THE EFFECTIVE DATE OF THIS ORDINANCE IS JANUARY 2, 2003

ORDINANCE NO. 02-22-318

Re: To Amend the Frederick County Roads and Streets Design Manual

RECITALS

Pursuant to the authority contained in, inter alia, the Public Local Law of Frederick County, Chapter 2-11, and the Annotated Code of Maryland, Art. 25, §1, the Board of County Commissioners of Frederick County, Maryland, in 1994, determined that it was necessary and appropriate to revise the previously enacted Roads and Street Design Manual, and by Ordinance No. 94-01-096 enacted as its replacement the present "Design Manual (Volume 1) - Streets and Roads" ("Design Manual").

Following a public hearing on April 3, 2001, the Board amended the Roads and Streets Design Manual by Ordinance No. 01-04-278.

Staff has recommended, and the Board agrees that it is appropriate at this time to again amend the Design Manual to add a section governing storm drainage conveyance.

A public hearing was held on these proposed revisions to the Design Manual on Tuesday, October 15, 2002, at which time the public was given the opportunity to comment.

NOW THEREFORE, BE IT ENACTED AND ORDAINED BY THE BOARD OF COUNTY COMMISSIONERS OF FREDERICK COUNTY, MARYLAND, that the Frederick County Roads & Streets Design Manual is hereby amended by the addition of Section 4.0 Storm Drainage Conveyance as set forth on the attached Exhibit A hereto.

pc: CAO, Hudak, Smith, Horn, Grossnickle, File

AND BE IT FURTHER ENACTED AND ORDAINED, that this Ordinance shall take effect on January 2, 2003.

AND BE IT FURTHER ENACTED AND ORDAINED, that Exhibit A hereto shall not be incorporated into the Frederick County Code 1979, but shall be reproduced as part of the Roads and Street Design Manual, a separate publication, and made available to interested persons through the Division of Public Works.

THE UNDERSIGNED HEREBY CERTIFIES that the foregoing Ordinance was approved and adopted by the Board of County Commissioners of Frederick County, Maryland on the 29th day of October, 2002.

ATTEST:

Douglas D. Browning
Acting County Manager
10/29/02

BOARD OF COUNTY COMMISSIONERS
OF FREDERICK COUNTY, MARYLAND

By: _____
Terre R. Rhoderick, Vice President

THE EFFECTIVE DATE OF THIS ORDINANCE IS MAY 1, 2001

ORDINANCE NO. 01-04-278

Re: To Amend the Frederick County Roads and Streets Design Manual

RECITALS

Pursuant to the authority contained in, inter alia, the Public Local Law of Frederick County, Chapter 2-11, and the Annotated Code of Maryland, Art. 25, §1, the Board of County Commissioners of Frederick County, Maryland, in 1994, determined that it was necessary and appropriate to revise the previously enacted Roads and Street Design Manual, and by Ordinance No. 94-01-096 enacted as its replacement the present "Design Manual (Volume 1) - Streets and Roads" ("Design Manual").

Staff has recommended, and the Board agrees that it is appropriate at this time to amend the Design Manual to add a section governing Pavement Design, and to replace Appendix 7 and add Appendixes 7A and 20.

A public hearing was held on these proposed revisions to the Design Manual on Tuesday, April 3, 2001, at which time the public was given the opportunity to comment.

NOW THEREFORE, BE IT ENACTED AND ORDAINED BY THE BOARD OF COUNTY COMMISSIONERS OF FREDERICK COUNTY, MARYLAND, that the Frederick County Roads & Streets Design Manual is hereby amended by the addition of Section 3.0 Pavement Design, and the Appendix is modified by the replacement of Appendix 7, and the addition of Appendixes 7A and 20 as set forth on the attached Exhibit A hereto.

pc: BoC, Co. Atty, DPW, File

AND BE IT FURTHER ENACTED AND ORDAINED, that this Ordinance shall take effect on May 1, 2001.

AND BE IT FURTHER ENACTED AND ORDAINED, that Exhibit A hereto shall not be incorporated into the Frederick County Code 1979, but shall be reproduced as a separate publication and made available to interested persons through the Division of Public Works.

THE UNDERSIGNED HEREBY CERTIFIES that the foregoing Ordinance was approved and adopted by the Board of County Commissioners of Frederick County, Maryland on the 3rd day of April, 2001.

ATTEST:

Ronald A. Hart, County Manager

RAH 4/4/01

BOARD OF COUNTY COMMISSIONERS
OF FREDERICK COUNTY, MARYLAND

By: David P. Gray
David P. Gray, President

THE EFFECTIVE DATE OF THIS ORDINANCE IS June 1, 1994

ORDINANCE NO. 94-01-096

Re: TO REPEAL AND REENACT WITH AMENDMENTS THE FREDERICK COUNTY ROADS AND STREETS DESIGN MANUAL

RECITALS

Pursuant to the authority contained in, inter alia, the Public Local Law of Frederick County, Chapter 2-11, and the Annotated Code of Maryland, Art. 25, §1, the Board of County Commissioners of Frederick County, Maryland has determined that it is necessary and appropriate to revise the previously enacted Roads and Street Design Manual (Ordinance No. 76-3-63), and to enact as its replacement the document set forth as Exhibit A hereto.

A public hearing was held on the proposed Roads & Streets Design Manual on Tuesday, August 3, 1993, at which time the public was given the opportunity to comment. A second hearing was held on April 5, 1994 to receive comments on the revised document.

NOW, THEREFORE, BE IT ENACTED AND ORDAINED BY THE BOARD OF COUNTY COMMISSIONERS OF FREDERICK COUNTY, MARYLAND, that the Frederick County Roads & Streets Design Manual as set forth on the attached Exhibit A hereto be enacted as the new regulations for the purposes therein specified.

AND BE IT FURTHER ENACTED AND ORDAINED, that this Ordinance shall take effect on June 1, 1994.

AND BE IT FURTHER ENACTED AND ORDAINED, that Ordinance No. 76-3-63 is repealed in its entirety, effective May 31, 1994.

AND BE IT FURTHER ENACTED AND ORDAINED, that Exhibit A

hereto shall not be incorporated into the Frederick County Code 1979, but shall be reproduced as a separate publication and made available to interested persons through the Department of Public Works.

The undersigned hereby certifies that the aforegoing Ordinance was approved and adopted on the 5th day of April, 1994.

ATTEST:

Dawn Hatzer
Administrative Officer

BOARD OF COUNTY COMMISSIONERS
OF FREDERICK COUNTY

By
Ronald L. Sundergill
President

ACKNOWLEDGMENT

At the request of the Land Use Council of the Frederick County Builders Association and with the support and endorsement of the Frederick County Board of County Commissioners and Planning Commission, the Frederick County Road Code Committee was formed and the first meeting held in July 1991. The prime goal of the Committee was to review and rewrite as necessary, the existing Streets and Roads Design Manual. A committee consisting of engineering, developer and contractor representatives, coupled with County staff, met over the past two years on a biweekly schedule. The resultant product is a new Design Manual. A special acknowledgment goes out to Seawright Catering who made the 8:00 a.m. Friday meetings more tolerable with their supply of bagels and cream cheese.

The Committee consisted of the following individuals:

Michael H. Shifler, P.E., Chair (Fox & Associates, Inc.)
William Brennan (KCI Tecnologies, Inc.)
Anthony R. Giancola, P.E. (Frederick County Public Works)
Charles P. Gilmore, P.E. (KCI Technologies, Inc.)
Bradley Guyton (Morgan - Keller, Inc.)
Stephen P. Oder, P.E. (Ausherman Construction Co.)
D. Stephen Seawright (Seawright Corporation)
James R. Shaw (Frederick County Planning & Zoning)
Neil Spiller (Frederick County Public Works)
Elisabeth S. Smith, P.E. (Frederick County Public Works)
Michael Smariga, P.E. (Harris, Smariga & Associates)
Michael C. Thompson (Frederick County Planning & Zoning)
Douglas L. Trettien, R.L.A. (Landscape Architect)

DESIGN MANUAL (VOLUME 1) - STREETS AND ROADS
(March 1994)

Table of Contents

Page No.

Page No.

Amended January 2003

DESIGN MANUAL (Volume 1) – STREETS AND ROADS

(March 1994)

1.0 GENERAL DESIGN GUIDELINES

1.01 Introduction:

Local residential streets are part and parcels of the neighborhoods they serve. People live on them. It is desirable, therefore, to not only move traffic safely and efficiently but to provide a residential neighborhood that is quiet, safe, pleasant, convenient, and sociable. Streets should be designed to serve the neighborhoods and we have attempted to set these standards. In addition, guidance on non-residential streets is provided.

Modifications (waivers) to the recommendations and requirements of this manual for Chapters 1 and 2 may be pursued under the authority granted by the Frederick County Subdivision Ordinance, Section 1-16-30. Modifications for Chapters 3 and 4 may be granted by the Director of Frederick County Division of Public Works or a designee.

1.02 Purpose:

The purpose of the provisions for local residential streets is to establish appropriate standards for the design of streets in residential subdivisions that will (1) promote the safety and convenience of vehicular traffic, (2) protect the safety of neighborhood residents, (3) minimize the long term costs for the maintenance and repair of streets, (4) minimize crime in residential areas , (5) protect residential qualities of neighborhoods by limiting traffic volume, traffic speed, noise, and air pollution, (6) encourage the efficient use of land, (7) minimize the cost of street construction and thereby restrain the rise of housing costs, (8) minimize the construction of impervious surface, thereby protecting the quantity and quality of the County water resources, and (9) encourage and promote pedestrian circulation. Non-residential streets have larger design parameters than local residential streets in order to account for greater traffic volumes and increased truck traffic.

1.03 Street Hierarchy

An ideal street system separates routes which carry traffic passing through An area from streets which provide access to people within the area. All residential streets between these two extremes can be described in terms of their relative service for through-traffic movement and property access. Movement and access criteria can form the basis for an ordered classification system and appropriate design standards. A street hierarchy system is, therefore, vital in promoting safety, ensuring residential quality and maintenance efficiency, preventing crime, allowing land use efficiency, lowering housing costs, and fostering environmental protection. Frederick County requires all new streets to conform to the design standards of residential local access, sub-collector, or collector streets depending upon the manner in which the street will be used. Similarly in the hierarchy of streets a need for special purpose and non-residential streets exists. The non-residential streets are intended for the main movement of through traffic or distributed traffic (i.e. collectors and arterials) or alternatively, the delivery of traffic through and about localized retail or industrial hub.

1.0 GENERAL DESIGN GUIDELINES:

1.01 Introduction:

Local residential streets are part and parcels of the neighborhoods they serve. People live on them. It is desirable, therefore, to not only move traffic safely and efficiently but to provide a residential neighborhood that is quiet, safe, pleasant, convenient, and sociable. Streets should be designed to serve the neighborhoods and we have attempted to set these standards. In addition, guidance on non-residential streets is provided.

Modifications (waivers) to the recommendations and requirements of this manual may be pursued under the authority granted by the Frederick County Subdivision Ordinance, Section 1-16-30.

1.02. Purpose:

The purpose of the provisions for local residential streets is to establish appropriate standards for the design of streets in residential subdivisions that will (1) promote the safety and convenience of vehicular traffic, (2) protect the safety of neighborhood residents, (3) minimize the long term costs for the maintenance and repair of streets, (4) minimize crime in residential areas, (5) protect the residential qualities of neighborhoods by limiting traffic volume, traffic speed, noise, and air pollution, (6) encourage the efficient use of land, (7) minimize the cost of street construction and thereby restrain the rise in housing costs, (8) minimize the construction of impervious surface, thereby, protecting the quantity and quality of the County water resources, and (9) encourage and promote pedestrian circulation. Non-residential streets have larger design parameters than local residential streets in order to account for greater traffic volumes and increased truck traffic.

1.03. Street Hierarchy:

An ideal street system separates routes which carry traffic passing through an area from streets which provide access to people within the area. All residential streets between these two extremes can be described in terms of their relative service for through-traffic movement and property access. Movement and access criteria can form the basis for an ordered classification system and appropriate design standards. A street hierarchy system is, therefore, vital in promoting safety, ensuring residential quality and maintenance efficiency, preventing crime, allowing land use efficiency, lowering housing costs, and fostering environmental protection. Frederick County requires all new streets to conform to the design standards of residential local access, subcollector, or collector streets depending upon the manner in which the street will be used. Similarly in the hierarchy of streets a need for special purpose and non-residential streets exists. The non-residential streets are intended for the main movement of through traffic or distributed traffic (i.e. collectors and arterials) or alternately, the delivery of traffic through and about localized retail or industrial hub

Table 1

VARIOUS STREET DESIGN OPTIONS

SEE APPENDIX NO.	QUICK REFERENCE CODE	HIERARCHY	ROW (feet)	PAVEMENT	MEDIAN SIZE	FOR USE WITH DENSITY	DESCRIPTION
RESIDENTIAL STREETS							
1, 2	A(a)	Residential Local Access Street	50	1 @ 20'	NA	L	Two 10' lanes/Open section/see note (a) regarding SW location
3	B	Residential Local Access Street	50	1 @ 22'	NA	Lh	Two 11' lanes/Open section
4	C	Residential Local Access Street	50	1 @ 20'	NA	L	Two 10' lanes/Open section/7' shoulder and 5' grass shoulder
5	D	Residential Local Access Street	50	1 @ 26'(b)	NA	L,M,Lh	Two 13' lanes/Closed section/7' grass strips/SW both sides
5	E	Residential Local Access Street	50	1 @ 28'(c)	NA	H,Mh	Two 10' lanes w/8' parking lane/Closed section/6' grass strips/SW both sides
5	F	Residential Local Access Street	50	1 @ 32'(b)	NA	Hh	Two 12' lanes w/parking either side/Closed section/4' grass strips/2 SW's
9, 10	G(d)	Residential Local Sub-collector	50	1 @ 24'	(d)	L,Lh	Two 12' lanes/Open section/6' grass shoulder
9	H	Residential Local Sub-collector	50	1 @ 32'	NA	All	Two 12' lanes w/8' parking either side/Closed section/4'4" grass plus 4' SW each side
11	I	Residential Local Collector	60	1 @ 22'	NA	L	Two 11' lanes/Open section/7' grass shoulders/two 4' SW's/8' ditches
11	J	Residential Local Collector	60	1 @ 28'	NA	All	Two 14' lanes/Closed section/11'4" grass plus 4' SW each side
12	K	Residential Local Collector	60+med.	2 @ 12'	10' min.	L	2 each: One 12' lane/Open section with SW's
12	L	Residential Local Collector	60+med.	2 @ 14'	10' min.	All	2 each: One 14' lane/Closed section with SW's
NON-RESIDENTIAL STREETS							
15	M(d)	Rural Collector Road	60	1 @ 22'	ROW(d)	NA	Two 11' lanes/Open section/8' grass shoulders
16	N(d)	Commercial Collector Road	60	1 @ 46'	ROW(d)	NA	As needed, 2-4 lanes/ Closed section/ 6'4" seeded slopes
17	O(d)	Industrial Collector Road /Open	60	1 @ 24'	ROW(d)	NA	Two 12' lanes/Open section/6' grass shoulders/8' ditches
17	P(d)	Industrial Collector Road /Closed	60	1 @ 28'	ROW(d)	NA	Two 14' lanes/Closed section/11'4" grass
18	Q	Minor Arterial, Open Section	80	1 @ 24-40'	NA	NA	Two 12' lanes w/8' paved or stab'd shoulders/Open section
18	R	Minor Arterial, Closed Section	80	1 @ 40'	NA	NA	Combination travel & parking lanes/Closed section/19'4" seeded slopes
19	S	Major Arterial, Open Section	100	2 @ 22-32'	12' grass	NA	2 each: Two 11' lanes w/10' paved or stab'd shoulders/Open section/16' grass median
19	T	Major Arterial, Closed Section	100	2 @ 32'	14' conc.	NA	2 each: Two 12' lns. and 8' parking lane/Closed section/16' median

a) Placement of single sidewalk can be "inside" or "outside" the ditch. See Appendix 1 and 2, respectively.
b) Intended to accommodate scattered parking on both sides of the street
c) Intended for 8' parking lane designated on only one side of street. Opposite side should be signed "No Parking".
d) Can also be designed with a median. Add median width "W" to basic ROW.

NA = Not Applicable
L=Low M=Medium H=High SW=Sidewalk
Lh= Low/hilly Mh= Medium/hilly Hh=High/hilly

File/lle: RDCT

centers (i.e. commercial and industrial streets). The design standards for each type of street have been incorporated into the ordinance as minimum requirements. Table 1 summarizes the various street design options which will be discussed in greater detail in this manual. Each proposed street shall be classified and designed for its entire length to meet or exceed the minimum standards for one of the following street types:

(a) Residential Local Access Street:

This is the lowest order street in the hierarchy. It is intended to carry the least amount of traffic at the lowest speed and provide the safest and most desirable environment for a residential neighborhood. Developments should be designed so that the maximum number possible of homes will front on this classification of streets.

(b) Residential Subcollector Street:

This is the middle order street in the residential hierarchy. It will carry more traffic than the residential access street, have lot access and provide for through traffic and on-street parking. It should provide an acceptable, if not an optimum, environment for a residential neighborhood.

(c) Residential Collector Street:

This is the highest order street that could be classed as residential. It will carry the largest volume of traffic at higher speeds. In large residential developments, this class of street may be necessary to carry traffic from one neighborhood to another or from the neighborhood to streets connecting to other areas in the community. This level of street is unsuitable for providing direct access to homes and such access should be avoided.

(d) Special Purpose Streets:

Under special circumstances a new residential street may be classified and defined as one of the following:

(1) Alley:

An alley is a special type of street which provides a limited, i.e., access to parking or trash collection, cut-through secondary means of access to lots. It will normally be on the same level in the hierarchy as a residential access street, although different design standards will apply. Refer to Section 2.01.12.

(2) Marginal Access Street:

A marginal access street is a street parallel and adjacent to a collector or higher level street which provides access to abutting properties and separation from through traffic. It may be designed at the level of a residential access street or a residential subcollector as anticipated traffic volumes will dictate.

(3) Median Divided Streets:

For the purpose of protecting environmental and aesthetic features or avoiding excessive grading, or to provide two points of ingress/egress in case of long cul-de-sacs the County may require that the street be divided. In such a case, the design standards shall be applied to the aggregate dimensions of the two street segments.

e. Non-Residential Streets:

Higher order non-residential streets exist and normally provide through traffic in a subdivision or to handle the needs of industrial and commercial traffic. These include:

(1) Collectors:

Primarily provide intracounty access. They are spaced to connect residential and employment populations with like generators. The rural collectors provide service to the scattered smaller communities, and the commercial and industrial collectors accumulate traffic from local urban streets.

(2) Arterials:

Provide the primary access to the expressway system and supplement the system by providing inter and intra County access through the more rural areas. Efficient movement is the primary function of arterial roads, hence, private access and frontage should be controlled and limited to high-volume generators of vehicle trips.

(3) Freeways and Expressways:

Are limited access interregional arterial routes ("superhighways"). They are designed exclusively for unrestricted movement, have no private access, and intersect only with selected arterial highways or major streets by means of interchanges engineered for free-flowing movement.

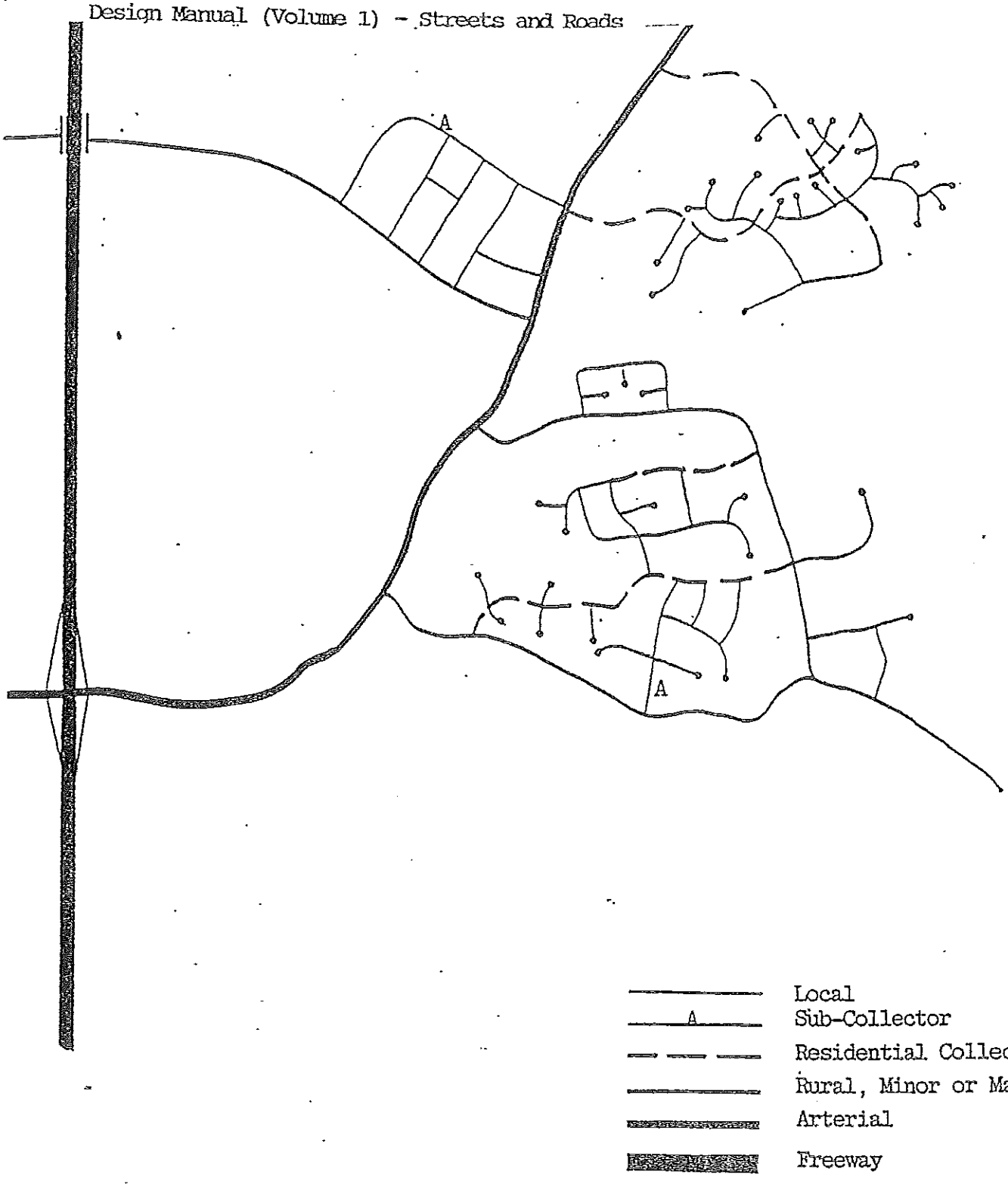
1.04. Planning Guidelines:

As a guide only, the average daily traffic (ADT) figures listed below can be used to initially outline residential street designations. This, however, is only an indicator and criteria outlined later should be used for specific design requirements.

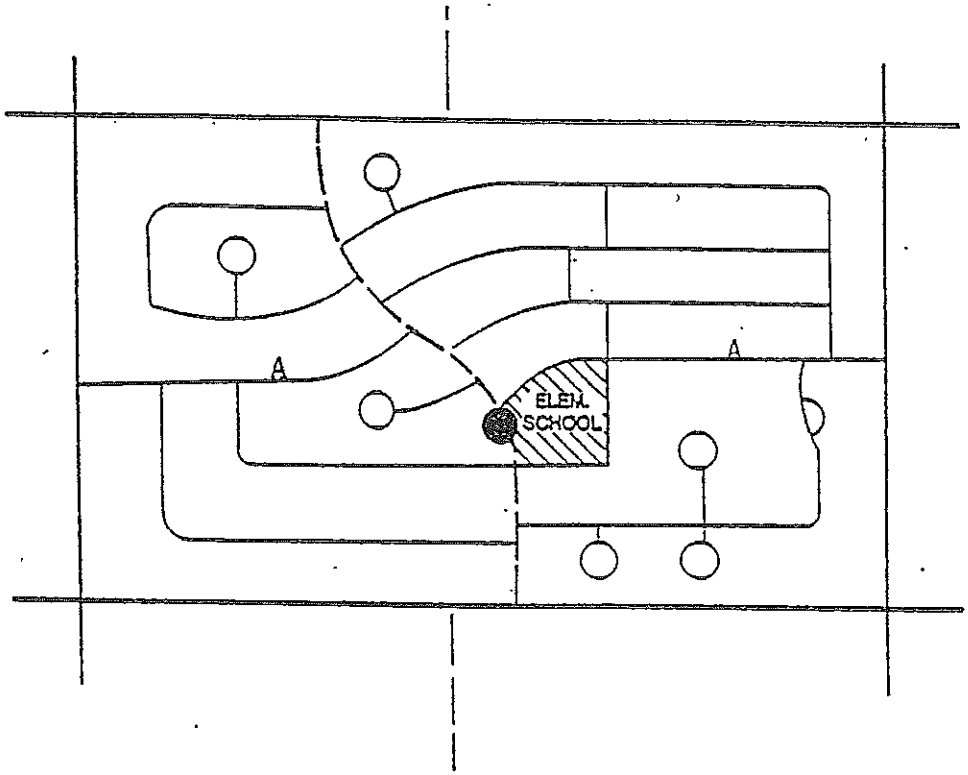
Designation	ADT
Residential Local access	250 or less
Residential Subcollector	200 - 2,500
Residential Collector	2,000 - 4,000
Higher classification	3,000 or greater

1.05. Existing Streets:

Each street abutting or affecting the design of a subdivision or land development which is not already classified in the comprehensive plan shall be classified to its function, design and use by the County at the request of the applicant or during plan review. The classification of existing streets shall include the hierarchy noted above or classification of higher order as determined by the County. Refer to Figures 1 & 2 for a further understanding of how each type of street relates to another.



COUNTY WIDE RELATIONAL STREET HIERARCHY
FIGURE 1



——— Local
—A— Sub-Collector
— — Residential Collector
═══ Major or Minor Rural Collector

RELATIONAL STREET HIERARCHY WITHIN A DEVELOPMENT
FIGURE 2

2.0 SPECIFIC DESIGN GUIDELINES

2.01. RESIDENTIAL LOCAL ACCESS STREET DESIGN:

Figure 3 provides a worksheet for determining local access street options. Table No. 2 provides an outline of design factors and street standards. Items are assigned reference paragraphs to provide explanatory notes which are intended to amplify and clarify specific standards.

2.01.01 Road Grade Classification:

Where the grade is 9 to 12 percent for over 25 percent or more of the road's entire length, the designation "Hilly" shall apply. Otherwise, the road grade shall be considered "nominal." A grade of over 12 percent at any point shall not be allowed. A grade below 1% for closed and open section roads shall not be allowed.

2.01.02 Development Density:

Figures for density classification in terms of existing zoning designations are as noted. Streets fronting minimum lot widths of less than 80' or serving average lot areas of less than 15,000 s.f. will be closed section.

(1) Low density - Agricultural, conservation, and R-1* and R-3*

(2) Medium density - R-5*, R-8, and PUD's

(3) High density - R-12, R-16, and PUD's

*Except in approved cluster developments

2.01.03 Right-of-Way Width:

Sufficient right-of-way is required to contain the elements of:

(1) Pavement and/or curbing

(2) Sidewalks, where indicated on specific cross-sections

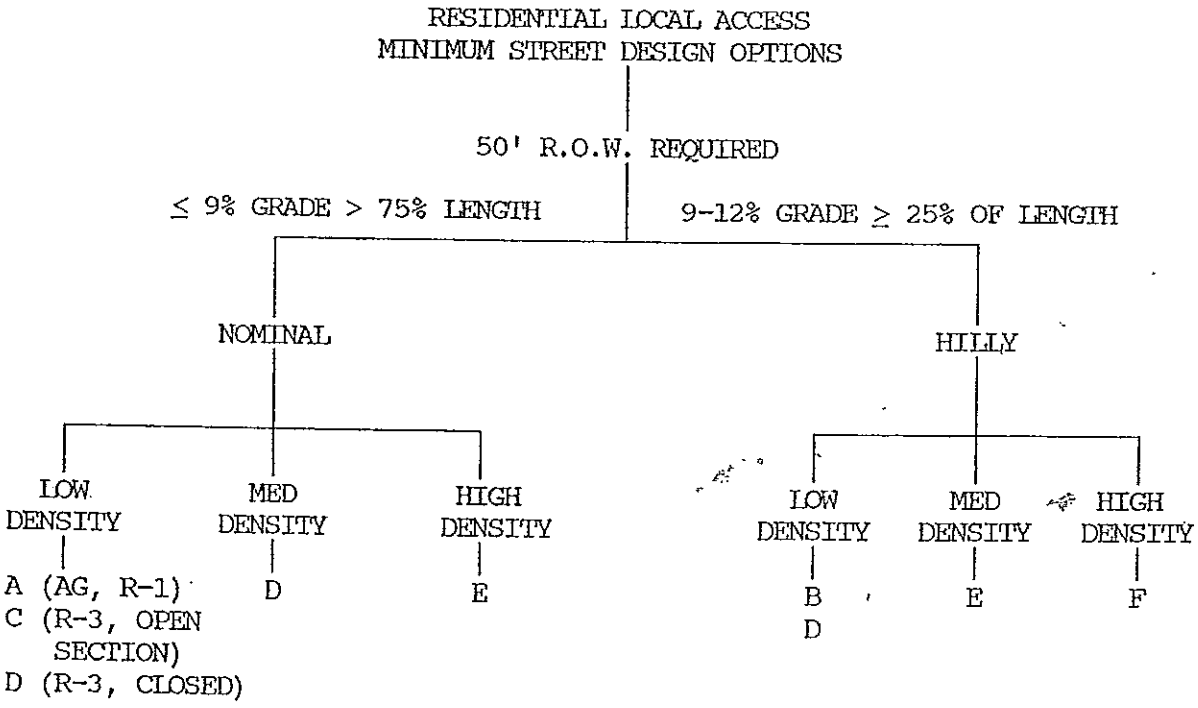
(3) Street appurtenances customarily installed in border areas; such as, traffic signs, street trees, utility lines (overhead and underground).

(4) A moderate amount of cross section grading, including shoulders where utilized.

A 50-foot basic right-of-way width is required for local streets except that a 40-foot right-of-way may be utilized for closed section roads in medium density (nominal and hilly) and low density hilly subdivisions served by public water and sewer.

In no case is it recommended that full grading of the entire right-of-way be mandatory. Where necessary, front yard (and corner lot side yard) easements may be considered for utilities and/or sidewalks or plantings.

WORKSHEET



BASIC DESCRIPTION (SEE SCHEMATIC FOR COMPLETE NOTES)

A(1) OPEN SECTION, 20' PAVED, SIDEWALK, "INSIDE" THE DITCH, 3-5' SHOULDERS.
A(2) OPEN SECTION, 20' PAVED, SIDEWALK, "OUTSIDE" THE DITCH, 3' SHOULDERS.
B OPEN SECTION, 22' PAVED WITH 8' SHOULDERS + 1 SIDEWALK.
C OPEN SECTION, 20' PAVED WITH 5' AND 7' SHOULDERS + 1 SIDEWALK.
D CLOSED SECTION, 26' PAVED WITH 7' GRASS STRIPS + 2 SIDEWALKS.
E CLOSED SECTION, 28' PAVED WITH 7' GRASS STRIPS + 2 SIDEWALKS.
F CLOSED SECTION, 32' PAVED WITH 4' GRASS STRIPS + 2 SIDEWALKS.

See text for more detailed discussion of when sidewalks are warranted.

