CHAPTER 7—ROADWAY STANDARDS AND TECHNICAL CRITERIA

Table of Contents

List of Figures

List of Tables

Chapter 7—ROADWAY STANDARDS AND TECHNICAL CRITERIA

This chapter presents standards and technical criteria to be used in the preparation of a roadway design and project plans submitted to Adams County for review and approval. The following information should be viewed as minimum requirements and changes to these standards must receive prior written approval from the Director of the Public Works Department.

7-01 ROADWAY DESIGN AND TECHNICAL CRITERIA

7-01-01 GENERAL

The County has adopted a street classification system based on traffic volumes and surrounding land use (both existing and future). The listing of the roadway types is as follows:

1. Local - Residential
2. Local - Residential, Rural
3. Local - Industrial/Commercial
4. Minor Collector
5. Minor Collector, Rural
6. Major Collector
7. Minor Arterial
8. Minor Arterial, Rural
9. Major Arterial

The information presented in this section applies to each classification and graphical representation of each roadway type and is shown in Appendix A. The design methodology outlined in this chapter is based upon the 1990 AASHTO, A Policy on Geometric Design of Highways and Streets ("Green Book") and existing conditions.

In the event that there is a revised edition of the AASHTO standards, the most recent edition shall be used. The latest edition of the Colorado Department of Transportation (CDOT) Design Guides may also be used for roadway design, after obtaining approval from the Director of the Public Works Department. It is important to note that Adams County standards may supercede both AASHTO and CDOT design policy/criteria for County maintained roads.

7-01-02 REQUIRED DESIGN SUBMITTALS

Project Plans submitted to the County for review shall contain a comprehensive circulation system designed in accordance with these criteria and other applicable standards (local, state, and federal). Prior to receiving approval, the Project Plans must be sealed by a Colorado Registered Professional Engineer who has extensive knowledge of the project being submitted for review.

Based on the application being submitted, the level of design detail required varies and can be determined by the checklist attached to the application and/or by contacting the County. All required information is to be submitted for County review prior to receiving an approved application or permit. Applicants are encouraged to prepare the required submittals with as much detail as possible to minimize possible confusion and cut down on overall processing time. Should there be questions regarding the required submittals, please contact the Public Works Department.

7-01-03 DESIGN CRITERIA

The engineer shall design all local circulation systems recognizing the following factors:

1. Safety – for vehicular and pedestrian traffic.
2. Performance – efficiency of service for all users.
3. Livability – impacts mitigated by circulation system improvements.
4. Economy – of construction and use of land.

Each of the principles in Table 7.1 is an elaboration on one or more of these four factors. The principles are not intended as absolute criteria, since instances may appear where certain principles or existing conditions conflict. The principles should, therefore, be used as guidelines to proper systems layout and for obtaining County approval. Table 7.2 presents a summary of the minimum roadway design requirements for each of the nine roadway types. Within this table the following characteristics are discussed:

1. Speed Limit
2. Number of Through Lanes
3. Right-of-Way
4. Street Width and Composition of Cross-Section
5. Type of Curb and Gutter
6. Sidewalk Width
7. Traffic Volumes
8. Continuity

9. Safety
10. Traffic Control
11. Function
12. Access Conditions
13. Planning Characteristics

Table 7.1—Roadway Design Criteria

	Concern	Guide
Ensure Vehicular and Pedestrian Access	The primary function of local streets is to serve abutting properties.	Street widths, placement of sidewalks, patterns of streets and number of intersections are related to safe and efficient access to abutting lands.
Minimize Through Trips	Through traffic on local and collector streets potentially increases the average speed and volume. Therefore increasing the potential for accidents and reducing residential amenities.	Through traffic can be discouraged between neighborhoods and higher volume streets by creating a circuitous route, channeling or controlling median crossings along peripheral routes.
Control Access to Arterials	Local circulation systems and land development patterns should not detract from the efficiency of peripheral arterial facilities. The local streets that intersect arterial systems will tend to have higher volumes since they tend to be primarily exit points	The number of access points between local circulation systems and adjacent arterial streets should be minimized. Intersections along arterial routes should be properly spaced for efficient signalization and traffic flow.
Discourage Speeding	Residential streets should be designed to discourage fast movement.	Use of curvilinear alignments, traffic calming devises and circuitous routes in the street system.
Minimize Pedestrian – Vehicular Conflicts	Pedestrian travel from within the area to points outside should require a minimal number of street crossings.	Typical methods include use of cul-de-sacs and looped streets, special pedestrian routes or walkways, and the proper placement of high pedestrian traffic generators. In general, vehicular flow must be outward oriented to the peripheral arterials and pedestrian travel should be inward-oriented to avoid these heavier vehicular flows.
Minimize Space Devoted to Street Use	It is desirable to minimize local street mileage, therefore reducing construction and maintenance costs as well as to permit the most efficient use of land. Streets should also have an appearance commensurate with their function.	Streets should be designed to complement local character.
Relate Street to Topography	Local streets are more attractive and economical if constructed to closely adhere to topography (minimize cut and fill).	The important role streets play in the overall storm drainage system can be enhanced by closely following existing topography.
Layout Street to Achieve Optimum Subdivision of Land	The arrangement of streets should allow for economical and practical patterns, shapes and sizes of adjacent parcels. Streets as a function of land use must not unduly hinder the development of land.	Distances between streets, number of streets, and related elements all have a bearing on efficient subdivision of an area. Access to adjoining properties should also be encouraged.

Table 7.2—Roadway Design Requirements

		Local – Residential	Local – Residential, Rural	Local – Industrial/Commercial
Posted Speed Limit[1] (mph)		25		
Design Speed (mph)[2]		30		
Number of Through Lanes		2		
Right-of-Way[3]		50' min.[4]	60'	60'
		ROW radius in cul-de-sacs bubble: 60'	ROW radius in cul-de-sacs bubble: 60'	ROW radius in cul-de-sacs bubble: 70'
Street Width & Composition of Cross-Section	flowline-flowline	SF and MF: 36'	-	44'
	paved width	SF and MF: 32'	24'	40'
	shoulders	-	2-6'	-
	gutter pans	2-2' for SF and MF areas	-	2-2'
Curb and Gutter		Combination curb, gutter, and sidewalk	-	Vertical curb and gutter
Sidewalk Width (measured from flowline)		5.5' wide combination w/curb, attached	-	5.5' wide w/curb, attached
Traffic Volumes		Less than 1500 vpd		
Continuity		Limited		
Safety		Designed for the safety of pedestrians and bicyclists, and ease of access to adjacent parcels of land.		
Traffic Control		As warranted by the MUTCD Manual for uncontrolled intersections.		
Function		• Direct access to adjacent property. • Traffic carried should have an origin or a destination within the neighborhood. • Utility line easements should be available.		
Access Conditions		Intersections at grade with direct access to abutting property permitted.		
Planning Characteristic		• Designed to discourage through traffic from moving through the neighborhood. • Local streets should not intersect major collectors or arterial streets. • Parking may be limited to one side of the street. • Street parking, backing or loading maneuver may or may not be allowed.		
Cul-de-sacs	min. flowline radius	53'	42' to edge of asphalt	62'
	max length	Max. length (for local residential and industrial/commercial only): most restrictive of 1,200'or 40 dwelling units (if approved by the Fire District). Longer than 600' or with more than 25 dwelling units-may require all units to be sprinkled per NFPA-13D		

Notes:

[1] See County for posted speed if the traffic study indicates that a reduced speed is required.

[2] Design speeds for the various street classifications shall be 5mph more than the posted speed of that street.

[3]ROW for cut/fill conditions may be required,

[4]Change in ROW width due to a change in street classification shall be made at intersections to accommodate turn lanes.

SF = Single Family Residential

MF = Multi Family Residential

vpd = vehicles per day

Table 7.2—Roadway design requirements (continued)

		Minor Collector	Minor Collector, Rural[6]	Major Collector
Posted Speed Limit (mph)		30		35
Design Speed[5] (mph)		35		40
Number of Through Lanes		2		4
Right-of-Way		80’		80’
Street Width & Composition of Cross-Section	flowline-flowline	44’	-	64’ (ability to convert 1 travel lane to 1 turn lane)
	paved width	40’	44’	60’
	Shoulders (paved)	-	2-8’	-
	gutter pans	2-2’	-	2-2’
Curb and Gutter		Vertical curb and gutter	-	Vertical curb and gutter
Sidewalk Width (measured from flowline)		5.5’ – attached	-	5.5’ - attached
Traffic Volumes		Greater than 1500 vpd, less than 7000 vpd		Greater than 7000 vpd, less than 12,000 vpd
Continuity		Continuous for less than 2 miles		Continuous for 2 or more miles
Safety		Designed to handle traffic volumes loading from and onto local, other collector, and arterial roadways.		
Traffic Control		• As warranted by the MUTCD Manual and State Highway Access Code for Collectors. • Parking prohibited. • Traffic signals will normally be located only at intersections with streets of higher classification.		
Function		• Collect and distribute traffic between arterial and local streets and serve as main connectors within communities. • Traffic should have an origin or a destination within the community.		• Permit relatively unimpeded traffic movement • Intended for use on routes where 4 moving lanes are required, but a larger classified street is not warranted.
Access Conditions		• Intersections at grade. • Direct access to abutting property is not permitted unless no other access is reasonably available. • For major collector only, access from street of lower classification will be permitted with the use of traffic control devices.		
Planning Characteristic		Develop continuity throughout, but need not extend beyond the neighborhood.		• Should be employed where traffic demands dictate. • Landscaping elements are encouraged (trees, open space, etc.) where line of sight is not an issue. • Intersection with other collector and arterial streets should be at least one-quarter mile apart.

Notes:

[5]Design speeds for the various street classifications shall be 5mph greater than the posted speed of that street.

[6] Includes Section Line Arterial

vpd = vehicles per day

7-06 TABLE 7.2—ROADWAY DESIGN REQUIREMENTS (CONTINUED)

		Minor Arterial	Minor Arterial, Rural	Major Arterial
Posted Speed Limit (mph)		Greater than or equal to 35 MPH (actual posted speed to be determined by the Adams County Engineering Division prior to submittal of construction plans)		
Design Speed[7] (mph)		45 minimum		
Number of Through Lanes		4		4 minimum
Right-of-Way		120’	120’	140’
		ROW may be based on existing Master Plans.		
Street Width & Composition of Cross-Section	flowline-flowline	64’	-	74’
	paved width	60’	60’	2-15’ and 2-12’ travel lanes
	gutter pans	-	-	2-2’
	median	-	-	1-14’
	median gutter pans	-	-	2-1’
Curb and Gutter		Vertical curb and gutter	-	Vertical curb and gutter
Sidewalk Width		10’	-	10’
Traffic Volumes		Generally less than 12,000 vpd		Generally greater than 12,000 vpd
Continuity		Continuous for several miles, generally connecting with inter-city routes.		Continuous for several miles, generally connecting with inter-county and intra-county routes.
Safety		Designed to handle traffic volumes loading from and onto collector, and arterial roadways.		
Traffic Control		• As warranted by the MUTCD Manual and State Highway Access Code for Arterials. • Parking is prohibited.		• As warranted by the MUTCD Manual and State Highway Access Code for Arterials. • Parking is prohibited. • Roadways shall have median stripping.
Function		Permit relatively unimpeded traffic movement		Permit relatively unimpeded traffic movement.
Access Conditions				Abutting properties should not face on the roadway unless separated from it by a frontage road.
		• Intersection at grade. • Intersection spacing shall be ¼ mile. • Access from streets of lower classification may be permitted if controlled by traffic control devices. • Direct access to abutting properties is not permitted unless prior approval is obtained from the Director of the Public Works Department.		
Planning Characteristic		Arterials should be continuous and spaced from ½ to 1 mile apart.		Arterials should be spaced (1) one mile apart and should traverse an entire city and/or County.
		Arterials should act as boundaries between neighborhood areas.		

Notes:
[7]Design speeds for the various street classifications shall be 5mph greater than the posted speed of that street.
vpd = vehicles per day

7-01-03-01 SIGHT DISTANCES

Sight distance is the length of roadway clearly visible to the driver and is dependent upon the height of the driver's eye above the road surface, the specified object height above the road surface, and the height of sight obstructions within the line of sight. The minimum sight distance available on a roadway should be sufficient to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object.

In evaluating the overall performance of a roadway, both the horizontal and vertical sight distances should be checked to insure the distance along the major road is sufficient to allow a vehicle the opportunity to safely cross or turn left, whichever is required. For all sight distance calculations, the height of driver's eye is considered to be 3.50 feet above the road surface.

No Access Permit shall be issued for any project which does not include design elements for safe movement of any motorist using and/or passing an access.

Minimum Sight Distance requirements for existing access points shall meet the criteria listed in the Appendices B of these regulations.

7-01-03-01-01 *STOPPING SIGHT DISTANCE*

The minimum stopping sight distance is the distance required by the driver of a vehicle traveling at the design speed to bring the vehicle to a stop after an object on the road becomes visible. Stopping sight distance is the sum of the brake reaction time (the interval between the instant the driver recognizes the existence of an object on the roadway and the instant the driver applies the brakes) and the braking distance. The braking distance is related to the initial speed and the coefficient of friction between the tires and the roadway. Because of the lower coefficients of friction on wet pavement as compared with dry, the wet condition governs the stopping distances in design. Refer to Table 7.3 for minimum stopping sight distances. For stopping sight distance calculations, the height of the object is considered to be 6 inches above the road surface.

Table 7.3—Stopping Sight Distance for Wet Pavements
(Adapted from AASHTO "Green Book" Table III-1)

Design Speed	Assumed Speed for Condition (mph)	Brake Reaction		Coefficient of Friction f	Breaking Distance on Level[a] (ft)	Stopping Sight Distance	
		Time (sec)	Distance (ft)			Computed[a] (ft)	Rounded for Design (ft)
20	20-20	2.5	73.3-73.3	0.40	33.3-33.3	106.7-106.7	125-125
25	24-25	2.5	88.0-91.7	0.38	50.5-54.8	138.5-146.5	150-150
30	28-30	2.5	102.7-110.0	0.35	74.7-85.7	177.3-195.7	200-200
35	32-35	2.5	117.3-128.3	0.34	100.4-120.1	217.7-248.4	225-250
40	36-40	2.5	132.0-146.7	0.32	135.0-166.7	267.0-313.3	275-325
45	40-45	2.5	146.7-165.0	0.31	172.0-217.7	318.7-382.7	325-400
50	44-50	2.5	161.3-183.3	0.30	215.1-277.8	376.4-461.1	400-475
55	48-55	2.5	176.0-201.7	0.30	256.0-336.1	432.0-537.8	450-550
60	52-60	2.5	190.7-220.0	0.29	310.8-413.8	501.5-633.8	525-650
65	55-65	2.5	201.7-238.3	0.29	347.7-485.6	549.4-724.0	550-725
70	58-70	2.5	212.7-256.7	0.28	400.5-583.3	613.1-840.0	625-850

[a]Different values for the same speed result from using unequal coefficients of friction

7-01-03-01-01-01 *Effects of Grade on Stopping*

When a roadway is constructed on a grade steeper than 3%, the braking distance not only to the initial speed and coefficient of friction, but also the percent grade (both up and down). As intuition would lead you to believe, the safe stopping distance on upgrades is shorter and those on downgrades is longer. Refer to Table 7.4 for effects of upgrades and downgrades on the stopping sight distance in wet conditions.

Table 7.4—Effect of Grade on Stopping Sight Distance, Wet Conditions (Adapted from AASHTO "Green Book" Table III-2)

Increase for Downgrades				Decrease for Upgrades			
Design Speed (mph)	Correction in Stopping Distance (ft)			Assumed Speed for Condition (mph)	Correction in Stopping Distance (ft)		
	3%	6%	9%		3%	6%	9%
30	10	20	30	28	-	10	20
40	20	40	70	36	10	20	30
50	30	70	-	44	20	30	-
60	50	110	-	52	30	50	-
65	60	130	-	55	30	60	-
70	70	160	-	58	40	70	-

7-01-03-01-01-02 *Decision Sight Distance*

Decision sight distance is defined as the distance it takes for a driver to detect an unexpected or difficult-to-perceive hazard along the roadway which may be visually cluttered, recognize this hazard, select an appropriate speed and path, and complete the required safety maneuver. Therefore, based on this definition, these values tend to be greater than stopping sight distances. Interchanges and intersections, locations where unusual or unexpected maneuvers are required, changes in cross section, and areas of "visual noise" are examples of locations where decision sight distances may be needed. In computing and measuring decision sight distances (refer toTable 7.5), the 3.5-foot eye height and 6-inch object height criteria used for stopping sight distance have been used.

