Update Date	Revision Type	Reference	Section Description	Description of Revision	New or Deletion
1/16/2026	L&D Vol. 1	101.3	Classification Used in ODOT Design Criteria	Updated Office of Systems Planning and Program Management to Office of Technical Services	
1/16/2026	L&D Vol. 1	105.5.1	Documentation Format	Updated Safety Analysis Guidelines link & updated Office of Program Management to Office of T.E.D.	
1/16/2026	L&D Vol. 1	106.1	General	Updated Office of Program Management to Office of T.E.D.	
1/16/2026	L&D Vol. 1	106.3	Data-Driven Safety Analysis	Updated Safety Analysis Guidelines link & updated Office of Program Management to Office of T.E.D.	
1/16/2026	L&D Vol. 1	106.4	Data-Driven Safety Analysis Documentation	Modified language on when safety should be considered for projects. Updated Safety Analysis Guidelines link & updated Office of Program Management to Office of T.E.D.	
1/16/2026	L&D Vol. 1	Figure 107-1	Non-Complex Project Flowchart	Deleted because this figure is managed by Safety and posted to their website	Deletion
1/16/2026	L&D Vol. 1	Figure 107-2	Complex Projects Assessment with Alternatives Analysis without Safety	Deleted because this figure is managed by Safety and posted to their website	Deletion
1/16/2026	L&D Vol. 1	Figure 107-3	Complex Projects Assessment with Alternative Analysis with Safety	Deleted because this figure is managed by Safety and posted to their website	Deletion
1/16/2026	L&D Vol. 1	Figure 202-2	Maximum Degree of Curve	Corrected errors	
1/16/2026	L&D Vol. 1	Figure 202-5	Methods of Superelevation Rotation	Corrected print-error (letter A was missing in multiple locations)	
1/16/2026	L&D Vol. 1	305.2	Types and Uses	Added Type 11 curb	
1/16/2026	L&D Vol. 1	307.6.4	Adjacent to Noise Sensitive Areas	Revised Noise Wall contact to Statewide Noise Wall Coordinator	
1/16/2026	L&D Vol. 1	401.3	Crossroad Alignment	Added guidance for curves approaching a stop-controlled intersection	
1/16/2026	L&D Vol. 1	Figure 401-11	Double Left Turn Lanes	Corrected Green Book sheet reference in note 2	
1/16/2026	L&D Vol. 1	Figure 403-2	Roundabout Critical Design Parameters	Deleted merged cells to conform to website accessibility requirements (WCAG 2.1)	
1/16/2026	L&D Vol. 1	550.1	General	Defined access point and updated references to 23 CFR Part 624.	
1/16/2026	L&D Vol. 1	550.2	Interchange Study (Access Point Request Document)	Substantial guidance additions/revisions. Clarified that safety includes all users. The safety analysis shall include at least the most recent 3 years of available safety data in the project's area of influence. Updated references to 23 CFR Part 624.	
1/16/2026	L&D Vol. 1	550.2.1	Interchange Operations Study (IOS)	Updated references to 23 CFR Part 624 and made other minor clerical edits. A reevaluation of the IOS may be required by ODOT if the project or a phase of the project has not progressed to construction within 5 years of the approval date of the document	
1/16/2026	L&D Vol. 1	602.6.1	Transverse Drainage	Added guidance on decision making process for extending culverts versus installing guardrail.	
1/16/2026	L&D Vol. 1	603.1.2	Semi Rigid Barriers	Changed three inches to two inches for asphalt paving around MGS	
1/16/2026	L&D Vol. 1	603.1.2.1	Type MGS Guardrail	Revised guardrail grounding guidance	
1/16/2026	L&D Vol. 1	603.1.2.4	Barrier Design Guardrail with Rub Rail	Added guidance associated with new MGS-2.2 SCD	New
1/16/2026	L&D Vol. 1	603.1.2.6	MGS Top-Mounted to Culverts	Added information on mounting guardrail to culverts, associated with new and revised details from MGS-2.1.	New
1/16/2026	L&D Vol. 1	603.1.2.7	Socketed Weak Post - Side Mounted to Headwall	Added guidance associated with MGS-2.4.	New
1/16/2026	L&D Vol. 1	603.1.4.7	Type N Single Slope Barrier	Revised nomenclature to "Type N"	
1/16/2026	L&D Vol. 1	603.3.2	Type B	Updated system length, LON, and offset guidance due to new device (4F-T)	
1/16/2026	L&D Vol. 1	604.3	Glare Screen Options	Corrected link to APL	
1/16/2026	L&D Vol. 1	606.3.3	Freeway Fence Design Conditions	Revised fence grounding requirements	
1/16/2026	L&D Vol. 1	Figure 603-2	TYPICAL PERMANENT BARRIER USES & WORKING WIDTHS	Added working width information for various details that were added to MGS-2.1, added MGS-2.2, and revised 81" to Type N	
1/16/2026	L&D Vol. 1	Example 602-2	Length of Need at a Large Culvert	Completely new version of this sample problem using modern standards	
1/16/2026	L&D Vol. 1	Example 602-4	Barrier on the Outside of a Curve	Revised calculations and improved graphic readability	
1/16/2026	L&D Vol. 1	1002.2	HSM for Evaluation	Updated Safety Analysis Guidelines link & updated Office of Program Management to Office of T.E.D.	
1/16/2026	L&D Vol. 1	Plan Note R112a	ITEM 606 – ANCHOR ASSEMBLY, MGS TYPE B	Updated designer notes for system length, LON, and offset guidance due to new device (4F-T)	
1/16/2026	L&D Vol. 1	Plan Note R113a	ITEM 606 – ANCHOR ASSEMBLY, MGS TYPE E	Fixed typo	
1/16/2026	L&D Vol. 1	Plan Note R116	MGS GUARDRAIL INSTALLED IN ASPHALT	Revised asphalt item, allowable depth to 2", and other minor edits in conjunction with new detail added to MGS-2.1	
1/16/2026	L&D Vol. 1	Plan Note R127	CABLE BARRIER	Corrected title and item Special references.	

101.3 Classification Used in ODOT Design Criteria

The rural and urban functional classifications are further defined for design purposes as follows:

- Interstate
- Other Freeways and Expressways
- Principal Arterial Roads (rural) and Streets (urban)
- Minor Arterial Roads (rural) and Streets (urban)
- Collector Roads (rural) and Street (urban)
- Local Roads (rural) and Streets (urban)

The functional classifications for streets and highways in Ohio are kept on record in the Office of Technical Services. ~~Systems Planning and Program Management.~~

105.5.1 Documentation Format

The Design exception document must contain at least the following information:

1. The Design Designation for the project.
2. A Title Sheet Location map and a schematic or plan sheet if needed for clarity.
3. The controlling criteria affected by the proposed design exceptions. (As noted in Figure 105-1, normal design criteria must be used as the basis for all design exceptions.)
4. A description of the project.
5. Proposed mitigation for the deviation (if any).
6. Support for the proposed deviation based upon sound engineering practices, cost comparison/ analysis, impact on the environment, the relationship between any crash patterns and the proposed design exception, etc.
7. The GCAT/CAM Tool must be attached. HSM Analysis may also be required by ORE or CPA based upon the nature of the exception request. Refer to the Safety Analysis Guidelines maintained by the Office of Transportation and Economic Development ~~Program Management~~ for information to conduct the analysis. The GCAT/CAM Tool should include the three most recent years of complete crash data. The GCAT/CAM Tool analysis area should encompass approximately 250’ in advance and past the project limits.

106.1 General

The purpose of the Data-Driven Safety Analysis (DDSA) is to better understand the safety performance of a project and each of the alternatives. Additionally, it can be used to determine if there is a pattern or concentration of crashes within the project limits that can be reasonably and practically addressed through the inclusion of countermeasures in the project.

Factors that can affect countermeasures being "reasonable and practical" include but are not limited to:

1. Cost;
2. Environmental or R/W impacts;
3. Countermeasure work type being compatible with the planned project;
4. Schedule impacts

A minimum safety assessment should be performed in the early phases of project development (i.e. project programming). This will allow schedule, scope, and budget considerations to be accounted for when reasonable and practical countermeasures are to be included in the project. Reference Safety Analysis Guidelines maintained by the Office of Transportation and Economic Development ~~Program Management~~ for items included in the minimum safety assessment.

106.3 Data-Driven Safety Analysis

(DDSA) is defined as using real data and established methods to analyze crash and roadway data to estimate the safety impacts of highway projects, assess existing safety conditions, and prioritize locations for safety analysis and/or funding. This allows agencies to target investments with greater confidence that will improve safety on the roadway.

Each project is categorized depending on the project size, complexity, and/or potential impact to the environment. Based on the complexity of the project, one of three safety assessment processes should be followed as part of the project development process to qualitatively assess safety. The analysis process is outlined in the Safety Analysis Guidelines maintained by the Office of Transportation and Economic Development ~~Program Management~~.

A minimum assessment for all projects involves reviewing any applicable studies for the project area, reviewing the ODOT Safety integrated Project (SIP) Maps, documenting any other safety priorities in the area (state or local), and reviewing historical crash trends.

Where in the opinion of the district there is a noteworthy location or pattern of crashes, a determination should be made if there is a reasonable and practical countermeasure(s) that can be incorporated into the project and if a safety funding request will be made. For high priority locations, there may be situations when there are reasonable and practical countermeasures, but they can't be incorporated into the project due to factors such as schedule or work type incompatibility. In these cases, consideration should be given to creating a standalone safety project to address the high priority location.

Projects that have an identified location on the SIP maps or statewide/regional safety priority maps are eligible for supplemental safety funding up to $500,000 through an abbreviated safety funding application process. Requests exceeding this amount should be submitted through the annual HSIP Safety Funding Application process.

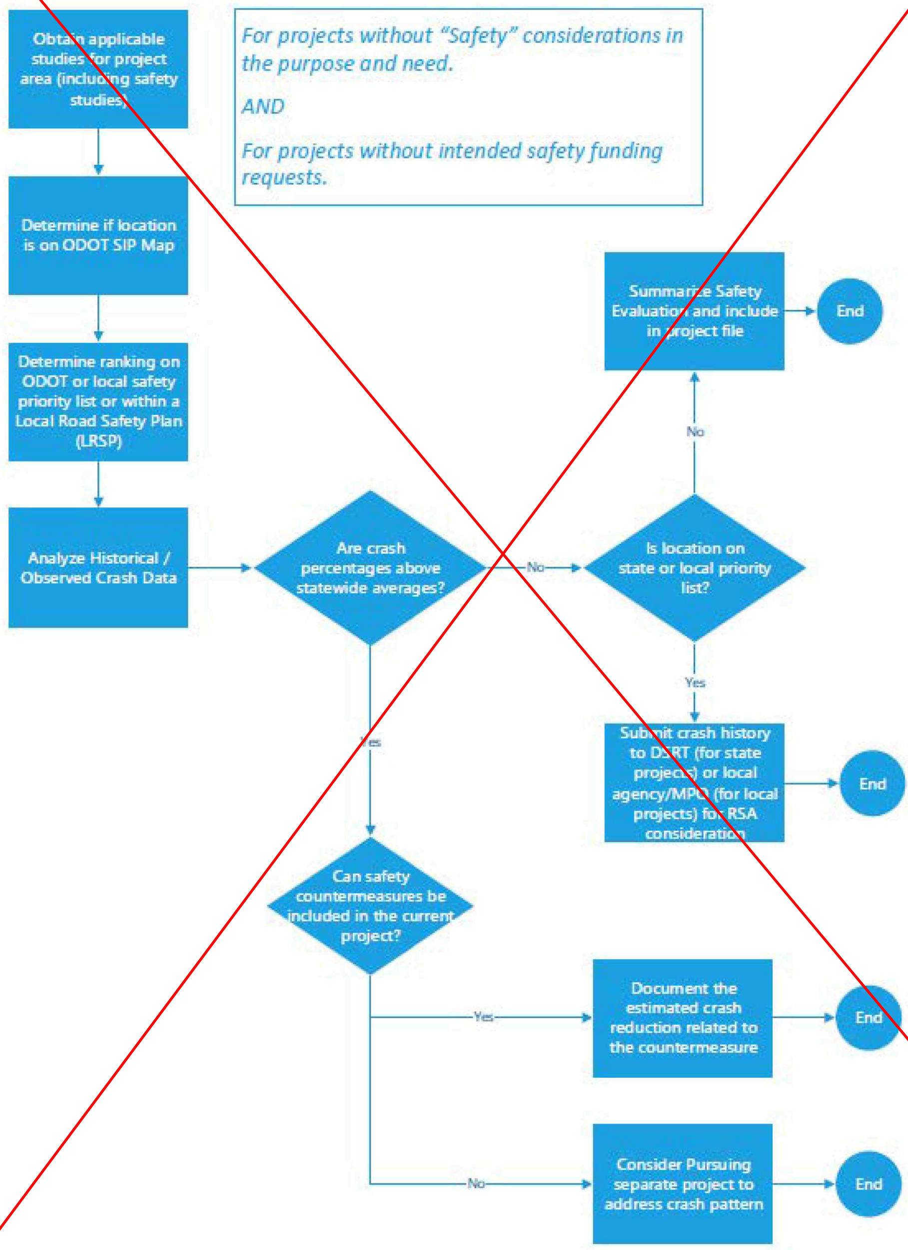
Refer to the Safety Analysis Guidelines maintained by the Office of Transportation and Economic Development ~~Program Management~~ for detailed analysis requirements. The Office of Transportation and Economic Development ~~Program Management~~ also maintains the SIP Maps, the Statewide HSIP Priority Location Lists and data related to historical crash trends t can be used to conduct a minimum project assessment. Abbreviated Safety Applications should be coordinated through the District Safety Review Team (DSRT) coordinator.

106.4 Data-Driven Safety Analysis Documentation

~~While s~~Safety should be considered and evaluated for every project.~~, there is no requirement to include safety countermeasures for projects without safety included in the purpose and need. Rather,~~ Projects without safety in the purpose and need should be evaluated to determine if there is a reasonable and practical countermeasure(s) that can be incorporated ~~into the project~~ without ~~expanding~~ major impacts to the project scope. Decisions should be documented on the appropriate Safety Analysis Checklist. ~~"Data-Driven Safety Analysis Documentation" form.~~ Refer to the Safety Analysis Guidelines maintained by the Office of Transportation and Economic Development ~~Program Management~~ for documentation templates.

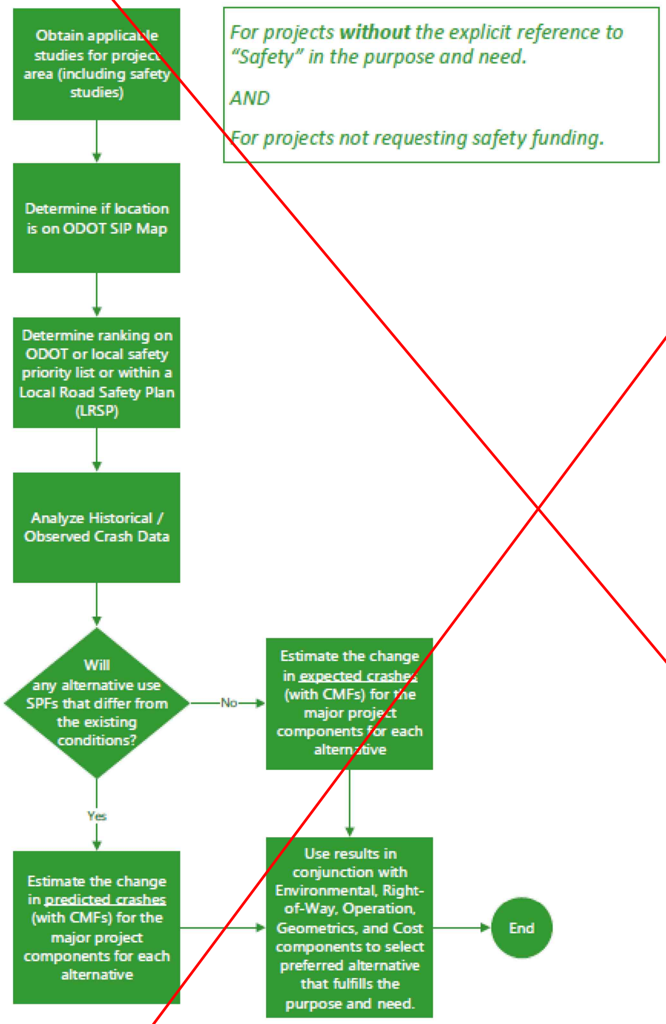
DELETE FIGURE

Figure 107-1 Non-Complex Projects (No Alternative Analysis)



DELETE FIGURE

Figure 107-2 Complex Projects Assessment with Alternatives Analysis without "Safety" in the Purpose and Need Statement



Definitions:

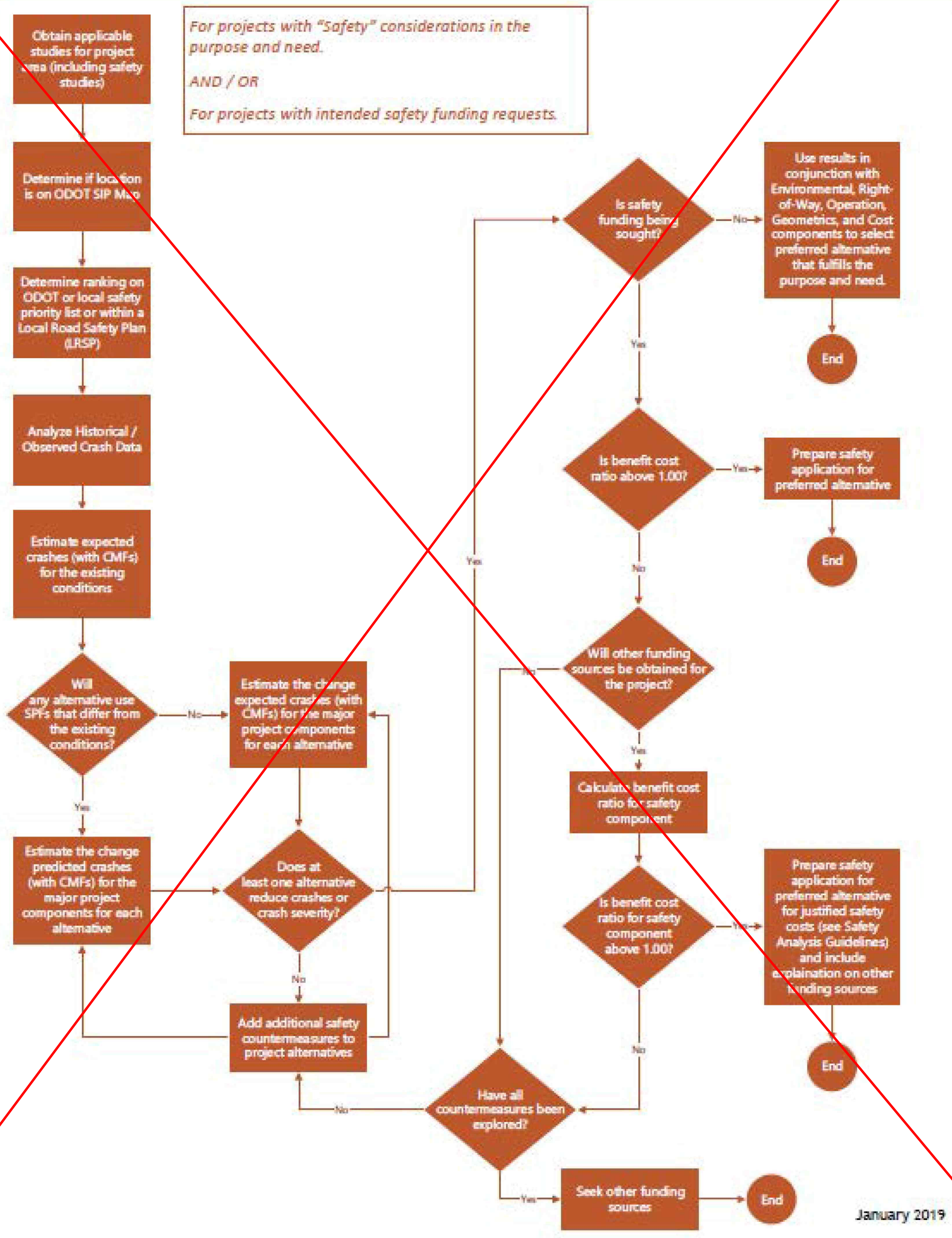
Crash modification factor (CMF): value which quantifies the change in crash frequency at a site as a result of implementing a specific countermeasure or treatment. It can be single value or function and may apply to all crashes or specific crash type(s).