Frederick County Department of Public Works	Revisions		RESIDENTIAL LOCAL ACCESS STREET OPTIONS	Detail No. DM WKS01
	Date	Note		Date: 94

Figure 3

TABLE 2
LOCAL ACCESS STREET DESIGN GUIDELINES

REFERENCE NUMBER							
2.01.01	Road Grade Classification	Nominal			Hilly		
2.01.02	Development Density	LOW	MEDIUM	HIGH	LOW	MEDIUM	HIGH
2.01.03	Right-of-Way Width (ft)	50	50*	50	50*	50*	50
2.01.04	Pavement Width (ft)	20/26	26	28	26*	28	32
2.01.05	Type of Curb: V = vertical face R = roll-type O = none	O/R/V	O/R/V	R/V	V/R*	V	V
2.01.06	Sidewalks (ft)	< ---------- 4 ---------- >					
2.01.07	Sidewalk Distance from Curb Face (ft) Edge Pavement	< ---------- 5 ---------- >					
2.01.08	Minimum Stopping Sight Distance (ft)	< ------ 200 ------- >			< ---120 - 200 --- >		
2.01.09	Minimum Intersection Sight Distance	< ---------- 300 ---------- >					
2.01.10	Maximum Cul-de-sac Length (ft)	1,800	1,000	700	1,800	1,000	700
2.01.11	Minimum Cul-de-sac Radius	< ----------See Discussion---------- >					
2.01.12	Alley Policy and Width	< ----------See Discussion---------- >					
2.01.13	Design Speed (mph)	< ---------- 30 mph or less ---------- >					
2.01.14	Minimum Centerline Radius of Curves (ft)	< ----------125---------- >					
2.01.15	Minimum Tangent Between Reverse Curves (ft)	< ----------50---------- >					
2.01.16	On-Street Parking	< ----------See Discussion---------- >					
2.01.17	Driveway Aprons	< ----------See Discussion---------- >					
2.01.18	Private Streets	< ----------See Discussion---------- >					
2.01.19	Vertical Curves	< ----------See Discussion---------- >					

* For variations and exceptions refer to text discussion.

2.01.04 Pavement Width:

A minimum pavement width must allow safe passage of moving traffic in each direction, exclusive of other interferences, such as conventional on-street parking. Such parking will occur occasionally within all residential subdivisions. The rate of occurrence will be a function of density, off-street parking code requirements, and County ordinances. Refer to Section 2.01.16. Appendices 1, 2, 3, and 4 provide some alternative cross section schemes for open-section roads. For closed-sections, Appendix 5 provides sample cross section schemes.

As density of land use increases, the probability of curb parking increases. Pedestrian traffic is also higher. Widths of 26 or 28 feet, with curbs, are recommended for the medium density developments depending on the terrain classification.

In the higher density areas, frequently comprising apartment developments, curb parking increases still more. Parking may be expected to be found on both sides of the street. Traffic volumes are also higher with greater likelihood of two opposing vehicles meeting one another adjacent to curb-parked vehicles. The 28-foot minimum width provides for continuous movement at reasonable rates of speed for the nominal terrain classification, while for hilly terrain the minimum 32-foot width is required. A second variable of street width concerns the horizontal alignment. As terrain becomes more difficult, frequency of curves increases. In the low and medium density areas, consideration should be given to wider streets in hilly terrain. This does not apply to the high density area, where adequate width for clear passing is required as basic.

One function of an improved shoulder on open-section roads is to provide for pedestrians and bicycle riders. On-street parking is infrequent in very low density areas and conflict should not normally develop between shoulder parking and pedestrian or bicycle rider usage. While a minimum width of 26 feet closed section is required for low density development in hilly terrains, if storm drainage computations indicate no difficulties, this could be reduced to 22 feet open section upon request and approval.

In an effort to enhance as well as maintain the scenic beauty of our streets and roads, varying shoulder widths will be entertained. Issues to consider are:

1. Sidewalks: For open section roads, sidewalks will be provided, at a minimum, on one side of the street (except in R-1 density).

2. Drainage Ditches: Treatments will vary with existing conditions (drainage volumes, trees, driveways, etc.).

When a school or park is located within a single-family residential area, the adjacent street may require a greater width to accommodate increased traffic and possibly added curb parking.

2.01.05 Type of Curb:

Generally, the need for open or closed (curb required) sections will be determined by lot width. Streets fronting minimum lot widths of less than 80' or serving minimum lot areas of less than 15,000 s.f. will be closed section. Mountable curbs, as shown in Appendix 6 or Maryland State Highway Administration "Type A" or "Type B" vertical curbs, are allowed on residential local access and subcollector streets.

Closed section roads will be required in the hilly classification. However, in the low density, hilly designation, and where it can be justified that storm drainage has been adequately addressed, a 22-foot, open section option will be considered.

The advantages of vertical curb are:

(1) Pedestrians, street trees, utilities, and signs are best protected by the vertical curb.

(2) A positive limit of vehicle encroachment on the border area is established. This minimizes parkway erosion and also reduces probability of vehicles sliding off the roadway under unfavorable pavement and weather conditions.

(3) Depression of curb is required at driveways. Such depression is desirable for clear identification of driveway, which minimizes blockage by curb parkers.

(4) Excellent drainage control may be maintained by either variable height or standard height curb.

(5) Provides improved control of potential parked runaway vehicles.

The advantages of mountable curb are:

(1) It is slightly less expensive than the vertical type.

(2) Some persons feel that the mountable curb is the more aesthetically pleasing.

(3) Less costly driveway construction can be employed without curb depression. This allows the subdivider and developer certain flexibility in their construction, in that driveway locations are not required to be determined prior to curb installation.

The advantages of open section roads are:

(1) The soft edges of the road create a more rural feel.

(2) Grass lined drainage ways provide for removal of nutrients in surface runoff, and thereby, help to improve water quality in the streams and rivers of the County.

(3) The elimination of curbs is a considerable cost savings in infrastructure requirements.

(4) Overlaying is much easier to accomplish without curbs.

(5) Maintenance costs are reduced.

(6) Less costly driveway construction can be employed without curb depression. This allows the subdivider and developer certain flexibility in their construction, in that driveway locations are not required to be determined prior to curb installation.

A discussion of curb types would not be complete without consideration of gutter design. Some Counties use a separate vertical curb. Others employ a 12 to 18 inch wide gutter, poured integrally with the curbing. Still others employ large V-type gutter designs, or wide apron, high-slope gutters of 3 or 4 feet in width. This variation in design policy is an important consideration in specifying street width. As referred to on Table 2, the term "Pavement Width" is intended to be the practical driving travel-way available between faces of abutting curbs. In the case of the roll-type curb, in 12 to 18 inch gutter design, this distance is measured between points approximately halfway up the roll curb. In the case of standard vertical curbs, with or without gutter widths of normal slope, the distance is measured face-to-face of curb. In the case of large V-gutters or high-slope gutters, the width must be measured across only the pavement area within which the average driver operates.

2.01.06 Sidewalks:

When designated, the minimum sidewalk width should be 4 feet. In today's typical subdivision, sidewalks have the following function:

(1) Providing for maximum safety of children playing on their block.

(2) Protection of children walking to and from schools and neighborhood parks.

(3) Provision for adults to walk to and from neighborhood shopping and transit stops (if any).

Sidewalks should ordinarily be provided along streets used for pedestrian access to schools, parks, shopping areas, and transit stops. Paved sidewalks should also be provided within pedestrianways giving midblock access to these types of generators. Wider sidewalks may be considered next to higher density pedestrian generators, such as schools, transit stops, and churches. For all closed-section roads (with curbs) sidewalks will be provided on both sides of the road. In open-sections, a minimum of one sidewalk on one side of the road will be provided, except in R-1 density.

Depending on appurtenance placement, a meandering of the sidewalk placement within the border area may be considered. This may in fact be outside the right-of-way. Such alignment may be more visually appealing, and may allow saving of trees or other major plantings, avoid rock outcroppings, etc. However, this should not be regarded as a justification for locating long sections of walk near the street edge.

There have been a number of Federal mandates to provide accessibility for the handicapped through provisions such as sidewalk ramps. These will be required.

2.01.07 Sidewalk Distance from Curb Face (Border Area):

Although, many agencies specify a standard location for sidewalk, 1 foot, from right-of-way line, in order to maintain adequate separation between the curb and sidewalk on the closed section roads, the outside edge of the sidewalk will be located on the right of way line. This location provides a 5-foot minimum border area between the inside of the sidewalk and curb face. This location has the following advantages:

(1) Children walking and playing side by side have increased safety from street traffic.

(2) Conflict between the pedestrians and garbage or trash cans awaiting pickup at the curb is eliminated by using the border area for such temporary storage.

(3) The warped area necessary for a proper driveway gradient is minimized by having a major portion of this gradient fall within the border area.

(4) Danger of collision by runoff-road vehicles is minimized by placement of the walk at maximum practical distance from the curb, and with further separation by tree plantings.

(5) Conflict with storage of snow plowed off the roadway is minimized.

(6) The optimal planting width for street trees is 5 feet.

(7) Pedestrians are less likely to be "splashed" by passing vehicles.

In addition to sidewalk width and placement, several physical factors should be considered:

(1) Provide proper traction by use of a roughened surface.

(2) The maximum longitudinal grade will be 12 percent which is consistent with the maximum street grade.

(3) Provide a minimum lateral drainage slope of at least 2 percent and no more than 6%.

(4) Avoid use of steps where sidewalk ramps can be substituted.

(5) Ramping at slopes compatible with Americans with Disabilities Act (ADA) provisions.

2.01.08 Minimum Stopping Sight Distance:

Stopping sight distance is the length of the roadway ahead, visible to the driver. It is the sum of braking reaction distance and braking distance. The AASHTO recommendation for "Local Roads and Streets" is between 120 to 200 feet. This is reasonable when, by their very nature, local access streets are low volume, low speed roads. Other inherent design functions like pavement width, curb parking, minimum centerline radii, etc., all contribute to "force" lower speeds. Frederick County (will) require(s) that the stopping sight distance consistently tend towards the high end range (200 feet) for all streets. Hilly sections may tend towards the low end (120 feet) range for exceptional areas only as approved on a case by case basis.

2.01.09 Minimum Intersection Sight Distance:

There must be an unobstructed sight distance along all approaches at an intersection across their included corners for a distance sufficient to allow operators of vehicles to accelerate, slow down, or stop. The design is commonly called the intersection sight triangle. All intersections should be designed with angle of intersection at 90 degrees. In extenuating circumstances a maximum skew of 15 degrees will be permitted. AASHTO's discussion of intersection sight distance shall predominate, but is too long to be included here. Since local residential access streets will inherently be low speed roads, then one can plan on only having to satisfy AASHTO's requirement for, say, 30 mph situations. Driveways shall meet requirements for stopping sight distances only (see section 2.01.08). Stopped minor intersections shall have a minimum sight distance of 300 feet to be verified by the consultant.

At the intersection of two (2) open section streets consideration must be given to the radius of the return and edge protection. A minimum radius of 25 feet should be provided. In addition, some method of edge protection must be provided to protect the shoulders beyond the pavement. This protection can be provided by:

1) Providing a larger radius, and therefore additional paving
2) Providing curbing along the return with appropriate transitions
3) Providing railroad ties or equivalent along the return just behind the edge of pavement.

A clear zone should be established pursuant to that described in Paragraph 2.04.02 and Appendix 14 that is free of all opaque obstructions greater than 3.5 feet high and greater than 6 inches in diameter. Such objects typically include: buildings, cut slopes, hedges, trees, bushes, or tall crops. The triangular dimensions of the zone allow for the desired sight lines. This triangle shall have a 70' dimension on the edge of the pavement on both legs. This design

requires elimination of parking within the sight triangle. Small diameter trees with high canopies, street signs, fire hydrants, and utility poles typically can be located within a sight triangle as long as they are not clustered and do not contribute to sight limitation.

2.01.10 Maximum Cul-de-sac Length:

Generally, all residential parcels should be accessible from two directions. This usually reduces total vehicle miles of travel and improves emergency vehicle access. However, the most efficient subdivision of certain tracts (considering shape and terrain) may work best by locating limited numbers of lots along dead-end streets.

An 1,800-foot length is recommended as a maximum for cul-de-sacs in low density developments, with no more than 25 lots as outlined in the subdivision regulations, and lesser lengths for other densities. This is proposed for the ordinary type of subdivision layout, and obviously does not apply to a cluster-type development, nor to one involving a single road winding up a mountain.

A high density cluster development may involve several apartment buildings with hundreds of total dwelling units. Use of only a single roadway to provide access to such sites should be allowed only after a careful consideration of alternative treatments, and with full regard for the potential problems. As the number of persons exclusively served by a given roadway increases, the potential hazard of temporary roadway blockage also increases.

Blockages can result from numerous causes; such as, vehicular accidents, utility breaks, falling trees or poles, and pavement repairs. While such occurrences are exceptional, they must still be regarded in terms of their effect on access to the development by emergency, police, fire, or ambulance equipment. It may be necessary to provide an emergency access drive with restricted access whose design standards may be less than required by this manual. Any variance to the design standards established herein, may be modified at the discretion of staff for an emergency access drive. In addition to this problem, it is even possible to run into capacity limitations. As an extreme example, consider a 1,000-unit development. During the peak hour, the exit flow could reach 400 to 500 vehicles per hour. Depending on characteristics of the boundary roadway, signal control warrants might be reached. In this case, consolidation of exit traffic at a single point might be a desirable design feature.

Joint consideration of the factors of both emergency access and capacity suggest alternative layouts for access to high density development, as follows:

(1) Provide at least two separate roadways, fully connected to the internal system of roadways or parking access drives, or

(2) Provide a divided-type entrance roadway, with median of sufficient width to largely ensure freedom of continued emergency access by lanes on one side. Depending on location and height of nearby poles or trees, the median width would range between 10 and 20 feet.

2.01.11 Minimum Cul-de-sac Radius:

The minimum right-of-way for a traditional circular cul-de-sac is 50 feet. The minimum outside pavement/curb radius is 40 feet. Larger cul-de-sacs will be required in subdivisions with very large lots with sufficient lot width to allow curb parking around the cul-de-sac. The curb parking creates the need for larger pavement/curb radii to accommodate the parking while providing sufficient turning radius for large trucks and fire apparatus. Oversized cul-de-sacs will also be required for school bus access as determined necessary by staff at the preliminary plan stage. In situations where an outside curb (pavement) radius of 45 feet or greater is used, the sidewalk may be placed behind the right-of-way line, in an easement, to preserve the 5 foot planting strip without creating larger rights-of-way.

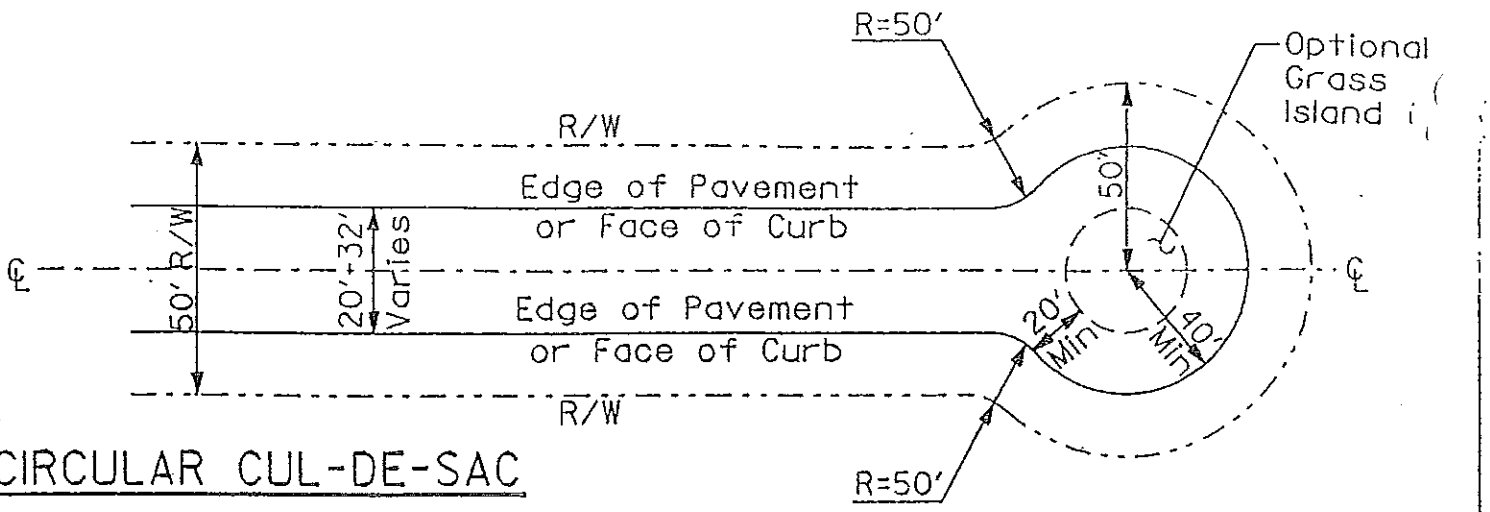
When outside curb (pavement) radii of 40 feet or greater are used, they create, large expanses of pavement which may be unsightly. The use of center islands may be considered, to reduce this paved area, if care is given to keeping adequate maneuver space around the island. A minimum pavement width of 20 feet is required around the island.

In addition to the traditional circular cul-de-sac an offset cul-de-sac may be provided. Generally offset cul-de-sacs are used to overcome environment, topographic and property constraints. Another useful design feature in overcoming these constraints is the eyebrow. See Figure 4.

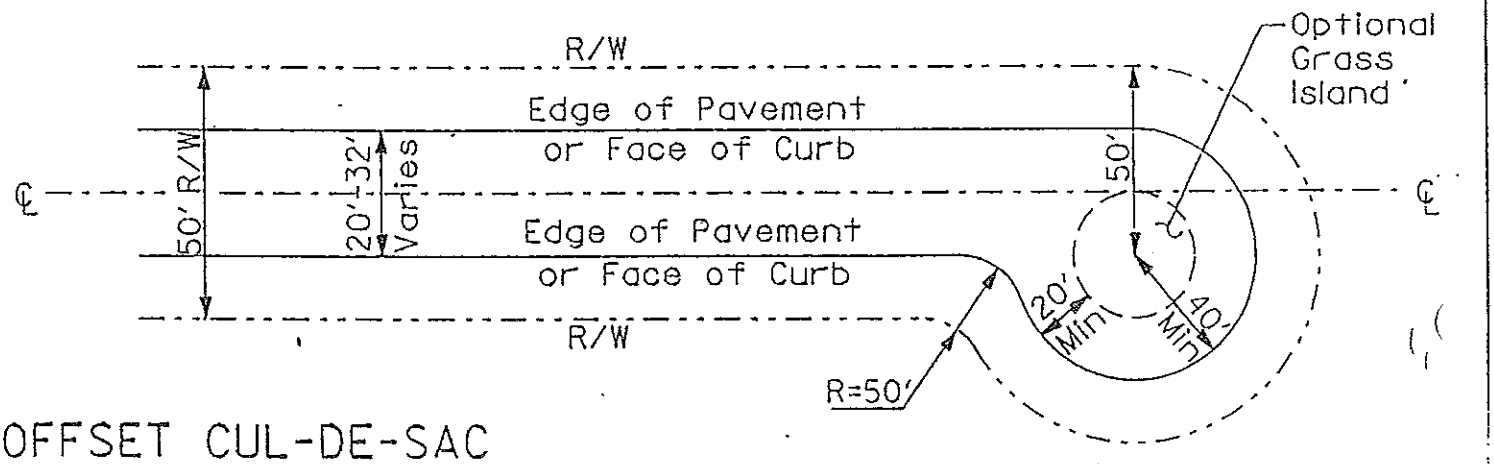
At the connector between the cul-de-sac right-of-way, a transition radius is required. This radius should be at least 50 feet, to avoid an unsightly sidewalk layout and to provide smooth turning movements into and out of the cul-de-sac. Also a more constant curb to right-of-way line dimension is achieved.

2.01.12 Alley Policy and Width:

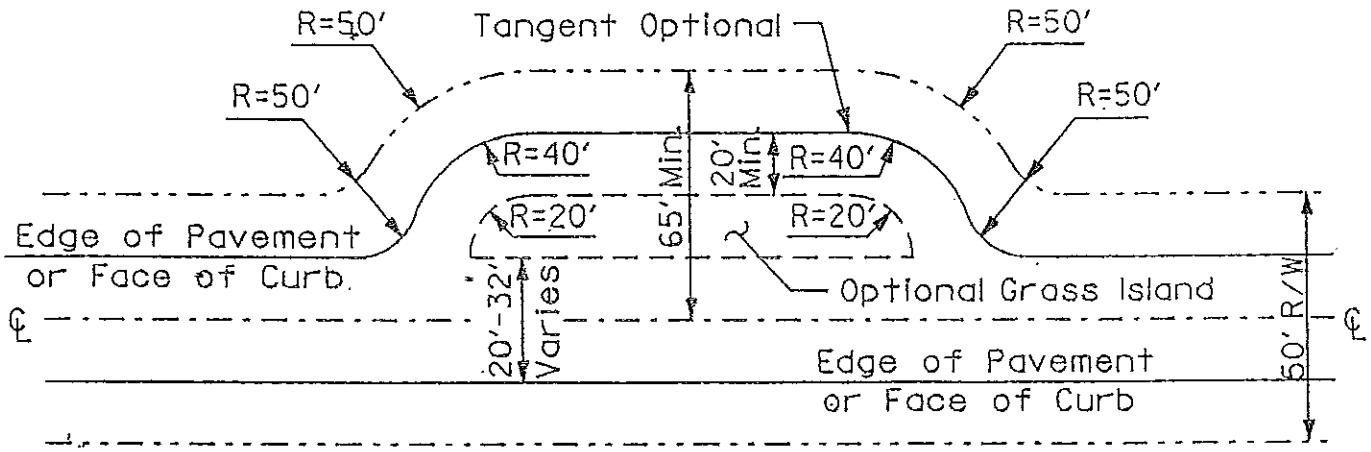
In modern subdivision design, there is a strong trend to eliminate alleys. In lower density areas of 4.0 or less dwelling units per acre, lot widths are ample to provide building width plus side drives to open pads, carports, or garages. As density increases, such construction becomes progressively more difficult. At a density of between 5.5 and 6 dwelling units per acre, with 10 foot side yards, buildable width is reduced to 30 to 34 feet. A mandatory provision for front driveways, therefore, would impose severe architectural limitations. Common driveways and off-center home construction on lots may not be particularly desirable solutions. The use of alleys may be a preferable alternative and may be considered at early Technical Advisory Committee (TAC) meetings, when their use is being considered.



CIRCULAR CUL-DE-SAC



OFFSET CUL-DE-SAC



EYEBROW

REVISIONS	
DATE	NOTE

PAVEMENT
TURN-AROUNDS

FIGURE 4

DETAIL

DATE

In higher density and conventional apartment developments, alleys may provide access to rear lot parking spaces, becoming, in effect, a common driveway. The alley also affords secondary access for fire equipment, service trucks, and maintenance access to rear-line utilities.

The modern alley may be an asset if provided with a total right-of-way width of 20-foot minimum, adequate radii at street intersections of 15 to 20 feet, a paved surface of 10-foot minimum width, and protected by building and parking bay setback limits.

Dead-end alleys will not be allowed unless a minimum 20-foot paved surface can be provided. In these cases the maximum length will be limited to 450 feet.

Alleys designed to modern standards are worthy of consideration in providing required service to conventional subdivisions. However, certain disadvantages, such as additional pavement to be constructed and maintained, the area removed from the tax rolls, the added length of police patrol, and street lighting needs all suggested alternative solutions to current design problems. The trend toward clustered designs, the integration of various housing types in a single development, the increased use of underground electric utilities, the pressure for more open space, and the increasing usage of common greens, plus an attempt at pedestrian/vehicular separation in residential areas, all suggest that even well constructed and maintained alleys may play only a limited role in future residential construction.

2.01.13 Design Speed:

Designation of a design speed is suspended here because other design elements serve to "limit" speeds in residential areas. Wherever possible in the other sections, an effort to design for 30 mph or less has been considered. Lower design speeds must be considered as progressively more difficult terrain is encountered.

2.01.14 Minimum Centerline Radius of Curves:

The centerline value of 125 feet relates to midblock curves and not to intersection radii. When a street makes a right-angle-type turn, a much shorter radii such as 50-foot centerline will apply.

When topography or other constraints cause minimum radii to be employed and superelevation is not used, an off-center crown may be considered. Thus, on a 30-foot wide street, the crown line might be at 10 feet rather than at the normal 15-foot centerline position. This can reduce the effective amount of negative superelevation on the adverse crown side of the curve or right-angle turn.

2.01.15 Minimum Tangent Between Reverse Curves:

A minimum tangent of 50 feet at curves and intersections is needed between reverse curves to facilitate steering and control. Refer to Sections 2.01.08 and 2.01.09 as to meeting minimum sight distance requirements.

2.01.16 On-Street Parking:

Off-street parking requirements are addressed in the zoning and subdivision regulations. However, the adequacy of street widths is tied to available off-street parking and the need to provide on-street parking capability when off-street parking is not sufficient. The below criteria applies:

1. In low density areas normally two off-street parking spaces are provided per dwelling unit. As such, a 20-foot minimum width for the roadway is sufficient. In situations where curb and gutter is utilized, then a minimum width of 26 feet (10-foot travel lane with two 8-foot parking lanes) should be used because some curb parking is likely to occur at all times.

2. In medium density developments, with a nominal road grade classification, a minimum width of 26 feet (10-foot travel lane with two 8-foot parking lanes) is required. In the hilly classification, a minimum width of 28 feet (12-foot travel lane with two 8-foot parking lanes) is required.

3. In high density developments, parking demand per dwelling unit will vary with zoning and size of dwelling unit. At the minimum for nominal classifications, a minimum width of 28 feet (12-foot travel lane and two 8-foot parking lanes) is required. For the hilly classification, a minimum width of 32 feet (14-foot travel lane with two 9-foot parking lanes or 12-foot travel lane with two 10-foot parking lanes) is required.

It is the policy of the County to not allow on-street parking on open-section (no curbs) roads. Reasons include:

1. The maintenance of grass shoulders increases (rutting due to noncompacted grass areas and erosion).

2. Vehicle damage and liability due to insufficient shoulder capacity.

3. Aesthetics (ground cover inconsistency).

4. Potential for partial parking on both shoulders and roadways causing accidents.

Studies have shown curb parking to be a primary factor in accidents on all types of streets. The number of children killed and injured each year as a result of entering the street from behind parked cars is particularly tragic. For these reasons, every attempt should be made to require sufficient off-street spaces so as to minimize curb parking.

Angle parking along the curbs of local streets should never be allowed. When the traffic lanes are used for parking and parking maneuvers, the accident potential is much higher than with parallel parking. Therefore, all such bays and lots allowing any parking other than parallel, should be physically separated from the roadway and confined by barrier curbing beyond the street and the sidewalks.

2.01.17 Driveways Aprons:

Because they are deceptively simple in appearance, driveway aprons often do not receive the design consideration that they merit. Common deficiencies include:

(1) Inadequate radii at intersection with street.

(2) Excessive grades and grade changes (breakover angles).

(3) Inadequate width and depth of paving

(4) Inadequate sight-distance due to landscaping.

(5) Poor drainage characteristics.

The typical residential driveway apron should be designed for passenger car operation only. Temporary encroachment on the wrong side of a local street while entering or leaving a private driveway is generally considered allowable. The driveway radius or flare should be designed with consideration given to both the driveway and road width as noted in Appendix 7.

Standard driveway cross sections are also outlined in Appendix 7. In addition, for driveways with pipes:

(1) Shoulder cross slope to be reduced to 1/2":1' for 5 feet (minimum) from edge of pavement.

(2) A grade break will be provided 5 feet (minimum) from the edge of pavement and the driveway will begin sloping up at 1/2":1 for 10 feet.

(3) A 25' landing is required, beyond the landing a grade change ± 5 percent can occur.

(4) The low point in the driveway will need to be graded so that the drainage will flow off the driveway and into the swale.

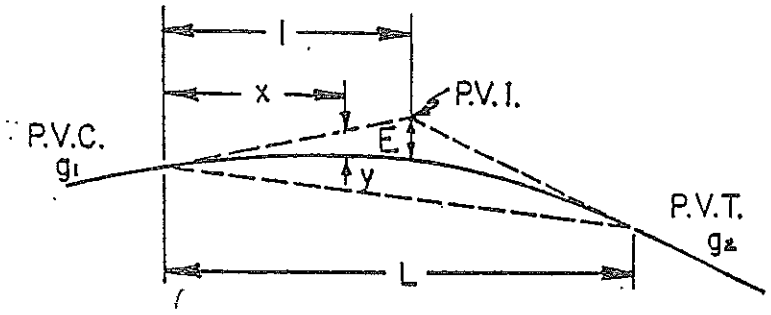
2.01.18 Private Streets:

In apartment developments, driveways connecting to buildings and parking areas are usually privately owned and maintained. Similar concepts in cluster housing have led to extensive networks of private streets for single-family homes, townhouses, or condominiums. These streets will not be accepted into the County's public road network.

The reason a developer utilizes private streets is to minimize his right-of-way or geometric design requirements. Both of those reductions can cause problems for the public agency that may eventually have to take over the private street system. The takeovers of maintenance are generated by property owner complaints on poor maintenance, or their objections to paying a maintenance fee plus property taxes.

2.01.19 Vertical Curves:

The parabolic curve is used almost exclusively in connecting grade tangents because of the convenient manner in which the vertical offsets can be computed. Appendix 8 provides the Standard Landing Requirements for Local and Collector Streets. A typical symmetrical vertical curve is shown below.



PARABOLIC VERTICAL CURVE

P.V.C.....Point of Vertical Curvature
P.V.I.....Point of Vertical Intersection
P.V.T.....Point of Vertical Tangency
E.....External Distance - In Feet
L.....Length of Curve - In Feet
g_1.....Grade from which stationing starts (in %)
l.....1/2 or half the Length of Curve
y.....Offset in Feet
x.....Any Distance from P.V.C. in Feet
g_2.....Grade toward which station heads (in %)

To design the curve for use in profile drawings, first the minimum allowable length of curve must be established. This minimum length is: K (a constant) multiplied by the absolute value of the algebraic difference of the 2 grades (in percent). Per AASHTO for a design speed of 30 mph in a crest(1) condition K = 30 (min) and a sag (2) condition K = 40. For other design speeds refer to AASHTO.

(1) A vertical crest is the same as a hill or high point, with the extensions of the two tangents forming an angle point up.

(2) A vertical sag is the same as a valley or a low point, with the extensions of the two tangents forming an angle pointing down.

Other equations that may be helpful are as follows:

$Lmin = K \times |g1 - g2|$ = Minimum Vertical Curve lengths

$E = \frac{[g1 - g2] \cdot L}{800}$ = Vertical Offset at P.V.I.

$r = \frac{g1 - g2}{L(\text{in stations})}$ = Rate of Grade Change

$y = \frac{r}{2} x^2 + g1x + \text{Elevation P.V.C.}$ = Vertical Offset of any point X Station from the P.V.C.

In order to determine the high (low) point along the curve use the equation

$X \text{ (in stations)} = -\frac{g1}{r}$

2.02 - RESIDENTIAL SUBCOLLECTOR STREET DESIGN:

Figure 5 provides a worksheet on determining residential sub-collector street options. Table 3 provides an outline of design factors and street standards.