Table 7.5—Decision Sight Distance (adapted from AASHTO "Green Book"" Table III-3)

Design Speed (mph)	Decision Sight Distance for Avoidance Maneuver (ft)				
	A	B	C	D	E
30	220	500	450	500	625
40	345	725	600	725	825
50	500	975	750	900	1025
60	680	1300	1000	1150	1275
70	900	1525	1100	1300	1450

- Avoidance Maneuver A: Stop on rural road.
- Avoidance Maneuver B: Stop on urban road.
- Avoidance Maneuver C: Speed/path/direction change on rural road.
- Avoidance Maneuver D: Speed/path/direction change on suburban road.
- Avoidance Maneuver E: Speed/path/direction change on urban road.

7-01-03-01-02 *PASSING SIGHT DISTANCE FOR TWO-LANE ROADS*

Passing sight distance is the minimum distance (traveling at the design speed) that must be available to enable the driver of one vehicle to pass another safely and comfortably without interfering with oncoming traffic. Required passing sight distances for given design speeds are given in Table 7.6. For all sight distance calculations, the height of driver's eye is considered to be 3.50 feet above the road surface. For passing sight distance calculations, the height of the object is considered to be 4.25 feet above the road surface.

Table 7.6—Minimum Passing Sight Distance for Design of Two-Lane Highways (Adapted from AASHTO "Green Book" Table III-5)

Design Speed (mph)	Assumed Speeds		Minimum Passing Sight Distance (Rounded) (ft)
	Passed Vehicle (mph)	Passing Vehicle (mph)	
20	20	30	800
30	26	36	1100
40	34	44	1500
50	41	51	1800
60	47	57	2100
65	50	60	2300
70	54	64	2500

7-01-03-01-03 *MEASURING AND RECORDING SIGHT DISTANCE ON PLANS*

Methods for scaling sight distances are shown in Figure 7.1. Both horizontal and vertical sight distances should be measured as well as passing sight distance and stopping sight distance. Sight distance charts such as those in Table 7.6 through Table 7.8 may be used to establish minimum lengths of

vertical curves and charts similar to Figure 7.3 and Figure 7.4 are useful in determining the degree of horizontal curve necessary for the required sight distance. Refer to AASHTO "Green Book" for further details on scaling and recording sight distances.

7-01-03-01-04 *INTERSECTION AND DRIVEWAY SIGHT DISTANCE (SIGHT TRIANGLE)*

There shall be an unobstructed sight distance along both approaches and both sides at an intersection (within the right-of-way) for distances sufficient to allow the operators of vehicles, approaching simultaneously, to see each other in time to prevent collisions at the intersection.

Any object within the sight triangle more than 30 inches high (such objects include: buildings, cut slopes, hedges, trees, bushes, utility cabinets, or tall crops) above the flowline elevation of the adjacent street shall constitute a sight obstruction, and shall be removed or lowered. **In no case shall any permanent object encroach into the "line of sight" of any part of the sight-distance triangle.** In addition, parking (except on local streets) shall be eliminated within the sight triangle whether or not the intersection roads are level or on grades. The sight distance shall be measured to the centerline of the closest through lane in both directions.

All sight-distance triangles (shown in Figure 7.2) must be presented on the submitted street plans.

Refer to the AASHTO "Green Book" for more information on sight distances for intersections.

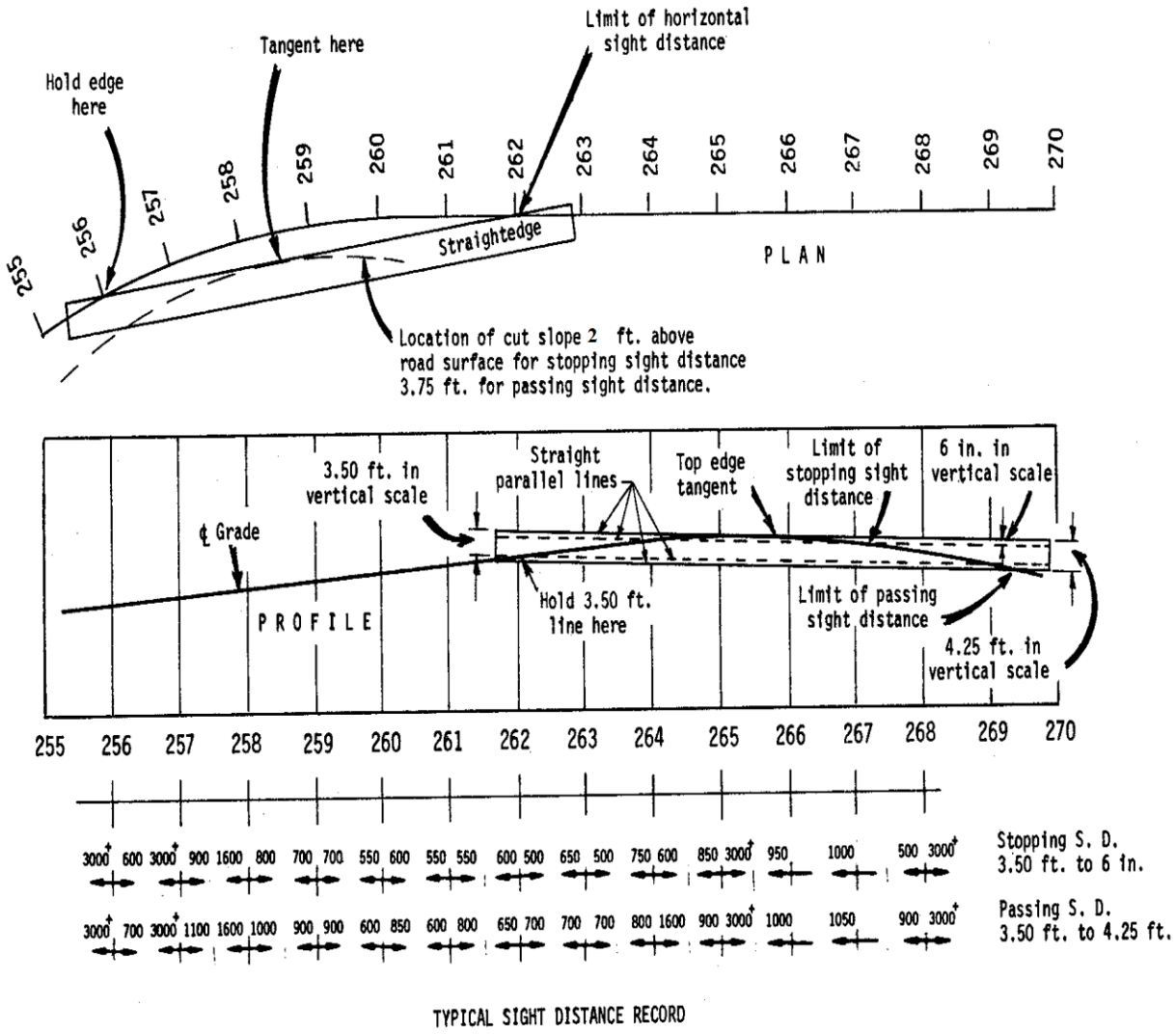


Figure 7.1—Scaling and recording sight distance on plans (adapted from AASHTO "Green Book" Figure III-3)

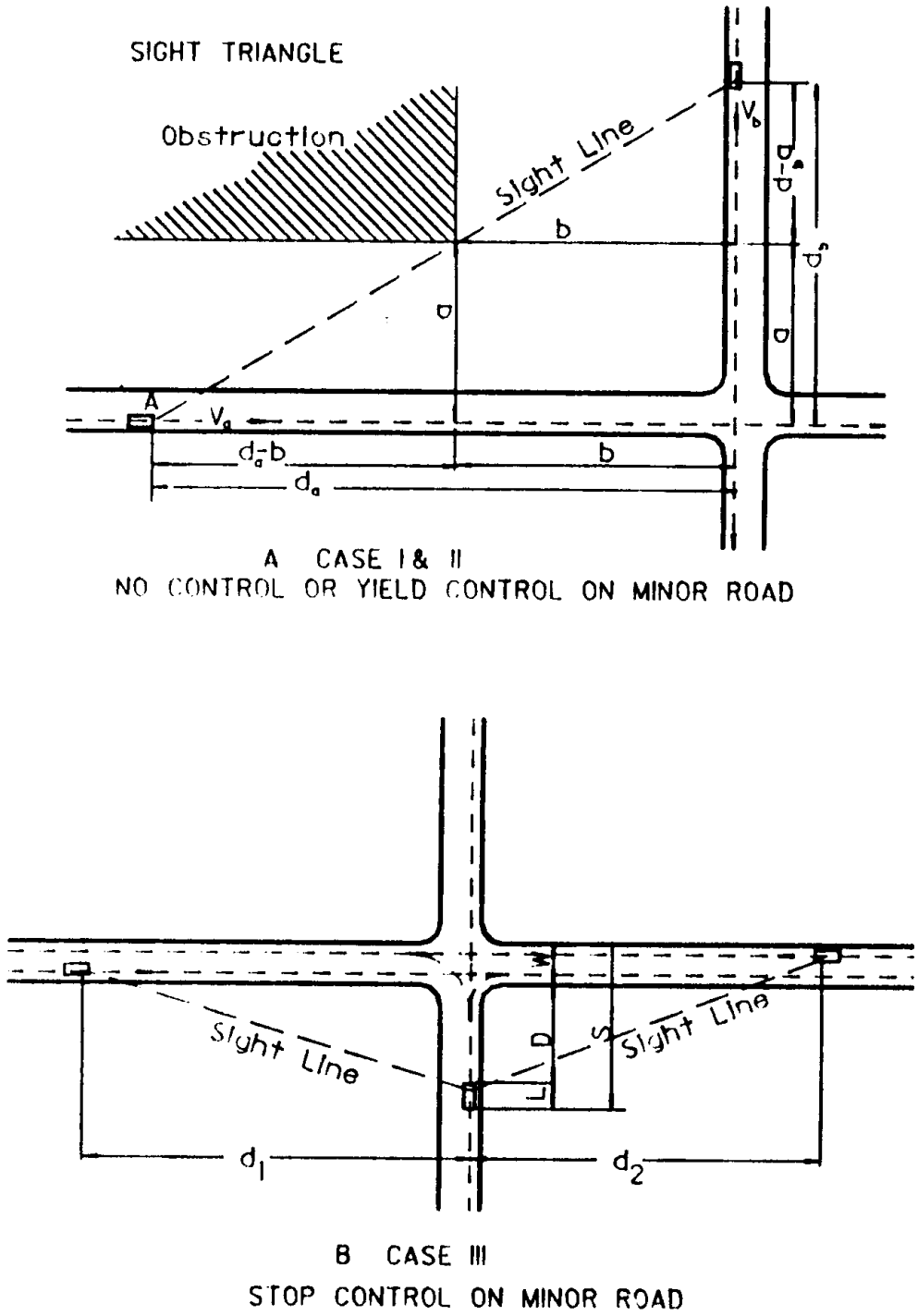


Figure 7.2—Sight distance at intersections, minimum sight triangle (adapted from AASHTO "Green Book" Figure IX-32)

7-01-03-02 HORIZONTAL ALIGNMENT

The major considerations in horizontal alignment design are road width, design speed, sight distance, and performance of heavy-duty vehicles. The proper alignment should provide for safe and continuous operation at a uniform design speed. Proposed road layouts shall bear a logical relationship to existing or platted roads in adjacent properties (i.e., not create increased congestion or unsafe intersections) and fit within the overall transportation plan for the County.

All new streets must intersect at or nearly at right angles. The minimum allowable intersection flowline radius for any street shall be 15 feet. Modified existing streets must allow for safe operations and proposed orientations reviewed and approved by the County.

Superelevation and horizontal curve radii must be in accordance with the recommendations of the AASHTO "Green Book."

7-01-03-02-01 *SUPERELEVATION*

It is necessary to determine superelevation rates which are applicable over the range of curvature for each design speed. For a given design speed, the superelevation should be distributed in such a manner that there is a logical relation between the side friction factor and the applied superelevation rate.

The maximum rate of superelevation on highways are controlled by factors including climate conditions, terrain conditions, land use characteristics (rural or urban), and frequency for slow-moving vehicles. For highway curves, several rates shall be recognized in establishing design controls. A rate of 0.040 to 0.060 is a typical rate used for urban areas with little to no constraints (where areas with snow and ice will require the lower value).

Superelevation will not be approved for local and/or other roadways classified with a design speed of 50 mph or less and not without prior approval by the Director of the Public Works Department.

7-01-03-02-01-01 *Standards for Superelevation*

The rate of superelevation shall be clearly shown on the project plans along with exaggerated (1"=10'H, 1"=1' V) profiles of the centerline and both flowlines. The superelevation runout length, crown runout length, and the point at which full superelevation is reached, shall be clearly represented and consistent with Table 7.7 through Table 7.10, the AASHTO "Green Book" and CDOT M & S Standards (M-203-10 through M-203-13).

7-01-03-02-01-02 *Urban Street Conditions*

Standard rates of superelevation must be maintained throughout the curve where applicable. Although superelevation is advantageous for highways (design speeds greater than 50 mph), street intersections, established street grades, curbs and adverse drainage conditions may require a reduction in the rate of superelevation, or different rates for each half of the roadbed may be proposed. In areas where pavement warping is required for drainage, adverse superelevations should be avoided.

Table 7.7—Design Values For Rate of Superelevation (e) and Minimum Length of Runoff, e_{max} = 0.04

D	R (ft)	V=30			V=40			V=50			V=60		
		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)	
			2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE
0°15’	22918	NC	0	0	NC	0	0	NC	0	0	NC	0	0
0°30’	11459	NC	0	0	NC	0	0	NC	0	0	NC	0	0
0°45’	7639	NC	0	0	NC	0	0	NC	0	0	RC	175	265
1°00’	5730	NC	0	0	NC	0	0	RC	150	225	.023	175	265
1°30’	3820	NC	0	0	RC	125	190	.024	150	225	.029	175	265
2°00’	2865	RC	100	150	.022	125	190	.027	150	225	.033	175	265
2°30’	2292	RC	100	150	.025	125	190	.030	150	225	.037	175	265
3°00’	1910	.020	100	150	.027	125	190	.033	150	225	.039	175	265
3°30’	1637	.022	100	150	.028	125	190	.035	150	225	.040	175	265
4°00’	1432	.024	100	150	.030	125	190	.037	150	225	Dmax=3°45’		
5°00’	1146	.026	100	150	.033	125	190	.039	150	225			
6°00’	955	.028	100	150	.035	125	190	.040	150	225			
7°00’	819	.030	100	150	.037	125	190	Dmax=6°00’					
8°00’	716	.031	100	150	.039	125	190						
9°00’	637	.033	100	150	.040	125	190						
10°00’	573	.034	100	150	.040	125	190						
11°00’	521	.035	100	150	Dmax=10°00’								
12°00’	477	.036	100	150									
13°00’	441	.037	100	150									
14°00’	409	.038	100	150									
16°00’	358	.039	100	150									
18°00’	318	.040	100	150									
19°00’	302	.040	100	150									
		Dmax=19°00’											

D – Degree of curve
R – Radius of curve
V – Assumed design speed
L – Minimum length of runoff (does not include tangent runout)
NC – Normal crown section
RC – Remove adverse crown, superelevate at normal crown slope

Note:

- In recognition of safety considerations, use of e_{max} = 0.04 should be limited to urban conditions.
- Use applicable rates for the next higher V. Do not interpolate.