Expected average crash frequency: the estimate of long-term expected crash frequency of a site, facility, or network under a given set of geometric conditions and traffic volumes (AADT) in a given period of years.

Predicted average crash frequency: the estimate of long-term average crash frequency – based on the average number of crashes of a peer group (exact same base conditions) with a given AADT.

DELETE FIGURE

Figure 107-3 Complex Projects Assessment with Alternative Analysis and Safety Component



MAXIMUM DEGREE OF CURVE

202-2

REFERENCE SECTION 202.3

DESIGN SPEED (mph)	MAXIMUM DEGREE OF CURVE (A)				DESIGN SPEED (mph)	MAXIMUM DEGREE OF CURVE (A)			
	RURAL	HIGH-SPEED URBAN	LOW-SPEED URBAN RAMPS/ INTERCHANGE	LOW-SPEED URBAN		RURAL	HIGH-SPEED URBAN	LOW-SPEED URBAN RAMPS/ INTERCHANGE	LOW-SPEED URBAN
	MAXIMUM SUPERELEVATION RATE					MAXIMUM SUPERELEVATION RATE			
	.08	.06	.06	.04		.08	.06	.06	.04
20	--	--	--	66°35'	45	9°45'	--	8°55'	8°05'
21	--	--	--	60°25'	46	9°15'	--	--	--
22	--	--	--	53°15'	47	8°50'	--	--	--
23	--	--	--	47°05'	48	8°20'	--	--	--
24	--	--	--	41°45'	49	7°55'	--	--	--
25	42°40'	--	39°55'	37°10'	50	7°35'	6°55'	--	--
26	38°40'	--	36°05'	33°35'	51	7°10'	6°35'	--	--
27	35°10'	--	32°45'	30°25'	52	6°50'	6°15'	--	--
28	32°00'	--	29°50'	27°35'	53	6°35'	5°55'	--	--
29	29°15'	--	27°10'	25°10'	54	6°15'	5°40'	--	--
30	26°45'	--	24°50'	22°55'	55	6°00'	5°25'	--	--
31	24°40'	--	22°55'	21°05'	56	5°40'	5°10'	--	--
32	22°50'	--	21°10'	19°30'	57	5°25'	4°55'	--	--
33	21°10'	--	19°35'	18°00'	58	5°15'	4°40'	--	--
34	19°40'	--	18°10'	16°40'	59	5°00'	4°30'	--	--
35	18°15'	--	16°50'	15°25'	60	4°45'	4°15'	--	--
36	17°00'	--	15°40'	14°20'	61	4°35'	4°05'	--	--
37	15°50'	--	14°35'	13°20'	62	4°25'	3°55'	--	--
38	14°45'	--	13°35'	12°25'	63	4°10'	3°45'	--	--
39	13°45'	--	12°40'	11°30'	64	4°00'	3°35'	--	--
40	12°55'	--	11°50'	10°45'	65	3°50'	3°25'	--	--
41	12°10'	--	11°10'	10°05'	66	3°45'	3°20'	--	--
42	11°30'	--	10°30'	9°35'	67	3°35'	3°10'	--	--
43	10°55'	--	9°55'	9°00'	68	3°25'	3°05'	--	--
44	10°20'	--	9°25'	8°30'	69	3°15'	2°55'	--	--
					70	3°10'	2°50'	--	--
					71	3°00'	2°40'	--	--
					72	2°55'	2°35'	--	--
					73	2°50'	2°30'	--	--
					74	2°40'	2°25'	--	--
					75	2°35'	2°15'	--	--

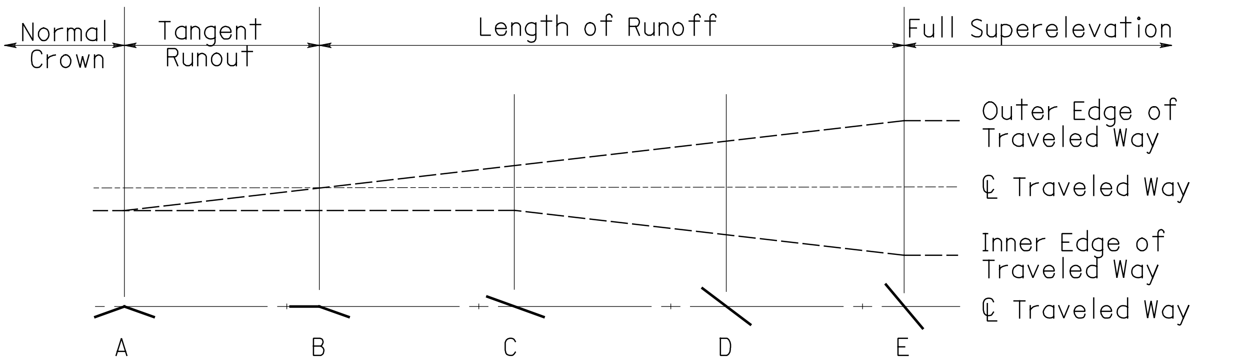
(A) See Superelevation Tables 202-7, 8, 9, and 10 for corresponding radii values.

METHODS OF SUPERELEVATION ROTATION

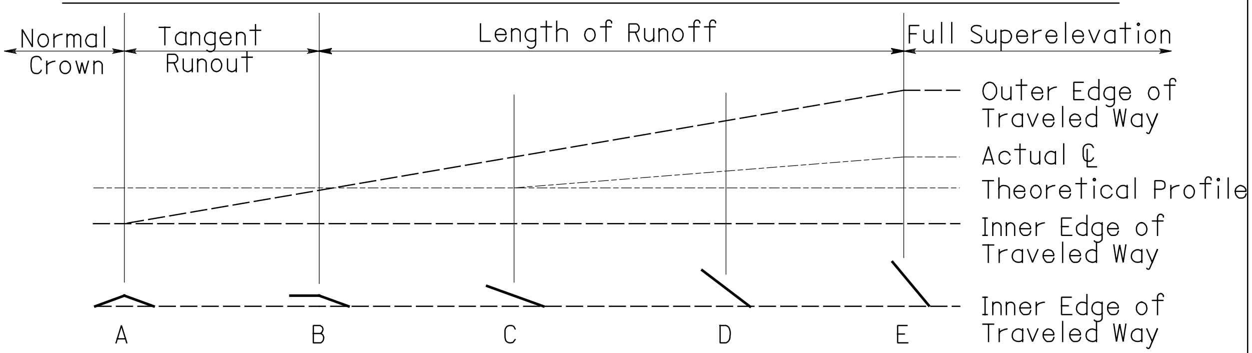
202-5

REFERENCE SECTION 202.4.4

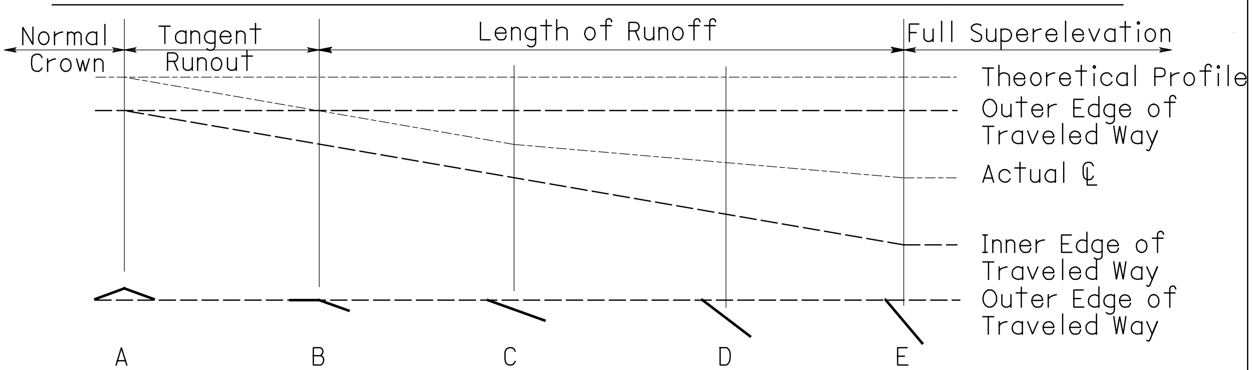
METHOD 1 - PAVEMENT REVOLVED ABOUT THE CENTERLINE (Crowned)



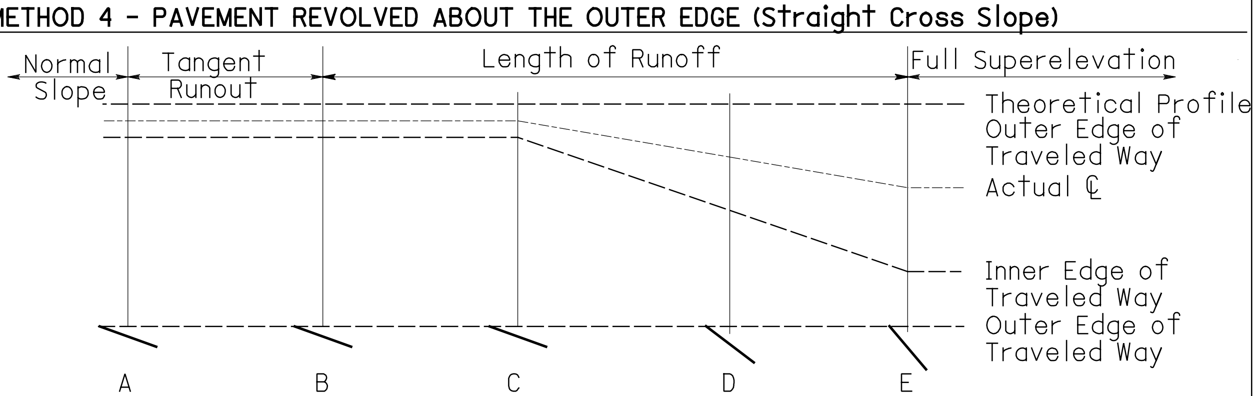
METHOD 2 - PAVEMENT REVOLVED ABOUT THE INNER EDGE (Crowned)



METHOD 3 - PAVEMENT REVOLVED ABOUT THE OUTER EDGE (Crowned)



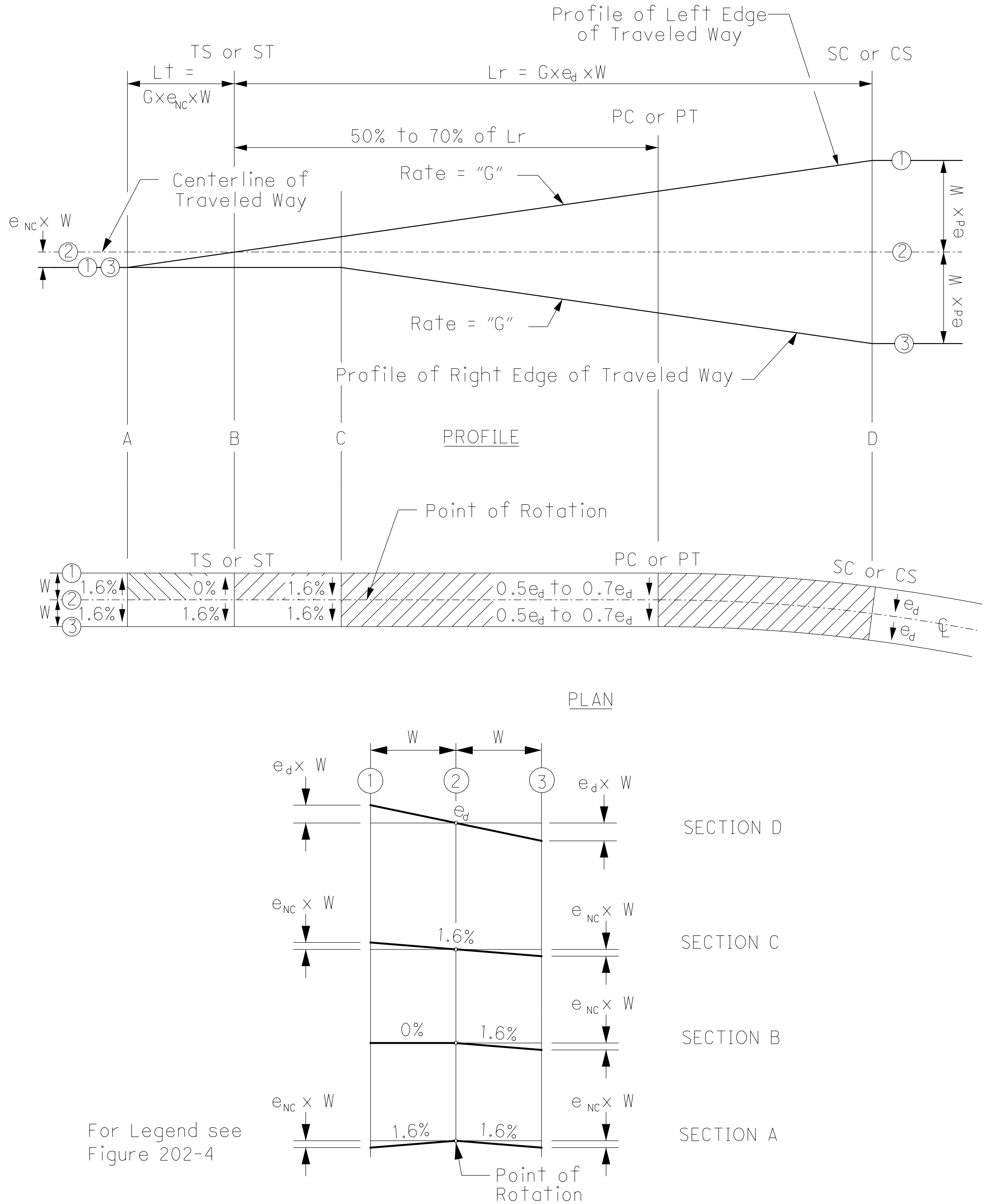
METHOD 4 - PAVEMENT REVOLVED ABOUT THE OUTER EDGE (Straight Cross Slope)