2.02.01 Terrain Classifications. Discussed Previously (Section 2.01.01)

2.02.02 Development Density: Discussed Previously (Section 2.01.02)

2.02.03 Right-of-Way Width:

A minimum residential subcollector street right-of-way width of 50 feet is required for all density areas. Where necessary, front yard (and corner lot side yard) easements may be considered for utilities and/or sidewalks or plantings. Along residential collector streets, and land abutting major streets, consideration should also be given to permanent easements about 10 feet wide for utilities, sidewalks and bikeways. This allows for wider separation between utilities or for future utilities not currently foreseen, for greater sidewalk setback and reserves the entire right-of-way of a major street for potential roadway widening. Such easements retain land area on the tax rolls and increase the area available for landscaping controls to enhance sight distance at intersections, driveways and alleys.

2.02.04 Pavement Widths:

A basic pavement width of 24 feet (open section) or 32 feet (closed section) is required for the density categories outlined in Table 3. Appendix 9 provides typical cross sections, and Appendix 10 details the open section, median-divided option.

The minimum widths discussed above will be the acceptable standard unless sufficient justification is presented for wider pavement widths by the developer. In no case will widths less than the minimum be allowed.

2.02.05 Type of Curb:

Refer to discussion on Residential Local Streets (Section 2.01.05).

2.02.06 Sidewalk Width:

Refer to discussion on Residential Local Streets (Section 2.01.06).

2.02.07 Sidewalk Distance from Curb Face:

Refer to discussion on Residential Local Streets (Section 2.01.07).

2.02.08 Minimum Stopping Sight Distance:

Stopping distance is required to conform with AASHTO. A minimum stopping sight distance of 200 feet is required, for nominal grades, and as low as 120 feet for hilly grades.

WORKSHEET

RESIDENTIAL SUB-COLLECTOR
MINIMUM STREET DESIGN OPTIONS

50' RIGHT OF WAY
REQUIRED

LOW DENSITY	MED DENSITY	HIGH DENSITY
G H	H	H

BASIC DESCRIPTION (SEE SCHEMATIC FOR COMPLETE NOTES)

G OPEN SECTION, 24' PAVEMENT, 2-6' GRASS SHOULDERS. FOR SIDEWALKS, REFER TO DISCUSSION.

H CLOSED SECTION,32' PAVEMENT, 4' GRASS PLUS SIDEWALKS EACH SIDE.

Frederick County Department of Public Works	Revisions: Date	Revisions: Note	RESIDENTIAL SUB-COLLECTOR STREET OPTIONS	Detail No. DM WKS02
				Date: 94

Figure 5

TABLE 3
RESIDENTIAL SUB-COLLECTOR STREET DESIGN GUIDELINES

2.02.01	Road Grade Classification	Nominal			Hilly		
2.02.02	Development Density	Low	Med	High	Low	Med	High
2.02.03	Right-of-way Width (ft)	< ---------- 50 ---------- >					
2.02.04	Pavement Width (ft)	24/32	32	32	24/32	32	32
2.02.05	Type of Curb	O/R/V	V/R	V/R	O/V/R	V	V
2.02.06	Sidewalks (ft)	< ---------- 4 ---------- >					
2.02.07	Sidewalk Dist. from Curb Face	6	6/5	5	< ---- 5 --- >		
2.02.08	Min. Stopping S. Dist.	< ------ 200 ----- >			< 120 --- 200 >		
2.02.09	Min. Inter. S. Dist.	< ---------- See Discussion --------->					
2.02.10	Max. Cul-de-sac Length (ft) (a)	1,800	1,000	700	1,800	1,000	700
2.02.11	Design Speed	< ---------- See Discussion --------->					
2.02.12	Centerline Radius (ft)	< ------ 200 ------>			< -- 150 --- >		
2.02.13	Min. Tangent Between Reverse Curves (ft)	< ---------- 100 ---------->					
2.02.14	On-Street Parking	< ---------- See Discussion --------->					
2.02.15	Driveway Aprons	< ---------- See Discussion --------->					
2.02.16	Bicycle Trails/Paths	< ---------- See Discussion --------->					
2.02.17	Vertical Curves	< ---------- See Discussion --------->					

(a) Maximum lengths shown shall include the sub-collector plus attached Local Street designed cul-d-sacs, if any.

2.02.09 Minimum Intersection Sight Distance:

Refer to Residential Local Streets Section 2.01.09 and Section 2.04.02 for discussions of this design element.

2.02.10 Maximum Cul-De-Sac Length:

Please refer to Residential Local Streets Section 2.01.10 for a general discussion of cul-de-sac design. The maximum lengths in Table 3 are intended to be the sum of any combination of sub-collector and local streets, beginning at the intersection of the nearest through street.

2.02.11 Design Speed:

Sub-collector streets are similar in function to local access streets. In an effort to purposefully keep speeds down in residential areas, these streets should be designed for 30 mph or less.

No minimum design speed is identified. To do so would create conflict between other design elements (sight distance, horizontal and vertical curves, etc.) that are individually defined elsewhere, and the strictest interpretations of AASHTO's tables and figures. While minimum design elements are allowed, we expect that the greater length of a sub-collector street will be designed for between the minimum element, and "up to" 30 mph

2.02.12 Centerline Radius:

A radius of 300 feet will approximately meet AASHTO's criteria for a 30 mph design speed, with no superelevation. Therefore 300 feet is preferred, but in order to meet the committee's intent to keep speeds down, this radius can be reduced to 200' for nominal grades, and 150' for hilly grades at staff level, with justification.

2.02.13 Minimum Tangent Between Reverse Curves:

Minimum should be 100 feet regardless of terrain or development density.

2.02.14 On-Street Parking:

Please refer to Section Residential Local Streets (Section 2.01.16) for a discussion of parking. Note that where pavement widths are referenced in the local residential street section, 24' for open section and 32' for closed section streets shall apply.

2.02.15 Driveway Aprons:

Please refer to Residential Local Streets (Section 2.01.17). Note that values associated with a 20' street would not apply since the minimum sub-collector size is 24'.

2.02.16 Bicycle Trails/Paths:

Please reference Section 2.03.13.

2.02.17 Vertical Curves:

Refer to discussion on residential local streets. Since the speeds are assumed to be the same for subcollectors as for local access, the K values will remain unchanged. In a crest K = 30 and in a sag K = 40.

2.03 - RESIDENTIAL COLLECTOR STREET DESIGN:

Figure 6 provides a worksheet on determining residential collector street options. Table 4 provides an outline of design factors and street standards.

2.03.01 Terrain Classifications. Discussed Previously

2.03.02 Right-Of-Way Width:

A minimum residential collector street right-of-way width of 60 feet is required for all density areas. This provides for a wider pavement and greater distance from sidewalk to curb.

Along residential collector streets, and land abutting major streets, consideration should also be given to permanent easements about 10 feet wide for utilities, sidewalks and bikeways. This allows for wider separation between utilities or for future utilities not currently foreseen, for greater sidewalk setback and reserves the entire right-of-way of a major street for potential roadway widening. Such easements retain land area on the tax rolls and increase the area available for landscaping controls to enhance sight distance at intersections, driveways and alleys.

2.03.03 Pavement Widths:

A basic pavement width of 22 feet (open section) or 28 feet (closed section) is required for all types of terrain and for all densities. No lot access is allowed on residential collectors. No curb parking is allowed on residential collector streets.

The basic residential collector street provides space for one lane of moving traffic in each direction, by prohibiting curb parking, the provision of an added turn lane or by-pass lane at points where required. Examples of such points include approaches to intersections along major traffic routes and sections between adjacent offset intersections, so that through traffic would not be impeded by left-turning vehicles. Appendices 11 & 12 provides sample cross sections for the non-median, and median-divided sections, respectively.

2.03.04 Type of Curb:

Curbed streets are recommended for medium and high density development. AASHTO also states that curbs should be considered when solving R.O.W. constraints, to protect pedestrians, to control drainage, and to delineate lanes and medians. All of the above considerations shall be reviewed when deciding on open versus closed sections.

When curbing is used, Maryland State Highway Administration "Type A" (8-inch) or "Type B" (6-inch) vertical curb is mandated but a 6-inch curb is recommended. Rolled curbs are not allowed on this street classification.

WORKSHEET

RESIDENTIAL COLLECTOR
MINIMUM STREET DESIGN OPTIONS

60' R.O.W. (NON-MEDIAN DIVIDED) *
70'-76' R.O.W. (MEDIAN DIVIDED)

NO LOT ACCESS ALLOWED

FOR NOMINAL AND HILLY CLASSIFICATIONS

LOW DENSITY	MED DENSITY	HIGH DENSITY
I	J	J
J	L	L
K		
L		

BASIC DESCRIPTION (SEE SCHEMATIC FOR COMPLETE NOTES)

I OPEN SECTION, 22' PAVEMENT, WITH 7' GRASS SHOULDERS AND 8' DITCHES "INSIDE" THE 4' SIDEWALKS, ON EACH SIDE.

J CLOSED SECTION, 28' PAVEMENT, PLUS 4' SIDEWALK JUST INSIDE THE RIGHT OF WAY LIMITS ON EACH SIDE.

K (MEDIAN DIVIDED), OPEN SECTION, 2-12' TRAVEL LANES WITH 4' SIDEWALKS JUST INSIDE THE RIGHT OF WAY LIMITS.

L (MEDIAN DIVIDED), CLOSED SECTION, 2-14' TRAVEL LANES WITH 4' SIDEWALKS JUST INSIDE THE RIGHT OF WAY LIMITS.

* SEE TEXT DISCUSSION

Frederick County Department of Public Works	Revisions Date	Revisions Note	RESIDENTIAL COLLECTOR STREET OPTIONS	Detail No. DM WKS03
				Date: 94

Figure 6

Table 4
RESIDENTIAL COLLECTOR STREET DESIGN GUIDELINES

REFERENCE NUMBER		
2.03.01	Terrain Classification	All Classifications
2.03.02	Right-of-Way Width (feet)	60
2.03.03	Pavement Width (feet)	22-28
2.03.04	Type of Curb	Vertical Face
2.03.05	Sidewalk Width (feet)	4
2.03.06	Sidewalk Distance from Curb Face (feet)	6
2.03.07	Minimum Stopping Sight Distance	200
2.03.08	Maximum Grade	12%
2.03.09	Minimum Spacing Along Major Traffic Route (feet)	500
2.03.10	Design Speed (mph)	40 mph or less
2.03.11	Minimum Centerline Radius (feet) (a)	350
2.03.12	Minimum Tangent Between Reverse Curves (feet)	100
2.03.13	Bicycle Trails/Paths	See Discussion

(a) With proper justification the radius can be reduced at the staff level to 200' for short distances.

2.03.05 Sidewalk Width:

The provision of sidewalks along both sides of all residential collector streets is required. Collectors provide for pedestrian, as well as vehicular access through neighborhoods. If sidewalks are not provided on both sides of the road, the internal path systems must provide convenient and safe access between destination points, i.e. schools, shopping centers, recreation areas etc. For a combined pedestrian and bicycle path a minimum of 10 feet is required. Maintenance shall be the responsibility of the HOA and the covenants shall provide unrestricted access to the general public.

The Planning Commission shall determine if the path system may be used in lieu of sidewalks within the public right-of-way.

2.03.06 Sidewalk Distance from Curb Face:

A minimum border area of 6' between curb and sidewalk edge is recommended as a practical method of retaining setback of residential property from the street. Another factor in cold climates includes area for plowed snow storage. Plowing is more frequent on residential collector routes, and the quantity of snow is increased by the added pavement width.

2.03.07 Minimum Stopping Sight Distance:

Stopping distance is recommended to conform with AASHTO. A minimum stopping sight distance of 200 feet is required.

2.03.08 Maximum Grade:

No greater than 12 per cent maximum grade on residential collector streets is desirable.

2.03.09 Minimum Spacing of Residential Collectors Along Major Traffic Route:

Refer to Section 2.04.05 and/or Table 6.

In situations where successive left turns from a higher classified major street onto residential collectors will occur, a minimum spacing of 500 feet is required. In situations where near-left, far-right offsets of residential collectors will occur, a minimum spacing of 250 feet is permitted.

The spacing of a residential collector street to a higher classified street shall be minimum of 500 feet. The closest spacing to a lower classified street shall be 250' minimum. Refer to Table 6.

2.03.10 Design Speed:

Residential collector streets should generally be designed to allow for improved movements over local access streets. However, in an effort to purposefully lower speeds in residential areas, these streets should be designed for 40 mph or less.

No minimum design speed is identified. To do so would create conflict between other design elements (sight distance, horizontal and vertical curves, etc.) that are individually defined elsewhere, and the strictest interpretations of AASHTO's tables and figures. While minimum design elements are allowed, we expect that the greater length of a residential collector street will be designed for between the minimum element, and "up to" 40 mph

2.03.11 Centerline Radius:

A radius of 350 feet will approximately meet AASHTO's criteria for a 35 mph design speed, with no superelevation. This figure meets the committees intent to design this road for 40 mph or less while acknowledging that other planning tenets will combine to lower speeds. With proper justification and in exceptional circumstances, this radius can be reduced to 200' on case-by-case basis.

2.03.12 Minimum Tangent Between Reverse Curves:

Minimum should be 100 feet regardless of terrain or development density.

2.03.13 Bicycle Trails/Paths:

Frederick County supports providing bicycle facilities to promote recreational and utilitarian use.

Residential collector streets and higher classification roads are favorable to allowing bicycle facilities because they are typically longer than local access streets, have no conflicts with driveways and parked cars, do not dead-end, and have greater rights-of-way. Site planners are urged to look for opportunities to interconnect bikeways to neighboring land uses or existing trails and routes.

Appendix 13 illustrates the three primary classifications of bikeways:

Class I	Bike path
Class II	Bike lane
Class III	Shared roadway

Class I bikeways are completely separated from vehicular traffic and may or may not be designed separate from pedestrian traffic.

Class II bikeways establish delineated bike lanes within the roadway directly adjacent to travel lanes, or on the shoulder. They are separated by a mountable median or striping. The Institute of Traffic Engineers (ITE) recommends against a single, two-way lane on only one side of the street, citing unconventional turns and transitions as potential hazards.

Class III shared bikeways are the simplest. They do not designate exclusive bike lanes. Instead, they require the bicyclist to share the travel lane with motorists. Signs are used to alert motorists to the presence of bicyclists and to guide bicyclists to other, more suitable streets. In this way, continuous routes can be established and connected.

Please contact Frederick County Department of Public Works for more detailed planning principles and designs.

2.03.14 Vertical Curves:

Refer to discussion on residential local streets. The only change necessary in the discussion of vertical curves on collector roads is that the K values will change for both crest and sag conditions based on the assumed change of speed. For a design speed of 40 mph (maximum collector road discussions), in a crest condition K = 80 and in a sag K = 70.

2.04 INTERSECTION DESIGN:

2.04.01 Terrain Classification:

Recommended design guidelines are shown in Table 5. Definitions of terrain classification are the same as given in Section 2.01.01.

2.04.02 Clear Sight Distance:

The intersection of two local streets should be designed such that any leg might operate without a control device. In practice, one street will typically be designated "minor" to the other, and will be stopped. Situations may arise, however, that could change this.

By maintaining a clear zone as shown in Appendix 14 a driver on any approach will have an unobstructed view of the entire intersection to permit control of the vehicle. There shall be provided an unobstructed view for the given dimensions, and having no sight-obscuring or partly obscuring walls, fences, grading, signs or foliage higher than 3 feet above curb grade, or in the case of trees, branches lower than 7 feet. Street signs, power poles, hydrants and the like are permitted as long as they are not clustered so as to create an obscured view.

The 70 foot measurement specified in Table 5 is intended to be measured along the centerline of the curb lanes of each approach, back from the intersecting curb line as shown on Appendix 14. The clear zone defined within the triangle is independent of property ownership by public or private title. Note that this accommodates a 20 foot setback from a typical property right-of-way line.

The above requirements, combined with good design practice to eliminate horizontal and vertical street alignments in proximity to intersections, will virtually ensure that intersection sight distance for stopped conditions can meet County design criteria for the (ultimate) posted speed limits.

2.04.03 Minimum Angle of Intersection:

It is desirable for all intersections to meet at approximately a 90-degree angle. Highly skewed intersections should be avoided, and in no case should the angle be less than 75 degrees or greater than 105 degrees.

2.04.04 Minimum Curb Radius:

As curb radius is increased, paving costs and intersection area required for a pedestrian to traverse are increased, and higher turning speeds are encouraged. Substandard radii result in unnecessary lane encroachment and increased traffic conflict and accident potential. Reasonable design values of 20 feet are required for intersection radii of two local streets, based on curb clearance of 3 feet and without lane encroachment for a typical width street, using the AASHTO design passenger vehicle. This design will also accommodate garbage trucks and moving vans, with wide swings.

Table 5
INTERSECTION DESIGN GUIDELINES

REFERENCE NUMBER		Nominal	Hilly
2.04.01	Terrain Classification		
2.04.02	Clear Sight Distance (length along each approach leg) (feet) (a,b)	70	
2.04.03	Minimum Angle of Intersection	75° (90° preferred)	
2.04.04	Minimum Curb Radius (feet):		
	a. Local-local	20	
	b. Local-collector	30	
	c. Collector-major	30	
2.04.05	Minimum Centerline Offset of Adjacent Intersection (feet):	See Discussion	
2.04.06	Minimum Tangent Length Approaching Intersection (each leg) (a)	50-30	20
2.04.07	Drainage Structures	See Discussion	
2.04.08	Traffic Control	See Discussion	

a. These are minimum values and greater safe approach speeds are desirable.

b. At an alley intersection with a street (or with another alley) a 15-foot minimum clear sight distance leg is recommended along each intersecting property line.

Any intersection with a collector road should have a 30-foot radius. If on-street parking is allowed in a unique exception the curb radius can be 15 feet. Some form of edge treatment should be provided as discussed in Section 2.01.09

2.04.05 Minimum Centerline Offset of Adjacent Intersection:
(Also see Section 2.03.09)

Several studies of intersection design types have shown offset T-type intersections to be far safer than cross-type. Use of offset T intersections in residential subdivisions is allowed. One disadvantage, however, is "corner-cutting" when inadequate offset exists between adjacent intersections. To reduce this hazardous practice, offsets of at least 125 feet between centerlines are desirable. In the case of two collector-street intersections, this offset should be increased in order to allow for left-turn storage between intersections if a near-right/far-left offset is used. Table 6 summarizes various circumstances.

Offset intersections have disadvantages when one or both such streets is a collector intersecting a major street, if volumes will warrant traffic signals. Operations at such locations are more complicated than those for normal cross-type intersections. Therefore, other design solutions should be sought if signalization might otherwise be required. When offset intersections are used at a major street, they should be located to avoid conflicting left turns (this is especially important where two-way left-turn lanes are to be provided, or where left-turn lanes are used in a fairly narrow median). Such left-turn conflicts exist when an intersection first offsets to the right rather than to the left.

Multi-leg intersections (over four) are undesirable from the control and safety standpoint and should not be used.

TABLE 6
MINIMUM INTERSECTION SEPARATION DISTANCES (a)

	On a Local or Sub-Collector	On a Residential Collector	On a Non-Residential Street
Minimum Distance between:			
Residential Driveways	24'	(b)	(c)
Commercial Driveways	50'	100'	250'
Local/Sub & Local/Sub	125'	125'	250'
Local/Sub & Resid. Coll.	125'	125'	250'
Local/Sub & Non-Res. Street	NA	250'	300'
Resid. Coll. & Resid. Coll.	250'	300'	500'
Resid. Coll. & Non-Res. Street	300'	500'	750'
Non-Res. Street & Non-Res. Street	NA	750'	750'

(a) Centerline to centerline
(b) Access is not recommended
(c) Minimum stopping sight distance as defined by Frederick County Department of Public Works

2.04.06 Minimum Tangent Length Approaching Intersection:

It is desirable to provide a tangent section of roadway approaching intersections, when the street leg has a minimum or near-minimum radius curve. However, curving collector streets need not have tangents approaching intersections with local streets, if the collector radius is about 1,000 feet or greater.

2.04.07 Drainage Structures:

Inlets or catch basins should not be located within the corner radius or within 6 feet of either end. Clearance is needed to keep the area relatively dry and to allow space for streetlights, name signs, utility poles, etc. Grate design should provide for safety of bicycle traffic.

Special considerations should be given to the middle of the curb return at the upper end of the intersection of two streets in a downhill condition. A small area of ponding in the gutter can be created due to the gutter slope. Detailed spot elevations must be provided to show that all drainage will flow to the appropriate storm drain inlet.

2.04.08 Traffic Control

All intersection signs and markings will be placed according to the Manual of Uniform Traffic Control Design (MUTCD). All intersections of County roads and streets with other private or public streets, with the exception of state roads, are under the jurisdiction of the County Department of Public Works. Intersections at state facilities are under Maryland State Highway Administration jurisdiction.

2.05 - NON-RESIDENTIAL STREET DESIGN

This section applies to all non-residential streets, which are defined herein as those streets intended for the main movement of through traffic or distributed traffic (i.e., collectors and arterials) or alternately, the delivery of traffic through and about localized retail or industrial hub centers (i,e, commercial and industrial streets). These streets have larger design parameters than residential streets in order to account for greater traffic volumes and increased truck activity.

The various types of non-residential streets are as follows: Collectors consist of rural, commercial, and industrial options. Arterials consist of "minors" and "majors".

The general differences among road types are due to the required rights-of-way. Also, as a group, the arterial streets (open sections) require paved shoulders, whereas the open section, non-residential collectors do not. The design guidelines in this section spell out other differences between the various non-residential streets.

2.05.01 Right-of-Way-Width

The non median-divided section right-of-ways are as follows: rural, commercial, and industrial collector streets require 60-foot ROW's. Minor arterials require 80-foot ROW's and major arterials require 100-foot ROW's.

Median-divided sections may be also permitted for rural collectors, commercial, and industrial collector streets, upon approval by the County. In such cases, the rights-of-way above shall be increased by the width of the median. For example, a collector proposed with a 16-foot median would require a 76-foot ROW.

Unless specifically noted below, all of the following design guidelines refer to the basic, non median-divided sections.

2.05.02 Pavement Widths and Determination of Open vs. Closed Section

Appendices 15 through 19 depict cross section schematics of the various street designs described below.

Rural Collector Streets require a 22' open section travel way. As the name implies, they are intended for rural areas typically having only light residential, farm, or open development.

Commercial Collector Streets are required for the General Commercial (GC) retail zone. The basic pavement width is 46' curb-to-curb for the closed section.

Industrial Collector, Open Section Streets are required for the General Industrial (GI) zone, and may be permitted for Light Industrial (LI) and Office/Research Industrial (ORI) when the average lot size is greater than or equal to 1.0 acre and when no background through traffic is anticipated. All open section intersections of non-residential streets should be improved to provide curb return protection, as discussed in Section 2.05.13.

Industrial Collector, Closed Section Streets are required for the LI and ORI zones having an average lot size of less than 1.0 acre, or where background through traffic is anticipated to mix with development traffic.

Arterials are intended for faster travel and heavier volumes. Open section minor arterials require a 24' travelway plus 8' shoulders. Closed section minor arterials require 40' of pavement. Open section major arterials require two 22' travelways, with paved shoulders, separated by a 16' grass median. Closed section "majors" require two 32' sections separated by a 16' concrete median.

2.05.03 Type of Curb

Only standard SHA 8-inch curb or SHA modified 6-inch curb is acceptable. Specifically, mountable curbs and rolled curbs are not acceptable on closed section, non-residential streets.

2.05.04 Sidewalks

When sidewalks are required by the County, then six foot wide sidewalks are recommended in GC (retail) zones in order to accommodate the possibility of greater foot traffic. Elsewhere, for non-residential streets, sidewalks shall be four (4) feet wide.

Where a suitable path system has been identified throughout the commercial or industrial zone, sidewalks along the road may be eliminated with approval of staff. Continuous hiker/biker bituminous paths are highly desirable options or additions where longer distances might be provided as jogging or biking circuits. Such paths should not typically crisscross the development; that would be better served by campus sidewalks. Hiker/biker paths should proceed fairly uninterrupted, perhaps around the perimeter of the development or as interconnections to neighboring developments or streets.

2.05.05 Minimum Stopping Sight Distance

Should conform to County specifications.

2.05.06 Minimum Intersection Sight Distance

Should conform to County specifications.

2.05.07 Design Speed

According to AASHTO, the design speed is "the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern."

The main factor is the type of terrain through which the road must pass. A road in a hilly, mountainous area will have a lower design speed than one in gentle, rolling terrain. Whereas design speeds were not the prime criteria in the residential category streets, they are identified here as the focal design parameter around which all other design parameters are formed. There is no hard and fast rule that states a design speed for a collector, arterial, etc. For purposes of discussion only, the following ranges are presented:

Rural and Urban Collectors	30 - 45 MPH
Commercial and Industrial Streets	30 - 45 MPH
Minor and Major Arterials	40 - 60 MPH

The design speed shall not be so high (compared to the posted speed and/or 85th percentile speed) that it will encourage unsafe driving beyond the intended speed ranges. Also, to set a higher design speed makes it difficult to maintain other AASHTO design parameters.

2.05.08 Centerline Radius

Should conform to AASHTO specifications for the design speed.

2.05.09 Minimum Tangent Between Reverse Curves

Should conform to AASHTO specifications for the design speed.

2.05.10 Superelevation

From AASHTO: "When a vehicle moves (along a curve) it is forced radially outward by centrifigul force. The force is counterbalanced by the vehicle weight component related to the roadway superelevation and/or the side friction component of tires on pavement. When a vehicle travels at constant speed on a superelevated curve such that friction, f, is zero, the centrifugal force is balanced by the weight component of the vehicle and, theoretically, no steering force is required."

Whereas normal crowning of the road allows for water runoff, superelevation ("tilting" the road) counters the "overdriving" characteristics that occur on sharp, flat curves. At the least extreme, no superelevation is needed for tangent highways or ones with exceptionally long curves. At the most extreme, there is a practical limit such that a standing or slow vehicle does not slide down the cross slope when the pavement is icy.

AASHTO concludes that e, the rate of superelevation (ft/ft) between 0.040 to 0.080 is applicable for urban design. Table III-6 in AASHTO, "Maximum degree of curve and minimum radius determined for limiting values of e and f, rural highways and high-speed urban streets" shall be used to design curves for the given design speeds. Values of $e \geq 0.10$ shall not be used.

Finally, the length, L, of superelevation runoff is defined as the length of road needed to accomplish the change in cross slope from a "normal" section to a superelevated section. L is also equal to the length of spiral necessary to transition concurrent sections such that a driver will not experience a sudden shift in centrifugul force as he/she enters or leaves a curve. AASHTO recommends that L is not necessary for roads having design speeds $\leq$ 40 MPH.

2.05.11 Vertical Curves

Should conform to AASHTO specifications for the design speed.

2.05.12 On-Street Parking

As a general rule, on-street parking is discouraged from non-residential streets because the primary function of these streets is to carry through traffic, and because some open section designed streets do not require paved, improved shoulders. However, it is inappropriate here to say that on-street parking on non-residential streets will always be prohibited. In special cases, one may be allowed to improve the open section shoulders, but that will be the exception, and not the rule. Each case should be discussed on its own merits. Certain situations like street-front retail, or certain developments, may be conducive to on-street parking. It is anticipated that the closed section designs, as a group, would address these situations.

Rural Collector Streets do not require paved, improved shoulders on open section design. On-street parking is prohibited.
Commercial Collector Streets do not provide for paved, improved shoulders on open sections, but do inherently provide extra width, which may be used for parking, on closed section streets. However, that extra width may also be intended for traffic lanes. The concept of on-street parking on this type road must be discussed with staff.
Industrial Collector Streets do not have improved shoulders for either open or closed sections; only travel lanes. Therefore, on-street parking is not allowed.
Arterials provide paved, improved shoulders, but they are for recovery and exclusive turn lanes and bypass lanes; therefore, on-street parking is prohibited.

2.05.13 Intersections of Open Section Collector Roads

The design committee has determined that open section collector roads suffer unsightly and potentially unsafe rutting in the vicinty of intersection curb radii. This phenomenon is observed to occur irrespective of radius size. The higher volume of cars and heavy trucks on these roads perpetuates this problem more severely than on low volume, local streets. For this reason, intersection curbing is required for all combinations of open section collectors meeting other public streets. Said curbing shall be mandatory from point-of-curve to point-of-curve between all intersection legs, and then may be properly transitioned.

2.05.14 Bicycle/Trails Paths

Frederick County supports providing bicycle facilities and connections to promote recreational and utilitarian uses. It may be appropriate to include a bike path when upgrading existing roads or building new ones.

Non-residential streets have wider rights-of-way, faster vehicle speeds, and heavier volumes than residential streets. Because of these items, non-residential streets are preferred candidates for Class I (separate path) or Class II (striped or divided bike lane within travel way) facilities. Section 2.03.13 outlines the various classes of bicycle facilities.

Designated bike lanes and paths are recommended to be at least 8 feet wide. The Department of Public Works and the Department of Planning and Zoning may be contacted for other design parameters and planning coordination, respectively, for bicycle facilities.

2.05.15 Commercial Driveway Entrances

The minimum width of a commercial driveway access shall be 30-feet.

Median-divided entrance roads are permitted, however, they must meet a minimum 100-foot depth. The median width may range from 4' to 10'. The minimum drive-aisle width shall be 15-feet. Any other non-standard design (channelization, right-in, right-out, angled entrances, etc.) shall be worked out with staff on a case-by-case basis.

In all cases the minimum curb return of radius shall be 30-feet and shall have curbed edge protection consistent with section 2.05.13. Larger radii are recommended for larger design vehicles.

For all commercial driveways having access to higher volume, higher classified roads, the County can require that accel-decel lanes and bypass lanes be provided. When required by the County, a sufficient bypass lane design shall include a 150' departure taper, a 150' bypass, a 100' transition, and a 150' merge taper. The bypass lane shall be a full width lane equal to or greater than the travel lane width.

Chapter 3. Pavement Design – County Street Construction

3.01 Introduction

All engineering drawings proposing construction of public streets shall be required to provide a pavement design. The design shall be prepared and sealed by a Maryland licensed Professional Engineer specializing in geotechnical or pavement engineering.

3.02 Development of Traffic

A first step in the design process is determination of traffic. The following assumptions may be made for average annual daily traffic (AADT) counts on residential streets:

- Residential local access (local) – 250
- Residential subcollector – 2,500
- Residential collector (60 ft right-of-way) – 4,000

For streets classified as other than residential collector, a detailed traffic analysis shall be required projecting traffic on the new roadway or detailed traffic counts shall be required for reconstruction of existing roadways including percentages of vehicles by type. Assumed percentages of vehicles by type for residential streets are as shown in Table 1.

Table 1. Percentage of vehicles by classification

Vehicle	Percentage of vehicles by type		
	Residential Local Access	Residential Subcollector	Residential Collector
Cars	96.8%	93.0%	90.0%
Trucks, 2-axle 4-tire	2.4%	5.1%	7.1%
Trucks, 2-axle 6-tire	0.4%	0.7%	1.1%
Trucks, 3 axles	0%	0.3%	0.4%
Tractor semi-trailer, 4-axles	0%	0.2%	0.3%
Tractor semi-trailer, 5-axles	0.4%	0.7%	1.1%

Estimates of truck percentages do not include construction traffic associated with build-out of a new residential area. An estimated 80 18-kip equivalent single axle loads (ESALs) is associated with construction of each house. Therefore, the number of trucks is based on the number of lots to be serviced by each roadway.

3.03 Matrix Pavement Design

A matrix is provided of typical sections that may be used under certain conditions. In particular, these sections apply to construction of residential/subdivision streets. Industrial collector, commercial collector, rural collector, and arterial pavement sections shall be developed in accordance with Section 3.04 using appropriately estimated traffic levels.

The matrix shall be used for all residential/subdivision streets, any street with daily traffic up to 4,000 vehicles and 10 percent trucks, or an estimated design ESALs of up to 586,800.

