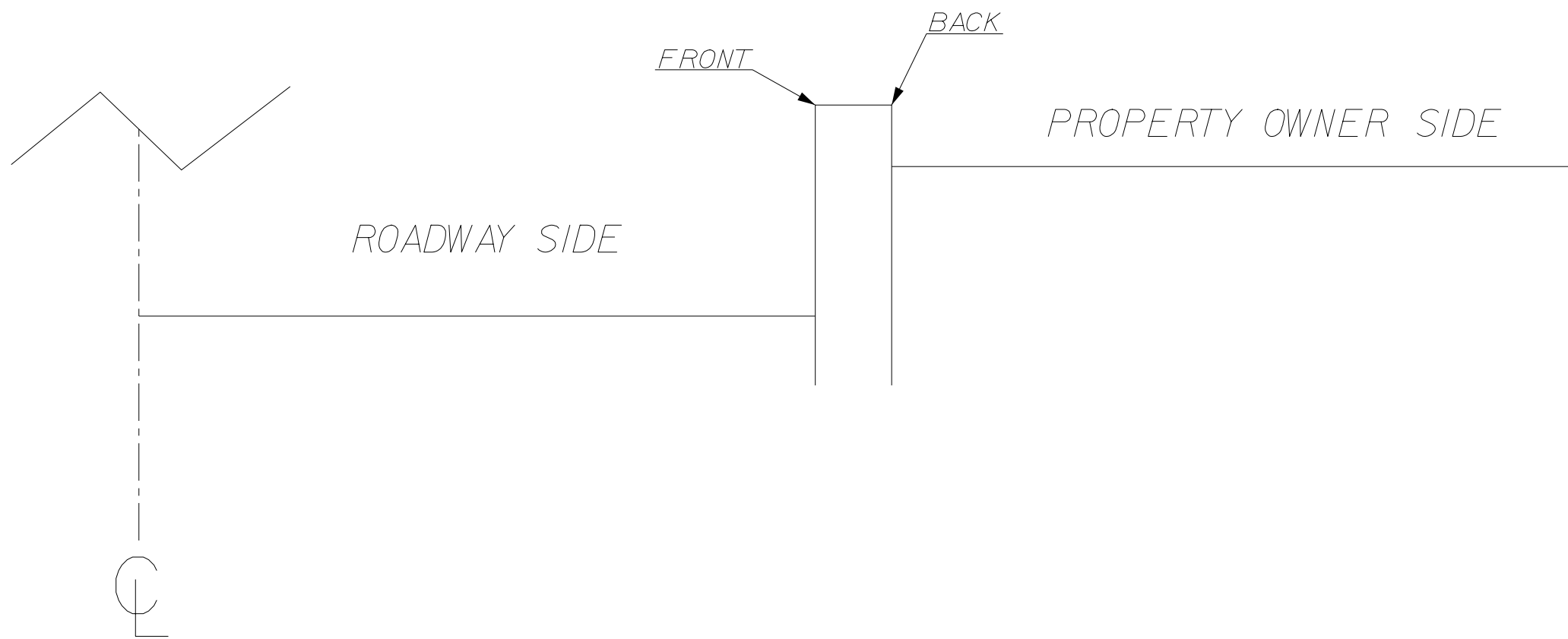
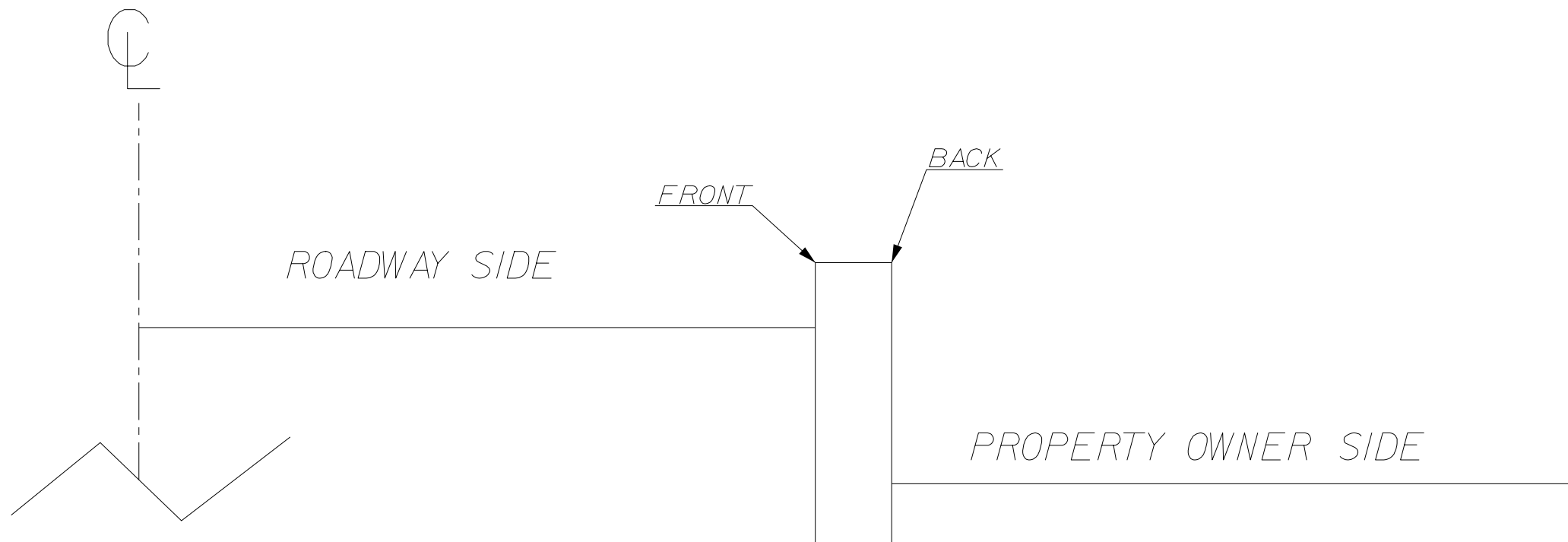
Whenever it becomes necessary for the Department to propose construction of retaining walls to contain cut or fill slopes, the back of the wall shall be established as the right of way. Depending upon design of the wall footing, permission may be required to construct and maintain the footing. If permission cannot be obtained for the footing, sufficient right of way to construct and maintain the wall and footing must be obtained.