SUPERELEVATION DEVELOPMENT TWO-LANE UNDIVIDED

202-5a

REFERENCE SECTION 202.4.4 - 202.4.6, 202.4.8

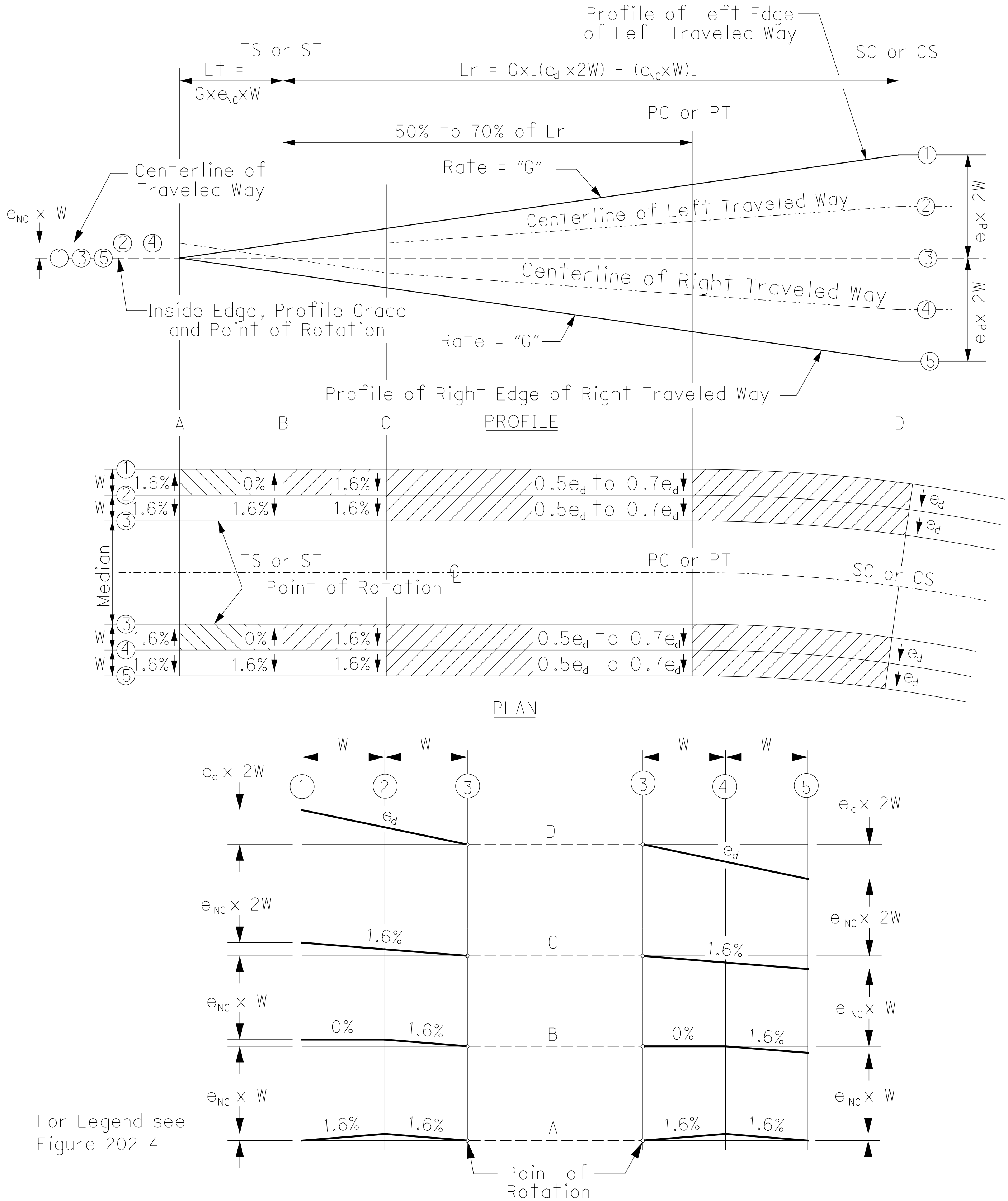


JANUARY 2006

SUPERELEVATION DEVELOPMENT FOUR-LANE DIVIDED

202-5b

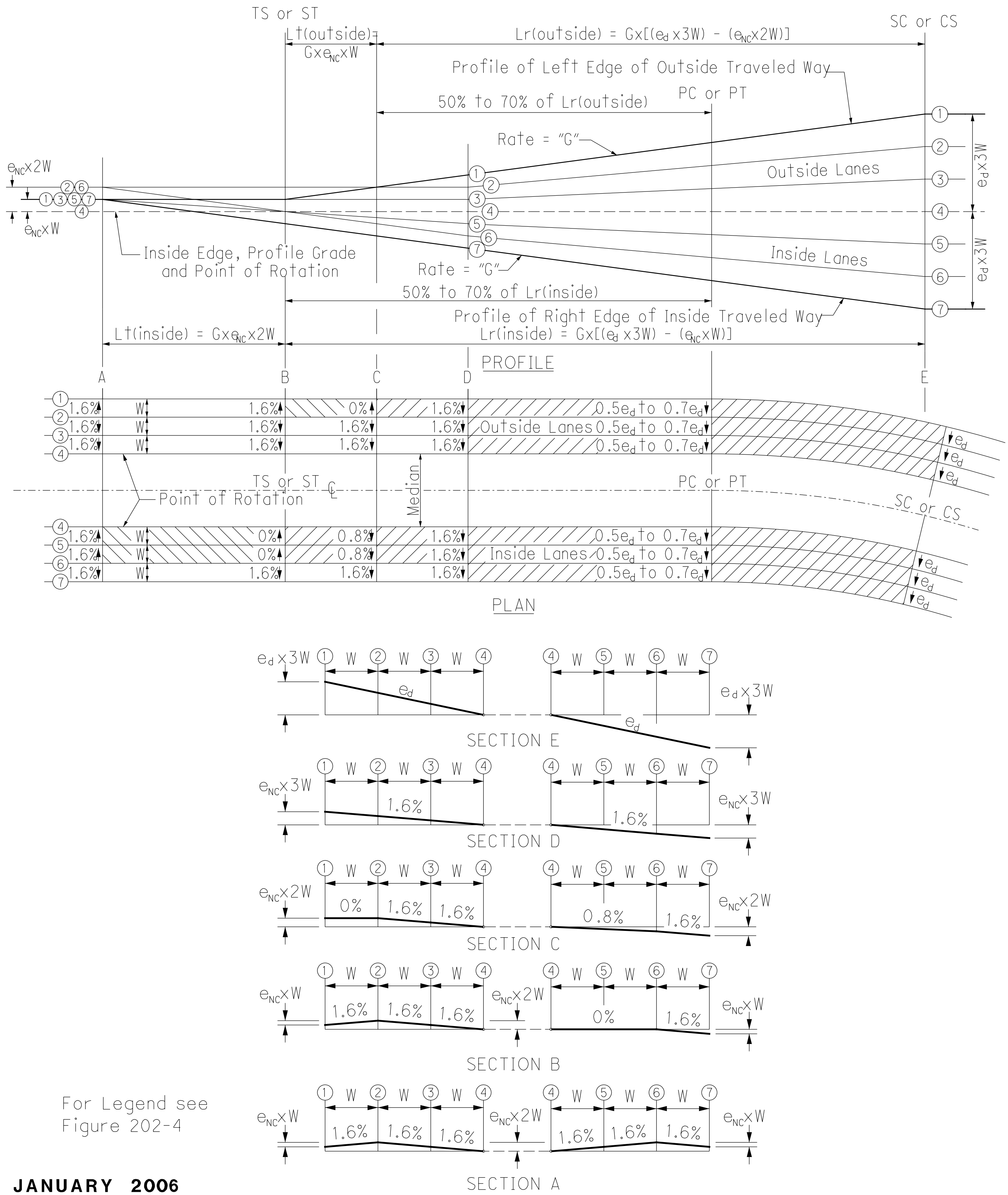
REFERENCE SECTION
202.4.4 - 202.4.6, 202.4.8



SUPERELEVATION DEVELOPMENT SIX-LANE OR MORE DIVIDED (OR FOUR-LANE DIVIDED WITH FUTURE MEDIAN LANES)

202-5c

REFERENCE SECTION 202.4.4 - 202.4.6, 202.4.8

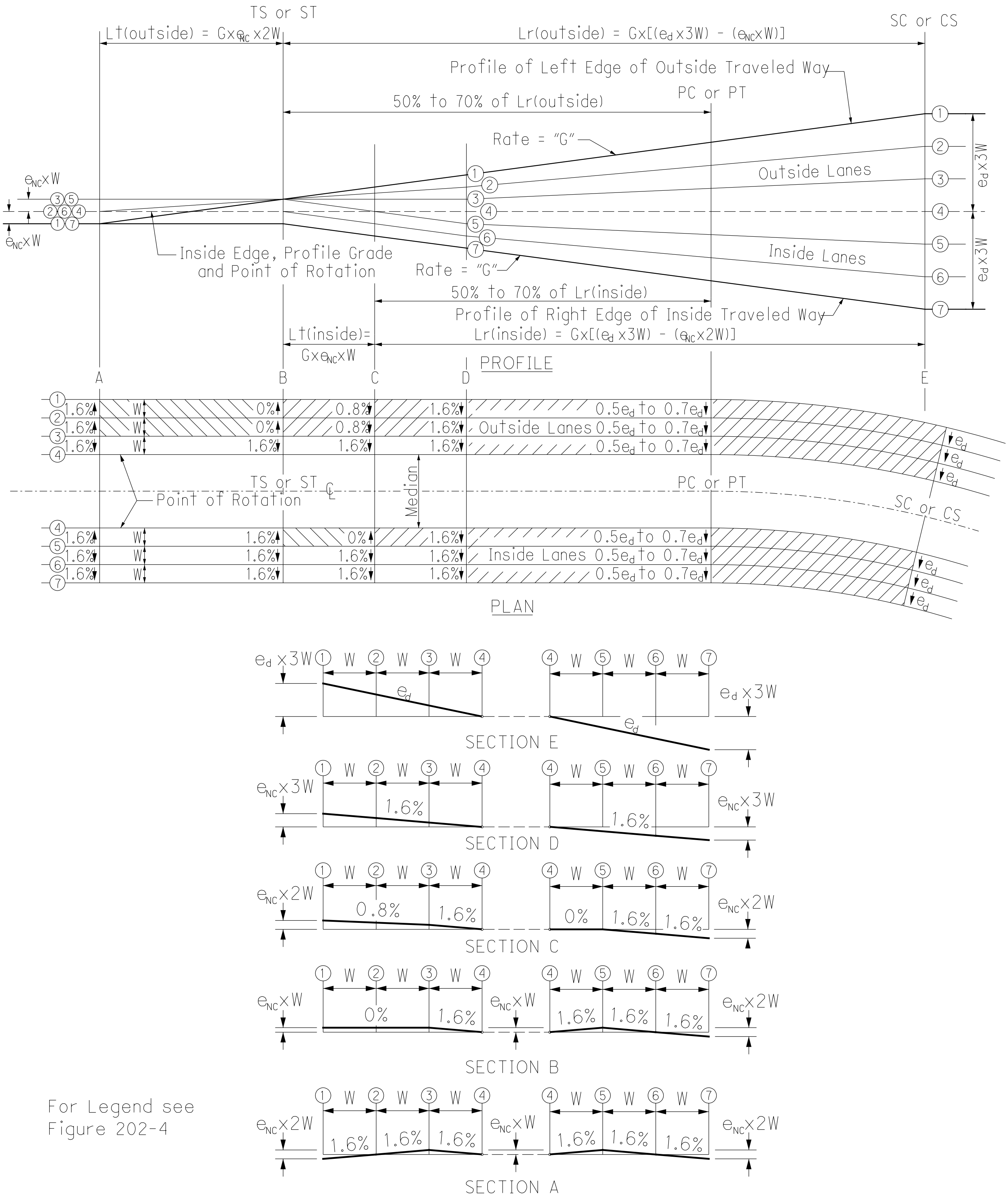


For Legend see Figure 202-4

SUPERELEVATION DEVELOPMENT SIX-LANE OR MORE DIVIDED (OR FOUR-LANE DIVIDED WITH FUTURE OUTSIDE LANES)

202-5d

REFERENCE SECTION
202.4.4 - 202.4.6, 202.4.8



For Legend see Figure 202-4

305.2 Types and Uses

There are two general types of curbs; vertical curbs and sloped curbs. Vertical curbs are relatively high (6 inches or more) and steep-faced. Sloped curbs are 6 inches or less in height and have flatter, sloping faces so that vehicles can cross them with varying degrees of ease.

The curb sections detailed on **Standard Construction Drawing BP-5.1** are approved types to be used as stated below:

- Type 1 Curb (asphalt curb) is a sloping 6 inch curb used mostly for temporary situations, such as correcting special drainage problems.
- Type 2, 2-A, and 2-B curbs are 6 inches high with a steep sloped face. They are widely used along the edges of traveled way in urban areas where design speeds are less than 50 mph. Type 2 curb is preferred to Type 6 curb to eliminate the joint between the curb and the gutter.
- Types 3, 3-A, 3-B and Type 4, 4-A, 4-B and 4-C curbs are 4 inches high with a sloped face. They are used for channelizing islands and occasionally along medians and edges of traveled way. Type 3 is preferred for channelizing islands with the gutter sloped at the same rate as the adjacent pavement.
- Type 6 Curb is a 6 inch high steep faced vertical curb. It is used in situations similar to Type 2 described above.
- Type 7 Curb is a vertical type used in low speed areas (design speed of less than 50 mph) for protection at bridge approaches. It may also be used to control traffic in areas involving heavy trucks.
- Type 9 Curb is a sloping 3 inch high curb used around the truck apron of a roundabout.
- Type 10 is a sloping curb used along separated bicycle lanes. Type 10 and 10-A/10-B should be used to reduce pedal strikes along street level and intermediate level separated bicycle lanes respectively. See Section 6.3.7 of the Multimodal Design Guide for curbing considerations along separated bicycle lanes.
- Type 11 Curb is a mountable curb and gutter used along the edge of traveled way of a roundabout.

307.6.4 Adjacent to Noise Sensitive Areas

Excess or disposable fill material may be placed adjacent to a noise sensitive area via the construction of a small height berm. Consult with the Office of Environmental Services-Statewide Noise Wall Coordinator ~~Policy Section-Noise Unit~~ regarding opportunities. A minimum 3’-6” tall berm height is recommended. Consult with the Office of Geotechnical Engineering regarding taller berm heights. Designer must adhere to clear zone requirements in LDM Vol 1 **Section 600** and grading requirements in LDM **Section 307**. The designer must consider issues including but not limited to underground utilities, tower lighting, signage, landfills, floodplains, utility markers, valve boxes, manholes, hydrants, exposed conduits, drainage concerns, tree removal, ecological items, etc.

401.3 Crossroad Alignment

Intersection angles of 70 degrees to 90 degrees are to be provided on all new or relocated highways. An angle of 60 degrees may be satisfactory if: (1) the intersection is signalized; or (2) the intersection is skewed such that a driver stopped on the side road has the acute angle (at center of intersection) on their left side (vision not blocked by their own vehicle).

Relocation of the crossroad is often required to meet the desired intersection location, to avoid steep crossroad profile grades and to adjust intersection angles. Horizontal curves on crossroads should be designed to meet the design speed of the crossroad. The crossroad alignment should be as straight as possible. Figure 401-1 shows an example of a crossroad relocation. Both curve 1 and curve 3 may be reduced per the figure.

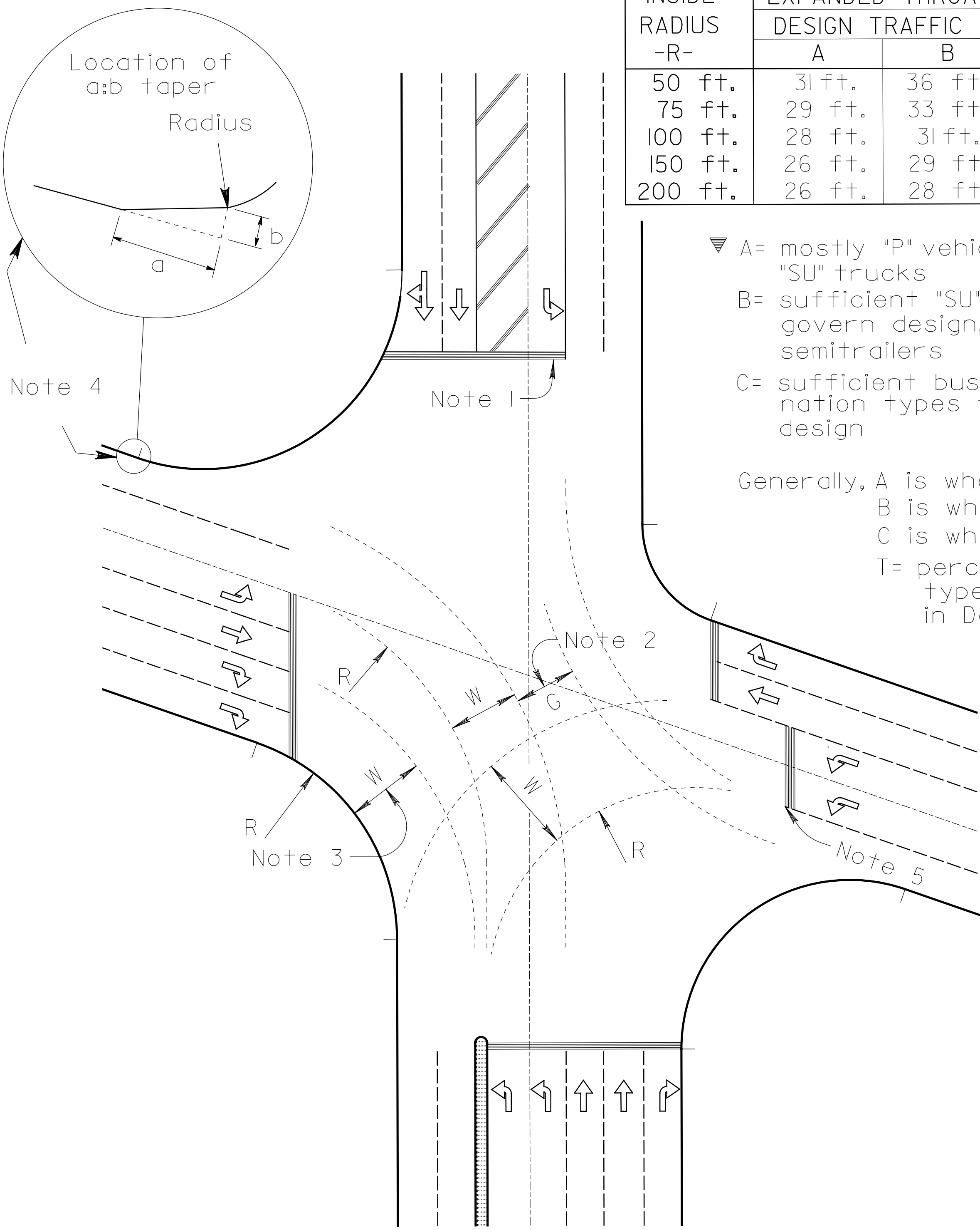
The design speed for horizontal curves on a crossroad approaching a stop-controlled intersection may be reduced from the design speed of the crossroad since the vehicles will be decelerating to a stop. The design speed of the horizontal curve approaching the stop bar may be based on the estimated speed of a vehicle as it enters the curve while decelerating. Calculate the estimated speed of a vehicle during deceleration utilizing Figure 2-34 (Deceleration Distances for Passenger Vehicles Approaching Intersections) from A Policy on Geometric Design of Highways and Streets (The Green Book, 7th Edition). First, determine the total deceleration distance with Figure 2-34 using the initial speed (design speed of the crossroad) to a speed of 0 MPH at the stop bar (line E on the chart). Then, interpolate the estimated speed using the distance from the entry of the curve to the stop bar with the total deceleration distance. The design speed for the curve may be the estimated speed rounded down to the nearest 5 mph increment, but must be no lower than 25 MPH.