3.03.01 Staged Construction

In construction of new residential areas, staged construction may be necessary. The first stage incorporates construction to support traffic building new homes. The second stage involves the placement of the final surfacing after the subdivision has been substantially built out and prior to acceptance by the County. The matrix provides typical sections that may be used in either staged or nonstaged construction. When staged construction is used, the surface layer shall be placed after substantial build-out of the subdivision.

3.03.02 Investigation Requirements

A geotechnical report will be required sealed by a Professional Engineer. As a minimum, the report shall include the following items:

- Plans showing boring and sampling locations. Bores shall be obtained after mass grading at a maximum spacing of 500 ft with a minimum of three borings for a roadway.
- Road layout.
- Suitability of all proposed road subgrade materials.
- Classification of the subgrade including both the Unified Soil Classification designation and the American Association of State Highway and Transportation Officials (AASHTO) designation.
- Laboratory test results that demonstrate the California Bearing Ratio (CBR). Any CBR below a value of 2 will require mitigation for the low value. These areas will be undercut and backfilled with suitable material. The report will identify the locations where this measure is required.
- The various recommended pavement sections for each proposed road provided as typical cross section details.

3.03.03 Details of Section Development

The pavement sections within the matrix were developed in accordance with the 1993 AASHTO Guide for the Design of Pavement Structures. Table 2 presents the parameters used in the development of the designs presented in the matrix.

Table 2. Parameters used in matrix pavement section development

Parameter	Value	
	Residential Local Access	All Others
Reliability	80%	90%
Standard Deviation	0.45	0.45
Initial Serviceability	4.2	4.2
Terminal Serviceability	2.4	2.6

Table 3 presents the development of the 18-kip equivalent single axle load counts for use in developing the matrix pavement sections. In each case, a growth rate of 2.2%/year is assumed. The directional distribution is set to 50% and the lane distribution for one lane in each direction of travel is 100% and for two lanes in each direction of travel is 90%. The design life is set at 20 years.

Table 4 presents the matrix of sections to be used for construction of residential pavements. The matrix presents a minimum pavement section to be used for all cul-de-sac pavements.

Table 3. Development of design ESAL estimates

Vehicle	AADT	Design Traffic	ESAL Factor	Design ESAL
Residential Local Access				
Cars	242	2,189,453	0.0008	1,752
Trucks, 2-axle 4-tire	6	54,284	0.01	543
Trucks, 2-axle 6-tire	1	9,048	0.3	2,715
Trucks, 3-axle	0	0	0.78	-
Tractor semi-trailer, 4-axle	0	0	1.44	-
Tractor semi-trailer, 5-axle	1	9,048	1.44	13,030
All Vehicles	250			18,040
By Direction, Single Lane				9,020
Residential Subcollector				
Cars	2,325	21,035,030	0.0008	16,829
Trucks, 2-axle 4-tire	127	1,149,011	0.01	11,491
Trucks, 2-axle 6-tire	18	162,852	0.3	48,856
Trucks, 3-axle	7	63,332	0.78	49,399
Tractor semi-trailer, 4-axle	5	45,237	1.44	65,142
Tractor semi-trailer, 5-axle	18	162,852	1.44	234,507
All Vehicles	2,500			426,224
By Direction, Single Lane				213,112
By Direction, 2-Lane				191,801
Residential Collector				
Cars	3,600	32,570,369	0.0008	26,057
Trucks, 2-axle 4-tire	284	2,569,441	0.01	25,695
Trucks, 2-axle 6-tire	44	398,083	0.3	119,425
Trucks, 3-axle	16	144,758	0.78	112,912
Tractor semi-trailer, 4-axle	12	108,568	1.44	156,338
Tractor semi-trailer, 5-axle	44	398,083	1.44	573,240
All Vehicles	4,000			1,013,667
By Direction, Single Lane				506,834
By Direction, 2-Lane				456,151

Table 4. Matrix of Pavement Sections

Road Classification / Project ESAL[1] per Lane	CBR[2]	Resilient Modulus (M_R), psi[3]	Pavement Section				Calculated ESALs[7]
			GAB, in[4]	HMA Base, in[5]	HMA Surface, in[5,6]	Total Thickness, in	
Cul-de-sac	Min 2	Min 4,000	6	4.0	1.5	11.5	27,800
Residential Local Access 9,000 ESALs	2	4,000	6	4.0	1.5	11.5	116,700
	3	5,200	6	4.0	1.5	11.5	213,000
	5	7,200	6	4.0	1.5	11.5	454,800
	8	9,700	6	4.0	1.5	11.5	913,900
Residential Subcollector (1 or 2 lanes in each direction) 237,100 ESALs[8]	2	4,000	8	4.5	2.0	14.5	248,700
	3	5,200	7	4.0	2.0	13.5	259,400
	5	7,200	6	4.0	2.0	12.0	454,700
	8	9,700	6	4.0	2.0	12.0	913,600
Residential Collector (1 or 2 lanes in each direction) 586,800 ESALs[9]	2	4,000	8	6.0	2.0	16.0	685,600
	3	5,200	8	5.0	2.0	15.0	645,200
	5	7,200	8	4.0	2.0	14.0	670,700
	8	9,700	6	4.0	2.0	12.0	913,600

[1]ESAL = 18-kip equivalent single axle load
[2]CBR = California Bearing Ratio
[3]$M_R = 2555 \times CBR^{0.64}$
[4]GAB = Graded Aggregate Base
[5]For specific mix designations for HMA base and surface layers, see Section 3.05.01
[6]HMA surface is assumed to occur after significant build-out of the subdivision has been completed.
[7]Allowable ESALs estimated based on pavement section identified. Calculation of allowable ESALs based on final construction.
[8]Assume residential subcollectors service a maximum of 300 homes. The matrix pavement section shall not be used if this condition is exceeded and a non-matrix pavement design report shall be required.
[9]Assume residential collectors service a maximum of 1,000 homes. The matrix pavement section shall not be used if this condition is exceeded and a non-matrix pavement design report shall be required.

3.04 Non-Matrix Pavement Design

The matrix may not be used when the California Bearing Ratio (CBR) of the subgrade is less than 2 or when the road is classified higher than residential collector.

3.04.01 Design Requirements

A detailed pavement design must meet the following criteria:

- Performed in accordance with the 1993 AASHTO Guide for the Design of Pavement Structures. Other methodologies may be used only if approved by the Frederick County Division of Public Works.
- Bores should be obtained at a maximum spacing of 500 ft with a minimum of three borings for a roadway. At each location, the subgrade classification should be determined in accordance with both the Unified Soil Classification designation and the American Association of State Highway and Transportation Officials (AASHTO) designation. Additionally, the CBR shall be determined at each location.
- Reliability (R) shall be 80% for residential local access roads and 90% for all other functional classes.
- The standard deviation (S) shall be 0.45.
- The design life of the pavement section shall be 20 years.
- Traffic volume and classification counts shall be based on the minimum counts provided in Section 3.02 or shall be based on counts of nearby roadways of similar classification and use. Traffic counts shall be required on roadways with classifications higher than residential collector.
- The 18-kip ESAL estimate shall be estimated using the following factors:
  - Growth Rate: 2.2% per year
  - Directional Distribution: 50%
  - Lane Distribution for single lane of travel in each direction: 100%
  - Lane Distribution for two lanes of travel in each direction: 90%
  - Truck Factors will be:
    - Cars – 0.0008
    - Trucks, 2-axle 4-tire – 0.01
    - Trucks, 2-axle, 6-tire – 0.3
    - Trucks, 3-axle – 0.78
    - Tractor Semi-trailer, 4-axle – 1.44
    - Tractor Semi-trailer, 5-axle – 1.44
- Initial Serviceability: 4.2
- Terminal Serviceability:
  - For residential local access – 2.4
  - All other road classifications – 2.6

- Structural Coefficients (per MDSHA Pavement and Geotechnical Design Guide, maximum layer thicknesses are as shown in Section 3.05)
  - HMA Surface – 0.44
  - HMA Base – 0.40
  - Cement Treated Base – 0.25
  - Asphalt Treated Aggregate Base – 0.20
  - Graded Aggregate Base – 0.10

3.04.02 Submission Requirement

A design report shall be submitted sealed by a Professional Engineer. The report shall provide the following documentation:

- Introduction and proposed scope;
- Method of subsurface exploration;
- Laboratory testing: grain size, index property, proctor testing, CBR;
- Discussion of pavement subgrade material;
- Method of design and design assumptions;
- Recommended pavement section(s);
- Discussion of subgrade stabilization, as needed;
- Drainage recommendations;
- If staged construction is planned, documentation regarding design to meet construction traffic prior to placement of final surfacing; and
- Plans showing boring location and street layout.

3.05 Notes on Construction

3.05.01 Asphalt Mixes

Binders for asphalt surface mixes shall be selected in accordance with Table 5. All other mixes shall use a PG64-22 binder.

Table 5. Binder Types for Surface Mixes (per MDSHA Pavement and Geotechnical Design Guide)

Traffic Speed	Traffic (ESALs)		
	< 300,000	300,000 to 3 Million	> 3 Million
≥ 45 mph	PG64S-22	PG64S-22	PG64E-22
15 to 45 mph	PG64S-22	PG64S-22	PG64E-22
< 15 mph	PG64S-22	PG64E-22	PG64E-22

Compaction levels for mix designs shall be as follows:

- Level 1: Design ESALs < 0.3 Million
- Level 2: 0.3 Million ≤ Design ESALs < 6.5 Million
- Level 4: Design ESALs ≥ 6.5 Million

Lift thicknesses, maximum layer thicknesses, and uses for the various mix sizes shall be selected in accordance with Table 6. The Preferred column in Table 6 is provided as guidance in developing the pavement design. In order to meet the required thickness for the pavement section, use of lift thicknesses anywhere within the range shown in Table 6 is appropriate.

Table 6. Aggregate Size and Lift Thickness
(per MDSHA Pavement and Geotechnical Design Guide)

Lift Thickness, inches			Layer Total Maximum	Mix Size	Design Application
Minimum	Preferred	Maximum			
3.0	4.0	5.0	10.5	25.0 mm	Base, Patching
2.0	3.0	4.0	9.0	19.0 mm	Base, Patching
1.5	2.0	3.0	6.0	12.5 mm	Non-Residential Area Surface, Binder
1.0	1.5	2.0	3.0	9.5 mm	Surface, Leveling

A tack coat shall be applied per MDSHA Specification Section 504.03.

When staged construction is to be implemented, a minimum thickness of either 4 inches of HMA base or 1.5 inches of HMA binder on 2.5 inches of HMA base shall be placed for Stage I use. Either of these structures shall be placed on the appropriate thickness of GAB per the pavement design.

Prior to placement of the surface mix (Stage II of construction):
1) Sweep the surface to remove any accumulated debris.
2) The existing pavement shall then be inspected by the County or their representative and any distresses shall be repaired.
3) If the HMA base is polished as determined by the County, the surface shall be roughened prior to application of the surface layer.
4) Apply tack coat per MDSHA Specification Section 504.03.

3.05.02 Aggregate Base Construction

Maximum aggregate base thickness by material type is as follows:
Cement Treated Aggregate – 6 inches
Asphalt Treated Aggregate – 6 inches
Graded Aggregate Base – 8 inches

Aggregate base course shall be placed within 48 hours of acceptance of subgrade materials by the County Inspector unless delay is approved by County. If a precipitation event occurs during this time frame, the County Inspector shall reinspect the subgrade prior to placement of the aggregate base course.

Prime coat should be applied to aggregate base material prior to placement of any HMA.

3.05.03 Density Requirements

Compact the material that is 1 ft below the top of subgrade to at least 92 percent of the maximum dry density per AASHTO T 180 Modified proctor. Compact the top 1 ft to at least 97 percent of the maximum dry density per AASHTO T 180 Modified proctor. Determine in-place density per MSMT 350 or 352. When necessary, add water or dry the layer in order to compact to the required density. When finally compacted to the required density, the resultant moisture content of embankment material shall be within two percentage points of optimum.

Compaction of graded aggregate base courses shall be to at least 97% of maximum dry density per Modified proctor (AASHTO T180 Modified proctor).

Chemically stabilized aggregate base shall be compacted to at least 95% of maximum dry density per Modified proctor (AASHTO T180 Modified proctor).

During construction the density of HMA shall be evaluated per MDSHA Specification 504.03.11. Target density of placed material should be between 92% and 97%.

3.05.04 Drainage Options

Subgrade drainage is to be placed in accordance with MDSHA Standard 387.51.

Longitudinal underdrains shall be placed, as needed, in accordance with MDSHA Standard 387.11 or 387.11A, as appropriate. Specific locations shall be included on improvement plans or civil drawings.

Provide for 1-inch weeps in inlets for staged construction of curb and gutter sections.

The gutter pan should rest on top of the aggregate base material or a minimum of 4 inches of granular aggregate base where a bound base material (either HMA base or chemically stabilized aggregate base) is used.

A cross slope of up to 3% is acceptable with approval from the County. This cross slope should receive additional consideration with respect to ADA Standards for Frederick County Right-of-Way where sidewalks are planned adjacent to the roadway. The 3% cross slope may be helpful in areas where drainage may be a concern due to the existing terrain, such as where a designed road is relatively flat.

SECTION 4
GENERAL SUBMISSION REQUIREMENTS

4.1.1 INTRODUCTION

This manual has been developed to provide guidance for the design of stormwater management and drainage conveyance systems to safely control and convey storm water runoff associated with the development of commercial and residential subdivisions and related construction projects in Frederick County, Maryland. While the requirements set forth in this manual must be complied with for public systems to be adequately reviewed by the Frederick County Division of Public Works (FCDPW), some private systems may not require review by FCDPW. However, no manual can substitute for the responsibility of the design engineer to ensure public safety and excellence of design.

4.1.2 GENERAL PLAN REQUIREMENTS

4.1.2.1 Sketch and/or Preliminary Subdivision Plans

Enough information should be shown on the sketch and/or preliminary plans to ensure that adequate space has been provided for the stormwater management facility proposed. Adequate space and lot alignment also need to be provided in addressing storm drainage conveyance systems. The information should include topography, as outlined in the Frederick County Subdivision Regulations Sec. 1-16-60 and Sec. 1-16-72, type and approximate size of the proposed stormwater management facility, approximate stormdrain alignments, location, and approximate size of outfalls into the stormwater facilities, easement locations, proposed road culvert locations, and proposed open channels.

Typically, detailed stormwater and storm drainage conveyance computations are not required at this level of detail. However, in questionable situations, such as limited space and/or steep slopes in the area designated for the proposed stormwater management facility, computations may be requested.

Careful planning of stormwater management and conveyance systems is encouraged at this stage. Additional measures that may be determined necessary during Improvement (Construction) Plan review may cause adverse impact to construction quantities and lot location and layout.

4.1.2.2 Site Plans

As with sketch and/or preliminary plans, enough information should be provided on a site plan to depict an accurate layout and size determination for both the stormwater management facility and the storm conveyance systems. The type of stormwater management facility proposed should be identified and enough area provided to allow the facility to be constructed to meet the storage requirements. Approximate pipe sizes should be shown on the site plan. As an option, the engineer may include full Improvement Plans as part of the Site Plan submission, supplying all information required for Improvement Plan approval.

4.1.2.3 Improvement Plans

An improvement plan submission must include full engineering computations, drawings, details, notes, specifications, easements, and any additional information necessary for the complete construction and inspection of the proposed stormwater management and storm conveyance systems. The computations and minimum design criteria shall be in accordance with this manual. All documents must be signed and sealed by an appropriate licensed professional in the State of Maryland.

4.2 STORM CONVEYANCE SYSTEM

4.2.1 Hydrology and Hydraulic Computations

The computation package submitted to FCDPW shall include all information to support the proposed conveyance system: specifically, a drainage area map, hydrologic computations, hydraulic calculations, hydraulic gradient information, and certified structural shop drawings for nonstandard structures. All hydrologic and hydraulic computations and improvement plans shall be developed under the direct supervision of, and sealed by, a Registered Professional licensed in the State of Maryland in accordance with COMAR 09.13.06.

The storm conveyance system shall be designed based on ultimate land use planned per the current comprehensive plan, for all contributing drainage areas. In cases where stormwater management is to be regionalized, ultimate zoning, land use shall be considered for those drainage areas to be served by the regional stormwater management facility. The Frederick County Division of Planning and Zoning should be contacted to obtain both the current and ultimate land use information for the contributing drainage areas.

4.2.1.1 Drainage Area Map

The drainage area map should be based on the most recent and accurate topographic information available for the contributing watershed. Onsite drainage divides should be based on proposed site grading plans. Offsite areas may use U.S.G.S. 7.5 minute quadrangle sheets if more accurate information is not available, however, the engineer is expected to field verify all drainage areas. The following information shall be required on the drainage area map and included in the computation package:

4.2.1.1.1 The entire drainage area served by the conveyance system shall be shown. Topography shall be included to support the drainage area delineation.

4.2.1.1.2 The outline of the proposed construction/design site, as well as all pertinent streets and rights-of-way, shall be shown to accurately depict the area under consideration.

4.2.1.1.3 The contributing area, in acres, to each inlet shall be labeled and shown with the individual drainage area delineation.

4.2.1.1.4 All storm conveyance systems shall be shown with structure numbers and pipe sizes corresponding to the computations and improvement plans. Existing systems shall be shown dashed, and proposed systems shall be shown solid.

4.2.1.1.5 All land use/zoning information shall be shown, and the runoff coefficients for the contributing area to each inlet shall be labeled.

4.2.1.1.6 Flow paths for Time of Concentration (Tc) determination shall be shown if the Tc differs from the guidelines listed in Table 2.

4.2.1.1.7 A title block shall be included with the map, including scale, revision dates and all other pertinent information.

4.2.1.2 Peak Discharge Determination

4.2.1.2.1 General Flow Equations

The rational formula shall be used to determine the peak discharge in the design of storm conveyance systems of less than 100 acres. In cases where the contributing drainage area exceeds 100 acres, the methods developed by the Soil Conservation Service, including Technical Release No. 55 (TR-55) and Technical Release No. 20 (TR-20), are recommended. Rational method shall not be used for drainage areas over 100 acres.

In the Rational Formula:

$$Q=C*I*A$$

Where;

- Q = Peak discharge of storm runoff in cubic feet per second (cfs).
- C = Runoff coefficient (See Table 1).
- I = Intensity of rainfall in inches per hour (iph). "I" is dependent on the Tc & the storm frequency (See Table 2).
- A = Contributing area in acres (ac).

4.2.1.2.1.1 Runoff Coefficient, "C"

The runoff coefficient shall be a composite of all the ultimate land uses in the contributing drainage area. The value should represent the proportion of area covered by impervious surfaces or by lawn. The following values should generally be used for "C":

TABLE 1

RATIONAL METHOD RUNOFF COEFFICIENTS

ZONE	TYPICAL LOT SIZE	TYPE OF DEVELOPMENT	"C" VALUE
VC, GC, HS		Commercial	0.90
LI, GI, MM, ORI		Industrial	0.85
R-12, R-16	Less than 6,000 sf	Residential	0.75
R-5, R-8	6,000 to 8,000 sf	Residential	0.55
R-1, R-3	12,000 to 43,560 sf	Residential	0.45
*A	2 acres	Agriculture	0.35
C	5 acres	Conservation	0.30

* For residential *Ag Cluster* developments within the *Agriculture Zone*

"C" values for zoning and land uses not listed in Table 1 above shall be determined based on SHA specifications. For inlet design, a breakdown to each inlet, shown on a detailed drainage area map, shall be provided using the following coefficients:

Impervious Area	0.90
Lawn	0.30

4.2.1.2.1.2 Rainfall Intensity, "I"

The storm rainfall intensity "I" can be determined based on the time of concentration (Tc) of flow to the storm system inlet. The time of concentration shall be determined by considering the length of time water would travel along the hydraulically most distant flow path within the contributing drainage area. Soil Conservation Service TR-55 methodology should be used for determining Tc. A minimum of five (5) minutes shall be used.

As a guide, the following time of concentrations may be employed based on the type of proposed development:

TABLE 2

TYPICAL TIME OF CONCENTRATIONS

LAND USE	"Tc" VALUE
Commercial, Industrial, Townhouse ("C" values greater than 0.60)	5 min.
Single Family Residential (1/5 to 1 ac.) ("C" values between 0.40 and 0.60)	7 min.
Single Family Residential (2 ac. or greater) ("C" values less than 0.40)	10 min.
Parks and Open Space	15 min.

Using the computed time of concentration and the appropriate storm frequency, the rainfall intensity "I" can be determined from the Rainfall, Intensity - Frequency - Duration data in Table 4.

4.2.1.2.2 Selected Storm Frequencies

The storm frequency used for the design of the conveyance system depends upon the type of system. The following is a guide to determine the appropriate storm event:

TYPE OF SYSTEM	DESIGN STORM
Storm Drain Inlets	2 year
Enclosed Storm Drain Systems	10 year
Driveway Culverts	10 year
Residential Roadside Swale	10 year – W/6" Freeboard
Natural Channels	25 year
County Road Culverts	25 year

TABLE 4
RAINFALL, INTENSITY - FREQUENCY - DURATION
(Inches per hour)

Tc (Min)	STORM RETURN PERIOD 2 Year	10 Year	25 Year	50 Year	100 Year
5.00	5.33	6.93	7.92	8.61	9.40
6.00	5.07	6.70	7.62	8.41	9.21
7.00	4.75	6.47	7.47	8.22	8.91
8.00	4.70	6.25	7.23	7.97	8.71
9.00	4.46	6.11	6.93	7.72	8.51
10.00	4.29	5.80	6.70	7.52	8.22
11.00	4.07	5.53	6.39	7.18	7.86
12.00	3.96	5.37	6.22	6.99	7.66
13.00	3.83	5.21	6.03	6.80	7.47
14.00	3.72	5.05	5.86	6.62	7.28
15.00	3.59	4.90	5.68	6.42	7.08
16.00	3.49	4.77	5.56	6.26	6.91
17.00	3.40	4.65	5.42	6.10	6.72
18.00	3.30	4.52	5.30	5.94	6.55
19.00	3.20	4.39	5.16	5.78	6.36
20.00	3.10	4.27	5.03	5.62	6.19
21.00	3.02	4.17	4.92	5.50	6.06
22.00	2.93	4.07	4.80	5.39	5.95
23.00	2.85	3.98	4.69	5.28	5.82
24.00	2.76	3.88	4.58	5.17	5.70
25.00	2.68	3.78	4.46	5.05	5.58
26.00	2.63	3.72	4.38	4.97	5.48
27.00	2.58	3.67	4.31	4.89	5.38
28.00	2.52	3.61	4.23	4.80	5.28
29.00	2.47	3.55	4.15	4.72	5.18
30.00	2.42	3.49	4.07	4.64	5.08
31.00	2.40	3.43	4.02	4.57	5.01
32.00	2.36	3.38	3.95	4.49	4.93
33.00	2.33	3.32	3.89	4.42	4.86
34.00	2.30	3.26	3.82	4.36	4.78
35.00	2.27	3.20	3.76	4.29	4.70
36.00	2.23	3.14	3.70	4.21	4.63
37.00	2.20	3.08	3.64	4.14	4.55
38.00	2.17	3.03	3.57	4.07	4.48
39.00	2.13	2.97	3.51	4.00	4.40
40.00	2.10	2.91	3.44	3.93	4.33

(From S.H.A. - 61.1-403.01, adjusted for Frederick County)

4.2.1.2.3 Computer Software

The design engineer may utilize computer programs for the determination of hydrology and hydraulics associated with the design of storm conveyance systems. FCDPW shall review and approve all software packages prior to the acceptance of the specific software for use in design. Currently acceptable software packages include Soil Conservation Service TR-55 and TR-20 methodologies and the Federal Highway Administration HY-8, HEC-1, HEC-2, and HEC-12 methodologies, and some HAESTED software.

4.2.1.3 Enclosed Storm Drain Systems

4.2.1.3.1 Enclosed Conveyance System Sizing

The Manning Formula shall be used to determine the appropriate pipe sizes required to convey the calculated peak discharge. The Manning Formula is:

$$Q = \frac{1.486 * A * R^{2/3} * s^{1/2}}{n}$$

with

$$R = \frac{A}{P}$$

where;

Q = Peak discharge (cubic feet per second)
A = Cross-sectional area of flow (square feet)
n = Manning's roughness coefficient
R = Hydraulic radius (feet)
s = Slope (feet per foot)
P = Wetted perimeter (feet)

The Manning's roughness coefficient "n" used for design shall be as shown in Table 5. The minimum hydraulic pipe slopes shall appear in the computations and be included on the plans.

Water shall not cross the centerline of a local street or exceed the width of eight feet during a two (2) year rainfall event. The flow across any intersection shall not exceed 2.5 cfs for the ten (10) year storm. Spread shall be calculated using FHWA Hydraulic Engineering Circular No. 12, "Drainage of Highway Pavements," from which the following equations are taken:

$$Q = \frac{0.56}{n} * Sx^{5/3} * S^{1/2} * T^{8/3}$$

and

$$d = T*Sx$$

where;

Q = Flow rate in the gutter (cfs)

Sx = Cross slope of the roadway (ft/ft)

S = Longitudinal slope (ft/ft)

T = Width of flow (spread in ft)

d = Depth of flow in the gutter at the flow line (ft)

n = Manning's roughness coefficient

4:2.1.3.2 Public Street Capacity

(Future)

TABLE 5

MANNING'S ROUGHNESS COEFFICIENT "n" FOR PIPE

PIPE MATERIAL	VALUE OF "n"
Reinforced Concrete Pipe (RCP)	0.013
Cast or Ductile Iron Pipe (CIP or DIP)	0.013
Smooth Bore, High Density Polyethylene Pipe (HDPEP)	0.011
Corrugated Polyethylene Pipe (CPEP)	0.020
Aluminized Type 2 Corrugated Steel Spiral Rib Pipe (3/4"x3/4"x7-1/2" corrugations) (ALCMP-SR)	0.013
Aluminized Type 2 Corrugated Steel Pipe (2-2/3"x1/2" corrugations) (ALCMP)	
12" to 36" Diameter	0.019*
42" to 96" Diameter	0.014*
Aluminized Type 2 Corrugated Steel Pipe (6"x1" helical corrugations) (ALCMP)	
36" to 84" Diameter	0.021*
96" to 144" Diameter	0.024*
Aluminized Type 2 Corrugated Steel Pipe (2-2/3"x1/2" annular corrugations) (ALCMP)	0.024
Aluminized Type 2 Corrugated Steel Pipe (3"x1" corrugations) (ALCMP)	0.028
Aluminized Type 2 Corrugated Steel Pipe Arch (ALCMPA)	0.024
Structural Plate Pipe (6"x2" corrugations)	0.034
Aluminized Type 2 Corrugated Steel Pipe Concrete Lined (ALCMP-CL)	0.013
Monolithic Concrete Box Culvert	0.015

*Limitations: While it is true that helical corrugated metal pipe may have a lower "n" value than annular corrugated metal pipe, care should be exercised in the use of the reduced values. Since the low values depend upon the development of spiral flow across the entire cross-section of pipe, the designer must assure himself that fully developed spiral flow can occur in his design situation. It is recommended that the "n" values for annular pipe be used under the following conditions:

1. Partly full flow in the pipe
2. Extremely high sediment load
3. Short culverts less than 20 diameters (Min. length equals 20 x pipe diameter)
4. Non-circular pipes
5. Partially paved pipes

(From S.H.A. - 61.1 - 404.1)

4.2.1.3.3 Inlet Sizing and Capacity

4.2.1.3.3.1 Curb Opening Inlets on Grade

Curb opening inlets shall be sized to capture at least 85% of the flow coming to them during a two (2) year storm and shall be located in accordance with Sec. 4.2.2.2.4 through Sec. 4.2.2.2.8. These inlets shall be located at the uphill side of all public or private intersections where the flow exceeds 2.5 cfs. Curb opening inlets without grates shall be sized based on the following equations from FHWA Hydraulic Engineering Circular No. 12, "Drainage of Highway Pavements":

The length of curb opening required for total interception of gutter flow is:

$$Lt = 0.6 * Q^{0.42} * S^{0.3} * \left(\frac{1}{n * Sx}\right)^{0.6}$$

where:

Lt = Curb opening required for 100% flow interception (ft)

Q = Gutter flow (cfs)

S = Slope of gutter (Street Slope) (ft/ft)

Sx = Pavement cross slope (ft/ft)

n = Manning's roughness coefficient

The efficiency of curb opening inlets shorter than the length required for total interception is determined by the following equation:

$$E = 1 - \left(1 - \frac{L}{Lt}\right)^{1.8}$$

where:

E = Interception efficiency of an inlet (in decimal form)

L = Actual curb opening

Lt = Curb opening for total interception

4.2.1.3.3.2 Curb Opening Inlets on Sumps

The length of a curb opening inlet in a low point (sump) shall be sized based on the following equation:

$Q = 3.1(Ph^{3/2})$

where:

Q = Capacity (in cubic feet per second)

P = Perimeter of grate opening (ignoring bars and with no curb opening - in feet) times 0.75 (75% to account for inlet clogging).

h = Head over grate (in feet) (Note: strictly applicable only where h is less than 0.4 feet.)

Maryland State Highway Administration design information shall be used for other inlet types. Equations, nomographs and other support information for other inlet types shall be included in the design computation package for review and approval by FCDPW.

4.2.1.3.3.3 Swale and Yard Inlets

In residential subdivisions swale inlets shall be utilized within roadside ditches where the flow depth of the ditch is greater than one foot (1') based on a ten (10) year storm frequency, or where the maximum average flow velocity in a stabilized grass swale exceeds four feet(4')per second. Swale inlets shall be sized in accordance with Maryland State Highway Administration criteria and computations included in the design package. Top elevations, as shown on the Structure Schedule, shall be at the grate elevation.

Yard inlets shall be placed where the ten (10) year storm runoff across a property line exceeds four (4) cfs, or where insufficient grade exists for the conveyance of surface flow to a street or roadside ditch. A sump condition shall be created at all yard drains to assure 100% capture of a ten (10) year storm. Adequate means of overflow shall be provided for larger storm events so as not to adversely impact private property. The water surface elevation of the ten (10) year storm shall be shown on the profile.

4.2.1.3.4 Manhole, Inlet, and Field Connection Energy Losses

Head loss computations shall be computed for all storm drain structures using the following equations:

$$HL = \frac{Vop^2 - Vr^2}{2 * g}$$

For manholes and inlets;

$$Vr = \frac{\left(Q * V * \cos\frac{\theta}{2}\right) ip1 + \left(Q * V * \cos\frac{\theta}{2}\right) ip2 + \ldots}{Qop}$$

For field connections;

$$Vr = \frac{Qip * Vip}{Qop}$$

where:

HL = Head loss (ft)
V = Pipe velocity (fps)
Vr = Resultant velocity (fps)
Q = Flow rate (cfs)
ip = Inlet pipe
op = Outlet pipe
θ = Angle between inlet and outlet pipes
g = Acceleration of gravity (32.2 ft/sec/sec)

The invert difference between inlet and outlet pipes may be determined by the head loss (HL) without adjustment. A minimum invert difference of 0.1 feet shall be considered for all manholes and inlets.

4.2.1.3.5 Hydraulic Grade Lines

The hydraulic gradient for the ten (10) year design storm shall be shown on all profiles for pipes 24 inches or larger. The gradient shall take into consideration pipe friction losses, tailwater at pipe outfalls, losses in the structures and other applicable conditions. If no tailwater condition exists, begin the analysis at the crown of the pipe.