In situations where the landowner negotiates for a wall in lieu of slopes, the right of way shall be established as the front of the wall. The wall shall become the property of the landowner after the Department has accepted the structure from the contractor. The right of way instrument shall reflect that any future maintenance is the responsibility of the property owner.

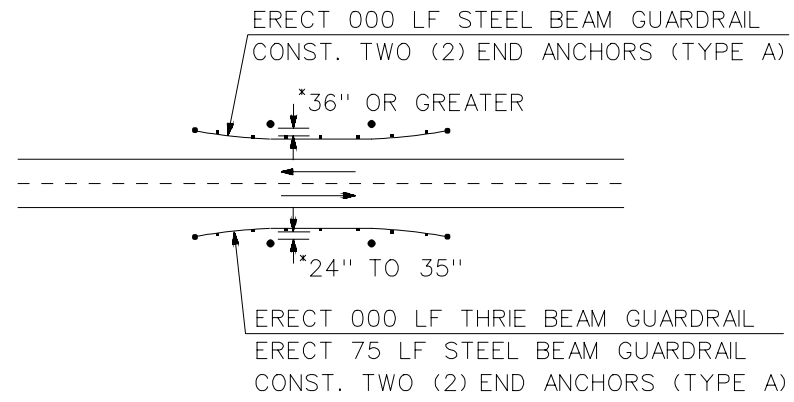
See detail on following sheet.

**7. Guardrail in Radius**

When guardrail is needed at intersecting roads/streets, sharp radii are required. It is possible to bend guardrail to fit a maximum of an eight-foot radius. Radii this sharp should be used only in extreme cases.