Table 7.8—Design Values for Rate of Superelevation (e) and Minimum Length of Runoff, $e_{max} = 0.06$

D	R (ft)	V=30			V=40			V=50			V=55			V=60			V=65			V=70		
		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)	
			2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE
0°15’	22918	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	00
0°30’	11459	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	RC	190	190	RC	200	200
0°45’	7639	NC	0	0	NC	0	0	NC	0	0	RC	160	160	.021	175	175	.024	190	190	.026	200	200
1°00’	5730	NC	0	0	NC	0	0	.020	150	150	.023	160	160	.027	175	175	.030	190	190	.033	200	200
1°30’	3820	NC	0	0	.020	125	125	.028	150	150	.032	160	160	.037	175	175	.041	190	190	.046	200	200
2°00’	2865	RC	100	100	.025	125	125	.035	150	150	.040	160	160	.045	175	180	.050	190	210	.055	200	230
2°30’	2292	.020	100	100	.030	125	125	.040	150	150	.045	160	170	.051	175	200	.056	190	230	.059	200	260
3°00’	1910	.023	100	100	.034	125	125	.045	150	160	.050	160	190	.055	175	220	.059	190	250	Dmax=2°45’		
3°30’	1637	.026	100	100	.038	125	125	.048	150	170	.054	160	210	.058	175	230	.060	190	250			
4°00’	1432	.029	100	100	.041	125	130	.052	150	180	.057	160	220	.060	175	240	Dmax=3°30’					
5°00’	1146	.034	100	100	.046	125	140	.056	150	200	.060	160	230	Dmax=4°15’								
6°00’	955	.038	100	100	.050	125	160	.059	150	210	Dmax=5°15’											
7°00’	819	.041	100	110	.053	125	170	Dmax=6°45’														
8°00’	716	.043	100	120	.056	125	180															
9°00’	637	.046	100	120	.058	125	180															
10°00’	573	.048	100	130	.059	125	190															
11°00’	521	.050	100	140	.060	130	190															
12°00’	477	.052	100	140	Dmax=11°15’																	
13°00’	441	.054	100	140																		
14°00’	409	.055	100	150																		
16°00’	358	.058	100	160																		
18°00’	318	.059	110	160																		
20°00’	286	.060	110	160																		
21°00’	273	.060	110	160																		
		Dmax=21°00’																				

D – Degree of curve
R – Radius of curve
V – Assumed design speed
L – Minimum length of runoff (does not include tangent runout)
NC – Normal crown section
RC – Remove adverse crown, superelevate at normal crown slope

Note:

- Use applicable rates for the next higher V. Do not interpolate.

Table 7.9—Design Values for Rate of Superelevation (e) and Minimum Length of Runoff, e_{max} = 0.08

D	R (ft)	V=30			V=40			V=50			V=55			V=60			V=65			V=70		
		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)	
			2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE
0°15’	22918	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0
0°30’	11459	NC	0	0	NC	0	0	NC	0	0	NC	0	0	RC	175	175	RC	190	190	RC	200	200
0°45’	7639	NC	0	0	NC	0	0	RC	150	150	RC	160	160	.022	175	175	.025	190	190	.028	200	200
1°00’	5730	NC	0	0	NC	0	0	.021	150	150	.025	160	160	.029	175	175	.032	190	190	.036	200	200
1°30’	3820	NC	0	0	.021	125	125	.030	150	150	.035	160	160	.041	175	175	.046	190	200	.051	200	240
2°00’	2865	RC	100	100	.027	125	125	.038	150	150	.045	160	170	.051	175	210	.058	190	250	.065	200	290
2°30’	2292	.021	100	100	.033	125	125	.046	150	170	.053	160	200	.061	175	240	.068	190	300	.075	220	330
3°00’	1910	.025	100	100	.038	125	125	.053	150	190	.060	160	230	.068	180	270	.075	210	320	Dmax=3°00’		
3°30’	1637	.028	100	100	.043	125	140	.058	150	210	.067	170	260	.074	200	300	.079	220	350			
4°00’	1432	.031	100	100	.047	125	150	.063	150	230	.071	180	270	.078	210	310	Dmax=3°45’					
5°00’	1146	.038	100	100	.055	125	170	.071	170	260	.078	200	300	Dmax=4°45’								
6°00’	955	.043	100	120	.062	130	190	.077	180	280	Dmax=6°00’											
7°00’	819	.048	100	130	.067	140	210	.080	190	280												
8°00’	716	.053	100	140	.071	150	220	Dmax=7°30’														
9°00’	637	.056	100	150	.075	160	240															
10°00’	573	.060	110	160	.078	160	240															
11°00’	521	.063	110	170	.079	170	250															
12°00’	477	.065	120	180	.080	170	250															
13°00’	441	.068	120	180	Dmax=12°15’																	
14°00’	409	.070	130	190																		
16°00’	358	.074	130	200																		
18°00’	318	.077	140	210																		
20°00’	286	.079	140	210																		
22°00’	260	.080	140	230																		
Dmax=22°45’																						

D – Degree of curve
R – Radius of curve
V – Assumed design speed
L – Minimum length of runoff (does not include tangent runout)
NC – Normal crown section
RC – Remove adverse crown, superelevate at normal crown slope

Note:

- Use applicable rates for the next higher V. Do not interpolate.

Table 7.10—Design Values for Rate of Superelevation (e) and Minimum Length of Runoff, e_{max} = 0.10

D	R (ft)	V=30			V=40			V=50			V=55			V=60			V=65			V=70		
		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)		e	L (ft)	
			2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE		2-LANE	4-LANE
0°15’	22918	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0
0°30’	11459	NC	0	0	NC	0	0	NC	0	0	NC	0	0	RC	175	175	RC	190	190	RC	200	200
0°45’	7639	NC	0	0	NC	0	0	RC	150	150	RC	160	160	.023	175	175	.025	190	190	.028	200	200
1°00’	5730	NC	0	0	NC	0	0	.021	150	150	.025	160	160	.030	175	175	.033	190	190	.037	200	200
1°30’	3820	NC	0	0	.021	125	125	.031	150	150	.037	160	160	.043	175	190	.048	190	220	.054	200	260
2°00’	2865	RC	100	100	.028	125	125	.040	150	150	.048	160	180	.055	175	230	.062	190	290	.070	220	330
2°30’	2292	.021	100	100	.034	125	125	.049	150	180	.056	160	210	.067	190	280	.075	220	330	.085	260	390
3°00’	1910	.025	100	100	.040	125	125	.057	150	210	.067	170	250	.077	210	320	.087	250	380	.096	280	420
3°30’	1637	.029	100	100	.046	125	140	.065	160	240	.075	190	290	.086	350	350	.095	270	400	.100	300	450
4°00’	1432	.033	100	100	.051	125	160	.072	180	260	.083	210	320	.093	250	380	.099	280	420	Dmax=3°30’		
5°00’	1146	.040	100	110	.061	130	190	.083	200	300	.094	240	360	.098	270	400	Dmax=4°15’					
6°00’	955	.046	100	120	.070	150	220	.092	220	330	.099	250	380	Dmax=5°15’								
7°00’	819	.053	100	140	.078	160	240	.098	240	350	Dmax=6°30’											
8°00’	716	.058	110	160	.084	180	260	.100	240	360												
9°00’	637	.063	120	170	.089	190	280	Dmax=8°15’														
10°00’	573	.068	120	180	.094	200	290															
11°00’	521	.072	130	200	.097	200	310															
12°00’	477	.076	140	210	.099	210	310															
13°00’	441	.080	140	220	.100	210	320															
14°00’	409	.083	150	220	Dmax=13°15’																	
16°00’	358	.089	160	240																		
18°00’	318	.093	170	250																		
20°00’	286	.097	170	260																		
22°00’	260	.099	180	270																		
24°00’	239	.100	180	270																		
		Dmax=24°45’																				

D – Degree of curve
R – Radius of curve
V – Assumed design speed
L – Minimum length of runoff (does not include tangent runout)
NC – Normal crown section
RC – Remove adverse crown, superelevate at normal crown slope

Note:

- Use applicable rates for the next higher V. Do not interpolate.

7-01-03-02-02 *SIDE FRICTION FACTOR*

With there being a wide variation in vehicle speeds and curves, an unbalanced force, whether the curve is superelevated or not, usually occurs. This force typically results in a tire side thrust counterbalanced by friction between the tires and surface. The coefficient of side friction, f, is related to the design speed, superelevation, and radius of curvature.

7-01-03-02-03 *DESIGN SPEED*

Horizontal alignment design speed must be consistent with the requirement for vertical alignment design speed. The horizontal curve data shown in Table 7.11 and Table 7.12 shall be used as minimum design guidelines.

7-01-03-02-04 *MAXIMUM DEGREE OF CURVATURE AND MINIMUM RADIUS*

The maximum degree of curvature (or minimum radius) is a limiting value of curvature for a given design speed. At a proposed design speed both the superelevation rate and the assumed value for side friction factor determine the minimum safe radius, R. The radius of curvature may be determined from Equation 7.1. The degree of curve is given in Equation 7.2.

Equation 7.1

$$R = \frac{V^2}{15(e+f)}$$

Equation 7.2

$$D = \frac{85{,}660(e+f)}{V^2}$$

Where

R = Radius of curve, ft
V = Vehicle speed, mph
e = Rate of roadway superelevation, ft/ft
f = Friction factor
D = Degree of curve

Table 7.11 presents maximum degree of curve and minimum radius for rural highways and high-speed urban areas. The minimum radii for limiting values of superelevation and friction for low-speed urban areas are presented in Table 7.12. Refer to AASHTO “Green Book” for other requirements regarding the design of rural highways and high and low speed urban streets.

Table 7.11—Maximum Degree of Curve and Minimum Radius for Rural Highways and High-Speed Urban Areas (adapted from AASHTO Table III-6).

Design Speed (mph)	Max. e	Max. F	Rounded Max. Degree of Curve	Min. Radius (ft)
20	0.04	.17	45.0	127
30		.16	19.0	302
40		.15	10.0	573
50		.14	6.0	955
55		.13	4.75	1186
60		.12	3.75	1528
20	0.06	.17	49.25	116
30		.16	21.0	273
40		.15	11.25	509
50		.14	6.75	849
55		.13	5.5	1061
60		.12	4.25	1348
65		.11	3.5	1637
70		.10	2.75	2083
20	0.08	.17	53.5	107
30		.16	22.75	252
40		.15	12.25	468
50		.14	7.5	764
55		.13	6.0	960
60		.12	4.75	1206
65		.11	3.75	1528
70		.10	3.0	1910
20	0.10	.17	58.0	99
30		.16	24.75	231
40		.15	13.25	432
50		.14	8.25	694
55		.13	6.5	877
60		.12	5.25	1091
65		.11	4.25	1348
70		.10	3.5	1637

Table 7.12—Minimum Radii for Limiting Values of e and f for Low-Speed Urban Streets (adapted from AASHTO Table III-16)

Design Speed, (mph)	Max. e	Max. f	Min. R, (ft)
20	0.060	0.300	75
25		0.252	135
30		0.221	215
35		0.197	320
40		0.178	450
20	.040	0.300	80
25		0.252	145
30		0.221	230
35		0.197	345
40		0.178	490
20	0	0.300	90
25		0.252	165
30		0.221	275
35		0.197	415
40		0.178	600

7-01-03-02-05 *EFFECT OF GRADE*

Grade effects the operating speeds of vehicles and should be recognized as a critical issue in the design of roadways. Where practical, the roadway should be designed for a higher design speed on the downgrade and a lower design speed on the upgrade. This variation in design speed will depend on the rate and length of grade and the degrees of curvature, as compared with other curves on the roadway section.

7-01-03-02-06 *SIGHT DISTANCE ON HORIZONTAL CURVES*

The proposed horizontal alignment must provide for the minimum stopping distance for the design speed at all points along the roadway. In addition, the design must take into account the visibility at intersections as well as around curves and roadside encroachments. Obstructions to the horizontal sight distance such as buildings, hedges, wooded areas, high ground or other topographical features, are to be presented on the project plans.

Figure 7.3 and Figure 7.4 are design charts showing the required middle ordinates for clear sight areas to satisfy the lower and upper values of stopping sight distance required for curves of various degrees. These charts utilize the stopping sight distance values in Table 7.3. A value at or approaching the upper limit should be used as a minimum wherever conditions permit.

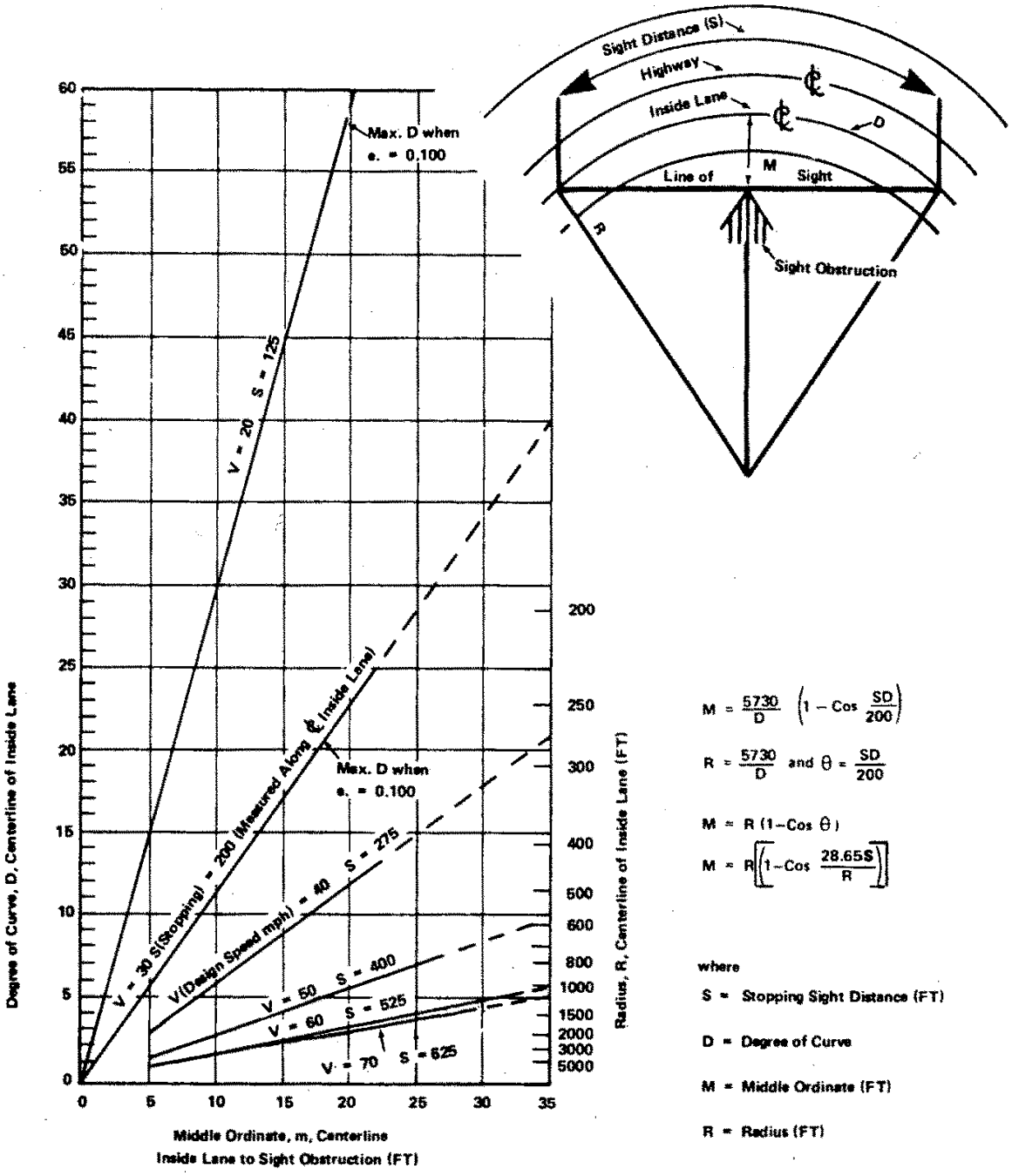


Figure 7.3—Range of lower values: relation between degree of curve and value of middle ordinate necessary to provide stopping sight distance on horizontal curves under open road conditions (adapted from AASHTO "Green Book" Figure III-26A)