DOUBLE LEFT TURN LANES

401-11

REFERENCE SECTIONS 401.6.2, 401.6.4

INSIDE RADIUS -R-	EXPANDED THROAT WIDTH -W- DESIGN TRAFFIC CONDITION ▼		
	A	B	C
50 ft.	31 ft.	36 ft.	45 ft.
75 ft.	29 ft.	33 ft.	38 ft.
100 ft.	28 ft.	31 ft.	35 ft.
150 ft.	26 ft.	29 ft.	32 ft.
200 ft.	26 ft.	28 ft.	30 ft.



▼ A= mostly "P" vehicles, some "SU" trucks

B= sufficient "SU" trucks to govern design, some semitrailers

C= sufficient bus and combination types to govern design

Generally, A is when T < 5%
B is when T = 5-10%
C is when T > 10%
T= percentage of type B and C trucks in Design ADT

Notes for Figure 401-11 - Double Left Turn Lanes

1. Notice that the single left turn lane at the top of the page has been laterally offset from the through lanes in order to prevent conflicts between opposing turning paths.
2. Opposing turning paths should always be checked to verify that there is no conflict (see dimension “G”). Per AASHTO “Green Book”, page 9-115, dimension “G” should be a minimum of 10’.
3. The double right turn lane design follows the same criteria as the double left turn lane for expanded throat width.
4. The pavement width of the receiving lanes for a double left turn at an intersection needs to be checked to see if design vehicles can complete their turns within the pavement area. This is especially important where the radius returns are curbed. The use of radius templates is one method that can be used to check wheel tracking to see if additional pavement area adjacent to the far return area is needed. If the turning lanes are 12 ft. in width, the following formula is recommended to estimate a need for widening the pavement at the receiving throat:

   $F = (W-24)/2$

   where W is the maximum expanded throat width from the table on Figure 401-11. If the turn lanes are not 12 ft., use truck turning templates.
   Then use the following guidelines:

   If $F < 2.0$, no widening is required.
   If F = 2.0 through 3.9, use a 40:4 taper.
   If F = 4.0 through 5.9, use a 45:6 taper.
   If F = 6.0 through 9.0, use a 50:8 taper.

   See **Figure 503-5** for examples of how these tapers are used at radius returns

5. Stop bar locations may need to be adjusted to the inside radius return of the left turn movements.

Roundabout Critical Design Parameters

Project - County Route Section

PID

Design Parameters	**Leg 1**	**Leg 2**	**Leg 3**	**Leg 4**	**Leg 5**
Entry Width, FT					
Entry Angle PHI ϕ, DEG					
Exit Width, FT					
Circulatory Roadway Width, FT					

Fastest Path Speed	**Leg 1**	**Leg 2**	**Leg 3**	**Leg 4**	**Leg 5**
R_1, Radius/Speed, FT/MPH					
R_2, Radius/Speed, FT/MPH					
R_3, Radius/Speed, FT/MPH					
R_4, Radius/Speed, FT/MPH					
R_5, Radius/Speed, FT/MPH					
R_5, Bypass Radius/Speed, FT/MPH					

Minimum Sight Parameters	**Leg 1**	**Leg 2**	**Leg 3**	**Leg 4**	**Leg 5**
Approach Design Speed, MPH					
Approach Stopping Sight Distance, FT/MPH					
Circulatory Stopping Sight Distance, FT/MPH					
Exit (Crosswalk) Stopping Sight Distance, FT/MPH					
Intersection Sight Distance, FT/MPH					

General	
Inscribed Circle Diameter, FT	
Design Vehicle(s)	
Truck Apron Width, FT	

Designer:

Signature:

Date:

Link to editable Excel File

550.1 General

Control of access on the Interstate and other freeway systems is considered critical to providing the highest quality of service in terms of safety and mobility. An access point is any permanent connection (including those metered or closed at times) to the through lanes or shoulders, managed lanes, collector-distributor roads, or ramps on the Interstate System, including “locked gate access”. This section provides guidance for the preparation and processing of access point requests in relation to new and existing interchanges on the Interstate and other freeway systems in accordance with ~~to~~ Federal Code 23 U.S.C. 111 and 23 CFR Part 624 dated August 27, 2025. ~~FHWA’s Policy on Access to the Interstate System, dated May 22, 2017.~~

The documentation required depends on the type of change requested - new or revised.

New Access is the addition of a point of access where none previously existed. This includes the construction of an entirely new interchange such that it will result in additional points of access or additional ramps to existing interchanges. As an example, the reconstruction of an existing diamond interchange to a full cloverleaf interchange would add four new points of access.

Revised Access is the major revision of an existing interchange such that the number of access points will remain the same but the operation and/or safety of the Interstate/freeway system may be affected. The changing of a cloverleaf interchange to a fully directional interchange, the conversion of a traditional diamond to a diverging diamond interchange, relocating an existing ramp to terminal to a new roadway, and adding a collector-distributor system are all considered examples of revised points of access.

New or revised access point requests require the preparation and processing of an Access Point Request Document. Generally, a new access requires an Interchange Justification Study (IJS) or an Interchange Modification Study (IMS). A revised access requires an Interchange Modification Study (IMS) or an Interchange Operations Study (IOS).

550.2 Interchange Study (Access Point Request Document)

The degree of complexity of the Interchange Study will vary depending on the character of the location (urban or rural) and/or whether the change involves a revised access point, a new access point at an existing interchange, or an entirely new interchange location. To coincide with 23 CFR Part 624,~~FHWA's Policy on Access to the Interstate System,~~ the following is a list of items which must be addressed in the interchange study for a new or revised access on the Interstate/freeway system:

A. The interchange study shall be a standalone report with all relevant information from other previous documents included in the appropriate section of the study.

B. Every IMS/IJS shall include all of the following:

1. A description and overview of the proposed change in access including a project location map and distances to adjacent interchanges.
2. Preliminary design documents demonstrating the geometric viability of the proposed change. This shall include the design criteria, existing geometry overlaid with clearly labeled proposed geometric plan views, lane configuration schematics, typical sections, proposed right of way lines, interchange spacing, ramp spacing and other design features necessary to evaluate the proposed design. Proposed design must meet or exceed current design standards.
3. Operational and safety analyses evaluating the impact of the proposed change in access on the Interstate System and local road network extending to the following area of influence limits at a minimum:
    i. Along the Interstate System, and interchanging freeway if applicable, to the adjacent existing or proposed interchange on either side of the proposed change in access, extending further as needed to ensure the limits of the analysis are appropriate to fully understand the impact of the proposed change in access on the Interstate System.
    ii. Along each crossroad to the first major intersection on either side of the proposed change in access, extending further as needed to demonstrate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local road network

~~Evidence~~ The IJS/IMS shall include analyses that the proposed new or revised access does not have significant adverse impact on the Interchange System traffic operations or the safety for all users of the transportation system in the project's area of influence. ~~safety and operation of the Interstate/freeway system.~~ The analysis must address design year traffic with and without the new or revised access point (build vs. no-build). Design year traffic must reflect future land use changes and associated trip generations. Traffic projections must be based upon traffic data that is no more than 5 years old and certified as per Section 102.1.

Requests involving new access points or revised access points must use 20-year design traffic projected from the opening day of the interchange. Certified Traffic (High Risk Design Traffic Forecasting Procedure) will be required for all projects involving an IMS or IJS, in accordance with the most current version of the Ohio Traffic Forecasting Manual.

Traffic volumes for interchange studies that do not require High Risk Design Traffic (i.e. Certified Traffic), must be reviewed and approved by the District prior to the preparation of traffic analyses. Written documentation of the District's approval of the Low Risk Design Traffic must be included in the interchange study report.

The level-of-service (LOS) of the Interstate/freeway system and the interchange components that are built new or modified should meet the level of service goals in **Figure 301-1**.

The proposed Interstate/freeway interchange or improvements cannot have a significant adverse impact on the Interchange System traffic operations or the safety for all users of the transportation system in the project's area of influence ~~safety and operation of the Interstate/freeway facility~~ based on an analysis of design year traffic.

The safety analysis shall include at least the most recent 3 years of available safety data in the project's area of influence. Refer to the Safety Analysis Guidelines maintained by the Office of Transportation and Economic Development for documentation information.

The operational analysis shall, particularly in urban areas, include an analysis of sections of Interstate/freeway to and including at least the first adjacent existing or proposed upstream and downstream interchange. For crossroads, analysis shall include the first major intersection on either side of the proposed change and can extend further as needed to demonstrate the safety and operational impacts that the change may have on the local network. Crossroads and other roads and streets shall be included in the analysis to the extent necessary to assure their ability to collect and distribute traffic to and from the interchange with new or revised access points. New interchanges must include analysis of the local street system to the extent that local road system improvements can be compared as an alternative to constructing a new interchange.

Maps and/or diagrams should be provided as needed to clearly describe the location and study limits of the proposal. All traffic analyses on ODOT projects must be prepared per the OATS Manual.

For requests involving entirely new interchanges, the study should include a discussion of the distance to, and size of, communities to be served by the new interchange. An examination of proper interchange spacing must also be included.

4. Every IMS/IJS shall include a conceptual signing plan showing the type and location of signs to support the proposed design per 23 CFR 624.11.
5. Assurance that the new or revised access connects to a public road and is part of a configuration that provides for all traffic movements. Less than "full interchanges" for special purpose access for transit vehicles, for HOV's, or into park and ride lots may be considered on a case-by-case basis. ~~Proposed design must meet or exceed current design standards.~~

C. For a proposed partial interchange, the IJS/IMS shall meet the following additional requirements.

1. In rare instances where all basic movements are not provided by the proposed design, the report must include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option.
2. The report must also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, and other proposed strategies as necessary. ~~etc.~~
3. The report must describe whether future provision of a full interchange is precluded by the proposed design.

D. In the case of complex changes in access, adjustments to the extent of the safety and operational analysis and the format of the study may be coordinated with the Office of Roadway Engineering.

The development of an Access Point Request Document should be performed in accordance with the ODOT Project Development Process (PDP). As part of the PDP for all projects that require an IJS/IMS, the relevant PDP submissions (including, but not limited to the Feasibility Study and Alternative Evaluation Report), will include consideration of the following points:

1. Adequate documentation that the existing access points and/or local roads are unable to handle the design year traffic demands while providing the access intended by the proposal, or be improved to do so, if the new or revised access is not provided. If the request involves a new access point, and particularly an interchange at a new location, a comprehensive description of the public need for the

access must be included. A justification based on enhanced property values or access to private facilities will not be accepted.

2. Assurance that all reasonable alternatives for design options, location, and transportation system management type improvements (such as ramp metering, mass transit, and HOV facilities) have been assessed and provided for if currently justified, or provisions are included for accommodating such facilities if a future need is identified.

3. The proposal considers and is consistent with local and regional land use and transportation plans. Prior to final approval, all requests for new or revised access must be consistent with the metropolitan and/or statewide transportation plan, as appropriate, the applicable provisions of 23 CFR part 450 and the transportation conformity requirements of 40 CFR parts 51 and 93.

The request should include a statement and analysis of compatibility with, and the effect on, the local road network. Letters of support and commitment are required from the State and other sponsoring agencies for any required street or road improvements as well as for the access point.

4. In areas where the potential exists for future multiple interchange additions, all requests for new or revised access are supported by a comprehensive Interstate/freeway network study with recommendations that address all proposed and desired access within the context of a long-term plan.

5. Evidence that the request for the new or revised access generated by new or expanded development demonstrates appropriate coordination between the development and the necessary transportation improvements. A discussion of potential funding sources, if known, should be included.

6. The request for new or revised access contains information relative to the planning requirements and the status of the environmental processing of the proposal.

As part of ODOT's Project Development Process, the Office of Roadway Engineering is required to review all Feasibility Studies and Alternative Evaluation Reports involving an Interchange Study (IJS/IMS/IOS). If the FS and/or AER involves an interchange, the study limits must encompass the applicable interchange study (IJS/IMS/IOS) limits.

The Office of Roadway Engineering will not review any Interchange Study (IJS/IMS/IOS) that:

1. Does not have an approved Purpose & Need (if applicable); or
2. Does not have appropriate study limits required to support the approved Purpose & Need; or
3. Has interchanges that ORE did not review and approve in the Feasibility Study and Alternative Evaluation Report (if applicable)

The Access Point Request Document should only be performed for the preferred alternative, however a discussion of feasible alternatives should also be included in the study. The preferred alternative will comply to all State and FHWA design requirements, including but not limited to: interchange spacing, interchanges to provide for all traffic movements to and from the freeway, not allowing lanes to drop into private facilities, not allowing intersections (driveways or streets) to intersect ramps (except in special cases such as facilities for utilities.

Interchange Modification and Justification Studies (IMS & IJS) are required to reference and describe how each 23 CFR 624 ~~policy point in FHWA's Policy on Access to the Interstate System~~ is being met.

All IJS or IMS documents should follow the Report Format/Outline found in the **Traffic Academy Interchange Studies (IJS/IMS/IOS) Course** and the OATS Manual. The Interchange Studies Course ~~Manual~~ can be found on the Office of Roadway Engineering's Interchange Studies page.

A reevaluation of the IJS/IMS may be required by FHWA if the project or a phase of the project has not progressed to construction within 5 years of the approval date of the document.

An IJS/IMS Addendum is required if any of the following condition(s) apply:

1. A Revised-Build condition is proposed that is different than the Build condition (per the approved IJS/IMS) and is not an Interim-Build condition (a phased condition between the No-Build condition and Build condition, per the approved IJS/IMS).

See **Section 550.2.1** if your project does not meet the condition(s) listed above. Contact The Office of Roadway Engineering.

550.2.1 Interchange Operations Study (IOS)

~~Many minor~~ Some interchange projects~~, especially those involving service interchanges,~~ do not fall under the definition of warranting an Access Point Request Document (IJS/IMS) per 23 CFR 624, ~~the FHWA's Policy on Access to the Interstate System,~~ but still require an operational evaluation and approval by the Office of Roadway Engineering. This operational evaluation would be in the form of a report referred to as the Interchange Operations Study, IOS. The IOS is intended to be an abbreviated version of the more comprehensive IMS report, highlighting critical traffic operations that may be affected by the proposed improvement. The IOS will utilize the same analysis methodology and 20-year ~~yr.~~ design as the IMS, but the IOS will be more limited with respect to the number of analysis points evaluated and the study narrative. For an IOS, Certified Traffic is typically not required. Instead, the Low Risk Design Traffic Forecasting Procedure, per the Ohio Traffic Forecasting Manual, is considered acceptable. Certified Traffic is required when thru lanes on the freeway/crossroad are increased or decreased. In urban areas with significant congestion and oversaturated conditions, coordinate with the Office of Modeling & Forecasting to discuss if Certified Traffic is needed to capture the full demand volumes. An IOS can be applied to an Interstate or non- Interstate. All traffic analyses on ODOT projects must be prepared per the OATS Manual. The following is a list of projects, including, but not limited to, that require an IOS:

1. Changing lane configurations at a ramp intersection approach, including:
    - Adding/removing a left, thru, or right turn lane along a crossroad
    - Adding/removing turn lanes to the exit ramp
    - Changing lane assignments without altering the number of lanes
        - Example: Changing a 2-lane approach from a (Left/Thru-Right) to (Left- Thru/Right)
    - Implementing a Road Diet (reducing the number of lanes on the crossroad)
    - ~~"Squaring" up~~ Moving a continuous right turn to/from the ramp/crossroad to an intersection
    - Converting a ~~"squared"~~ right turn at an intersection to/from ramp/crossroad to a slip ramp
2. Changing the exit or entrance ramp terminus point with the freeway mainline by:
    - Adding/removing an optional exit lane
    - Adding/reducing exit lanes
    - Adding/reducing entrance lanes
    - Shifting a ramp's location within the same interchange configuration
3. Changing traffic control type at a ramp/crossroad intersection from a signalized/unsignalized condition to a roundabout (only if altering the number of lanes on the approaches)
4. Adding an auxiliary lane between 2 adjacent ramp interchange ramps

The Office of Roadway Engineering has established the Study Area of an IOS for various conditions. This information can be found in the **Traffic Academy, Interchange Studies Course.** ~~**Manual**.~~ Note, that although most projects follow these study limits, the limits can be expanded or reduced with the approval of the Office of Roadway Engineering.

For mainline capacity additions on a freeway facility or interchange intersection improvements that do not warrant an IOS/IMS/IJS, a 20-year design year traffic analysis is still required to be performed to ensure good engineering design. For such cases, traffic analysis may be documented as part of a Feasibility Study or an AER.

For all other interchange or mainline modifications that result in significant operational changes, not covered above or by an Interchange Modification Study, please contact the Office of Roadway Engineering.

An IOS may be required if an interim (phased) condition does not match the approved build condition in the IJS/IMS. Contact the Office of Roadway Engineering for further guidance.

A reevaluation of the IOS may be required by ODOT if the project or a phase of the project has not progressed to construction within 5 ~~3~~ years of the approval date of the document.