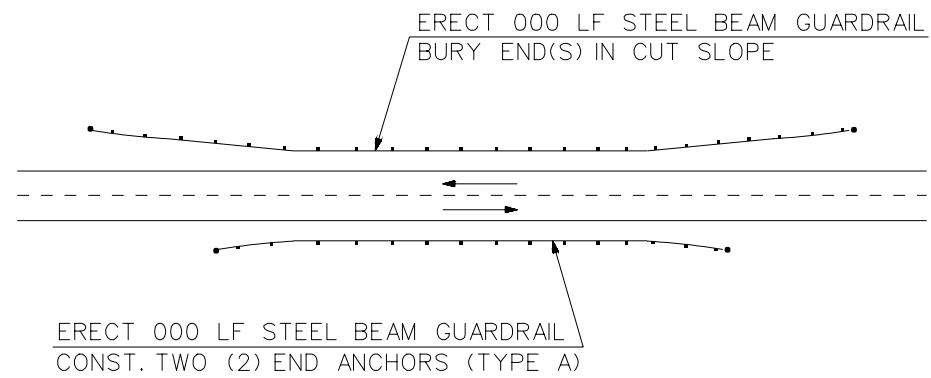


METHOD OF PLACING GUARDRAIL  
ON UNDIVIDED ROADWAYS



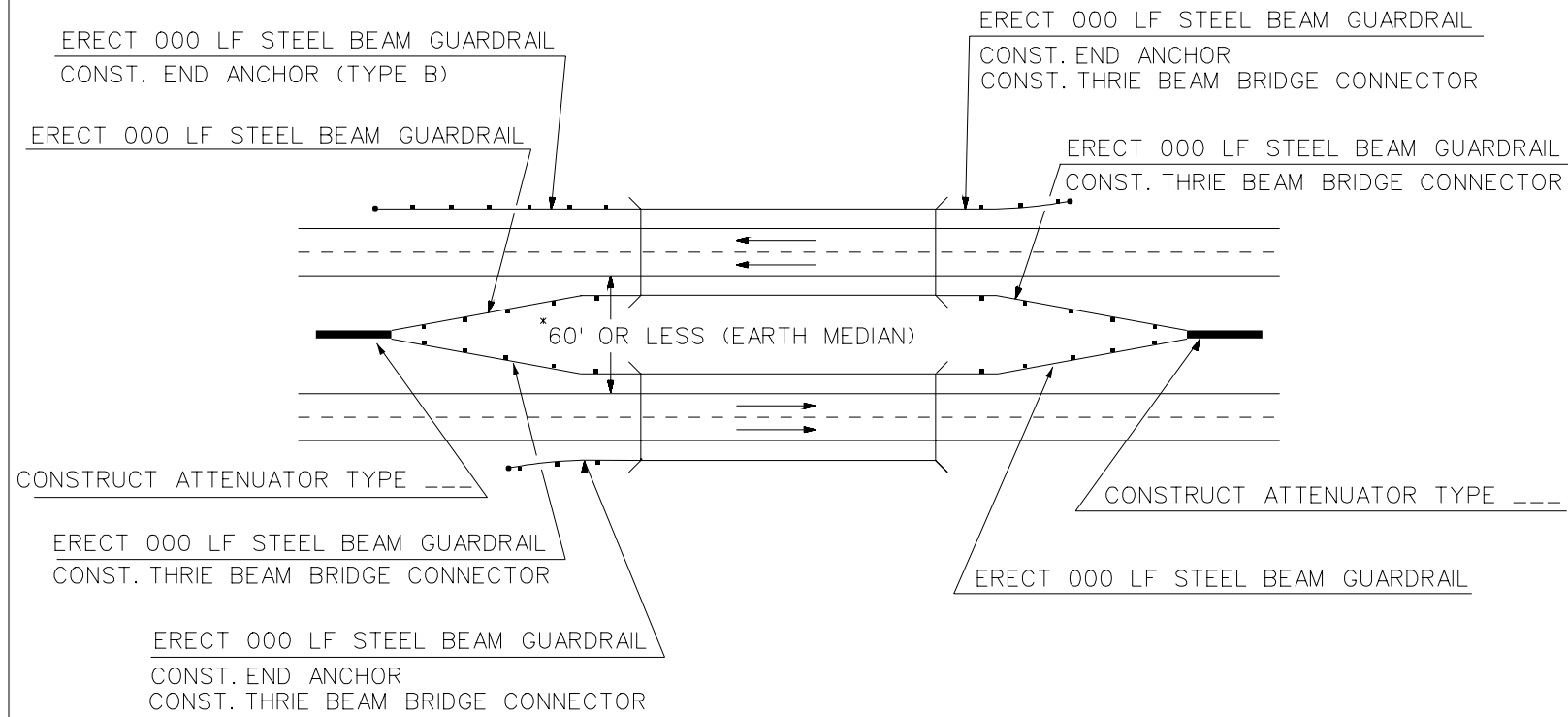
\*GUARDRAIL OFFSET DISTANCE IS MEASURED FROM OBSTACLE TO BACK OF POST

GUARDRAIL DETAIL AT ROADSIDE OBSTACLES