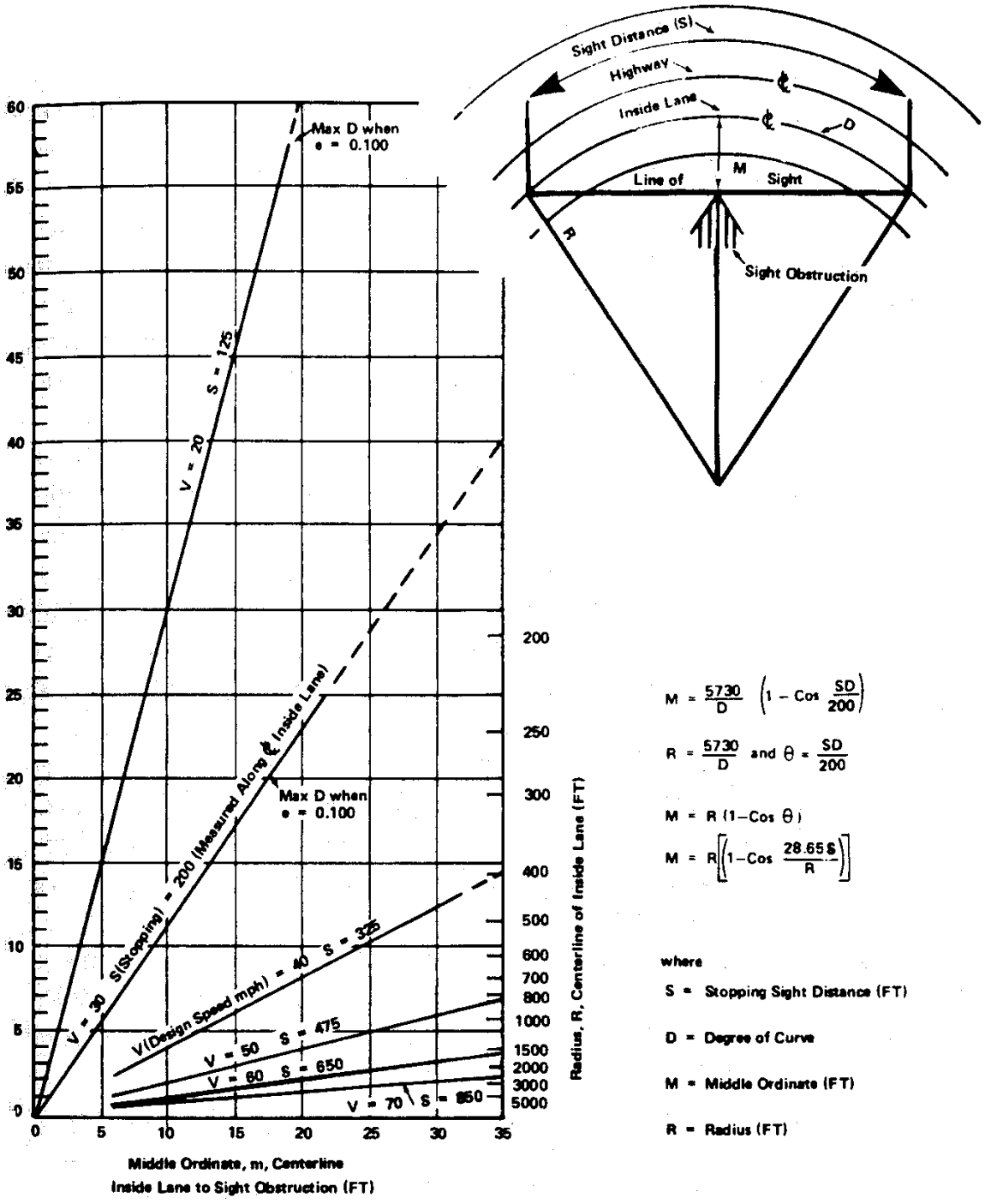


Figure 7.4—Range of upper values: relation between degree of curve and value of middle ordinate necessary to provide stopping sight distance on horizontal curves under open road conditions (adapted from AASHTO "Green Book" Figure III-26B)

7-01-03-02-07 *CURB RETURN RADII*

Table 7.13 presents minimum curb return radius for each of the roadway types at intersections with the applicable through street.

Table 7.13—Minimum Curb Return Radius at Intersection

Through Street	Local	Collector	Minor Arterial	Major Arterial
Local	15’	25’	30’	30’
Collector	25’	30’	30’	35’
Minor Arterial	30’	30’	35’	40’
Major Arterial	30’	35’	40’	50’

7-01-03-03 VERTICAL ALIGNMENT

7-01-03-03-01 *VERTICAL CURVES*

The major issues for safe operation on a crest vertical curve are the provisions of ample sight and stopping distances for the proposed design speed. Vertical curves may be any one of the crest or sag types depicted in Figure 7.5. The County requires vertical curves on a proposed roadway when the algebraic difference in grades is equal to or greater than 1.0%.

7-01-03-03-01-01 *Crest Vertical Curves*

When the height of eye and the height of object are 3.50 feet and 6 inches, respectively (used in stopping sight distance), the length of vertical curve (L) is related to the algebraic differences in grades (A) and the estimated sight distance (S). The required lengths of vertical curves for different values of A to provide ranges of stopping sight distances for each design speed are graphically shown in Figure 7.6. The solid lines represent the required lengths based on rounded values of K (defined as L/A). Table 7.14 shows the computed K values for lengths of vertical curves as required for the range of values of stopping sight distances for each design speed.

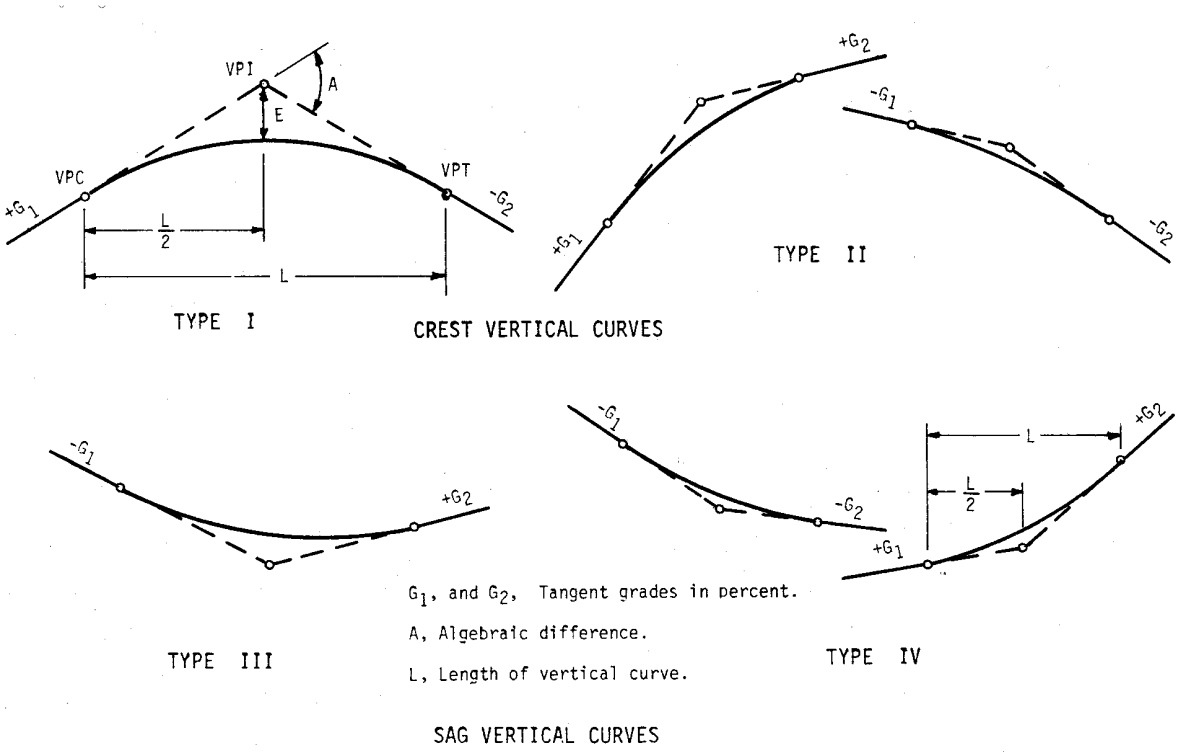
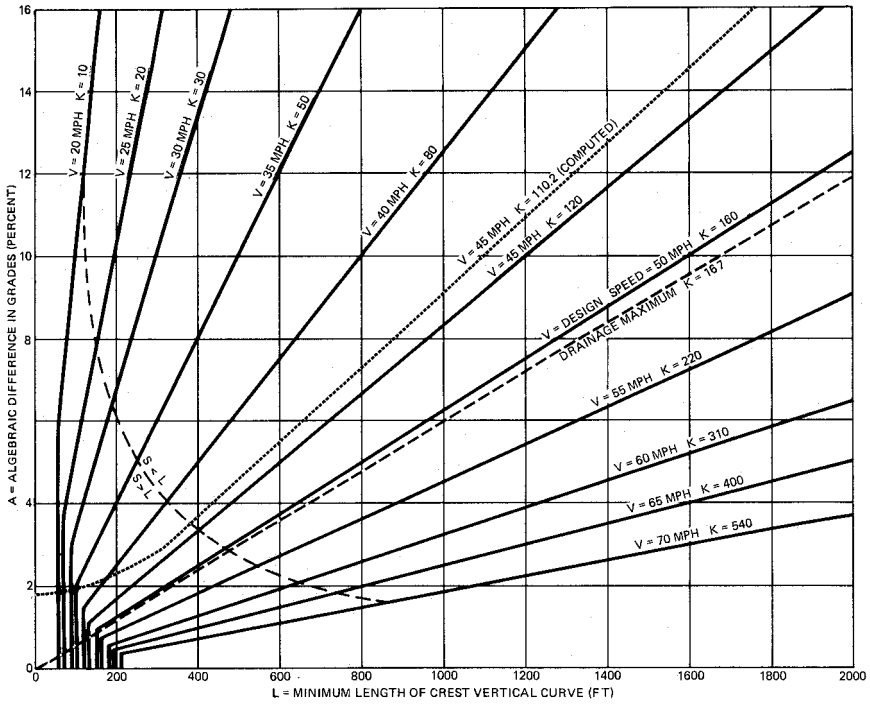


Figure 7.5—Types of vertical curves (adapted from AASHTO "Green Book" Figure III-40)



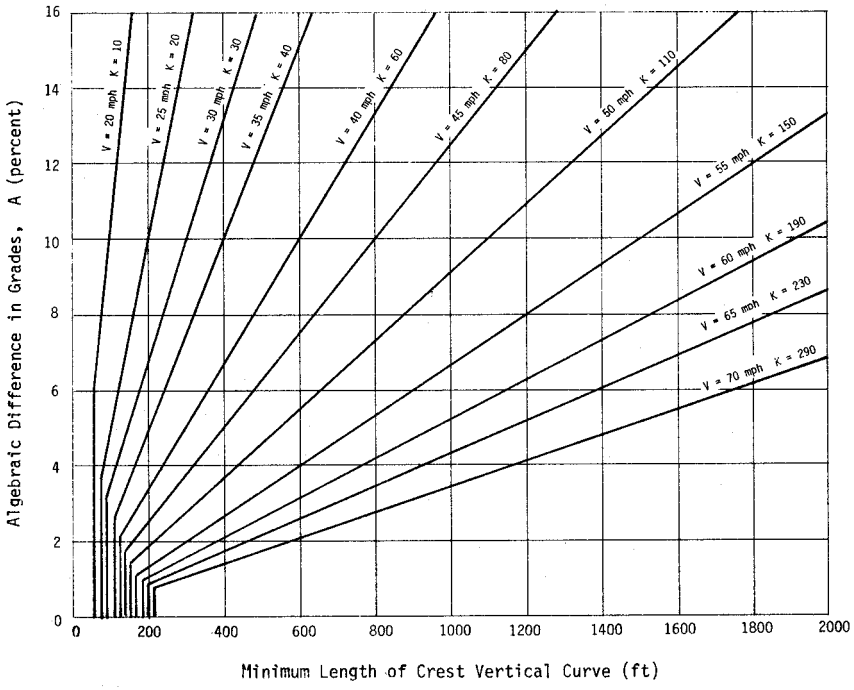


Figure 7.6—Design controls for crest vertical curves for stopping sight distance and open road conditions, upper and lower range (adapted from AASHTO "Green Book" Figure III-41 and Figure III-42)

Table 7.14—Design Controls for Crest and Sag Vertical Curves Based on Stopping Sight Distance (Adapted from AASHTO "Green Book" Tables III-40 and III-42)

Design Speed (mph)	Assumed Speed for Condition (mph)	Coefficient of Friction f	Stopping Sight Distance, Rounded for Design (ft) (refer to Table 7.3)	Rate of Vertical Curvature, K $\frac{L(ft)}{A(\%)}$			
				Crest Vertical Curve		Sag Vertical Curve	
				Computed[a]	Rounded for Design	Computed[a]	Rounded for Design
20	20-20	0.40	125-125	8.6-8.6	10-10	14.7-14.7	20-20
25	24-25	0.38	150-150	14.4-16.1	20-20	21.7-23.5	30-30
30	28-30	0.35	200-200	23.7-28.8	30-30	30.8-35.3	40-40
35	32-35	0.34	225-250	35.7-46.4	40-50	40.8-48.6	50-50
40	36-40	0.32	275-325	53.6-73.9	60-80	53.4-65.6	60-70
45	40-45	0.31	325-400	76.4-110.2	80-120	67.0-84.2	70-90
50	44-50	0.30	400-475	106.6-160.0	110-160	82.5-105.6	90-110
55	48-55	0.30	450-550	140.4-217.6	150-220	97.6-126.7	100-130
60	52-60	0.29	525-650	189.2-302.2	190-310	116.7-153.4	120-160
65	55-65	0.29	550-725	227.1-394.3	230-400	129.9-178.6	130-180
70	58-70	0.28	625-850	282.8-530.9	290-540	147.7-211.3	150-220

[a]Using computed values of stopping sight distance

Design values of crest vertical curves for passing sight distance differ from those for stopping sight distance because of the different height criterion (4.25 feet instead of 6 inches). K-values for crest vertical curves based on passing sight distance are shown in Table 7.15.

Table 7.15—Design Controls for Crest Vertical Curves Based on Passing Sight Distance (adapted from AASHTO "Green Book" Table III-41)

Design Speed (mph)	Minimum Passing Sight Distance (refer to Table 7.6) (ft)	Rate of Vertical Curvature, K[a] Rounded for Design $\frac{L(ft)}{A(\%)}$
20	800	210
25	950	300
30	1100	400
35	1300	550
40	1500	730
45	1650	890
50	1800	1050
55	1950	1230
60	2100	1430
65	2300	1720
70	2500	2030

[a]Computed from rounded values of minimum passing sight distance

7-01-03-03-01-02 *Sag Vertical Curves*

At least four criteria affect the lengths of sag vertical curves. These include headlight sight distance, rider comfort, drainage control, and general appearance. Figure 7.7 and Figure 7.8 graphically illustrate the resulting lengths of vertical curves for the upper value of the range of minimum stopping sight distances for each design speed. Table 7.14 shows the range of computed values and the rounded values of K (L/A).