602.6.1 Transverse Drainage

The design of the roadside at transverse conduits typically involves extending the existing conduit and providing clear zone grading or shielding the conduit ends with barrier. A large conduit terminating at the clear zone boundary may still pose a risk to run-off-the-road vehicles. Therefore, when extending the conduit, especially ones with a larger rise, it is preferable to maximize the length of the conduit within the available right-of-way versus terminating the end at the clear zone line. When extending the conduit, it is imperative to remove or relocate all existing fixed objects (typically trees, utility poles) within the clear zone area to maximize the likelihood of a safe recovery for errant vehicles. There are many cases where extension of the conduit will be more costly than installing guardrail due to limited right-of-way or other site-specific limitations. There are some situations where extension may be preferred if the guardrail installation would not meet standards, such as the length of need would not be met, the barrier offset from the edge of traveled way would be deficient, the installation of a MASH end terminal is infeasible, etc. Overall, since each site poses different constraints that must be considered, engineering judgement and a cost and safety analysis should guide the decision on selecting the appropriate treatment. But in general, the preferred roadside treatment of transverse drainage is as follows:

For conduits with a rise or span greater than 60 inches:

Shield the ends of the exposed pipe per **Section 602.5.1**.

For conduits with a rise or span greater than 36 inches and less than or equal to 60 inches:

1. Extend the exposed pipe ends outside the clear zone when practical. See **Section 307.2.2** for additional information and see **Sample Calculations 600-4**.
2. When the above option is impractical, shield the ends of the exposed pipe per **Section 602.5.1**.

For individual pipes with diameters or spans less than or equal to 36 inches or multiple pipes each with a diameter less than or equal to 30 inches located in areas where clear zone or safety grading is not provided:

Provide standard half-height headwalls (SCD HW 2.1 or HW 2.2) at exposed pipe ends.

For individual pipes with diameters or spans less than or equal to 36 inches or multiple pipes each with a diameter less than or equal to 30 inches located in areas where clear zone or safety grading is provided:

Extend the exposed pipe ends outside the clear zone when practical and provide standard half- height headwalls.

When the above option is impractical, use slope tapered pipe end treatments.

603.1.2 Semi Rigid Barriers

ODOT's approved semi rigid barriers include: Type 5 and Type MGS guardrail – both strong post w-beam guardrail systems. Other proprietary guardrail systems are not considered equivalent and are not acceptable for use on ODOT jobs.

- Type MGS guardrail is a MASH TL-3 crashworthy system at a 31 inch installation height (+/-1 in.) New guardrail designs should utilize MGS.
- Type 5 guardrail is an NCHRP 350 TL-3 crashworthy system at a 29 inch installation height (+/-1 in.). Still acceptable on the State System, this system should be limited to repair locations of existing rail. **Refer to Plan Insert Sheets (GR series)** and **the July 2012 Version of this Manual** for Type 5 guardrail design standards**.**

The three major components of a strong post barrier are the rail, posts, and blockouts. This ribbon of rail acts to capture impacting vehicles and to dissipate energy up and down the rail length. The tension on the rail from an impact can be transferred a considerable distance. Proper anchoring of the rail at both ends is critical in achieving proper performance.

Guardrail posts are designed to support the rail at the appropriate height and provide lateral support during an impact. For most impacts, the posts are designed to rotate through the soil, rather than bend at or near the ground surface. This rotation helps to contribute considerably to the energy absorbed in the collision and helps to prevent contact between the vehicle and the posts. For this reason, paving around posts is not advisable if the thickness or mass of the pavement would prevent this rotation from occurring. Two ~~Three~~ inches of asphalt pavement is the maximum allowable thickness for paving under guardrail. Eight inches is the maximum distance that the asphalt can extend beyond the pack of post. See **Sample Plan Note R116** and **SCD MGS-2.1** for additional information. Guardrail posts should never be directly embedded in concrete. But grout leave outs can be provided per **SCD MGS-2.1** when posts must be installed in a section of concrete or asphalt that extends greater than 8" behind the back of post.

When guardrail is being installed in rocky terrain locations, refer to the details in **SCD MGS-2.1** for special installation guidance.

For guardrail installations to perform properly during an impact, adequate soil support must be provided for the posts in the guardrail run. To ensure this support, longer posts should be specified at locations where the distance behind the post to the slope break point is less than one foot. These locations should be specifically identified in the plans. See **SCD MGS-2.1** for additional details and proper post length.

The use of blockouts increase the overall performance of a guardrail system. Blockouts minimize the potential for a vehicle's wheels to snag on the posts and reduce the likelihood of a vehicle vaulting over the barrier. This is accomplished by maintaining the height of the rail as the barrier deflects and rotates downward during an impact. The standard Type MGS Guardrail uses a 6" wide x 12" deep x 14" long blockout. Crash testing has also been successfully completed on MGS with reduced and eliminated blockouts. On 2 lane facilities where the overall typical section width is limited by steep foreslopes, drop-offs, or other site constraints, engineering judgment may be used to consider eliminating the blockout - particularly if this will help improve the overall backfill/embedment of the guardrail posts.

603.1.2.1 Type MGS Guardrail

The Midwest Guardrail System, Type MGS, is Ohio's strong post barrier used for roadside protection where 5 feet of barrier clearance is available. Type MGS guardrail uses w-beam rail with a top rail height of 31 inches to accommodate larger vehicles and the blockouts are 12 inches deep. This guardrail system can be placed on foreslopes as steep as 10:1 and may be flared away from the roadside at a rate of 7:1. Type MGS guardrail has passed MASH TL-3 testing. See **SCD MGS-2.1** for additional details.

Type MGS guardrail may be constructed with steel, rectangular wood, or round wood posts per **MGS-2.1.** For standard runs of MGS, the selection of the post type is at the discretion of the contractor. Wood post MGS runs shall be grounded where a transmission/sub-transmission (>69kv) power line passes over them. Wood post MGS runs shall also be grounded where a parallel transmission/sub-transmission (>69kv) power line ~~easement is~~ runs within 50 feet (measured horizontally) of the guardrail alignment. Designers shall include quantity in the plans for Item 625 - Ground Rod at these locations with the assumption that wood posts may be chosen by the contractor. The ground rod(s) should be non-performed in construction if the contractor elects to install steel posts. For grounding details see **SCD MGS-2.1.** A distribution line crossing does not typically necessitate the guardrail to be grounded unless a nuisance current has been reported, or other site-specific conditions indicate grounding the run may be needed.

603.1.2.4 Barrier Design Guardrail with Rub Rail

Barrier Design Guardrail with Rub Rail can be used in bi-directional median situations, similar to standard Barrier Design Guardrail, but when the 10:1 minimum foreslope on the median side cannot be achieved. This design is a double sided MGS guardrail system with a rub rail on the median/ditch side of the system. The purpose of the rub rail is to reduce the potential for underride and snagging for vehicles that have crossed the median ditch and are traveling up the opposing foreslope. A maximum 6:1 foreslope is allowed on the median/rub rail side of the system. The design in **SCD MGS-2.2** replaces the previously retired "Type 5MR" guardrail. Type 5MR guardrail may continue to be repaired, but new installations shall utilize the Barrier Design Guardrail with Rub Rail design per **SCD MGS-2.2.** See **SCD MGS-2.2** for additional details.

603.1.2.6 MGS Top-Mounted to Culverts

There are two details provided in **SCD MGS-2.1** for mounting posts to the top of reinforced concrete box culverts or other flat-top (reinforced) concrete structures/conduits. Do not use these details to mount posts to unreinforced concrete. Both designs have met MASH TL-3 criteria and are considered equivalent; Detail #1 is compatible with standard post spacing, and Detail #2 is compatible with half post spacing. Do not use either detail in conjunction with quarter post spacing. Both assemblies are designed to have a minimum of 9" of fill at the post. Each detail has different requirements for the minimum offset from the foreslope wall to the back of post, see **SCD MGS-2.1** for more information.

When applying this standard to existing culverts, coordinate with the District Hydraulic Engineer or appropriate conduit inspection staff to ensure the condition of the existing culvert is adequate to permit installation of the mounted post(s).

If the thickness of the conduit is going to require the bolt-through method, ensure that viable access to within the conduit can be maintained following construction to allow for maintenance staff to inspect and replace hardware.

A detail sheet should be provided in the plan that indicates the station, offset, and total height of each mounted post on the culvert/structure. The detail sheet should include the culvert segments or "sticks" to verify that the proposed post installation(s) maintains 4" of clearance between the center of any attachment anchor and any culvert end (abutting segment or free end). A spreadsheet has been developed to aid designers in determining the post height "H": Culvert Mounted Posts - Height Calculator

603.1.2.7 Socketed Weak Post - Side Mounted to Headwall

This design uses socketed S3x5.7 posts spaced at half-post spacing (3'-1 1/2") that are attached to the side of a reinforced concrete headwall. This system can be transitioned to standard MGS guardrail at normal post spacing and is typically used to protect box culverts with limited cover. The socketed weak post system with half-post spacing performs similarly to standard MGS guardrail. The primary benefits of the socketed weak post system are that it has a shorter system width and less intensive post-impact maintenance than the two top mounted systems (**Section 603.1.2.6** and **SCD MGS-2.1**). Additionally, the socketed weak post system can be used when the 9" of soil/fill (required with both top mounted systems) cannot be provided in front of the headwall.

See **SCD MGS-2.4** for more details.

603.1.4.7 ~~81"~~ Type N Single Slope Barrier

Noise walls located inside the clear zone are a fixed object requiring barrier protection. Preliminary testing indicates that an 81" tall single slope concrete barrier adjacent to the shoulder can be an effective noise barrier. An 81" single slope barrier as shown in SCD RM-4.8, may be considered at locations under the following conditions:

- Where a noise wall along the shoulder is already planned to include barrier protection.
- Where the roadway is higher than the surrounding residences making a traditional noise wall outside the clear zone infeasible.
- Where clear zone grading does not exist.

603.3.2 Type B

The Type B anchor assembly is a flared, redirective, gating end terminal. The overall system length of the Type B varies by device: the length from post #1 to the splice point with standard MGS is 36'-5.5" for the MFLEAT and 34'-4.5" for the 4F-T. To be conservative on the overall footprint of the guardrail installation, the designer should assume a device length of 36'-5.5". The device's length of need for the Type B begins at post #4; therefore, the length from post #4 to the splice point with standard MGS ~~post #9~~ can be applied toward the overall calculated length of need for the guardrail run ~~(22'-11")~~. This length slightly varies depending on which approved device is installed: the distance is 19'-9.5" for the MFLEAT and 21'-10.5" for the 4F-T. Since the designer cannot predict which device the contractor elects to install, it should be assumed that 19'-9.5" (measured from the final MGS splice) of the Type B device can be applied toward the overall calculated length of need. Additionally, the offset from the face of the downstream rail to the face of rail at post #1 varies system to system. The MFLEAT is installed at a tangent flare with an offset of three feet, and the 4F-T is installed at a tangent flare with an offset of four feet.

The Type B may be used as an approach end treatment for guardrail on any roadway. The Type B cannot be used when the back side of the device is in the clear zone of bidirectional traffic. The Type B products require a recovery area immediately behind the terminal detailed on **SCD MGS-5.2**. Designers should check that this grading is present on existing cross-slopes or otherwise revise the cross-slopes to conform. Where feasible regrade the roadside area to permit installation of a Type B versus installing a tangential (Type E) terminal, assuming the regrading does not trigger right-of-way acquisition on a project that is otherwise wholly contained in the existing right-of-way. **Table 603-1** provides guidance on where to use this anchor assembly. See **Roadway Sample Plan Note R112a** in Appendix B for additional information. All products listed in this section are gating as described in **Section 602.1.4**. These end treatments should connect to Type MGS guardrail, but it is acceptable to connect to Standard Bridge Terminal Assemblies.

The pay length and additional details for the Type B anchor assembly can be found under the Roadway Approved Products List on the Office of Roadway Engineering website.

An earlier version of the Type B known as the ELT or MELT depicted on Standard Drawings until 1994 is still found throughout the state highway system. This generic flared end terminal should be systematically replaced with approved Type B terminals meeting MASH criteria.

604.3 Glare Screen Options

Glare screening may be accomplished in a number of ways. These include, but are not limited to, the following options (shown in order of preference):

1. Use a taller standard barrier. For example use Type B1 in lieu of Type B concrete barrier.
2. On a NJ shape barrier, install a concrete cap to extend the height of existing 32 inch concrete barrier where barrier thickness is adequate.
3. Attach a paddle or intermittent type of glare screen to the top of a 42 inch Single Slope or 32 inch tall NJ shape concrete barrier, or on top of steel beam guardrail. These devices shall be designed using a 20-degree cut-off angle measured relative to the centerline of the barrier. They shall be securely fastened to the barrier using the hardware and procedures specified by the manufacturer. ~~Contact the **Office of Materials Management**~~ Refer to the Roadway Approved Products List for a list of approved products.

Options 1-3 may only be used in locations where barrier is required.

606.3.3 Freeway Fence Design Conditions

1. Where chain link fence is located within the design clear zone, such as along the edge of a roadway shoulder, in a median, or between a frontage road and the mainline, a fence with tension wire, Type CLT, shall be used.
2. Type 47RA fence shall be used to fence rest areas where the highway fence is Type 47. It may also be used in other locations where the aesthetics of the area make this type more desirable.
3. Fence installed across a stream or ditch shall be designed using fence terminals or crossings as shown in SCD F-3.3 and F-3.4, respectively.
4. Where a drainage channel is located parallel to the freeway in a channel easement, the fence shall be located on a bench between the main facility and the channel. Maintenance openings shall be provided at 700 feet maximum intervals where the length of fence between a deep channel and the freeway exceeds 1800 feet, unless access can be provided by another means.
5. Fence shall be provided in the median to connect the abutments of all twin bridges on divided highways.
6. All types of fence shall be grounded where a transmission/sub-transmission (>69kv) power line passes over them. Fence shall also be grounded where a parallel transmission/sub-transmission (>69kv) power line ~~easement is~~ runs within 50 feet (measured horizontally) of the fence alignment. For grounding details see **SCD F-3.5.** A distribution line crossing does not typically necessitate the fence to be grounded unless a nuisance current has been reported, or other site-specific conditions indicate grounding the run may be needed.
7. In the vicinity of some airports, fencing should be non-metallic since it sometimes interferes with airport traffic control radar. The **Federal Aviation Administration** should be contacted to ascertain if metallic fencing will be a problem.
8. Fence should normally be continued behind a noise wall. Sufficient distance should be provided between the fence and the noise wall to permit normal maintenance operations. If there is no critical maintenance responsibility between the noise wall and the right-of-way or limited access line (generally in "cut" sections) the fence may be terminated at each end of the noise wall.

TYPICAL PERMANENT BARRIER USES & WORKING WIDTHS

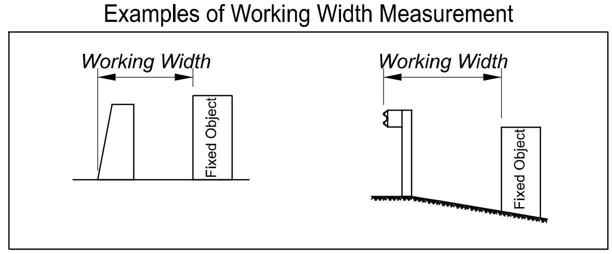
603-2

REFERENCE SECTIONS
603.1

	Barrier Type		Standard Drawing	Working Width (see Note 1)	Typical Use & Additional Notes
Steel Beam Guardrail	Type MGS (see Note 3)	Design Speed ≤30mph	MGS-2.1	3'-2"	Roadside protection. 6'-3" Standard Post Spacing (MASH TL-1)
		Design Speed: >30mph and ≤40mph	MGS-2.1	4'-2"	Roadside protection. 6'-3" Standard Post Spacing (MASH TL-2)
		Design Speed >40mph	MGS-2.1	5'	Roadside protection. 6'-3" Standard Post Spacing (MASH TL-3)
	MGS with Half Post Spacing		MGS-2.1	3'-6"	3'-1 ½" Half Post Spacing
	MGS with Quarter Post Spacing		MGS-2.1	3'	1'-6 ¾" Quarter Post Spacing
	MGS Installed in Asphalt		MGS-2.1 (Sheet P.5)	5'	Roadside protection installed directly into 2" of asphalt pavement
	MGS Installed in Vegetation Control Strip (with grout leave outs)		MGS-2.1 (Sheet P.5)		Roadside protection with an asphalt or concrete vegetation control strip, and posts embedded in grout leave outs
	MGS Embedded in Rock		MGS-2.1 (Sheet P.5)	7'	Roadside protection in rocky terrain
	MGS Top Mounted Culvert Detail #1		MGS-2.1 (Sheet P.6)	4'-3"	Roadside protection along box culverts with shallow cover
	MGS Top Mounted Culvert Detail #2		MGS-2.1 (Sheet P.6)		
	MGS Barrier Design (Double-Sided MGS)		MGS 2.1 MGS-6.1 MGS-6.2	5'	Narrow medians where deflections can be tolerated.
	MGS Barrier Design with Rub Rail		MGS-2.2	4'-6"	Narrow medians with steeper than 10:1 slopes on the median/rub rail side
	MGS Long-Span		MGS-2.3	8'*	*When the headwall is flush to grade, the back of the post can be aligned with the near side of the headwall. But if the headwall protrudes above grade, the system should be offset 8' from the fixed object. Used primarily to span culverts that have limited depths of cover.
	Socketed Weak Post Mounting		MGS-2.4	5'	Used primarily on precast structures that have limited depths of cover
Permanent Concrete Barrier (see Note 2)	Type B		RM-4.3	Width of Barrier (28")	Narrow medians
	Type B1		RM-4.3	Width of Barrier (33 3/4")	Narrow medians where additional height is required.
	Type C		RM-4.3	Width of Barrier (Varies 28" to 32 3/8")	Narrow medians where the difference in shoulder elevation is 24 inches or less.
	Type C1		RM-4.3	Width of Barrier (Varies 33 ¾" to 38 1/4")	
	Type D		RM-4.5	Width of Barrier (28")	Roadside protection adjacent to fixed obstacles. Area where impact angles over 15 degrees are unlikely or where maintenance may be difficult/dangerous.
	Type E		RM-4.9	Width of Barrier (14.5")	Where grading requirements behind a Type D wall cannot be met.
	Type N		RM-4.8	Width of Barrier (3.57')	In lieu of a noise wall with Type D barrier placed in front; typically when the roadway elevation is higher than the surrounding residences making a traditional noise wall outside the clear zone infeasible.