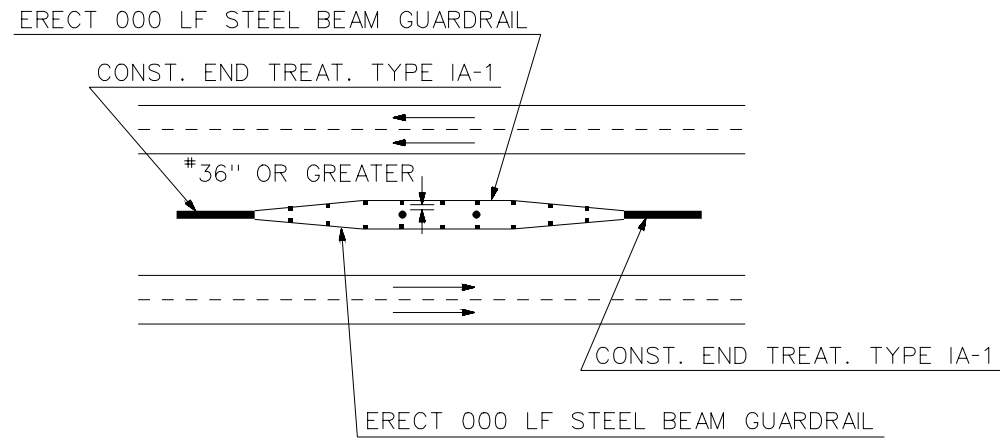
STANDARD GUARDRAIL DETAIL

METHOD OF PLACING GUARDRAIL  
ON DIVIDED ROADWAYS  
50 MPH OR GREATER



\* WHEN MEDIAN WIDTH EXCEEDS 60' TREAT AS SEPARATE ROADWAYS

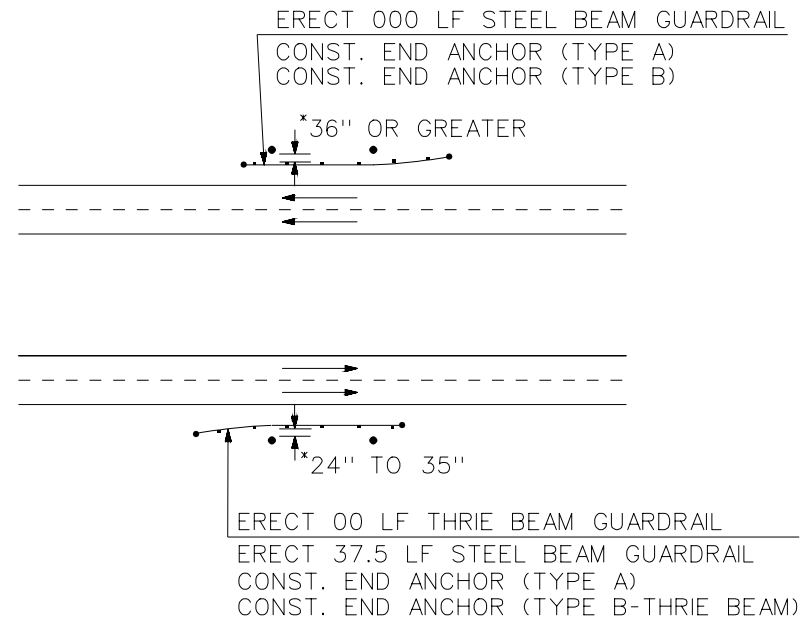
GUARDRAIL DETAIL AT BRIDGES ( $\geq$  50 MPH)