All enclosed systems shall be designed so that they will generally operate without hydrostatic pressure under the design flow conditions. Where the hydraulic gradient is greater than one foot (1') above the crown of the pipe, special joint treatment shall be required per ASTM standard as follows:

Pipe Material	**Specification**
HD PEP	ASTM D3212
RCP	ASTM C361 or ASTM C443/AASHTO M198
Metal Pipe	O-Ring Rubber Gasket or Sleeve Gasket

Storm drains designed in locations where one or more of the following conditions exist, may be required to provide special joint treatment as described above:

1) Karst topography
2) Under public paved areas
3) Within 5' horizontally of other utilities
4) Other extenuating circumstances under which exfiltration could create a safety/health hazard.

The hydraulic grade line shall start at the storm system outlet and shall account for any outfall tailwater conditions. The existing or proposed design storm tailwater surface elevation shall be computed and shown on the profiles.

4.2.1.4 Open Channels

Peak discharge computations for all open channels shall be provided based on Manning's Equation (See Section 4.2.1.3.1). The roughness coefficients used for design of open channels shall be as shown in Table 6. Each channel design shall be accompanied with a typical section, a plan view and slope information, with the typical section location clearly marked for each reach on the plan. In the case of existing channels, field run topography may be required to verify channel adequacy.

TABLE 6

MANNING'S ROUGHNESS COEFFICIENTS FOR OPEN CHANNELS (From S.H.A. - 61.1 - 404.1)

GUTTERS, DITCHES, AND CHANNELS	VALUE OF "n"
Concrete or Bituminous Lined Channels	0.013
Grass Swales - Flow Greater than 6"	0.040
Grass Swales – Flow Less than 6"	0.060
Gabions	0.030
Rip-Rap	0.035
Channels not maintained, uncut weeds & brush	0.08 to 0.12
Natural Stream Channels	0.035 to 0.150
Permanent Turf Reinforcement (Enkamat, Miramat, Tri-lock, Pyramat, Etc.)	Per Manufacturer's Specifications

4.2.1.4.1 Designed Channels (To be constructed)

Open channels may be designed to convey stormwater on residential lots of ½ acre or less where the volume of flow for the ten (10) year storm event is less than four (4) cubic feet per second or where the number of lots being crossed by drainage is four (4) or fewer. These channels shall be designed at a minimum slope of two (2) percent, trapezoidal in shape or parabolic with side slopes of 3:1 or flatter. No V ditches will be allowed.

Open channels for lots larger than ½ acre or in open space areas may be designed to convey drainage across more than four (4) lots. Where possible, these channels shall be designed at a maximum slope of ten (10) percent, with minimum velocities of two feet (2') per second for the two (2) year storm. The maximum velocity shall also be based on the ten (10) year storm and the lining used to avoid erosion problems (See Appendix 22). In cases where the minimum slope can not be achieved or where springs are encountered, a pilot channel may be required. This channel may consist of a French drain, concrete flume, perforated PVC pipes, or other *materials acceptable to FCDPW.

The open channel system shall be vegetated and may be parabolic or trapezoidal in shape. The maximum velocities through the channel shall not exceed erosive velocities for the type of stabilization used.

- Rip –rap shall not be used in residential areas.

4.2.1.4.2 Natural Non-Engineered Channels (Existing)

Any natural stream channel receiving additional offsite water from upstream development must be analyzed to assure safe conveyance of the ultimate ten (10) year flow. The existing stream must remain stable under ultimate design conditions. Computations shall be provided by the engineer comparing the pre-developed flow conditions of the stream during the ten (10) year storm event with the ultimate flow conditions as a result of the proposed development. Computations modeling the proposed stabilization practices shall be provided to ensure adequacy.

Stream stabilization measures may include, but are not limited to, any or a combination of the following practices:

4.2.1.4.2.1 STREAM BANK PROTECTION that may include riprap, root wads, brush bundles or other means of protecting isolated areas from potential stream bank erosion.

4.2.1.4.2.2 DROP STRUCTURES that may be constructed using gabions, or logs to create defined areas for velocity dissipation.

4.2.1.4.2.3 PARALLEL PIPE SYSTEMS which consist of a means of splitting part of the increased runoff and conveying that flow through an enclosed pipe system parallel to the existing stream and discharging the water in an area capable of handling the increased flow.

4.2.1.4.3 Roadside Swales

All open section roadways, whether designed as part of a new subdivision or upgraded as part of a road widening, shall have drainage swales provided for storm water conveyance. Roadside swales shall be capable of conveying the ten (10) year storm. Computations may be required to verify capacity and velocity. The minimum slope for a vegetated swale shall be one) percent (1%). Low flow channels, such as French drains, concrete lined, PVC drain pipes, etc. may be used for slopes less than one percent (1%).

The design must include information pertaining to the water velocity, flow depth, and typical section of the swale. The flow velocities shall not exceed those allowed by the soils and vegetated cover proposed for the swale. The swale must flow into an adequate outfall capable of handling the storm runoff in a non-erosive fashion.

4.2.1.5 Culverts

4.2.1.5.1 County Road Crossings

All culverts designed to convey streams and storm drainage under road crossings shall be sized to carry the 25 year ultimate storm based on ultimate zoning with one foot (1') of freeboard vertically from the edge of paved travelway. Computations shall also be provided to evaluate the impact of the 100-year storm on the road crossing. Flow over the road surface shall be kept below twelve inches during the 100 year storm. Note that the following requirements need to be met:

1. The maximum headwater must be less than 1.5 times the depth of the culvert. This means that the culvert should not cause water to pond for a depth higher than one and one-half of the depth of a culvert (e.g., for a 48" RCP, the maximum headwater is
   1.5 x 48" = 72" = 6'). Stormwater management facilities are exempt from this rule.
2. The maximum headwater should be less than five feet (5') above the crown (top) of the culvert, except where the road is being used to store runoff.

Road crossings shall be sized based on headwater and tailwater conditions using culvert design procedures, such as Federal Highway Administration Report No. FHWA-IP-85-15, Hydraulic Design of Highway Culverts (HDS No. 5), FHWA Culvert Analysis, HY-8, Maryland State Highway Administration (MSHA) Design Manual, or others acceptable to Frederick County Division of Public Works. Outlet protection shall be designed to reduce velocities to non-erosive conditions.

4.2.1.5.2 Driveway Culverts

All driveway culverts shall be designed to fully convey the ten (10) year storm. In most cases, the minimum culvert size shall be 15 inches or a pipe of an equivalent flow area. Smaller pipe sizes may be allowed with proper justification and approval from the Division of Public Works. Computations may be required to justify the size of the farthest (largest) downstream culvert size shown.

4.2.1.6 Energy Dissipaters

Acceptable energy dissipation measures shall be placed at all storm drain outlets. They shall be designed to reduce pipe outlet velocities to a velocity that the downstream conveyance system can handle without causing erosion problems during a ten (10) year storm. Outfalls should not terminate at the top or on the sides of slopes where erosive velocities could be regenerated beyond the limits of the dissipater. Rip Rap shall not be used unless all other energy dissipation devices are found to be impractical.

A typical section and plan view of the energy dissipater shall be provided with the construction drawing details. Additionally, the dissipater shall be shown graphically on the storm drain plan view with existing and proposed grading continuing to the receiving channel, but not less than 100 feet. Energy dissipater information shall include, at a minimum, material type, thickness, side slopes, depth, length, and type of blanket. The design of a riprap outlet shall be based on Soil Conservation Service Methodology or other acceptable methods approved by FCDPW.

4.2.1.6.1 Filter Fabric

A filter fabric shall be placed between the riprap blanket and the underlying soil surface. The filter fabric shall be approved by Frederick County Division of Public Works. The filter fabric proposed is to be Geotextile Class 'C' meeting ASTM D 1682 for grab tensile strength (200 lbs. min.) and ASTM D 3786 for burst strength of 320 pounds per square inch minimum. Examples are to be shown on the plan.

4.2.1.6.2 Riprap Outlet Shape

The riprap channel bottom width shall be equal to the width of the flared end section, if used, or 1.75 times the inside diameter of the outlet pipe or outlet width. The riprap channel side slopes shall be a maximum of 2:1. The riprap outfall shall meet the requirements of either the Soil Conservation Service or the Maryland State Highway Administration. Blanket thickness shall be 2.0 times the d_{50} stone size or the theoretical diameter of the maximum stone within the call of riprap required, whichever is greater.

4.2.1.7 Safe Conveyance Analysis

Properties discharging less than four (4) cubic feet per second in a ten (10) year storm and properties which contribute less than 10% of the total flows in a 10 yr storm up to the study point will not be required to perform a safe conveyance analysis.

Developers may choose to manage the 2, 10 and 25 yr storms to pre-development flow rates in accordance with the stormwater management ordinance and design guidelines, in lieu of addressing safe conveyance requirements.

In order to protect downstream conditions, the County will require an analysis of the effect of runoff from developed properties on existing road culverts, stormdrain conveyance systems, roadside ditches, stream channels, or other conveyance systems. Safe conveyance means the adequate capacity of downstream systems to carry concentrated flows, (storm events in accordance with this manual) or in a non-erosive manner.

When analyzing the adequacy of the downstream conveyance system, the rational method shall be used to determine the flows to the study point. Drainage areas and times of concentration should be determined based on, in order of preference; field run topography (if available), aerial photography, and USGS quad maps. C valves should be determined based on the current comprehensive plan.

If a downstream system is found to be inadequate in current conditions, and the proposed development does not increase flows (for the design storms specified in this manual) by greater than 10%, that applicant will not be required to improve the existing system.

This analysis of the impacts of stormwater flows downstream in the watershed shall be performed to a point downstream of the first downstream tributary whose drainage area equals or exceeds the sites contributing area.

In cases where inadequate downstream conditions exist, the Division of Public Works will consider a shared solution based on a prorata share.

Any staff determinations regarding the scope or requirement of Safe Conveyance Analysis or the scope of required off-site improvements resulting from the analysis are to be appealed to the Director of the Division of Public Works.

4.2.2 IMPROVEMENT PLAN DESIGN GUIDELINES

The improvement plans that are to be used for construction shall be submitted to Frederick County Division of Public Works (FCDPW) in conformance with the requirements of "THE SITE PLAN AND SUBDIVISION IMPROVEMENT PLAN MINIMUM SUBMISSIONS GUIDELINES" and shall include sufficient information for the accurate installation of all storm conveyance systems. The plans shall be complete, reflect sound engineering practices, and be signed and sealed by a Maryland Registered Professional before paper review copies are submitted to FCDPW for review. Once all comments have been addressed to the satisfaction of all review agencies, mylars can be submitted to the Soil Conservation Service for signature. After Soil Conservation Service signature, the mylars and mylar sepias may be submitted to FCDPW for signature.

4.2.2.1 Pipes

Pipe size shall be determined as previously discussed in this manual. The pipe to be used shall be determined by the type of application, the characteristics of the runoff and the properties of the soils that will surround the pipe within the trench.

4.2.2.1.1 Pipe Materials

The various pipe materials shall meet the criteria set forth in SECTION 905-PIPE of the Maryland Department of Transportation, State Highway Administration, Standard Specifications for Construction and Materials, Oct., 1993 edition (MSHA Specs), or as amended. For public rights-of-way, TABLE 7 addresses the allowable storm drain pipe materials to be used. Pipe type, class, or gage shall be specified on the profiles and in the pipe schedule. The depth of cover and bedding material shall be based on manufacturer's specifications. Pipe schedules will only be required for public systems.

TABLE 7

*ALLOWABLE STORM DRAIN PIPE FOR FREDERICK COUNTY

MATERIAL	DESIGNATION
Reinforced Concrete Pipe	RCP
Aluminized Type 2 Corrugated Steel Pipe	ALCMP
Smooth Bore, High Density Polyethylene Pipe, Type "S"	HDPEP
Cast or Ductile Iron Pipe	CIP or DIP
Polyvinyl Chloride Pipe, Sch. 40 or Sch. 80	PVC

*Others as approved by Frederick County Division of Public Works

4.2.2.1.2. Minimum Pipe Size

The minimum pipe size for any storm drain pipe considered to be a component part of the public storm drainage system shall be 15 inches in diameter.

4.2.2.1.3 Cover and Loading Requirements

One foot minimum cover shall be provided over the outside of the pipe. Additional cover may be required as directed by the pipe manufacturer or the engineer, depending upon the application. In road crossing applications and under paving, the one foot (1') minimum criteria shall be measured from the bottom of the bituminous base course.

4.2.2.1.4 Curved Pipe Systems

Pipe systems with the capability of joint deflection may be used for pipes greater than 24" in diameter. Pipe deflection shall follow the manufacturer's specifications. All pertinent data is to be shown on the plan: i.e., radius, chord, tangent length, curve length, PC, PT, and Delta.

4.2.2.1.5 Pipe Slope

To enhance self-cleaning characteristics, pipes shall be designed on an actual slope of at least one percent (1%). Storm drain may need to be installed on slopes of less than one percent (1%), under extreme circumstances. In these cases, the pipe shall have a smooth interior and velocities greater than two (2) feet per second for the two (2) year storm, with proper justification of need provided. Where slopes of any pipe exceed 20%, concrete anchors will be required per Frederick County Standard Detail No. 106 (See Appendix 23).

4.2.2.2 Manholes and Inlets

All storm drain structures shall be specified by MSHA standards or as previously approved by FCDPW. All nonstandard or modified structures shall be approved by FCDPW first and a detail shown on the construction plans. The type, size and MSHA Structure Number of the proposed structure is required. All inlet structures shall be sized as previously presented with support information provided in the design computation package. The structures are to be numbered and listed on the structure schedule. Structure numbers are to match the drainage area map and computations.

4.2.2.2.1 Manhole and inlet structures shall be spaced as follows:

15" - 24" pipe	400' max
27" - 42" pipe	600' max
48" or larger pipe	as necessitated by site conditions and maintenance equipment

4.2.2.2.2 All inlet and manhole structures shall provide positive flow through the structure. The invert drop through the structure will be based on hydraulic losses calculated in accordance with Section 4.2.1.3.4.

A minimum drop of 0.1 foot is to be provided. Where the drop through a structure is greater than that which can be accommodated by a shaped channel with the invert on a one and one-half foot horizontal to one foot (1') vertical slope, the bottom of the structure shall be lined with granite blocks at least four inches (4") thick. No shaped channel will be required for this type of construction, but the bottom of the structure shall slope at least one-half inch per foot towards the invert of the outlet pipe.

4.2.2.2.3 Field connections of branch lines into main line pipes may be used only where the main line pipe involved is 27 inches in diameter and larger. The diameter of the incoming branch line is not to exceed 50 percent of the main line diameter. The branch line should enter the main line at an angle between 90 degrees to 115 degrees at the main line pipe centerline.

4.2.2.2.4 Street inlets in sump areas shall be located at the low point of the street grade. One hundred percent (100%) capacity is to be provided to allow interception of flows that bypass other inlets.

4.2.2.2.5 Curb inlets shall be placed in line and on grade with the proposed curb and gutter. Curb inlets should be placed far enough from any curb fillet to maintain a standard localized depression. If three inch (3") mountable curb is used, a ten foot (10') transition to all structures will be provided. Top of curb elevations shall be provided.

4.2.2.2.6 Non-standard inlets and those in excess of 20 feet (20') require special design approval by Frederick County Division of Public Works.

4.2.2.2.7 Inlets placed within the public road right-of-way shall have traffic bearing grates per MSHA Specifications.

4.2.2.2.8 Inlet openings within the public road right-of-way or within residential subdivisions shall limit incoming ditchline opening sizes to four (4) inches max. Horizontal double-dipped galvanized smooth bars and/or angle iron are to be bolted to the structure as needed. Other acceptable methods may be used as an alternative to protect the opening.

4.2.2.3 Pipe and Culvert Entrances

4.2.2.3.1 Pipe and culvert entrances are not to be located on developed lots unless an alternate location is not feasible. The 25-year water surface elevation shall be shown on the profile. Generally, lots should be located outside of the area inundated by the 100 year storm backwater.

4.2.2.3.2 Suitable topographical information is to be provided on the plan view to show drainage path(s) to the entrance structure and to ensure interception of flow. The channel invert, top of structure elevation in sump condition and top of banks of incoming drainage course(s) shall be shown on the plan view and profile. Riprap shall be provided as necessary to alleviate erosion potential created by the transition from the channel into the pipe or culvert entrance.

4.2.2.3.3 Pipe and culvert entrances may be constructed with end sections or headwalls for pipes smaller than 24 inches in diameter. Pipes equal to or larger than 24 inches in diameter shall be constructed with a concrete headwall.

4.2.2.3.4 A cutoff wall may be used for pipe entrances when future extension of the system is anticipated within a five (5) year time frame. The structure shall be located sufficiently beyond the development so that regrading will not be required on occupied lots of this development when the system is extended.

4.2.2.4 Pipe and Culvert Outfalls

4.2.2.4.1 Outlets are not to be located on developed lots with lot areas less than 30,000 square feet except in extenuating circumstances and with permission of FCDPW. Outfalls shall be located at the bottom of slopes, near a receiving stream or other area that will adequately handle the concentrated flow. Suitable field run topographic information shall be furnished on the plan and profile views to show the drainage path from the structure to an existing established drainage course.

4.2.2.4.2 All storm drain outfalls are to terminate prior to a downstream property line and the drainage pattern reestablished as close to a natural and pre-developed state as possible. Exceptions may be made in situations such as continuous downstream development or with written agreement from downstream property owner(s) in conjunction with non-erosive conveyance of runoff.

4.2.2.4.3 Erosion protection is to be provided at all outfalls. Transition of the erosion protection section to the natural section shall be shown in the plan view and cross-section. The channel invert and tops of banks of the receiving drainage course are to be shown on the plan and profile views. (See Section 4.2.1.6)

4.2.2.5 Required Plan Information

4.2.2.5.1 Plan View

4.2.2.5.1.1 The information that must be included for each run of storm drain pipe shall include the following: All pipe sizes are to be clearly labeled. All manholes, inlets, headwalls, etc., shall be clearly numbered and shall match the drainage area map, computations and pipe profiles. All structures shall be tied to features on the plan such as centerline stations or property lines.

4.2.2.5.1.2 An adequate overflow path for the stormwater is to be shown on the plan view if the path does not follow directly over the pipe. In most cases arrows will suffice to show flow paths. Where applicable, grading will be required to ensure the safe conveyance of overflow. For these cases, grading plans showing existing and proposed contours on plan view, as well as cross-sectional details, are required.

4.2.2.5.1.3 Storm drain running parallel to property lines shall be offset from the property line by a minimum of five feet (5') to allow for fencing and planting.

4.2.2.5.2 Profile View

4.2.2.5.2.1 Profiles of all proposed storm drains and culverts shall include, at a minimum, the following information:

1. Existing and proposed utility crossings;
2. Pipe size, type, and slope;
3. Class or gage;
4. Section length measured from structure to structure;
5. Invert elevations at each structure and at outfalls;
6. Flow characteristics (Q_{10}, V_{10} and the minimum slope (S_{min}) required for full flow in pipe);
7. The existing ground and proposed grade over the proposed system;
8. V_{10} actual for the proposed pipe slope at the outfall.

4.2.2.5.2.2 The hydraulic grade line for the ten (10) year storm shall be shown on all pipe profiles and at structures per Section 4. 2.1.3.5.

4.2.2.5.2.3 A pipe schedule tabulating pipe lengths by diameter and class or gage to be used shall be included on the drawings with the pipe profiles. A structure schedule which outlines the type of structure being used, the appropriate MSHA standard for that structure, structure ties to lots or road centerlines, elevations to the top of the structure and any other pertinent information required for construction shall also be included.

4.2.2.6 Clearance with Other Utilities

4.2.2.6.1 All existing and proposed utilities crossing or parallel to designed storm drain systems shall be shown on both the plan view and profile views.

4.2.2.6.2 A minimum vertical clearance of 12 inches and a minimum horizontal clearance of five feet, wall to wall, shall be provided between storm drainage lines and other utilities. Exceptions may be granted on a case-by-case basis when justified. If other regulations are more restrictive they shall apply.

4.2.2.6.3 The crossing angle between storm drain systems and any other utilities shall not be less than 45 degrees. Exceptions may be granted on a case-by-case basis.

4.2.2.6.4 Erosion protection, such as curlex or a permanent type matting, shall be provided where concentrated storm water flows across the trench of other utilities.

4.2.2.7 Open Channels: Designed and Natural

4.2.2.7.1 Channel inverts and tops of banks shall be shown on plan views for all designed open channels and any work associated with existing channels. Limits and types of bank protection, design flow rates, actual velocities and water surface elevations shall also be detailed.

4.2.2.7.2 The limits of the 100-year floodplain shall be shown. The minimum setbacks between any building and the 100-year floodplain shall be in accordance with the Frederick County Zoning Ordinance and other applicable codes.

4.2.2.8 Storm Drain Plan Revisions

In most situations, minor stormdrain and/or stormdrain structure revisions may be submitted for review and approval on a red-lined, blue print copy of the approved plans. The revisions shall be completed on both the plan view and profile, and all pertinent information provided. Pertinent information includes, but is not limited to:

1. Slope changes for the stormdrain shown on the profile sheet(s);
2. Computations necessary to verify stormdrain capacity should the stormdrain slope or size be decreased;
3. Conflicts with other utilities, both horizontal and vertical;
4. Changes to a stormdrain structure, including top elevations, depth of structure, dimensional changes, etc;
5. Grading modifications associated with the change shown on the plan view and the profile;
6. Other information as deemed necessary on a case-by-case basis;
7. Revised mylars must then be provided for signature.

Those modifications involving more significant changes must be submitted as a formal plan revision with supporting engineering information and new Frederick County Division of Public Works signature blocks. To facilitate the review of these revisions, all changes should be clouded or distinguished from the previously approved plans by another means. Supporting information shall include that outlined above or as needed on a case-by-case basis.

4.2.2.9 Special Structures

All structures which do not meet standard Maryland State Highway Administration details and specifications, such as flow splitters or large box culverts, shall be detailed on the improvement plans or shop drawings and signed, sealed and certified by a registered professional engineer licensed in the State of Maryland. The detail(s) shall include wall thickness, reinforcement details, elevations, etc. Those culvert-type structures, either single or multiple cell, spanning 20 feet or more shall also be reviewed by the Office of Transportation Engineering.

4.2.2.10 Stormdrain Easements

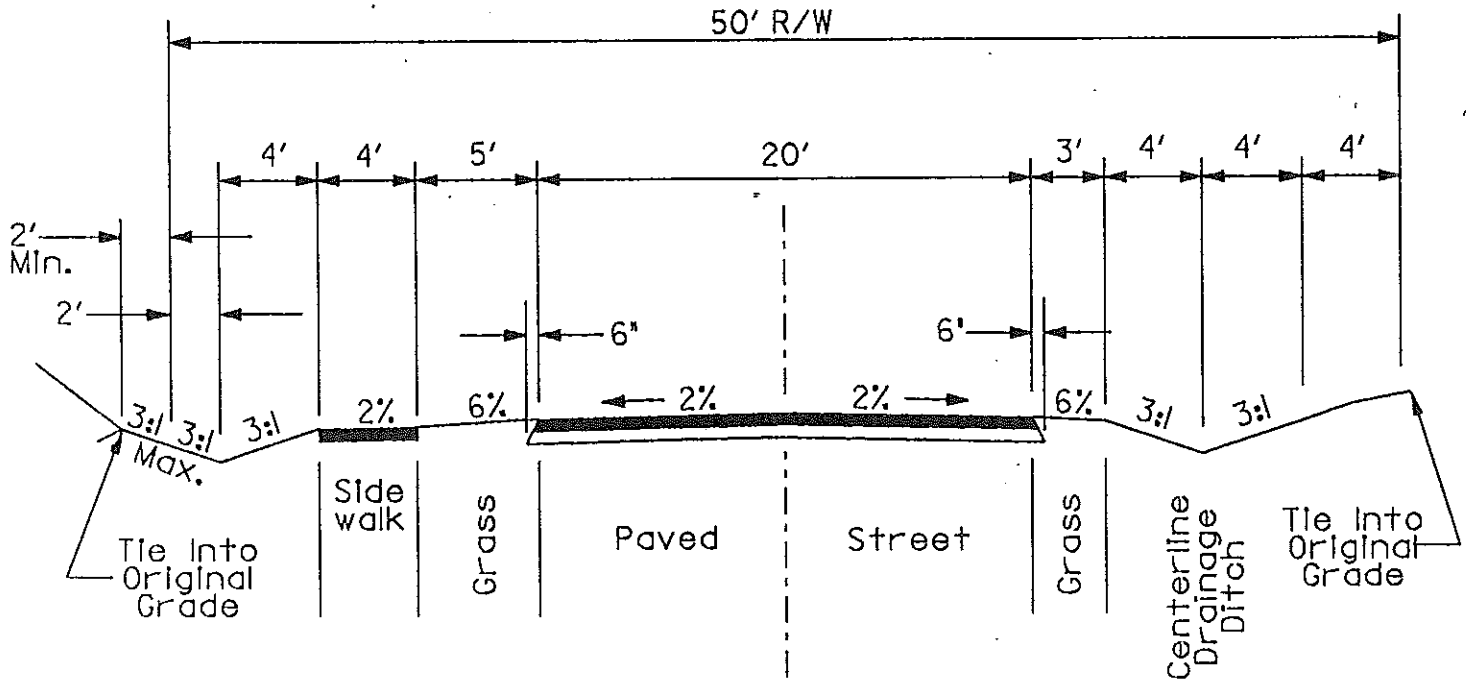
All stormdrain, both public and private, used as an essential component for conveyance of stormwater to a stormwater management facility shall be shown in a stormdrain easement. Private stormdrain requiring a stormdrain easement is that stormdrain where, if failure of the system were to occur, stormwater runoff would bypass the stormwater management facility. The minimum easement width shall be 30 feet. Special consideration for smaller stormdrain easement widths shall be reviewed by FCDPW on a case-by-case basis with adequate justification. In conjunction with the easement, a deed of easement and maintenance agreement must also be executed.

4.2.2.10 Asbuilts (Future)

DESIGN MANUAL (Volume I) – STREETS AND ROADS

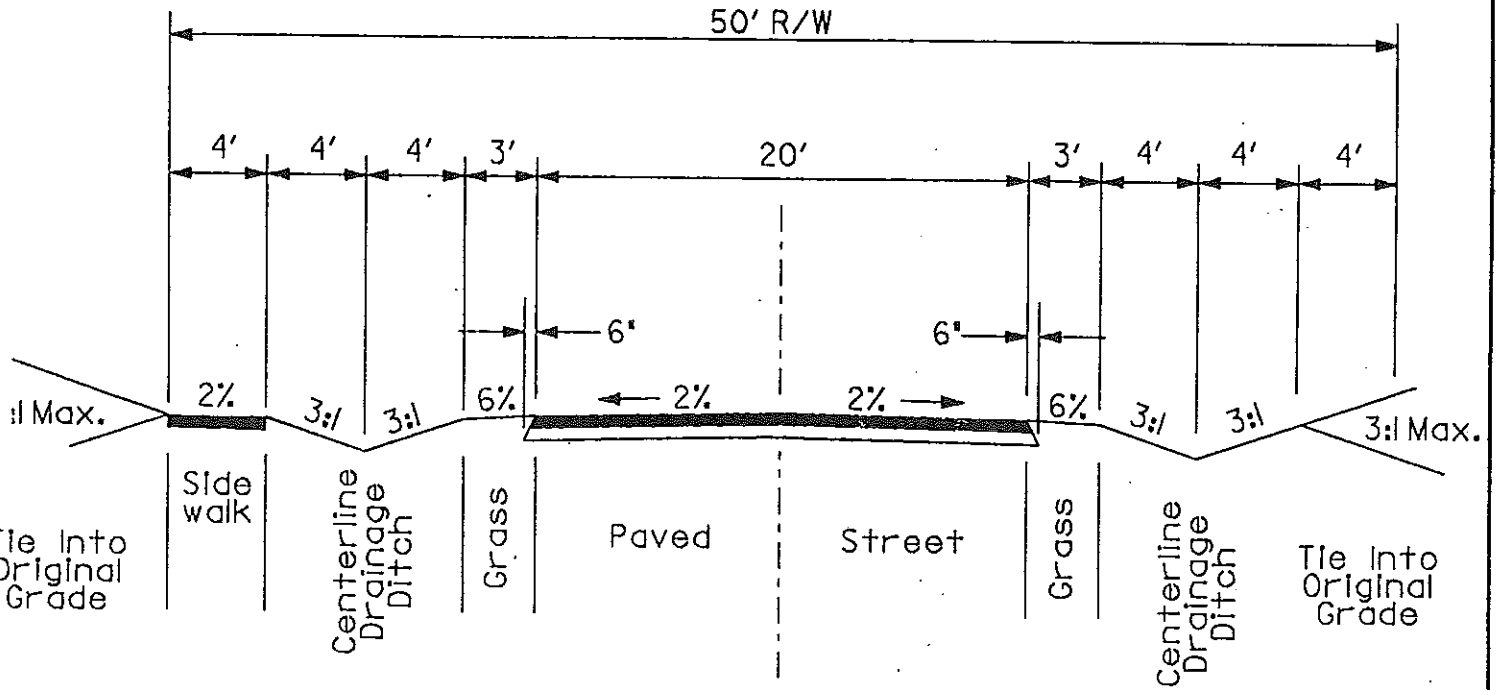
APPENDIX

(Quick Reference Code Where Applicable)



OPEN SECTION
STREET OPTION "A" (ALTERNATE I)

REVISIONS		TYPICAL SECTION LOCAL ACCESS STREETS LOW DENSITY (ALTERNATE I)	DETAIL NO. DM APX01
DATE	NOTE		
		APPENDIX I	DATE: 1994



OPEN SECTION
STREET OPTION "A" (ALTERNATE 2)

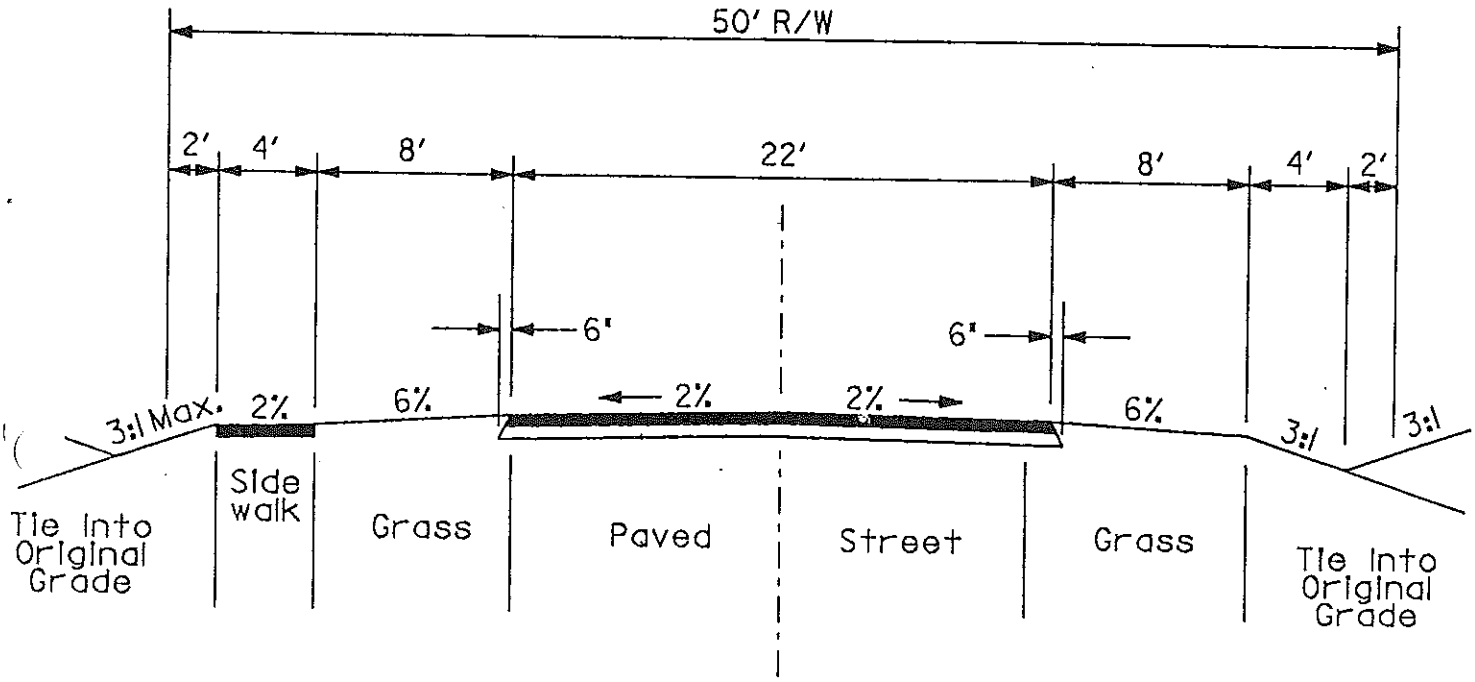
REVISIONS	
DATE	NOTE

TYPICAL SECTION
LOCAL ACCESS STREETS
LOW DENSITY
(ALTERNATE 2)