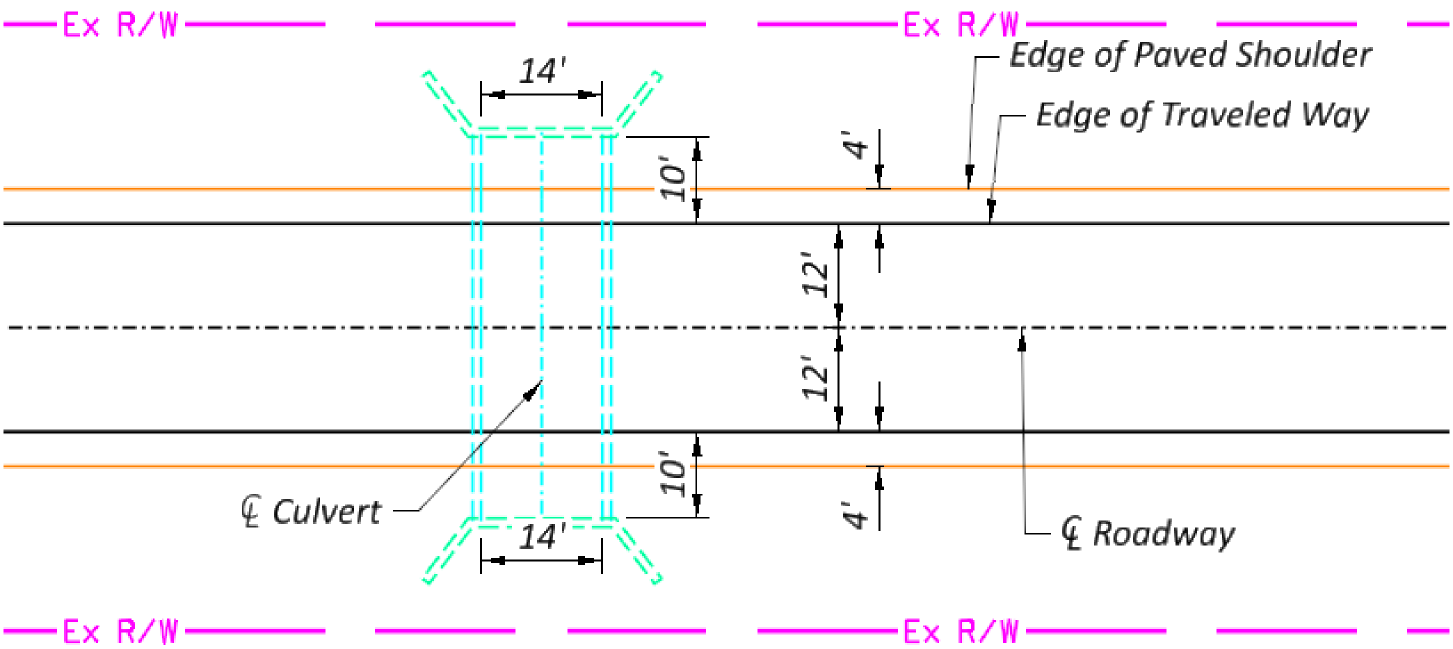
NOTES:
1) Working Width - The distance between the traffic face of the barrier before impact and the maximum lateral position of any major part of the system or vehicle after impact. See examples below on how to measure available working width.
2) See Figure 603-6 for minimum design offset values of ODOT (Generic) Portable Concrete Barrier.
3) MASH TL-3 is required on all ODOT maintained routes & locally maintained NHS routes. MASH TL-3 is preferred elsewhere, but in urban low-speed situations TL-2 or TL-1 may be appropriate when the 5' of working width (TL-3) is not achievable due to various constraints.

Examples of Working Width Measurement



SAMPLE CALCULATIONS	
Ex. 602-2	Length of Need at a Large Culvert

Problem 2: Design barrier if needed to shield the existing culvert headwalls and drop off located on the two-lane rural collector shown below. This project has a design speed of 55 mph, 4:1 foreslopes, and a design year traffic volume of 4,500 ADT.



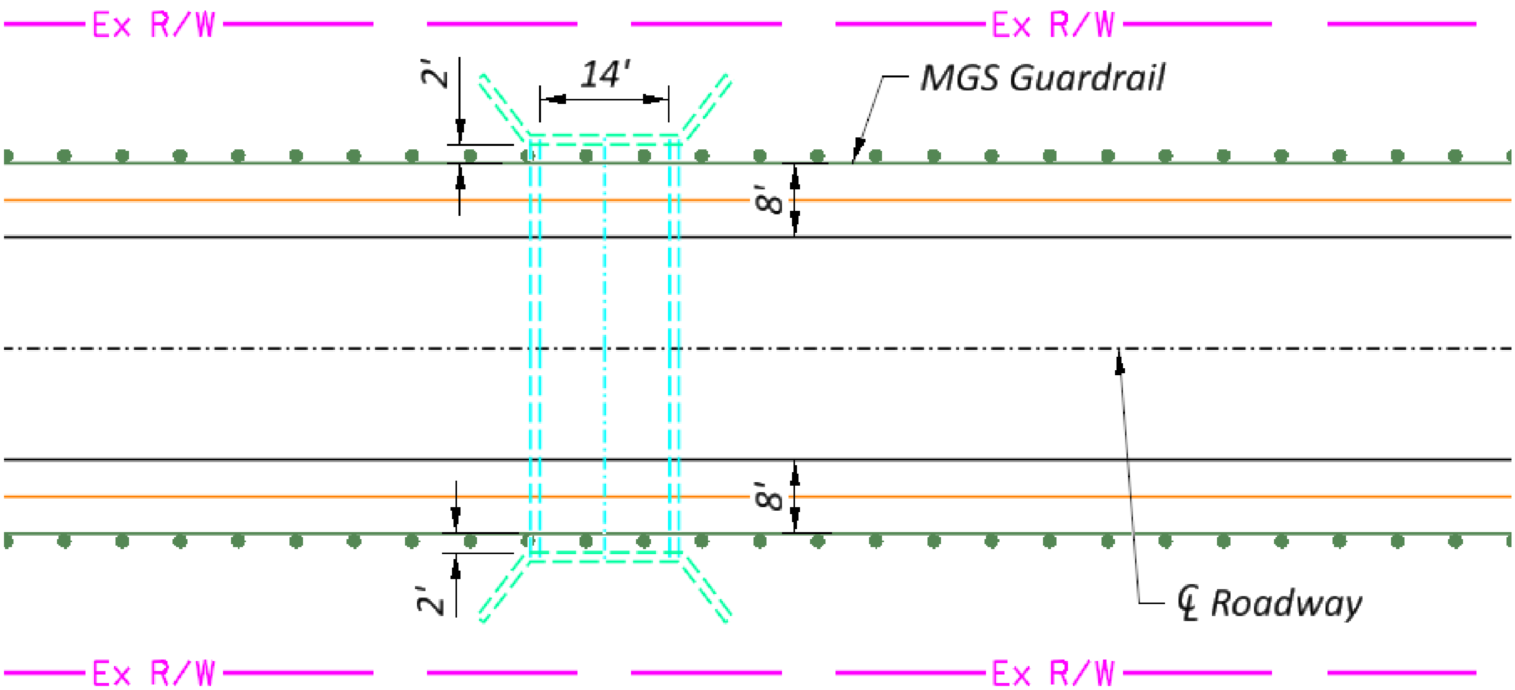
Solution 2: **Step 1** – Determine whether the headwall is in the clear zone for adjacent traffic. Refer to **Figure 600-1** (for foreslopes steeper than 6:1, 55 mph design speed, and 1,510 ≤ ADT ≤ 6,000) to determine that the required clear zone distance is 27 feet measured from the edge of traveled way.

For this situation, it is impractical to extend the culvert outside of the clear zone as it would substantially increase project costs and require the acquisition of right-of-way, which is outside of the scope of the project.

SAMPLE CALCULATIONS	
Ex. 602-2	Length of Need at a Large Culvert

(continued)

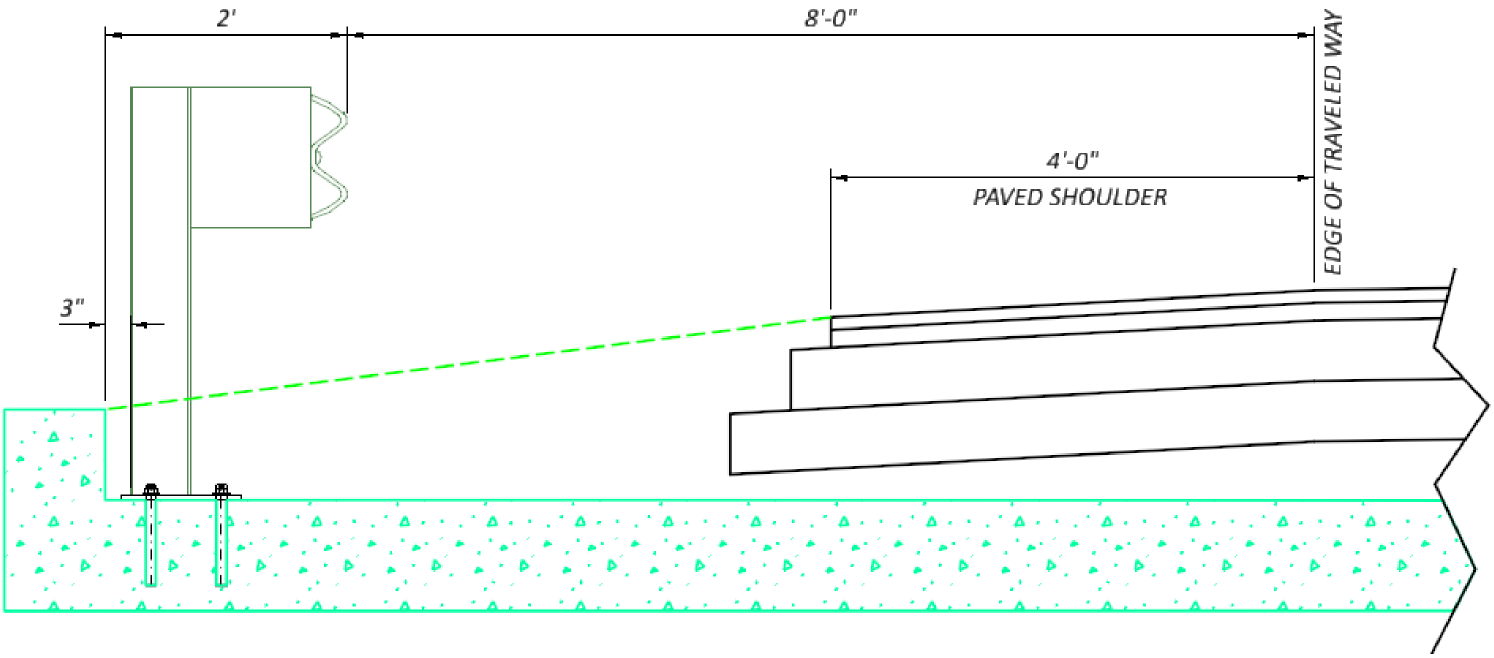
Step 2 – Select the type of barrier to be installed. Using **Figure 301-3**, the normal barrier offset for a rural collector (Design Year ADT greater than 2,000) is 8' from the edge of traveled way. The available working width at this location for MGS guardrail installed at an 8' offset from edge of traveled way to face of guardrail would be 2' measured from the face of guardrail to the culvert headwall.



Refer to **Figure 603-2** for working widths of permanent barrier systems to determine that standard MGS requires 5' of working width, which is not available in the situation. Furthermore, due to the span of the culvert (14') the use of standard MGS would be precluded as the required post spacing is 6.25', which would result in multiple posts conflicting with the existing culvert. Another option to evaluate is the use of the top mounted culvert details from **SCD MGS-2.1**.

SAMPLE CALCULATIONS	
Ex. 602-2	**Length of Need at a Large Culvert**

(continued)



The top mounted culvert details from **SCD MGS-2.1** require either 12" of clearance from the back of post to near face of the headwall wall for half-post spacing or 18" for standard post spacing. When offsetting the barrier 8' from the edge of traveled way, the offset to the face of the headwall is 3" and therefore mounting a post on top of the culvert is not a viable for this situation.

The other remaining options to evaluate are the use of MGS Long-Span per **SCD MGS-2.3** or Socketed Weak Posts attached to the Headwall per **SCD MGS-2.4**. The previous site visit to the location revealed that the headwalls are not in a suitable condition to have hardware directly attached to them. Therefore, MGS Long-Span will be evaluated, and the requirements for this system are 8:1 grading for 2' behind the posts, 3 breakaway CRT posts on both sides of the span, 62.5' of standard MGS adjacent to CRT posts #1 and #6, and the back of post can be aligned with the near side of the headwall if the top of the headwall is flush to grade.

The first step of evaluating the MGS Long-Span is determining the required span length, which can be in 6.25' increments with a maximum of 25'. Additionally, the adjacent CRT posts (#3 and #4) must maintain an 8" offset to the edge of the box culvert.

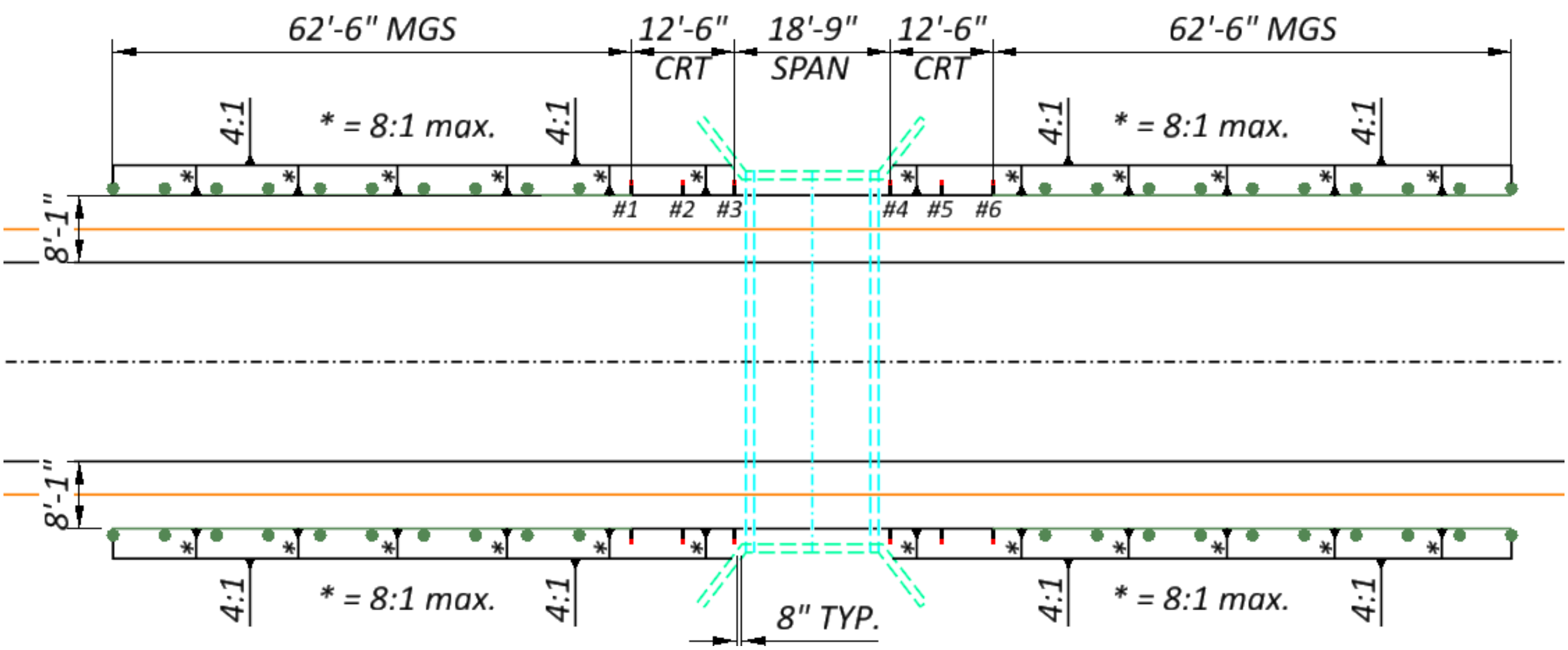
SAMPLE CALCULATIONS

Ex. 602-2 | **Length of Need at a Large Culvert**

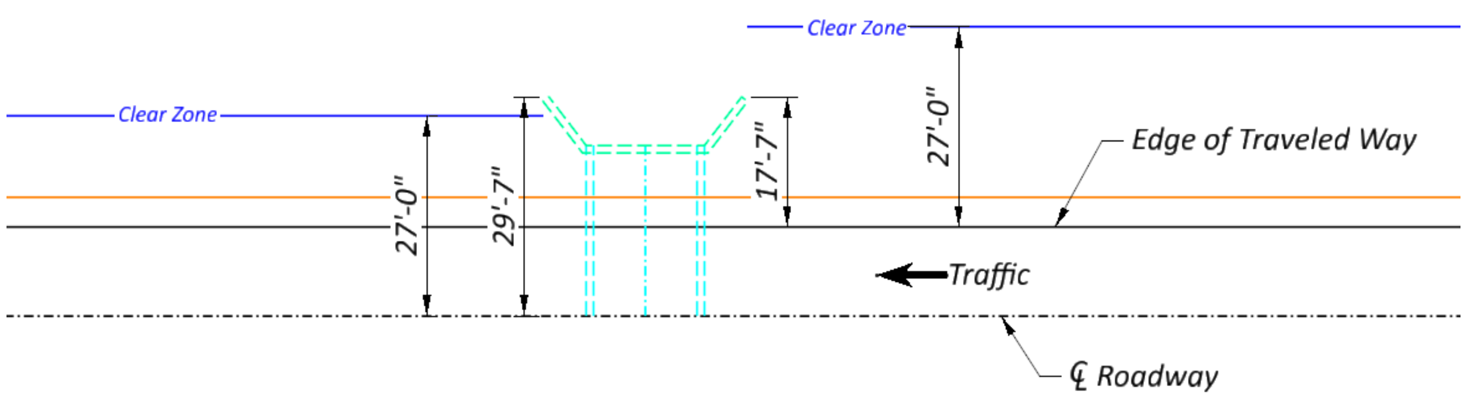
(continued)

14’ span of culvert + 2*(1’ wall thickness) + 2*(8” offset from outer wall) + 2*(3” to center line of CRT post) = 17.83’

An 18’-9” span will be sufficient for this situation.