\* GUARDRAIL OFFSET DISTANCE IS MEASURED FROM OBSTACLE TO BACK OF POST

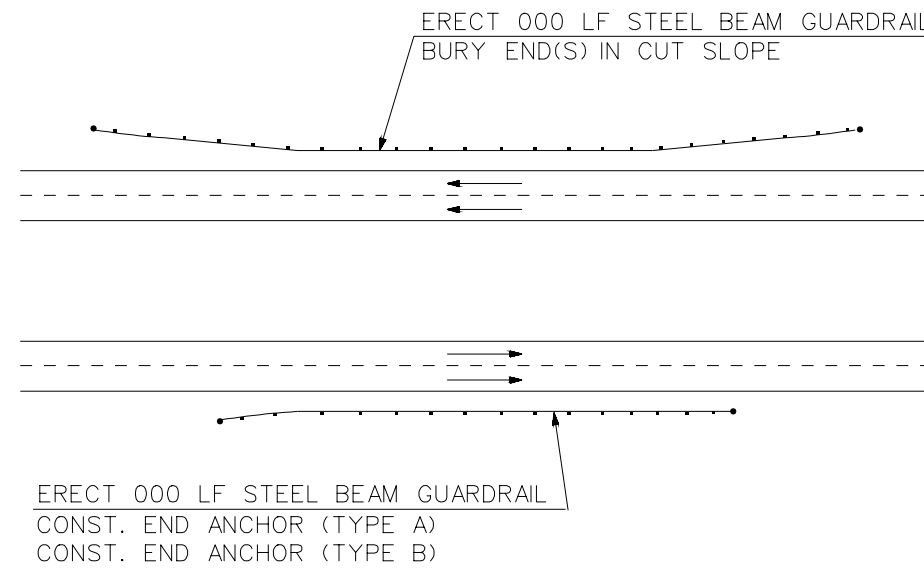
GUARDRAIL DETAIL AT MEDIAN OBSTACLES ( $\geq$  50MPH)