APPENDIX 2

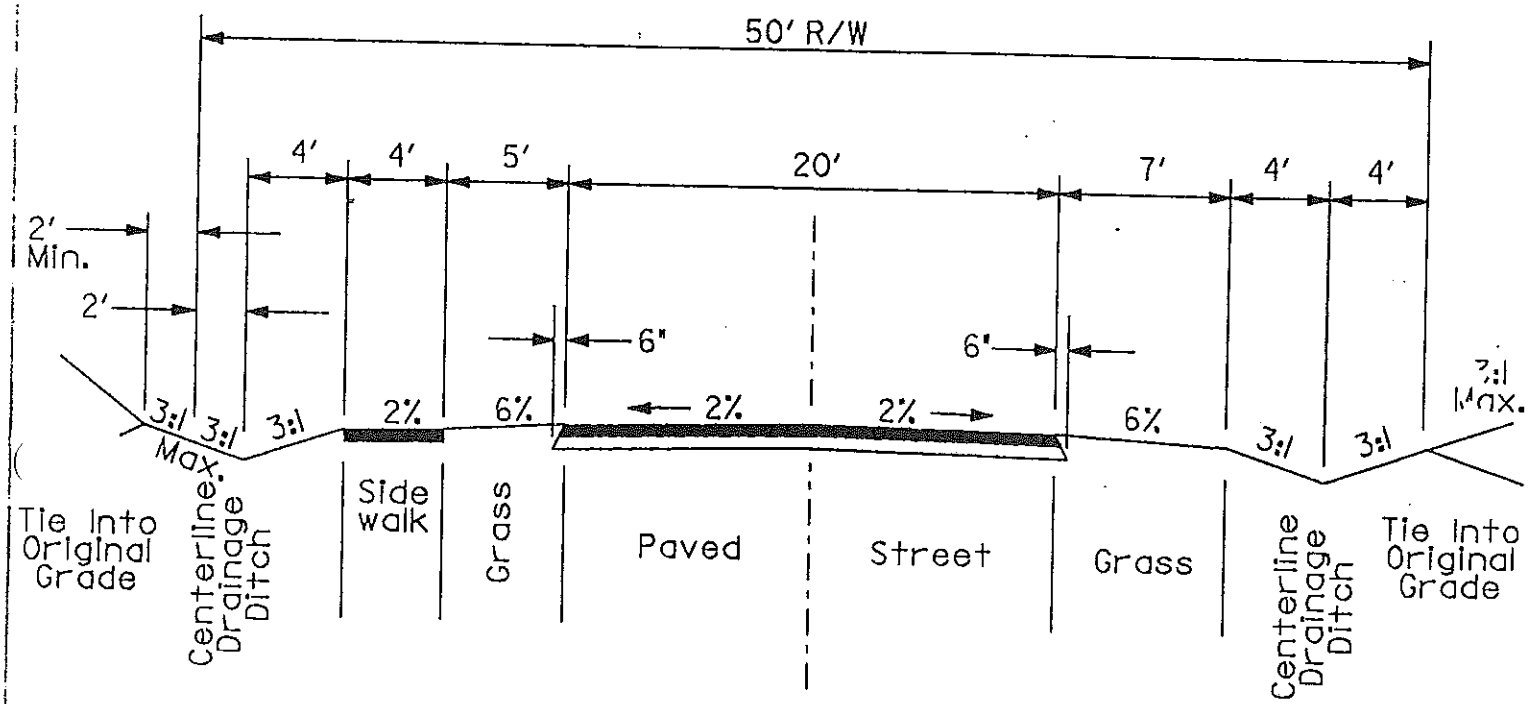
DETAIL NO.
DM
APX02

DATE: 1994



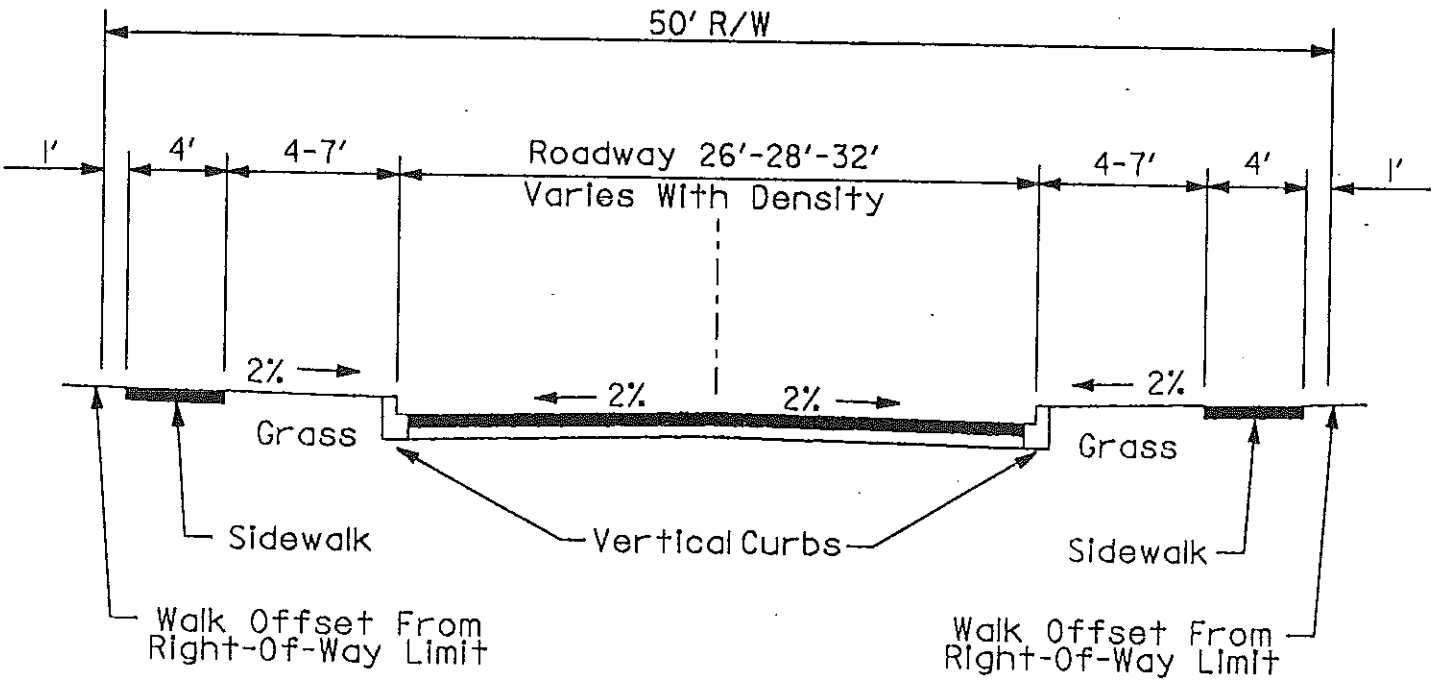
OPEN SECTION
STREET OPTION "B"

REVISIONS		TYPICAL SECTION LOCAL ACCESS STREETS HILLY TERRAIN LOW DENSITY APPENDIX 3	DETAIL NO. DM APX03 DATE: 1994
DATE	NOTE		



OPEN SECTION
STREET OPTION "C"

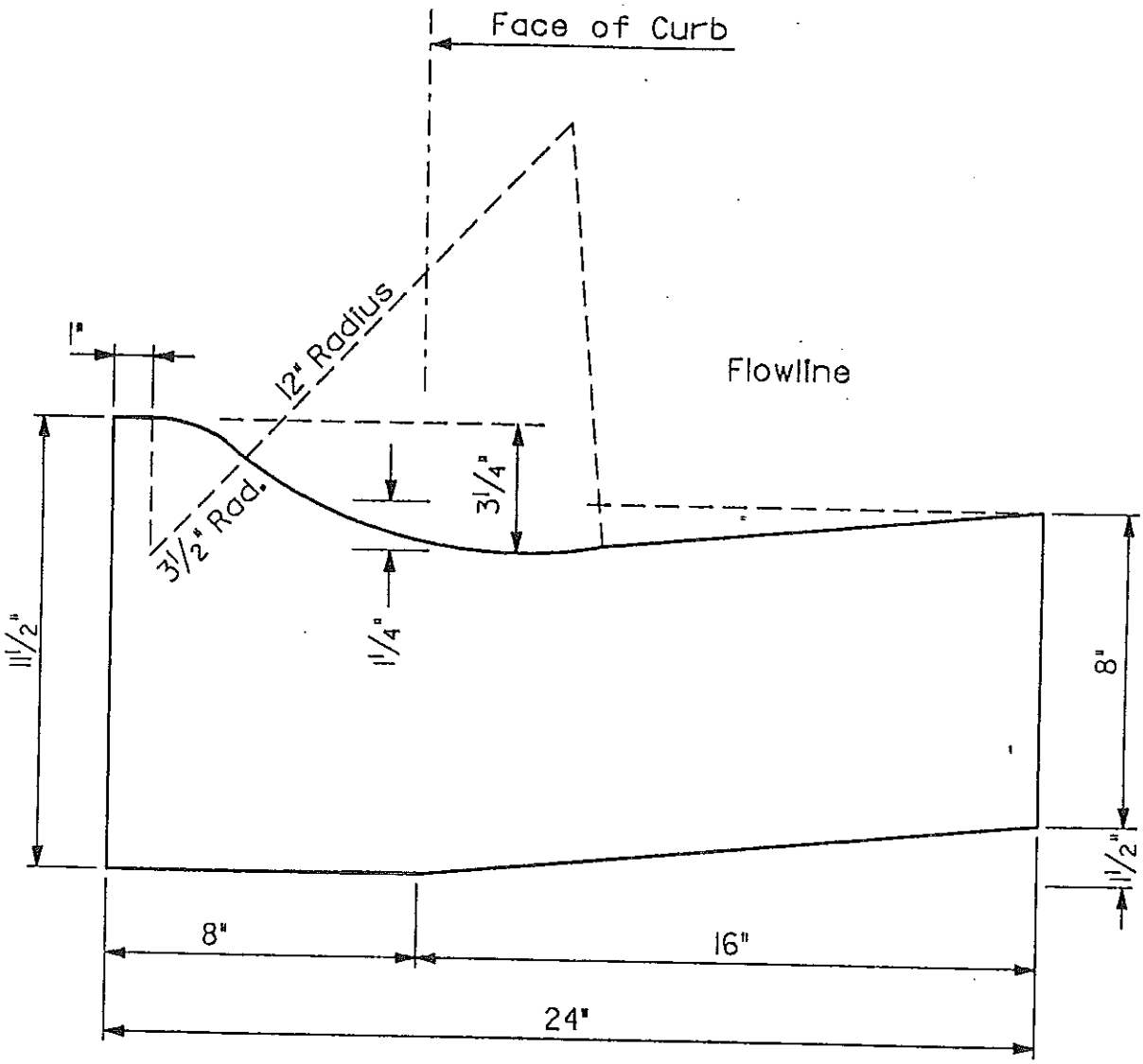
REVISIONS		TYPICAL SECTION LOCAL ACCESS STREETS LOW DENSITY (R-3, OPEN SECTION) APPENDIX 4	DETAIL NO. DM APX04 DATE: 1994
DATE	NOTE		



CLOSED SECTION
STREET OPTIONS "D", "E", & "F"

NOTE: FOR HIGH DENSITY DEVELOPMENT IN THE HILLY CLASSIFICATION, THE MINIMUM GRASS AREA CAN BE REDUCED TO 4'.

REVISIONS		TYPICAL SECTION LOCAL ACCESS STREETS CLOSED SECTION DESIGNS	DETAIL NO. -DM APX05
DATE	NOTE		
		APPENDIX 5	DATE: 1994

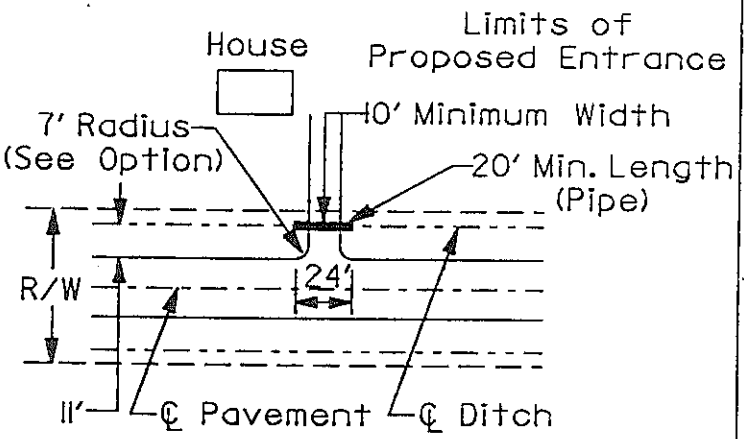


MOUNTABLE CURB

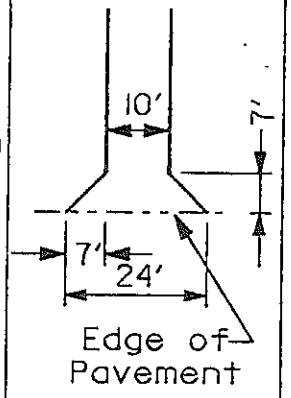
NOTE: THE STANDARD DISTANCE BETWEEN JOINTS SHALL BE 10' (MAXIMUM DISTANCES SHALL BE 13' AND 6' RESPECTIVELY).

REVISIONS		3" MOUNTABLE CURB	DETAIL NO. DM APX06
DATE	NOTE		
		APPENDIX 6	DATE: 1994

PIPED ENTRANCE

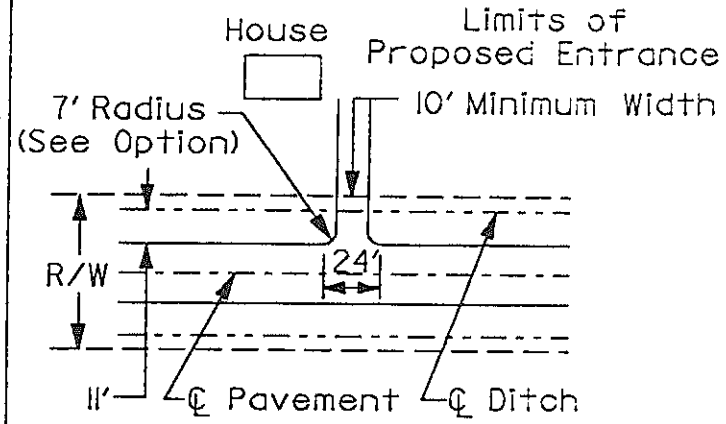


(DETAIL "A")



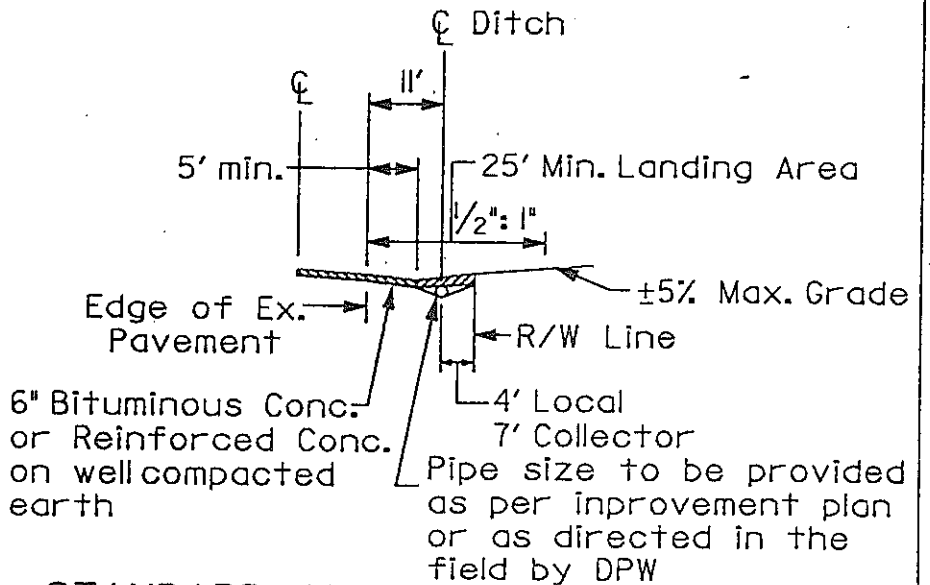
APRON OPTION

SWALED ENTRANCE

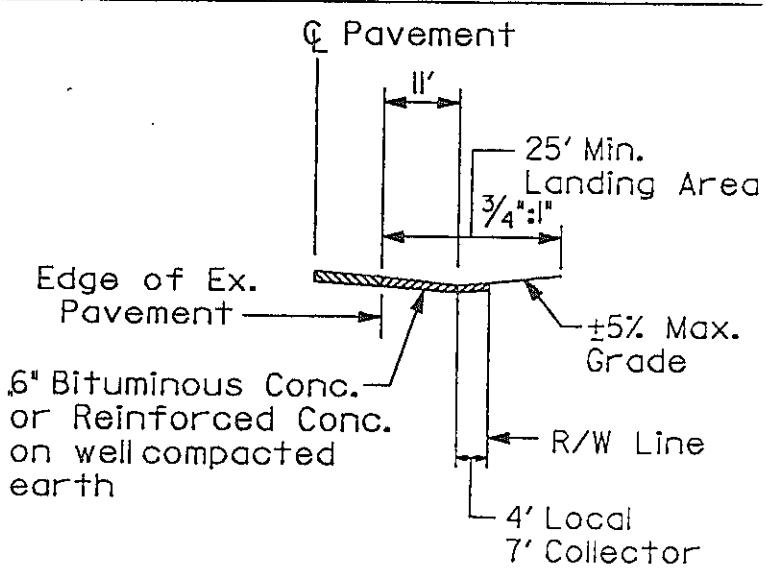


(DETAIL "B")

NOTE: Curve radius shall be 10' on all 20-foot streets in medium and hilly designations



STANDARD CROSS SECTION PIPED



STANDARD CROSS SECTION SWALED

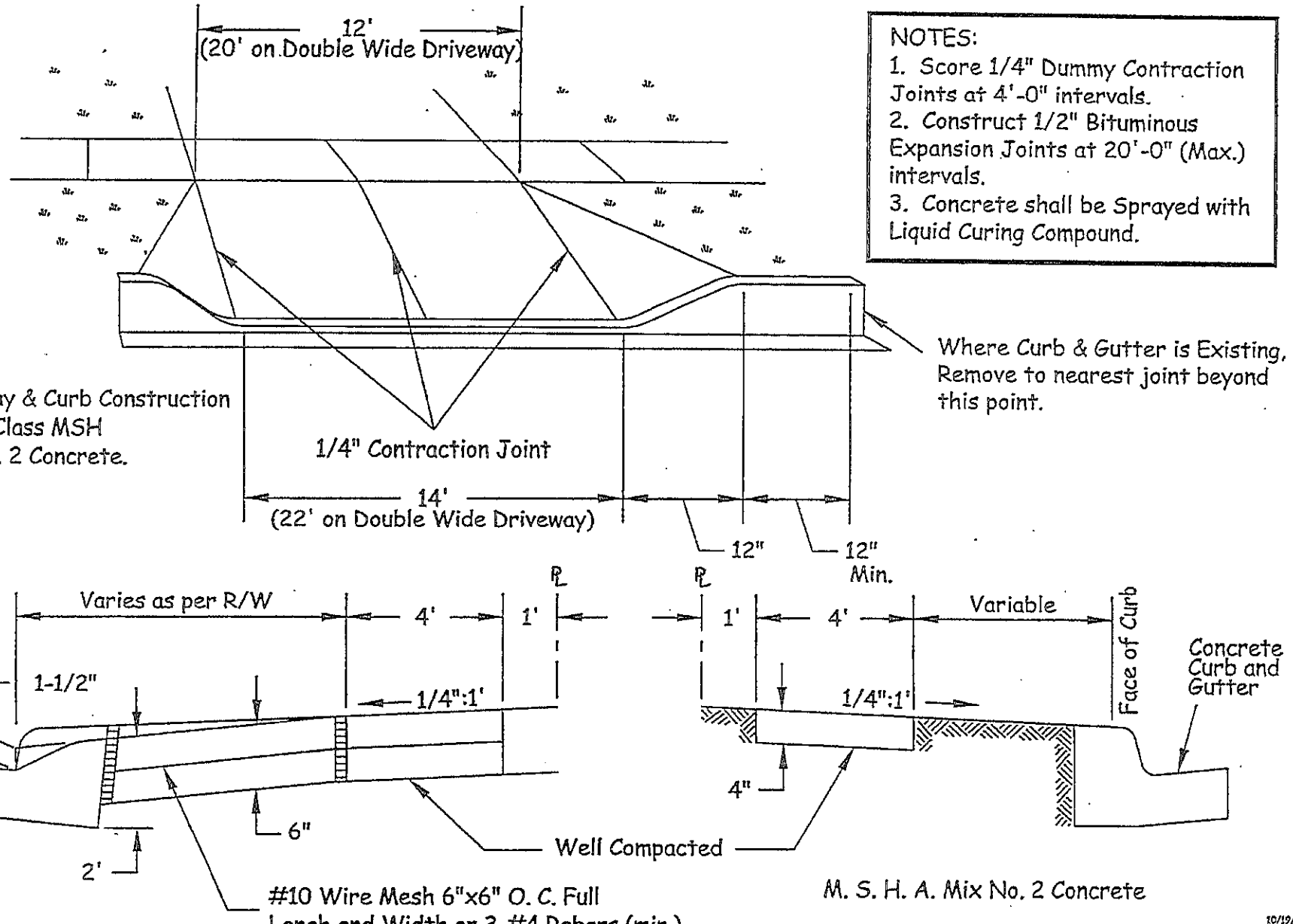
REVISIONS

DATE	NOTE

DRIVEWAY ENTRANCE DESIGN DETAILS

APPENDIX 7

DETAIL NO.	DATE: 1994
DM APX07	



NOTES:
1. Score 1/4" Dummy Contraction Joints at 4'-0" intervals.
2. Construct 1/2" Bituminous Expansion Joints at 20'-0" (Max.) intervals.
3. Concrete shall be Sprayed with Liquid Curing Compound.

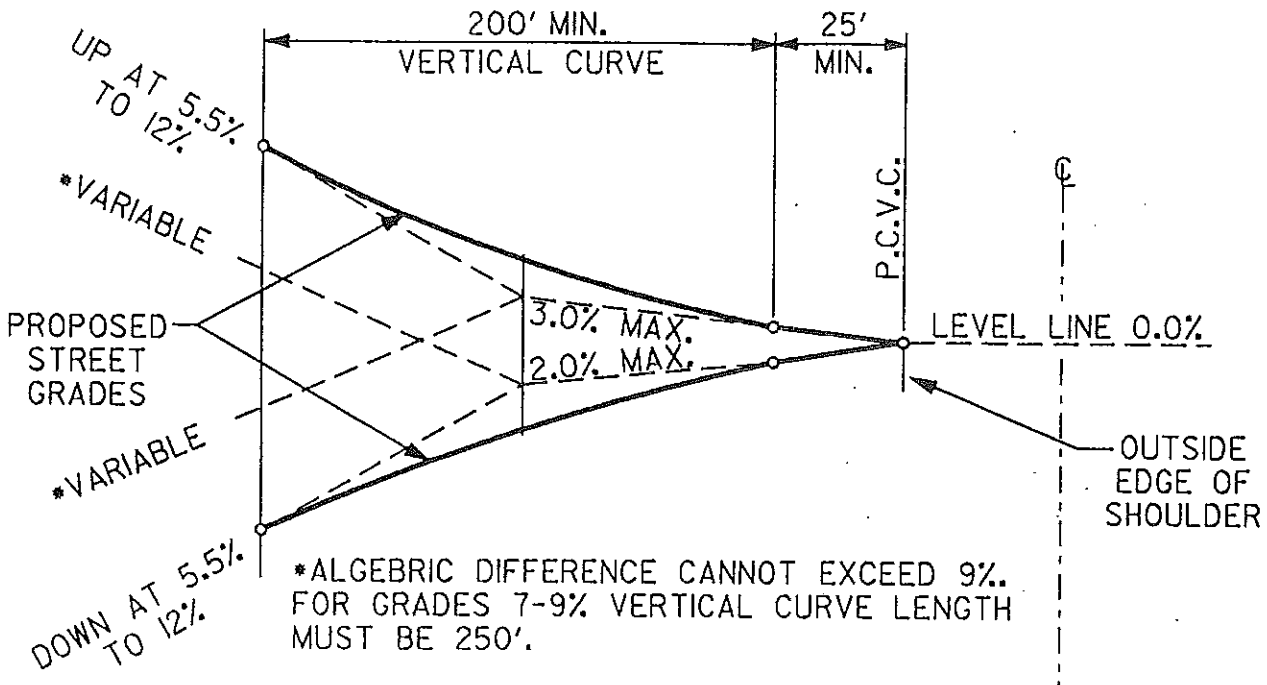
10/19/00
BMW
File: o:\bweddle\specifications\closed_driveway.dwg

Revisions:

TYPICAL DRIVEWAY / CURB DETAIL
AND TYPICAL SIDEWALK LOCATION
APPENDIX 7A

DETAIL NO.
APPX 07A
DATE: 10/19/00

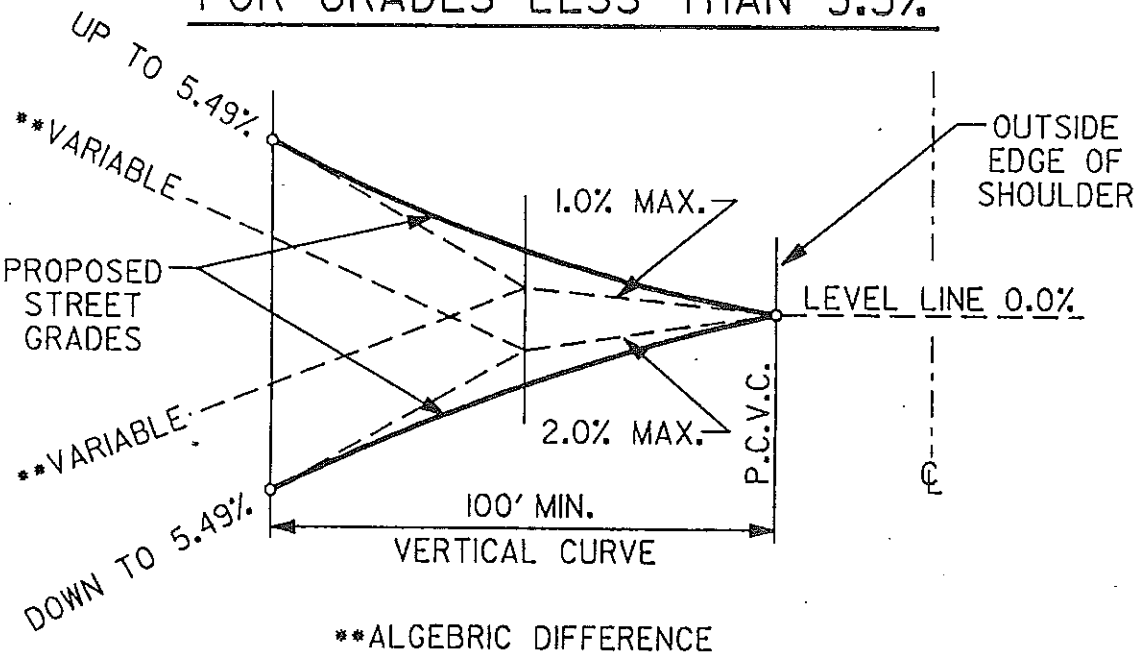
FOR GRADES OF 5.5% TO 12%



*ALGEBRIC DIFFERENCE CANNOT EXCEED 9%. FOR GRADES 7-9% VERTICAL CURVE LENGTH MUST BE 250'.

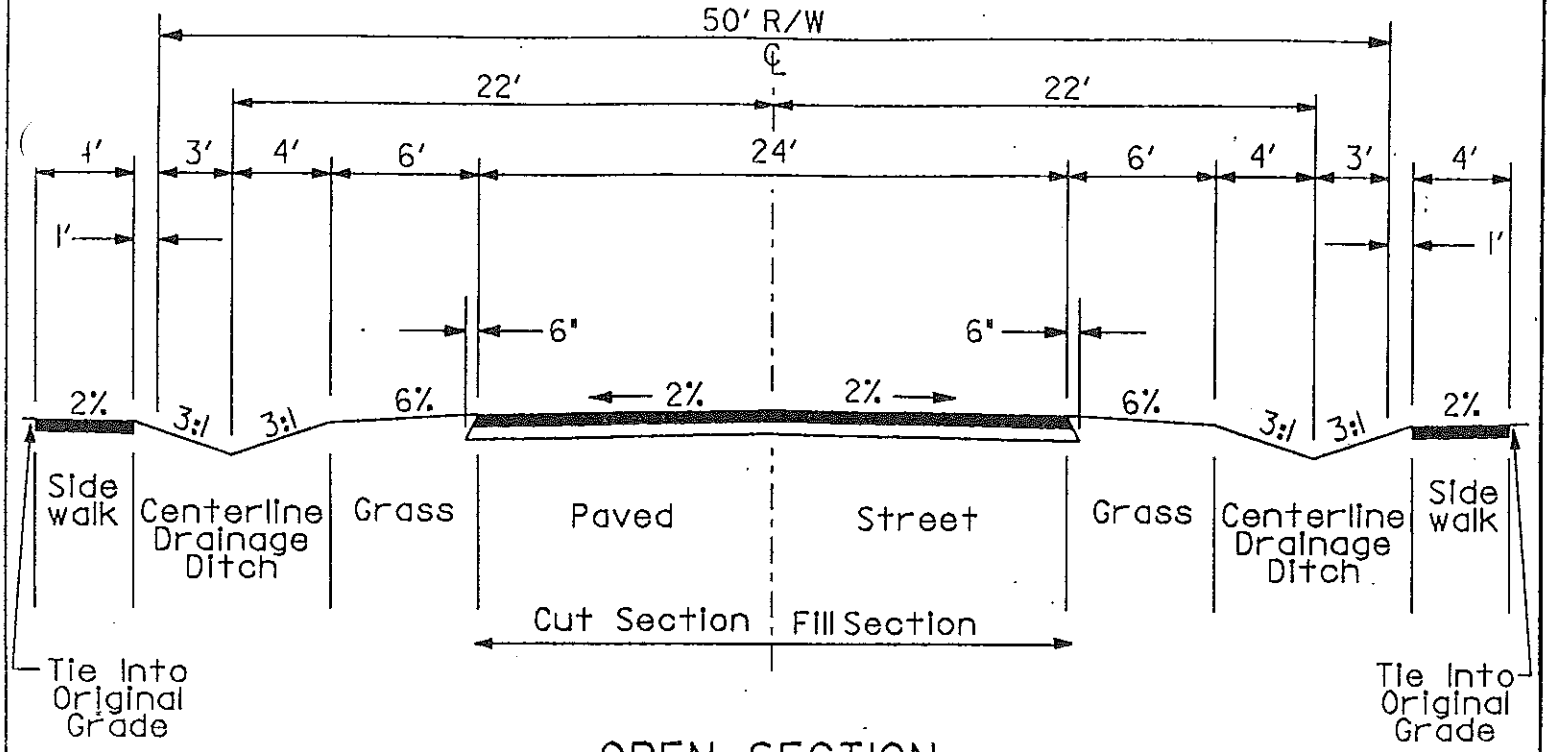
NOTE: DESIGN GRADES FOR STREETS WITHOUT CURB AND GUTTER SHALL BE AT CENTERLINE OF PROPOSED STREET.