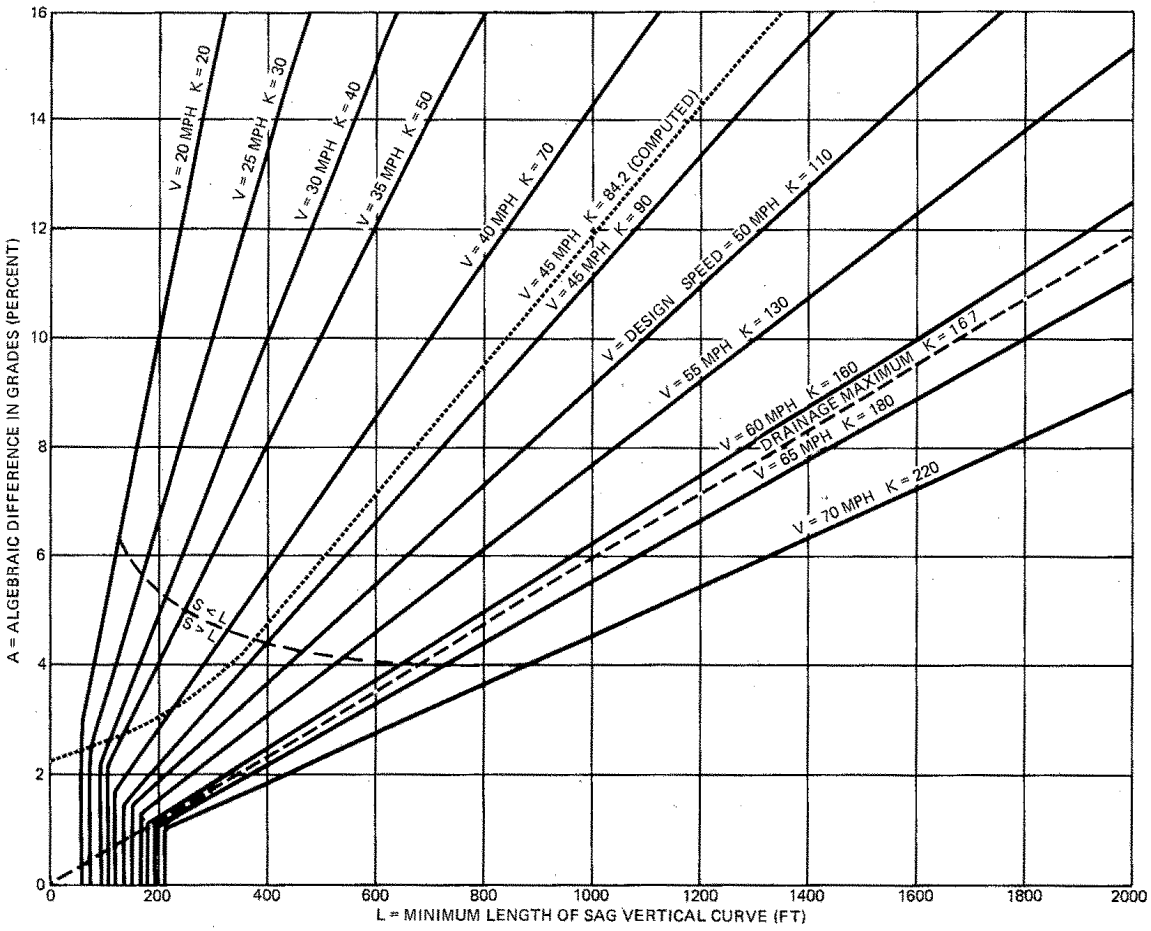


Figure 7.7—Design controls for sag vertical curves, open road conditions, upper range (adapted from AASHTO "Green Book" Figure III-43)

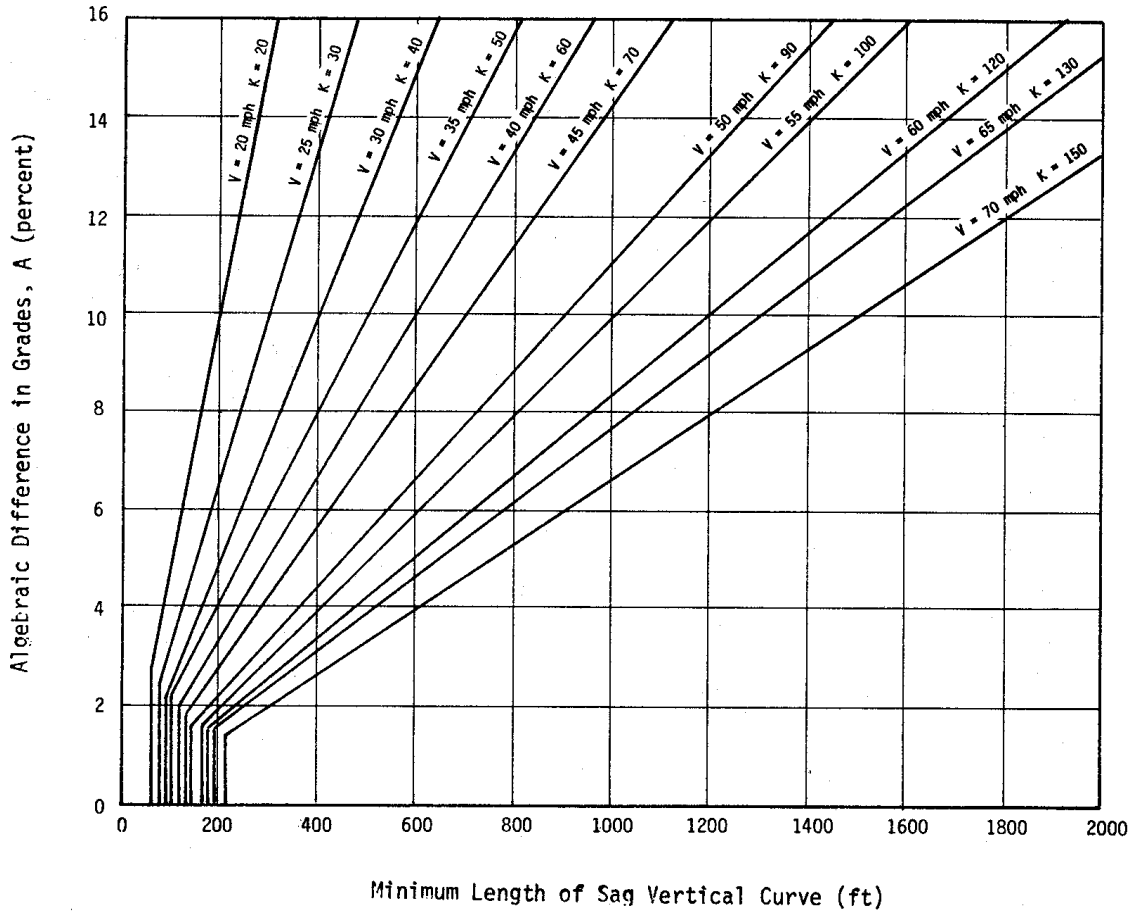


Figure 7.8—Design controls for sag vertical curves, lower range (adapted from AASHTO "Green Book" Figure III-44)

7-01-03-03-02 *PERMISSIBLE DESIGN GRADES*

See Table 7.16 for permissible design grades on roadways and at intersections.

7-01-03-03-03 *GRADE CHANGES*

Newly proposed roadways must not be designed using grade breaks, unless prior authorization from the County is obtained. Vertical curves meeting minimum criteria outlined in this section are preferred. However, should conditions arise during existing roadway modifications that dictate a grade break be used in lieu of vertical curves and the algebraic difference in grade does not exceed 1% (0.01 ft/ft), the grade break will be permitted. In addition, the maximum grade break allowed at the point of tangency at a curb return for local and collector roads shall be 2%.

7-01-03-03-04 *CROSS FALL*

Except at intersections or where a superelevation is required, roadways must be designed to maintain a constant cross slope from top of curb to top of curb (or flowline to flowline). The distance from intersections with which 'cross-fall' will only be permitted on a project specific basis and the design engineer must obtain the maximum distance from the Director of the Public Works Department.

7-01-03-04 SPIRAL CURVES

Spiral curves may only be designed into major and minor arterial roadways within the County (State Highways excluded) and/or with written approval of the Director of the Public Works Department.

7-01-03-05 RAILROAD CROSSINGS

All railroad crossings shall be designed in accordance with all Federal Railroad Association (FRA) requirements. In addition, project plans must receive prior written approval from the railroad owner before submitting them to the County.

Table 7.16—Permissible Grades

Local Streets	Minimum longitudinal flowline grade: 0.5%.
Curb Returns	Minimum flowline grade: 0.3%.
Centerline of Collector and Arterial Streets	Minimum longitudinal grade = 0.5%
Permissible Intersection Grades (within Public ROW)	
Grades at Intersecting Major and Minor Arterials	Maximum: 2% for 200 feet on either side of the intersection.

Grades at All Other Streets	Maximum: 3% for 200 feet
Dead End Streets (except cul-de-sacs)	Continue the proposed grade and existing ground lines for 500 feet or to its intersection with another street.
Cul-de-sacs	Continue the proposed and existing grade lines a minimum of 100 feet past the radius point.
Arterial Streets	Continue the proposed grade and existing ground lines 1000 feet.
Connection with Existing Streets	Provide smooth transitions and show existing grades for at least 300 feet on each side of the intersection.
Private Commercial Driveways with Curb Return Radii	Follow the standard set forth for a local street. The length of the maximum grade: minimum of 50 feet measured from the flowline intersection of the public roadway.
Normal crown shall be maintained on the through street, and the intersecting street grade shall be subordinate thereto.	

7-01-03-06 CUL-DE-SACS

The minimum design criterion for cul-de-sacs is included in Table 7.2. See Standard Drawings in Appendix A for further details.

7-01-03-06-01 *PAVEMENT SURFACE*

All new non-rural cul-de-sacs shall be surfaced with concrete pavement in the bubble area.

7-01-03-07 INTERSECTIONS

7-01-03-07-01 *ALIGNMENT AND PROFILE*

Intersections are points of convergence between vehicles, pedestrians, bikes and facilities. The design of the intersecting roads should permit users to pass through the intersection safely and with minimal interference. It should be the intent of the engineer to design an intersection which meets existing demands, and also accommodates the future volumes and traffic mix as determined by an approved Traffic Impact Study.

Traditional intersection improvements are preferred for all County roads and should be designed using the criteria outlined in this chapter. However, modern roundabouts may also be allowed assuming they meet modeled traffic demands and the design is completed by an engineer with prior experience. This experience will require verification by the Director of the Public Works Department prior to receiving written approval.

For reasons of safety and economics, traditional intersections will be designed with all intersecting roads meeting at or as near to right angles. Roads intersecting at acute angles require extensive ROW and limits visibility and obtuse angles create blind areas.

Substantial grade changes should be avoided at intersections. Adequate sight distance should be provided along both approaching roads and across the corners even if the intersecting roads are on vertical curves.

7-01-03-07-02 *SIGHT DISTANCE-INTERSECTION CONTROL*

Refer to Table 7.17 for simple definitions of the five types of controls which apply to at-grade intersections.

Table 7.17—Sight Distance, Intersection Control

No Intersection Control	• An intersection where a crossing is not controlled by yield signs, stop signs, or traffic signals • The safe stopping distances for intersection design are the same as those used for design in any other section of the road.
Yield Control	• Requires the minor roadway be posted with yield signs as it approaches the major roadway. • The sight distance for the driver on the minor road must be sufficient to allow the driver an opportunity to observe a vehicle on the major roadway approaching for the left or the right, and then bring the vehicle to a stop prior to reaching the intersecting road. • Proper adjustments for all distances must be made when any of the approach legs are not on level. • When an obstruction cannot be removed, modifications to the vertices of a sight triangle to points that are less than the design speed's safe stopping sight distance from the intersection, appropriate adjustments must be made for the design speed. Refer to the AASHTO "Green Book" regarding yield control for secondary roads to determine appropriate stopping sight distances or reduced design speeds for this condition.
Stop Control	• Requires that the minor road of an intersection be controlled by stop signs. • The driver of the vehicle on the minor road must have sufficient gaps in traffic and adequate sight distances to safely proceed through the intersection from the stopped position. • Refer to AASHTO "Green Book" for sight distance calculations for vehicles intending to cross the intersection, turn left, or turn right.
Signal Control	• Requires that all signal-controlled intersections give ample time for drivers to see the control device and allow enough time to perform the required action(s).

Modern Roundabout	• Requires ample warning, through signage and striping, be given to drivers to see the intersection and allow enough time to reduce speed and prepare to perform the required action(s). • The approaching drivers must have sufficient sight distance to see vehicles within the roundabout and allow them to yield as they enter the intersection.

7-01-03-07-03 *DESIGN FACTORS*

Refer to Table 7.18 for additional intersection design factors and criteria for local roads, collectors and arterials. Refer to the AASHTO "Green Book" for specific intersection design factors.

Table 7.18—Intersection Criteria

	Criteria
Precedence at intersections	• The grade of the "through" street shall take precedence at intersections. • At intersections of roadways with the same classification, the more important roadway, as determined by the Director of the Public Works Department, shall have precedence. • The design should warp side streets to match through streets with as short a transition as possible.
Determination of the elevation of the curb return on the side street and the amount of warp needed on a side street transitioning to a through street	Key criteria are: • Permissible grade in the stop/start lane. • Pavement cross slope at the PCR's on the side street and permissible warp in pavement cross slope. • Normal vertical curve criteria. • Vertical controls within the cub return itself.
Elevation at the PCR of the curb return on the through street	Always set by the grade of the through street in conjunction with normal pavement cross slope (2.0%).
Carrying the crown at a side street into the through street	Permitted only when drainage considerations warrant such a design.
Dipping the flowline	• To the extent the lip of gutter is dipped is not permitted. • Only permitted as specified by Adams County Standard Details concerning curb opening inlets. • Tipping an inlet for the benefit of drainage is also not permitted.
Pavement surface	All new intersections of roads classified as collector or higher shall be surfaced with concrete pavement extending 70 feet each direction from the centerline of the intersection.

	Criteria
Arterial-arterial intersections	A more detailed review shall be performed to maximize drivability. Few arterial intersections will have a uniform 2% cross slope, the majority of them having one or more sides warped.
Intersection sight distances	Shall conform to the requirements of 7-01-03-01-04.
Effect of Vertical Profiles	The differences in stopping distances on various grades at intersections are the same as those given in Table 7.4. Grades on an intersection leg should be limited to 3 percent unless the sight distances are greater than the lower limits for stopping on a level grade, in which case the grades should not be greater than 6 percent.
Stopping Sight Distance at Intersections for Turning Roadways	The values for stopping sight distances apply to turning roadway intersections of the same design speed (refer to Table 7.3). The length of vertical curve is determined as it is for open highway conditions (refer to the section regarding Vertical Alignment and Table 7.14).
Superelevation for Curves at Intersections	The general factors that control the maximum rates of superelevation for road conditions also apply to intersection curves.

7-01-03-07-04 *CURB RETURNS*

The minimum fall around curb returns along the flowline shall be 0.3%.

7-01-03-07-05 *CURB RETURN PROFILES*

Curb return profiles are required for radii equal to or greater than 30 feet within the public ROW. A midpoint elevation along the arc length of the curb return shall be shown in plan view for radii equal to or greater than 25 feet. Curb return design shall be set in accordance with the following design procedure. Refer to Table 7.19 for general standards for flowline control and profiles within the curb returns.

Table 7.19—General Standards for Flowline Control and Profiles Within Curb Return

Point of Tangency at Each Curb Return	Determine by the projected tangent grade beginning at the point of intersection (PI) of the flowlines.
Arc Length and External Distance of the Curb Return	Compute and indicate on the drawing.
Roadways Beyond PCR	Show the corresponding flowline (or top of curb) grade.
Design of the Flowline of the Curb Return	Maximum slope along the flowline: do not exceed +8%.

Maximum Grade Breaks at the PCR's	2% for local and collector streets 1% for arterials.
Maximum Vertical Curves	Equals the arc length of the curb return.
The Elevation and Location of the High or Low Point within the Return	If applicable, call out in the profile.
Vertical Difference in Elevation across the Street at the PCR	No more than 1'.
Scale for the Curb Return Profile	1" = 10' horizontally 1" = 1' vertically.
Curb Return	Show existing and proposed.

7-01-03-07-06 *CONNECTION WITH EXISTING ROADWAYS*

Refer to Table 7.20.

Table 7.20—Connection with Existing Roadways

Transitions	Shall be smooth conforming to normal vertical curve criteria if the algebraic difference in grade between the existing and proposed grade exceeds 0.5%.
Vertical Curve	If used for the transition, it shall: • Be fully accomplished prior to the connection with the existing improvement. • Comply with the grade requirements at intersection approaches.
Existing Grade	Show for at least 300 feet with field verified as-builts showing stations and elevations at 25-foot intervals. In the case of connection with an existing intersection, these as-builts are to be shown within a 300-foot radius of the intersection. This information will be included in the plan and profile, which shows the proposed roadway.
Limits and Characteristics of the Existing Improvement	These are the primary concern in the plan view and include horizontal alignment, off-site intersections, limits of the improvement, etc.
Previously Approved Designs for the Existing Improvement	Not an acceptable means of establishing existing grades but are to be referenced on the construction plan.
The Basis of the As-built Elevations	Shall be the same as the design elevations (both flowlines or both top of curbs, etc) when possible.