METHOD OF PLACING GUARDRAIL  
ON DIVIDED ROADWAYS



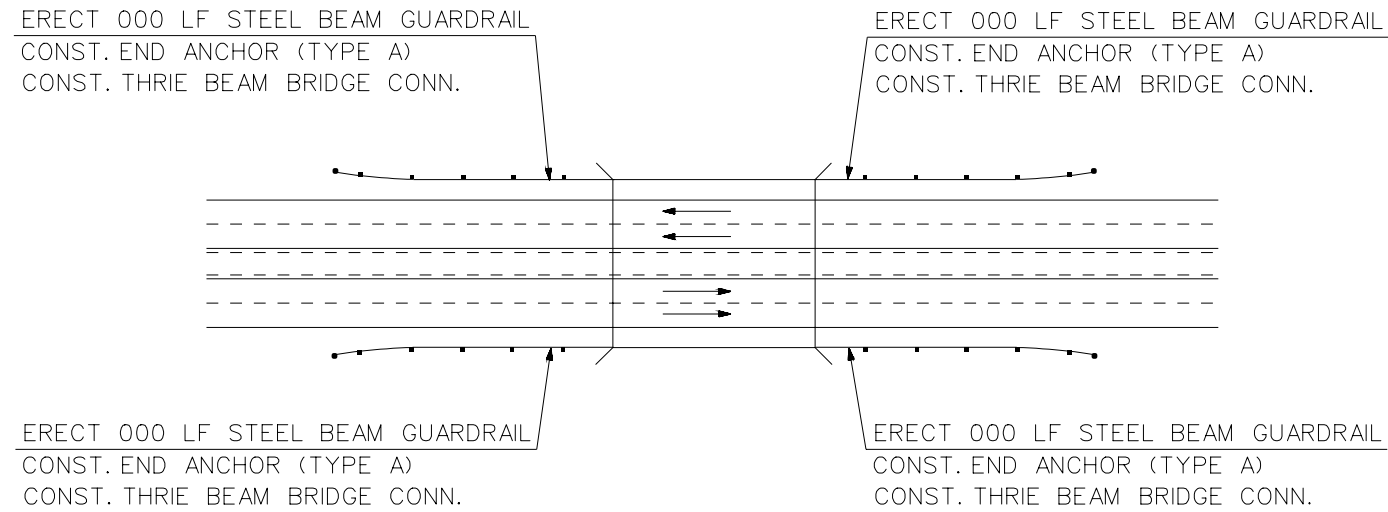
\*GUARDRAIL OFFSET DISTANCE IS MEASURED FROM OBSTACLE TO BACK OF POST

GUARDRAIL DETAIL AT ROADSIDE OBSTACLES

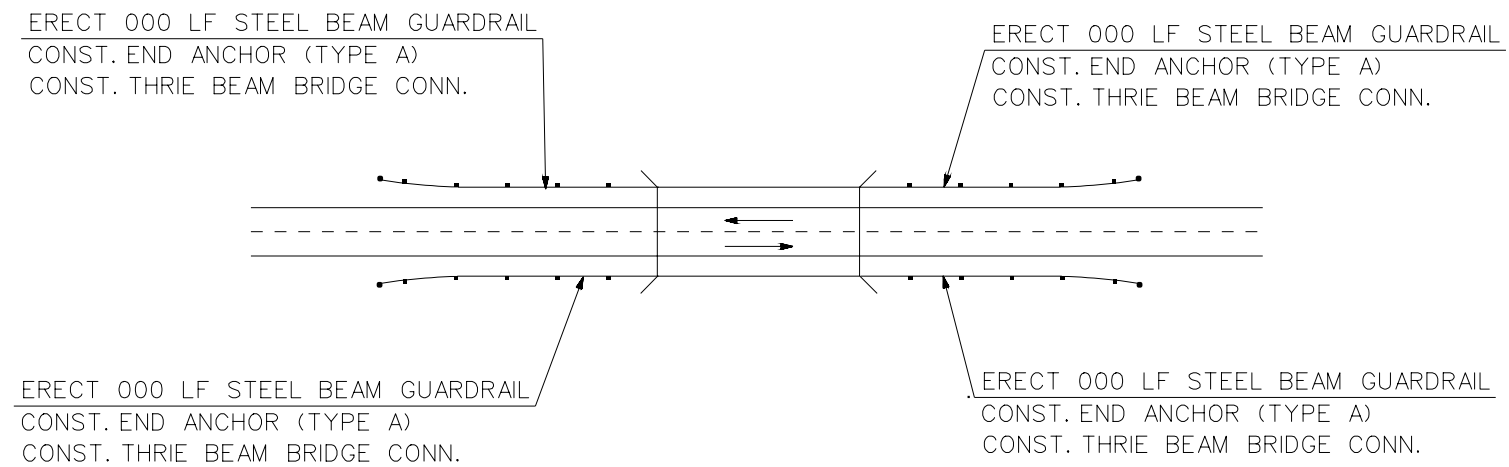


STANDARD GUARDRAIL DETAIL

METHOD OF PLACING GUARDRAIL  
ON UNDIVIDED ROADWAYS  
(INCLUDES PAVED-PAINTED MEDIAN)



GUARDRAIL DETAIL AT BRIDGES  
( FIVE LANE SECTION)