FOR GRADES LESS THAN 5.5%

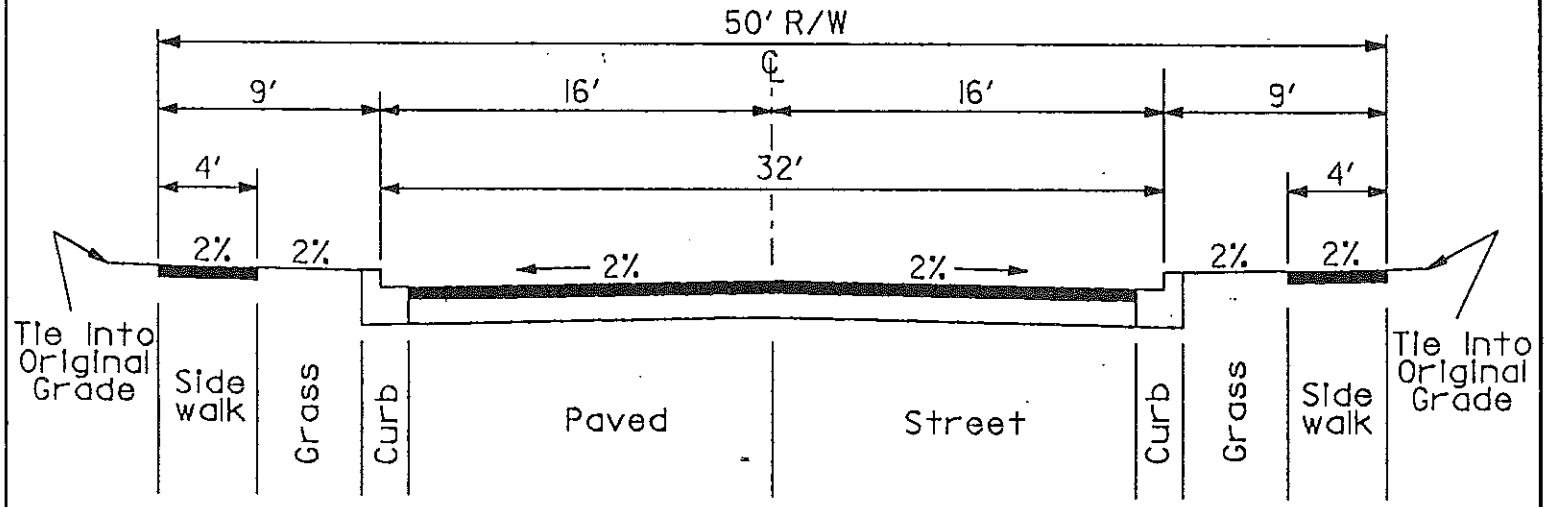


**ALGEBRIC DIFFERENCE CANNOT EXCEED 5%

REVISIONS		STANDARD LANDING REQUIREMENTS FOR LOCAL AND COLLECTOR STREETS	DETAIL NO. DM APX08
DATE	NOTE		
		APPENDIX 8	DATE: 1994

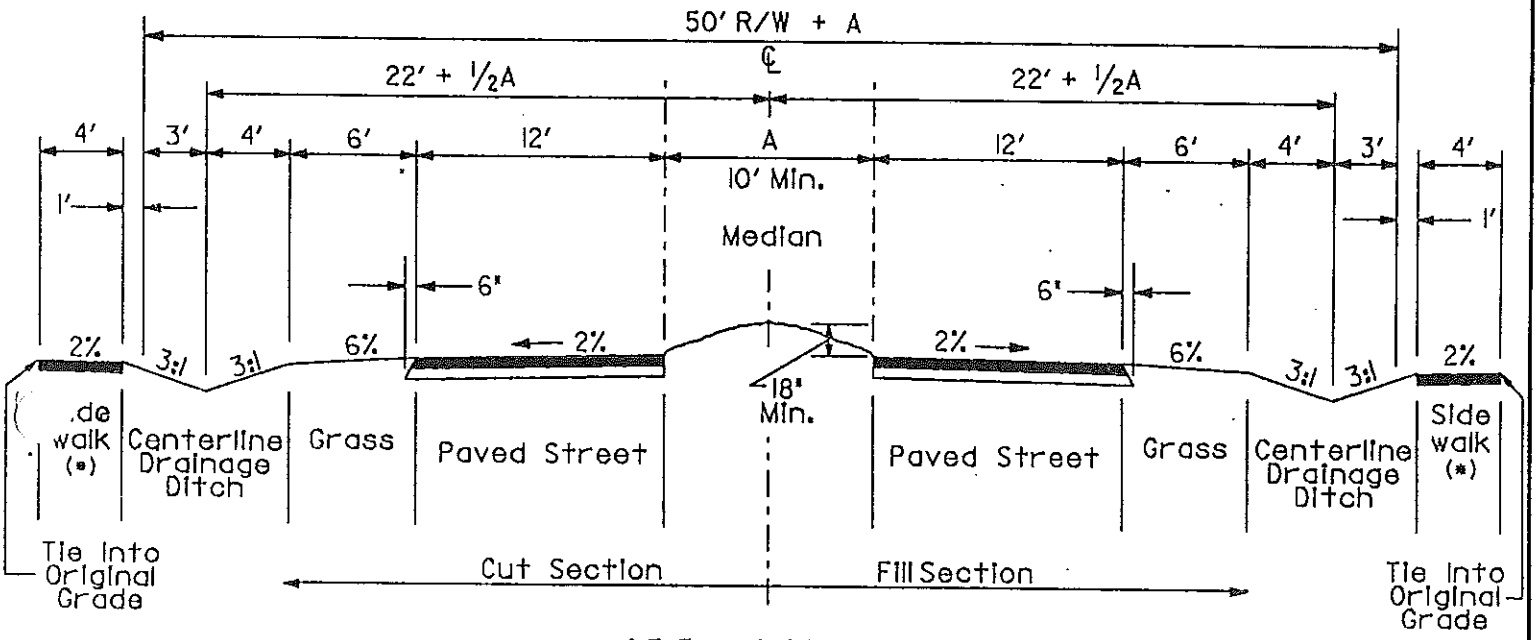


OPEN SECTION
STREET OPTION "G"



CLOSED SECTION
STREET OPTION "H"

REVISIONS		TYPICAL SECTIONS RESIDENTIAL SUB-COLLECTOR ROADS	DETAIL NO. DM APX09
DATE	NOTE		
		APPENDIX 9	DATE: 1994



OPEN SECTION
STREET OPTION "G"

(*) = Minimum Of One Sidewalk Is Required, Except In R-1 Density. Sidewalks On Both Sides Are Optional As Per The Authority Of The Planning Commission.

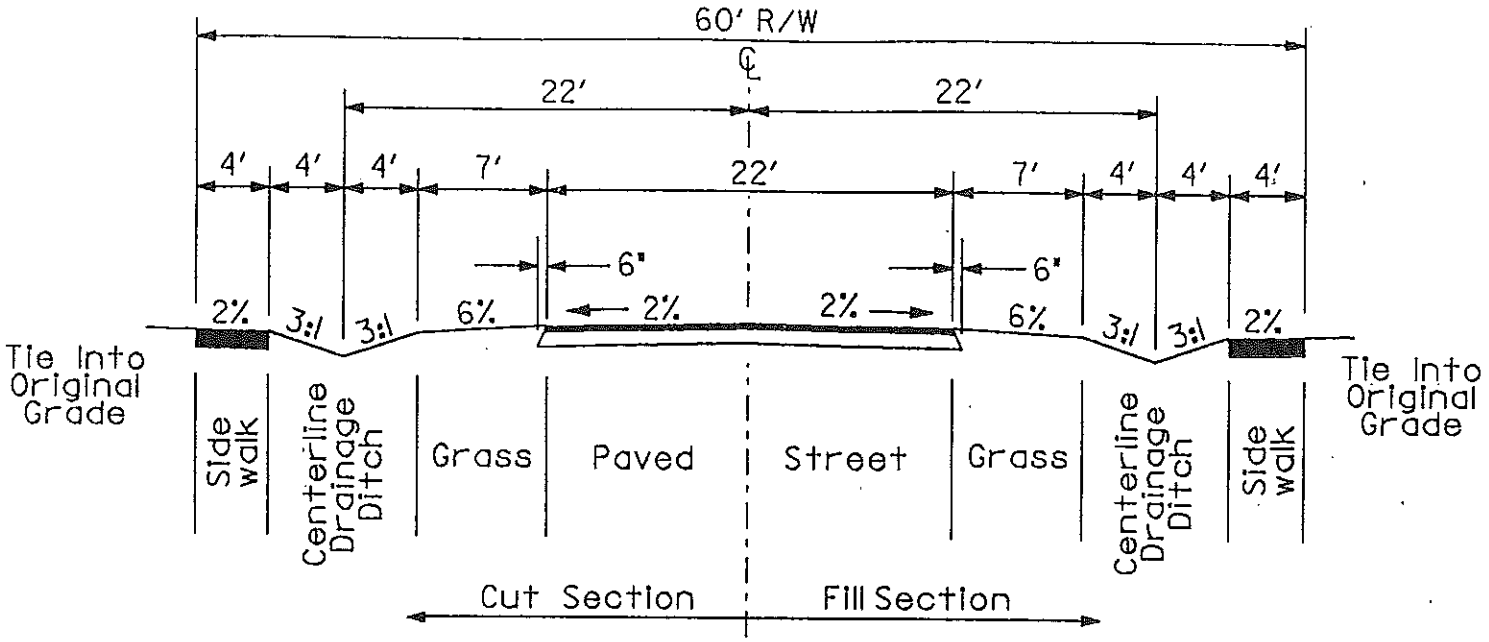
REVISIONS	
DATE	NOTE

TYPICAL SECTION
RESIDENTIAL
SUB-COLLECTOR ROADS
MEDIAN-DIVIDED OPTION

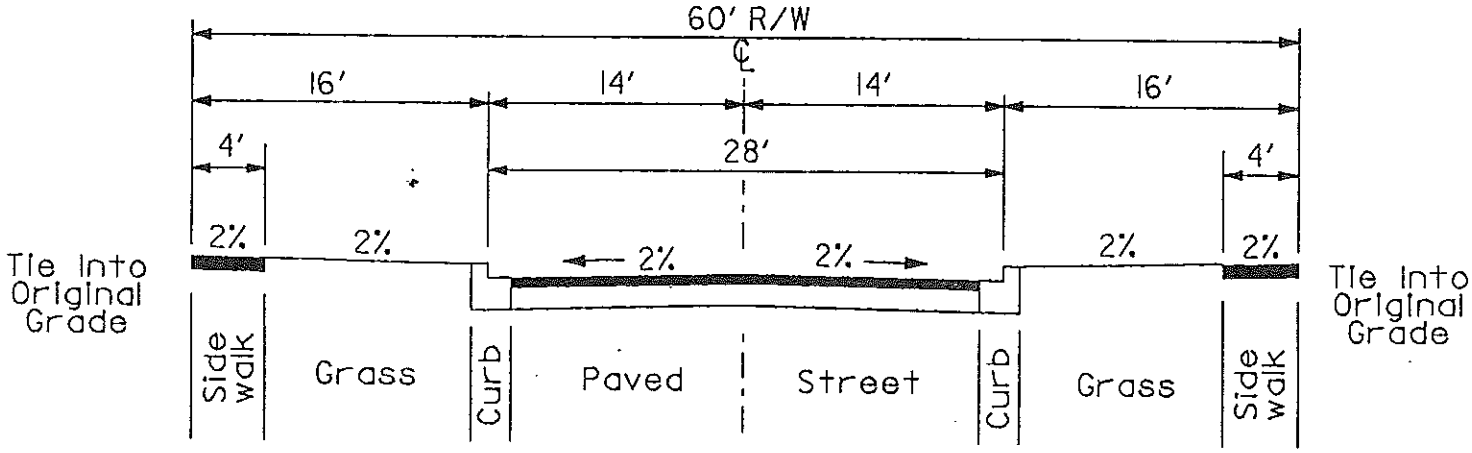
APPENDIX 10

DETAIL NO.
DM
APX10

DATE: 1994



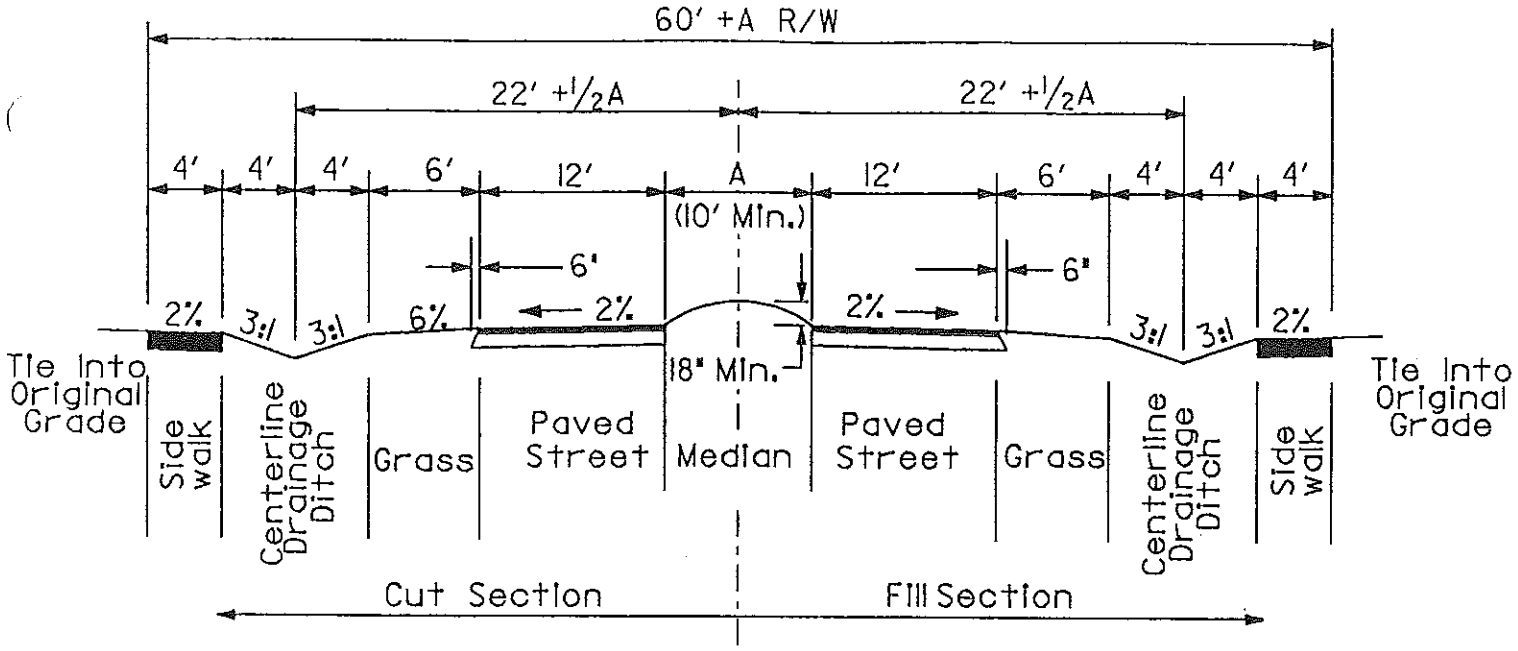
OPEN SECTION
STREET OPTION "I"



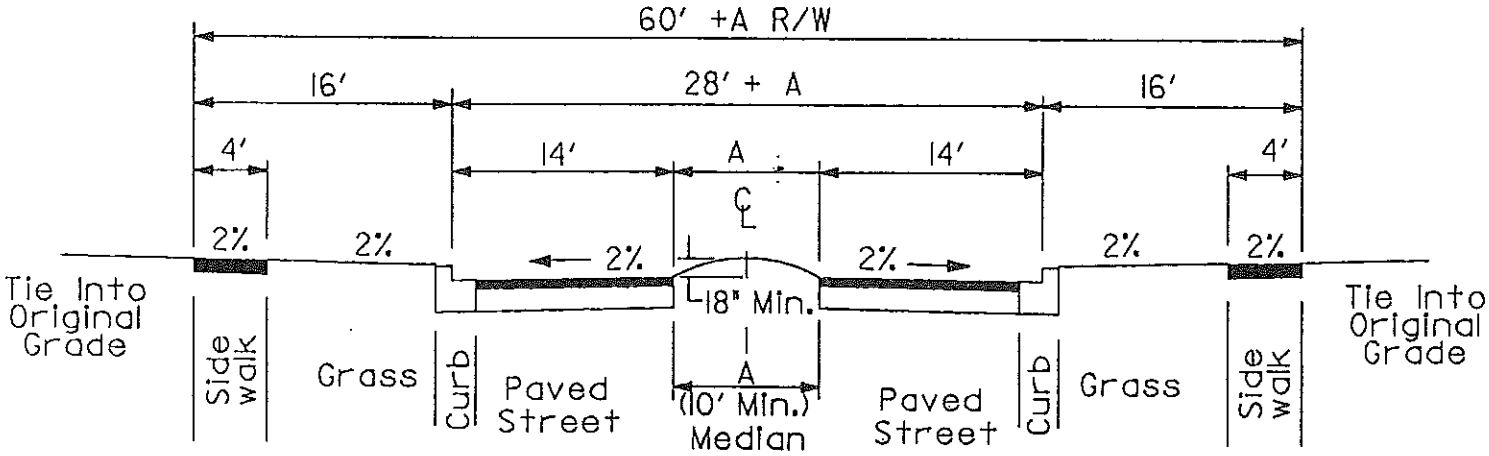
OPEN SECTION
STREET OPTION "J"

Note: Sidewalks Are Required On Both Sides Of Residential Collectors. A Path (System) May Be Provided In Lieu Of Sidewalks.

REVISIONS		TYPICAL SECTIONS RESIDENTIAL COLLECTOR ROADS	DETAIL NO. DM APXII
DATE	NOTE		
		APPENDIX II	DATE: 1994



OPEN SECTION
STREET OPTION "K"

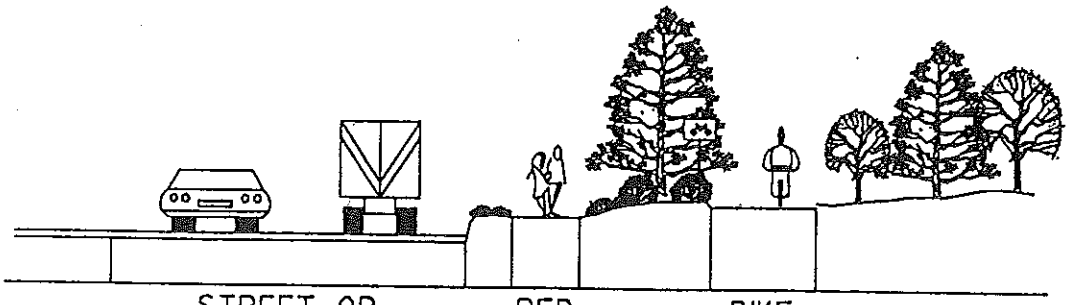


CLOSED SECTION
STREET OPTION "L"

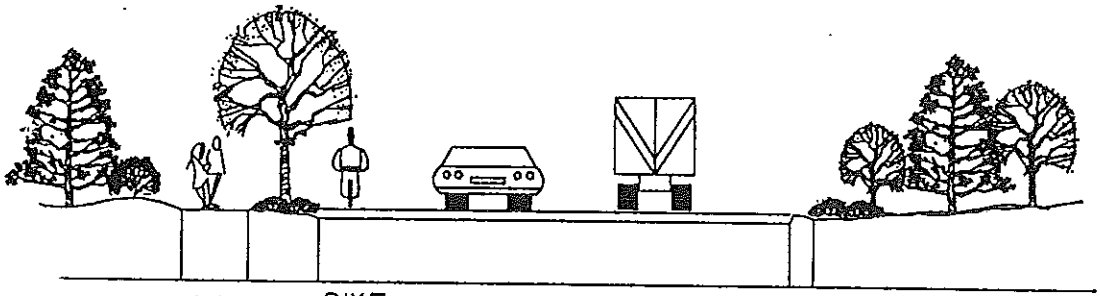
Note: Sidewalks Are Required On Both Sides Of Residential Collectors. A Path (System) May Be Provided In Lieu Of Sidewalks.

REVISIONS		TYPICAL SECTIONS RESIDENTIAL COLLECTOR ROADS MEDIAN - DIVIDED OPTION	DETAIL NO. DM APX12
DATE	NOTE		
		APPENDIX 12	DATE: 1994

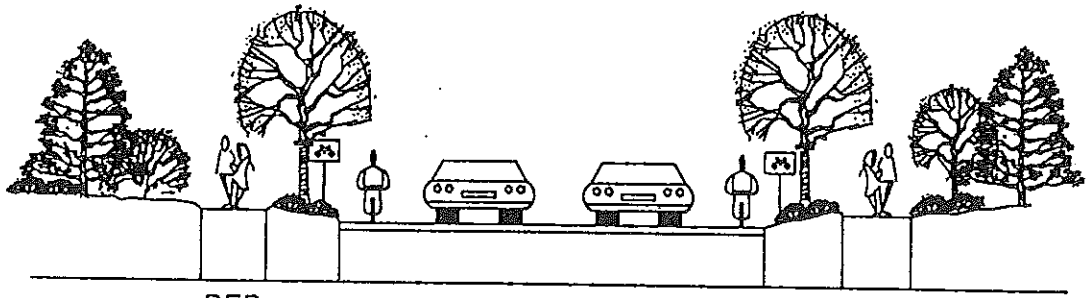
BIKE PATH
(CLASS I)



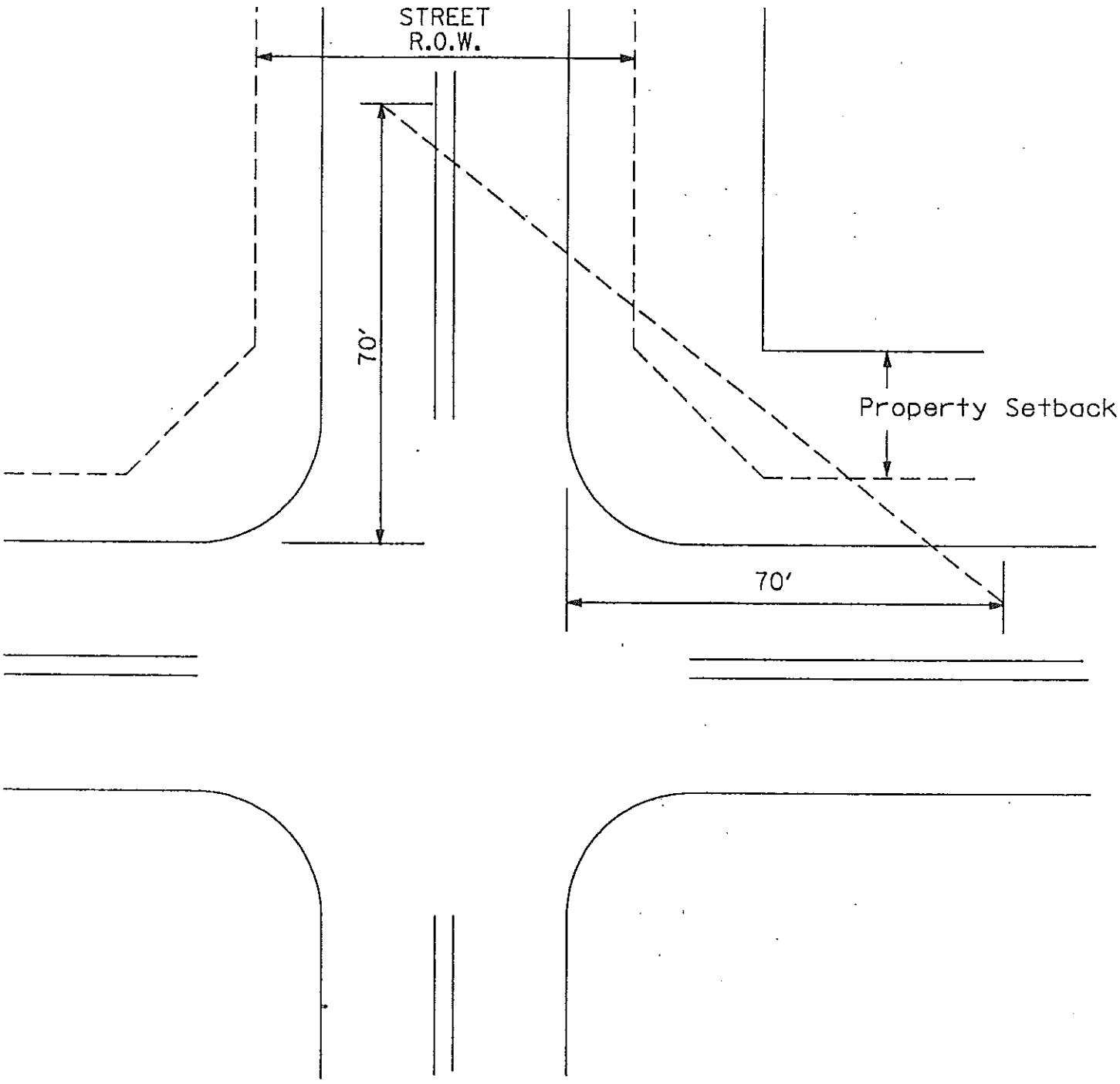
BIKE LANE
(CLASS II)



SHARED ROADWAY
(CLASS III)

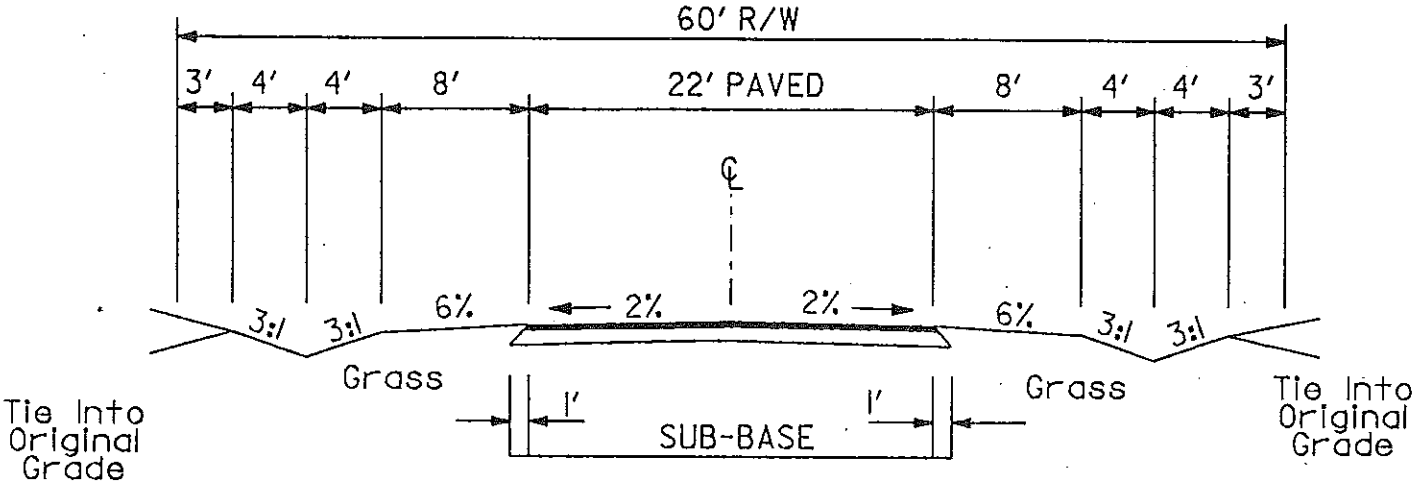


REVISIONS		BICYCLE FACILITY ALTERNATIVES	DETAIL NO. DM APX13
DATE	NOTE		
		APPENDIX 13	DATE: 1994



Example of Clear Sight Distance Intersections (Nominal)
(No natural or artificial obstructions should be located within the above triangle, in the zone 3-feet to 7-feet above street grade).

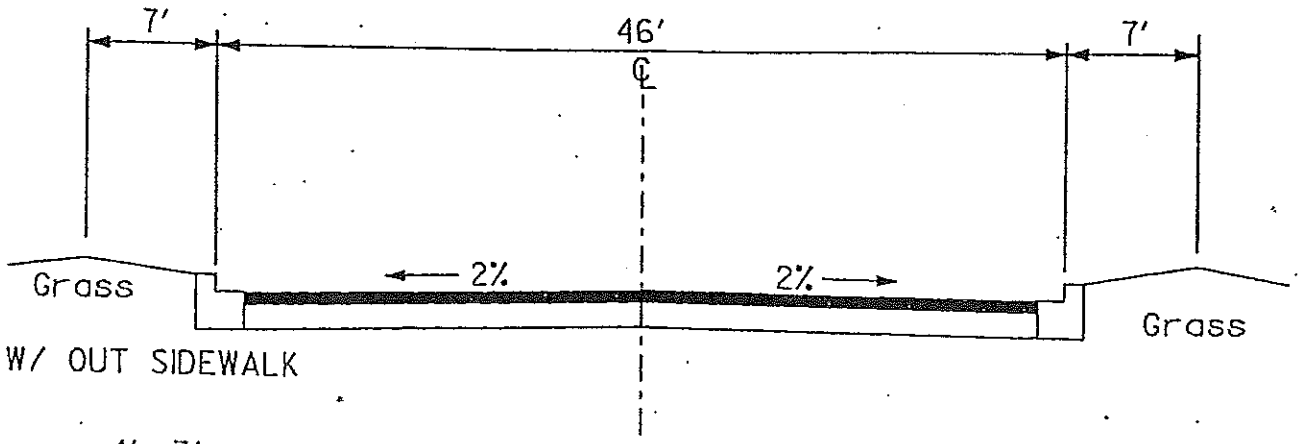
	REVISIONS			
	DATE	NOTE	CLEAR ZONE SIGHT DISTANCE DESIGN	DETAIL NO. DM APX14
			APPENDIX 14	DATE: 1994



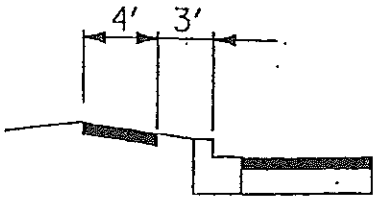
OPEN SECTION NON-RESIDENTIAL STREET OPTION "M"

Note: Sidewalks, When Required, Shall Be Placed Within The 8-Foot Shoulders.