7-01-03-08 OFF-SITE DESIGN

7-01-03-08-01 *GENERAL*

The design grade of all roadways which dead end due to project phasing, subdivision boundaries, etc., shall be continued, in the same plan and profile as the previously proposed design, for at least 500 feet or to the nearest intersection. This limit shall be extended to 1,000 feet when arterial roadways are being designed.

7-01-03-08-02 *TRANSITION*

If the off-site roadway, adjacent to the proposed development is not fully improved to the required County section, the developer is responsible for the design and construction of a transition for the safe conveyance of traffic from the improved section to the existing roadway. The following formula shall be applied to the taper of lane change necessary for this transition.

$$L = \frac{WS^2}{60}$$

Where

L = Length of transition in feet
W = Width of offset in feet
S = Speed limit or 85^{th} percentile speed (mph)

The Director of the Public Works Department should be contacted in order to receive written approval of unusual transitions. This contact is the responsibility of the applicant.

7-01-03-09 ACCELERATION/DECELERATION LANES

7-01-03-09-01 *GENERAL*

The long-term performance of an arterial street system greatly depends upon the proper control of access to the roadway from adjacent properties. The location and design of access points must minimize traffic hazards and interference to through traffic movements. Acceleration/Deceleration lanes shall be designed using Chapter 8. The warrent for acceleration or deceleration lanes shall be based upon the approved Traffic Impact Study for the final plat or final development plan.

7-01-03-10 BUS PULLOUT LANES

7-01-03-10-01 *GENERAL*

If recommended by the Regional Transportation District, bus pullout lanes shall be designed according to the following criteria and constructed by the adjacent developer.

7-01-03-10-02 *DESIGN*

Refer to Table 7.21 for lead-in and lead-out lengths (based on roadway speed) for bus pullout lanes. The applicant must communicate with the Regional Transportation District to obtain further design requirement prior to submitting to the County for review and approval.

Table 7.21—Bus Pullout Lanes

Speed Limit, (mph)	Lead-In Length, (feet)	Lead-Out Length, (feet)
35 & under	60	60
40	100	70
45	150	80
50	200	90
55	250	100

Bus pullouts shall be constructed with no less than 50 feet between an intersection curb return curve (PC) and the beginning of the lead-in taper.

7-01-03-11 ENTRY STREETS

7-01-03-11-01 *GENERAL*

“Entry Streets” are generally short (160’ minimum, one block or first intersection max.) streets with no driveway access, and are designed to allow a reduction in the separation between an arterial street and the first local street intersection, or to allow more than 40 dwelling-units with a single access. Table 7.22 summarizes the posted speed limit and minimum flowline-flowline dimensions.

Table 7.22—Entry Streets

		Value
Posted Speed Limit		25 MPH.
Minimum flowline-flowline dimension	Off of arterial	40’
	Off of arterial with median island	20’ min. both sides.
	Off of collector	38’
	Off of collector with median island	20’ min. both sides

If an “Entry Street” off of a collector has a FL-FL dimension of 40’, driveways may be allowed on one side of the “Entry Street.” Entry Streets shall be posted “No Parking.”

An “Entry Street” is considered a lower classification street than a collector, but greater than a local street, therefore, for example, “Entry Street” criteria for separation between intersections along a minor collector cannot be used to place collector street within 160 feet of another intersection.

7-01-04 INSPECTION, TESTING PROCEDURES, AND CONSTRUCTION GUIDELINES

During new circulation system construction, the developer/contractor shall notify the County Inspector (minimum of 24 hours) of initiation, drastic changes in existing conditions, and completion. In addition, as-built drawings will be submitted to the County prior to final acceptance. See appropriate Application Package for as-built requirements.

7-02 PAVEMENT DESIGN AND TECHNICAL CRITERIA

7-02-01 GENERAL

This section presents pavement design standards which are based upon methodologies outlined in the "Pavement Design Standards and Construction Specifications" first published by the Metropolitan Government Pavement Engineers Council (MGPEC) in April of 1998. The intent of these design standards is to obtain a pavement section which considers not only the roadway classification, but also factors in other criteria such as: subgrade, traffic (based on local land uses), pavement material, life-cycle costs, future maintenance, and special considerations such as swelling soils, slope instabilities and frost susceptible soils.

This methodology was developed by take existing AASHTO design parameters and modify them to account for County typical subgrade soils and pavement materials so that sections have equal design life based upon fatigue. The pavement designs obtained from this procedure should have equal life and serviceability provided the minimum material specifications are met, construction recommendations are followed, and proper maintenance is provided.

All requirements within this section shall conform to the latest published version of the MGPEC manual.

7-02-02 REQUIRED DESIGN SUBMITTALS

As outlined in the "Pavement Design Standards and Construction Specifications" published by MGPEC; three design report options were developed for obtaining County approval. Two of these reports must be submitted for County review and approval prior to receiving a construction permit.

7-02-03 DESIGN CRITERIA

7-02-03-01 TRAFFIC LOADING

It is the responsibility of the engineer to determine roadway classifications (based upon criteria outlined in Section 7-02) and confirm this classification with the County prior to initiating the design. More importantly, understanding the adjacent land use and its impacts on traffic loading will enable the engineer to develop the most appropriate pavement section.

For the purpose of pavement design only, the roadway land use classifications are divided into four basic service descriptions: residential, commercial, industrial,

and collector/arterial. These classifications are defined by the projected roadway land use of the land accessed by the street (Figure 7.9). Refer to the MGPEC standards and specifications for equation definitions.

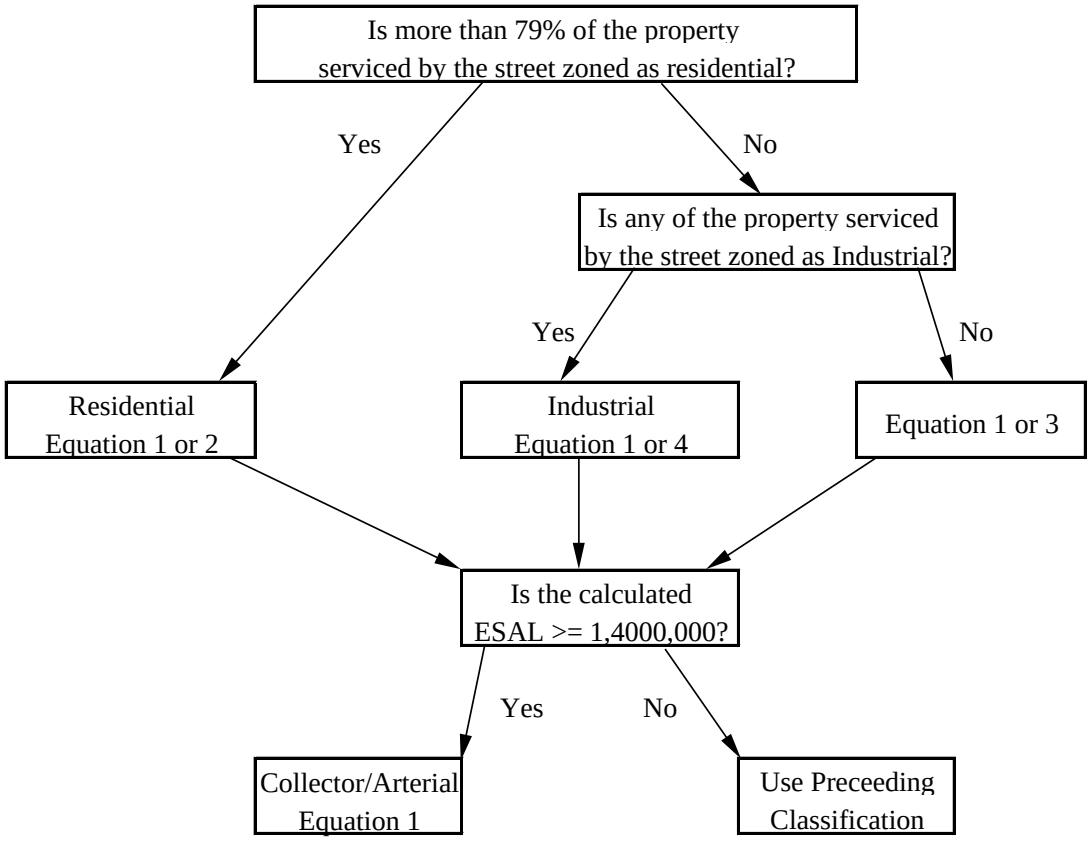


Figure 7.9—Roadway land use classification flowchart

The 20-year design ESAL (Equivalent Single Axle Load) shall be determined using data obtained from a Pavement Design Traffic Study or use of default equations for residential, commercial, and industrial streets. Refer to MGPEC standards and specifications for the equations to be used in development of the 20-year design ESAL.

7-02-03-01-01 *PAVEMENT DESIGN TRAFFIC STUDIES*

Equation 1 of the MGPEC standards and specifications requires estimates of average daily traffic volumes and distribution of traffic including a break-down of traffic by types (i.e. trucks and buses).

7-02-03-01-02 *RESIDENTIAL, COMMERCIAL, INDUSTRIAL TRAFFIC LOADS*

Refer to Table 7.23 for references to equations for residential, commercial, and industrial streets.

Table 7.23—Equations for Residential, Commercial, and Industrial Streets

	Residential	**Commercial**	**Industrial**
Traffic Loads	If a Pavement Design Traffic Study is not available, use Equation 2.	• If Pavement Design Traffic Studies are not available, use Equation 3. • This equation should not be used for commercial properties larger than 10 acres; Equation 1 should be used for those cases	• If a Pavement Design Traffic Study is not required, use Equation 4. • This equation should not be used for industrial properties larger than 10 acres; Equation 1 should be used for those cases.
Purpose		This equation is used for commercial streets that provide access to retail stores, businesses, offices, and other commercial areas.	Streets having property zoned for industrial use (manufacturing, distribution, warehousing, etc.)
Type of Traffic		Large mix of residential traffic along with trash services and delivery trucks.	Many trucks with heavy loads. Some commercial and residential traffic.
Considerations for Design	The number of residential units must include both those actually located on the street and all other residential units which use the street including adjacent existing or planned subdivisions.	In calculating ESAL's for commercial streets, future development and zoning in areas served by the street should be considered as part of the design.	Heavy truckloads.
Note: • Equation 3 is also applicable for mix use streets having both commercial and residential traffic. • All equations are defined in "Pavement Design Standards and Construction Specifications" published by MGPEC.			

7-02-03-02 SUBGRADE CHARACTERIZATION

Subgrade characterization consists of determining swell movement potential and strength values. This swell potential is used to determine the depth of moisture treatment necessary to reduce the heave at the surface. The support value is expressed in the form of Resilient Modulus as determined from unconfined strength or R-value testing.

7-02-03-02-01 *SWELLING SUBGRADE*

Tests performed for each of the soil groups shall be averaged to determine the swell potential. The highest average swell will be used to determine the depth of moisture treatment in accordance with MGPEC standards and specifications.

Moisture treatment operations will proceed until the soil moisture content is between 1 and 3 percent over optimum moisture content as determined by AASHTO T 99, and recompacted to 95 percent of Standard Proctor density.

7-02-03-02-02 *SUBGRADE STABILIZATION*

Soils requiring moisture treatment may also require subgrade stabilization operations due to the moisture contents normally causing the soils to be soft and yielding. Chemical stabilization of at least the upper 12 inches (8 inches for residential streets) may be required. Recommended chemical stabilizing agents are lime, lime/fly ash, and Portland cement. Other agents can be used with prior approval by the County and provided the mix design requirements are satisfied. Laboratory mix designs shall meet the criteria listed in the MGPEC standards and specifications.

7-02-03-02-03 *RESILIENT MODULUS*

Subgrade support characteristics for AASHTO and MGPEC Designs are measured using Resilient Modulus. Due to cost and time constraints associated with determining the Resilient Modulus, a series of correlations and alternative equations have been developed. The equations relate the R-value for sand subgrades to the modified unconfined compressive strength procedure for clay subgrades. The strength values are to be determined by laboratory testing, and converted into Resilient Modulus (M_r) using Equations 5 through 9 in the MGPEC standards and specifications. Resilient modulus values obtained from these equations shall be reduced by 25 percent unless one of the following apply:

1. A subdrain system is provided and properly maintained.
2. The subgrade is permeable (k > 1,000 ft. Per year).

3. Rural pavement with designed drainage ditches.
4. Subgrade is gneiss or granite in nature.

7-02-03-03 PAVEMENT SECTION

The pavement section being proposed will be determined using the traffic ESAL's, the Resilient Modulus, and the depth of moisture treatment and stabilization. Tire stresses and wheel loads used in the calculations will be 130 psi and 6,000 pounds (minimum).

7-02-03-03-01 *PORTLAND CEMENT CONCRETE PAVEMENT (PCCP)*

PCCP is not recommended where swells exceed 4 percent (2 percent for speed limits > 35 mph). The design shall be calculated using Equation 10 in the MGPEC standards and specifications.

Joint spacing, doweling and tie bars will be in accordance with Portland Cement Association recommendations contained in "Joint Design for Concrete Highway and Street Pavements." Dowels are required for Industrial and arterial streets for longitudinal and expansion joints.

7-02-03-03-02 *ASPHALT CEMENT CONCRETE PAVEMENT (ACCP)*

The design shall be calculated using Equation 11 in the MGPEC standards and specifications.

7-02-03-03-03 *COMBINATION SECTIONS*

Refer to MGPEC standards and specifications for a presentation of equivalent fatigue Combination sections for ACCP.

7-02-03-03-04 *PAVEMENT THICKNESS*

The design of collector or arterial streets will be confirmed using Finite Element Method or Elastic Layer Analysis. The Asphalt Institute DAMA program is preferred, but other programs such as CHEVPC, TTIPAVE, or MICHPAVE will be allowed. Trial thickness designs can be obtained using the design equations. Thickness design for PCCP shall be performed according to Equation 10 in MGPEC standards and specifications. No Finite Elastic Method or Elastic Layer Analysis is required for PCCP.

Refer to MGPEC standards and specifications for minimum pavement thickness.

7-02-03-03-05 *RESILIENT MODULUS AND POISSON'S RATIO*

Values shall be according to MGPEC standards and specifications.

7-02-03-04 LIFE CYCLE COST ANALYSES

A Life Cycle Cost Analyses (using a present worth method) may be required for pavement design approval. The discount rate will be fixed at 4 percent and the analysis period shall be 30 years. Initial and maintenance costs will be based upon "Colorado Department of Transportation Cost Data" or County supplied cost data. The maintenance schedules presented in Table 7.24 and Table 7.25 are for life cycle cost analysis only.

Table 7.24—Scheduled Maintenance for Asphalt Cement Concrete Pavements

Year	Residential	Commercial, Industrial, Collector, and Arterial
1	Fog Seal	Fog Seal
3	---	Crack Sealing
5	Crack Sealing, Fog Seal	---
6	---	Crack Sealing, Fog Seal
10	Crack Sealing, Slurry/Chip Seal	2-inch Overlay
13	---	Crack Sealing
15	2-inch Overlay	---
16	---	Crack Sealing, Fog Seal
20	Crack Sealing, Fog Seal	4-inch Planing, 3-inch Overlay
23	---	Crack Sealing
25	Crack Sealing, Slurry/Chip Seal	---
26	---	Crack Sealing, Fog Seal
30	3.5-inch Planing, 2.5-inch Overlay	2-inch Overlay
1-30	Annual Maintenance	Annual Maintenance

Table 7.25—Scheduled Maintenance for Portland Cement Concrete Pavement

Year	Residential	Commercial, Industrial, Collector and Arterial
5	---	Clean & Seal Cracks and Joints
7	Clean & Seal Cracks and Joints	---
10	---	Clean & Seal Cracks and Joints
14	Clean & Seal Cracks and Joints	---
15	---	Clean & Seal Cracks and Joints
20	Grind ½ inch as necessary (25%)	Grind ½ inch as necessary (25%)
25	---	Clean & Seal Cracks and Joints
27	Clean & Seal Cracks and Joints	---
30	---	Clean & Seal Cracks and Joints, Grind ½ inch as necessary (25%)
1-30	Annual Maintenance	Annual Maintenance

Scheduled maintenance for heavy industrial areas having distribution centers or large truck traffic volumes and collector/arterial level roadways will be based upon a rational analysis of expected pavement distress for each site, and present in the report. The County should be consulted to determine the minimum level of maintenance required for the analysis.