GUARDRAIL DETAIL AT BRIDGES

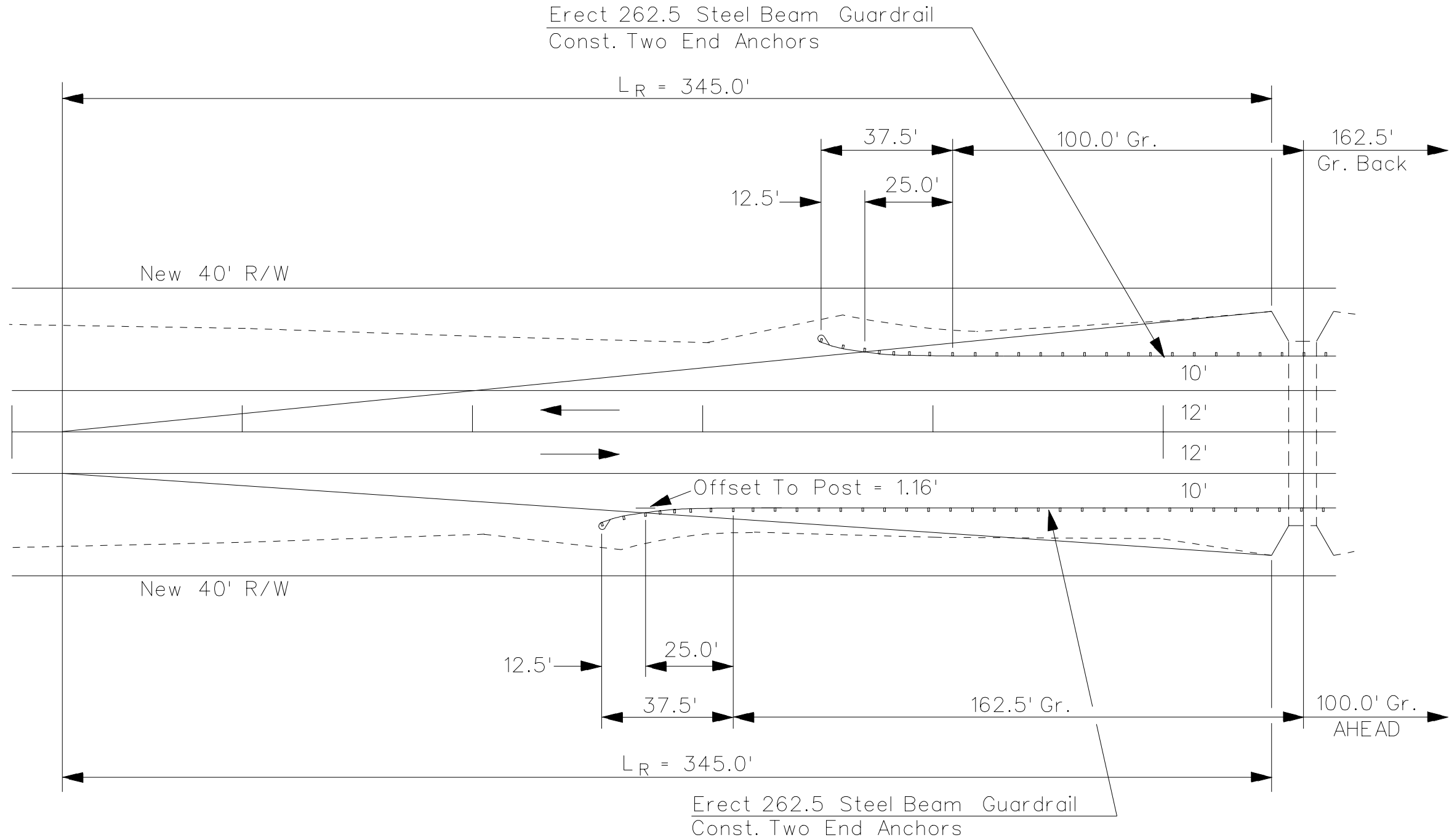


# EXAMPLE OF GUARDRAIL LENGTH OF NEED

DS = 55mph

ADT = 3600

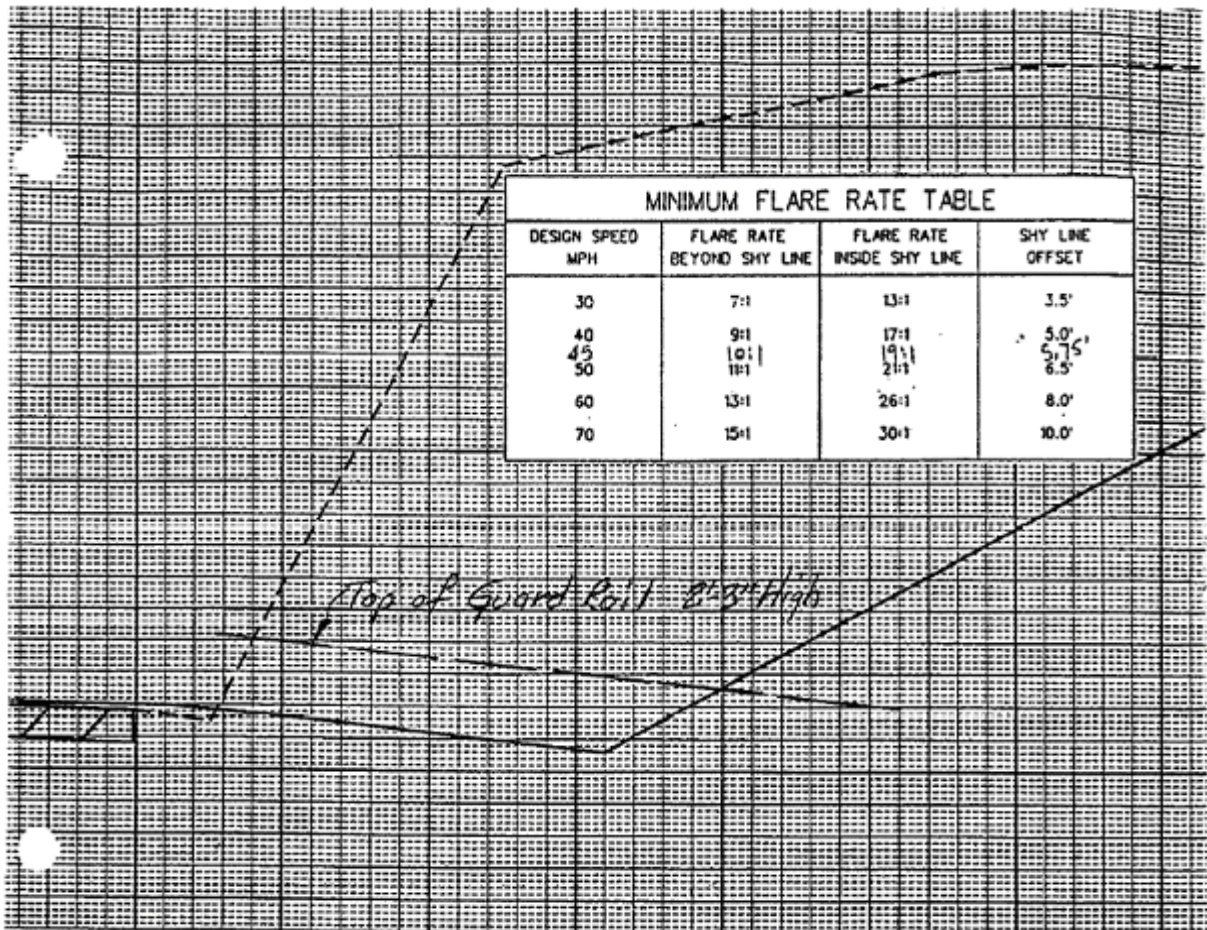
SHOULDER WIDTH = 10.0'



Guardrail Length In Multiples Of 12.5'

Post Spacing = 6.25'

MINIMUM FLARE RATE TABLE			
DESIGN SPEED MPH	FLARE RATE BEYOND SHY LINE	FLARE RATE INSIDE SHY LINE	SHY LINE OFFSET
30	7:1	13:1	3.5'
40	9:1	17:1	5.0'
45	10:1	19:1	5.75'
50	11:1	21:1	6.5'
60	13:1	26:1	8.0'
70	15:1	30:1	10.0'



30' From E to Where Guard Rail crosses New Ground Line

6' Extends approx 6' into Bank E.

Use 118.5' Guard Rail  
Scale: 1 in. = 20 Ft.