Step 3 – Check the length of need on both the approach and trailing ends.



SAMPLE CALCULATIONS	
Ex. 602-2	**Length of Need at a Large Culvert**

(continued)

The hazard (outer limit of wingwall) on the approaching end is 17.58' from the edge of traveled way, which is within the limits of the 27' clear zone, therefore $L_H < L_C$. Refer to **Figure 602-1** (design speed of 60 mph, 1,000-5,000 veh/day) to determine the required runout length of 210'.

$$L_H < L_C : X = \frac{L_H + (b/a) * L_1 - L_2}{(b/a) + L_H/L_R}$$

$$X = \frac{17.58 + (0/0) * 0 - 8}{(0/0) + 17.58/210} = 114.44'$$

The hazard (outer limit of wingwall) on the trailing end is 29.58' from the edge of traveled way (center line of roadway), which is outside of the limits of the 27' clear zone, therefore $L_H > L_C$.

$$L_H > L_C : X = \frac{L_C + (b/a) * L_1 - L_2}{(b/a) + L_C/L_R}$$

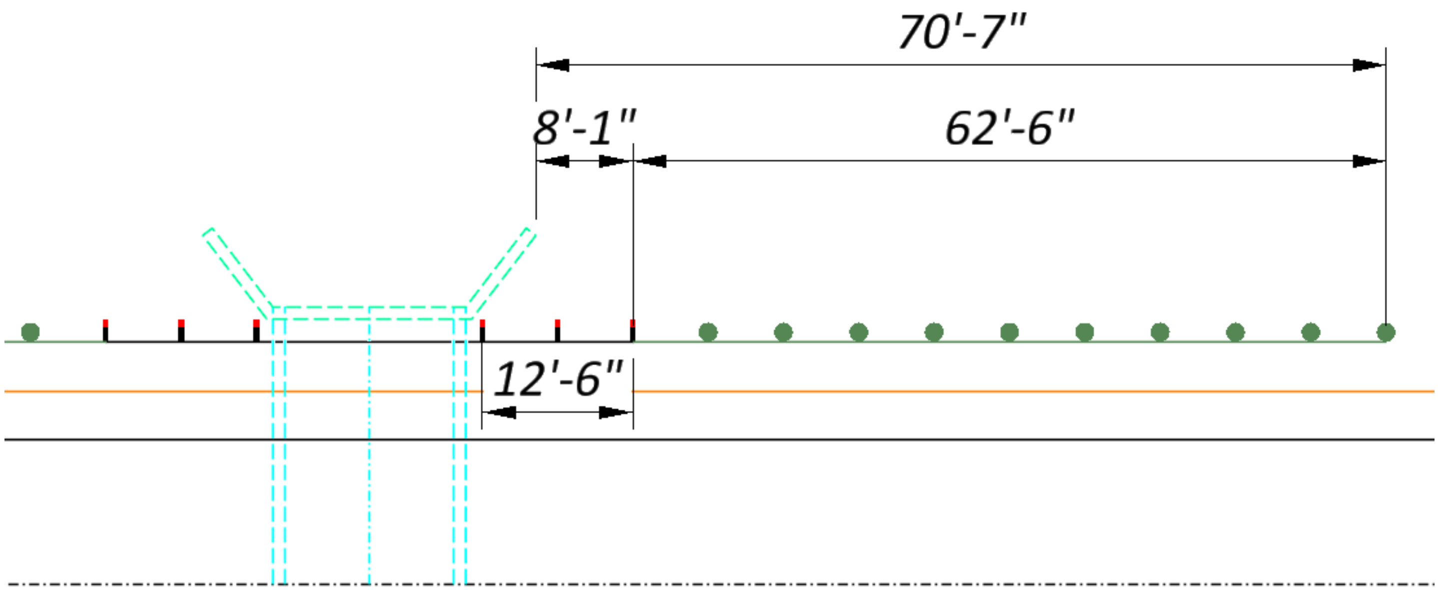
$$L_2 = 12'(lane) + 8'(offset) = 20'$$

$$X = \frac{27 + (0/0) * 0 - 20}{(0/0) + 27/210} = 54.44'$$

To determine the additional guardrail required for the approach end, subtract the length of guardrail that is required per **SCD MGS-2.3** from the calculated total.

SAMPLE CALCULATIONS	
Ex. 602-2	Length of Need at a Large Culvert

(continued)



$$Remaining\ LON = 114.44' - 70.58' = 43.86'$$

43.86’ of additional barrier length will be required on the approach end. Since 70.58’ of barrier protection exists on either side of the hazard being protected, the 54.44’ required Length of Need on the trailing end is inherently met with the requirements of **SCD MGS-2.3**.

SAMPLE CALCULATIONS	
Ex. 602-2	Length of Need at a Large Culvert

(continued)

<u>**Step 4**</u> - The final step is to select the appropriate end anchors to terminate both runs of guardrail.

It is assumed that a Type E or B anchor assembly may be feasible for this situation, therefore a Type A anchor assembly is not permitted. Since the foreslopes are 4:1, use a Type E end anchor assembly. Per **L&D1 603.3.3** 37.5' of the Type E can be applied toward the length of need. Additionally, note that per **SCD MGS-2.3** 37.5' of the Type E anchor assembly may contribute to the 62.5' MGS requirement, therefore the 62.5' length may be reduced on the trailing end:

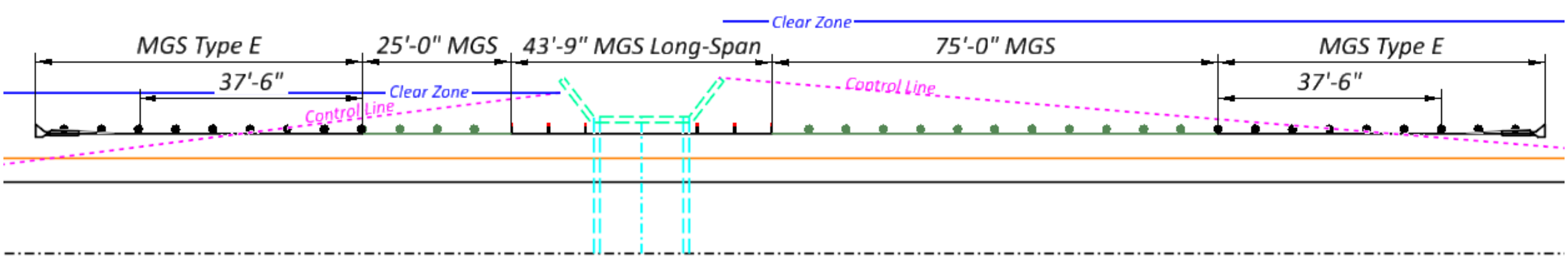
Re-calculate the length required beyond the 62.5' of MGS for the approach end when accounting for the Type E:

$$43.86' - 37.5' = 6.36' (round\ up\ to\ 1\ panel = 12.5')$$

Re-calculate the length of MGS required for the trailing end when accounting for the Type E:

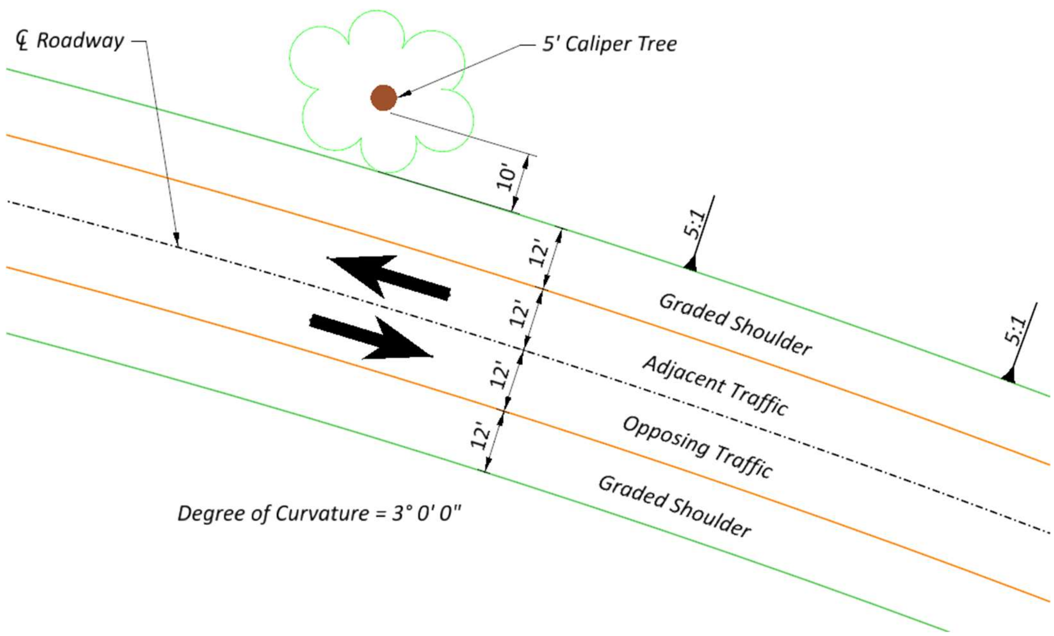
$$54.44' - 8.08' (length\ of\ CRT\ posts) = 46.36'$$

Since 46.36' of protection is required, we can reduce the 62.5' of MGS to 25' and count the first 37.5' of the Type E towards the 62.5' requirement and the length of need requirement as 62.5' > 46.36'.



SAMPLE CALCULATIONS	
Ex. 602-4	**Barrier on the Outside of a Curve**

Problem 4: Calculate the barrier length of need to shield the 200-yr old 5-ft. diameter tree located on the outside of a 3-degree curve as shown below. The HSP project is on a rural arterial and has a design speed of 55 mph, a design year traffic volume of 3,800 ADT, and a 5:1 foreslope. Assume that the HSP project is needed to address run-off-the-road impacts with the tree and assume that the tree cannot be removed.



Solution 4: **Step 1** – Determine whether the tree is in the clear zone for adjacent traffic. From **Figure 600-1** (for foreslopes steeper than 6:1 up to 4:1, 55 mph design speed, and 1,501 ≤ ADT ≤ 6,000) the required clear zone distance is 27 feet measured from the edge of traveled way. Since the tree is on the outside of a 3-degree curve, the clear zone should be widened by using the curve correction factor for 55 mph design speed (1.2) from the chart at the bottom of **Figure 600-1**.

Required Clear Zone = 1.2(27’) = 33.4 ft.

Do not reduce this value to 30 ft. since this is a high accident location.

The offset to the face of the tree is 12’ + 10’ = 22 ft.
This is less than L_C = 33.4 ft.; therefore, install barrier.

SAMPLE CALCULATIONS	
Ex. 602-4	**Barrier on the Outside of a Curve**

(continued)

Step 2 – Select the type of barrier to be installed. Using **Figure 301-3**, the normal (minimum) barrier offset for a rural arterial (Design year ADT greater than 2,000) is 10 feet from the right edge of traveled way. The available barrier clearance at this location is 12 feet; therefore, use MGS Guardrail, which has a minimum barrier clearance of 5 feet (See **Figure 603-2**).

Step 3 – Calculate the length of need for adjacent traffic. The radius for the 3-degree curve is $R_{centerline} = 5729.58/D_C = 5729.58/3.0 = 1909.86'$

The radius at the edge of traveled way is 1909.86' + 12' = 1921.86'.

The lateral offset to the back of the tree is $L_H = 22' + 5' = 27'$.

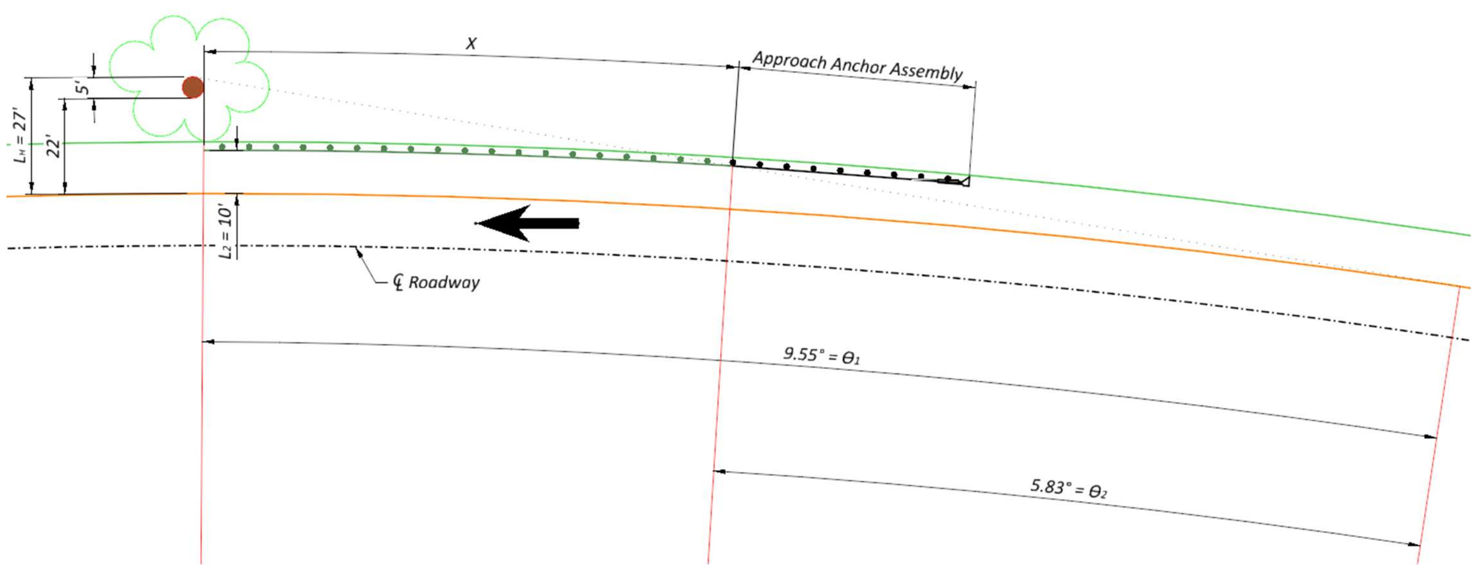
$\theta_1 = \cos^{-1} (R_{adj} / (R_{adj} + L_H)) = \cos^{-1} (1921.86 / (1921.86 + 27)) = 9.5484^0$

$9.5484^0(\pi/180) = 0.1666$ radians

$\theta_2 = \cos^{-1} (R_{adj} / (R_{adj} + L_2)) = \cos^{-1} (1921.86 / (1921.86 + 10)) = 5.8323^0$

$5.8323^0(\pi/180) = 0.1018$ radians

$X = (R_{adj} + L_2)(\theta_1 + \theta_2) = (1921.86 + 10)(0.1666 + 0.1018) = 125.18'$



SAMPLE CALCULATIONS	
Ex. 602-4	**Barrier on the Outside of a Curve**

(continued)

Step 4 – Determine whether the tree is within the clear zone for opposing traffic. The offset to the face of the tree is 12' + 12' + 10' = 34'. Since this is outside the clear zone, guardrail is not needed last the left side of the tree to shield it from opposing traffic. At the trailing end install a Type T Anchor Assembly because it is outside the clear zone for opposing traffic; per **Section 603.3.5,** the end post of the Type T must be located 25' downstream of the hazard being shielded. Assuming a post will be placed on the far side of the hazard, add 12.5' to the total (3.125' from post to splice + 12.5' + 9.375' from splice to end post of Type T = 25')

The total length of guardrail needed is 125.18' + 5' (hazard length) + 12.5' = 142.68' → Use 12 panels (150')

Refer to **Table 603-1** in **Section 603.3.3** to determine the recommended approach anchor assembly for a project with foreslopes steeper than 6:1 up to 4:1. On the approach end install a Type E Anchor Assembly. Since 37'-6" of the 50' long Type E can be deducted from the guardrail length of need, decrease the amount of rail specified above at the approach end by this amount. (Use 112.5').

Notes – If a point of curvature exists in the vicinity of the runout path, the curve may need to be extended past the PC or OT (into the tangent portion of the roadway) to construct the tangent control line. If this is the case, then the standard runout lengths for tangent roadways should be used to calculate length of need.

1002.2 HSM for Evaluation

HSM is an analytical tool, which in some cases, can be used to compare the expected crashes between different alternatives. HSM, like other analytical tools, should not normally be the sole basis of making decisions. It can, however, be a factor providing a quantified comparison of potential safety performance in terms of expected crashes.

When appropriate and when the situation does not exceed the capabilities of the software (ECAT) or research data set, HSM can be used to compare expected crashes between alternatives. Safety should always be an important consideration, however, that does not mean an HSM analysis cannot predict an increase in crashes on any proposed alternatives. The question becomes what is the magnitude of the predicted crash increases and what are the associated severities.

For example, it may be perfectly appropriate for a PBPD alternative to accept a modest increase in property damage (PDO) crashes if the offsetting benefits afforded by the alternative are commensurately high.