Life cycle costs, which are within 10 percent, will be judged to be equal and alternatives should be presented. The County has final decision authority on the alternate to be constructed.

7-03 SIDEWALKS, CURB AND GUTTER, AND DRIVEWAYS

7-03-01 GENERAL

Design of sidewalks, curb and gutter, and driveways shall meet criterion specified below and applicable federal and state standards. County Standard Drawings are shown in Appendix A.

7-03-02 REQUIRED DESIGN SUBMITTALS

Design details to be included as part of the Site Plan are outlined in the Submittals checklists. These include, but not limited to, locations, typical sidewalk, curb and gutter and driveway section(s), flowline grading and major intersection layouts. The County may require more or less detail depending on the project size and its location. Contact the Director of the Transportation Department or request a pre-application conference to determine the level most appropriate for the subject project.

7-03-03 DESIGN CRITERIA

7-03-03-01 MINIMUM SIDEWALK WIDTH

New sidewalks shall have a minimum width of 5.5 feet measured from the flowline. Expanded widths may be required in areas of heavy pedestrian traffic. In case of repair, match existing sidewalk width.

7-03-03-02 COMBINATION CURB, GUTTER AND WALK

Combination curb, gutter and walk shall be restricted to use on Local Residential streets. Vertical curb and gutter sections shall be used for all other streets.

7-03-03-03 HANDICAP RAMPS

State law requires handicap ramps be installed at all intersections and at certain mid-block locations for all new construction or reconstruction of curb and sidewalks (CRS43-2-107[2]).These ramps shall be constructed in accordance with the Standard Drawings (see Appendix A). Handicap ramps shall be shown at all curb returns or called out by a general note on the development plans, but must be shown (located) at all “T” intersections directly opposite either curb return. Where sidewalk is not continuous around a curb return, the handicap ramp shall be

constructed, and curb and gutter shall be constructed to the radius point of the adjoining street.

7-03-03-04 CURB CUTS AND DRIVEWAYS

Concentrated storm water runoff must not be discharged across the sidewalk where curb cuts or downspouts in industrial and commercial areas are located but must be directed to a sidewalk chase. The top of curb elevation shall be the same on both sides of a street, except at intersections or where superelevation is required.

Curb cuts and driveways shall be constructed in accordance with the Standard Drawing (see Appendix A) and meet access requirements outlined in Chapter 8. Radius returns and a crosspan must be used if this is not possible due to grading restraints.

Radius returns are required when the number of parking spaces serviced by the driveway exceeds ten (10). Minimum fall around curb returns shall be 0.3%. Desirable fall shall be 0.5%. See Table 7.13 for curb return radii.

7-03-03-05 UNDER-PASS/OVER-PASS PEDESTRIAN CROSSINGS

Under-pass or over-pass pedestrian crossings may be required for regional/neighborhood trails on County collectors and arterials as determined by the Parks Department.

7-03-04 MEDIAN ISLANDS

7-03-04-01 PERMANENT STRUCTURES

Permanent structures (trees, poles, large rocks, etc.) shall not be placed in any location that would obstruct the sight distance.

7-03-04-02 NOSE

The nose of the median shall not extend past the curb return at the intersection.

7-03-04-03 LANDSCAPING

Shall have a mature height of 24 inches or less above the traveled way in areas around intersections to facilitate adequate sight distance and will preferably be dry land or native vegetation. If irrigation is planned for a median island,

mitigation will be provided to protect the subgrade under the pavement form being saturated.

7-03-04-04 FLOWLINE

A minimum flowline-flowline dimension of 20 feet must be maintained on both sides of all median islands.

7-04 BRIDGES AND MAJOR DRAINAGE STRUCTURES

7-04-01 GENERAL

All bridges and major drainage structures will be designed considering factors such as loads, drainage capacities, future maintenance and safety. All culvert pipe, box culverts, guard rails, and bridges which will ultimately be maintained by County shall conform to:

1. CDOT, "Bridge Manual, Volume I and Volume II," latest edition.
2. CDOT, "Standard Specifications for Road and Bridge Construction," latest edition.
3. AASHTO "Standard Specifications for Highway Bridges," latest edition and applicable interim.

7-04-02 REQUIRED DESIGN SUBMITTALS

A complete set of project plans, analysis and specifications related to the design of any bridge and/or major drainage structure shall be submitted to the County for review and approval. The plans are to be certified by a Colorado registered Structural Engineer who is competent to perform such designs. The County may require more or less detail depending on the scope of the project. Contact the Director of the Public Works Department or request a pre-application conference to determine the level of detail most appropriate for the subject project.

New structures will be assigned a structure identification number by the County which shall be used on all design plans and specifications submitted for review.

7-04-03 CLEAR WIDTH & SPAN

Bridges and major drainage structures will be designed with a clear width equal to the width of the approach roadway including full shoulder width and any future pedestrian crossing(s) indentified in the ulitmate road crossection.

The clear span for structures crossing a roadway shall be equal to or greater than the ultimate roadway section. For structures crossing drainageways, channels or other non-roadway features, the clear span shall be approved by the agency having jurusdiction over the feature being crossed.

7-04-04 STRUCTURE DESIGN LOADING

All major structures being proposed within the County, must be designed to meet HS-25 loading or as required by the Director of the Public Works Department and/or CDOT.

7-04-05 DRAINAGE CAPACITY

Bridges and major drainage structures shall be designed to conform to the parameters of Chapter 9.

7-04-06 EROSION CONTROL

Where appropriate, the design will include measures to control erosion as per requirements and policies outlined in Chapter 9.

7-04-07 STRUCTURAL AND INSPECTION REQUIREMENTS

The complete requirements and criteria to be used for testing and inspection of Bridges are detailed in the Colorado Department of Highways Standard Specifications for Road and Bridge Construction. The design structural engineer, familiar with assumptions inherent in the structure design, shall review the construction in sufficient detail to confirm the construction is appropriate. Qualified technical personnel experienced in the inspection of similar structures shall provide inspection of construction, as frequently as necessary to confirm the construction conforms to County approved plans and specifications. A written log or report of all work shall be furnished to the County at or prior to the request for probationary acceptance of the bridge or major drainage structure.

7-05 TRENCHING AND BACKFILLING

7-05-01 GENERAL

Trenching operations within the County ROW will only be permitted after obtaining a Right of Way Construction Permit from the County. This section briefly outlines general requirements for obtaining this approval and presents standards to be used in a trench design.

7-05-02 REQUIRED DESIGN SUBMITTALS

As part of the overall project site plan, the location(s), depth and utility description shall be submitted for County review and approval.

7-05-03 DESIGN CRITERIA

7-05-03-01 TRENCHING

Table 7.26 presents general requirements for trenching operations within the County ROW. Refer to the Standard Drawings in Appendix A for typical trench sections with varying surface materials.

7-05-03-02 BACKFILLING

Refer to Table 7.27 for general requirements for backfilling open trenches.

7-05-03-03 SUBBASE

Refer to Table 7.28 for requirements on conformity, material, deviations, and procedure for subbase placement.

7-05-03-03-01 *TRENCH COVER*

Refer to Table 7.29 on general requirements for temporary and permanent trench cover.

7-05-03-03-02 *REPAIR TO GRAVEL ROADS AND SHOULDERS*

Refer to Table 7.30 on requirements for restoration of unpaved areas.

7-05-04 MAINTENANCE PERIOD

The permittee shall be responsible for the condition of the backfilled trench and permanent patching of the roadway surface for a period of one (1) year upon acceptance by the County of the completed work identified on the permit. Permanent patching shall include restoration of gravel surfaced roadways and shoulders. Upon notification by the County, the permittee shall immediately repair to the County's satisfaction any of the said patches which become settled, cracked, broken, or otherwise faulty at the expense of the permittee. If test results do not meet the standards for compaction as set forth in this section the permittee shall be responsible for repairs or replacement to meet these standards. Settlement of 3/8 inch or greater with a 6 foot straight edge will be cause for replacement.

The permittee shall notify the County in writing upon completion of work accomplished under the provisions of the permit.

7-05-05 BONDING REQUIREMENTS

A Maintenace Bond for trenching operations performed within the County's ROW will be required in the amount approved by the County shall be submitted per requirements outlined in Appendix B or as specified by the Director of the Public Works Department.

Table 7.26—Design Criteria for Trenching

Existing Pavement	• Saw cut to full depth so the joint line between existing and replacement pavement is straight and neat – i.e. within 5° of vertical and free from horizontal irregularities. • Concrete removal shall be by full panel only, per existing control joints.
Removed Pavement	Haul away and dispose of in a proper manner (recycle or waste facility).
Base Course Material	Remove and stockpile off of the road surface area for reuse during backfilling if it meets specifications. If not, haul away from the R.O.W. and dispose of in a proper manner.
Sub-base Material	Stockpile parallel to the trench alignment, in such a manner that encroachment upon the non-disturbed portion of the roadway and/or pedestrian walkways and private properties is kept to a minimum.
Trench	• Maintain safety standards relating to the shoring and stabilization of trench sidewalls as prescribed by appropriate safety regulatory agencies (OSHA, State of Colorado). All excavations to be left over night will be backfilled if not properly barricaded. Type IV Barricades will be required if construction area is in or within 10 feet of the roadway. • Do not open the trench for such construction for a distance of more than 300 feet at any one time, unless specifically authorized by the County. • Confine the trench width to those minimum dimensions, which will permit proper installation and acceptable pipe loading, as established by current acceptable engineering practices and all OSHA requirements.
Street Cuts and Trenching Operations in Public Roadways	• Do not leave street cuts in an open condition overnight, except for the portion necessary to commence work the following morning. • Warning signs, barricades and flashing lights, all in conformance with the Manual of Uniform Traffic Control Devices (MUTCD), shall be used in areas where trenching operations are in public roadways. • Type IV barricades will be required in or within 10 feet of the traffic area.
Trenched Roadway	• In trenching across the road, do not close more than one-half of the traveled way to traffic at one time, which requires the use of a traffic signal or flaggers unless approved by the Adams County Public Works Department. • Completely backfill the trenched roadway and restore a suitable driving surface before trenching the other half of the road. • Final pavement restoration can be accomplished at one time when the utility installation or repair work is complete within a maximum of five working days for the permanent surface replacement.

Table 7.26—Design criteria for trenching (continued)

Street, Road Approaches and Other Access Points	• Total Street Closure will not be permitted unless approved by the Adams County Public Works Department. • Upon trenching across such facilities, steel running plates, planks or other safe methods shall be used to provide for traffic to enter or leave the road or adjacent property.
Access	• Access to private property will be maintained at all times. • Provide free access at all times to fire hydrants.
Excavation in County Easements	• All excavation within the County's ROW will require an approved permit prior to initiating construction. • Take precautions to limit the removal of or damage to existing pavements, sidewalks, curbs, lawns, shrubbery, trees, hedges, walls, fences, buildings, or other existing improvements to the least practicable amounts and replace or restore such improvements to their original location and condition after the excavation has been backfilled and compacted.
Conditions Contained in Private Easements	Appraise all conditions contained in private easements and perform all work in accordance with the stipulations contained therein.
Trenching Excavation within the Roadway Surface	Where trenching excavation occurs within the roadway surface, the minimum allowable remaining pavement sections shall not be less than 4 feet (not including the curb and gutter or concrete pavement) unless it is part of a monolithic concrete pavement section, which shall be full panel or stone.
Road Closures	The Director of the Public Works Department must approve all scheduled and emergency road closures.

Table 7.27—Backfilling

Trench Backfill Date	• The permittee shall simultaneously notify the County of the trench backfill and construction dates. A minimum of 24 hours advance notification is required. • Backfill will take place on the same day of trenching; if this is not the case, the County must be given the same prior notice as required for the initial trenching.
Foundation	• Prepare the bottom of the trench to provide a firm foundation for the pipe or facility in accordance with the bedding conditions specified by the geotechnical engineer for the type of pipe or facility to be installed. • The foundation shall be stable and the subgrade of the trench shall be kept free of standing water.
Backfill Depth	• Place backfill so that the pipe will not be displaced or damaged.
Approved Backfill Material	• Immediately after the utility authorized by the permit has been placed in the trench, backfill the trench with approved material. This material cannot include debris of any kind, frozen material, clods, or stones. Fill with approved material to an elevation which will allow placing the pavement base and wearing surface according to the Standard Drawings. • Compaction test reports shall be required daily and all fill over one foot in elevation shall require a tester on site during backfill operation. • If the excavated material is unsuitable for backfill it shall be hauled away and satisfactory granular backfill material shall be used.
Completed Surface and Trench Compaction	• The subgrade shall conform to the lines, grades, and cross-sections as shown on the approved plans. Compact the backfill material in successive layers not to exceed 8 inches thick and finish and maintain in a smooth compacted condition. The completed surfaces shall be free from rutting or other objectionable irregularities. • Within the roadway area, trench compaction shall be in accordance with AASHTO T99 or T180 as required by the CDOT Standard Specifications. Compaction tests must be performed by a Geotechnical Engineer and shall be a minimum of every 250 feet along the trench and every one foot in elevation.
Low Slump Material	Use of an approved controlled low slump material (flowfill, shrink-crete, flashfill or equivalent) for backfill of trenches is required under all roadways or as approved by the Director of the Public Works Department. All controlled low slump material (CLSM) must have a 28-day strength of 60-100 psi, and a maximum slump of 7-10 inches.

Table 7.28—Subbase for Trenching Operations

	Subbase	**Foundation For Base Course**
Conformity	Shall conform to the lines, grades, cross-sections and thickness shown on the approved plans and shall be finished and maintained in an acceptable condition at least one day's progress in advance of base construction or placing prime coat (foundation for base course).	
Material	When placed and compacted will result in a firm, dense, unyielding foundation.	
	Subbase material shall be well mixed, free of organic matter and lumps or balls of clay, and shall consist of sound aggregate particles and suitable filler or binding materials.	
Deviations	Deviations from the gradation limits may be permitted by the Director of the Public Works Department for unpaved roads provided it can be unequivocally demonstrated that the subbase material is not conducive to rutting, raveling or forming a soft yielding surface in the presence of moisture (it is adequately demonstrated that the proposed subbase material can fulfill the intent of these specifications).	
Procedure	Material shall be deposited and spread, without particle segregation in loose layers not to exceed 6 inches in depth. Wetting or aerating and rolling of the material shall be required when ordered by the County following review of all field test results. Subbase or base course shall not be placed on soft, spongy, or frozen subgrade, other subgrade, or subbase, the stability of which is unsuitable.	
	Each layer shall be thoroughly and individually compacted to 100% of proctor (AASHTO T 99) density for soils classified as A-1 through A-2-5 and 95% proctor (AASHTO T 99) density for all other classifications (AASHTO M 145).	