REVISIONS		TYPICAL SECTION NON-RESIDENTIAL RURAL COLLECTOR ROAD	DETAIL NO, DM APX15
DATE	NOTE		
		APPENDIX 15	DATE: 1994



W/ OUT SIDEWALK



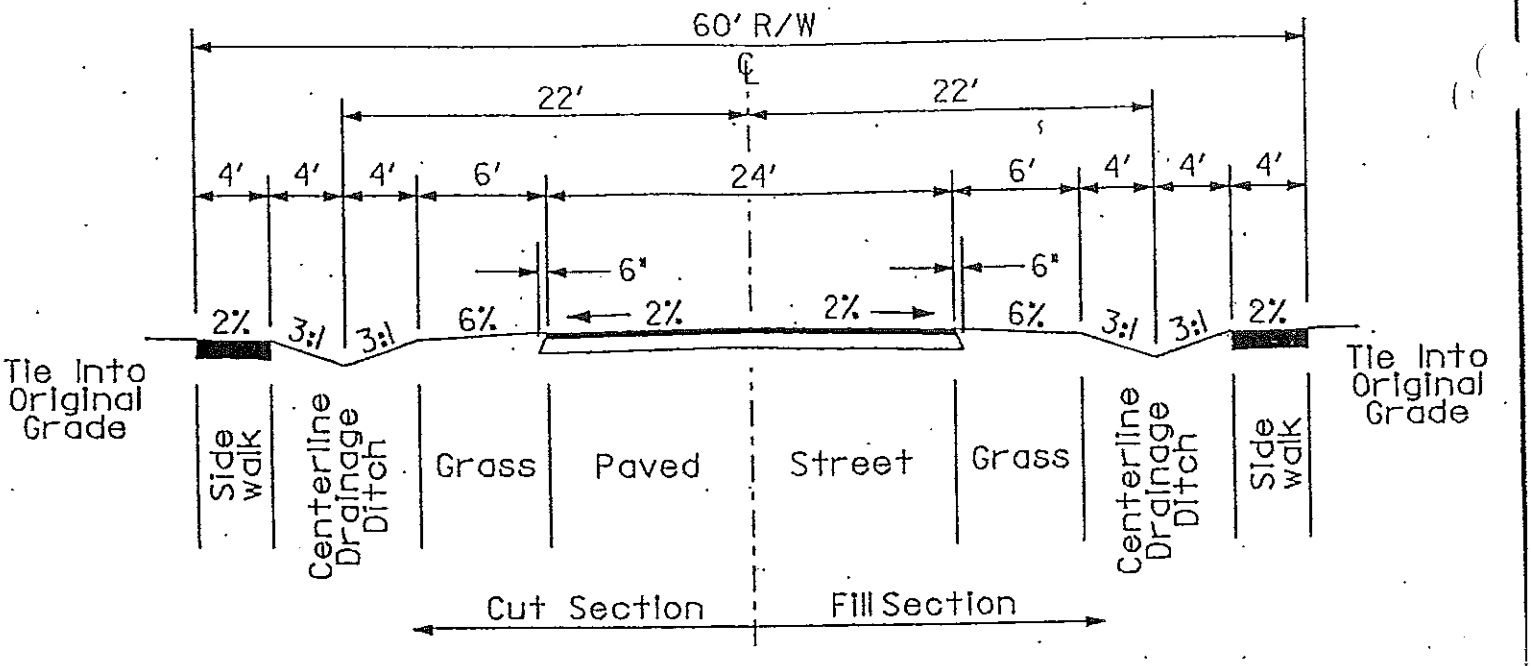
W/ SIDEWALK (TYP.)

CLOSED SECTION NON-RESIDENTIAL STREET OPTION "N"

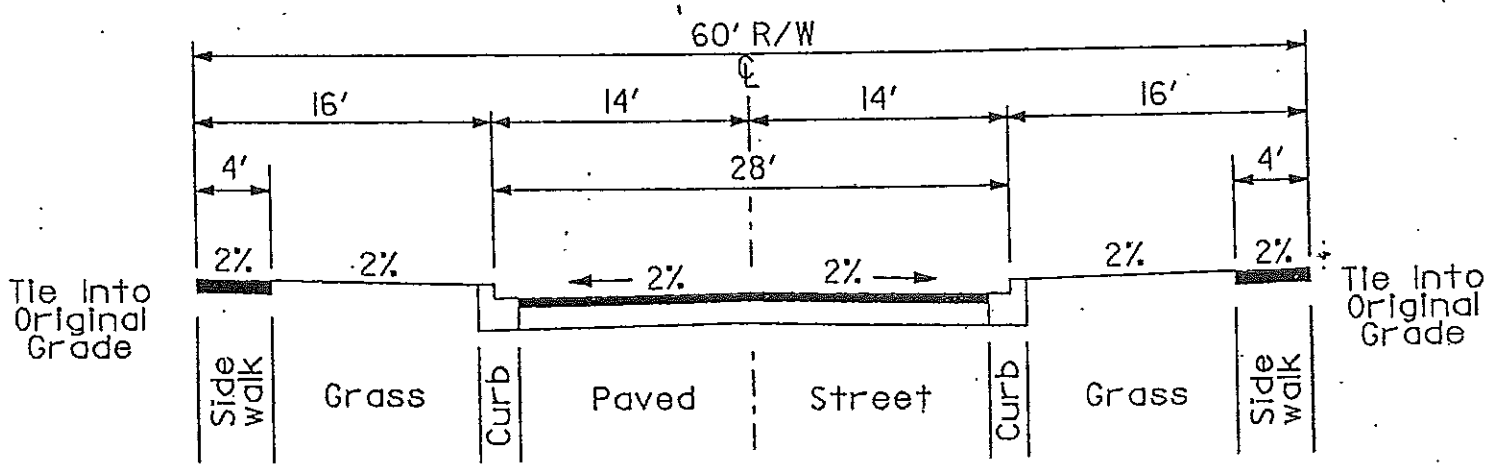
REVISIONS	
DATE	NOTE

TYPICAL SECTION
NON-RESIDENTIAL
COMMERCIAL COLLECTOR
ROAD

DETAIL NO.
DM
APX16



OPEN SECTION
STREET OPTION "O"



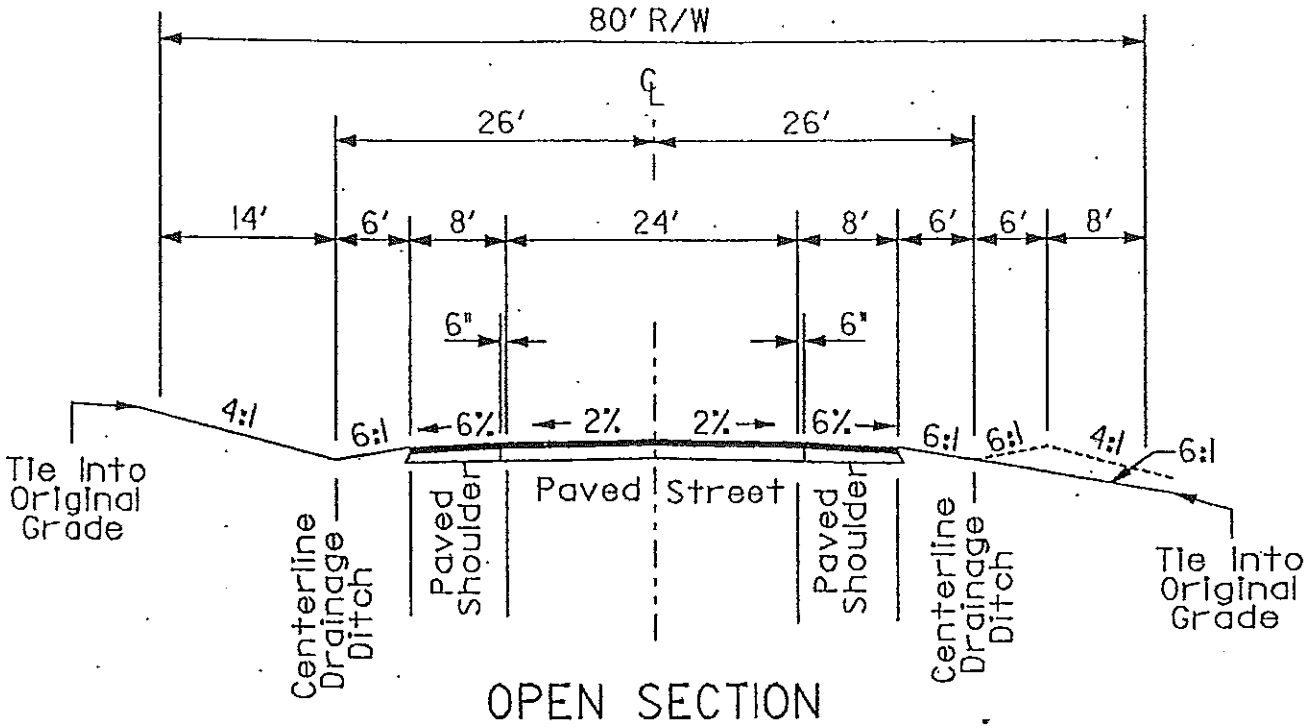
OPEN SECTION
STREET OPTION "P"

Note: Provisions Of Sidewalks To Be Determined By County.

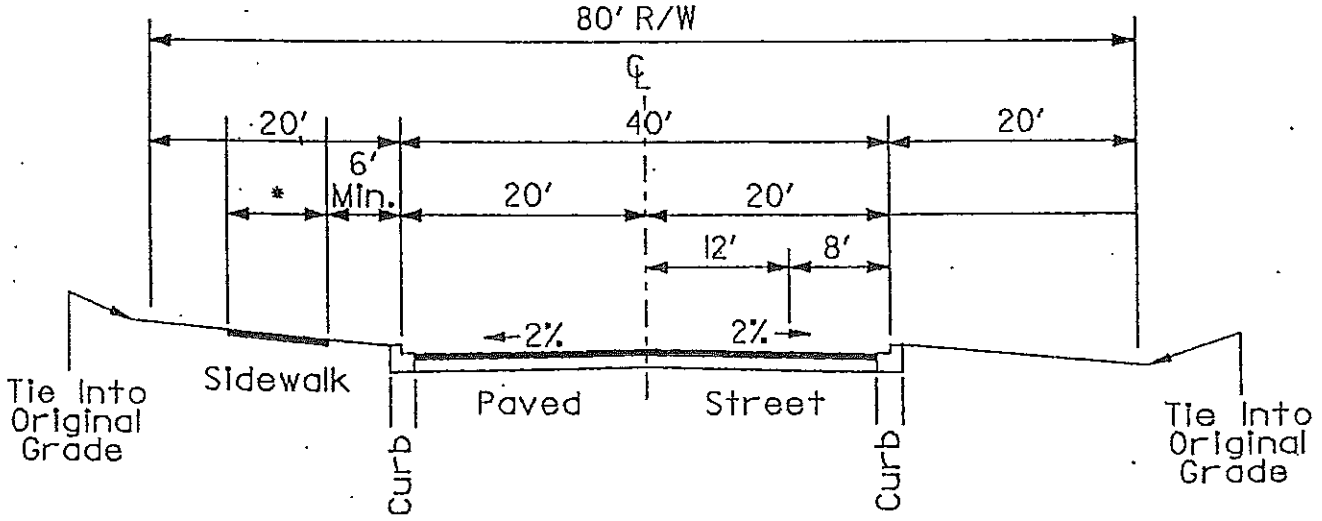
REVISIONS	
DATE	NOTE

TYPICAL SECTIONS
NON-RESIDENTIAL
INDUSTRIAL COLLECTOR
ROADS

DETAI
DM
APX17



OPEN SECTION
STREET OPTION "Q"

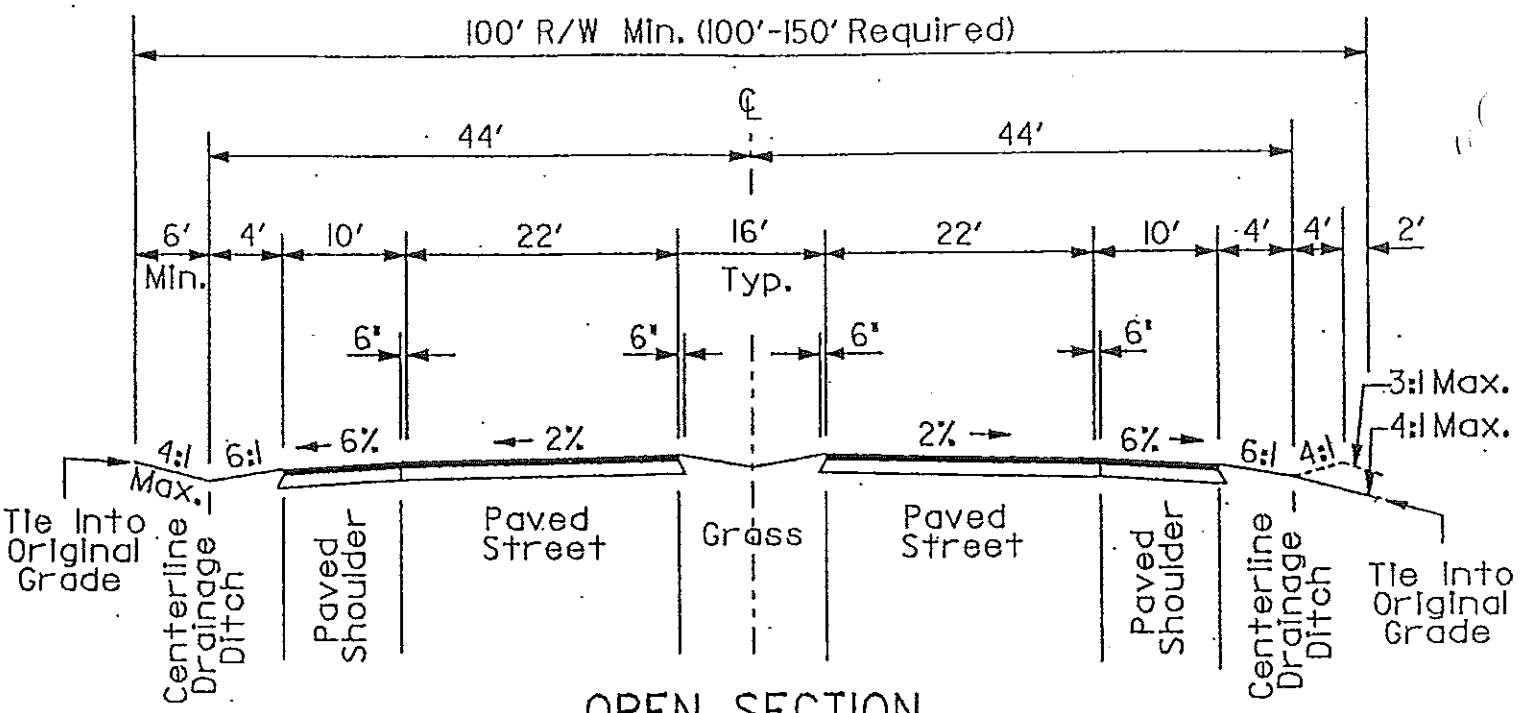


* Size Depends On Zoning

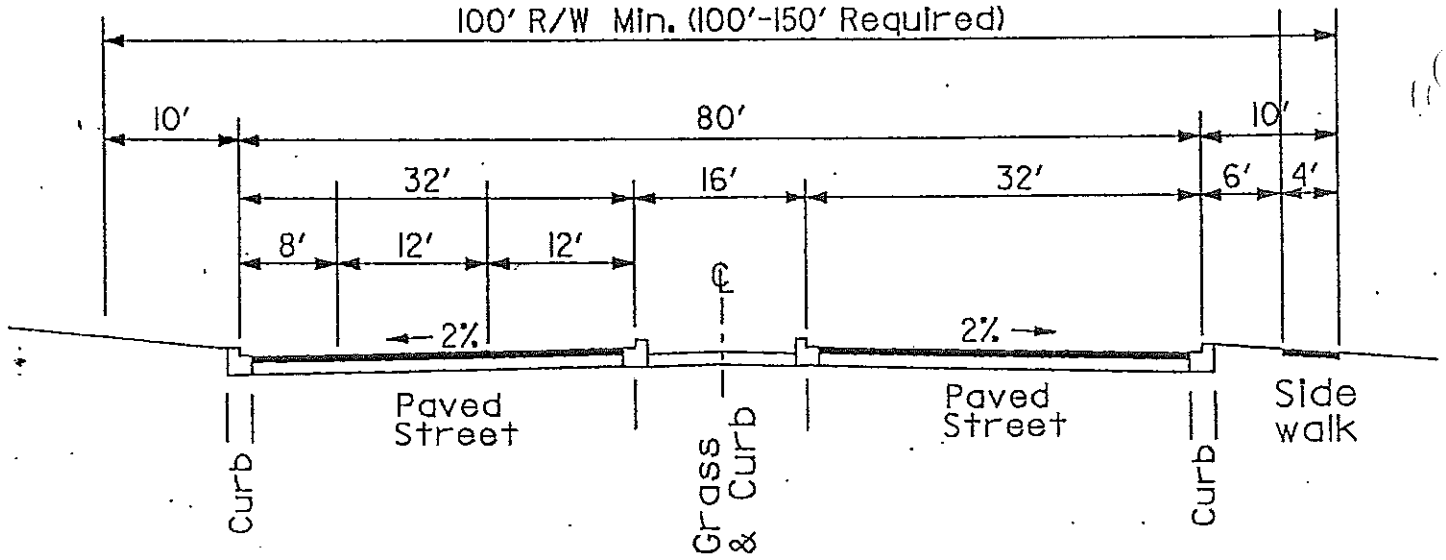
CLOSED SECTION
STREET OPTION "R"

Note: Provision Of Sidewalks To Be Determined By County.

REVISIONS		TYPICAL SECTIONS MINOR ARTERIAL ROADS	DETAIL NO. DM APX18
DATE	NOTE		



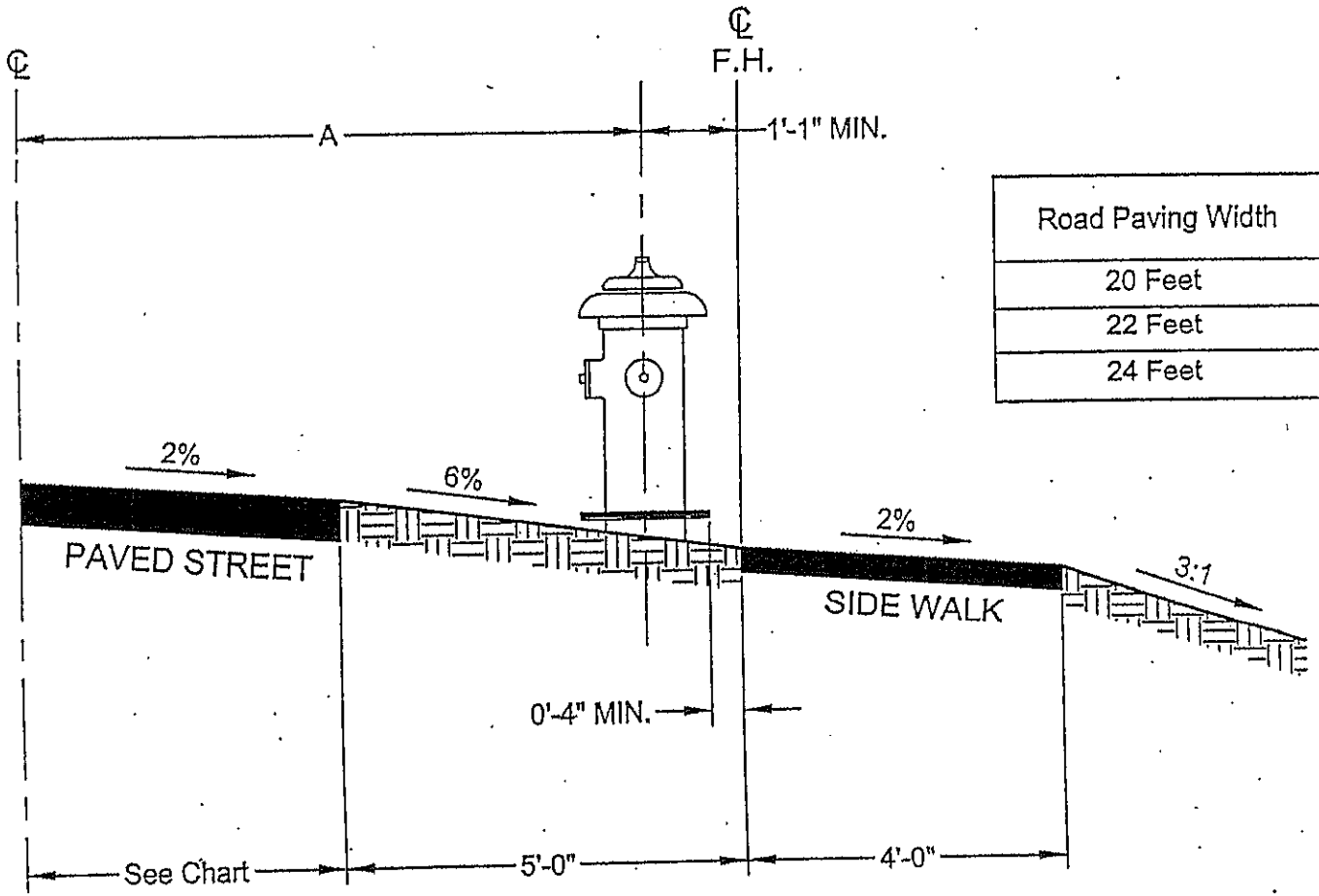
OPEN SECTION
STREET OPTION "S"



CLOSED SECTION
STREET OPTION "T"

Note: Provision Of Sidewalks To Be Determined By County.

REVISIONS		TYPICAL SECTIONS MAJOR ARTERIAL ROADS	DETAIL DM APX19
DATE	NOTE		



Road Paving Width	Minimum Distance 'A'
20 Feet	13 Feet
22 Feet	14 Feet
24 Feet	15 Feet

Scale: N.T.S.

Revisions	
Date	Note

FIRE HYDRANT SETTING IN OPEN SECTION STREETS WITH SIDEWALKS

Date: APX 20

Date: OCT 2000

APPENDIX 21

FREDERICK COUNTY, MARYLAND

Standard Pipe and Structure Schedules

STRUCTURE SCHEDULE				
STR. NO.	STRUCTURE TYPE	TOP ELEVATIONS		REMARKS
		Upper	Lower	

PIPE SCHEDULE				
SIZE	TYPE	CLASS/GAGE	LENGTH	REMARKS

APPENDIX 22

PERMISSIBLE FLOW VELOCITIES

Ditches and swales will be designed to restrict maximum permissible flow velocities for the ten-year frequency storm, and for various soil types, covers, and slopes as follows:

		PERMISSIBLE VELOCITY	
Cover	*Slope Range (percent)*	*Erosion Resistant Soils (fps)*	*Easily Eroded Soils (fps)*
Seeded Grasses	0 - 5	6	4
	5 - 10	5	3
	10	4	2
Sod	0 - 5	8	6
	5 - 10	7	5
	10	6	4
Permanent Sod Stabilization Mattings	Per Manufacturer Specs		
Bare Earth	0 - 5	5	3
	5	2	1
*Gabions:			
Twelve inches thick	-	10	10
Eighteen inches thick	-	15	15
Paved Channels	-	20	20
*Riprap:			
Minimum diameter=0.5 feet	-	6	4
Minimum diameter=1.0 feet	-	8	6
Minimum diameter=2.0 feet	-	12	10

(A) Velocities should be reduced by twenty-five (25) percent for a meandering channel with bends (radius one hundred (100) feet).

(B) Velocities exceeding five (5) fps can only be used where good cover and proper maintenance are assured.

(C) Erosion-resistant soils are defined by the soil erodability factor (k) in the universal soil loss equation with K 0.35. Easily eroded soils are defined by 0.35.

*May be used only when all other methods are shown to be infeasible.

APPENDIX 23

HYDRAULIC GRADIENT FOR STORM SEWERS

DESIGNED BY: _____ PROJECT NAME: _____ SHEET ___ OF ___

CHECKED BY: _____ SECTION or PHASE: _____ DATE: _____

Structure		___ Year Runoff				Pipe									Hydraulic Gradient	
From	To	ΣCA	t_c Time Conc. Min.	i_r rainfall Intes. In./Hr.	Q Cfs	Size In.	n Mann-ing's Coef.	S_o Slope %	S_f Slope %	V_f Vel. ft/sec.	L Length ft.	d_n Norm. Depth ft.	K_b	Description of Loss	Head Loss @ Str.	Elevation

APPENDIX 24

STORM SEWER DESIGN

DESIGNED BY: _____ PROJECT NAME: _____ SHEET ___ OF ___

CHECKED BY: _____ SECTION or PHASE: _____ DATE: _____

Structure		Contributing Area		___ Year Runoff						Pipe									Remarks
From	To	A Area Acres	Runoff Coef.	CA	ΣA	ΣCA	t_c Time Conc Min.	I_r rmfall Intes. In./Hr	Q cfs	Size In.	Type	n Manning's Coef.	S_o Slope % Min.	S_o Slope % Act.	L Length Ft.	V_o Vel. ft./sec.	Time in Pipe Min.	Capac Full Cfs	Note: Provide V act. At Outfall Structures

APPENDIX 25

INLET SPACING

DESIGNED BY: _____ PROJECT NAME: _____ SHEET ___ OF ___

CHECKED BY: _____ SECTION or PHASE: _____ DATE: _____

Inlet No.	Area Acres	C	CA	By-Pass CA	Total CA	T_c Min.	$I_2 i_r$ "/hr	Q_2 cfs	Inlet Type	Cross Slope	Chart No.	Street Grade	spread ft.	Pickup %	Bypass to CA	Inlet to No.	Remarks

APPENDIX 26

PROJECT: _____ DESIGNER: _____

DATE: _____

HYDROLOGIC AND CHANNEL INFORMATION

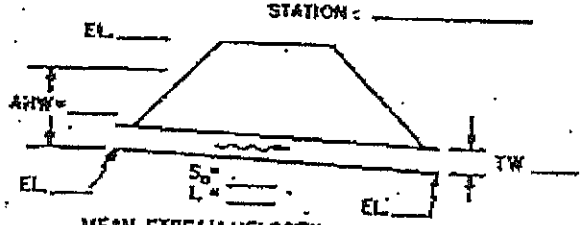
Q_1 = _____ TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{10}
Q_2 = CHECK DISCHARGE, SAY Q_{25} OR Q_{100})

SKETCH

STATION = _____

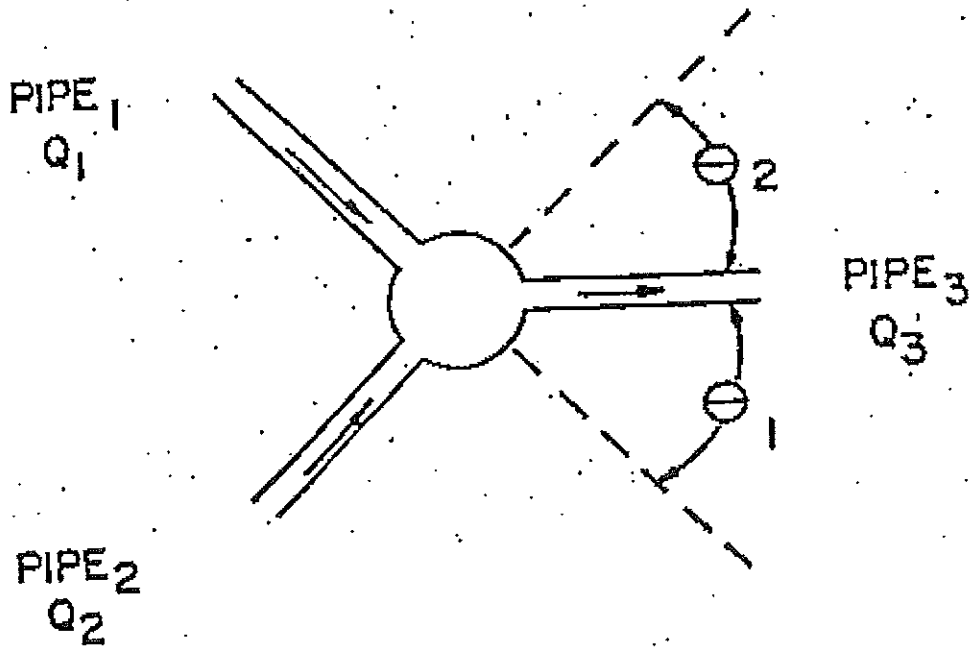


MEAN STREAM VELOCITY = _____

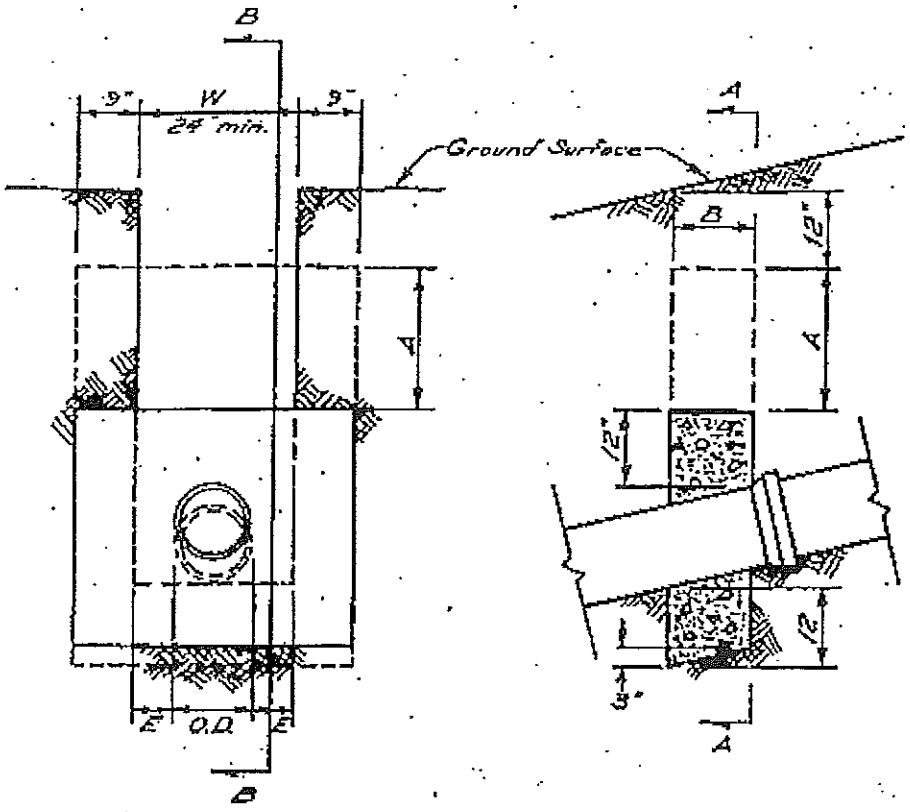
MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	#	SIZE	HEADWATER COMPUTATION										CONTROLLING H.W.	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL $HW = H + h_o - LS_o$											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				

SUMMARY & RECOMMENDATIONS:


PIPE 1
Q1
2
PIPE 3
Q3
1
PIPE 2
Q2

APPENDIX 28



Section "A-A" Section "B-B"

A = Extension of anchor to 12" below ground surface, when necessary to prevent washout of backfill by surface water.
B = 12" for pipes 10" or less, 18" for pipes 10" to 18" nominal dia.
W = O.D. + 2E

1. Provide no anchors on grades less than 20% unless noted.
2. Provide anchors 36' c/c to c/c on grades between 20% & 34%.
3. Provide anchors 24' c/c to c/c on grades between 34% & 50%.
4. Provide anchors 16' c/c to c/c on grades between 50% & 70%.
5. All anchors to be Md. S.H.A. mix no. 1 concrete, placed downgrade of bell, as shown above.

APPENDIX

K.C.H.			
Frederick County Division of Public Works	Revisions Date / Note	Concrete Anchors for Pipe installed on Grades 20% or More	Detail No.
			Date: 3-20-90