Below is an example HSM analysis for a pilot PBPD project where:

- KA = Fatalities and Incapacitating Injuries;
- B = Visible Injuries;
- C = Non-Visible Injuries;
- O = Property Damage

Project Summary Results (Without Animal Crashes)						*Crashes Per mile
	KA	B	C	O	Total	
Npredicted - Existing Conditions	0.6030	2.1520	2.3725	10.6309	15.7585	
Npredicted - Proposed Conditions	0.7413	2.5861	2.8332	12.9360	19.0967	
				Difference	3.3382	21.2%

Project Summary Results (Without Animal Crashes)						*Crashes Per mile
	KA	B	C	O	Total	
Npredicted - Existing Conditions	0.6030	2.1520	2.3725	10.6309	15.7585	
Npredicted - Proposed Conditions	0.4445	2.3177	2.5450	12.7505	18.0577	
				Difference	2.2993	14.6%

Countermeasures installed:			
	Rumble Stripes	Source:	HSM Supplement
	Wider Pavement Marki	Source:	http://library.modot.mo.gov/RDT/reports/Ri06043/cm12002.pdf
	Lanes Narrow signage	Source:	None. Assumed small crash reduction

It should be noted that an increase to the expected crashes predicted by HSM may be potentially mitigated with the application of appropriate safety countermeasures. These countermeasures should be factored into the HSM analysis. In the above “Project Summary Results”, the difference between the upper and lower comparisons is the lower has incorporated Safety Countermeasures to reduce the number of predicted crashes.

Refer to the Safety Analysis Guidelines maintained by the Office of Transportation and Economic Development ~~Program Management~~ for detailed analysis requirements.

R112a – ITEM 606 – ANCHOR ASSEMBLY, MGS TYPE B

THIS ITEM SHALL CONSIST OF FURNISHING AND INSTALLING ANY OF THE MASH 2016 TYPE B FLARED END TREATMENTS FOR TYPE MGS GUARDRAIL AS LISTED UNDER "PRODUCTS ACCEPTED FOR NEW INSTALLATIONS" ON THE ROADWAY APPROVED PRODUCTS LIST POSTED ON ROADWAY ENGINEERING'S WEB PAGE. INSTALLATION SHALL BE AT THE LOCATIONS SPECIFIED IN THE PLANS, IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS. REFER TO THE POSTED SHOP DRAWINGS FOR THE MOST CURRENT APPROVED PRODUCT MODELS.

REFER TO THE MANUFACTURER'S INSTRUCTIONS REGARDING THE INSTALLATION OF, AND THE GRADING AROUND, THE FOUNDATION TUBES AND GROUND STRUT. THE TOP OF ANY FOUNDATION TUBE SHOULD BE LESS THAN 4 INCHES ABOVE THE GROUND. ON-SITE GRADING IS REQUIRED IF THE TOP OF THE FOUNDATION TUBES OR TOP OF THE GROUND STRUT DOES PROJECT MORE THAN 4 INCHES ABOVE THE GROUND LINE.THE PLACEMENT OF THE FOUNDATION TUBES SHOULD BE AN APPROPRIATE DEPTH BELOW THE LEVEL LINE IN ORDER TO MAINTAIN THE FINISHED GUARDRAIL HEIGHT OF 31 INCHES FROM THE EDGE OF THE SHOULDER.

THE FACE OF THE TYPE B IMPACT HEAD SHALL BE COVERED WITH SOLID FLUORESCENT YELLOW REBOUNDABLE RETROREFLECTIVE SHEETING, PER CMS 730.191.

PAYMENT FOR THE ABOVE WORK SHALL BE MADE AT THE UNIT PRICE BID FOR ITEM 606, ANCHOR ASSEMBLY, MGS TYPE B, EACH, AND SHALL INCLUDE ALL LABOR, TOOLS, EQUIPMENT AND MATERIALS NECESSARY TO CONSTRUCT A COMPLETE AND FUNCTIONAL ANCHOR ASSEMBLY SYSTEM, INCLUDING REFLECTIVE SHEETING AND ALL RELATED HARDWARE, GRADING, EMBANKMENT AND EXCAVATION NOT SEPARATELY SPECIFIED, AS REQUIRED BY THE MANUFACTURER.

Designer Notes:

1. The system length varies with each device but should be assumed to be 36'-5.5". System length is measured from the splice with MGS to post #1 of the Type B.
2. The device's length of need (LON) point is at post number 4; therefore, after calculating the required LON for the guardrail, deduct ~~the last~~ 19'-9.5" ~~22'-11" of the unit (from post #4 to post #9)~~ from the calculated length of need for the guardrail. The designer must show the calculated LON point on all guardrail runs in the plans.
3. Pre-approved shop drawings are reviewed and are on the Office of Roadway Engineering's web page under the Roadway Approved Products List.
4. These end treatments are gating systems.

5. The standard offset for the face of rail at post #1 for the Type B varies from ~~is~~ 3’-0” to 4'-0" depending on the device.

6. Use this plan note in conjunction with Type MGS Guardrail.

7. If the intent is to supply a non-MASH 2016 device per one of the exceptions allowed under Section 601.3, then paragraph 1 of the note shall be modified accordingly.

R113a – ITEM 606 – ANCHOR ASSEMBLY, MGS TYPE E

THIS ITEM SHALL CONSIST OF FURNISHING AND INSTALLING ANY OF THE MASH 2016 TYPE E TANGENTIAL END TREATMENTS FOR TYPE MGS GUARDRAIL AS LISTED UNDER "PRODUCTS ACCEPTED FOR NEW INSTALLATIONS" ON THE ROADWAY APPROVED PRODUCTS LIST POSTED ON ROADWAY ENGINEERING'S WEB PAGE. INSTALLATION SHALL BE AT THE LOCATIONS SPECIFIED IN THE PLANS, IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS. REFER TO THE POSTED SHOP DRAWINGS FOR THE MOST CURRENT APPROVED PRODUCT MODELS.

REFER TO THE MANUFACTURER'S INSTRUCTIONS REGARDING THE INSTALLATION OF, AND THE GRADING AROUND THE FOUNDATION TUBES AND GROUND STRUT. THE TOP OF ANY FOUNDATION TUBE SHOULD BE LESS THAN 4 INCHES ABOVE THE GROUND. ON-SITE GRADING IS REQUIRED IF THE TOP OF THE FOUNDATION TUBES OR TOP OF THE GROUND STRUT DOES PROJECT MORE THAN 4 INCHES ABOVE THE GROUND LINE. THE PLACEMENT OF THE FOUNDATION TUBES SHOULD BE AN APPROPRIATE DEPTH BELOW THE LEVEL LINE IN ORDER TO MAINTAIN THE FINISHED GUARDRAIL HEIGHT OF 31 INCHES FROM THE EDGE OF THE SHOULDER.

THE FACE OF THE TYPE E IMPACT HEAD SHALL BE COVERED WITH SOLID FLUORESCENT YELLOW REBOUNDABLE RETROREFLECTIVE SHEETING, PER CMS 730.191.

WHEN THE FACE OF THE ADJACENT (ATTACHED) GUARDRAIL IS LESS THAN 4' OFFSET FROM THE PROPOSED EDGE LINE, AND PERMITTING SITE CONDITIONS EXIST: THE PROPOSED TYPE E ANCHOR ASSEMBLY SHALL BE INSTALLED AT A CONSISTENT FLARE RATE THROUGH THE FULL LENGTH OF THE SYSTEM. THE FLARE RATE SHALL BE A MAXIMUM OF 25:1 (RESULTING IN A 2' OFFSET). THE INSTALLATION SHALL BE IN ACCORDANCE WITH THE SHOP DRAWINGS, PRODUCT INSTALLATION MANUAL/GUIDANCE, AND AS DIRECTED BY THE ENGINEER.

PAYMENT FOR THE ABOVE WORK SHALL BE MADE AT THE UNIT PRICE BID FOR ITEM 606, ANCHOR ASSEMBLY, MGS TYPE E, EACH, AND SHALL INCLUDE ALL LABOR, TOOLS, EQUIPMENT AND MATERIALS NECESSARY TO CONSTRUCT A COMPLETE AND FUNCTIONAL ANCHOR ASSEMBLY SYSTEM, INCLUDING ALL RELATED TRANSITIONS, REFLECTIVE SHEETING, HARDWARE, GRADING, EMBANKMENT AND EXCAVATION NOT SEPARATELY SPECIFIED, AS REQUIRED BY THE MANUFACTURER.

Designer Notes:

1. The device's length of need (LON) point for all systems is at post number 3; therefore, after calculating the required LON for the guardrail, deduct the last 37’-6” of the unit (from post #3 to post #9) from the calculated length of need for the guardrail. The designer must show the calculated LON point on all guardrail runs in the plans.
2. Pre-approved shop drawings are reviewed and are on the Office of Roadway Engineering’s web page under the Roadway Approved Products List.
3. These end treatments are gating systems.
4. A Type C delineator should be installed on a flexible post at the head of all Type E units located on the right side of the through roadway in areas that have known snowdrift/piling problems, or per District policy. A Type D delineator should be installed on a flexible post at the head of all Type E units located on the left side of the through roadway. Delineators shall be itemized separately and shall comply with Standard Construction Drawing TC-61.10 and CMS 620.
5. Use this plan note in conjunction with Type MGS Guardrail.
6. If the intent is to supply a non-MASH 2016 device per one of the exceptions allowed under Section 601.3, then paragraph 1 of the note shall be modified accordingly.

R116 – ~~PAVING UNDER~~ MGS GUARDRAIL INSTALLED IN ASPHALT

THIS OPERATION SHALL INCLUDE PREPARATION OF THE GRADED SHOULDER USING ITEM 209, LINEAR GRADING, AS PER PLAN AND PAVING UNDER THE GUARDRAIL USING ITEM 441, ~~411~~ ASHPALT CONCRETE INTERMEDIATE COURSE, TYPE 1, (4498), (UNDER GUARDRAIL).~~, AS PER PLAN.~~

ITEM 209, LINEAR GRADING, AS PER PLAN SHALL CONSIST OF EXCAVATING TOPSOIL, AND PLACING GRANULAR MATERIAL. ALL COLLECTED DEBRIS AND TOPSOIL, INCLUDING RHIZOMES, ROOTS AND OTHER VEGETATIVE PLANT MATERIAL SHALL BE REMOVED AND DISPOSED OF AS SPECIFIED IN 105.17. THE REMOVED MATERIAL SHALL BE REPLACED WITH COMPACTABLE GRANULAR MATERIAL CONFORMING TO 703.16 PLACED TO GRADE AS DETAILED ON THE TYPICAL SECTION OR AS APPROVED BY THE ENGINEER.

ALL EQUIPMENT, MATERIALS AND LABOR REQUIRED TO PERFORM THE WORK OUTLINED ABOVE SHALL BE INCLUDED FOR PAYMENT UNDER ITEM 209, LINEAR GRADING, AS PER PLAN.

~~PAVING UNDER GUARDRAIL SHALL CONSIST OF PLACING ITEM 441 TO THE DEPTH SPECIFIED~~ THE GUARDRAIL SHALL BE INSTALLED IN X" OF ITEM 441, ASHPALT CONCRETE INTERMEDIATE COURSE, TYPE 1, (449), (UNDER GUARDRAIL) PER THE DETAIL ON **SCD MGS-2.1** USING ONE OF THE FOLLOWING METHODS:

METHOD A:

1. SET GUARDRAIL POSTS
2. PLACE X" OF ITEM 441

METHOD B:

1. PLACE X" OF ITEM 441
2. ~~BORE ASPHALT AT POST LOCATIONS (MAY BE OMITTED IF STEEL POSTS ARE USED)~~
3. ~~SET~~ DRIVE 6'-0" W6X9 OR W6X8.5 STEEL GUARDRAIL POSTS TO CORRECT DEPTH (31" FROM FINISHED GRADE TO TOP OF W-BEAM)
4. PATCH AROUND POSTS IF ASPHALT WAS DAMAGED DURING POST INSTALLATION. THE MATERIALS USED FOR PATCHING SHALL BE AN ASPHALT CONCRETE APPROVED BY THE ENGINEER. PATCHED AREAS SHALL BE COMPACTED USING EITHER HAND OR MECHANICAL METHODS. FINISHED SURFACES SHALL BE SMOOTH AND SLOPED TO DRAIN AWAY FROM THE POSTS.

ALL EQUIPMENT, MATERIALS AND LABOR REQUIRED TO PERFORM THE WORK OUTLINED ABOVE, WITH THE EXCEPTION OF SETTING GUARDRAIL POSTS, SHALL BE INCLUDED FOR PAYMENT UNDER ITEM 441, ASPHALT CONCRETE INTERMEDIATE COURSE, TYPE 1, (449~~8~~), (UNDER GUARDRAIL).~~, AS PER PLAN.~~

Designer Notes:

1. Quantities for Item 441 should be calculated in Cubic Yards.
2. The asphalt concrete thickness should be shown on the typical sections and specified in the note (replace "X"). The depth may vary according to project requirements, but shall be a maximum of 2 ~~3~~ inches.
3. The area to be paved shall not exceed 8" measured from the back of post. ~~be from the edge of the paved shoulder to the break point between the graded shoulder and the foreslope~~.
4. The slope shall be the same as the graded shoulder slope.
5. The designer may specify either paving Method A or B, or leave the option to the contractor.
6. Guardrail shall be paid for under Item 606.

R127 – ITEM SPECIAL – CABLE BARRIER ~~GUARDRAIL~~

THIS ITEM SHALL CONSIST OF FURNISHING AND INSTALLING ANY ONE OF THE HIGH TENSION FOUR CABLE GUARDRAIL SYSTEMS AS LISTED ON THE OFFICE OF ROADWAY ENGINEERING'S WEB PAGE. PAYMENT FOR THE ABOVE WORK SHALL BE MADE AT THE UNIT PRICE BID FOR ITEM SPECIAL, CABLE BARRIER WITH CONCRETE LINE POST FOUNDATION, AND ITEM SPECIAL, CABLE BARRIER, ANCHOR ASSEMBLY AND SHALL INCLUDE ALL LABOR, TOOLS, EQUIPMENT AND MATERIALS NECESSARY TO CONSTRUCT A COMPLETE AND FUNCTIONAL HIGH TENSION CABLE GUARDRAIL SYSTEM NOT SEPARATELY SPECIFIED, AS REQUIRED BY THE MANUFACTURER. THE LENGTH OF THE TENSIONED CABLE NECESSARY TO INSTALL A FUNCTIONAL ANCHOR SYSTEM SHALL BE INCLUDED IN ITEM SPECIAL, CABLE BARRIER WITH CONCRETE LINE POST FOUNDATION.

INSTALLATION SHALL BE AT THE LOCATIONS SPECIFIED IN THE PLANS, IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATIONS.

SYSTEMS SHALL HAVE A MAXIMUM DEFLECTION OF 8 FEET AND THE MAXIMUM LONGITUDINAL DISTANCE BETWEEN POSTS SHALL BE 15 FEET.

INSTALLATION WILL BE A FOUR CABLE HIGH TENSION SYSTEM INSTALLED IN SOCKETED POSTS FOUNDATION WITH A FOUR FOOT WIDE "NO MOW STRIP".

DELINEATE THE CABLE BARRIER USING TYPE 6 BARRIER REFLECTORS PER ITEM 626 OR USING FLEXIBLE POSTS PER ITEM 620 AS CALLED FOR IN THE PLANS OR DIRECTED BY THE ENGINEER.

ANCHOR TERMINAL STRUTS SHALL BE COVERED COMPLETELY ON BOTH SIDES WITH YELLOW REBOUNDABLE RETROREFLECTIVE SHEETING, PER CMS 730.191.

TRANSITIONS TO W-BEAM GUARDRAIL ARE NOT ALLOWED.

REFER TO MANUFACTURER FOR MAXIMUM OFFSET FROM BREAK POINT.

TORPEDO OR BULLET SPLICES ARE NOT ALLOWED. ALL CABLE SPLICES SHALL BE A SWAGED OR OPEN BODY DESIGN THAT ALLOWS FOR ANNUAL INSPECTION BETWEEN THE WEDGE AND STRANDS OF CABLE.

POSTS ARE SET IN SOCKETED CONCRETE FOUNDATIONS AND SHALL NOT BE PERMANENTLY INSTALLED UNTIL THEIR RESPECTIVE RUNS OF TENSIONED CABLE GUARDRAIL ARE READY FOR FINAL CONNECTION TO THE END TERMINAL ASSEMBLY. THE CONTRACTOR SHALL REPLACE ANY POSTS DAMAGED DURING INSTALLATION AS DETERMINED BY THE ENGINEER AT NO ADDITIONAL COST TO THE STATE.

<u>Designer Notes:</u>

High tension cable barrier systems shall only be installed to meet the requirements of Location and Design Manual Section 601.2 Median Barrier Warrants.

The most current approved products and models are updated regularly online, as such, individual products should generally not be listed on the plans.

Cable barrier should be delineated using Type 6 Barrier Reflectors per Item 626 or using flexible posts per Item 620 and the delineation should be itemized and paid for under its respective item number.

Designer should look at the entire corridor before selecting which side of the median the cable will be installed on. At breaks in the runs of cable such as turnarounds the layout of the cable should limit the gating potential of the cable end treatments. Installing the end treatments behind the trailing bridge parapets can eliminate the gating part of the end treatments. When overlapping cable runs eliminate all of the gating part of the end treatments. Review Figure 602-3 and 602-4 of L&D Vol. 1 for appropriate layouts. Additional information is provided in Location and Design Manual Volume 1 Section 600 and the manufacturer.

Additional pay items primarily used in maintenance projects may include:

606E55020 SPECIAL – CABLE BARRIER, REPLACEMENT CABLE
606E55100 SPECIAL – CABLE BARRIER, CONCRETE LINE POST FOUNDATION
606E55110 SPECIAL – CABLE BARRIER, CONCRETE ANCHOR FOUNDATION WITH SLEEVE
606E55120 SPECIAL – CABLE BARRIER, CONCRETE SOCKETED FOUNDATION
606E55130 SPECIAL – CABLE BARRIER, TERMINAL POST, CAST IN PLACE
606E55140 SPECIAL – CABLE BARRIER, ANCHOR POST
606E55160 SPECIAL – CABLE BARRIER, TERMINAL STRUT
606E55170 SPECIAL – CABLE BARRIER, TURNBUCKLE
606E55180 SPECIAL – CABLE BARRIER, SPLICE
606E55190 SPECIAL – CABLE BARRIER, POST REFLECTOR
606E55200 SPECIAL – CABLE BARRIER, TENSIONING
606E55210 SPECIAL – CABLE BARRIER, ANCHOR RECONSTRUCTED
606E55220 SPECIAL – CABLE BARRIER, ANCHOR POST RESET