Table 7.29—General Requirements for Temporary and Permanent Trench Cover

<table>
<tr><th colspan="3">Temporary</th></tr>
<tr><td colspan="2">Temporary Trench Cover</td><td>Provide all trenches across traffic lanes, where it becomes necessary to remove any existing surfacing or pavement, with temporary trench cover.
Stockpile temporary trench cover surfacing material on the job site and place within six hours after completion of trench backfill and compaction.
Maintain temporary trench cover until permanent trench cover is placed.
Trench covered with temporary surfacing will be considered as open to traffic.
The surface of the temporary repaving shall be smooth and at the same level as the adjacent undisturbed paved area.</td></tr>
<tr><td colspan="2">Pavement Surface Cuts Immediately After Backfilling</td><td>When permanent pavement-patching material is not available, a temporary patch of cold mix asphalt will be required on all pavement surface cuts immediately after backfilling has been completed and removed at the time a permanent patch is made.</td></tr>
<tr><td colspan="2">Minimum Requirements</td><td>Minimum requirements for temporary trench cover shall be well compacted surfacing material conforming to “Road Mixed Asphalt Surfacing Material” of the CDOT Standard Specifications and shall match the existing asphalt or Concrete thickness, but shall not be less than 4 inches thick. The mineral aggregate shall, with a tolerance of 5 percent, conform to the grading specified for 3/8 inch maximum aggregate. Bituminous binder to be mixed with the mineral aggregate shall be liquid asphalt, Grade MC-3000 and shall be between 5 ½ percent and 6 percent by weight of the dry mineral aggregate.</td></tr>
<tr><th colspan="3">Permanent</th></tr>
<tr><td colspan="3">Unless otherwise specified, the replacement of pavement shall be as follows:</td></tr>
<tr><td rowspan="3">In areas where wearing surface is:</td><td>Asphalt Concrete</td><td>Minimum patch thickness will be 5” on residential streets, 7” on collector streets, and 9” on arterials. In all cases, the patch will extend one (1) foot beyond the existing pavement. If the permittee or their engineer does not agree to these standards, a paving design will be submitted for review and approval by the Adams County Public Works Department. A sample of this pavement will also be submitted to the Adams County Public Works Department to ensure that the pavement sample will match the submitted design.</td></tr>
<tr><td>Portland Cement Concrete</td><td>Replace the pavement with concrete pavement conforming to the requirements of the County. Said concrete pavement replacement shall be of the same depth as the original pavement, but not less than six inches thick on alleys or residential streets, nor less than eight inches on major or secondary streets and highways.</td></tr>
<tr><td>Other</td><td>Replace the pavement and base in kind. Said surface replacement shall be of materials and thickness conforming to the requirements of the County.</td></tr>
</table>

Table 7.30—Repair to Gravel Roads and Shoulders, Restoration of Unpaved Areas

Where the original wearing surface and foundation materials was crushed rock or gravel	Use Class 6 aggregate base course as replacement material. Place to a compacted thickness minimum of 8 inches or the thickness of the removed material plus 2 inches, whichever is greater.
Compaction	In the area from the ROW line (fence line/property line) to a point 5 feet outside of the roadside ditch flowline, backfill all trenches with excavated material and compact to 90% standard compaction, or to the density of the existing ground, whichever is greater.
	Other areas including the gravel road, the shoulders and the roadside ditch to a point 5 feet outside of the flowline, all trench compaction shall be in conformance with Figure 7.21 of these standards.
Erosion Control	During construction and after the trench is backfilled and compacted, erosion protection shall be provided per Chapter 9.

7-06 UTILITY LOCATIONS

7-06-01 GENERAL

Repairs being made to County roadways or other properties, must be performed under an approved permit. At the completion of these repairs, the roadway or other properties must be returned to a condition equal to or better than the original. In addition, these repairs must be accomplished in the least possible time and with the least disturbance to the normal functioning of the street or other adjacent properties.

All backfill material, compaction, and resurfacing of any excavation made in the County ROW will be done in accordance with specifications and standards in Section 7-05.

7-06-01 ROAD CLOSINGS

Only one side of a street may be blocked at any given time. Traffic must be provided a minimum lane width of 10 feet in the construction area. Any plan for traffic control during construction that indicates a complete closure must show detour routes, and must be approved by the Director of the Public Works Department at least 24 hours prior to issuance of permit.

The applicant must get written permission from the Department of the Public Works Department to temporarily close a public road.

7-06-02 LOCATION

See Table 7.31 and Figure 7.10 through Figure 7.11 for utility location requirements and Standard Drawings (see Appendix B) for typical details.

7-06-03 INSPECTION, TESTING PROCEDURES, AND CONSTRUCTION GUIDELINES

7-06-03-01 GENERAL

Table 7.32 presents general testing requirements for installations.

7-06-03-02 SPECIFICATIONS

Road construction for new development shall conform to the latest edition of the Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction. Adams County criteria may supercede CDOT standards.

7-06-03-03 EROSION PROTECTION

Erosion and sediment control measures are essential during construction to mitigate adverse impacts to adjacent properties resulting from development. Due to both the dynamic nature of construction, and federal/state water quality guidelines, construction activity in Adams County shall require erosion protection.

In the event that one of the following situations occur:

- construction plans lack sufficient detail for erosion protection
- it has been determined that the submitted erosion control measures are not applicable to actual field conditions
- installed erosion & sediment controls are non-functional

Adams County field inspection personnel shall be able to mandate corrective action to be taken by the developer and/or contractor.

7-06-03-04 CONTRACTOR RESPONSIBLITIES

The contractor will be held responsible for the cleanliness and safety of all roadways adjacent to construction sites. If at any time, these roadways are found to be dangerous or not passable due to debris or mud, the Adams County Public Works Department will shut down the project, until the roadway conditions have been improved by the contractor, and are deemed acceptable by the County. If the contractor/applicant fails to keep the adjacent roadways clean and free from debris, the Public Works Department has the option to do the required clean up and bill the charges directly to the contractor.

Erosion and sediment control with inlet protection will be required for the storm drainage conveyance systems adjacent to construction sites. Dirt and other construction debris cannot be washed into the County's storm drainage facilities. The contractor will be held responsible to ensure that storm drainage facilities are protected during construction activity. If debris from construction activity is being washed into storm drainage facilities, the Adams County Public Works Department

will shut down the project, until the contractor cleans the affected storm drainage facility. If the contractor fails to keep the adjacent storm sewer free from debris, the Public Works Department has the option to do the required clean up and bill the charges directly to the contractor.

7-06-03-05 DAMAGED INFRASTRUCTURE

The contractor shall be responsible for repairing or replacing County infrastructure that was damaged as a result of construction activity.

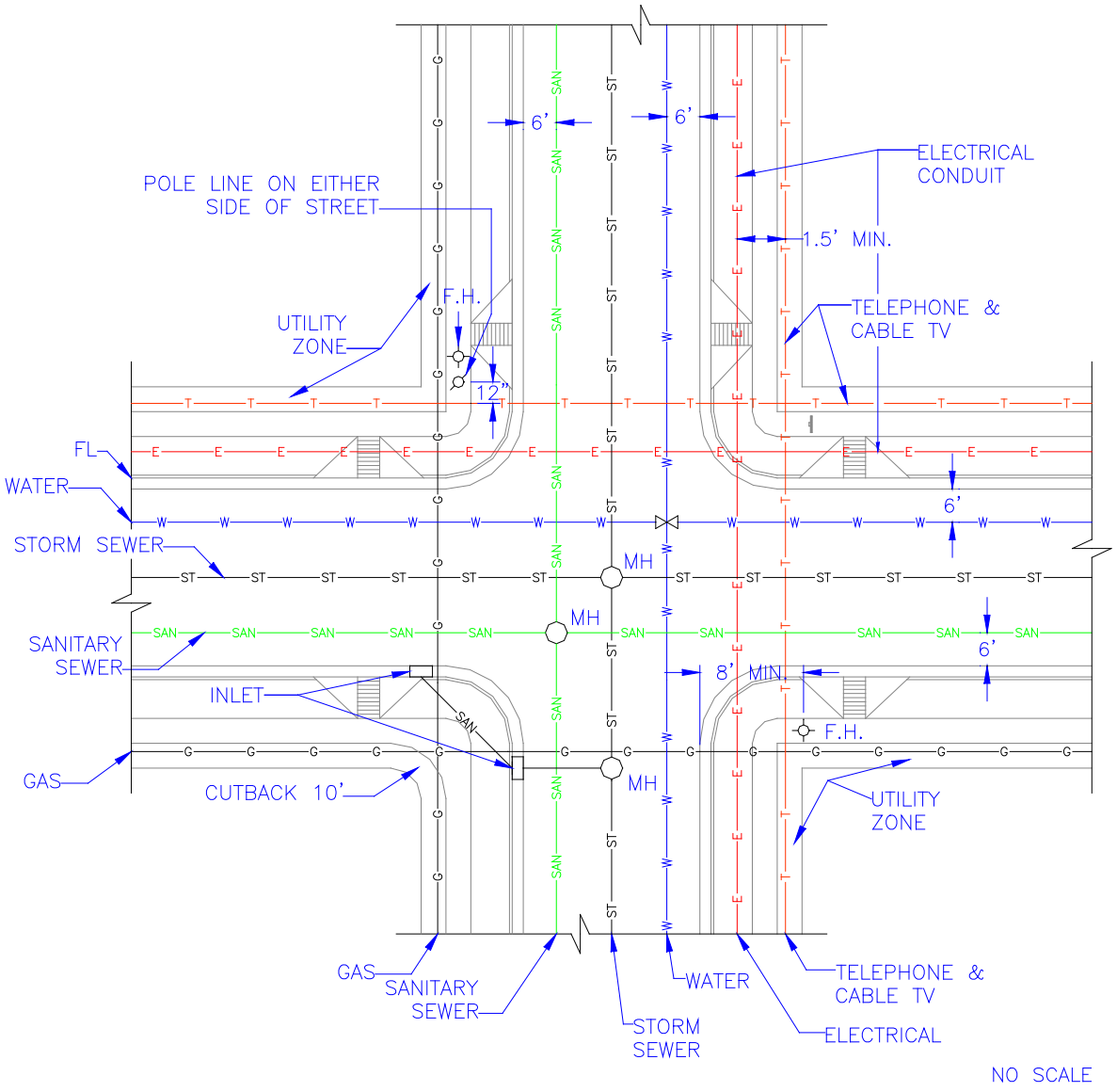
Table 7.31—General Utility Location Requirements

	Location
Water Main	North and East Sides of streets. Provide min. 10’ horizontal separation from sanitary sewer or as required by the appropriate water district.
Fire hydrant	3’ min. from back of curb, 1’ min. from back of attached walk, or 10’ minimum from edge of pavement if no curb is present
Sanitary Sewer	South and West of sides of streets
Storm Sewer	Street centerline or 3’ either side of centerline for adequate utility separation. Other locations may be considered if given written approval by Director of the Public Works Department.
Natural Gas	Either within ROW or in an adjacent easement on the South and West sides of the street or 3’ either side of centerline for adequate utility separation.[1]
Power and Telephone	North and East sides of the street either within the ROW or in an adjacent easement.[1, 2]
Cable TV, Fiber optics	North and East sides of the street either within the ROW or in an adjacent easement.[1]
Poles, signs and any other above-ground streetscape	No poles, signs, or any other above ground streetscaping should be allowed within the public right of way not directly related to any utility that is not regulated by the Public Utilities Commission, local franchise agreement, or quasi governmental agency such as a local water and sewer district. Exceptions will only be made by variance procedure of the County or granted specifically by the Adams County Board of Commissioners.
Light Poles	Min. 2’ behind a vertical curb line or 6” behind the sidewalk for attached sidewalk conditions with prior written approval by the County. Poles placed within County ROW having a posted speed limit of 40 mph or higher may be required to be breakaway, per CDOT Design Manual, Section 1002.6. Specifications for all poles within County ROW must be accepted by the Public Works Department prior to the permit application for installation.
Landscaping	Caution: Trees or large shrubs shall not be planted over buried utilities, within the sight distance triangle at intersections or accesses, or within 10’ of the flowline of the public street. On low speed (posted 30 mph or less) minor collectors and local streets, trees may be planted to within 6’ of the flowline (except within 150’ in either direction from an intersection, where the trees must be a minimum of 10’ back from the flowline). In no case shall landscaping over 30” above the adjacent flowline be allowed to encroach into the sight-distance triangle.
Overhead	A minimum ground clearance of 18.5’ shall be provided where overhead utility lines cross public roads and streets. The clearance shall be measured at the lowest point where the line crosses the traveled portion of the roadway.

1. For utility companies that wish to run double mains, the requirement of north and east/south and west may be waived by the Public Works Department.
2. Or as directed by the National Electrical Safety Code.

Table 7.32—Testing Requirements for Utility Installations

Materials, Placement and Compaction	Place all utility trenches within the ROW and compact in accordance with the project specifications.
Testing	• Field moisture-density testing: perform during backfill operations beginning 1-foot above the top of the pipe and extending to the finished subgrade elevation. • Minimum number of tests: one test within 1-foot of manholes, water valves or other obstacles. A sufficient number of tests shall be taken at various depths to confirm backfill compaction and moisture content specifications are met. • Perform testing in accordance with project specifications. • Trench Compaction within the roadway area: in accordance with AASHTO T-99 or T-180.
Bond	A bond (based on size of project) in an amount designated by the County will be required until final acceptance is received. See Appendix B for details.
Acceptance	The results of field density tests shall be submitted to and reviewed by the County. Provided all tests are acceptable, the two-year probationary period may begin. If no failures of the trenches are evident after 1 year, the County will assume maintenance obligations. Any failures must be corrected in accordance County specifications.



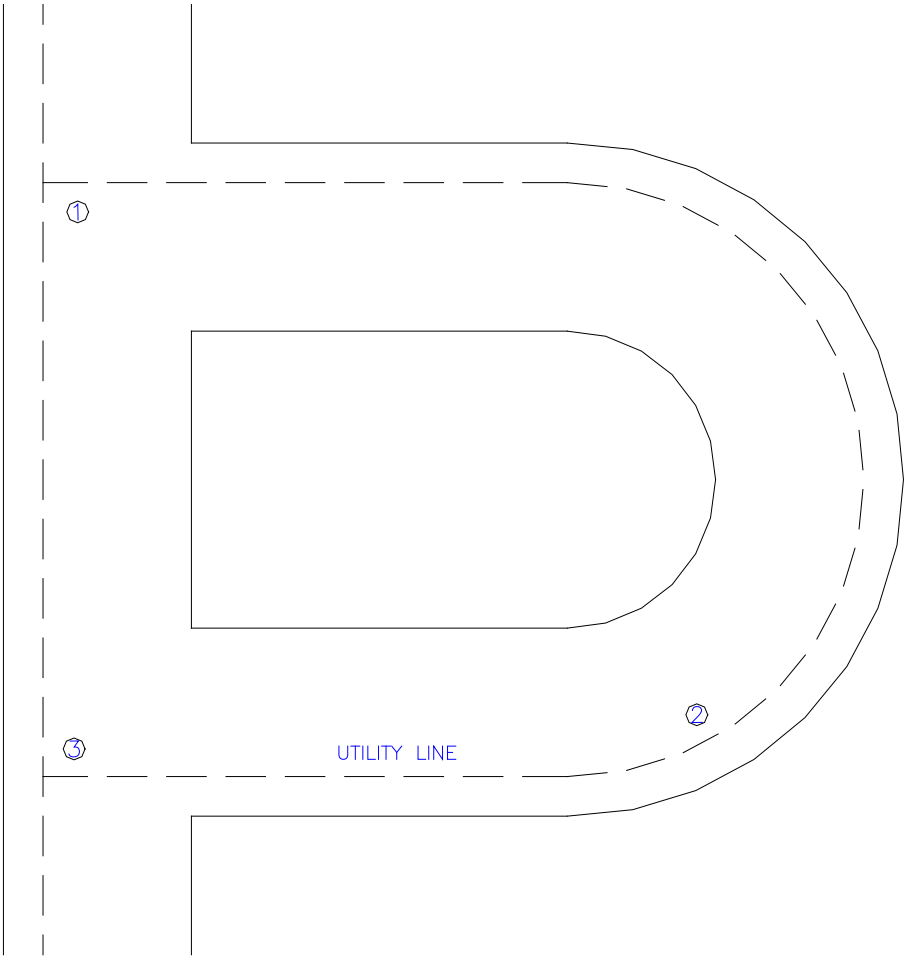
NOTES:

① THIS STANDARD IS A GUIDE ONLY AND DEVIATIONS MAY BE ACCEPTABLE WHERE THE CONDITIONS DICTATE. DIMENSIONS SHOWN ARE DESIREABLE BUT DO NOT GOVERN. THE INTENTION IS TO SHOW THE RELATIVE POSITION OF ALL UTILITIES. THIS DOES NOT PRECLUDE THE USE OF UTILITIES IN EASEMENTS IN OTHER LOCATIONS (I.E. BACK LOT LINES).

② UTILITY ZONE EASEMENT IF REQUIRED

Figure 7.10—

For Utility location requirements and Standard Drawing typical details



NOTES:

EXAMPLE OF A UTILITY RELOCATION
TO A NORMAL POSITION AT AN INTERSECTION

① CARRY UTILITY AROUND CORNER
② STAY ON SAME SIDE OF STREET.
③ RETURN UTILITY TO NORMAL SIDE OF STREET AT INTERSECTION

Figure 7.11

Utility location requirements and Standard Drawing typical details